INDIAN COLLEGE OF RADIOLOGY AND IMAGING

ICRI GUIDELINES FOR IMAGING PROTOCOLS AND REPORTING CHECKLISTS IN ONCO IMAGING

ICRI SUB-SPECIALTY GROUP FOR ONCO IMAGING

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DR. ARVIND CHATURVEDI (SUB-SPECIALITY HEAD)

DR. RAMESH CHANDER (SUB-SPECIALTY CO-ORDINATOR)
Editorial

Radiology plays a central role in management of cancers. Radiologists associated with oncology centres have a responsibility beyond the routine. A casual reporting of imaging studies may leave certain key questions unanswered. And these are precisely the answers that the oncologist is seeking. Radiologists need to identify the key components of a report that are necessary to guide the most appropriate management strategy. Their opinion often makes a significant difference to the plan of management throughout the course of disease. To serve the best interests of a patient in an oncology setting radiologists need to go a little beyond a routine radiology report. In fact the report needs to be crafted to meet the specific needs in the given context. It is with this background that the Indian College of Radiology and Imaging (ICRI) and the Indian Radiological and Imaging Association (IRIA) conceptualised creating a document to frame Guidelines for standard Imaging Protocols and Reporting formats in cancers.

It is recognised that each cancer has its unique biological behavior and response pattern. To remain relevant in oncology practice radiologists need to know a few basics of oncology. They cannot solely depend on the clinical notes provided on request forms, or the lack of it. They need to proactively extract the information that is required for a sound radiology report. Such information is nearly always available from the patient or the case file. The key is to integrate radiology with the practice of oncology. It is imperative therefore for radiologists to acquire some basic concepts in oncology. It will enable them to optimally address and implement the most appropriate imaging protocols and reporting checklists.

We have attempted to consider these guidelines under the following heads:-

- Background information
- Imaging protocol
- Reporting checklist

However it needs to be emphasized that our practice changes over time as new evidence accumulates. These guidelines therefore are relevant at the present times and will need revisions as and when new evidence becomes available. An attempt has been made to make these guidelines realistic and practical in the Indian setting. Care has been taken to ensure that they remain relevant and practical across all facilities, from specialized tertiary care hospitals to small healthcare establishments. During the course of disease imaging studies are performed multiple times. Comparison with the previous study therefore becomes a relevant piece of information. It is so important for the treating team that they will revert to you if you have not done a comparison upfront. We have tried to emphasize that an initial baseline study and a follow up study therefore may have slightly different structures.

I hope you will find it useful to implement these guidelines in your practice. A taskforce of eminent nationwide radiologists has been instrumental in formulating them. I express my profound appreciation for each one of the contributing authors, who spent many precious hours
in the making of these guidelines. Your comments and feedback is very valuable to us. It will provide us useful inputs for future revisions.

Best wishes and stay safe.

Arvind Chaturvedi, MD
New Delhi
email: arvind.chaturvedi@gmail.com
Head, Onco Imaging, ICRI
President, Society of Oncologic Imaging India
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BRAIN TUMORS

Abhishek Mahajan (Mumbai)
Brain tumors:

Background information:

- Tumours of the brain and the CNS comprise only 1-2% of the overall cancer incidence.
- Brain tumours are the commonest solid tumour in children.
- The most common histological type of primary CNS cancer is glioma.
- Glioblastomas is the most common primary brain cancer of glial origin with a very poor survival. Despite aggressive surgery and adjuvant treatment GBM is fatal within 2 years.
- The most common histological types in paediatric age group include astrocytoma, medulloblastoma, germ-cell tumours, brainstem gliomas, and ependymomas.
- The recent WHO classifications are based on genetic alterations and categorises gliomas based on distinct genetic mutations that have been useful in differentiating tumour types, prognoses, and treatment responses.
  - Mutations in IDH1 and IDH2 genes are commonly found in low grade gliomas.
  - Loss of both IDH genes combined with loss of chromosome arms 1p and 19q indicates the tumour is an oligodendroglioma.
  - Loss of TP53 and ATRX characterizes astrocytomas.
  - Genes EFG, TERT, and PTEN, are commonly altered in gliomas and are useful in differentiating tumour grade and biology.

Imaging protocol:

Initial:

- MR imaging is the most accurate investigation for diagnosing brain tumour.
- Multiparametric imaging including diffusion imaging, perfusion imaging and MR spectroscopy must be included in the imaging protocol both at presentation and at follow-up.
- DTI and functional imaging studies are indicated in patients undergoing surgery with tumour close to eloquent cortex.
- FDG-PET-CECT/MR is the most accurate investigation in suspected CNS lymphoma.
- MRI protocol should include the following: 3-dimensional (3-D) T1, axial fluid-attenuated inversion recovery (FLAIR), axial diffusion-weighted imaging (DWI), axial gadolinium contrast-enhanced T2, and 3-D gadolinium contrast-enhanced T1, performed on a minimum 1.5 tesla MR system.1
- If 3-D sequences cannot be performed due to time constraints or technical limitations, 2-D sequences can be substituted.
- Susceptibility weighted imaging is superior to gradient imaging in detecting blood products, tumoral vascularity, calcification, radiation-induced micro haemorrhage.
- There is emerging role of FLT PET MR in post-treatment imaging of gliomas. It helps differentiate tumour recurrence from radiation necrosis.

MR tips:

- MR imaging is aimed at:
  - Initial differential diagnosis with the distinction between newly diagnosed brain tumours and non-neoplastic lesions, ischemia, extra-axial neoplasm and metastasis;
  - Preoperative planning, estimating the tumour grade, guiding the biopsy, resection, local ablative therapy
  - Therapeutic follow-up; the monitoring of disease progression and therapeutic response, including the differentiation of recurrent tumour from delayed radiation necrosis.
• High signal intensity on T2/ FLAIR imaging seen in peritumoral edema (vasogenic and infiltrative), non enhancing tumour, white matter injury, gliosis
• Non-enhancing lesions may represent low-grade gliomas (LGGs), viral encephalitis and developmental anomalies, such as focal cortical dysplasia.
• The degree and heterogeneity of contrast enhancement, oedema ± mass effect and necrosis/cyst formation is related to higher tumour grade
• Oedema and multi focality are poor prognostic indicators in high-grade gliomas, while non-contrast enhancing tumour are associated with longer survival
• On DWI imaging, reduced (high signal intensity) in highly cellular tumour or regions of tumour with increased cellularity and in cytotoxic edema or postoperative injury
• On MR spectroscopy, tumour spectra include elevated Cho, decreased NAA; higher grade glioma show higher Cho/NAA and Cho/Cr ratios than lower grade gliomas. Lipid and lactate peaks are not normal and represent necrosis and hypoxia, respectively
• On perfusion MR,
  o Perfusion curves in gliomas should return close to baseline, perfusion curves in tumours with leaky capillaries (metastases, choroid plexus tumours, extra-axial tumours) generally do not return to baseline.
  o Higher blood volume suggests higher grade or progressive/recurrent tumour.
  o High permeability suggests higher grade and within a tumour may identify regions of higher grade as well or progressive/recurrent tumour.
• DTI demonstrates displacement or infiltration of white matter fibber tracts for surgical planning
• Task-based fMRI is used for preoperative functional localization
• Imaging features most commonly reported to be shared by tumour recurrence and treatment necrosis include (1) origin near the primary tumour site, (2) contrast-agent enhancement, (3) vasogenic edema, (4) growth over time, and (5) mass effect.
• Features such as conversion from a non enhancing to an enhancing lesion after radiation therapy, lesions appearing distant from the primary resection site, corpus-callosum or peri-ventricular white matter involvement and “Swiss cheese” or “soap bubble” shape pattern shave been suggested to favour treatment necrosis over tumour recurrence.

Synoptic Reporting in Brain tumor (Glioma):

MRI OF THE BRAIN WITH IV CONTRAST

CLINICAL INDICATION: brain tumor

Tumor Type & Mutations: [tumor type]

Surgical history: [surgical history]

Radiation history: [radiation history]

Relevant Medications: [medications]

TECHNIQUE: Detailed description of technique tailored to institution/examination.

COMPARISON: [last comparison date]

FINDINGS:

TUMOR:

Location: [tumor location]
FLAIR:
[change in FLAIR at primary tumor site]
[presence of new sites of FLAIR abnormality]

Enhancement:
[change in enhancement at primary tumor site]
[presence of new sites of enhancement]

Perfusion: [perfusion findings, if performed]
Diffusion: [diffusion findings]

Post treatment changes: [brief description of other postsurgical findings]

OTHER:
[presence of acute infarction]
[presence of new/significant hemorrhage]
[hydrocephalus]
[herniation]
[presence of new/unexpected fluid collection]

IMPRESSION:

1. [Brain tumor] status post treatment. [brain tumor surveillance score]

2. [Other relevant findings]

<table>
<thead>
<tr>
<th>Score</th>
<th>Title</th>
<th>Sub score</th>
<th>Description</th>
<th>Associated Management Recommendation</th>
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<tr>
<td>0</td>
<td>Not scored</td>
<td></td>
<td>New baseline, incomplete study, or otherwise unable to categorize</td>
<td>Continued follow-up, no change</td>
</tr>
<tr>
<td>1</td>
<td>Imaging improvement</td>
<td>1a: Improvement</td>
<td>Improvement in imaging findings suspected to reflect decreasing tumour burden and/or improving treatment effect</td>
<td>Continued follow-up, no change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1b: Medication effect</td>
<td>Improvement in imaging findings potentially due to medication effect such as increasing steroids or initiating Avastin</td>
<td>Continued follow-up, no change</td>
</tr>
<tr>
<td>2</td>
<td>No change</td>
<td></td>
<td>No appreciable change from the prior</td>
<td>Continued follow-up, no change</td>
</tr>
<tr>
<td>3</td>
<td>Imaging worsening</td>
<td>3a: Favours treatment effect</td>
<td>Worsening imaging findings favoured to represent treatment effects, including radiation therapy and medications</td>
<td>Decreased time interval of follow-up</td>
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<tr>
<td></td>
<td></td>
<td>3b: Indeterminate</td>
<td>Worsening imaging findings favoured to represent an indeterminate mix of treatment effect and tumour worsening</td>
<td>Decreased time interval of follow-up</td>
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<tr>
<td></td>
<td></td>
<td>3c: Favour tumour progression</td>
<td>Worsening imaging findings favoured to represent increasing burden of tumour</td>
<td>Consider change in management vs. decreased time interval of follow-up</td>
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<tr>
<td>4</td>
<td>Imaging worsening</td>
<td></td>
<td>Worsening of imaging findings highly suspicious for tumour progression</td>
<td>Consider change in management</td>
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Note: post-operative imaging must be performed using MR within 48 hrs of surgery.
Definitions:

Pseudo-progression: transient increases in apparent tumour size and enhancement are seen during and shortly after aggressive chemo-radiotherapy regimens: commonly seen in tumours with favourable MGMT

Pseudo-regression: decreased enhancement without actual tumour regression: this seen with steroid treatment and anti-angiogenic therapies
HEAD AND NECK

Version v1.2020

Supreeta Arya (Mumbai)

Diva Shah (Ahmadabad)

Ankush Jajodia (Delhi)

Saugata Sen (Kolkata)
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      III. Larynx & Hypopharynx
      IV. Oral Cavity (all sub sites)
      V. Parotid gland
      VI. Maxillary Sinus
      VII. Nasal cavity & Ethmoid sinus
      VIII. Thyroid

   2. Reporting checklist for Nodal status

   3. Impression

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   III. Post treatment Oral cavity (all sub sites)
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   V. Post treatment Nodal site

Key Points
References
Part I

Background information

- Head and neck cancers in India differ from those in the Western countries in terms of etiology, age, disease site and molecular biology.
- Head and neck cancers account for 30% of cancers in India and form one fourth of male cancers and one tenth of female cancers in India.
- About 60% head and neck cancers present at advanced stage and combined with factors like poverty, lack of access to health care and inadequate treatment infrastructure, become a major challenge for management.
- The commonest of all head and cancers are oral cancers and 90% of these are seen in lower income groups.
- Major risk factors for oral cancers include use of tobacco, areca nut, and alcohol with a diet lacking in antioxidants. Other factors are chronic trauma from a sharp tooth/denture and a genetic susceptibility.
- Nasopharyngeal cancers have an etiology arising out of genetic susceptibility combined with environmental factors, including consumption of nitrosamines in dry salted fish and chronic nasal infections with Epstein-Barr virus.
- Oropharyngeal squamous cell carcinoma (OPSCC) have two types of etiology; one related with alcohol and tobacco use and another less aggressive variety related to human papilloma virus (HPV) infection. HPV positive OPSCC have improved prognosis in terms of overall survival after primary radiotherapy, or primary surgery with or without radiotherapy despite higher stage at presentation. This is the reason for a separate classification of T & N category in HPV +ve OPSCC in the AJCC 8th edition TNM staging system, that is distinctly different from that of HPV -ve OPSCC & hypopharyngeal cancers.
- The AJCC 8th edition of TNM staging has other significant changes as compared to the 7th edition such as 1) Modified classification for T and N category of nasopharyngeal cancers (NPC) and thyroid cancers 2) Change in T & N category for oral cavity cancers 3) For all sites there are separate classifications for clinical and pathological neck nodes; extra nodal extension (ENE) factor was added in the clinical nodal classification 4) a new classification for cervical nodal metastases from unknown primary 5) a new classification and chapter for skin squamous cell carcinoma.
- Radiologists have an important role in the correct staging and sometimes diagnosis of these cancers that can render help in optimal management.
- The document below describes the choice of imaging methods in the primary staging and post therapy staging of each cancer, CT & MRI imaging protocols, and reporting checklists for each head and neck cancer (pre and post therapy).

Part II

Imaging Methods in Oncology: Desirable & Minimal (Pretherapy & Post therapy)

Cross sectional imaging with CT and MRI form the cornerstone of AJCC 8th edition TNM staging. Stage I and stage II (T1 T2 N0) cancers need T & N staging while stage III and stage IV need M staging too, i.e. metastatic workup. Table 2 shows the optimal imaging method for loco regional staging of each head and neck region (called “Desirable”) and the alternate available method often used in a resource constrained setting (called “Minimal/ Essential” which though may not provide all required information).
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<td>A. Primary setting using puffed cheek method -a close second alternative. Preferred method in gingivo-buccal and RMT cancers where bone erosion is critical</td>
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<td>disease &amp; bulky nodal disease</td>
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Imaging protocols for pretherapy & post-therapy evaluation in head & neck cancers

**CECT HEAD & NECK**

**Topogram** - Supine head to toe direction.

**Coverage** - Cover from above base skull down to aortic arch. Hands should be by the side of patient; voluntary shoulder pull-down as much as possible.

**Quiet breathing; refrain from coughing or swallowing**

**Scan Type** - Helical

**KV/MAs/Rotation Time** - 120KV/200MAs/0.8-1sec (Depends on scanner slice)

**Pitch** 0.8 to 1.5

**Display Field of view** - 25 cm, 16-20 cm for larynx

**IV contrast (Nonionic iodinated)** with Iodine concentration - 300/350 mg/mL.

Inject 80 ml with flow rate 2.5 to 3.5 ml/sec; scan delay 40 seconds

**Slice thickness** - Acquire scans with 2.5 or 5 mm slice thickness; preferably retro reconstruct at 0.625/0.75 mm or 1.25 mm respectively.

**Scan plane** - For larynx, scan plane should be parallel to hyoid bone for an optimal study.

Dental amalgam can seriously degrade image quality in patients with tumors of the oral cavity. This can be corrected by scanning with a tilted CT gantry or with an open mouth.

**Algorithms** - acquire both bone and soft tissue algorithms (study bone in bone algorithm images*)

*Bone algorithm sequences particularly useful for nasopharynx, oral cavity and larynx-hypopharynx to study base skull, mandible and laryngeal cartilages respectively.

*It is good to study multiplanar reformations; particularly a) coronal reformations for perineural spread and skull base and b) oblique sagittal and coronal reformations for mandibular evaluation and to see inferior alveolar canal in entirety

**Special Maneuvers**

Puffed cheek technique for oral cavity lesions, occasionally modified valsalva for Nasopharynx, e-phonation for larynx.
MRI HEAD & NECK

Magnet strength – 1.5 T or 3T

Coil – Head and neck coil – particularly for lesions near the skull base; and a neck coil can be used for lesions lower in the neck. Special superficial coil – for small laryngeal lesions

Position: Supine head to toe direction.

Coverage: From above skull base down to root of neck / aortic arch

Quiet breathing and ask patient to avoid coughing/swallowing

Field of view - 20-25cm; 20 cm for larynx; 25-30 cm for Diffusion weighted imaging

Matrix 256x 256

Slice thickness - 4mm with 0-1mm inter slice gap; 3 mm with 0mm inter slice gap for small oral tongue / base tongue/ palatal / laryngeal lesions

Contrast- Post contrast study performed after injection of 0.1 mmol/kg of gadolinium based contrast.

Sequences

| Coronal STIR (short tau inversion recovery) (inversion time, 150 ms) |
| Axial and Coronal spin-echo T1-weighted (TR, 330–600 ms; TE, 8–15 ms) OR Axial T1 weighted Turbo Spin Echo (TSE)/ Fast Spin Echo (FSE) |
| Axial and Sagittal fast spin-echo T2-weighted (TR, 3500–4500 ms; TE, 80–110 ms) OR Axial T2 weighted SE/TSE/Dixon Optional- T2 weighted fat saturation sequence |
| Post gadolinium Axial, coronal & sagittal T1-weighted Spin Echo / Turbo Spin Echo (TSE)/ Fast Spin Echo (FSE) with fat suppression |
| Echo planar DWI & ADC maps with b value 0, 800, 1000 in axial plane |
| Optional - 2D time-of flight (TOF) or 3D TOF sequences (TR, 25–35 ms; TE, 4–8 ms), with a section thickness of 1 mm |

Part III
Head & Neck Oncoimaging Reporting checklists

A. PRETREATMENT

These are for the 1. Primary site & 2. Nodal staging

Primary sites

*Primary sites are* - Nasopharynx, Oropharynx (includes base tongue), Oral cavity (includes anterior two thirds tongue and 6 other subsites), Larynx & Hypopharynx, Salivary glands, Maxillary sinus, Nasal Cavity & Ethmoid sinus, & Thyroid cancer.
IMPORTANT NOTE
Each site has a specific checklist based on patterns of spread, the AJCC staging system and issues that affect management.

For general radiologists who are not familiar with intricacies of head and neck, the above points can be answered as
1) Yes (present/involved/invaded/eroded), or 2) No (absent/not involved/invaded/eroded) Or 3) Cannot comment

The Structured report template has the following elements-

1. CT / MRI study dated:
2. Clinical Indication:
3. Legend: Describe Procedure & any special maneuvers
4. Report (use checklist to generate it)

1. Reporting Checklist – Primary sites

   I. Nasopharynx
   1. Lesion epicenter & location
   2. Laterality
   3. Measurement _ x _ x _cm
   4. Further Spread to
   - Oropharynx
   - Hypopharynx
   - Nasal cavity
   - Parapharyngeal space
   - Prevertebral muscle/Medial pterygoid muscle
   - Lateral pteryoid muscle
   - Parotid
   - Paranasal sinuses
   - Orbits
   - Skull base marrow/cervical vertebra/pterygoid plates/Internal carotid artery
   - Perineural spread -along V1/ V2/ V3/ skull base foraminae/cavernous sinus

   II. Oropharynx
   If available, record HPV status – positive or negative (recall HPV positive OPSCC has different T and N staging as compared to HPV negative cancers)

   1. Lesion epicentre
   2. Laterality: right/ left/ crossing midline ( R → L/ L → R)
   3. Measurement _ x _ x _cm
   4. Further Spread to adjacent regions
• Nasopharynx
• Hypopharynx
• Epiglottis (lingual surface) & Rest of larynx
• Hard palate & Retromolar trigone
• Tongue muscles
• Maxillary sinus
• Bony maxillary alveolus
• Parapharyngeal space
• Medial pterygoid muscle/ lateral pterygoid muscle
• Mandible / pterygoid plates
• Skull base/ Internal carotid artery
• Perineural spread -along V1/ V2/ V3/ skull base foraminae/ cavernous sinus

III. Larynx & Hypopharynx

1. **Lesion epicenter:** tick one/more (if large lesion) / cannot comment
2. **Laterality**: right/ left/ crossing midline (R → L/ L → R)
3. Measurement _ x _ x _ cm
4. **Further Spread to adjacent regions**
   - Paraglottic space
   - Preepiglottic space
   - Tongue base mucosa
   - Extrinsic Tongue muscles
   - Cricoid cartilage
   - Arytenoid cartilage
   - Thyroid cartilage – intact/ sclerosis/ inner cortex erosion/ inner & outer cortex erosion
   - Extralaryngeal spread (ELS) – Absent/ present
   - Strap muscle invasion
   - Invasion of Trachea/ Thyroid gland/ Esophagus/ rest of mediastinum
   - Prevertebral fascia/ Retropharyngeal space invasion
   - Internal carotid artery– free/ invaded
   - Internal jugular vein– free/ invaded

IV. Oral Cavity

**Subsite/s- Anterior tongue*/ Floor of mouth/ Hard palate/ Gingival/ Buccal / Retromolar trigone/ Lip**

(* Anterior tongue is the anterior two thirds of the tongue and is a part of oral cavity while the posterior one third tongue also called base tongue is part of oropharynx;

**The wet inner part of the upper and lower lips is now considered part of the oral cavity while cancers of the vermilion border and outer dry part are considered skin cancers as per AJCC 8th edition)

i) **Anterior Tongue & Floor mouth lesion**

1) **Epicenter** – Lateral border / dorsal surface/ventral surface/Tip of tongue
2) **Laterality**
3) **Dimensions of lesion** – AP x Height X transverse dimension*
(*for lesion with epicentre along lateral tongue border , the transverse or latero-medial dimension would give an approximate idea of “Depth of invasion”, the new concept in AJCC 8th edition staging )

4) **Further spread** –
   - Up to or across midline
   - Neurovascular bundle – ipsilateral side/ ipsilateral & contralateral
   - Posterior third tongue/ tonsil
   - Pre-epiglottic space/Valleculae
   - Hyoid-free/ abutted/eroded
   - RMT
   - Mandible
   - Parapharyngeal space/ Masticator space/ Skull

ii) **Hard Palate**

1) **Laterality**

2) **Dimensions of lesion** – AP x Height X transverse dimension

3) **Palatal Bone** – Abutted/eroded

**Further spread**

- Soft palate
- Maxillary alveolus
- Maxillary sinus
- RMT
- Masticator space (Medial pterygoid muscle/ lateral pterygoid muscle)
- Pterygoid plates
- Perineural spread— up to greater palatine foramen/ up to pterygopalatine fossa

iii) **Gingival & Buccal mucosa, Lip& RMT**

1) **Epicenter &Laterality**

2) **Dimensions of lesion** – AP x Height X transverse dimension

3) **Mandible** – Abutted/eroded*
   
   ( *if eroded , if possible comment if erosion involves only cortical rim/ marrow / reaches inferior alveolar canal / mandibular foramen and which part of mandible is involved with respect to teeth region )

4) **Further spread**

- Buccal space
- Skin of cheek
- Maxillary sinus
- Medial spread—Anterior Tongue /Floor of mouth /Base tongue
- Masticator space –Masseter/Medial pterygoid muscle/ lateral pterygoid muscle
• Pterygoid plates
• Perineural spread -Mandibular foramen/ V3 nerve/ Foramen ovale / cavernous sinus / Greater palatine foramen/ pterygopalatine fossa/ foramen rotundum

V. Parotid Gland
1) Laterality
2) Location of lesion – Superficial/deep lobe
3) Dimensions of the lesion---AP x craniocaudal X transverse
4) Relationship with facial neurovascular bundle (landmark retromandibular vein) – medial/lateral
5) Lesion Morphology
   • Margins & capsule
   • Shape
   • Density – Plain CT scan
   • Signal intensity on T1W and T2W
   • Pattern of enhancement and delayed enhancement after 15 minutes
   • Optional-DWI restriction and ADC value
6) Status of parotid duct
7) Relationship of lesion with adjacent spaces and structures
   • Distance of tumour from overlying skin
   • Para pharyngeal space
   • Medial pterygoid muscle &Rest of Masticator space
   • Stylomastoid foramen (facial nerve) &Retro-mandibular region (auriculotemporal nerve)
   • V3 nerve /Foramen ovale / Cavernous sinus

VI. Maxillary sinus
1) Laterality- Right /Left
2) Epicenter– Floor of sinus /roof of sinus /sinus cavity
3) Dimensions of lesion – AP x Height X transverse dimension
4) Insipissated collection if any – describe location & signal intensity
5) Anterior spread- Anterior wall /Infra-orbital nerve/ Premaxillary region
6) Medial spread- nasal cavity invaded/ ethmoid sinus
7) Superior spread-
   • Lamina papyracea / Orbital floor/ Orbital contents/ orbital apex
   • Sphenoid sinus /Frontal sinus
   • Cribiform plate
8) Posterior spread-
   • Postero-lateral wall /Retroantral fat/ pterygomaxillary fissure
   • Sphenopalatine foramen/ pterygopalatine fossa / Infratemporal fossa
   • Vidian canal/ inferior orbital fissure/ superior orbital fissure

18
• Nasopharynx/clivus/ middle cranial fossa /dura / brain

9) **Inferior spread**- Hard Palate/Roof or oral cavity

VII. Nasal Cavity & Ethmoid Sinus

1) **Laterality**
2) **Probable epicenter & location**
3) **Dimensions of lesion** – AP x Height X transverse dimension
4) **Inspissated collection if any** – describe location & signal intensity
5) **Anterior spread**- Nasal ala
6) **Medial spread**- Nasal Septum/ contra lateral extension
7) **Lateral spread**- maxillary sinus
8) **Superior spread**-
   • Lamina papyracea /Orbital floor/Orbital contents/Cribriform plate
   • Skull base / Extradural space/Dura/ Brain parenchyma

9) **Posterior spread**
   • Nasopharynx/ sphenopalatine foramen/ pterygomaxillary fissure / Infratemporal fossa
10) **Inferior spread**- Hard Palate/Roof or oral cavity

VIII. Thyroid cancer (CT or MRI)

1) **Lesion epicenter & location**
2) **Measurement** _ x _ x _ cm
3) **Single /Multifocal**
4) **Extathyroidal extension** ( ETE)
5) **Describe ETE** invades
   • Strap muscles only
   • Subcutaneous soft tissue
   • Larynx
   • Trachea
   • Esophagus
   • Recurrent laryngeal nerve
   • Prevertebral fascia
   • Major vessels

2. Reporting Checklist – Nodal status

For this
• Look at drainage area for nodes with abnormal features
• Look at nodes at other sites

Template should have information about

1. **Abnormal nodes**
   • Ipsilateral (midline nodes are considered ipsilateral)– levels, number, size & abnormal features (necrosis & extranodal spread, shape & margins, increased enhancement, clustering)
   • Contralateral - levels, number, size & abnormal features
if extranodal spread +ve – mention
   a) Circumferential contact with artery (internal or common carotid artery) - < 180° / > 180° and < 270° / > 270°
   b) Invasion/ adherence of node to internal jugular vein (IJV) or tumour thrombus in IJV
   c) Relation with muscles-- sternocleidomastoid or strap muscles.

2. **Reactive/ benign nodes** – levels and normal features qualifying as benign.
3. **Equivocal nodes** – levels, features.

*Note- an attempt has to be made to categorize visible nodes into these 3 categories.*

**Impression**

- Mention brief extent of primary tumour
- Describe location and number of abnormal nodes.
- Mention location of reactive and equivocal nodes separately.
- In abnormal nodes with extranodal spread, mention structures invaded, particularly vessels.

Confident derivation of T & N category may not be always possible and will not serve the purpose if inaccurate. The cTNM stage should ideally be assigned by the treating clinician. Hence radiologist should provide all information so that clinician can assign a cTNM stage from the information. These checklists if adhered to, are designed to provide all information about cT&N category to the clinician.

**B. POST TREATMENT**

Following templates are being provided in the post treatment setting

1. Nasopharynx
2. Oropharynx
3. Oral cavity with various sub sites
4. Larynx & hyopharynx

**POST TREATMENT TEMPLATE** should have

**Structured report (common elements)**

A. **CT / MRI study dated:**

B. **Previous study** : available / not available (mention which study- CT/MRI) and **If available** : date

C. **Clinical Indication & Previous treatment :**

D. **Legend:** Describe Procedure & any special maneuvers

E. **Report – Use Checklists → see Table 3**
### Table 3. Check lists for reports in various regions

<table>
<thead>
<tr>
<th>Region</th>
<th>Checklists</th>
</tr>
</thead>
</table>
| **Post treatment Nasopharynx**| • Mucosal recurrence  
• Skull base marrow  
• Foraminae of skull base  
• Perineural spread – V1, V2, V3  
• Further spread – Parapharyngeal space, masticator space, oropharynx, paranasal sinuses, prevertebral fascia and muscles etc  
• Nodes – examine all levels, retropharyngeal and supraclavicular  
• Bones – for lytic lesions suggestive of metastases |
| **Post treatment Oropharynx** | • Asymmetry—in cases of Trans Oral Robotic surgery (normal side should not be mistaken as disease)  
• Mucosal recurrence  
• Further spread – Parapharyngeal space, masticator space, nasopharynx, skull base, oral cavity, paranasal sinuses, hypopharynx, prevertebral fascia etc  
• Nodes – examine all levels and retropharyngeal |
| **Post treatment Anterior Tongue & Floor mouth lesion** | In wide excision cases, look at site of surgery –  
• **Focal enhancement with rounded contours** in the tongue suggests recurrence  
• **Dark signal intensity ill defined soft tissue on all sequences without enhancement suggests fibrosis**  
In hemiglossectomy or total glossectomy and reconstruction with myocutaneous flaps, pearls are-  
• Homogeneous fat intensity of flap – normal appearance  
• Intermediate T2 signal intensity **focal mass like lesion within flap, with enhancement and rounded contours** suggest recurrence  
• Further spread – Describe as in pre-treatment primary template & also look for nodes |
| **Post treatment Hard palate** | • Describe surgery and asymmetry if any  
• Look for any **enhancing focal soft tissue with rounded margins** at/ around the site of surgery or in the adjacent soft palate  
• Further spread – Describe as in pre-treatment primary template |
| **Post treatment Gingival & Buccal mucosa, Lip & RMT** | • Describe surgery and asymmetry if any  
• Look for **any enhancing focal soft tissue with rounded margins** abutting cut end of bone (mandible/maxilla)  
• Look for **any enhancing focal soft tissue with rounded margins** within the soft tissue of the pectoralis major myocutaneous flap (that is seen in the operated masticator space)  
• Further spread – Describe as in pre-treatment primary template & also look for nodes |
| **In non-surgically treated cases,** | • Symmetry with no mass seen and with post RT edematous changes – complete response |
| Post treatment Larynx & Hypopharynx | • Asymmetry without any mass like lesion – post treatment changes likely  
• Asymmetry with enhancing focal mass like lesion > 1cm and with rounded contours suggests recurrence (this is a clue when previous study not available) and requires biopsy  
• Asymmetry with focal enhancing mass < 1cm is equivocal and requires close follow up. If unchanged, likely post treatment; if increased suggestive of recurrence.  
• Comparison with previous study – if mass is unchanged or has increased in size- highly suggestive of residual disease or recurrence  
• Look for nodal sites for relapse as well  
In total laryngectomy cases  
• Abnormal enhancing focal mass like lesion with rounded contours in the postop bed- suggests recurrence and requires biopsy |
|---|---|
| Nodal checklist – all regions | • Laterality, level and number of abnormal nodes  
• Compare with previous study  
1. if node decreased in size – suggests response  
2. if node unchanged and no new nodes – either response or residual disease  
3. If increasing in size or new node with abnormal features -s/o recurrence  
4. Fine needle aspiration often yields a non diagnostic aspirate in a post radiation setting and hence comparison of morphological appearances is important |

**Key Points**

- Imaging head & neck cancer requires thorough knowledge of anatomy and patterns of disease spread.

- Reporting checklists provided in the pre-treatment scenario helps the radiologist avoid overlooking important sites of disease spread. Such detailed information (about the primary as well as nodal sites) helps the clinician to accurate stage disease, which is needed for planning optimal therapy.

- AJCC staging 8th edition has several changes including a separate T & N category for HPV positive oropharyngeal cancers and EBV positive nasopharyngeal cancers. Since radiologist may not be privy to the HPV and EBV status and for other reasons too, it is safer not to commit to a T & N category in general in any head and neck cancer, but instead provide detailed information according to the points in each checklist so that clinician can derive the cTN stage.

- Reporting checklists in the post treatment scenario helps increase vigilance for foci of recurrence.
References

- Francis D. Trends in incidence of head and neck cancers in India. EJC. Volume 92, SUPPLEMENT 1, S23, 2018. DOI:https://doi.org/10.1016/j.ejca.2018.01.056


- Hermans R, Pameijer FA, Mancuso AA, Parsons JT, Mendenhall WM. Laryngeal or hypopharyngeal squamous cell carcinoma: can follow-up CT after definitive radiation therapy be used to detect local failure earlier than clinical examination alone? Radiology. 2000; 214(3): 683-7

OESOPHAGUS

Version v1.2020

Diva Shah (Ahmedabad)

Binoy Chowdhary (Guwahati)
CONTENTS

1. Part I
   Background information

2. Part II
   Imaging Methods & Imaging Protocols for Oesophageal cancers in pre and post therapy settings

3. Part III
   Reporting checklists

4. Key points

5. References
Part I

Background information
- Gastro-esophageal and oesophageal cancers are worldwide a leading cause of death. Oesophageal cancer is the sixth common cause of death, while in India; it is the 4th most common cause of cancer related death.

- Absence of serosal layer allows the rapid spread of the tumour to neighbouring mediastinal structures in oesophageal cancers and an extensive network of lymphatic drainage facilitates tumour dissemination faster in both gastric and oesophageal cancers.

- Risk factor includes tobacco consumption in various forms, alcohol, hot beverages and poor nutrition.

- 90% esophageal cancers are SCC or adenocarcinoma, SCC occurs in middle or upper third of esophagus.

- Apart from clinical symptoms diagnosed by Upper GI scopy and guided biopsy. Endoscopic ultrasound, CECT and PETCT are major diagnostic investigation.

- Radiologists have an important role in the correct staging. TNM Staging: The 8th edition of the AJCC (American Joint Committee on Cancer) staging of the cancer of esophagus and esophago-gastric junction (EGJ) is widely used now.

- The document below provides a list of oesophageal cancers, the role of imaging methods in the primary staging and post therapy staging of each cancer, imaging protocols, and pre as well as post treatment reporting checklist for the same.

Types
Oesophageal cancers divided into following regions
- Upper esophagus
- Middle thoracic oesophagus
- Lower thoracicoesophageus
- GE junction

Types of malignancy commonly encountered include:
- Squamous cell carcinoma
- Adenocarcinoma

Part II

Imaging methods
Cross sectional imaging -contrast enhanced CT scan form the cornerstone of TNM staging for oesophageal cancers. PET/CT evaluation from skull base to mid-thigh is recommended if metastatic disease is not evident. The routine use of PET-CT has got practical difficulties in Indian setting because of cost, availability, and the high false-positive rate due to infections such as tuberculosis. However, most major centres in the country have included this investigation as part of the routine preoperative workup.

After Initial workup (upper GI scopy and guided biopsy), cross sectional imaging enables patients to be classified into 2 clinical stage groups:

- Locoregional cancer (stage I–III)
- Metastatic cancer (stage IV)

Table 1 shows the optimal imaging methods for oesophageal cancers (called “Essentials”), and additional/optional methods (for providing additional important clinical information needed for planning treatment in that region).
### Table 1: Imaging methods for oesophageal cancers

<table>
<thead>
<tr>
<th>Region</th>
<th>Minimal/Essential imaging method &amp; reason</th>
<th>Desirable method/s</th>
</tr>
</thead>
</table>
| Post cricoid and upper oesophageal malignancy | A. Primary setting Contrast enhanced CT to best show  
a) An extent of the post cricoid lesion  
b)Involvement of upper oesophagus and involvement of thyroid/cricoid cartilage (enables optimal treatment planning & local control)  
B. *Post therapy*  
**Contrast enhanced CT scan** to show local recurrence/residual disease versus post treatment changes | A. Primary setting  
PETCT  
a) Metastatic workup in advanced cancers  
b) To map nodal burden while RT planning  
c) To evaluate small mucosal, sub-mucosal lesions involving post cricoid region.  
B. *Post therapy*  
1. PETCT to a) detect residual/recurrent mucosal disease and b) detect disease in nodes equivocal on contrast enhanced CT scan and c) for distant metastases |
| Middle third of oesophagus | A. *Primary setting* Contrast enhanced CT scan to best show local extent in to adjacent mediastinal structures.  
B. *Post therapy*  
**Contrast enhanced CECT** – to show local recurrence/residual disease versus post treatment changes | A. *Primary setting*  
1. EUS  
It is very useful in early mucosal lesions that can be resected endoscopically. It is superior in locoregional staging of tumour invasion and lymph nodal involvement.  
1. PETCT for a) metastatic workup in advanced cancers  
b) To map nodal burden while RT planning  
B. *Post therapy*  
1. PETCT to a) detect residual/recurrent mucosal disease and b) detect disease in nodes equivocal on CT scan and c) for metastases |
| Lower oesophagus, GE junction cancers | A. *Primary setting* Contrast enhanced CT - preferred method in GE junction malignant lesions and extension into stomach malignancy, show soft tissue involvement, extent, locoregional involvement including nodal spread, peritoneal and omental disease.  
B. *Post therapy*  
**Contrast enhanced CECT** – to show local recurrence/residual disease versus post treatment changes, locoregional extent of the residual disease. | A. *Primary setting*  
1. PETCT for a) metastatic workup in advanced cancer  
B. *Post therapy*  
1. PETCT to a) detect residual/recurrent disease, better, any new appearance of metastatic disease also. |

*Imaging protocols.*
In Indian setting, Imaging protocols are varied depending on local facilities available and affordability of the patient.

Computed Tomography (CT) is the preferred and minimum imaging procedure for staging of GI cancer, supplemented by Upper GI scopy/EUS/ PET CT scan as appropriate. For early stage cancers (T1/Tis) Endoscopic ultrasound and resection is choice of the investigation.

Oesophagus
- Area to be examined chest and upper abdomen- upto the aortic bifurcation (*pelvis and neck optional*).
- CT with intravenous contrast medium with distension of the oesophagus with water/oral contrast as mentioned above (*optional - muscle relaxant or prone scans*) is the preferred technique for staging.

**Clinical Profile:**

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<tbody>
<tr>
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<tr>
<td>Sex</td>
<td></td>
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<tr>
<td>Name(S) Of Referring Physician(S) Or Other Health Care Provider(S)</td>
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<tr>
<td>Name or Type Of Examination</td>
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<td>Date &amp; Time Of The Examination</td>
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<td>Date and Time Of Report</td>
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<td>Clinical Profile</td>
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<td>Creatinine Clearance</td>
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**Technical Protocol:**

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<td>Detector width x-Raws</td>
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<td>Radiation dose calculation CTDI &amp;DLP</td>
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Part III
Reporting Template
A cancer imaging report for staging a primary tumour should include:

- A description of the tumour, and appropriate measurement of primary tumour site.
- A descriptive statement of the primary tumour and the extent of tumour spread in relation to adjacent anatomy, image and series numbers on which the tumour is demonstrated.
- A statement regarding the presence or absence of nodal enlargement in nodal chains draining the primary tumour and a guide as to the number of enlarged nodes identified
- A statement regarding the presence of distant metastases
- Dimensions and location of metastases should be recorded with reference to specific image numbers—at least the largest and smallest should be measured (RECIST reporting criteria)
- Dimensions and recognition of metastases may be useful as marker lesions for measuring response information provides the clinician with an overall assessment of tumour burden prior to treatment.

Reporting checklist template for oesophageal and GE junction cancers

- **Site**
  - Cervical oesophagus (lower border cricoid to thoracic inlet)
  - Intrathoracic
    - Upper (inlet to tracheal bifurcation)
    - Mid (bifurcation to just above OGI)
    - Lower thoracic/abdominal (including OGI / intra-abdominal oesophagus).

- **Extent** – Length segment involved, Maximum thickness, margin, Cranio-Caudal length of the growth including upper and lower vertebral level

- **Type** Siewert – Applies to GE junction tumors (I,II,III)

- **Peri-esophageal soft tissue** – Preserved, effaced, infiltrated

- **Fat planes and an area of contract of involved length of the segment of lesion with aorta** – Length and circumference Relationship with adjacent mediastinal/lower neck structures

- **Nodal status**
  - **Regional** – Number and morphology - supra-clavicular, peri-oesophageal, Upper and lower para-tracheal, diaphragmatic, peri-gastric, common hepatic, coeliac, splenic artery
  - **Non regional** – A part from regional nodal classification

- **Metastasis**

- **Synchronous primary malignant lesion elsewhere in the esophagus or stomach.**

- **Arterial anatomy** – Coeliac artery and its branches and any anatomic arterial variation.

Comments/Impression –

- T-tumour site, location and locoregional extent
- **Nodal status Regional and Non regional nodal metastasis.**
- Distant metastasis.

Post-operative imaging (Oesophageal cancers)

- Locally advanced thoracic oesophageal carcinoma (stage III & IV) requires pre-operative chemoradiation, followed by response evaluation, followed by three stage esophagectomy(Sub-total) esophagectomy with anastomosis in neck, while for gastro-oesophageal tumours (Type I & II) following chemoradiation, required Ivor Lewis surgery and intrathoracic anastomosis.

- Locally advanced/metastatic oesophageal cancers need palliative chemotherapy.

Comparison with previous study is ideal to generate an accurate post treatment template.
Reporting checklist for post operative oesophageal cancers.

NCCT thorax/abdomen pelvis.

- Pleural effusion, atelectasis.
- Any collection at peri-operative site (Neo-oesophagus, partial/total gastrectomy).

**NCCT THORAX /ABDOMEN & PELVIS WITH ORAL CONTRST (50-100 ML plain water /or ADD 20CC Oral contrast in water), followed by intravenous contrast**

- Distend the neo-oesophagus with contrast (oral /water), look for any leak, areas of stenosis or narrowing or abnormal wall thickening or mucosal enhancement. Also look for normal passage of oral contrast upto the proximal jejunal loops.
- Look for stoma site
- Look for any leak, fistula from proximal or distal stoma site.
- Look carefully of retroperitoneal and supraclavicular nodes.

**Comments/Impression –**

- Post operative status
- Any recurrent lesion at operative bed site /leak /stricture
- Recurrent nodal status or distant nodal metastasis
- Distant metastasis

**KEY POINTS :**

- Imaging of oesophageal cancer requires thorough knowledge of anatomy and patterns of disease spread.
- Imaging plays pivotal role – for selection of treatment strategies.
- Multimodality-assessed preoperative staging of oesophageal cancer includes the use of CT, endoscopic US, and PET/CT.
- Upper GI scopy is BASIC.
- Endoscopic US-is the best modality for determining the depth of tumour invasion and presence of regional lymph node involvement.
- MDCT- Basic primary essential modality to rule out unresectable or distant metastatic disease. Use multiplanar oblique reformations for depth of tumour infiltration and relationship with adjacent structures.
- Use reporting checklist templates in pretherapy and post therapy settings.
REFERENCES:


THYROID

Version v1.2020

Bagyam Raghavan (Chennai)
Background Information:

- In India 42 million people have been identified to have thyroid disease and the incidence of thyroid nodules is 12.2% [1].
- Thyroid malignancy is the 8th most common malignancy in women and the annual incidence of is increasing by 4% worldwide [2].
- The main histologic types of thyroid carcinoma are (1) differentiated thyroid carcinoma (DTC; including papillary, follicular, and Hürthle cell); (2) medullary thyroid carcinoma (MTC); and (3) anaplastic thyroid carcinoma (ATC).
- Common presentation of carcinoma thyroid is painless neck swelling due to primary thyroid lesion or due to metastatic lymph nodes. Some of the malignant lesions are found in routine ultrasound screening in asymptomatic individuals.
- Ultrasound is the modality of choice for screening and to do to biopsy.
- Though the reported prevalence of thyroid nodules are exceedingly common on high-resolution ultrasound in adults (up to 68%) the possibility of malignancy in such nodules is only in 5%[3].
- Even malignant nodules smaller than 1 cm, frequently exhibit indolent or nonaggressive behaviour and the mortality is extremely low in papillary thyroid cancer detected from ultrasound screening in asymptomatic patients [4].
- Therefore, not all detected nodules require FNA and/or surgery.
- Triaging the nodules done by TI-RADS (Thyroid Imaging Reporting and Data System) based on the ultrasound findings.
- Color Doppler can be used since many studies proved nodules with predominant central blood flow has high chance for malignancy.
- Elastography (Real time/ARFI) is an adjunct modality to ultrasound which increases the diagnostic accuracy and can be used to select the nodule for FNAC/ biopsy in patients with multiple nodules.
- PET CT is useful for initial staging work up, to detect the distant metastasis like brain, pulmonary and bone metastases and for post therapy evaluation.
- Tumor markers are thyroglobulin for DTC and calcitonin for MTC, allow for dynamic risk-adapted stratification for follow-up.
- \textbf{BRAF and TERT, RAS, RET/PTC, and PAX8/PPARY}, are now used as molecular markers and included in a multigene mutational panel investigated in FNA or surgically resected specimens.
- \textbf{BRAF} mutations are present in 30% to 67% of PTCs and are associated with locoregional metastases, extrathyroidal extension, and higher AJCC stage at presentation.

TNM staging [7]

<table>
<thead>
<tr>
<th>TNM definitions (AJCC 8e)</th>
<th>For papillary, follicular, poorly differentiated, Hürthle cell, medullary and anaplastic thyroid carcinomas</th>
</tr>
</thead>
<tbody>
<tr>
<td>TX</td>
<td>Primary tumour cannot be assessed</td>
</tr>
<tr>
<td>T0</td>
<td>No evidence of primary tumour</td>
</tr>
<tr>
<td>T1</td>
<td>Tumor &lt; 2cm is greatest dimension limited to the thyroid</td>
</tr>
<tr>
<td></td>
<td>\hspace{1cm} T1a – Tumor &lt; 1cm in greatest dimension limited to the thyroid</td>
</tr>
<tr>
<td></td>
<td>\hspace{1cm} T1b – Tumor &gt;1cm but &lt; 2cm in greatest dimension limited to the thyroid</td>
</tr>
<tr>
<td>T2</td>
<td>Tumor &gt;2cm but &lt; 4cm in greatest dimension limited to thy thyroid</td>
</tr>
<tr>
<td>T3*</td>
<td>Tumor &gt;4cm limited to the thyroid or gross extrathyroidal extension invading only stra muscles</td>
</tr>
<tr>
<td></td>
<td>\hspace{1cm} T3a* – Tumor &gt;4cm limited to the thyroid</td>
</tr>
<tr>
<td></td>
<td>\hspace{1cm} T3b* – Gross extrathyroidal extension invading only strap muscles (sternohyoid) from a tumour of any size</td>
</tr>
<tr>
<td>T4</td>
<td>Includes gross extrathyroidal extension into major neck structures.</td>
</tr>
<tr>
<td></td>
<td>\hspace{1cm} T4a – Gross extrathyroidal extension invading subcutaneous soft tissues, larynx, trachea, esophagus or recurrent laryngeal nerve from a tumour of any size</td>
</tr>
</tbody>
</table>
- T4b – Gross extrathyroidal extension invading prevertebral fascia or encasing carotid artery or mediastinal vessels from tumour of any size

NX  Regional lymphnodes cannot be assesses.

N0  No evidence of regional lymph nodes metastasis
   - N0a* – One or more cytologic or histologically confirmed benign lymph nodes
   - N0b* -- No radiologic or clinical evidence of locoregional lymph nodes metastasis

N1*  Metastasis to regional nodes
   - N1a* – Metastasis to level VI or VII (pretracheal, paratracheal or pralaryngeal/ Delphian or upper mediastinal) lymph nodes; this can be unilateral or bilateral disease
   - N1b* -- Metastasis to unilateral, bilateral or contralateral lateral neck lymph nodes (levels I, II, III, IV or V) or retropharyngeal lymph nodes.

M0  No distant metastasis
M1  Distant metastasis

*all categories may be subdivided as solitary tumour (s) and multifocal tumour (m) – the largest tumour determines the classification.

**Imaging Protocol:**

- **Ultrasound:**
  
<table>
<thead>
<tr>
<th>Patient position</th>
<th>Supine position with a fully exposed neck suitably extended over a pillow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transducer</td>
<td>High frequency linear array transducer (4.0 to 9.0 MHz)</td>
</tr>
<tr>
<td>Scanning plane</td>
<td>Both lobes of thyroid examined in transverse and longitudinal planes.</td>
</tr>
<tr>
<td></td>
<td>Scanning includes bilateral cervical lymph nodal regions</td>
</tr>
</tbody>
</table>

- **Elastography:**
  - Real time elastography – Colour coded images of the lesion.
  - ARFI – VTI images of the lesion and VTQ value within the solid component of the lesion.

- **Doppler**

- **PET CT**
**Thyroid Ultrasound**

**Indication:** Evaluation of incidental nodule in right lobe of thyroid.

**Technique:** Ultrasound examination of the thyroid and adjacent soft tissues was performed.

**FINDINGS:**

- **Thyroid size:**
- **Texture:**

Estimated total number of nodules ≥1 cm:

Number of spongiform nodules ≥2 cm not described below (TR1):

Number of mixed cystic and solid nodules ≥1.5 cm not described below (TR2):

**Nodule # 1**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Findings</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Composition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Echogenicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Margins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Echogenic foci</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional echogenic foci 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional echogenic foci 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACR TI-RADS total points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACR TI-RADS risk category</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparison images</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACR TI-RADS recommendation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vascularity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elastography</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**IMPRESSION:**

ACR TI-RADS recommendations:

- TR5 (≥7 points) - FNA if ≥1 cm, follow-up if 0.5 - 0.9 cm every year for 5 years
- TR4 (4-6 points) - FNA if ≥1.5 cm, follow-up if 1 - 1.4 cm in 1, 2, 3 and 5 years
- TR3 (3 points) - FNA if ≥2.5 cm, follow-up if 1.5 - 2.4 cm in 1, 3 and 5 years
- TR2 (2 points) & TR1 (0 points) - No FNA or follow-up
## Thyroid Ultrasound

**Indication:** Evaluation of incidental nodule in right lobe of thyroid.

**Technique:** Ultrasound examination of the thyroid and adjacent soft tissues was performed.

### FINDINGS:
Thyroid size:
Texture:
Estimated total number of nodules ≥1cm: 1
Number of spongiform nodules ≥2cm not described below (TR1):
Number of mixed cystic and solid nodules ≥1.5cm not described below (TR2):

### Nodule #: 1

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Findings</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum size</td>
<td>[ ] cm; Other 2 dimensions [ ] cm</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>[right, left, isthmus];[upper, mid, lower]</td>
<td></td>
</tr>
<tr>
<td>Composition</td>
<td>[cystic/almost completely cystic (0), spongiform (0), mixed cystic and solid (1), solid/almost completely solid (2), cannot determine (2)]</td>
<td></td>
</tr>
<tr>
<td>Echogenicity</td>
<td>anechoic (0), hyperechoic (1), isoechoic (1), hypoechoic (2), very hypoechoic (3), cannot determine (1)</td>
<td></td>
</tr>
<tr>
<td>Shape</td>
<td>[not taller-than-wide (0), taller-than-wide (3)]</td>
<td></td>
</tr>
<tr>
<td>Margins</td>
<td>[smooth (0), ill-defined (0), lobulated/irregular (2), extra-thyroidal extension (3), cannot determine (0)]</td>
<td></td>
</tr>
<tr>
<td>Echogenic foci</td>
<td>[none (0), large comet-tail artifacts (0), macrocalcifications (1), peripheral calcifications (2), punctate echogenic foci (3)]</td>
<td></td>
</tr>
<tr>
<td>Additional echogenic foci 1</td>
<td>macrocalcifications (1), peripheral calcifications (2), punctate echogenic foci (3)</td>
<td></td>
</tr>
<tr>
<td>Additional echogenic foci 2</td>
<td>macrocalcifications (1), peripheral calcifications (2), punctate echogenic foci (3)</td>
<td></td>
</tr>
<tr>
<td>ACR TI-RADS total points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ACR TI-RADS risk category</td>
<td>TR1 (0 points), TR2 (2 points), TR3 (3 points), TR4 (4-6 points), TR5 (≥7 points)</td>
<td></td>
</tr>
<tr>
<td>Comparison images</td>
<td>• Nil&lt;br&gt;• Significant change in size (≥/≤ 20% in two dimensions and minimal increase of 2 mm): [No/Yes]&lt;br&gt;• Change in features: [No/Yes]&lt;br&gt;• Change in ACR TI-RADS risk category: [No/Yes]</td>
<td></td>
</tr>
<tr>
<td>ACR TI-RADS recommendation</td>
<td>[Ultrasound-guided fine needle aspiration, Follow-up ultrasound in 1 year, No further follow-up]</td>
<td></td>
</tr>
<tr>
<td>Vascularity</td>
<td>Avascular /peripheral vascularity /central blood flow</td>
<td></td>
</tr>
<tr>
<td>Elastography</td>
<td>Soft / stiffness equal to the gland/ Hard</td>
<td></td>
</tr>
</tbody>
</table>

**IMPRESSION:**
Sample Report - 1.

Clinical scenario:

47-year-old asymptomatic female found to have nodular swelling in the region of right lobe of thyroid during routine health checkup. Referred for USG thyroid for further evaluation.

USG Findings:

Transverse sonogram (A) shows hypoechoic solid nodule noted in the right lobe of thyroid. The nodule appears taller than wide and showing lobulated margin. Punctate echogenic foci noted within the nodule. (B) Colour doppler shows peripheral and minimal central vascularity. (C)ARFI elastography shows hard nodule.

Representative images:
**Thyroid Ultrasound**

**Indication:** Evaluation of incidental nodule in right lobe of thyroid.

**Technique:** Ultrasound examination of the thyroid and adjacent soft tissues was performed.

**FINDINGS:**

Thyroid size: 23 x 11 x 44 mm.
Texture: Normal.
Estimated total number of nodules ≥1 cm: 1
Number of spongiform nodules ≥2 cm not described below (TR1): Nil
Number of mixed cystic and solid nodules ≥1.5 cm not described below (TR2): Nil

**Nodule #1**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Findings</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum size</td>
<td>1.8 x 1.4 x 1.3 cm</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Right lobe lower pole</td>
<td></td>
</tr>
<tr>
<td>Composition</td>
<td>Solid</td>
<td>2</td>
</tr>
<tr>
<td>Echogenicity</td>
<td>Very hypoechoic</td>
<td>3</td>
</tr>
<tr>
<td>Shape</td>
<td>Taller-than-wide</td>
<td>3</td>
</tr>
<tr>
<td>Margins</td>
<td>Lobulated/irregular</td>
<td></td>
</tr>
<tr>
<td>Echogenic foci</td>
<td>Punctate echogenic foci</td>
<td>3</td>
</tr>
<tr>
<td>Additional echogenic foci 1</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>Additional echogenic foci 2</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>ACR TI-RADS total points</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>ACR TI-RADS risk category</td>
<td>TR5 (Highly suspicious for malignancy)</td>
<td></td>
</tr>
<tr>
<td>Comparison images</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>ACR TI-RADS recommendation</td>
<td>FNA</td>
<td></td>
</tr>
</tbody>
</table>

Vascularity: Peripheral and minimal central vascularity

Elastography: Hard nodule

**IMPRESSSION:**

Solitary nodule in lower pole of right lobe with features highly suspicious for malignancy. Suggested FNAC.

ACR TI-RADS recommendations
- TR5 (≥7 points) - FNA if ≥ 1 cm, follow-up if 0.5 - 0.9 cm every year for 5 years
- TR4 (4-6 points) - FNA if ≥ 1.5 cm, follow-up if 1 - 1.4 cm in 1, 2, 3 and 5 years
- TR3 (3 points) - FNA if ≥ 2.5 cm, follow-up if 1.5 - 2.4 cm in 1, 3 and 5 years
- TR2 (2 points) & TR1 (0 points) - No FNA or follow-up

**HPE:** Papillary carcinoma
Sample Report –2.

Clinical scenario:

23-year-old asymptomatic female with hypothyroidism. Referred for USG thyroid.

USG Findings:

Transverse sonogram (A) shows spongiform isoechoic solid nodule noted in the right lobe of thyroid. The nodule appears wider than tall and showing ill-defined margin. No echogenic foci noted within the nodule. (B) Colour doppler shows peripheral vascularity. (C) ARFI elastography shows soft nodule.

Representative images:
**Thyroid Ultrasound**

**Indication:** Evaluation of hypothyroidism.

**Technique:** Ultrasound examination of the thyroid and adjacent soft tissues was performed.

**FINDINGS:**

Thyroid size: 18 x 17 x 38 mm.

Texture: Normal.

Estimated total number of nodules ≥1 cm: 1

Number of spongiform nodules ≥2 cm not described below (TR1): Nil

Number of mixed cystic and solid nodules ≥1.5 cm not described below (TR2): Nil

**Nodule #: 1**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Findings</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum size</td>
<td>1.3 x 1.0 x 1.1 cm</td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td>Right lobe upper pole</td>
<td></td>
</tr>
<tr>
<td>Composition</td>
<td>Spongiform</td>
<td>0</td>
</tr>
<tr>
<td>Echogenicity</td>
<td>Isoechoic</td>
<td>1</td>
</tr>
<tr>
<td>Shape</td>
<td>Wider-than-tall</td>
<td>0</td>
</tr>
<tr>
<td>Margins</td>
<td>Ill-defined</td>
<td>0</td>
</tr>
<tr>
<td>Echogenic foci</td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>Additional echogenic foci 1</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>Additional echogenic foci 2</td>
<td>Nil</td>
<td></td>
</tr>
<tr>
<td>ACR TI-RADS total points</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>ACR TI-RADS risk category</td>
<td>TR1 (Benign)</td>
<td></td>
</tr>
<tr>
<td>Comparison images</td>
<td>Nil</td>
<td></td>
</tr>
</tbody>
</table>

| ACR TI-RADS recommendation            | No FNA / Follow up | |
| Vascularity                           | Peripheral vascularity | |
| Elastography                          | Soft Nodule | |

**Impression:**

Solitary nodule in upper pole of right lobe with benign features.

**ACR TI-RADS recommendations**

- TR5 (≥7 points) - FNA if ≥1 cm, follow-up if 0.5 - 0.9 cm every year for 5 years
- TR4 (4-6 points) - FNA if ≥1.5 cm, follow-up if 1 - 1.4 cm in 1, 2, 3 and 5 years
- TR3 (3 points) - FNA if ≥2.5 cm, follow-up if 1.5 - 2.4 cm in 1, 3 and 5 years
- TR2 (2 points) & TR1 (0 points) - No FNA or follow-up

**HPE:** Colloid Nodule
References:

8. ACR Thyroid Imaging, Reporting and Data System Lexicon Directory
LUNG

Version v1.2020

Abhishek Mahajan (Mumbai)
Background information:

- Lung cancer is the most common malignancy in men and the third most common in women.
- It is classified as small cell (20%) and non-small cell carcinoma (80%).
- Adenocarcinoma is the most common histologic subtype
- The most common genetic alterations in lung adenocarcinoma are epidermal growth factor receptor (EGFR) and KRAS activating mutations. Additional driver mutations in lung adenocarcinoma occur with a frequency of <1–4%, including ALK gene rearrangements, ROS1 translocations, HER2 mutations, BRAF mutations, and RET translocations
- EGFR mutation predicts a more favourable prognosis and sensitivity to EGFR tyrosine kinase inhibitors (TKIs) such as erlotinib, gefitinib, and afatinib
- KRAS mutations occur more commonly in smokers and appear to confer worse prognosis
- ALK rearrangement are clinically important as predicts sensitivity to ALK tyrosine kinase inhibitors such as crizotinib and ceritinib

Imaging protocol:

Initial:

- F18-FDG PET-CECT is the most accurate investigation for staging NSCLC
- Contrast enhanced CT of thorax, abdomen and pelvis if PET is not available. However bone scan (MDP) should be done along with CT.
- Small cell is stage with CT.
- MRI is indicated in superior sulcus tumours
- MRI brain is indicated in patients with neurological symptoms and stage IIIb and above
- Quantitative lung perfusion studies (99mTc DTPA and 99mTcMAA) are indicated before surgery to assess the ventilation and perfusion capacity of each lung
- In and out phase MRI can be used as problem solving tool to differentiate adrenal metastasis from adrenal adenoma

CT tips:

- It’s often difficult to differentiate collapse/consolidated lung from the involved lung. Tumoral parenchyma enhances less as compared to the collapse/consolidated lung
- Nodes evaluation based on size criteria is less accurate (PET is far superior)
- Early bone metastasis might be missed on CT.

MRI tips:

- MR is indicated for superior sulcus tumours for assessment of invasion of chest wall and critical structures.
- Loss of signal on out phase imaging is diagnostic sign for adrenal adenoma however absence of signal loss is suggestive of adrenal metastasis and also lipid poor adenoma
- Leptomeningeal metastasis should be looked for brain MRI.

FDG tips:

- F18-FDG PET-CECT is far superior in differentiating collapsed/ consolidated lung from tumoral parenchyma.
- It is the most accurate non-invasive technique for nodal involvement
- F18-FDG PET-CECT may detect unexpected metastatic disease and prevents futile thoracotomies.
• False negative results may be seen bronchoalveolar carcinoma, small tumours and carcinoids. Similarly false positive results may be seen in infections such as tuberculosis and inflammatory conditions such as sarcoidosis

Synoptic Reporting in lung cancer:

• **Demographics** (Information provided by RIS and DICOM headers)
  a. Name of facility where examination was provided
  b. Name of the patient
  c. Patient’s gender
  d. Patient’s date of birth and age
  e. Name(s) of referring physician(s) or other health care provider(s)
  f. Name of type of examination
  g. Date and time of the examination
  h. Date and time of dictation and final transcription

• **Relevant clinical information**

  a. Clinical symptoms
  b. Addictions – Smoking/Alcohol/ Chewing tobacco
  c. Co-existing health morbidities – COPD/ Diabetes Mellitus/ Immuno compromised status
  d. Occupational history for any relevant occupational exposures
  e. Previous cancer
  f. Previous surgery
  g. Previous chemotherapy or radiation
  h. Current working diagnoses (if any)
  i. Recent most relevant lab tests and/or imaging tests

• **Body of the report:**

  a. Type of study and the technical protocol
  b. Contrast information
  c. Quality of examination
  d. Comparison to the previous study and date

• **Findings :**

  b. Lung Mass -
     Location:
     Size:
     Shape : Spiculated / Round / Smoothly shaped
     Consistency : Centrally/ peripherally calcified/ ground glass / fatty
  c. Local extent (Involved/ Not involved and extent)
     Pleural surfaces:
     Airways:
     Chest wall:
     Vessels:
     Nerves:
  d. Regional extent
     Lymph nodes:
Size:
Location:
Anatomical list of nodes:
Level of suspicion:
Characterization, if relevant
e. Distant Metastases
   Pulmonary:
   Lymphangitic spread:
   Hepatic:
   Adrenal:
   Skeletal:
f. Effusion
   Pericardial:
   Pleural:
g. Associated lung parenchymal diseases: ILD/COPD
h. Other findings:

• Impression
• Recommendations
  
o  None
o  Routine follow-up
  Close follow-up
  Follow up with PET-CECT for documentation of functional CR (Complete Response)

• Follow-up imaging is adequate using CT. CT of thorax abdomen and pelvis should be performed. PET-CECT may be advocated as per institutional guidelines.
• For patients treated with immunotherapy: pseudoprogression should be kept in mind before labelling a progression and it should be confirmed on next follow-up imaging (4 weeks apart)
  o  Unconfirmed progressive disease (iUPD): Enlarging or new lesions are not immediately considered to indicate progression
  o  Confirmed Progressive disease (iCPD): Confirmed on 2 consecutive studies at least 4 weeks apart
BREAST

Version v1.2020

Jyoti Arora (Gurugram)

Bhawna Dev (Chennai)

Smriti Hari (Delhi)
• Breast cancer is the most common cancer affecting women in India. It accounts for 27.7% of all new cancer diagnoses and 23.5% of all cancer deaths among women in India[1].
• The age-standardized incidence rate of breast cancer in India is 24.7 cases per 100,000 per year.
• The increasing burden of disease may be associated with lifestyle factors such as later age at marriage, age at first birth, reduced breastfeeding and westernisation of diet and physical activity patterns[2].
• Though the incidence of breast cancer in India is one-third that of Western countries, the mortality rates are disproportionately higher[3].
• Recent evidence suggests that breast cancer in Indian and Caucasian women may differ given the younger age at diagnosis, higher proportion of high-grade (45.7% for grades III & IV vs. 38.7%) and hormone receptor-negative tumors (30.6% ER-/PR- vs. 21.8%), higher incidence of inflammatory cancer (1.4% vs. 0.8%) and larger proportion with early-onset disease (16.2% <40 yrs vs. 6.23%)[4,5].

Imaging Modalities; Minimum requirements

Mammography

• Mammography must include medio-lateral oblique (MLO) and cranio-caudal (CC) views of each breast. If a suspicious abnormality is identified on mammography, further mammographic views (magnification, compression or digital breast tomosynthesis [DBT]) may be performed to help characterise the abnormality.
  ○ In CR or FFDM mammography systems, hard copies on film may be required for the use of patients and referring clinicians, however, reporting should be performed on mammography quality monitors, preferably 5 megapixel or more.

Ultrasound

• High frequency linear probe (12 MHz or more) must be utilised for breast evaluation.
• Mass characterization with ultrasound is highly dependent on technical factors. Proper depth, gain, and focal zone settings should be optimized to obtain high-quality images.
• The patient should be positioned to minimize the thickness of the portion of the breast being evaluated.

MRI

• A high strength, 1.5 T MRI systems along with dedicated phased array breast coil is the basic requirement of breast MRI.
• Patient is placed prone with both breasts hanging in the breast coil.
• T1 3D Axial Non Fat Sat
• T2 Axial Non-Fat Sat
• Dynamic T1 3D FS Pre and Post Contrast
• STIR Coronal for Axillae
• DWI (optional)
• MIP images provide a good global view of the breast and must be reviewed.
• The enhancement pattern over time must be plotted for mass or any other suspicious area of enhancement.

Indications:

• Breast cancer high-risk screening.
• Preoperative evaluation – extent of disease especially if lobular cancer or dense breasts.
• Post neo-adjuvant chemotherapy.
• Positive surgical margins, post lumpectomy.
• Metastatic axillary lymphadenopathy with unknown breast primary malignancy.
• Equivocal mammographic findings- Problem-solving.
• Silicone breast implant integrity.

Imaging assessment of Breast Symptoms
Breast Lump

- Ultrasound (USG) is used as the first investigation in women below 30 years of age and pregnant or lactating women. If there are suspicious findings, mammography should be performed irrespective of age.
- Mammography should be performed first in older women (more than 30 years) presenting with breast symptoms with the addition of USG as required. If findings are suspicious then tissue sampling is must.
- **Ultrasound of the axilla** should be carried out in all patients when malignancy is suspected or confirmed. If suspicious lymph nodes are found, tissue sampling (FNAC or core biopsy) of at least one abnormal node should be performed under ultrasound guidance.
- It is important to note that clinically palpable breast cancer may not be demonstrated on mammograms in a minority of patients. Some of these may be apparent on ultrasound. Suspicious mass on any of these must be subjected to image guided biopsy.

Nipple discharge or ulceration of nipple-areola complex

- Cytological examination of duct discharge to look for atypical cells is of limited clinical utility as a negative result is of no value.
- Only pathological nipple discharge warrants imaging evaluation to confirm intraductal papillomas which is the commonest cause of the pathological discharge.
- As cancer is an important differential seen in % of cases of pathological nipple discharge, mammography is the initial modality for investigation. Ductal carcinoma in situ (DCIS) with or without an invasive component is the commonly associated malignant diagnosis with duct discharge.
- Ductography was the standard investigation for evaluation of single duct discharge; however, it is fast being replaced with high-resolution ultrasound and MRI.[3]
- Ultrasound is accurate in delineating the abnormally dilated duct often with an intraductal nodule or mass. If identified, its size, location on clock face and distance from the nipple should be carefully documented in the report to help the surgeon in planning the extent of duct excision (microdochectomy instead of radical duct excision especially in young patients).
- MRI is advised if suspicion for cancer is high and mammography and ultrasound are negative. MRI improves the cancer detection rate in women with pathological nipple discharge.

**Paget’s disease** is a centrally located ductal carcinoma in situ growing along the ducts into the nipple with eczematous changes at the summit of the nipple. Fifty per cent patients have a palpable mass.

- On mammography and ultrasound, underlying mass or calcification is seen in most patients.
- MRI is required to localize the mass and define its extent if mammography and USG are equivocal.
- Nipple areolar complex and retroareolar area is a challenging area for mammographic evaluation.

Occult breast cancer in patients with metastatic axillary lymphadenopathy

- Mammography and USG are standard part of the workup.
- If conventional imaging is negative MRI is recommended which has a high sensitivity for invasive cancers.

Systemic Staging

Systemic staging should be performed in patients with locally advanced breast cancer (LABC), inflammatory breast cancer, significant axillary burden, or in patients symptomatic with metastases.

Minimum requirement - CXR and USG abdomen

Desirable - CECT chest and abdomen or PET-CT

**Assessment of response to Neo-adjuvant chemotherapy (NACT)**
• Suitable patients with LABC are treated with NACT with the intent of down staging the tumour and offer breast conservation treatment (BCT).
• For response evaluation, mammography and ultrasound are performed. MRI is most accurate for measuring residual disease and should be performed if breast-conserving surgery is planned.
• Breast metallic marker clip is placed in these tumors to mark the tumour bed in case patients achieve a radiological complete radiological response. The metallic marker clip is then used to perform preoperative hook wire localization and local excision.

Post treatment Imaging

Regular imaging follow-up is required in women treated for breast cancer.

• Baseline mammogram of the treated breast is obtained at 3 to 6 months after completion of the radiotherapy and then annual mammograms are performed.
• USG is needed in case of suspicious findings on mammography and/or clinical examination. MRI may be needed in problematic cases; especially to differentiate scar with fat necrosis from recurrence.

Breast Interventions

Triple assessment is a standard method for assessment of breast diseases, which includes clinical evaluation, radiographic assessment and pathological assessment. Percutaneous image-guided breast biopsy for breast disease is the gold standard for pathological assessment and the results are comparable to excision biopsy with the advantage of quick recovery, less invasive, better cosmesis and avoid risk of general anaesthesia.

Indication:
• All BIRADS 4 and 5 lesions have to be biopsied.
• In few BIRADS 3 lesions to allay patient’s anxiety or if there is clinical concern.

Ultrasound Guidance: For lesions clearly visible on US. The needle should be kept parallel to the chest wall and perpendicular to the transducer to allow visualisation of its entire length throughout the procedure. Documentation of the needle within the mass in orthogonal planes is essential.

• Quick, safe and real time imaging
• Comfortable for the patient as procedure is performed in a supine position without compression.
• No exposure to ionizing radiation, no need for breast compression or contrast media.
• False-negative rate of less than 3% and sensitivity of at least 98%

Stereotactic guidance: For microcalcifications, distortions, asymmetry and small masses not seen on USG.

• Slightly uncomfortable for the patient as may be done in the sitting position with the breast compressed.
• Use of Ionizing radiation
• Specimen radiography is required to confirm the presence of microcalcifications in the sample
• Non-calcified lesions are difficult to visualise and cannot be confirmed on specimen radiography.

MRI guidance – for MRI only visible suspicious abnormalities. VABB is preferred over core biopsy.

• Slightly uncomfortable for the patient as the patient has to lay prone without moving for at least 30 minutes.
• Use of contrast media.
• Visualisation of the target reduces with time due to washout of the contrast, presence of post procedure blood and air.
• There is no real-time monitoring of tissue sampling. Immediate post biopsy MR images are acquired to determine the adequacy of sampling.

Choice of Device- Fine needle aspiration cytology (FNAC)/Core biopsy/ Vacuum-assisted breast biopsy (VABB) : Two main objectives of percutaneous biopsy techniques: first, achieving the maximum degree of accuracy and second, offering
as much information as possible about the tumour type, grade, invasion, hormonal receptors, HER-2 NEU, etc.

**FNAC:** False negative rate, insufficient samples and missed diagnosis are high, limiting the value of FNAC compared to core biopsy. FNAC has limitations and cannot differentiate between DCIS and IDC, as well as other pathologies like papillary lesions, intra cystic masses etc. It does not provide information regarding receptor status and tumour grade which are prudent for treatment planning. FNAC has useful role in sampling axillary lymph nodes in known cancer

Aspiration is widely used for draining complicated cysts, seroma - lactational abscesses.

**Core Biopsy:** Core biopsy utilises spring-loaded (14 G) needles that are semi automatically or automatically fired into the lesion. The false-negative rate ranges from 1 -3%.

**VABB:** VABB is performed by one-time insertion of a large core (8G-12G) needle with directional sampling capability allowing acquisition of contiguous and larger tissue samples and. This markedly helps in reducing sampling errors and histological underestimation rates

**Indications:**

- Microcalcifications (stereotactic guidance)
- MRI guided biopsy
- Complex solid cystic masses/ Intraductal masses/ Subtle infiltrative/ diffuse lesions where broad sampling is needed
- Therapeutic role in excision of small fibroadenoma, Papillary lesion and Radial scar

**Complications**

- Bleeding and pain are not significant
- Rare complications are infections, pneumothorax, pseudoaneurysms and epithelial
- Displacement.

**Breast clip markers**

- To mark the site of biopsy (if the lesion has significantly reduced in size or is barely visible) for future localization in cases of malignancy or to define area of biopsy for future follow-up imaging
- To mark site of cancer treated with neoadjuvant chemotherapy

**Preoperative Hook wire localization**

Preoperative hookwire localization is a procedure in which metallic hook wire is anchored in the nonpalpable breast lesion to provide intraoperative guidance to the surgeon for a lumpectomy. This would enable accurate removal of the malignant lesion with minimal removal of surrounding normal breast tissue and hence, better cosmesis.

The procedure is done under mammographic, ultrasound or MRI guidance, depending on the visibility of the lesion. The excised specimen is then subjected to specimen mammography, to confirm the complete removal of the lesion in excised specimen.

**Structured Reporting**

The level of suspicion for malignancy should be recorded using B1-RADS reporting system which is a structured reporting format and lexicon developed by American College of Radiology (ACR).

**Sample Composite Mammography and Ultrasound Report**
Indication:
Clinical Findings:

Report:
Breast Parenchymal Density (ACR Category):

There is a -------- (Mass/ microcalcification/ distortion/asymmetry) of size ---- in the ---- quadrant of the --------breast at ---- O’clock position ---- mm away from the nipple.

(Mass: shape, margins, density, associated findings
Asymmetry /focal/globular/developing
Microcalcification : morphology, distribution
Architectural Distortion)

Associated findings: Skin thickening or retraction
Nipple areolar complex thickening/retraction etc

Contralateral breast: There is no spiculate mass , pleomorphic microcalcification or distortion in the opposite breast.

Enlarged dense or lymph nodes with loss of fatty hilum in the ipsilateral breast.
No size significant lymphadenopathy in the contralateral axilla

Comparison with previous studies: None
USG Finding:

**Impression:** Suspicious Mass of size ---- in the -------breast as described.
**BIRADS Category:**
**Management Recommendation:** Biopsy/ follow up /routine surveillance.

**Contrast enhanced MRI (CEMRI ) BREAST**

Technique: T2, T1, T2 FAT SAT images of the breasts are obtained using dedicated breast coil, along with a coronal STIR/ TRIM sequence for the axillae. Dynamic pre and post-contrast MR imaging of the breasts is performed and correlated with subtracted images. Mean curves are also obtained.

Clinical details: -----------: Hormonal status:.................

Findings: There is minimal/ mild/moderately/extremely dense fibro glandular tissue with minimal/mild/moderate/extreme background enhancement seen in both the breasts.

There is an enhancing focus/mass/non mass enhancement seen in the --------quadrant of the --------breast at approx ---- -- O'clock position in the ----------anterior/mid/ posterior one third of the glandular tissue, measuring ----X------X------ mm in mediolateral (ML), superoinferior (SI), and anteroposterior (AP) dimensions respectively. The mass shows restricted/ unrestricted diffusion with an ADC value of ------mm²/s. Time- intensity curves were generated, showing slow/medium/ rapid initial enhancement with slow/ rapid washout (Type 1/2/3 curve)

The lesion is ------mm from the skin, ------mm from nipple, and------ from chest wall

**Associated features:**

No suspicious mass or area of non mass enhancement seen in the --------breast.

There is an enlarged node with irregularly thickened cortex in the ----------axilla, suggestive of a suspicious node.
There is no size significant (more than 6mm in SAD) internal mammary lymphadenopathy.

**IMPRESSION:** CEMRI breast reveals ------mm, focus/mass/non mass enhancement in the -------of the ---------breast

**BIRADS Category**

**Management Recommendation**
References


PRIMARY LIVER TUMORS

Version v1.2020

Abhishek Bansal (Delhi)

Rajchandra Kharayat (Bengaluru)
Those tumors which start within the liver- Primary liver tumors

- Most common malignant primary liver lesions are:
  - Hepatocellular Carcinoma (HCC)
  - Intrahepatic Cholangiocarcinoma
  - Hepatoblastoma
  - Angiosarcoma/ Hemangiosarcoma

**Hepatocellular Carcinoma (HCC)**

**BACKGROUND INFORMATION**

Most common primary liver cancer

5th most common cancer worldwide & 3rd most common cause of death due to cancers

Ranks 12 thin India in terms of Incidence and 8th in terms of deaths (GLOBOCAN 2018).

Men > Women

Usually asymptomatic. Non specific symptoms with advanced HCC are abdominal pain, malaise, loss of appetite and/or weight, jaundice.

Common risk factors

- Viral infections: Hepatitis B and C
- Cirrhosis from any cause- Alcoholic, Non-alcoholic fatty liver disease
- Aflatoxin

Cirrhosis of liver: present in 80% of HCC cases.

Chronic hepatitis in the absence of cirrhosis is also related to HCC.

**Fibrolamellar HCC:**

- Rarer subtype, less than 1% of HCC
- Commonly seen in women less than 35 years of age
- Background liver may be normal
- Better prognosis

Ultrasound and S. Alpha-fetoprotein (AFP)-most widely used methods of screening for HCC.

S. AFP cut of value of 100ng/ml- high specificity but less sensitivity.

Triple phase contrast enhanced CT/MRI abdomen is usually used for diagnosing, staging and treatment response evaluation.

Diagnosis of HCC can be noninvasive and biopsy confirmation is not required in many cases. Scenarios in which biopsy may be considered-

- Imaging and other findings are equivocal or not typical.
- Larger lesions in non-cirrhotic livers
- Conditions associated with formation of non-malignant nodules such as cardiac cirrhosis, congestive hepatic fibrosis, Budd Chiari syndrome
- Elevated Ca-19-9 or CEA in order to rule out intrahepatic cholangiocarcinoma.

**Hepatocarcinogenesis** in a liver with cirrhosis or choric hepatitis: Progression through cirrhotic nodule - dysplastic nodule (low grade and high grade) - early HCC well differentiated - moderately and poorly differentiated HCC.

Major role of Interventional Radiologists for loco-regional management of HCC

Molecular tests: Serum Alpha- Fetoprotein (AFP), Protein induced by Vitamin K absence-II (PIVKA II)

**STAGING**

A number of staging systems available. Barcelona Clinic Liver Cancer (BCLC) system is the most widely accepted and validated system and followed across the world.

**IMAGING PROTOCOL (INITIAL EVALUATION)**

Imaging is indicated in cases of rising Sr. AFP or following identification if a liver nodule greater than 10mm based on LI-RADS guidelines.

**ESSENTIAL:**

**CT: TECHNICAL SPECIFICATIONS**

- Multi-detector row CT
- Reconstructed axial slice thickness of less and equal of 5mm
- Multi-planar reconstruction in the coronal and sagittal planes
- Non-ionic contrast media with Iodine concentration >350mg/ml.
- Pressure Injection rates >3 ml/sec with dose of 1.5-2.0 ml/kg body weight
MRI: TECHNICAL SPECIFICATIONS

- High field strength magnet (>1.5 Tesla)
- Phased array multichannel torso coil
- For 2D sequences a slice thickness of less than 8mm and inter slice gap of less than equal to 2mm
- 3D acquisition for contrast images- Slice thickness < 5mm.
- Contrast- Both Extracellular contrast agent (ECA) or Hepato-biliary contrast agent (HBA) can be used
- ECA dose- 0.1mmol/kg
- Dose for gadoxelate disodium 0.025mmol/kg
- Dose of gadobenate dimeglumine 0.1 mmol/kg
- Chemical Shift Imaging
  - In-phase and Out-phase using a Dual echo technique
  - Out-phase images must be obtained before In-phase images
- T1/T2 Weighted images
- Diffusion weighted images- B value 0-50 and B value 400-1000

SCANNING PHASES

PRE-CONTRAST IMAGING

Tells the intrinsic attenuation, identifies fat, iron, calcification, blood products and iodized oil.

Necessary in cases of post ablation and other loco-regional treatments such as TACE/ SIRT

HEPATIC ARTERIAL PHASE

Complete contrast enhancement of hepatic arteries and their branches and non-enhancement of hepatic veins

Early arterial phase- non enhanced portal vein

Late arterial phase- fully enhanced portal vein. Preferred for HCC diagnosis and staging

For CT- Delay of 15-30 sec after aortic threshold enhancement of 150 Hounsfield units (HU) and post injection 30-45 sec.

For MRI multiple arterial acquisition technique should be used to increase the probability of acquiring a adequately timed late arterial phase

PORTAL VENOUS PHASE

Full and maximum enhancement of portal veins with enhancement of hepatic veins by antegrade flow and peak enhancement of hepatic parenchyma

45-55 s delay after aortic threshold enhancement using bolus tracking and 60-75s after start of injection

DELAYED PHASES

Decreased but persistent enhancement of portal and hepatic veins as compared to portal venous phase

>120s after start of injection preferably within a delay of 3-5min

HEPATOBLIARY PHASE (MRI)

Phases obtained after delayed phase hepatic parenchyma is characteristically hyperintense relative to the hepatic vasculature and the spleen and demonstrated contrast excretion into the biliary system
Gadoxelate disodium- 15-20 min after injection

Gadobenatedimeglumine- 60 -120 min after injection due to decreased excretion

**DESIRABLE:**

**CT: TECHNICAL SPECIFICATIONS**

- Use of Bolus tracking method
- Dual head pressure injector used to allow for saline chase (30-40 ml) after contrast injection
- Subtraction Images
  - Both CT and MRI
  - Increased detection of lesions
  - Useful in detection of lesions in post intervention cases

**CONTRAST ENHANCED ULTRASOUND (CEUS)**

- In patients with renal failure (eGFR< 30 ml/min), CEUS can be used

**POSITRON EMISSION TOMOGRAPHY (PET-CT)**

Poor sensitivity

No significant role except for detection of distant metastases

Prognostication of HCC. Higher the Standardized uptake value (SUV), poorer is prognosis.

**IMAGING PROTOCOL (FOLLOW UP/ POST TREATMENT)**

Non-contrast Phase is a must.

Rest of the protocols are similar to Multiphasic CT/MRI protocols for Initial evaluation

mRECIST applied to look for arterial enhancement in any residual lesions.

**REPORT (INITIAL EVALUATION)**

Clinical Indication:

**Procedure Description:** Multi-phasic CT/MRI abdomen study using _____ ml non-ionic intra-venous contrast (Iodine Strength _____ mg/ml) / ______ ml Gadolinium based contrast. No complications were reported.

**Report:**

Liver:

Features of cirrhosis  
Present/Absent

Liver Capsule  
Micronodular/ Macronodular/ Smooth
<table>
<thead>
<tr>
<th>Feature</th>
<th>Yes/No</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesion demonstrating Arterial Phase enhancement</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Lesion size (Diameter)</td>
<td>_____ mm</td>
<td></td>
</tr>
<tr>
<td>Lesion number</td>
<td>_____</td>
<td></td>
</tr>
<tr>
<td>Tumour in Vein</td>
<td>Present/Absent</td>
<td></td>
</tr>
<tr>
<td>Capsule appearance</td>
<td>Present/Absent</td>
<td></td>
</tr>
<tr>
<td>Threshold growth</td>
<td>Present/Absent</td>
<td></td>
</tr>
<tr>
<td>Washout</td>
<td>Present/Absent</td>
<td></td>
</tr>
<tr>
<td>Extracapsular tumour extension</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Hepatobiliary phase hypointensity</td>
<td>Present/Absent</td>
<td></td>
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<tr>
<td>Mild-moderate T2 hyperintensity</td>
<td>Present/Absent</td>
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<tr>
<td>T2 signal intensity</td>
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<tr>
<td>Mild-moderate T2 hyperintensity, well-defined</td>
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<tr>
<td>Marked T2 hyperintensity</td>
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<tr>
<td>Mild T2 hypointensity</td>
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<tr>
<td>Restricted Diffusion</td>
<td>Present/Absent</td>
<td></td>
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<tr>
<td>Mosaic architecture</td>
<td>Present/Absent</td>
<td></td>
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<tr>
<td>Intra-lesional fat</td>
<td>Present/Absent</td>
<td></td>
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<tr>
<td>Features of portal hypertension</td>
<td></td>
<td></td>
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<tr>
<td>Spleen</td>
<td>_____ cm in maximum AP dimension/Axial Plane/Coronal Dimension</td>
<td></td>
</tr>
<tr>
<td>Portal vein Diameter</td>
<td>_____ mm</td>
<td></td>
</tr>
<tr>
<td>Ascites</td>
<td>Present/Absent</td>
<td></td>
</tr>
<tr>
<td>Collateral Vasculature/Varices</td>
<td>Present/Absent</td>
<td></td>
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<tr>
<td>Hepatic arterial anatomy</td>
<td>Standard/Variant (Michel et al.)</td>
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<tr>
<td>Any regional lymph nodes</td>
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<td></td>
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<tr>
<td>Distant Metastases</td>
<td>Present/Absent</td>
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<tr>
<td>Is yes, the organ of involvement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lung</td>
<td></td>
<td></td>
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<tr>
<td>Bone</td>
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</tbody>
</table>
Impression:

ACR-LIRADS Assessment Category

LR1: Definitely benign
LR2: Probably benign
LR3: Intermediate probability of HCC
LR4: Probably HCC
LR5: Definitely HCC
LR5V: Definite tumour in vein
LRM: Probably malignant, not specific for HCC
LR Treated: Treated observation

REPORT (FOLLOW UP/ POST TREATMENT)

Clinical Indication: Known case of HCC. Post treatment evaluation scan.

Details of treatment:

Ablation (RFA/ MWA) Yes/No
TACE (Conventional/ Drug eluting beads/ Bland) Yes/No
SIRT (Y-90/ Other radioactive particles) Yes/No
SBRT Yes/No
Medical Oncology treatment (Sorafenib/ Lenvatinib/ Immunotherapy) Yes/No

If yes, the dose of the drug __________

Surgical treatments (Resection/ Transplant) Yes/No

Procedure Description: Multi-phasic CT/MRI abdomen study using ______ ml non-ionic intra-venous contrast (Iodine Strength _____ mg/ml) / ______ ml Gadolinium based contrast. No complications were reported.

Comparison: Previous study dated __________ available for comparison

Report:

Liver:

Features of cirrhosis Present/ Absent
Liver Capsule Micronodular/ Macronodular/ Smooth
Lesion demonstrating Arterial Phase enhancement Present/ Absent
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<td></td>
</tr>
<tr>
<td>Adrenal Gland</td>
<td></td>
</tr>
</tbody>
</table>
Peritoneum/ Omentum

**Impression:** Post treatment (_______) status with residual/ no residual arterially enhancing lesion

**KEY TAKE AWAY POINTS**

HCC is commonly seen on a background of cirrhosis.

Arterial phase enhancement- unequivocally greater than that of liver parenchyma

Washout appearance on venous/ delayed phases.

Capsule appearance- Peripheral rim of smooth hyper enhancement in portal venous and delayed phases

Corona enhancement- Enhancement of venous drainage area in peri-tumoral parenchyma seen in late arterial/ early portal venous phase with fading to iso-enhancement in subsequent phases.
INTRA-HEPATIC CHOLANGIOCARCINOMAS

BACKGROUND
Primary biliary tract tumor arising from the bile duct epithelium
Second most common primary hepatic tumor after HCC
20% of cases of cholangiocarcinomas.

Three growth patterns/ morphologic subtypes (Liver Cancer Study Group of Japan)

  Mass-forming (most common, accounting for 78% of all cases)
  Periductal-infiltrating
  Intraductal-growth

Chronic biliary inflammation- risk factor

Lymph node and extra-hepatic metastases are more likely than with HCC

STAGING

AJCC (8th edition)

T: primary tumor

  Tx: primary tumor cannot be assessed
  T0: no evidence of a primary tumor
  T1
    T1a: solitary tumor ≤5 cm without vascular invasion
    T1b: solitary tumor >5 cm without vascular invasion
  T2:
    solitary tumor with intrahepatic vascular invasion or,
    multiple tumors, with or without vascular invasion
  T3: tumor perforating the visceral peritoneum
  T4: tumor involving local extrahepatic structures by direct invasion

N: regional lymph node involvement

  Nx: regional lymph nodes cannot be assessed
  N0: no regional lymph node metastasis
  N1: regional lymph node metastasis present
M: distant metastasis

M0: no distant metastasis
M1: distant metastasis present

IMAGING PROTOCOL (INITIAL EVALUATION/ FOLLOW UP/ POST TREATMENT)

ESSENTIAL:

CT: TECHNICAL SPECIFICATIONS

- Multi-detector row CT
- Reconstructed axial slice thickness of less and equal of 5mm
- Multi-planar reconstruction in the coronal and sagittal planes
- Non-ionic contrast media with Iodine concentration >350mg/ml
- Pressure Injection rates >3 ml/sec with dose of 1.5-2.0 ml/kg body weight

MRI: Modality of choice for diagnosis and staging of cholangiocarcinoma.

TECHNICAL SPECIFICATIONS

- High field strength magnet(>1.5 Tesla)
- Phased array multichannel torso coil
- For 2D sequences a slice thickness of less than 8mm and inter slice gap of less than equal to 2mm
- 3D acquisition for contrast images- Slice thickness < 5mm.
- Contrast- Both Extracellular contrast agent (ECA) or Hepato-biliary contrast agent (HBA) can be used
- ECA dose- 0.1mmol/kg
- Dose for gadoxelatediosodium 0.025mmol/kg
- Dose of gadobenatedimeglumine 0.1 mmol/kg
- Chemical Shift Imaging
  - In-phase and Out-phase using a Dual echo technique
  - Out-phase images must be obtained before In-phase images
- T1/T2 Weighted images
- Diffusion weighted images- B value 0-50 and B value 400-1000
- MRCP

SCANNING PHASES

PRE-CONTRAST IMAGING

Tells the intrinsic attenuation and helps in differentiating radiodense intraductal biliary stones from an enhancing intraductal mass.

HEPATIC ARTERIAL PHASE

Helps to distinguish from HCC

To delineate the vascular anatomy prior to surgical resection

Prognostic implications – Those that are hypovascular in the hepatic arterial phase are more likely to demonstrate lymphatic, perineural, and biliary invasion.
PORTAL VENOUS PHASE

DELAYED PHASES
Performed at 3–10 minutes after contrast injection
Enhances in delayed phase due to fibrous stroma- distinguishing feature of cholangiocarcinoma.

HEPATOBIILIARY PHASE (MRI)
Phases obtained after delayed phase
Hepatic parenchyma is characteristically hyperintense relative to the hepatic vasculature and the spleen and demonstrated contrast excretion into the biliary system
Gadoxelate disodium- 15-20 min after injection
Gadobenatedimeglumine- 60 -120 min after injection due to decreased excretion

DESIirable:

CT: TECHNICAL SPECIFICATIONS
  • Use of Bolus tracking method
  • Dual head pressure injector used to allow for saline chase (30-40 ml) after contrast injection
  • Subtraction Images
    o Both CT and MRI
    o Increased detection of lesions
    o Useful in detection of lesions in post intervention cases

POSITRON EMISSION TOMOGRAPHY (PET-CT)
  • Improves nodal staging and identification of distant metastases
  • Recommended for pre-operative staging

REPORT (INITIAL EVALUATION)

Clinical Indication:

Procedure Description: Multi-phasic CT/MRI abdomen study using _____ ml non-ionic intra-venous contrast (Iodine Strength _____ mg/ml) / _______ ml Gadolinium based contrast. No complications were reported.
Report:

Liver:

Lesion size (Diameter)  _____ mm
Lesion number  _____
Enhancement on Delayed phase  Present/ Absent
Capsule retraction  Present/ Absent
Biliary obstruction  Present/ Absent

If present, type of block as per Bismuth’s classification  __________
Vascular encasement  Present/ Absent
Vessel encased  __________
Degree of encasement  __________
Lobar atrophy  Present/ Absent
Extracapsular tumour extension  Present/ Absent
Restricted Diffusion  Present/ Absent

Any regional lymph nodes

Distant Metastases  Present/Absent

Is yes, the organ of involvement  __________

Impression:

REPORT (FOLLOW UP/ POST TREATMENT)

Clinical Indication: Known case of Intrahepatic cholangiocarcinoma. Post treatment evaluation scan.

Details of treatment:

Procedure Description: Multi-phasic CT/MRI abdomen study using _____ ml non-ionic intra-venous contrast (Iodine Strength _____ mg/ml) / ________ ml Gadolinium based contrast. No complications were reported.

Comparison: Previous study dated __________ available for comparison

Report:

Liver:

Lesion size (Diameter)  _____ mm
Lesion number  _____
Enhancement on Delayed phase  Present/ Absent
<table>
<thead>
<tr>
<th>Capsule retraction</th>
<th>Present/ Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biliary obstruction</td>
<td>Present/ Absent</td>
</tr>
<tr>
<td>If present, type of block as per Bismuth’s classification</td>
<td></td>
</tr>
<tr>
<td>Vascular encasement</td>
<td>Present/ Absent</td>
</tr>
<tr>
<td>Vessel encased</td>
<td></td>
</tr>
<tr>
<td>Degree of encasement</td>
<td></td>
</tr>
<tr>
<td>Lobar atrophy</td>
<td>Present/ Absent</td>
</tr>
<tr>
<td>Extracapsular tumour extension</td>
<td>Present/ Absent</td>
</tr>
<tr>
<td>Restricted Diffusion</td>
<td>Present/ Absent</td>
</tr>
</tbody>
</table>

Any regional lymph nodes

Distant Metastases

Is yes, the organ of involvement

**Impression:** Post treatment (_______) status with residual/ no residual lesion. In comparison to previous available study, there is (CR/PR/SD/PD).

**KEY TAKE AWAY POINTS**

Second most common primary hepatic tumor

Three growth patterns/ morphologic subtypes (Liver Cancer Study Group of Japan)

- Mass-forming (most common, accounting for 78% of all cases)
- Periductal-infiltrating
- Intraductal-growth

Shows delayed phase enhancement due to their desmoplastic nature

Liver capsular retraction and biliary obstruction are commonly seen.
GALL BLADDER

Version v1.2020

Saugata Sen (Kolkata)

Argha Chatterjee (Kolkata)
CONTENTS

Part I

Background information

Part II

Imaging Methods: Desirable & Minimal (Pretherapy & Post therapy)

Imaging Protocols for Gall bladder cancer

Part III

Oncoimaging Reporting checklists

C. PRETREATMENT
   4. Reporting checklists for Primary site
   5. Reporting checklist for Nodal stage
   6. Impression

D. POST TREATMENT
Key Points

Part 1

Background information
The most common histopathology gall bladder cancer [GBC] is adenocarcinoma.

Epidemiology:-
- Gall bladder cancer [GBC] is most common in North and Eastern India in the Gangetic plains and relatively less common in Western and Southern states.
- Incidence of GBC can be as high as 8.8-17.1/ million population in Northern India
- Age of presentation in Indian patients is earlier than that of Western population and it is usually in the 5th to 6th decade.
- Women have 2-6 times higher risk of developing GBC than men.

Clinical features:-
- The clinical features comprise of dyspepsia, abdominal pain, jaundice, ascites or there may not be any symptoms at all.

Treatment outline:-
- Most patients present with inoperable and/or metastatic disease, principally in the liver. In such situations, palliative chemotherapy is the only option.
- In case of borderline lesions, neoadjuvant chemotherapy followed by surgery is offered.
- In operable candidates, the surgery may vary from radical cholecystectomy to right or extended right hepatectomy. Prior to hepatectomy, PTBD and Portal vein embolization may be required.
- 27-41% of patients of all gallbladder cancer are incidentally detected during or after routine cholecystectomy (post-op biopsy) for gallstone related or benign gallbladder disease. This category is named ‘incidental Gall Bladder Cancer [IGBC] and is treated by completion cholecystectomy, that includes resection of a wedge of liver. 40-76% of patients of IGBC are found to have residual disease on surgical re-exploration.
- Diagnosis of GBC is initially made by USG. For operability and follow up, CT or MRI or both are performed. Contrast imaging is essential. Image guided biopsy or FNAC are not performed in operable lesions to avoid tract dissemination. However, image guided FNAC/ biopsy is usually needed before any chemotherapy/ radiation.
Part 2

Imaging modality:-

- USG is the initial modality of choice to image a suspected case of GBC [dyspepsia, pain in the right upper quadrant of abdomen, jaundice or ascites]. Once there is a mass detected in the Gall Bladder fossa on USG, CT with contrast is needed for initial staging.
- CT abdomen, dual/ triple phase with contrast, is the principal modality in the initial staging, preoperative planning and follow up of GBC.
- MRI with contrast and MRCP sequence is performed when knowledge of detailed biliary anatomy and nature and level of biliary obstruction is important in the management.
- CT of thorax is advised preoperatively to rule out lung metastases.

<table>
<thead>
<tr>
<th>Desirable imaging method</th>
<th>Minimal imaging method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Primary setting</strong></td>
<td></td>
</tr>
<tr>
<td>Contrast enhanced CT and MRI for anatomical delineation of biliary tract.</td>
<td>Contrast enhanced CT in both primary and post therapy setting.</td>
</tr>
<tr>
<td><strong>B. Post therapy</strong></td>
<td></td>
</tr>
<tr>
<td>Contrast enhanced CT</td>
<td></td>
</tr>
</tbody>
</table>

Imaging protocol and minimum reporting requirement:-

**CECT ABDOMEN**

- Procedure: CT scan of the Upper Abdomen with contrast.
- Indication: To evaluate mass in the GB fossa detected on USG/Liver secondaries/retroperitoneal nodes.
- **Topogram-** Supine head to toe direction.
- **Coverage-Cover from domes of diaphragm through iliac artery bifurcation.** Hands should be raised above the head and provided support by a pillow.
- Quiet breathing; Scan done in cranio-caudal direction with narrative direction of inspiratory hold.
- **Scan Type-Helical**

<table>
<thead>
<tr>
<th>Technical / Contrast</th>
<th>Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>kVp</td>
<td>Care kV (ref. kV 120)</td>
</tr>
<tr>
<td>Effective mAs</td>
<td>Care Dose</td>
</tr>
<tr>
<td>Care Dose</td>
<td>200MAs</td>
</tr>
<tr>
<td>Reference mAs</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Time (Rotation)</td>
<td>0.5 sec (Depends on scanner slice)</td>
</tr>
<tr>
<td>Average Acquisition Time</td>
<td>5-7 sec.</td>
</tr>
<tr>
<td>Collimation</td>
<td>128 x 0.6 mm</td>
</tr>
<tr>
<td>Pitch Value</td>
<td>0.8 to 1.5</td>
</tr>
<tr>
<td>Scan Direction</td>
<td>Craniocaudal</td>
</tr>
<tr>
<td>Slice Thickness</td>
<td>2/3mm</td>
</tr>
<tr>
<td>Slice interval</td>
<td>0 mm</td>
</tr>
<tr>
<td>Multiplanar reformat</td>
<td>coronal and sagittal[thickness: 2 mm, interval: 0 mm].</td>
</tr>
<tr>
<td>Reconstruction Spacing</td>
<td>3 mm</td>
</tr>
<tr>
<td>Reconstruction Algorithm</td>
<td>l40f ( soft tissue ) and l26f ( thin )</td>
</tr>
<tr>
<td>Contrast Type</td>
<td>(Non ionic iodinated) with Iodine concentration- 300/350 mg/mL</td>
</tr>
<tr>
<td>Contrast dose</td>
<td>1.8 - 2 ml/kg of 300-350 mg Iodine/ml contrast through antecubital vein</td>
</tr>
<tr>
<td>Early arterial phase</td>
<td>15-20 sec</td>
</tr>
<tr>
<td>portal venous phase</td>
<td>75-90 sec</td>
</tr>
<tr>
<td>Contrast Volume</td>
<td>80 ml</td>
</tr>
<tr>
<td>Saline Flush</td>
<td>N/A</td>
</tr>
<tr>
<td>Injection Rate</td>
<td>3 ml/sec</td>
</tr>
<tr>
<td>Oral Contrast</td>
<td>Neutral oral contrast with of water immediately to 15 minutes before CT [optional]. Positive oral contrast is discouraged.</td>
</tr>
<tr>
<td>Contrast Volume</td>
<td>350-500 ml</td>
</tr>
</tbody>
</table>

**Comments:**

- Optimal contrast flow rate is crucial for arterial phase images. One may consider lower flow rate if the disease is already metastatic and information
regarding vascular anatomy and involvement is not critical.

- Bolus tracking is performed off the abdominal aorta using a 230 HU trigger setting.

[MRI with contrast is used as a problem solving tool. Minimum sequences: Axial and coronal T2W, Axial DWI, Axial and coronal T1 weighted [VIBE/LAVA] pre-contrast, early arterial, portal venous and delayed phase, thin-slab and thick-slab MRCP [HASTE/SSFSE/RARE] and 3D MRCP]

Part 3
Reporting checklists
1. Gall Bladder fossa mass lesion
   a) Endophytic and contained within the lumen. Size.
   b) Focal /diffuse wall thickening [wall thickness]
   c) Mass forming lesion.


3. Involvement of surrounding hollow viscus:
   a) Hepatic flexure/ duodenum/ antrum of stomach
   b) Nature of involvement of hollow viscus: Loss of fat plane/ obvious irregular wall thickening/ obvious intraluminal mass

4. Vascular involvement [degree of involvement, i.e. abutment/stenosis/occlusion, less critical]:
   a) Right hepatic artery/ common hepatic artery [isolated involvement of left artery rare]
   b) Right portal vein/ main portal vein.
   c) Intraluminal tumour

5. Biliary involvement
   a) Common duct: abutment/ stenosis/occlusion. Segment length of occlusion, if non-occluded normal CBD seen more distally [optional].
   b) Confluence of right and left hepatic ducts (floor of the confluence/ the roof of confluence) [coronal reformat is critical]
   c) Separation of primary/right secondary/left secondary biliary confluence
   d) Length of tumour-free extrahepatic left duct [at least 5 mm length needed for successful anastomosis after hepatectomy].

6. Distant involvement
   a) Peritoneal disease: absent/indeterminate/present
   b) Peritoneal/ omental nodule/thickening
c) Metastases: absent/indeterminate/present

d) Liver/adrenal/visualised portion of thorax.

**Reporting Checklist – Nodal stage**

a) Nodal disease: Nodes larger than 1 cm in short axis dimension are considered abnormal. Round shape, heterogeneous enhancement and irregular margin of nodes are also suspicious features.

b) Regional nodes [definitely regional; N1/N2 as per AJCC/TNM guideline]: Cystic duct, pericholedochal, retroportal [posterior to portal vein up to uncinate process of pancreas], liver hilar and common hepatic artery nodes.

c) Watershed nodes [controversially regional as per Japanese Society of Biliary Surgery]: Posterior-superior pancreatiduodenal [located in the posterior and superior portion of pancreato-duodenal groove] and right side of celiac artery nodes.

d) Metastatic nodes [definitely non-regional]: Left side of celiac or superior mesenteric artery, para-aortic, intero-aortocaval and retrocaval nodes.

[Note: final nodal staging is determined in the surgical specimen; therefore mentioning the number of involved nodes is not critical in the radiology report, especially in regional stations. However, detection of involved non-regional and watershed nodes is critical in imaging as they are missed in routine cancer surgery or staging laparoscopy].

**Impression**

If possible after brief description of primary and nodes, mention T and N category.

*Check the AJCC 8th edition T & N tables for each cancer and while doing so*

Primary –

If not possible to allocate T category confidently, simply summarize extent of primary tumour in impression

Nodes -

If not possible to give N category, describe location and number of abnormal nodes.
B. POST TREATMENT

POST TREATMENT TEMPLATE should have

Structured report (common elements)

CT study dated:

Previous study: available / not available (mention which study- CT/MRI) and If available : date

Clinical Indication & Previous treatment :

Legend: Describe Procedure

Report – Use Checklists

| Gall Bladder fossa mass lesion | Increased or decreased ( post Chemo setting )
|                              | If surgically operated - presence of any nodular enhancing lesions in post op bed. |
| Vascular involvement          | If response seen , whether vascular structures are still involved |
| Biliary involvement           | Extent of IHBRD - increased or decreased |
| Distant involvement           | increased or decreased |

Key Points

- Ultrasound is the initial modality of choice to image a suspected case of GBC.
- CT abdomen with contrast is the principal modality in the initial staging, preoperative planning and follow up of GBC.
- CECT helps to determine the resectability of gall bladder carcinoma and provides a vascular road map for radical cholecystectomy.
STOMACH

Version v1.2020

Diva Shah (Ahmedabad)
CONTENTS

Part I
Background information

Part II
Imaging Methods & Imaging Protocols for gastric cancers in pre and post therapy settings

Part III
Reporting checklists

Key points

References
Part I
Background information

- Gastric cancer is worldwide a leading cause of death and it is reported as the second cause of cancer-related deaths world-wide.
- Adenocarcinomas account for 95% of all GCs. (Gastric cancers) Most GCs are polypoid or ulcerated. Based on the level of invasion, GCs are divided into early gastric cancer (EGC) and advanced gastric cancer (AGC).
- Well established risk factors to the development of gastric cancer, includes H. pylori infection, smoking and alcohol, pernicious anemia, severe chronic atrophic gastritis, adenomatous polyps, billroth II surgery procedure, Ménétrier disease, salted and smoked food, and high nitrite and nitrate content.
- Surgical resection (Endoscopic/ robotic /laprotoscopic/laprotomy)is the only cure available and is dependent on the GC stage at presentation, which incorporates depth of tumour invasion, extent of lymph node and distant metastases. Accurate preoperative staging is therefore essential for optimal surgical management with consideration of preoperative and/or postoperative chemotherapy.
- Apart from clinical symptoms diagnosed by Upper GI Scopy and guided biopsy, Endoscopic ultrasound, CECT and PETCT are major diagnostic investigation. MRI provides better soft tissue contrast than CT scan, but due to its long acquisition time and susceptibility to motion artifacts, there has been limited use of MRI for gastrointestinal tract imaging.
- Radiologists have an important role in the correct staging .TNM Staging : The 8th edition of the AJCC (American Joint Committee on Cancer) staging of the cancer of gastric cancer is widely used now.
- The document below provides a list of gastric cancers, the role of imaging methods in the primary staging and post therapy staging of each cancer, imaging protocols, and pre as well as post treatment reporting checklist for the same.

Types of malignancy commonly encountered include:

- Squamous cell carcinoma
- Adenocarcinoma
- Lymphoma
- Leimyosarcoma
- Mucinous tumors
- GIST
- Neuroendocrine tumors

Part II
Imaging methods

Cross sectional imaging -contrast enhanced CT scan from the cornerstone of TNM staging for gastric cancers. PET/CT evaluation from skull base to midthigh are recommended if metastatic disease is not evident. The routine use of PET-CT has got practical difficulties in Indian setting because of cost, availability, and the high false-positive rate due to infections such as tuberculosis. However, most major centres in the country have included this investigation as part of the routine preoperative workup.

After Initial workup (upper GI Scopy and guided biopsy), cross sectional imaging enables patients to be classified into 2 clinical stage groups:

- Locoregional cancer (stage I–III)- Staging laproscopy needs to be mentioned here as it is an essential part of preoperative work up of resectable but locally advanced work up of gastric cancer. As it detects occult peritoneal and serosal metastases and prevent futile laparotomy in advanced gastric cancers.
- Metastatic cancer (stage IV)

Table 1 shows the optimal imaging methods for gastric cancers (called “Essential ”), and (“Desirable”) methods (for providing additional important clinical information needed for planning treatment in that region.

Table 1 : Imaging methods for gastric cancers
### Minimal/Essential imaging method & reason

<table>
<thead>
<tr>
<th>Minimal/Essential imaging method &amp; reason</th>
<th>Desirable method</th>
</tr>
</thead>
</table>
| **A. Primary setting** Contrast enhanced CT - preferred method in stomach malignancy show soft tissue involvement, extent, locoregional involvement including nodal spread, peritoneal and omental disease. | **A. Primary setting**
1. **PETCT** for a) metastatic workup in locally advanced cancer
b) DOTA PETCT for evaluation of neuroendocrine tumours of stomach. |
| **B. Post therapy** Contrast enhanced CECT – to show local recurrence/residual disease versus post treatment changes, locoregional extent of the residual disease. | **B. Post therapy**
1. **PETCT** to a) detect residual/recurrent disease, better, any new appearance of metastatic disease also. |

### Part II

**Imaging protocols.**

<table>
<thead>
<tr>
<th>Parameters (CECT ABDOMEN AND PELVIS for gastric cancers)</th>
<th>Phase 1 (NCCT)</th>
<th>Phase 2(arterial) (Optional)</th>
<th>Phase 3(portal venous)</th>
<th>Delay (optional)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slice thickness</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Interslice Gap Recon-mm</td>
<td>3mm</td>
<td>1mm</td>
<td>1mm</td>
<td>1mm</td>
</tr>
<tr>
<td>Algorithm</td>
<td>Soft tissue</td>
<td>Soft tissue</td>
<td>Soft tissue</td>
<td>Soft tissue</td>
</tr>
</tbody>
</table>

**Contrast**

- Oral contrast negative
  - Yes-plain water 1000ml/1000ml water + 30 ml contrast - nonionic iodinated contrast
- On table - two Glasses of oral contrast/Negative contrast
- IV contrast 1.5 ml /Sec 300/350 Iodine concentration
  - Nonionic
  - Flow rate 3 to 3.5 ml/sec
  - Yes

**Delay**

<table>
<thead>
<tr>
<th>Delay</th>
<th>25-30 sec</th>
<th>50-70 sec</th>
<th>300sec</th>
</tr>
</thead>
</table>

**Scanning**

<table>
<thead>
<tr>
<th>Start</th>
<th>Lower end of sternum</th>
<th>Lower end of sternum</th>
<th>Lower end of sternum</th>
<th>Iliac creast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop</td>
<td>Symphysis</td>
<td>Iliac crest</td>
<td>Symphysis pubis</td>
<td>Symphysis pubis</td>
</tr>
<tr>
<td>Inspiration and breath hold</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>-</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>-----</td>
<td>-----</td>
<td>-----</td>
<td>---</td>
</tr>
<tr>
<td>Reformatations</td>
<td></td>
<td></td>
<td></td>
<td>Coronal Sagittal</td>
</tr>
<tr>
<td>Lung window</td>
<td>Yes</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bone window</td>
<td>-</td>
<td>-</td>
<td>Yes</td>
<td>-</td>
</tr>
</tbody>
</table>

In Indian setting, Imaging protocols are varied depending on local facilities available and affordability of the patient.

Computed Tomography (CT) is the preferred and minimum, essential imaging procedure for staging of gastric cancer, supplemented by Upper GI scopy/ PET CT scan as appropriate.

**Stomach**
- Area to be examined abdomen and pelvis.
- Localisation - CT with intravenous contrast medium using 1 litre water as an oral contrast agent immediately prior to scan (muscle relaxant - optional).
  - Staging - CT with intravenous contrast medium. The liver should be examined in portal venous phase (*arterial phase optional*) 5mm max thickness preferred.

**Clinical Profile:**

<table>
<thead>
<tr>
<th>Name Of Patient</th>
<th>Patient’s Date Of Birth / Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Name(S) Of Referring Physician(S)</td>
<td></td>
</tr>
<tr>
<td>Name or Type Of Examination</td>
<td></td>
</tr>
<tr>
<td>Date &amp; Time Of The Examination</td>
<td></td>
</tr>
<tr>
<td>Date and Time Of Report</td>
<td></td>
</tr>
<tr>
<td>Clinical Profile</td>
<td></td>
</tr>
<tr>
<td>Creatinine Clearance</td>
<td></td>
</tr>
</tbody>
</table>

**Technical Protocol:**

<table>
<thead>
<tr>
<th>Topogram</th>
<th>Supine Head to toe direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scan Type</td>
<td>Helical</td>
</tr>
<tr>
<td>KV/MA/Rotation Time</td>
<td>120KV/ 200MAs/0.8 sec</td>
</tr>
<tr>
<td>Pitch/Speed</td>
<td>0.938:1/18.75</td>
</tr>
<tr>
<td>Dfov</td>
<td>Large (36 mm)</td>
</tr>
<tr>
<td>Detector width x-Raws</td>
<td>16 x 1.25/64 X 0.625</td>
</tr>
<tr>
<td>Radiation dose calculation CTDI &amp;DLP</td>
<td>Automated</td>
</tr>
</tbody>
</table>

Coronal and sagittal multiplanar reformatted images or with volume-rendering CT gastrography is required for better evaluation gastric tumour depth and extent.
Part III
Structured Reporting
A cancer imaging report for staging a primary tumour should include:

- A description of the tumour, and appropriate measurement of primary tumour site.
- A descriptive statement of the primary tumour and the extent of tumour spread in relation to adjacent anatomy, image and series numbers on which the tumour is demonstrated.
- A statement regarding the presence or absence of nodal enlargement in nodal chains draining the primary tumour and a guide as to the number of enlarged nodes identified.
- A statement regarding the presence of distant metastases.
- Dimensions and location of metastases should be recorded with reference to specific image numbers—at least the largest and smallest should be measured (RECIST reporting criteria).
- Dimensions and recognition of metastases may be useful as marker lesions for measuring response information provides the clinician with an overall assessment of tumour burden prior to treatment.

Reporting checklist template for gastric cancers

- Site
- Extent—Focal, segmental/Diffuse.
- Focal -location within the stomach. Maximum length of the involved segment.
- Peri-gastric fat planes - Preserved, effaced, infiltrated
- Relationship with adjacent structures
- Nodal status-Number and morphology
- Regional – Peri gastric, along left gastric artery, common hepatic artery, coeliac, splenic artery, hepato-duodenal and retro-pancreatic as well as superior mesenteric vessel nodes.
- Non regional -Apart from regional nodal classification
- Metastasis
- Synchronous primary lesion elsewhere in the esophagus or stomach.
- Parietal peritoneum – Focal nodular deposits/ Hazziness/ Nodularity
- Greater Omentum – Supra-colic /Infarcolic -Focal nodular deposits/ Hazziness/ Nodularity
- Lesser Omentum-focal nodular deposits/ Hazziness/ Nodularity
- Arterial anatomy- Coeliac artery and its branches and any anatomic arterial variation
- Ascites- Present /absent – if present predominate location/presence /absence of internal echoes.

Comments/Impression –

- T-tumour site , location and locoregional extent
- Nodal status Regional and Non regional nodal metastasis.
- Distant metastasis

Post-operative imaging (gastric cancers)

BACK GROUND

Most of the advanced gastric carcinoma and type III GE junction tumors requires neoadjuvant chemotherapy (3 cycle) followed response evaluation and followed by proximal, distal, subtotal or total gastrectomy, depending upon site and location of malignancy.

Locally advanced /metastatic oesophageal and gastric cancers need palliative chemotherapy. 

Comparison with previous study is ideal to generate an accurate post treatment template.

Reporting checklist for post operative gastric cancers.

NCCT abdomen pelvis.

- Basal Pleural effusion, atelectasis.
- Any collection at peri-operative site (partial/total gastrectomy).
- Status of bowel (small /large bowel) dilatation /narrowing.
**NCCT THORAX /ABDOMEN & PELVIS WITH (ORAL CONTRST/Water), followed by intravenous contrast**

- Area of stenosis or narrowing or abnormal wall thickening or mucosal enhancement. Also look for normal passage of oral contrast up to the proximal jejunal loops.
- Abnormal wall thickening or lesion at operative bed site (partial /total gastrectomy )
- Look for stoma site
- Look for any leak, fistula from proximal or distal stoma site .
- Look for intra abdominal drains and its position .
- Any focus of distant metastasis in other abdominal or thoracic organ.
- Look carefully of retroperitoneal nodes.
- Look for peritoneal /omentum nodularity /definite metastatic deposits.
- Ascites

**Comments/Impression –**

- ◊ Post operative status
- ◊ Any recurrent lesion at operative bed site /leak /striction
- ◊ Recurrent nodal status or distant nodal metastasis
- ◊ Distant metastasis .

**Key points:**

- Accurate preoperative staging of Gastric cancer is essential for planning optimal surgical management.
- MDCT is currently the preferred technique for staging of Gastric cancers.
- Radiologists should know which features need to be assessed to provide the surgeon clear and concise information for thorough preoperative evaluation (see reporting checklist template).
- Gastric cancer staging accuracy improved with MDCT including coronal and sagittal multiplanar reformatted images or with volume-rendering CT gastrography than with conventional 2D axial CT images.
- FDGPETCT is an desirable investigation for locally advanced gastric cancers, to evaluate distant/occult peritoneal and serosal metastasis and treatment response after adjuvant chemotherapy.
- DOTA PETCT is again desirable imaging investigation for evaluation neuroendocrine tumours

**References:**


PANCREAS

Version v1.2020

Saugata Sen (Kolkata)

Sumit Mukhopadhyay (Kolkata)
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   8. Reporting checklist for Nodal stage
   9. Impression

F. POSTTREATMENT

Key Points
Part 1

BACKGROUND INFORMATION

- Pancreatic ductal adenocarcinoma (PDAC) is the 12th most common cancer worldwide and is the 3rd leading cause of cancer-related deaths.
- More common in the west as compared to Asia.
- In India the incidence varies from 0.5 to 2.4/100,000 persons per year in women and 0.2 to 1.8/100,000 persons per year in men.
- More commonly in male in urban areas of Northern and Western India.
- Association between tropical pancreatitis and pancreatic cancer.
- Poor prognosis with a 5 year survival rate of 9%.
- Surgical resection is the only potentially curative treatment option.
- On presentation most of the patients are metastatic with only 15%-20% being operable.
- Distribution -- head (60-70%), body (10-20%) and tail (5-10%).
- Imaging plays a pivotal role in the management of PDAC.

STAGING: TNM staging, AJCC (8th edition)

Tumour (Usually best evaluated in late arterial/pancreatic parenchyma phase)

<table>
<thead>
<tr>
<th>T1</th>
<th>Tumor limited to pancreas &lt;2 cm in greatest dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1a</td>
<td>&lt; 0.5 cm in greatest dimension</td>
</tr>
<tr>
<td>T1b</td>
<td>&gt; 0.5 cm and &lt; 1 cm in greatest dimension</td>
</tr>
<tr>
<td>T1c</td>
<td>1–2 cm in greatest dimension</td>
</tr>
<tr>
<td>T2</td>
<td>Tumor limited to pancreas &gt; 2 cm and &lt;4 cm in greatest dimension.</td>
</tr>
<tr>
<td>T3</td>
<td>Tumor limited to pancreas &gt; 4 cm in greatest dimension.</td>
</tr>
<tr>
<td>T4</td>
<td>Tumor involves CA, SMA, and/or CHA regardless of size.</td>
</tr>
</tbody>
</table>

Node: Short axis diameter >10 mm is considered to be positive. However sensitivity is low. Other morphological characteristics such as round shape, heterogeneity, necrosis and perinodal irregularity can also be used. Nodal disease that is outside the surgical field is considered metastatic (Infra renal or retroperitoneal nodes, or nodes left of the superior mesenteric artery)

| N0   | No regional node metastases                          |
| N1   | Regional lymph node metastases 1-3                   |
| N2   | Regional lymph node metastasis 4 or more nodes       |
Metastases
Liver, peritoneum, lungs and bones are the most common sites

<table>
<thead>
<tr>
<th>M0</th>
<th>No distant metastasis.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>Distant metastasis.</td>
</tr>
</tbody>
</table>

**Beyond TNM: A clinically relevant way of classifying PDAC to guide treatment are:-**

1. Resectable
2. Borderline resectable
3. Unresectable (locally advanced and metastatic)

There are multiple societies providing guidelines especially in terms of definitions of vascular involvement and these guidelines have changed over a period of time. Therefore definitions of borderline resectable and unresectable disease vary, not only between societies, but within a society over time, and also between Institutions and Surgeons.

<table>
<thead>
<tr>
<th>Vessel Involvement</th>
<th>NCCN2017</th>
<th>MDACC</th>
<th>ACTO</th>
<th>AHPBA/SSAT/SSO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Celiac axis abutment(&lt;180 degree)</td>
<td>Borderline</td>
<td>Borderline</td>
<td>Borderline</td>
<td>Unresectable</td>
</tr>
<tr>
<td>Celiac axis encasement(&gt;180 degree)</td>
<td>Borderline</td>
<td>Unresectable</td>
<td>Unresectable</td>
<td>Unresectable</td>
</tr>
<tr>
<td>SMA abutment</td>
<td>Borderline</td>
<td>Borderline</td>
<td>Borderline</td>
<td>Borderline</td>
</tr>
<tr>
<td>HA abutment and short segment encasement</td>
<td>Borderline</td>
<td>Borderline</td>
<td>Borderline</td>
<td>Borderline</td>
</tr>
<tr>
<td>SMV/PV encasement (&gt; 180) or abutment (&lt;180) with contour abnormality</td>
<td>Borderline</td>
<td>Borderline</td>
<td>Borderline</td>
<td>Borderline</td>
</tr>
</tbody>
</table>

**Part 2**
**IMAGING PROTOCOL**

- Imaging should be easily available, affordable, have local expertise and accurate.

<table>
<thead>
<tr>
<th>Desirable imaging method</th>
<th>Minimal imaging method</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Primary setting</strong></td>
<td><strong>Contrast enhanced CT in both primary and post therapy setting.</strong></td>
</tr>
<tr>
<td>1. Contrast enhanced CT</td>
<td></td>
</tr>
<tr>
<td>2. DECT is preferred where available</td>
<td></td>
</tr>
<tr>
<td>3. MRI useful /problem solving tool to further evaluate indeterminate/indistinct pancreatic mass and liver lesion.</td>
<td></td>
</tr>
<tr>
<td>4. Endoscopic Ultrasound(EUS) is complementary to cross sectional imaging techniques. It plays a pivotal role in performing FNAB /FNAC from the pancreatic lesion.</td>
<td></td>
</tr>
</tbody>
</table>
5. PET-CT is usually a problem solver and helpful in detecting metastatic disease particular

**B. Post therapy**

Contrast enhanced CT - remains similar to that of pre-treatment protocol.

### CT SCAN

<table>
<thead>
<tr>
<th>CT scanner</th>
<th>Multidetector CT (16 slice and above is preferred)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tube potential</td>
<td>120 kVp (adjusted to 100 kVp to 140 kVp based on body habitus)</td>
</tr>
<tr>
<td>Tube current</td>
<td>Automated tube current modulation.</td>
</tr>
<tr>
<td>Oral contrast</td>
<td>Neutral agent, water (cheapest/easily available)</td>
</tr>
<tr>
<td>Dual phase</td>
<td>Late arterial/Pancreatic phase: 30-35 s / 40–50 s</td>
</tr>
<tr>
<td></td>
<td>Portal venous phase: 65–70 s</td>
</tr>
<tr>
<td></td>
<td>Delayed phase at 3 min and Pre-contrast imaging optional. Scan is initiated after an empiric delay appropriate to a phase or bolus tracking methods</td>
</tr>
<tr>
<td>Acquisition/Interslice gap</td>
<td>Submillimeter acquisition preferable/None</td>
</tr>
<tr>
<td>MDCT data Post-processing</td>
<td>Axial 2–5 mm thickness.</td>
</tr>
<tr>
<td></td>
<td>MPR (Coronal and sagittal) 2–3 mm.</td>
</tr>
<tr>
<td></td>
<td>Additional reconstructions MIP &amp; VR for vascular mapping</td>
</tr>
<tr>
<td></td>
<td>Oblique MPR: to view a structure, such as ducts.</td>
</tr>
</tbody>
</table>

### MRI SCAN

<table>
<thead>
<tr>
<th>Sequence</th>
<th>plane</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>T2 2D SSFSE or HASTE</td>
<td>Axial and coronal (4/5 mm)</td>
<td>Evaluate overall anatomy and pancreaticobiliary ductal system</td>
</tr>
<tr>
<td>T2 2D with fat suppression</td>
<td>Axial (5 mm)</td>
<td>Pancreatic mass and metastasis evaluation</td>
</tr>
<tr>
<td>T1 in-phase and opposed-phase gradient echo</td>
<td>Axial (5 mm)</td>
<td>To confirm intracellular fat (such as focal fatty changes in the pancreas that can mimic as lesion on CT)</td>
</tr>
<tr>
<td>T2-weighted MRCP (3D)</td>
<td>Coronal (1 mm)</td>
<td>Pancreaticobiliary ductal system</td>
</tr>
<tr>
<td>DWI (with ADC map)</td>
<td>Axial (5 mm)</td>
<td>Assess pancreatic mass and metastases.</td>
</tr>
<tr>
<td>T1 3D fat-suppressed SPGR without contrast</td>
<td>Axial (3 mm)</td>
<td></td>
</tr>
<tr>
<td>Post-contrast Dynamic T1 3D fat-suppressed SPGR (in pancreatic, portal venous, and delayed phases). Hepatobiliary phase can also be acquired to evaluate small lesions in liver</td>
<td>Axial [3 mm] (coronal is optional)</td>
<td>Portal venous and delayed phases are best for detecting lymphadenopathy and liver/peritoneal</td>
</tr>
</tbody>
</table>
### Part 3

**REPORTING TEMPLATE**

**Morphological Criteria**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>Appearance</td>
<td>hypo/iso/hyper attenuating/intense(usually in pancreatic phase)</td>
</tr>
<tr>
<td>Size</td>
<td>In two dimension --- axial sections</td>
</tr>
<tr>
<td>Location</td>
<td>head/body/tail</td>
</tr>
<tr>
<td>MPD narrowing/cut off /upstream dilatation</td>
<td>Present /absent</td>
</tr>
<tr>
<td>Bile duct narrowing/cut off/upstream dilatation</td>
<td>present/absent</td>
</tr>
</tbody>
</table>

**Arterial Evaluation**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMA involvement</td>
<td>present/absent</td>
</tr>
<tr>
<td>Degree of solid soft tissue/stranding/hazy attenuation</td>
<td>Less /more than 180 degree</td>
</tr>
<tr>
<td>Focal vessel narrowing/ contour irregularity</td>
<td>present/absent</td>
</tr>
<tr>
<td>Extension to first SMA branch</td>
<td>present/absent</td>
</tr>
<tr>
<td>Celiac axis involvement</td>
<td>present/absent</td>
</tr>
<tr>
<td>Degree of solid soft tissue/stranding/hazy attenuation</td>
<td>Less /more than 180 degree</td>
</tr>
<tr>
<td>Focal vessel narrowing/ contour irregularity</td>
<td>present/absent</td>
</tr>
<tr>
<td>CHA involvement</td>
<td>present/absent</td>
</tr>
<tr>
<td>Degree of solid soft tissue/stranding/hazy attenuation</td>
<td>Less /more than 180 degree</td>
</tr>
<tr>
<td>Focal vessel narrowing/ contour irregularity</td>
<td>present/absent</td>
</tr>
<tr>
<td>Extension to celiac axis/bifurcation of right and left hepatic arteries</td>
<td>present/absent</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Arterial variant</th>
<th>Present/Absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variant arterial -tumour contact</td>
<td>present/absent/usual format</td>
</tr>
</tbody>
</table>
Venous Evaluation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>finding</th>
</tr>
</thead>
<tbody>
<tr>
<td>MPV involvement</td>
<td>Present/absent</td>
</tr>
<tr>
<td>Degree/length of solid soft tissue/stranding/hazy attenuation</td>
<td>&lt;/&gt;/more than 180 degree/--- cm</td>
</tr>
<tr>
<td>Focal vessel narrowing/ contour irregularity</td>
<td>present/absent</td>
</tr>
<tr>
<td>SMV involvement</td>
<td>Present/absent</td>
</tr>
<tr>
<td>Degree/length of solid soft tissue/stranding/hazy attenuation</td>
<td>&lt;/&gt;/more than 180 degree/--- cm</td>
</tr>
<tr>
<td>Focal vessel narrowing/ contour irregularity</td>
<td>present/absent</td>
</tr>
<tr>
<td>Extension into the first jejunal vein</td>
<td>present/absent</td>
</tr>
</tbody>
</table>

Thrombus in vein present/absent(mention which vein)

Venous collaterals present/absent(location)

Extra pancreatic findings

<table>
<thead>
<tr>
<th>Parameters</th>
<th>findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver lesions/metastases</td>
<td>present/absent/indeterminate</td>
</tr>
<tr>
<td>Omental and peritoneal nodules</td>
<td>present/absent/indeterminate</td>
</tr>
<tr>
<td>Ascites</td>
<td>Present/absent</td>
</tr>
<tr>
<td>Suspicious lymph nodes</td>
<td>present/absent/indeterminate</td>
</tr>
<tr>
<td>Any other extra pancreatic disease</td>
<td>Present /absent/indeterminate</td>
</tr>
</tbody>
</table>

Reporting template in response assessment

B. POST TREATMENT
POST TREATMENT TEMPLATE should have
Structured report (common elements)
F. CT study dated:
G. Previous study : available / not available(mention which study- CT/MRI) and If available : date
H. Clinical Indication & Previous treatment :
I. Legend: Describe Procedure
J. Report – Use Checklists
Follow the pre-treatment reporting template
In case of surgical resection (post NACTRT) is contemplated to mention about the status of tumour-vessel contact as 1)increase 2)decrease 3)Stable
In case of Post CT/RT as the treatment modality categorization into complete response(CR)/partial response(PR)/stable disease(SD)/Progressive disease(PD) using RECIST1.1 criteria

**KEY POINTS**

- PDAC is an aggressive malignant lesion with a poor overall 5 year survival rate.
- Surgical resection is the only potentially curative option.
- Imaging plays a pivotal role in the management of PDAC.
- MDCT is the preferred modality.
- EUS plays an important role in tissue diagnosis/sampling.
- MRI and PET-CT are used as problem solving tools and detecting metastases.
- Response evaluation in post Neoadjuvant CTRT can be challenging and management of these patients should be decided in the multidisciplinary team meetings (MDTM).
KIDNEY TUMORS

Shivakumar Swamy (Bengaluru)
Background:
Renal tumours account for approximately 3% of all adult cancers. Most of the renal tumours are incidentally detected in routine ultrasound examinations or imaging for other purposes. Most common renal tumour in childhood is Wilms tumour and in adults is renal cell carcinoma (RCC). Imaging of renal tumours has come a long way from primitive imaging methods like retrograde pyelography, intravenous pyelography to the recent cross-sectional imaging modalities like CT, MRI and PET.

Relevant Anatomy:

The kidneys lie in the bilateral renal fossa of the retroperitoneum surrounded by the perinephric fat, anterior renal fascia (Gerota’s fascia) and posterior renal fascia (Zuckerkandl’s fascia). The renal fascias fuse laterally behind the ascending and descending colon to form lateral conal fascia. Anterior and posterior renal fascia separate the anterior and posterior pararenal spaces from perinephric space. There are multiple thin delicate complete and incomplete fibrous septa extending between the renal capsule to the renal fascia, between the anterior and posterior renal fascia which divides the perinephric space into multiple compartments.

Kidneys consist of the renal parenchyma and renal sinus. Renal parenchyma is constituted by cortex and medulla. Structures in renal sinus from anterior to posterior are renal veins, renal arteries and renal pelvis. Renal sinus also consists of renal sinus fat and lymphatics. Developmental renal anomalies are common and include renal ectopias, fusions, duplicated excretory system, accessory renal arteries, etc.

Imaging modalities:

Though most of the renal tumours are detected incidentally on the routine ultrasound scans, it is not the modality of choice for evaluation of renal tumours. Multiphasic contrast enhanced CT is the imaging modality used for diagnosis and staging. Ultrasound is mainly used for image guided procedures like percutaneous biopsies and nephrostomies. MRI is an alternative to the CT in patients with Iodine contrast allergies. When the risk of relapse is intermediate or high, CT of the chest and abdomen should be performed, although significant morbidity associated with the radiation exposure involved in repeated CT scans should be taken into account.

Imaging Protocol CT:

Multiphasic contrast CT imaging of the kidneys includes noncontrast, corticomedullary, nephrogenic and excretory phases.

Non Contrast study enables us to know the enhancement of a renal lesion, parenchymal and tumoral calcifications, calculi, hyperdense cysts and haemorrhage.

- Iodinated contrast is injected intravenously at the rate of 2-4 ml/s through a pressure injector.
- Corticomedullary phase extends from 20 to 45 seconds after the start of the contrast administration. This phase demonstrates the corticomedullary differentiation, with cortex enhancing more than medulla. Renal veins are maximally opacified in this phase is best to demonstrate tumour extension into the vein. Renal tumours are almost always less enhancing than that cortex.
- Nephrogenic phase extends from 60-90 seconds after the start of the contrast administration. Corticomedullary differentiation will be lost in this phase. It is the best phase to demonstrate small tumours involving the renal medulla.
- Excretory phase starts after 180 seconds (3-5 minutes) after the start of the contrast administration. This phase is important in evaluating the tumours involving the renal pelvis and urothelial tumours.
• Multidetector CT angiography is also helpful in pre-operative vascular anatomy by MIP and VR images.

Demonstration of enhancement in small lesions is extremely important to differentiate between a complex cyst with pseudoenhancement and a hypovascular tumor, especially papillary renal cell carcinomas. It is essential to compare the attenuation values of the lesion with that of the gallbladder lumen to rule out spurious enhancement. Enhancement greater than 20 HU on contrast enhanced images in a renal lesion is considered to be a true enhancement and 10-20 HU are considered to be indeterminate lesions and that less than 10 HU of enhancement is considered as no enhancement. Dual energy CT with iodine quantification has more confidence in demonstration of definitive true enhancement in a lesion.

**MRI Imaging protocol:**

Contrast enhanced MRI with gadolinium contrast is an alternative to CT in patients with iodinated contrast allergies. MRI is also advantageous in the evaluation of polar lesions (because of capability of true multiplanar acquisition), small indeterminate lesions on CT and ultrasound and in differentiating hemorrhagic cysts and tumors. However due to the risk of nephrogenic systemic fibrosis in patients with renal impairment, it should be cautiously used unless it is absolutely necessary. Gadolinium based contrast are absolutely contraindicated in patients with glomerular filtration rate of less than 30ml/min.

Axial T1 gradient echo in and opposed phase, T2 fast spin echo, DWI, chemical shift imaging (in-and out-of-phase imaging) and fat saturated T1 gradient echo pre and post contrast images in corticomedullary, nephrogenic and excretory phase are routinely acquired.

Chemical shift imaging (In-and-opposed phase images) demonstrate fat containing renal tumours. Subtraction imaging is especially useful to demonstrate true enhancement in complex and hemorrhagic renal cysts.

**PETCT:**

The sensitivity of conventional CT vs. FDG PET for detection of RCC is 91.7% vs. 60%.

Accuracy of PET vs. CT for detecting distant metastases of RCC, PET is shown to be more accurate (94% vs. 89%).

The pooled sensitivity of PET for the detection of RCC is 50-60%.

Higher FDG uptake correlates with higher stage and grade.

**Renal cell carcinoma: (Table 1)**

Renal cell carcinoma is the most common renal tumour corresponding to 80-90% of primary malignant renal neoplasms in adults. It peaks in the 6th and 7th decade of life. According to the 2016 WHO classification of renal tumours, there are sixteen types of renal cell tumours of which the major are clear cell RCC, papillary RCC and chromophobe RCC. RCCs are associated with a few syndromes, namely von Hippel-Lindau, tuberous sclerosis and Birt-Hogg-Dubé.

Clear cell RCC is the most common RCC, accounting for nearly 80% of all RCCs and it has got a worse prognosis compared with other RCCs. Hence it is imperative to differentiate between clear cell RCCs from other non-clear cell RCCs. It is associated with von Hippel-Lindau syndrome and is usually bilateral and multiple when it is associated.
Clear cell RCC is usually solitary and has heterogeneous appearance with strong enhancement in cortico-medullary phase and rapid washout. On MRI, they are hyperintense on T2 weighted images and DWI with low ADC values. Clear cell RCCs have intracellular fat in most of them, rendering them to lose signal on opposed phase GRE images.

On contrary, papillary RCCs are homogenous, hypoenhancing and are hypointense on T2 weighted MR images. It is more associated with multifocal and bilateral tumours than other RCCs. Differentiating chromophobe RCC from clear cell RCC is difficult, even though chromophobe RCCs are more homogenous and are relatively less enhancing than clear cell RCCs. Chromophobe RCCs cannot be differentiated from renal oncocytoma on imaging. They have a central scar and spoke wheel type of enhancement. Chromophobe RCCs are associated with Birt-Hogg-Dubé syndrome. Chromophobe RCCs have the best prognosis among all RCCs.

There are other less common RCCs. Few are associated with distinct clinical and imaging patterns. Collecting duct RCC is highly aggressive and is usually centered in medulla, hypovascular with infiltrating margins. Medullary RCC is another rare and aggressive tumour which commonly occurs in the young and those with sickle cell trait. It shares similar histologic and imaging features as collecting duct RCC. Xp 11 translocation RCC which is the most common MiT family translocation RCCs, are histologically similar to papillary RCCs. However, on imaging they are hyperdense on unenhanced images and have pseudocapsule, cystic changes, early lymph nodal and distant metastasis.

Metastasis is uncommon in RCCs measuring less than 4 cm. It metastasizes most commonly to lung, followed by bones. Other sites include lymphnodes, adrenals, liver and brain.

<table>
<thead>
<tr>
<th>ccRCC</th>
<th>pRCC</th>
<th>chrRCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Hypervascular</td>
<td>• Hypervascular</td>
<td>• Variable enhancement</td>
</tr>
<tr>
<td>• Peak enhancement</td>
<td>• Always hypoenhancing</td>
<td>• Less vascular than</td>
</tr>
<tr>
<td>during the corticomedullary phase</td>
<td>during the corticomedullary phase</td>
<td>ccRCC and show an</td>
</tr>
<tr>
<td>(&gt; cortex).</td>
<td>with its peak enhancement occurring</td>
<td>intermediate degree of</td>
</tr>
<tr>
<td>• T1 hypo &amp; T2 hyper</td>
<td>during the corticomedullary phase</td>
<td>enhancement to cortex.</td>
</tr>
<tr>
<td>• 80% has intracellular fat (imperative to do</td>
<td>with its peak</td>
<td>• Solid, sharply</td>
</tr>
<tr>
<td>(imperative to do</td>
<td>enhancement occurring</td>
<td>demarcated lesion.</td>
</tr>
<tr>
<td>opposed phase imaging).</td>
<td>during the nephrographic phase.</td>
<td>• Can have a central scar</td>
</tr>
<tr>
<td>• 5% are infiltrative type</td>
<td>• Iso - hypo on T1 and</td>
<td>or spoke-wheel pattern</td>
</tr>
<tr>
<td>– can mimic TCC</td>
<td>Hypo on T2. Show marked restricted</td>
<td>of contrast</td>
</tr>
<tr>
<td>• Associated with VHL</td>
<td>diffusion.</td>
<td>enhancement, similar to</td>
</tr>
<tr>
<td>• VHL - RCC are</td>
<td>• Bilateral and multifocal</td>
<td>oncocytomas.</td>
</tr>
<tr>
<td>bilateral and multifocal.</td>
<td>tumours are more frequent</td>
<td>• Seen in patients with</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Birt-Hogg-Dubé</td>
</tr>
<tr>
<td></td>
<td></td>
<td>syndrome.</td>
</tr>
</tbody>
</table>
### RCC Staging:

8th AJCC TNM staging is the latest and is described below

#### T Staging:
- **pTX:** primary tumour cannot be assessed
- **pT0:** no evidence of primary tumour
- **pT1a:** ≤ 4 cm, limited to the kidney
- **pT1b:** > 4 cm and ≤ 7 cm, limited to the kidney
- **pT2a:** > 7 cm and ≤ 10 cm, limited to the kidney
- **pT2b:** > 10 cm, limited to the kidney
- **pT3a:** invades renal vein / branches, perirenal fat, renal sinus fat or pelvicaliceal system
- **pT3b:** extends into vena cava below the diaphragm
- **pT3c:** extends into vena cava above the diaphragm or invades vena cava wall
- **pT4:** invades beyond Gerota fascia, including direct extension to adrenal gland

#### N Staging:
- **pNX:** cannot be assessed
- **pN0:** no regional lymph node metastasis
- **pN1:** regional lymph node metastasis

#### M Staging:
- **pM1:** distant metastasis, including noncontiguous adrenal involvement

### Staging RCC: NCCN

<table>
<thead>
<tr>
<th>Stage</th>
<th>Primary Tumor (T)</th>
<th>Regional lymph node (N)</th>
<th>Distant metastasis(M)</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>T1</td>
<td>N0</td>
<td>M0</td>
<td>Cancer has not spread to other part of the body</td>
</tr>
<tr>
<td></td>
<td>Tumor is 7cm or smaller and found only in kidney</td>
<td>There is no cancer in nearby lymph nodes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage II</td>
<td>T2</td>
<td>N0</td>
<td>M0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tumor is larger than 7cm and found only in kidney</td>
<td>There is no cancer in nearby lymph nodes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage III</td>
<td>T1 or T2</td>
<td>N1</td>
<td>M0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tumor has grown outside the kidney into major veins and tissues, but not into Gerota's fascia</td>
<td>There is cancer (metastasis) in nearby lymph nodes</td>
<td></td>
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<tr>
<td></td>
<td>T3</td>
<td>N0 or N1</td>
<td>M0</td>
<td></td>
</tr>
<tr>
<td>Stage IV</td>
<td>T4</td>
<td>Any N</td>
<td>M0</td>
<td></td>
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<tr>
<td></td>
<td>Tumor has grown beyond Gerota's fascia</td>
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<tr>
<td></td>
<td>Any T</td>
<td>Any N</td>
<td>M1</td>
<td>Cancer has spread to other parts of body (metastasized)</td>
</tr>
</tbody>
</table>
Angiomyolipoma:

Angiomyolipoma (AML) is the most common benign solid tumour of the kidneys. It has both sporadic and syndromic varieties. Sporadic is most common, accounting for about 80-90% of all AMLs. Sporadic AMLs are more common in females than males by a factor almost 4. Syndromic AMLs are encountered in patients with tuberous sclerosis and are usually bilateral and multifocal and larger. About 80% of patients with tuberous sclerosis develop AMLs.

On imaging, the presence of macroscopic fat is the characteristic feature of AMLs. However very rarely this can also be seen in clear cell RCCs. Presence of fat renders them hyperechoic on ultrasound. Fat poor AMLs account for approximately 5% of all AMLs and they are difficult to differentiate from other solid renal masses on imaging. Lesions that are less than 4 cm are usually asymptomatic while those that are more than 4 cm have risk of intratumoral or perinephric haemorrhage.

Oncocytoma:

Oncocytomas are the most common non-fat containing benign lesions of the kidney. They are from the proximal tubular epithelium. They are usually solitary, smoothly margined renal masses with homogenous enhancement. Few of the lesions show a central stellate scar and this finding is more common in larger lesions. Spoke wheel pattern is seen on angiography. Multifocal oncocytomas are seen in Birt-Hogg-Dubé syndrome and tuberous sclerosis. Renal oncocytomas are difficult to be differentiated from chromophobe RCC on imaging.

Lymphoma:

Renal lymphoma can be either primary renal lymphoma or secondary involvement. Primary renal lymphomas are exceedingly rare and are usually non-Hodgkin lymphoma of B cell type. Renal lymphoma has a wide variety of imaging presentations, including solitary mass, multifocal masses, diffuse infiltration causing renomegaly, perinephric deposits and direct lymph nodal infiltration. The masses are usually hypo dense and hypoenhancing on CT and relatively hypointense to the renal cortex on T2 weighted MR images with minimal enhancement on post contrast T1 weighted images.

Intracranial transitional cell carcinoma:

Transitional cell carcinoma (TCC) involving the renal pelvis may mimic centrally located RCC. It is important in differentiating the two because of change in management strategies. Homogenous irregular tumorcentered in the renal collecting system with narrowing and amputation of the calyces, preservation of the shape of the kidney and circumferential urothelial thickening favour the diagnosis of TCC over RCC.

Mesenchymal tumours:

Mesenchymal tumours other than AML are rare. They can be either benign or malignant. Benign mesenchymal tumours of the kidney include angiomyolipoma, leiomyoma, lipoma, lymphangioma, hemangioma, solitary fibrous tumour, medullary fibroma and schwannoma. Malignant neoplasms include leiomyosarcoma, rhabdomyosarcoma, angiosarcoma, fibrosarcoma, osteosarcoma and malignant fibrous histiocytoma. Except for the characteristic imaging feature of AMLs, other mesenchymal tumours cannot be differentiated from other solid renal tumours on imaging.
Metastasis:

Kidney is a rare site of metastasis. Most common primary tumour to metastasize to the kidneys is lymphoma, followed by lung carcinoma. Metastases are usually multiple bilateral discrete lesions. Metastasis can also present as solitary and perinephric masses. These solitary masses are difficult to differentiate from primary renal neoplasm, unless there is a known primary tumour with metastasis to other organs. They are usually detected incidentally as they seldom cause symptoms.

Pseudotumors:

Renal pseudotumors are mass-like lesions which are not truly neoplasms, but can be normal variants, inflammatory lesion or haemorrhage. Normal variants that can mimic renal tumours are hypertrophied columns of Bertini, Dromedary hump, persistent fctallobululations and splenorenal fusions. Inflammatory conditions like focal pyelonephritis, xanthogranulomatous pyelonephritis, tuberculomas, and abscess can also mimic renal tumours. Even a hematoma can simulate a mass, such as seen in subepithelial pelvic hematomas (Antopol-Goldman lesions).

STRUCTURED RADIOLOGIC REPORTING OF RENAL MASSES

1. "Essential" characteristics according
   - Mass size
   - Whether the mass is cystic or solid
   - Presence or absence of macroscopic fat
   - Presence or absence of enhancement
   - Bosniak classification for cystic masses
   - Size comparisons for solid and Bosniak IIF–IV masses
   - Axial location of the mass (e.g., anterior)
   - Staging information for solid and Bosniak III–IV masses

2. "Preferred" characteristics according to
   - Whether a solid mass has regions of necrosis
   - Mass margins (e.g., infiltrative, circumscribed)
   - Description of each individual Bosniak feature
   - Capsular location of the mass (e.g., [50% exophytic, endophytic)
   - Presence of bland thrombus peripheral to tumour thrombus
   - Findings that may predict aggressiveness (e.g., T2w hypointensity)
   - Specific RCC subtype if feasible (e.g., clear cell RCC)
   - Specifying optimal follow-up imaging type
   - Specifying whether a portion or all of a mass enhances
   - Distance of the mass to the sinus fat or collecting system

Other considerations in structured reporting of renal masses:

1. Findings that predict aggressiveness and the presence of bland thrombus would be good to include.
2. Necrosis should be optional because of the confusion over the exact meaning and lack of pathological correlate for necrosis. The presence of calcification should be optional.
3. We should consider including polar location, local extent of disease (hilar invasion, collecting system invasion, contacts Gerota’s fascia, invasion through Gerota’s fascia, invasion of adjacent organs), venous invasion, enlarged lymph nodes, and distant metastases.
4. Differentiating urothelial from cortical origin probably should be a core or optional feature
5. Optional features might include vascular anomalies (if any) and the total number of lesions
6. Multiphase MRI or multiphase CT is necessary for subclassifying a renal mass
7. The location in the vertical axis (upper pole/interpolar/lower pole) needs to be a core descriptor
8. We may want to break down fat into macroscopic fat and microscopic fat
9. We include the ‘clear cell RCC likelihood score,’ but I understand this is uncommon at this point
10. Consider differentiating free-floating IVC tumour thrombus from invasive (i.e., into wall) IVC tumour thrombus
11. Length of tumour thrombus should be added

**Nephrometry: Acronym: RENAL – H**

Nephrometry score probably should be an optional feature:

The RENAL Nephrometry Score was developed as a standardized system to objectify reporting of critical anatomical features of a renal mass.

- Provides a quantifiable and reproducible method to classify renal masses according to anatomic complexity.
- Stratifies masses into low, medium, and high complexity, with increasing complexity correlating with more aggressive tumour biology, more challenging resectability via nephron sparing surgery, and clinical outcomes.
- Can be used in preoperative evaluation, planning, and standardized literature reporting.
- Does not engender specific management strategies.
- Does not preclude the need to view imaging directly in surgical planning and prior to operation.
- Radius (cm) Largest diameter in any single plane: ≤4+1; >4 and <7+2; ≥7+3
- Exophytic/endophytic: % mass exophytic (protruding out) vs. endophytic (contained) relative to renal parenchyma:
  - ≥50% exophytic+1
  - <50% exophytic+2
  - Entirely endophytic+3
- Nearness to collecting system or sinus (mm): Measure shortest distance
  - ≥7+1
  - >4 and <7+2
  - ≤4+3
- Anterior/posterior: Primary location of tumour relative to coronal plane at level of hilar vessels
  - Anterior
  - Posterior
  - Neither
- Location relative to polar lines
  - Entirely above or below
  - Crosses a polar line
  - >50% across polar line
  - Crosses axial renal midline
  - Entirely between polar lines
- Hilar tumour: Touching renal artery or vein
  - No
  - Yes

Renal Mass Biopsy: The AUA (American Urological Association) guidelines

(a) RMB should be considered when a mass is suspected of being hematologic, metastatic, inflammatory, or infectious.

(b) RMB is not required for young or healthy patients who are unwilling to accept the uncertainties associated with RMB or for older or frail patients who will be treated conservatively, independently of RMB findings.

(c) Counsel regarding the rationale and the positive and negative predictive values for RMB, as well as the potential risks and nondiagnostic rates associated with RMB, is recommended.

(d) Multiple core-needle biopsies are preferred over fine-needle aspiration

Molecular Basis of RCC and Implications for Treatment: The Current Standard

The subtypes of RCC are different in terms of their genetic make-up and mutational status as given in the table:

CeRCC – Clear cell RCC; pRCC – Papillary RCC;
As a radiologist, knowledge of the exact subtype of RCC and its underlying mechanisms and treatment options can help in interpretation of the follow-up studies by anticipating its behaviour in terms of metastatic spread and potentially in planning the follow-up imaging strategies.

ccRCC is characterized by the loss of the short arm of chromosome 3 (3p), which harbours the von Hippel-Lindau (VHL) tumour suppressor gene. VHL, an autosomal dominant familial cancer syndrome characterized by increased risk of multiple tumours including nervous system hemangioblastoma and RCC, results from mutations in the VHL tumour suppressor gene located on chromosome 3p. The VHL gene is also inactivated in about 50%–84% of sporadic ccRCC as a result of the loss of 3p. Development of RCC as a result of VHL gene inactivation, either in the setting of VHL disease or sporadic ccRCC, represents a two-hit model, in which both the copies of VHL gene are inactivated.

When active, the VHL gene codes for a protein, which, in the presence of oxygen, degrades the hypoxia-induced factor (HIF)-α. HIF leads to transcription of several proangiogenic factors including vascular endothelial growth factor (VEGF) and platelet-derived growth factor, leading to angiogenesis, cell survival, and cell proliferation, thus playing a pivotal role in the pathogenesis of ccRCC. Inactivation of the VHL gene disrupts expected cellular degradation of HIF even in the presence of oxygen, thus contributing to pathogenesis of ccRCC. Overproduction of VEGF resulting in angiogenesis explains the hypervascular appearance of RCC at imaging.

### Imaging Assessment of Response to Therapy (CT & MRI)

- RECIST 1.1 remains the preferred criteria in current clinical trials.
- In the routine clinical setting size-based and morphologic tumour response criteria are used.
- Morphologic criteria - Attention to the amount of solid enhancing tumour, degree of enhancement, and tumour margin because these may indicate treatment response even if there is no decrease in tumour size.
- Early and modest change in tumour burden at first imaging follow-up after starting VEGF-targeted therapy, typically at 8–12 weeks after treatment initiation

### Functional Assessment of Therapeutic Response

1. **MR imaging**: Dynamic contrast-enhanced MR imaging studies including Ktrans (transfer constant); Diffusion-weighted imaging including IVIM (intravoxel incoherent motion).
2. **FDG PETCT**
Active Surveillance - AUA guidelines

(a) Active surveillance is an option for initial management in patients with renal masses suspicious for cancer, especially those smaller than 2 cm.

(b) Active surveillance or expectant management should be a priority when the anticipated risk of intervention or competing risks of death outweigh the potential oncologic benefits of active treatment.

(c) When the results of risk-versus-benefit analysis of the treatment are equivocal and the patient elects to undergo active surveillance, the physician should perform repeat imaging in 3–6 months to assess for interval growth and consider renal mass biopsy for additional risk stratification.

(d) When the oncologic benefits of intervention outweigh the risks of treatment and competing risks of death, the physician should recommend active treatment. In this setting, active surveillance should be pursued only if the patient understands and is willing to accept the associated oncologic risk.

Guidelines for follow-up post surgical resection of RCC

Summary of Recommendations

Variant 1: Follow-up for clinically localized renal cell cancer; post radical or partial nephrectomy.
CT abdomen with IV contrast, CT abdomen without and with IV contrast, or MRI abdomen without and with IV contrast is usually appropriate in the follow-up of patients after surgical excision of RCC.

These procedures are equivalent alternatives (i.e., only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care). The panel did not agree on recommending MRI abdomen and pelvis without and with IV contrast. There is insufficient medical literature to conclude whether the scan is of benefit in this clinical scenario, and its use may be appropriate but controversial.
Variant 2: Follow-up for clinically localized renal cell cancer; post ablation.

CT abdomen with IV contrast, CT abdomen without and with IV contrast, or MRI abdomen without and with IV contrast is usually appropriate in the follow-up of patients after localized RCC ablation.

These procedures are equivalent alternatives (i.e., only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care).

Variant 3: Follow-up for clinically localized renal cell cancer; active surveillance

CT abdomen with IV contrast, CT abdomen without and with IV contrast, MRI abdomen without and with IV contrast, or US abdomen with IV contrast is usually appropriate in the active surveillance of localized RCC. These procedures are equivalent alternatives (i.e., only one procedure will be ordered to provide the clinical information to effectively manage the patient’s care).

AUA guidelines: Recommends ultrasound, CT or MRI annually for 3 years in low risk patients post partial nephrectomy if initial post-operative scan is negative. After initial post-operative CT or MRI, for moderate to high risk patients, an ultrasound, chest X-ray, CT or MRI every 6/12 for at least 3 years and annually thereafter year five.

NCCN guidelines: Recommend for Stage 2 or 3 patients after radical nephrectomy, VY or MRI or ultrasound every 3-6/12 for at least 3 years and then annually up to 5 years.
Summary / Take home points:

- CT and MRI is mainstay of imaging in malignant renal neoplasms.
- Recent advances in genetics, imaging, and drug development have expanded the role of radiologists in the care of patients with advanced RCC, from diagnosis to death.
- State-of-the-art knowledge of the molecular basis of RCC, novel targeted therapies used for treatment of RCC, their response patterns, and toxicities is essential in order for the radiologists to have an effective dialogue with referring physicians and remain relevant in the care of patients with advanced RCC.
- Using nephrometry scoring may assist with patient education regarding perioperative expectations and complication risks.
- In high-risk patients, the follow-up examinations should include routine CT/MRI scans.
Background Information

- Most commonly gastric in origin, but can arise from anywhere in the GI tract; usually exophytic. c-KIT mutation positive
- Tumor size, location, and mitotic index correlate with prognosis
- Gastric tumors are overall lower risk than distal tumors
- Proximal tumors metastasize to liver, while distal tumors can spread to liver or peritoneum
- Treated with Imatinib; may respond by decrease in attenuation without decrease in size (Choi criteria)

Imaging protocol (Initial evaluation)

CT
- Non-contrast, late arterial, and portal venous phase
- Preferably neutral oral to increase sensitivity to detect a small lesion

MRI
- Only as a problem solving tool for liver evaluation

Other Imaging
- PET/CT may be performed

Imaging protocol (Follow up/post therapy)

CT
- Late arterial and portal venous phase, or a single venous phase CT should suffice

MRI
- Only in specific cases as a problem solving tool for liver evaluation

Other Imaging (As applicable)
- PET/CT may be performed

Report (Initial evaluation)

- Describe primary tumor in terms of size, location, morphology, and resectability
- Describe presence of absence of metastases (particularly hepatic and peritoneal)
- Describe any complications

Key take away points

- Described primary and look for hepatic and peritoneal metastases
- GIST can respond to Imatinib with decreased attenuation (Choi criteria); pseudoprogression should be differentiated from true progression
PAEDIATRIC MALIGNANCIES

Version v1.2020

L. Murali Krishna (Chennai)
WILMS TUMOUR:

STUDY: MRI abdomen plain and contrast
Clinical information:
Comparison:
Technique: T1WI, T2WI, STIR in multiple planes, Ax DWI and post contrast T1W in multiple planes

Findings:
Location-Upper pole/midpole/lower pole of kidney.
Laterality-Unilateral/Bilateral
Internal consistency-Homogenous solid mass/Heterogeneous solid mass (Necrosis, cyst and haemorrhage)
Size of the mass-

Signal intensity:
On T1WI-Hypointense/hyperintense. On T2WI-Hyperintense
DWI-Restriction/no restriction.
SWI-Calcification/haemorrhage.

Post contrast-Homogenous/heterogeneous enhancement.
Confined to the kidney-Yes/No or Rupture.
Vascular invasion- 1.IVC 2.Renal vein 3.Right atrium or No invasion.
Lymphnodes- -Local paraaortic or others or No lymph node involvement.
Hematogenous spread-Lungs/Liver/Bones.

Impression:
Homogenous/heterogeneous mass confined to one kidney or both kidneys.
Beyond renal capsule+-vessel infiltration
Lymph node/peritoneal invasion
Hematogenous spread
MEDULLOBLASTOMA:

STUDY: MRI brain plain and contrast.
Clinical information:
Comparison:
Sequences:

Findings:

Consistency-Solid/solid cystic
Margins-Well defined/Ill-defined
Location- 1.Cerebellum-Vermis/Hemispheric. 2.Fourth ventricle.
Appearance-Homogenous/heterogeneous
Size-
Signal intensity: T1WI-Iso/hypointense
 T2WI-Hyperintense/hypointense/iso/variable
 DWI-Restriction
 SWI- Blooming +/-Calcification/haemorrhage.

Post contrast: Intense enhancement/moderate enhancement.
 Homogenous/heterogeneous enhancement.
 Grape-like nodular enhancement.

Vasogenic edema-Yes-Mild/moderate or No edema.

Hydrocephalus-Yes/no

MR spectroscopy-Elevated choline peak/Reduced NAA levels/Elevated lipid lactate peak

Falcine calcification-YES/NO-Marker for nevoid basal cell carcinoma.


Metastasis-1.Gross nodular seedling of brain CSF spaces.2.Nodular seedling of spinal cord CSF spaces.3.Extraneural spread (Bone marrow/lymph node/liver/lung/peritoneum)

IMPRESSION:
A well-defined/Ill-defined
Homogenous/heterogeneous
Solid/solid-cystic mass
Hydrocephalus-+/-
Vasogenic edema-+/-
Invasion of adjacent structures-+/-
Drop metastasis-+/-
**Hepatoblastoma:**

**Study**: CT abdomen plain and contrast.
Clinical information-
Comparison-
Sequences-

**Findings**:
Internal consistency-Solid mass
Location of the mass-
Size –

**Plain study**:
1. Homogenous/heterogeneous
2. Well circumscribed
3. Speckled/Amorphous calcification
4. Hemorrhage+-/-

**Post contrast study**:
Homogenous/heterogeneous enhancement.
Hypo attenuating compared to the surrounding liver
Septa enhancement+-/-
Vessel involvement-Portal vein/hepatic vein/IVC
Metastasis-Nodal/Distant(lungs)

**Impression**:
Well circumscribed solid mass
Involving segments
Homogenous/heterogeneous enhancement
Vessel involvement +/-
Metastasis+-/-
RETINOBLASTOMA:

STUDY-MRI plain and contrast study of orbit and brain.

Clinical information-

Comparison-

Sequences:

Orbit: Transaxial or sagittal oblique T1WI, Transaxial or sagittal oblique T2WI (Slice thickness <2mm), 3D steady state free precession sequence with slice thickness <1 mm) and post contrast T1WI-axial and sagittal oblique.

Brain: Transaxial T2WI (Slice thickness <4mm) and post contrast T1WI (2D SE with slice thickness <3 mm or 3D GRE <1mm)

FINDINGS:

Tumour characteristics:

1. Signal intensity relative to vitreous body-Isointense or moderately hyperintense on T1WI and hypointense on T2WI.
2. Laterality-Unilateral/bilateral.
4. Tumour size and number-
5. Location-a. with respect to equator of the eye-Anterior, posterior or combined
   b. with respect to papilla(optic nerve disk) and macula.
6. Bupthalmia-+/-(Increase in size of the globe, globe deformation and reduced anterior chamber depth)

7. Tumour extension:

a. Optic nerve and meningeal sheath invasion(Post laminar invasion is abnormal contrast enhancement >2 mm in diameter in distal nerve, optic nerve invasion is interruption of normal linear enhancement at the optic disk)

b. Ocular wall invasion-Discontinuity of normal choroidal enhancement or focal choroidal thickening.

c. Scleral invasion-Protrusion of enhancing lesion through thickened choroid into low signal intensity sclera.

d. Extraocular invasion-Lesion extend beyond sclera.

e. Anterior eye segment invasion-Tumour extend into ciliary body or beyond.

f. Brain-Pineal gland involvement/leptomeningeal spread/any associated congenital malformation.

IMPRESSSION:

- Endophytic/exophytic/diffuse mass
- Involving one or both eye
- Tumour extension
- Brain involvement
NEUROBLASTOMA (INTRA ABDOMINAL):

Study-CT plain and contrast study of abdomen
Clinical information-
Comparison-
Sequences-

Findings:
Location- 1.Adrenal gland  2.Retroperitoneum –Organ of Zuckerkandl/celiac axis/paravertebral sympathetic chain
Lobulated heterogeneous solid mass
Size of the mass-
Inferior displacement of kidney (if it is adrenal origin).
Stippled calcification
Crossing the midline.

Description of image defined risk factors:

<table>
<thead>
<tr>
<th></th>
<th>Separation</th>
<th>Contact</th>
<th>Encasement</th>
<th>Invasion</th>
<th>Infiltration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aorta/IVC</td>
<td></td>
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<tr>
<td>Iliac vessels</td>
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<td></td>
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<tr>
<td>One/both renal pedicle</td>
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<tr>
<td>Porta hepatis and /or hepatoduodenal ligament</td>
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<td>Branches of SMA at mesenteric root</td>
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<td>Origin of celiac axis and or origin of SMA</td>
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<td>Pelvic tumour crossing sciatic notch</td>
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<tr>
<td>Kidney</td>
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<td>Liver</td>
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<td>Diaphragm</td>
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<tr>
<td>Duodenopancreatic block</td>
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<tr>
<td>Intraspinal extension</td>
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</tbody>
</table>

For thoracic neuroblastoma:

1.Encasing aorta and major branches-
2.Compression of trachea/principal bronchi
3.Infiltrating costo-vertebral junction between D9-D12 levels.
NOTE:

1. Separation-Maintained fat plane between tumour and organ
2. Contact-No visible fat plane (Artery-<50% of vessel circumference is in contact with the tumour, Vein-flattening with reduced diameter with partially visible lumen)
3. Encasement->50% of artery circumference is in contact with the tumour, completely surrounded by the tumour or flattened vein with no visible lumen)
4. Infiltration-Involvement of vital structure other than vessels or extension into neighbouring structure with lack of margin between tumour and adjacent structure.
5. Invasion-Used for renal vessel involvement and spinal canal.
6. Compression: Short axis of airway reduced
7. Spinal canal involvement->1/3 of canal involvement is IDRF

Metastasis:

1. Nodal-Loco-regional/distant
2. Distant-Bone marrow
   - Liver (diffuse infiltration/focal hypoenhancing masses)
   - Lungs (Discrete nodules/diffuse consolidation/pleural involvement)
   - Brain (Dural Mets/parenchymal Mets)

IMPRESSION:

Lobulated heterogeneous solid mass
Arising from -----
Crossing the midline
How many IDRF +
Metastasis +/-
SARCOMA

Version v1.2020

Ekta Dhamija (Delhi)
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Part II

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Part III

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a. Pretreatment
b. Post treatment

References
Part I

Background:

- Sarcomas can be classified as soft tissue sarcomas and bone sarcomas.
- Bone tumours include Osteosarcoma, Chondrosarcoma and Ewing’s sarcoma family.
- Soft tissue sarcomas (STS) are rare malignancy which account for approximately 1% of the adult sarcomas with extremities as the most common site of occurrence. (1)
- Advancements in pathological and molecular investigations have led to revision of tumour classification.
- The WHO classification of bone and soft tissue sarcomas was modified in 2013 which classified STS into benign, malignant and intermediate grade tumours based on their biological potential/ behaviour. (2)
- The intermediate grade STS are further sub classified into the ones which are locally aggressive and the ones which rarely metastasize (Table 1)
- One of the major changes is removal of the term malignant fibrous histiocytomas which are now labelled as undifferentiated pleomorphic sarcomas
- The diagnosis and management of sarcomas depend on their immunohistochemical and pathological analysis
- The main aim of radiological investigations is to detect, characterize the tumour, determine the extent for assessment of resectability and identify any metastatic disease.
- The baseline imaging also provides information about appropriate site of biopsy and assist in planning for biopsy from the solid component of the tumour.
- The most common site for metastases from sarcomas is lung
- Thus, for high grade tumours, NCCT chest is recommended to look for lung metastases at baseline as well as during follow up. (3)
PART II

Classification:

The revised WHO classification of bone and soft tissue sarcomas classifies the tumors according to the pathological subtype/cell of origin and malignant potential/biological behavior.

Table 1: WHO classification based on the biological behavior

<table>
<thead>
<tr>
<th></th>
<th>Local infiltration</th>
<th>Recurrence</th>
<th>Metastasis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Intermediate-LA (locally Aggressive)</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Intermediate-RM (rarely metastasizing.)</td>
<td>Yes</td>
<td>Yes</td>
<td>Rarely</td>
</tr>
<tr>
<td>Malignant</td>
<td>Yes</td>
<td>Yes</td>
<td>Common</td>
</tr>
</tbody>
</table>

Table 2: 2013 WHO classification of STS

<table>
<thead>
<tr>
<th>Category</th>
<th>Benign</th>
<th>Intermediate-LA</th>
<th>Intermediate-RM</th>
<th>Malignant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adipocytic tumors</td>
<td>Lipoma Lipoblastoma Lipomatosis</td>
<td>Well differentiated Liposarcoma/Atypical lipomatous tumor</td>
<td>- Dedifferentiated liposarcoma - Myxoid liposarcoma - Pleomorphic liposarcoma</td>
<td></td>
</tr>
<tr>
<td>Fibroblastic tumors</td>
<td>Fibromatosis colli</td>
<td>Superficial fibromatosis, Desmoid fibromatosis</td>
<td>IMFT SFT DFSP</td>
<td>Fibrosarcoma</td>
</tr>
<tr>
<td>Category</td>
<td>Example Tumors</td>
<td>Example Histologies</td>
<td>Example Carcinomas</td>
<td>Notes</td>
</tr>
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<td>--------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
<td>----------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>Skeletal muscle</td>
<td>Rhabdomyoma</td>
<td>-</td>
<td>-</td>
<td>RMS</td>
</tr>
<tr>
<td>Smooth muscle</td>
<td>Leiomyoma</td>
<td>-</td>
<td>-</td>
<td>LMS</td>
</tr>
<tr>
<td>Vascular</td>
<td>Hemangioma, lymphangioma</td>
<td>Kaposiform hemangioendothelioma</td>
<td>Kaposi sarcoma</td>
<td>Angiosarcoma Epitheloid hemangioendothelioma</td>
</tr>
<tr>
<td>Perivascular</td>
<td>Glomus tumor</td>
<td>-</td>
<td>-</td>
<td>Malignant glomus tumor</td>
</tr>
<tr>
<td>Fibrohistiocytic</td>
<td>Tenosynovial giant cell tumor</td>
<td>-</td>
<td>GCT of soft tissue</td>
<td>-</td>
</tr>
<tr>
<td>Chondro-osseous tumors</td>
<td>Chondroma of soft tissue</td>
<td>-</td>
<td>-</td>
<td>ExtraskeletalChondro/osteosarcoma</td>
</tr>
<tr>
<td>GIST</td>
<td>Benign</td>
<td></td>
<td></td>
<td>Malignant</td>
</tr>
<tr>
<td>Peripheral nerve sheath tumors</td>
<td>Schwannoma, Neurofibroma</td>
<td>-</td>
<td>-</td>
<td>MPNST</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Malignant triton tumor</td>
</tr>
<tr>
<td>Tumors of uncertain differentiation</td>
<td>Acral fibromyxoma</td>
<td>Phosphaturic mesenchymal tumor</td>
<td>Synovial sarcoma, ASPS, Clear cell sarcoma, ExtraskeletalEwings</td>
<td></td>
</tr>
</tbody>
</table>
PART III

Role of imaging at baseline evaluation is to-

- Assess the tumour size and location (deep or superficially located),
- Determine the extent for resectability: infiltration into the overlying skin, subcutaneous fat, muscles, intramuscular planes, bones, neurovascular bundle
- Detect any skip lesions/ metastases
- Detect distant metastases- especially in lungs

Imaging evaluation at follow up:

- In post op cases:
  - To detect local recurrence
  - Soft tissue recurrence or osseous recurrence
  - Distant metastases
- On chemotherapy or medical treatment:
  - Response assessment: Partial response/ stable disease/ progressive disease
  - Changes in internal morphology or signal intensity in addition to size assessment
  - Re-assess for resectability

Imaging modalities:

a. Radiographs/ X-rays- Radiographs should be first modality for extremities. They are able to demonstrate osseous changes, matrix mineralization, soft tissue masses/ density and periosteal changes. At times, the characteristic appearance of osseous or calcified densities like phleboliths in hemangioma and loose bodies of synovial osteochondromatosis indicates appropriate diagnosis on X-rays only.(4) However, they are limited by their inability to provide information on extent of disease, detection of skip lesions or metastases and internal characteristics of soft tissue neoplasms.

b. Ultrasound (USG): There is finite role of USG in evaluation of sarcomas. However, it often is the first imaging modality patient is subjected to when he/ she presents with pain or swelling due to its ready availability. USG can determine whether the swelling is due to abscess or neoplasm. It can assist in guiding further course of action in cases of arterio-venous malformations by demonstrating vascular channels, cystic spaces and color flow. It is also the modality of choice for conducting or planning biopsy from STS. However, its role is limited in detailed evaluation of local extent of the tumour.

c. CECT(5)- CT is the most accessible cross-sectional imaging modality at present with advantages of being rapid in acquisition of large anatomic regions in short scan time and with greater spatial and temporal resolution than MRI. However, it has lesser soft tissue resolution and is associated with radiation exposure. Hence, its role is limited in evaluation of local extent to the times when MRI is either not available or patient is not affordable. It is superior than MRI in evaluation of tumour matrix especially in
chondrosarcomas and osteosarcomas. It can provide information on involvement of cortical bone, pulmonary metastases and enables in planning CT guided biopsy, if required. CECT is the preferred modality while assessing lesions of chest and abdomen, for example in evaluation of liposarcomas of retroperitoneum where CT enables rapid acquisition of the entire thorax and abdomen with assessment of the visceral structures in relation to the primary mass.

d. MRI (6)- MRI is the modality of choice for local staging and disease extent owing to its superior soft tissue resolution. This should include axial T1, T2, DWI sequences with Sagittal & coronal T2 weighted sequences (STIR, T2 FS) followed by single phase Post contrast T1 fat sat images. No specific preparation is required except fasting over 4-6 hours in case of extremity lesions. The sequences may differ for abdomen, chest, head and neck for appropriate delineation and the information needed. For example, in neck region, if brachial plexus is to be evaluated, then the plane of acquisition will be along the course of nerves from the level of exit from neural foramina to the axillary region.

e. PET-CT- favoured modality because of its fusion and functional nature leading to higher accuracy in detection and determination of distant metastases, skip metastases vs. benign mimickers in same patient. Since it is a hybrid modality, it is often used in assessing tumour response following NACT to see if the tumour activity has reduced, if not size.

PART IV

Imaging checklists:

<table>
<thead>
<tr>
<th>Clinical background- Presenting complaints and clinical suspicion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Findings on Radiographs/ X-rays (in cases of extremities and oral cavity)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Procedure details- MRI of the local site using sequences...</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Report:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary osseous or soft tissue mass</td>
</tr>
<tr>
<td>Osseous tumour:</td>
</tr>
<tr>
<td>- Size,</td>
</tr>
<tr>
<td>- Extent in terms of distant from proximal and distal joints</td>
</tr>
<tr>
<td>- Joint involvement</td>
</tr>
<tr>
<td>- Extent of marrow involvement</td>
</tr>
<tr>
<td>- Cortex and periosteum</td>
</tr>
<tr>
<td>- Associated soft tissue component</td>
</tr>
<tr>
<td>- Internal morphology of the soft tissue component</td>
</tr>
</tbody>
</table>
- Necrosis/ Calcification/ Haemorrhage +/-
- Neurovascular bundle, muscle, skin involvement
- Extension into interosseous space +/-
- Skip lesions and metastases
- Lymph nodes

Soft tissue tumour:
- Size
- Extent
- Location: deep to the fascias or superficial
- Internal morphology and signal intensity
- Necrosis/ Calcification/ Haemorrhage +/-
- Infiltration of surrounding structures (bones, joints, ligaments, muscles) and planes
- Neurovascular bundle- according to the area of contact with circumference of the vessels, for example loss of interface with the vein or artery for an area of 180 degrees by the mass with or without contour deformity
- Lymph nodes
- Relation to underlying bone: Periosteum, cortex and marrow
- Extension into interosseous space +/-
- Extension in terms of joints, ligaments and muscles
- Lymph nodes

Comparison – if any

Impression: Primary osseous or soft tissue tumour with extent and infiltration.....

In view of the age, clinical history and imaging morphology; the differential diagnosis should include:
1.
2.
3.

Reporting format at follow up:

Clinical background- Presenting complaints and clinical suspicion
Treatment received and duration/ interval-
Radiographs, if any: findings

Procedure details- MRI of local site
**Report:**

<table>
<thead>
<tr>
<th>Mass involving bone and/or soft tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
</tr>
<tr>
<td>Location</td>
</tr>
<tr>
<td>Internal morphology/ signal intensity</td>
</tr>
<tr>
<td>Necrosis/ Calcification/ Haemorrhage +/-</td>
</tr>
<tr>
<td>Increase or decrease in signal intensity as compared to previous scan</td>
</tr>
<tr>
<td>Increase or decrease in soft tissue component and/or necrosis as compared to previous scan</td>
</tr>
<tr>
<td>Extent of the soft tissue with or without involvement of surrounding structures</td>
</tr>
<tr>
<td>Appearance of any new lesions- deposits, nodes, bone marrow lesions</td>
</tr>
</tbody>
</table>

**Comparison:** with previous imaging dated…- note the change in size as well as morphology

**Impression:** Mass with extent and morphology representing stable disease/ partial response/ progressive disease

NCCT chest for lung nodules need separate evaluation and comparison while assessing for response to chemotherapy and in patients on surveillance.
REFERENCES


SMALL BOWEL TUMORS

Version v1.2020

Akshay Baheti (Mumbai)
Background Information

- Most common are neuroendocrine tumor (NET), GIST, and adenocarcinoma
- NETs can be grade 1, 2, and 3, with worsening prognosis; grade 3 = neuroendocrine carcinoma and has poor prognosis
- Lower grade NETs demonstrate DOTA scan uptake, while higher grade demonstrate FDG uptake. Peptide receptor radionuclide therapy (PRRT) can be used to treat NETs using cytotoxic radiolabeled ligands in advanced cases

Imaging protocol (Initial evaluation): CT

- Oral contrast: Typically neutral oral contrast (water / Volumen/ methylcellulose/ polyethylene glycol etc)
- CT angiography for active bleeding
- CT enteroclysis/enterography for detecting suspect small NETs
- Prefer having arterial phase imaging in baseline scans anyway to detect hypervascular NET metastases

Imaging protocol (Initial evaluation): MRI

- SSFSE and HASTE sequences in axial and coronal planes
- 2D and 3D pre and post contrast images
- Hepatobiliary phase images very sensitive for detecting subtle metastases; prefer obtaining them if feasible

Report (Initial evaluation)

- Describe location, resectability, and enhancement pattern of tumor
- Described associated complications (if any) like bleeding / obstruction
- Nodal and liver metastases, and any other sites of disease

Imaging protocol (Follow up/post therapy): CT/MRI

- Multiphase study for screening for metastatic disease
- MRI technique similar to baseline
- Nuclear medicine studies like DOTA scan or PET/CT as applicable, both in baseline and post-treatment settings

Report (Follow up/post therapy)

- For surveillance scan in fully treated patient: Whether there is local or distant recurrence
- For restaging scan (patient with disease and on treatment): Whether there is stable disease, response, or progression (enhancement of metastases may vary depending on phase of study, making comparison difficult occasionally)

Key take away points

- Proper protocol key depending on clinical question
- Describe tumor staging, resectability, and complications
Ekta Dhamija (Delhi)
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Part II
FIGO 2018 staging system

Part III
Imaging modalities: Desirable and Minimal for patients with Carcinoma cervix

Part IV
Imaging checklists
  c. Pre treatment
  d. Post treatment

Key points and References
Part I

Background:

- Carcinoma cervix (CaCx) accounts for approximately 16% of total CaCx cases all over the world with around 120,000 women developing this disease every year.\(^{1}\)
- Unfortunately, most of the females present late with symptoms in our country as the coverage for screening of CaCx is low.
- Until recently, treatment of CaCx was based on 2009 FIGO staging system which was based on clinical assessment of the disease.
- The staging system for cervical carcinoma has been revised in 2018 with inclusion of imaging and pathological assessment.
- The major changes in revised FIGO staging include:
  - Revision of definition of micro invasion and size of lesion in Stage I
  - Incorporation of imaging and pathological findings in assessment of lymph nodes
  - Any size tumour, if associated with metastatic lymph nodes, upgrades the stage to Stage IIIc (IIIC1 for pelvic lymph nodes and IIIC2 for para-aortic lymph nodes)
  - Identification of the lymph node metastasis can be accomplished using any imaging or pathological technique/method and the choice of the technique should be based on availability with provider.
  - Considering the resource constraint setting where access and availability is limited, the lower staging should be assigned.
PART II

Staging(2,3):
CaCx may spread via three of the following pathways(2):

a. Direct extension/ infiltration: into parametrium, surrounding structures like urinary bladder and rectum (most common mode of spread)
b. Lymphatic spread: along lymphatic channels to involve pelvic (obturator, iliac) lymph nodes, retroperitoneal lymph nodes
c. Hematogenous spread: with resultant distant metastases (which is considered as a late occurrence)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>The carcinoma is strictly confined to the cervix (extension to the uterine corpus should be disregarded)</td>
</tr>
</tbody>
</table>
| IA    | Invasive carcinoma that can be diagnosed only by microscopic, with maximum depth of invasion ≤5mm
|       | • IA1 – Measured stromal invasion, 3mm in depth |
|       | • IA2 – Measured stromal invasion > 3mm and ≤5mm in depth. |
| IB    | Invasive carcinoma with measured deepest invasion >5mm (greater than Stage IA), lesion limited to the cervix uterus
|       | • IB1 – Invasive carcinoma > 5mm depth of stromal invasion, and <2 cm in greatest dimension. |
|       | • IB2 – Invasive carcinoma >2cm and ≤4cm in greatest dimension |
|       | • IB3 – Invasive carcinoma > 4cm in greatest dimension |
| II    | The carcinoma invades beyond the uterus, but has not extended into the lower third of the vagina or to the pelvic wall.
|       | -IIA – Involvement limited to the upper two-thirds of the vagina without parametrial involvement. |
|       | • IIA1 – Invasive carcinoma ≤4cm in greatest dimension |
|       | • IIA2 – Invasive carcinoma > 4cm in greatest dimension |
|       | -IIIB – With parametrial involvement but not up to the pelvic wall |
| III   | The carcinoma involves the lower third of the vagina and/or extends to the pelvic wall and/or causes hydronephrosis or non-functioning kidney and/or involves pelvic and/or para-aortic lymphnodes
|       | • IIIA – The carcinoma involves the lower of the vagina, with no extension to the pelvic wall |
|       | • IIIB – Extension to the pelvic wall and/or hydronephrosis or non-functioning kidney (unless known to be due to another cause) |
PART III

Role of imaging at baseline evaluation of Ca Cx is to-

- Assess the tumour size,
- Determine the extent- infiltration of parametrium, pelvic walls, ureters, urinary bladder or rectum
- Evaluate lymph node status and
- Detect distant metastases

Imaging evaluation at follow up:

- To detect local recurrence
- Nodal recurrence
- Distant metastases
- CT is preferred modality of choice due to its faster acquisition; however, limited role in post radiation setting due to overlap by radiation induced changes.

Modalities to evaluate:

f. MRI – modality of choice for local staging. This should include axial T1, T2, DWI sequences with Sagittal & coronal T2 followed by single phase Post contrast T1 fat sat images.

Pre-requisites: Urinary bladder should be partially filled. Anti-peristaltic agents are not routinely recommended.
g. TRUS or TVS- have been considered for local staging with comparable efficacy as MRI especially in resource constraint settings and patients with contraindications for MRI

h. CECT- is the most commonly used modality owing to faster acquisition and detection of nodes and status of distant metastases in same setting.

Pre-requisites: Positive oral contrast to be given like routine. Urinary bladder should be optimally distended. Single venous phase is considered enough for pelvic evaluation. Delayed excretory phase can be taken for ureteric or bladder involvement and in cases of suspicion of fistula formation.

i. PET-CT- favoured modality because of its fusion and functional nature leading to higher accuracy in detection and determination of lymph nodes involvement.

**PART IV**

Imaging checklists:

b. Reporting format at baseline:

| Clinical background- Presenting complaints and clinical suspicion |
| Procedure details- CECT with oral contrast (single venous phase with or without delayed excretory phase) |
| **Report:** |
| Liver, spleen, pancreas: normal in size, attenuation and enhancement characteristics |
| GB: distended, normal |
| CBD: Not dilated |
| Urinary bladder: adequately distended |
| Pelvis (same for MRI): |
| Mass in the region of cervix measuring approx. …. cms in largest dimension with extension into uterus (+/-). |
| Obliterating the endocervical canal with resultant hydro/pyometra (+/-) |
| Infiltrating parametrium right or left (+/-) with extension to lateral pelvic walls (+/-) |
| Infiltration of lower ureters (+/-), urinary bladder (+/-), rectum (+/-), vessels (+/-) |
| Upstream hydroureteronephrosis (+/-) |
| Lymph nodes (+/-): Obturator, External iliac, Internal iliac, at aortic bifurcation, retroperitoneal, mediastinal: Size, discrete/ conglomerate, necrosis (+/-) |
| Ascites and pleural effusion (+/-) |
| Bones and lungs: Metastases (+/-) |
Comparison: if available
Impression:
Mass in the cervix with infiltration…… Nodes…
FIGO stage……

c. Reporting format at follow up:

| Clinical background- Presenting complaints and clinical suspicion |
| Treatment received and duration/ interval- |
| Procedure details- CECT with oral contrast (single venous phase with or without delayed excretory phase) |

**Report:**

| Liver, spleen, pancreas: normal in size, attenuation and enhancement characteristics |
| GB: distended, normal |
| CBD: Not dilated |
| Urinary bladder: adequately distended |
| Pelvis: |
| Recurrent mass (+/-) in the vault or cervix with size and extent. |
| Lymph nodes (+/-):Size, discrete/ conglomerate, necrosis (+/-) |
| Ascites and pleural effusion (+/-) |
| Bones and lungs: Metastases (+/-) |

Comparison: if available
Impression:
Recurrent/ residual mass….. nodes…..
Post treatment changes…..
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   e. Pre treatment
   f. Post treatment

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Part I

Background:

- Endometrial carcinoma (EC) is more common in West as compared to India
- In India, the incidence is 4.3 per 100,000 women (1)
- It is usually detected early due to clinical presentation of bleeding per vaginum
- It most commonly occurs in 6th and 7th decades of life
- Histologically, carcinoma endometrium has been divided into two subtypes:
  - Type I- Estrogen dependent endometrial adenocarcinoma accounting for 90% of the ECs
  - Type II- include clear cell, serous papillary and carcinosarcoma subtypes- with no association with estrogen
- Based on degree of differentiation, ECs are divided in three grades:
  - Grade 1- well differentiated
  - Grade 2- moderately differentiated
  - Grade 3- poorly differentiated
- Type II ECs and Grade 3 ECs are considered as high grade tumours with poorer prognosis
- Prognosis and survival of patients with carcinoma endometrium depends on:
  - Stage of disease
  - Histological grade
  - Depth of myometrial invasion
  - Lymphovascular invasion
  - Lymph node status
PART II

Staging of ECs

- Staging is based on surgicopathological criteria devised by International Federation of Gynaecologic Oncology (FIGO) [Table]
- Imaging helps in determining depth of myometrial invasion pre-operatively as para-aortic lymphadenectomy is performed for patients with deep myometrial invasion and high histological tumour grade

<table>
<thead>
<tr>
<th>FIGO stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage IA</td>
<td>Tumor confined to the uterus, no invasion of less than 50% or one-half of the myometrial thickness</td>
</tr>
<tr>
<td>Stage IB</td>
<td>Tumor confined to the uterus with invasion of more than 50% or one-half of the myometrial thickness</td>
</tr>
<tr>
<td>Stage II</td>
<td>The tumour invades the cervical stroma, but does not extend beyond the uterus</td>
</tr>
<tr>
<td>Stage IIIA</td>
<td>The tumour invades the uterine serosa or adnexa</td>
</tr>
<tr>
<td>Stage IIIB</td>
<td>Vaginal and/or parametrial involvement</td>
</tr>
<tr>
<td>Stage IIIC</td>
<td>The tumour has spread to pelvic or para-aortic lymph nodes</td>
</tr>
<tr>
<td>Stage IIIC1</td>
<td>Pelvic lymph node involvement</td>
</tr>
<tr>
<td>Stage IIIC2</td>
<td>Para-aortic lymph node involvement (with or without pelvic nodes)</td>
</tr>
<tr>
<td>Stage IVA</td>
<td>Tumor invasion of the bladder and/ or bowel mucosa</td>
</tr>
<tr>
<td>Stage IVB</td>
<td>Distant metastases including abdominal metastases and/ or inguinal lymph nodes</td>
</tr>
</tbody>
</table>
PART III

Role of imaging at baseline evaluation is to-

- Detect malignancy
- Determine the extent-degree of myometrial invasion, extension beyond serosa, involvement of cervix
- Evaluate lymph node status and
- Detect distant metastases

Imaging evaluation at follow up:

- To detect local recurrence
- Nodal recurrence
- Distant metastases
- CT is preferred modality of choice due to its faster acquisition.

Modalities to evaluate (2-5):

j. Transvaginal ultrasound (TVS)- first imaging modality as it is readily available, inexpensive and less time consuming. In postmenopausal females, sensitivity and specificity of TVS in diagnosing ECs based on endometrial thickness is approximately 96% and 61% respectively, when the cut off of 5mm in considered(1). Determination of myometrial invasion may be performed with sensitivity and specificity upto 70%; however, its use is limited due to its operator dependency and limited field of view.(1) Thus, further evaluation with cross-sectional imaging is needed for evaluation of cervix, parametrium and lymph nodes

k. CECT- is the most commonly used modality owing to faster acquisition and detection of nodes and status of distant metastases in same setting. However, it has poor soft tissue resolution when it comes to accurately visualizing myometrial and cervical infiltration. Hence, it is predominantly used for assessment of advanced diseases.

l. MRI – modality of choice for local staging since it has better soft tissue resolution. The images are acquired with small field of view (upto 28mm) with plane along the uterus in sagittal sections.

Pre-requisites:

- Fasting at least 4-6 hours
- Void approximately 30 minutes prior to imaging
- Antiperistaltic agent like Buscopan can be given intramuscularly
- Supine position
- MRI contrast agent 0.1 mmol/kg @ 2ml/sec followed by 20ml saline at same flow rate.

Protocol includes:

- T2 weighted sequence- in sagittal and axial oblique plane (plane of uterus)
- T1 weighted axial
- T2 weighted coronal and axial of upper and lower abdomen- to screen for lymph nodes
- Diffusion weighted at b 0,500, 1000 s/mm² along with ADC maps
- Dynamic Pre and post contrast fat suppressed T1 weighted sequence in sagittal plane (along the uterus)
- Post contrast T1 fat suppressed 3D sequence

The accuracy of T2 WI with dynamic MRI in determining myometrial and cervical invasion approaches 98% and 100%, respectively. (1)
**PART IV**

Imaging checklists:

<table>
<thead>
<tr>
<th>d.</th>
<th>Reporting format at baseline (MRI):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Clinical background</strong>- Presenting complaints and clinical suspicion</td>
</tr>
<tr>
<td></td>
<td><strong>Procedure details</strong>- MRI with/ without antiperistaltic agent</td>
</tr>
<tr>
<td></td>
<td><strong>Protocol:</strong> Sequences used, dose of contrast administered, dynamic post contrast sequences</td>
</tr>
</tbody>
</table>

**Report:**

**Uterus:**

Normal size and contour

**On T2 WI:**

- Endometrial thickness and signal intensity
- Regular or Irregular endometrial lining
- Focal or diffuse thickening
- Sub endometrial zone/ signal intensity- intact or irregular/ breach +/-
- EM-MM (endometrium-myometrium) interface: smooth/ regular/ irregular/ indistinct

**On DWI:** restriction +/-

ADC value:

**On dynamic contrast sequences:**

- Enhancement as compared to the myometrium
- Sub endometrial zone/ stripe - intact or irregular/ breach +/-
- EM-MM interface: maintained/ not maintained
- Myometrial invasion: <50% or >50% at- location and depth
- Serosal breach +/-
  - Extra-serosal extension +/-
- Infiltration of surrounding structures +/-
- Cervix infiltration +/- Extent if yes
- Parametrium/ Vagina/ Urinary bladder/ rectum or bowel loops

Lymph node enlargement or necrosis

**Ascites and pleural effusion (+/-)**

Comparison: if available

**Impression:**

Stage

---

140
e. Reporting format at follow up:

| Clinical background- Presenting complaints and clinical suspicion |
| Treatment received and duration/ interval- |
| Procedure details- CECT with oral contrast (single venous phase with or without delayed excretory phase) |

**Report:**

| Liver, spleen, pancreas: normal in size, attenuation and enhancement characteristics |
| GB: distended, normal |
| CBD: Not dilated |
| Urinary bladder: adequately distended |
| Pelvis: |
| Recurrent mass (+/-) in the vault with size and extent. |
| Lymph nodes (+/-): Size, discrete/ conglomerate, necrosis (+/-) |
| Ascites and pleural effusion (+/-) |
| Bones and lungs: Metastases (+/-) |
| Additional information: Post-operative or post radiation changes +/- |
| Omentum/ peritoneum- nodularity or deposits +/- |

**Comparison:** if available

**Impression:**

| Recurrent/ residual mass….. nodes…. |
| Post treatment changes….. |
REFERENCES


OVARY

Version v1.2020

Ekta Dhamija (Delhi)

Diva Shah (Ahmedabad)
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Part I

Background:

- Most of the ovarian cancers present in late stage at the time of presentation due to non-specific complaints
- Most common histological subtype of ovarian malignancies is epithelial ovarian cancer which account for approx. 90% of the ovarian cancers
- Amongst the epithelial cancers, high grade serous ovarian carcinomas account for 70 to 80% and present in late stage (Stage III or above)
- Most important prognostic factor is stage at presentation as the 5-year survival reduces from 90% in stage I to less than 20% in stage IV

- The treatment strategies(1) include
  - Primary cytoreductive surgery
  - Interval debulking following neoadjuvant chemotherapy
  - Cytoreductive surgery (CRS) with hyperthermic intraperitoneal chemotherapy (HIPEC)
  - Palliative chemotherapy
- Complete CRS- refers to no macroscopic visible residual disease
- Optimal CRS is considered when <1cms visible disease remains after surgery
- And Suboptimal CRS- when >1cms visible disease is left behind after surgery.
PART II

Staging(2):

The revised version of FIGO classification 2014 has included ovarian, fallopian tube and peritoneal cancers in one group

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>Tumor confined to the ovaries or fallopian tube(s)</td>
</tr>
<tr>
<td>IA</td>
<td>Tumor confined to one ovary or fallopian tube (FT) with intact capsule</td>
</tr>
<tr>
<td>IB</td>
<td>Tumor limited to both ovaries or FTs with intact capsules</td>
</tr>
<tr>
<td>IC</td>
<td>Tumor limited to one or both ovaries or FTs with:</td>
</tr>
<tr>
<td>IC1</td>
<td>Intraperitoneal spill</td>
</tr>
<tr>
<td>IC2</td>
<td>Preoperative spill or tumor on the surface of the ovary or FT</td>
</tr>
<tr>
<td>IC3</td>
<td>Positive peritoneal washings or ascites</td>
</tr>
</tbody>
</table>

| Stage II | Tumor with pelvic extension, below pelvic brim |
| IIA | Extension and/or implants on the uterus and/or FTs and/or ovaries |
| IIB | Extension to other pelvic intraperitoneal structures like rectum, bladder, sigmoid colon and distal ureters |

| Stage III | Tumor with microscopically confirmed spread to the peritoneum outside the pelvis or metastasis to the retroperitoneal lymph nodes |
| IIIA | Positive retroperitoneal lymph nodes (IIIA1) OR microscopic extrapelvic peritoneal involvement (IIIA2) |
| IIIB | Macroscopic peritoneal metastases beyond the pelvic brim 2cms or less in greatest dimension like peritoneal nodule, liver or splenic surface disease and small bowel or mesenteric serosal disease |
| IIIC | Macroscopic peritoneal metastasis beyond the pelvis more than 2cms in greatest dimension like diffuse peritoneal thickening, liver or splenic surface disease and small bowel or mesenteric serosal disease |

| Stage IV | Disease metastasis excluding peritoneal metastases |
| IVA | Pleural effusion with positive cytology |
| IVB | Metastases to extra-abdominal organs |
PART III

Role of imaging at baseline evaluation is to (2)-

- Determine the origin of mass
- Assess adnexal masses- size, extent
- Evaluate respectability for CRS
- Determine CT-PCI and stage of the malignancy
- Detect distant metastases

Imaging evaluation at follow up:

- To detect residual/ recurrent disease
- Assess extent for amenability of revision surgery or chemotherapy

Modalities to evaluate (3, 4):

m. USG: is often the first modality to evaluate pelvic structures. USG helps to characterize the adnexa better than CT by differentiating solid and cystic components of the mass. At times, the former illustrates diagnostic imaging characteristics like presence of echogenic fat in dermoid, low level echoes in endometriotic cyst, solid papillary projections suggesting malignant nature of the mass. Hence, the main purpose of USG is to determine benign vs malignant imaging features of the mass.

d. CECT: Contrast enhanced CT scan of thorax, abdomen and pelvis is recommended for evaluation of carcinoma ovary patients and the images should be reviewed in axial as well as coronal planes. Image acquisition in two phases (Arterial and venous) is the ideal desirable protocol; however, single venous phase is minimally essential for evaluation. Peritoneal carcinomatosis index should be assigned while baseline assessment which includes careful inspection of specific locations for any deposits in the peritoneal cavity with size of largest nodule.

Pre-requisites: Fasting for 4-6 hours before acquisition. Positive oral contrast is required to opacify bowel loops as it helps in detecting any surface/ serosal deposits.

<table>
<thead>
<tr>
<th>Site number</th>
<th>Corresponding location in peritoneal cavity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Entire greater omentum, transverse colon and transverse mesocolon</td>
</tr>
<tr>
<td>1</td>
<td>Right subphrenic space</td>
</tr>
<tr>
<td>2</td>
<td>Epigastric region including lesser omentum, lesser sac and intersegmental fossures</td>
</tr>
<tr>
<td>3</td>
<td>Left subphrenic space, tail of pancreas, spleen and perigastric region</td>
</tr>
<tr>
<td>4</td>
<td>Left paracolic gutter and descending colon</td>
</tr>
<tr>
<td>5</td>
<td>Left pelvic side wall lateral to sigmoid colon and sigmoid colon</td>
</tr>
<tr>
<td>6</td>
<td>Ovaries (excluding the primary tumor), tubes, uterus, bladder, rectum, sigmoid below pelvic brim and pouch of Douglas</td>
</tr>
<tr>
<td>7</td>
<td>Right pelvic side wall lateral to caecum, caecum and appendix</td>
</tr>
<tr>
<td>8</td>
<td>Right paracolic gutter and ascending colon</td>
</tr>
<tr>
<td>9</td>
<td>Upper jejunum and its mesentery (bowel in left upper quadrant)</td>
</tr>
<tr>
<td>10</td>
<td>Lower jejunum and its mesentery (bowel in left lower quadrant)</td>
</tr>
<tr>
<td>11</td>
<td>Upper ileum and its mesentery (bowel in right upper quadrant)</td>
</tr>
<tr>
<td>12</td>
<td>Lower ileum and its mesentery (bowel in right lower quadrant)</td>
</tr>
</tbody>
</table>

CT-PCI of >20 indicates non-amenability of optimal CRS

Score based on lesion size

- 0: No visible tumor
- 1: Tumor size <0.5cms
- 2: Tumor size 0.5cm- 5cms
- 3: Tumor size > 5cms or confluent tumor
o. MRI(5): serves as problem solving tool in patients with indeterminate findings on USG and CT particularly for mucinous neoplasm and evaluation of small bowel and small bowel mesenteric disease. The protocol should include diffusion weighted imaging and post-contrast sequences

p. PET-CT: Since, not all ovarian malignancies show avidity on PET and the latter has less sensitivity in identifying nodules/deposits less than 1cms, it is not routinely recommended in ovarian cancers (NCCN recommendation)

PART IV

Reporting checklists:

a. Reporting format at baseline:

| Clinical background- Presenting complaints and clinical suspicion |
| Procedure details- CECT with oral contrast (single venous phase with or without delayed excretory phase) |

**Report:**

**Pelvis-** Primary lesion:
- Mass of ovarian origin- size and laterality
- Characteristics- cystic/ solid/ solid-cystic
- Walls- thick walled/ papillary projections/ thin imperceptible walls
- Margins- irregular/ smooth/ lobulated
- Calcification (+/-)
- Fat density (+/-)
- Infiltration (+/-) into uterus/ rectum/ sigmoid colon/ bladder/ ureters/ pelvic side walls/ vessels

**Spread:**
- Ascites (+/-)- Predominant location
- Omental deposits (+/-): location (Greater/Lesser omentum – Supra v/s infra-colic omentum) and size
- Peritoneal deposits (+/-): location (Pelvic /abdominal parietal peritoneum/Visceral peritoneum) and size (If measurable)
- Mesentery – Location size (Nodular or plaque like) Small bowel mesentery (Upper,mid,lower)
- Root of small bowel mesentery, Sigmoid mesentery
- Serosal – Overlying small bowel or large bowel

**Deposits:**
- Sub diaphragmatic surface- right/ left
- Liver surface
- Splenic surface
- Along the fissures- intersegmental fissure of liver
- Along porta, GB fossa, gastrohepatic region,
- Along the vessels- celiac trunk, left gastric artery, SMA/SMV
- Small bowel deposits/ obstruction
- Along mesocolon
- Along serosal surface of colon
- Along mesentery (As specified above)
- Along iliac vessels
- Presacral location
- Abdominal wall
- Resultant Hydronephrosis

<table>
<thead>
<tr>
<th>Lymph nodes (Common drainage site)</th>
<th>Left supraclavicular</th>
<th>Anterior para-cardiac</th>
<th>Pre and paraaortic – Supra renal hilar/ Infrarenal hilar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Iliac nodes</td>
</tr>
</tbody>
</table>

Distant organ Metastases (+/-)
- Lungs
- Pleural effusion
- Liver/ spleen
- Soft tissue/ umbilical Metastasis

Other abdominal organs:
Liver, spleen, pancreas GB
Small or large bowel obstruction /Narrowing

Comparison: if available

Impression:
Adnexal mass- unilateral/ bilateral with or without ascites, deposits in unfavorable sites
FIGO stage with CT-PCI

b. Reporting checklist at follow up:

| Clinical background- Presenting complaints and clinical suspicion |
| Treatment received and duration/ interval- |

<table>
<thead>
<tr>
<th>Procedure details- CECT with oral contrast (single venous phase with or without delayed excretory phase)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Report:</strong></td>
</tr>
<tr>
<td>Liver, spleen, pancreas: normal in size, attenuation and enhancement characteristics</td>
</tr>
<tr>
<td>GB: distended, normal</td>
</tr>
<tr>
<td>CBD: Not dilated</td>
</tr>
<tr>
<td>Urinary bladder:</td>
</tr>
<tr>
<td>Pelvis:</td>
</tr>
<tr>
<td>Recurrent mass (+/-) with size and extent</td>
</tr>
<tr>
<td>Peritoneal spread/ depositions:</td>
</tr>
<tr>
<td>Site, size and extent</td>
</tr>
<tr>
<td>Lymph nodes (+/-): Size, discrete/ conglomerate, necrosis (+/-)</td>
</tr>
<tr>
<td>Ascites and pleural effusion (+/-)</td>
</tr>
<tr>
<td>Metastases (+/-)</td>
</tr>
<tr>
<td>Comparison: if available</td>
</tr>
<tr>
<td>Impression:</td>
</tr>
<tr>
<td>Recurrent/ residual mass….. nodes…. Deposits…</td>
</tr>
</tbody>
</table>
REFERENCES


CONTENTS

Part I
Background information

Part II
Imaging Methods
   A. Colon cancer
   B. Rectal cancer

Imaging Protocols
   A. Colon Cancer CT protocol
   B. Rectal Cancer MRI protocol

Part III
Reporting checklists
   G. Colon Cancer CT Reporting checklist
   H. Rectal Cancer Reporting templates and checklist
      1) Pretreatment MRI template for loco-regional staging
      2) Restaging MRI template for loco-regional staging
      3) CT checklist for metastatic workup.
Part I

Background:

- *Globocan 2018 Indian fact sheet* documents 27,605 new cases of colon cancer and 24,251 new cases of rectal cancer in India.

- The risk for developing colorectal cancer are: a) a diet high in red, processed, or charred meats b) lack of exercise / obesity c) smoking (studies show that smokers are 30 to 40 percent more likely to die of colorectal cancer) d) family History of Lynch Syndrome or familial adenomatous polyposis e) Inflammatory bowel diseases, such as ulcerative colitis and Crohn’s colitis, have a small increased risk of colorectal cancer.

A. COLON CANCER

- Hyperplasia –adenoma –carcinoma sequence with chromosomal, micro-satellite and serrated pathways are the most widely recognized pathways for pathogenesis of colon cancer.

- Surgery with curative or palliative intent is the mainstay of treatment of colon cancer.

- The contemporary treatment strategies are divided into those aimed at local/primary tumor management and those at management of distant metastatic disease.

- Literature shows a best OS (overall survival) is supported by a decision of resection of liver metastatic disease and resection of disease at selected oligo-metastatic sites.

- Preoperative staging: The main objective is to identify the local and regional extension of the primary lesion (T & N category) ; however, it is necessary to search its extension to other locations as well (M category) before planning treatment.

- Multidetector CT is the most widely used method for loco-regional staging as well as distant metastatic workup. Pulmonary metastases though can be investigated either with chest X-ray or CT scan depending on availability. PET- CT is not recommended in the initial staging except when CT reveals curable M1 disease

B. RECTAL CANCER

- Treatment of rectal cancer heavily depends on the stage of the disease.

- Imaging in rectal cancer helps decide between a) Patients that need upfront surgery and b) Patients that need preoperative short course radiation therapy or long course chemoradiation.

- Imaging can also influence radiotherapy planning and surgical planning.
Part II
Imaging methods & Imaging Protocols

A. COLON CANCER

• Preoperative staging CT accurately distinguishes between tumours confined to the bowel wall and those invading beyond the muscularis propria; however, it is significantly poorer at identifying nodal status.

• Ideally CT is performed with IV contrast and can be performed as a single post contrast portal venous phase of the chest, abdomen, and pelvis. Alternatively, a multiphase protocol of the liver (generally consisting of arterial, portal venous, and delayed phases) can be paired with post contrast imaging of the chest and pelvis. Acquiring multiple phases of the liver may improve diagnostic characterization of focal liver lesions.

• In addition to the phases of contrast, thin slices (ranging from 3 to 5 mm) and optimized techniques (in relation to contrast bolus and imaging parameters) are essential for adequate staging accuracy with CT.

• MRI liver can be problem solving for liver metastases. Liver MRI is ideally performed with and without IV contrast, with multiphase dynamic post contrast imaging as the standard acquisition. There are two main types of MRI IV contrast for liver imaging, traditional extracellular agents (producing similar contrast kinetics to CT contrast) and hepatobiliary agents.

• Although the use of IV contrast agents is ideal for staging, in patients who cannot receive an IV contrast agent due to severe allergy or renal failure, MRI without an IV contrast agent may be an option that provides better anatomic detail than CT without contrast.

**COLON CANCER CT PROTOCOL :**

<table>
<thead>
<tr>
<th>IV Contrast Type</th>
<th>Non ionic iodine containing – Iohexol 350mg L/ml ; If Deranged Kidney function tests preferable to use Iodixanol 652 mg/ ml equivalent to 320 mg Iodine</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV Contrast volume</td>
<td>100ml</td>
</tr>
<tr>
<td>Saline Flush</td>
<td>N/A</td>
</tr>
<tr>
<td>Injection Rate</td>
<td>2.3ml/sec</td>
</tr>
<tr>
<td>Oral Contrast</td>
<td>Preferably water ( neutral solution) 45 mins before the study</td>
</tr>
<tr>
<td>Oral Contrast volume</td>
<td>1000ml</td>
</tr>
</tbody>
</table>

Ideally wait 45 minutes after administering the oral contrast before scanning the patient.

• Use of rectal/oral contrast is not recommended if clinical suspicion of acute abdomen due to bowel obstruction

• Routine use of antispasmodics is not recommended

<table>
<thead>
<tr>
<th>Acquisition Phase</th>
<th>Scan Timings</th>
<th>Anatomical Coverage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non Contrast</td>
<td>NA</td>
<td>Abdomen to include dome of liver through the pubic symphysis</td>
</tr>
<tr>
<td>Bolus Tracking</td>
<td>Done at level of celiac artery in abdominal aorta</td>
<td>HU set at 100 HU</td>
</tr>
<tr>
<td>Arterial Phase</td>
<td>6 seconds delay with scan time of 5 seconds</td>
<td>Upper abdomen to include dome of liver through the inferior extent of liver (has to be calibrated for each individual case based on the vertical span of liver)</td>
</tr>
<tr>
<td>----------------</td>
<td>------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Porto- Venous Phase</td>
<td>12 seconds delay with scan time of 14 seconds</td>
<td>Abdomen to include dome of liver through the pubic symphysis</td>
</tr>
<tr>
<td>Venous Phase</td>
<td>15 seconds delay with scan time of 6 seconds</td>
<td>Upper abdomen to include dome of liver through the inferior extent of liver (has to be calibrated for each individual case based on the vertical span of the liver)</td>
</tr>
</tbody>
</table>

**Technical Parameters**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>kVp</td>
<td>120</td>
</tr>
<tr>
<td>Effective mAs</td>
<td>CareDose</td>
</tr>
<tr>
<td>Care Dose Reference mAs</td>
<td>250</td>
</tr>
<tr>
<td>Time (Rotation)</td>
<td>0.5 sec</td>
</tr>
<tr>
<td>Average Acquisition Time</td>
<td>8-10 sec</td>
</tr>
<tr>
<td>Collimation</td>
<td>64 x 0.6mm</td>
</tr>
<tr>
<td>Pitch Value</td>
<td>0.8</td>
</tr>
<tr>
<td>Scan Direction</td>
<td>craniocaudal</td>
</tr>
</tbody>
</table>

**MRI liver protocol**

**RECTAL CANCER**

- High resolution MRI with external coil (NOT endorectal coil) is the **optimal/ desirable first method of choice** for locoregional staging of rectal cancer; MDCT abdomen and pelvis is the widely used method for distant metastatic workup. For pulmonary metastases, there is no consensus between chest X-ray and CT chest; however CT chest is preferred in low rectal cancers.

- PETCT may be added for distant metastatic workup in the initial staging in the following situations: a) in confirmed hepatic metastases to rule out extrahepatic disease when radical surgery is planned b) in suspected metastases not confirmed on CT c) and when tumour marker CEA is very high at presentation.

- Endorectal Ultrasound (ERUS) is useful only in very early stage rectal cancers to distinguish between T1 and T2 tumours and identify the T1N0 subset, which are offered local excision while the T2 tumours are treated with total mesorectal excision surgery.

- Hence in all cases MRI is the **first desirable investigation of choice** for locoregional staging and ERUS is added in high volume centres with expertise only to identify the Ti N0 cases.

- Locally advanced rectal cancers (T3 and above) are usually treated with preoperative long course chemo-radiation or short course radiotherapy and then restaged with MRI prior to surgery.

- In the absence of rectal MRI, ideally treatment for rectal cancer should not be offered, but this may not be practical in low resource constrained settings. The American college of Radiology has considered the use of contrast enhanced CT abdomen and pelvis for pretreatment loco regional staging of rectal cancer appropriate, **only when MRI cannot be performed and tumour is locally advanced**.

- After preoperative radiation / chemo-radiation, high resolution MRI with external coil is also the **first/ desirable investigation of choice** for loco-regional restaging.

- Restaging MRI helps assess response, plan surgery and adjuvant therapy.
• Diffusion weighted MRI sequences are essential in both pretreatment and post treatment settings and help optimize response assessment.

**RECTAL CANCER IMAGING PROTOCOL**

**Loco regional staging: High resolution MRI with external coil**

**Rectal MRI Protocol**

<table>
<thead>
<tr>
<th>Recommend</th>
<th>Not recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magnet strength of 1.5 or 3.0 T</td>
<td>Magnet strength &lt; 1.5 T</td>
</tr>
<tr>
<td>Patient positioned comfortably in supine position.</td>
<td>Administering spasmolytic agents such as glucagon or hyoscine butyl bromide is not mandatory but may reduce artifacts caused by peristalsis when administered immediately before the examination or just before the most motion sensitive sequences (eg, DWI or dynamic contrast material-enhanced [DCE] sequences) are obtained</td>
</tr>
<tr>
<td>Bowels and bladder emptied</td>
<td>Enema not routinely needed</td>
</tr>
<tr>
<td>Endorectal filling with gel or air is not recommended (may alter staging owing to compression of the mesorectal fat)</td>
<td></td>
</tr>
<tr>
<td>Correct placement of phased array coil (in low rectal cancers, distal edge of coil should be 10cm below the symphysis pubis)</td>
<td>Endorectal coil (does not provide information on the mesorectal fascia or lateral pelvic wall nodes)</td>
</tr>
<tr>
<td>Coverage should be for 5cm above the top of the tumour and at least up to L5/S1 for all tumours</td>
<td></td>
</tr>
</tbody>
</table>

**SEQUENCES**

**2 D T2-weighted FSE**

*Orthogonal sequences without fat saturation:*

a) Large FOV Axial & Sagittal
b) Small FOV Sagittal
c) Small FOV Coronal & Axial (perpendicular and parallel to rectal tumour axis) with slice thickness ≤ 3mm
d) Low rectal cancers-small FOV coronal parallel to anal canal
e) DWI with at least a high b value ≥ 800
f) Large FOV T1 W axial sequence useful for mucinous deposits

<table>
<thead>
<tr>
<th>Recommend</th>
<th>Not recommended</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-dimensional T2-weighted MRI is not routinely recommended</td>
<td>T2W Fat suppressed sequences not helpful</td>
</tr>
<tr>
<td>Use of intravenous contrast material does improve staging</td>
<td>Routine DCE-MRI not recommended</td>
</tr>
<tr>
<td>Quantitative ADC measurements not routinely needed</td>
<td></td>
</tr>
</tbody>
</table>
### MRI Protocol on 3T Siemens scanner

<table>
<thead>
<tr>
<th></th>
<th>Large FOV for Pelvis</th>
<th>Small FOV for Rectum</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T2 TSE Axial</td>
<td>T2 TSE Axial</td>
</tr>
<tr>
<td>TR (ms)</td>
<td>5000</td>
<td>4000-5500</td>
</tr>
<tr>
<td>TE (ms)</td>
<td>80-100</td>
<td>90-100</td>
</tr>
<tr>
<td>ETL</td>
<td>5</td>
<td>13</td>
</tr>
<tr>
<td>FOV (mm x mm)</td>
<td>380 x 330</td>
<td>180 x 180</td>
</tr>
<tr>
<td>Matrix</td>
<td>448 x 314</td>
<td>320 x 256</td>
</tr>
<tr>
<td>Slice thickness</td>
<td>5 mm</td>
<td>3 mm</td>
</tr>
<tr>
<td>b values</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

### Part III

Reporting checklists:

- **A. COLON CANCER**: for T, N, & M category
- **B. RECTAL CANCER:**
  1) Primary Staging MRI template for locoregional staging
  2) Restaging MRI template for locoregional staging
  3) CT checklist for metastatic work up

**A. COLON CANCER CT Checklist**

CT dated:

Procedure Description:

Clinical Indication:

**Report (Findings):**

**Primary Lesion**

1. **Key classification elements of T category**: (CT cannot reliably differentiate between mucosa and sub mucosa; T1 ~ T2)
   - Mural wall thickening absent/ present (when bowel optimally distended, thickening defined as > 5mm)
   - Contour: Polypoidal / Ulcerative / Annular
   - Exophytic / Intra luminal endophytic lesion
• If exophytic, tumour extension: <5mm / >5mm.
• Extra mural tumour spread ....mm.
• Peritoneal infiltration: yes / no

2. Location
• Ascending - If yes - Illeocecal junction involved / not involved; If not involved – Distance from IC junction
• Transverse – Flexures involved (Hepatic / Splenic)
• Descending colon
• Sigmoid colon

3. Focality (We only mention if growth is seen at one site of colon or more sites)

4. Size (disease-site groups should make recommendations on how measurement should be done)
   We will follow the most common method of drawing a line along the outer mucosal margin and drop a perpendicular to the outer most extent – The same way we do for determining T status – I don’t have exact clarity in this. Sorry, but this is what I found while reading the literature.

5. Lesion characteristics – If contains tiny calcifications – present / absent, Density - solid / mucinous.

6. Critical structures List, adjacent solid organs / abdominal vessels / with involved/not-involved and distances

7. Complications:
   a) Bowel obstruction
   b) Perforation
   c) Fistula
   d) Intussusception

Nodes
   A. Anatomic locations
   B. Size -- short axis diameter( SAD) , mention if more than 10mm.
   C. Number
   D. Necrosis
   E. Calcifications or cystic changes (may suggest mucinous origin)

Organ specific findings (metastasis sub-section)
   A. List of pertinent organs for comment: Liver / Lung / Peritoneum (but can metastasize anywhere)
   B. Location of lesion/s
   C. Size of lesion/s
   D. Level of suspicion - Add if further imaging is helpful (for example MR incorporating DWI sequences and Liver specific contrast)
   E. Characterization of lesion/s.

IMPRESSION:
   1) Stage
   2) Spread
   3) Further recommendations (Additional imaging / Histopathology).
**B.RECTAL CANCER:**

1) Primary Staging MRI template for loco-regional staging

**MRI dated:**

**Procedure Description: Baseline study:** sequences and planes

**Clinical Indication:** Case of Ca rectum. Baseline staging (free text information if any)

**Report (Findings):**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Distance of lowest tumour margin from anal verge</strong></td>
<td>cm cm Cannot be measured.</td>
</tr>
<tr>
<td><strong>2. Longitudinal tumour size</strong></td>
<td>cm cm Cannot be measured.</td>
</tr>
<tr>
<td><strong>3. Morphology &amp; Circumferential location</strong></td>
<td>Mucinous (T2 hyperintense) / Nonmucinous(hypointense/ intermediate signal on T2W)</td>
</tr>
<tr>
<td></td>
<td>Completely encircling lumen</td>
</tr>
<tr>
<td></td>
<td>Partially encircling: _ to _ o'clock in clockwise manner</td>
</tr>
<tr>
<td><strong>4. Tumor relationship to anterior peritoneal reflection:</strong></td>
<td>Entirely above anterior peritoneal reflection</td>
</tr>
<tr>
<td></td>
<td>Above and below the anterior peritoneal reflection <em>involved</em> _ not involved</td>
</tr>
<tr>
<td></td>
<td>Entirely below anterior peritoneal reflection</td>
</tr>
<tr>
<td></td>
<td>Cannot comment</td>
</tr>
<tr>
<td><strong>5. T stage:</strong></td>
<td>Tx/T1-T2/ T2/ T3/ T4a / ? T4b/ T4b</td>
</tr>
<tr>
<td><strong>6. For T3 lesion, maximum extramural depth of tumour invasion</strong></td>
<td>≤ 5 mm</td>
</tr>
<tr>
<td></td>
<td>5 -15mm</td>
</tr>
<tr>
<td></td>
<td>&gt;15mm</td>
</tr>
<tr>
<td><strong>7. For T4b lesion, involved structures:</strong></td>
<td>Small bowel</td>
</tr>
<tr>
<td></td>
<td>Right seminal vesicle</td>
</tr>
<tr>
<td></td>
<td>Right ovary and adnexa</td>
</tr>
<tr>
<td></td>
<td>Right obturator internus</td>
</tr>
<tr>
<td></td>
<td>Right piriiformis</td>
</tr>
<tr>
<td></td>
<td>Right internal iliac vessels</td>
</tr>
<tr>
<td></td>
<td>Other: please specify</td>
</tr>
<tr>
<td><strong>8. Mesorectal fascia involved/threatened</strong></td>
<td>by primary Yes/No/ not applicable (in tumours above peritoneal reflection)</td>
</tr>
<tr>
<td></td>
<td>If Yes - shortest distance cm at _ o'clock position</td>
</tr>
<tr>
<td><strong>Mesorectal fascia abutted by node deposit</strong></td>
<td>EMVI(mention which) at _ o'clock position and cm</td>
</tr>
<tr>
<td><strong>9. Anal canal involvement by tumour</strong></td>
<td>Absent</td>
</tr>
<tr>
<td></td>
<td>Partial thickness of internal sphincter</td>
</tr>
<tr>
<td></td>
<td>Full thickness of internal sphincter</td>
</tr>
<tr>
<td></td>
<td>Into intersphincteric fat plane</td>
</tr>
<tr>
<td></td>
<td>Into external sphincter</td>
</tr>
<tr>
<td></td>
<td>Beyond external sphincter and into levator ani</td>
</tr>
<tr>
<td></td>
<td>Other: please specify</td>
</tr>
</tbody>
</table>
10. **Mesorectal lymph node spread** (criteria for abnormal nodes mentioned below**)

|                |  
|----------------|---------------------------|
| **Absent**     |                           |
| **Present**    |                           |
|               | largest size ___ cm.       |
|               | Number of abnormal nodes- 1/2-3/3 nodes |

11. **Extra mesorectal lymph node spread:**

|                |  
|----------------|---------------------------|
| **Absent**     |                           |
| **Present**    | Location ___ Size: ___ cm (mention all suspicious nodes) |

12. **Any Other findings:**

Footnote --*CRM positive = tumor-MRF distance is <1mm; CRM threatened = tumor -MRF distance 1-2 mm, CRM negative = tumor –MRF distance > 2mm

**Criteria for abnormal nodes –1)round shape, 2)heterogeneous signal, 3)irregular margins**

Abnormal nodes  All nodes ≥ 9mm, nodes 5-8 mm with 2 criteria, nodes <5mm with all 3 criteria

**Impression:**

T (Tx-T4b), N (N0-N2), CRM (involved/threatened/not involved/not applicable)

Pelvic sidewall nodes

Sphincter involved/not involved

EMVI

-------------------------------------------------------------------------------------------------------

**RECTAL CANCER:**

2) **Restaging MRI template for loco regional staging (adapted from the SAR 2017 template)**

MRI dated:

Comparison study if present & date

**Procedure Description:** sequences and planes

**Prior Treatment:**

Clinical Indication: ☑ Case of Ca rectum. Restaging.

**Report (Findings):**

**A. Treated Tumor**

a. *(T2 characteristics):*

- Completely normal rectal wall (complete response)
- No obvious residual tumor / A fibrotic ring (near complete response)
- Residual tumor/mucin along with fibrosis
- Residual tumor/mucin with no fibrosis

b. **DWI:** Restricted diffusion in tumor bed: Present/ Absent

**B. Residual Tumor description**

1. Distance of lowest tumour margin from anal verge _____ cm. OR Cannot be measured. Distance of inferior
**Impression:**

-As compared to prior study [date], based on both T2 & DWI–there is
  
  No residual tumor
  Near complete response
  Partial response
  Absent or Minimal response

-yT (pick T0-T4b)
- yN(pick N0/N+/Nx)

--Suspicious Pelvic sidewall nodes Y/N

-EMVI: Y/N

yCRM: clear/ involved /threatened/not applicable

-Any suspicious node/EMVI within 2mm of CRM Y/N

-Sphincter involvement: Present/Absent

---------------------------------------------------------------------------------------------------------------------------

RECTAL CANCER:

3) CT checklist for metastatic work up

CT dated:

Procedure Description:

Clinical Indication:

Report checklist

Organ specific findings (for metastasis/es)

A. List of pertinent organs for comment: Liver / Lung / Peritoneum (but can metastasize anywhere)
B. Location of lesion/s
C. Size of lesion/s
D. Level of suspicion - Add if further imaging is helpful (for example MR incorporating DWI sequences and Liver specific contrast)
E. Characterization of lesion/s.
URINARY BLADDER

Version v1.2020

Dr Pankaj Sharma (Rishikesh)
Background Information

- Bladder Cancer (Bca) is a heterogeneous disease with a variety of pathological features, cytogenetic characteristics and natural history.
- Bca is 9th most common cancer in India (Indian Cancer Registry data).
- Bca accounts for 3.9% of all cancer cases and is the Commonest Urological Malignancy.
- Presenting complaint is usually painless haematuria or irritable Urinary bladder symptoms.
- Transitional Cell Carcinoma is most common bladder malignancy (90% cases).
- Squamous cell and adenocarcinoma is found in less than 10% cases.
- Important to look for other site of involvement (Renal pelvis or ureter) in Bladder TCC.
- Increasing use of tobacco and increasing exposure to industrial chemicals are the likely cause.
- Presenting age for Bca is usually more than 60 years.
- Male to female ratio 4:1 to 5:1. This ratio is more in India, due to smoking being less prevalent in females in India as compared to Western population.

Bca is divided into four categories:

- Non-muscle Invasive Bladder Cancer (NMIBC)
- Muscle Invasive Bladder Cancer (MIBC)
- Locally Advanced Disease (LAD)
- Advanced Bladder Cancer (ABC)

- In India, less than half Bca present as NMIBC, as compared to western population, where almost three fourth are NMIBC.
- NMIBC have a higher rate of recurrence than do MIBC.
- Nearly all cases of squamous carcinoma and adenocarcinoma of the bladder are invasive at the time of diagnosis, and carry a worse prognosis than do urothelial tumors.
- Within females, the disease is most likely to have aggressive/muscle invasive disease.
- Survival and prognosis of patients is affected by multiple factors such as age, gender and environment, in addition to tumour biology.
Feasibility for Radical cystectomy depends on staging by a combination of clinical, histopathological and imaging findings.

Treatment decisions and prognosis for BCa are based on the depth of muscle invasion by the tumor, degree of differentiation of the tumor, and presence or absence of metastasis.

**Imaging Protocol**

- Imaging for Bca should only be performed when it makes a difference to patient management.
- Cystoscopy and CT are complimentary and first line of investigation in patient who present with painless haematuria.
- Cystoscopy biopsy of suspicious looking bladder lesions is performed to assess the pathology, grade and depth of these tumours.
- Trans-urethral resection of bladder tumour (TURBT) is performed for complete resection of superficial bladder tumours and for deep biopsy to assess muscle invasive tumours.
- Biopsy is performed for all suspicious looking lesions.
- Cross Sectional Imaging is usually performed afterwards, for disease staging in patients, who are thought to have solid tumours.
- CT is the preferred imaging modality for diagnosing and staging urothelial cancer.
- MRI is superior for evaluation of the depth of tumour invasion into the bladder wall.
- MRI of pelvis is performed for T (tumour) staging, once BCa has been diagnosed.

**Staging (TNM)**

- TX: Primary tumour cannot be evaluated.
- T0: No evidence of primary tumour in the bladder.
- Ta: Refers to non-invasive papillary carcinoma.
- Tis: Carcinoma in situ.
- T1: Tumor has spread to lamina propria.
- T2: Tumor has spread to the muscle of the bladder wall.
- T2a: Tumor has spread to the inner half of the muscle wall.
- T2b: Tumor has spread to the outer half of the muscle wall.
- T3: Tumor has grown into the perivesical tissue.
- T3a : Tumor has grown into the perivesical tissue, as seen through a microscope
- T3b: Tumor has grown into the perivesical tissue macroscopically.
- T4: Tumor has spread to any of the following : the abdominal wall, the pelvic wall, prostate or seminal vesicle (male) ; or uterus or vagina (female).
• T4a: Tumor has spread to the prostate, seminal vesicles, uterus or vagina.

• T4b: Tumor has spread to the pelvic wall or the abdominal wall.

• NX: Regional lymph nodes cannot be evaluated.

• NO: Tumor has not spread to the regional lymph node.

• N1: Tumor has spread to a single regional lymph node in the pelvis.

• N2: Tumor has spread to 2 or more regional lymph nodes in the pelvis.

• N3: Tumor has spread to the common iliac lymph nodes, which are located behind the major arteries in the pelvis, above the bladder.

• M0: Disease has not metastasized.

• M1: There is distant metastasis.

• M1a: tumor has spread only to lymph nodes outside of the pelvis.

• M1b: Tumor has spread to other parts of the body.

Staging (TNM)

• Stage 0a : Ta, N0, M0

• Stage 0is : Tis, N0, M0

• Stage I : T1, N0, M0

• Stage II : T2, N0, M0

• Stage IIIA : T3a, T3b or T4a; N0; M0 or T1 to T4a, N1, M0

• Stage IIIB : T1 to T4a, N2 or N3, M0

• Stage IVA : T4b, any N, M0 or any T, any N, M1a

• Stage IVB : any T, any N, M1b

• Preoperative differentiation between Stage T1 tumours and Stage T2 (or greater) tumours is crucial for the appropriate choice of effective treatment options.

• Tumours of stage T2 or greater are treated with partial or total cystectomy or with adjuvant therapies, since TURBT for invasive tumours often results in local tumour recurrence.

• Upto 50% of patients with muscle invasive BCa eventually develop metastatic disease.
Imaging Protocol (Initial Evaluation) : CT

- Diagnostic Cystoscopy is required in all patients with suspected BCa.
- CT Urography has sensitivity and specificity of over 90% for the diagnosis of BCa in patients with hematuria.
- CT does not allow confident diagnosis of flat lesions and lesions at the bladder base adjacent to the prostate gland, particularly in patients with benign prostate hypertrophy.
- Hence, CT Urography cannot be used as replacement for Diagnostic Cystoscopy.
- Whole body CT is the primary imaging technique for the detection of metastasis in BCa patients, especially those with disease that invades muscle.
- It is possible to visualize bladder wall enhancement and thickness on nephrographic phase CT scans.

Imaging Protocol (Initial Evaluation): MRI

- Study of BCa requires high spatial resolution, which can be achieved with the use of a phased array external surface coils, thin sections and a large matrix.
- Preliminary localizer sequences are used to evaluate for appropriate coil placement and bladder distension.
- Optimizing echo time (60 to 80ms) is crucial for achieving a high contrast to noise ratio, which is important in assessing the depth of bladder wall involvement.
- Lack of bladder distension may limit the detection of small tumours, secondary to detrusor muscle thickening.
- Over distension of bladder may result in patient motion and can decrease patient sensitivity for plaque like lesions.
- Optimum bladder distension is achieved by instructing the patient to void 2 hours prior to imaging.
- Artifact from bowel peristalsis can be minimized by administering antiperistaltic agent and using anterior saturation bands.
- To reduce Chemical shift artefact, the bandwidth may be increased and the frequency encoding gradient changed, to select the direction that least interferes with examination of the bladder wall adjacent to the tumour.
- MRI imaging has shown to better depict intramural tumour invasion as well as extravesical extension and allows differentiation between muscle invasive and non-muscle invasive disease.
- Axial SE T1 weighted images with large FOV is useful for evaluating the perivesical fat planes for extravesical tumour infiltration, pelvic lymphadenopathy and bone metastasis.
- High resolution fast SE T2 weighted images of the bladder obtained in three orthogonal planes with a small FOV and a large matrix are used to evaluate the detrusor muscle for tumour depth and invasion of the surrounding organs.
• Coronal images are useful for delineating tumors located in the lateral bladder wall and dome.

• Sagittal images are useful for delineating tumors located in anterior wall, posterior wall and dome.

• In early phase (20 seconds after contrast material injection) on dynamic contrast enhanced MRI, BCa tend to enhance more than the surrounding bladder wall.

• Diffusion weighted imaging has the potential to complement other sequences in improving the diagnosis and staging of Bca.

• For most bladder tumors, increased cellular density manifests as increased signal intensity on diffusion weighted images, with a reduced apparent diffusion coefficient.

• PET with 2-[fluorine-18]fluoro-2-deoxy-D-glucose is considered to be of lesser value in the local staging of bladder cancer due to urinary excretion of the radiotracer.

**Imaging Protocol (Follow up/Post Therapy)**

• Because of high rate of local recurrence, patients with NMIBC must be followed up after treatment.

• Cystoscopy, Urine Cytology, and Imaging of the upper tract (CT Urography) with retrograde ureteroscopy are usually performed annually.

• In MIBC, Guidelines for post-cystectomy surveillance include Urine Cytology, Chest Radiography, and Abdominopelvic imaging (CT) every 3-6 months for the first 2 years.

• Following this period, imaging studies are indicated based on Clinical status.

• Metastasis usually occur in pelvis or retroperitoneal nodes.

• Less common sites of metastasis include the lungs, liver, adrenal glands, bones, and kidneys, and even the peritoneal space.

**Report (Initial Evaluation)**

The following components should be included in the Radiologist’s report during initial evaluation of bladder tumors:

1. **Evaluation of primary tumour:**
   a. Location: Bladder wall involved
   b. VUJ involvement: Present/ Absent
   c. Multiplicity of tumour: Present/ Absent
   d. Thickness of involved bladder wall/ Size of Tumor(three dimensions)
   e. Attenuation (CT)/ Signal characteristics (MRI): Pre and post contrast
   f. Extent:
g. Spread to Surrounding Organs:
   o Infiltration or Inflammation: Present/ Absent
   o Fat planes with surrounding pelvic structures (anteriorly: bladder wall, posteriorly: uterus/cervix/vagina or rectum, laterally: pelvic side walls): Maintained/ Lost

2. Lymphadenopathy:
   a. Suspicious features: Loss of fatty hilum/ Irregular outline/Post contrast enhancement- Present/Absent
   b. Location/Station
   c. Size of suspicious lymph nodes
   d. Lymph nodes below aortic bifurcation: Present/Absent
   e. Lymph nodes above aortic bifurcation: Present/Absent
   f. Lymph nodes in retroperitoneum: Present/Absent

3. Evaluation of Kidneys:
   a. Hydro-ureteronephrosis: Present/Absent
   b. Filling defects in Urinary tract/ Thickening of ureter wall/ Renal pelvis involvement: Present/ Absent; If present: Location/ Multiplicity/ Size/ Attenuation or signal characteristics

4. Metastatic Workup:
   a. Visceral metastasis (Lungs/ Liver/ Peritoneum/ Pleura/ Renal Parenchyma/ Adrenals): Present/Absent; If Present: Location/ Multiplicity/ Size/ Attenuation or signal characteristics
   b. Skeletal Metastasis: Present/ Absent; If Present: Location/ Multiplicity/ Size/ Attenuation or signal characteristics

Report (Follow up/Post Therapy)
The following components should be included in the Radiologist’s report during follow up/ post therapy of bladder tumors:

1. Identification and Evaluation of any recurrent/ residual primary tumour:
   a. Present/absent
   b. Location: VUJ involvement; Multiplicity; Size; Attenuation (CT)/ Signal characteristics (MRI); Extent; Involvement of Bladder muscle; Invasion of Surrounding Fat; Fat planes with surrounding organs

2. Surveillance to look for presence/absence of recurrence in:
   a. Lymph nodes
   b. Rest of the Urinary tract
   c. Recurrence in chest, abdomen or pelvis
   d. Viscera
   e. Bones

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3. **Comparison with baseline imaging- RECIST 1.1 criteria:** Mention of Complete Response/ Partial Response/ Progressive Disease/ Stable disease

**Key Take Away Points**

- Early detection of BCa is important, since upto 47% of BCa related deaths may be avoided.
- BCa has a high recurrence rate, necessitating long-term surveillance after initial therapy.
- MRI and CT both have limitations in detailing depth of muscle invasion.
- However, both MRI and CT have a prominent role helping to define the lesion and in staging.
- Microscopic perivesical spread (Stage T3a disease) cannot be identified at either CT or MRI.
- Current purpose of CT or MRI imaging is to detect T3b disease or higher, and to look for locoregional lymph node metastasis.
- Ureteroscopy is performed in patients with positive selective ureteral cytological findings or evidence of upper tract disease at CT Urography.
- In future, MR imaging with ultra small super paramagnetic iron oxide contrast agents may detect lymph nodes containing metastatic tumour.
References

PROSTATE

Version v1.2020

Jyoti Arora (Gurugram)
GUIDELINES FOR IMAGING IN PROSTATE CANCER

INTRODUCTION

- Prostate cancer is the second most frequent cause of cancer and the sixth major cause of cancer deaths among men worldwide. Its worldwide burden is anticipated to grow to 1.7 million new cases and 499 000 new deaths by 2030 simply because of the growth and aging of the global population [1].
- Although prevalence rates of prostate cancer are considered low in Asian and North African countries, varying from 1 to 9/100,000 persons [2], demographic and epidemiological transformation in developing countries like India have shown an increasing tendency in the burden of various cancers including prostate cancer. This is because the population of India in general have exhibited rapid changes in life styles, dietary practices and socio-economic background.
- Depending on the Gleason score, clinical assessment of the patient’s disease and radiological findings, treatment options for prostate cancer are active surveillance, surgery and radiotherapy.
- However, prostate cancer is a heterogeneous disease process, ranging from inert tumours that will never affect survival to highly lethal cancers that can advance rapidly. Historically, prostate cancer is diagnosed through a non-targeted transrectal ultrasound systematic (TRUS) biopsy. A standard biopsy is prone to miss clinically significant cancers as well as commonly detected indolent tumours. Because of these problems, patients and treating physicians often lack the confidence in the results of the biopsy, leading to anxiety, uncertainty, thereby resulting in serial repeat biopsies in an endeavour to establish a diagnosis and overall level of risk. The low sensitivity (described below) and fundamental limitations of this procedure have led to a range of challenges and changes in prostate cancer management [3].

CLINICAL DIAGNOSIS:

- **Digital rectal examination:** Majority of prostate cancers are located in the peripheral zone and may be detected by digital rectal examination when the volume is around 0.2 mL. In ~18% of cases, it is detected by suspect digital rectal examination alone, irrespective of PSA level [4]. An abnormal DRE is associated with an increased risk of higher Gleason Score (GS) and is therefore an indication for biopsy [5].

- **Prostate-specific antigen:** Prostate-specific antigen is organ but not cancer-specific, therefore, it may be increased in benign prostatic hypertrrophy (BPH), prostatitis and other non-malignant conditions. As an independent variable, PSA is a better predictor of cancer than either DRE or transrectal ultrasound (TRUS) [6]. In men with a minimal elevated PSA-value of 4-10 ng/ml, 25% will have a prostatic carcinoma regardless of the finding on digital-rectal examination [7]

- **Prostate biopsy:** The requirement for prostate biopsy is based on PSA level and/or suspicious DRE and/or imaging. If PSA is elevated (>3–4 ng/mL) or DRE indicates suspected tumour, TRUS-guided biopsy will be performed to detect potential cancer [8]. In the ProteaT study [9] cancer detection rates ranged from 23% [95% confidence interval (CI) 14–36%] to 53% (CI 40–65%) across eight centres. This variation is due to the fact that there’s still a wide discrepancy in the number of cores taken, direction of the needle and area targeted.

**Indications for repeat biopsy after previously negative biopsy:** [10]

- increasing and/or persistently elevated PSA
- suspicious digital rectal examination, 5-30% cancer risk [4, 7]
• atypical small acinar proliferation (i.e., atypical glands suspicious for cancer), 31-40% risk [11]
• extensive (multiple biopsy sites, i.e., > 3) high-grade prostatic intraepithelial neoplasia, ~30% risk [12]
• a few atypical glands immediately adjacent to high-grade prostatic intraepithelial neoplasia, ~50% risk [13]
• intraductal carcinoma as a solitary finding, > 90% risk of associated high-grade prostate cancer [14]
• positive multiparametric MRI findings

IMAGING IN PROSTATE CANCER:

1. TRUS (Trans rectal ultrasound)

TRUS remains the first modality of choice for imaging the prostate. Yet, despite of technological advancements in high-frequency wideband probes, grayscale ultrasound has a precision of only 50–60% with a positive predictive value as low as 6% for the detection of prostate cancer. Its accuracy for local staging is also relatively poor [15].

Traditionally 70% of cancers originate from the peripheral zone, 10% from the central zone and 20% from the transitional zone [16]. 60–70% comprise of echo poor cancers, but only around17–57% of the echo poor foci are malignant. 30–40% of cancers appear isoechoic while a small percentage of them are echogenic. Of sonographically visible cancers 30% appear as a focal nodule, whereas a focal lesion is associated with an infiltrative component in 50% and an infiltrative pattern predominates in approximately 20%. A prostate cancer appears as a focal echo poor lesion with or without capsular invasion on axial transrectal ultrasound.

However, TRUS is limited in detecting prostate cancer because of the variability in ultrasound appearance, poor specificity of sonographic abnormalities; the actual fact being tumors are frequently multifocal and significant proportion of isoechoic cancers that cannot be differentiated from benign changes [17]. The accuracy of TRUS for local staging is poor, with sensitivity, specificity and accuracies of 50–92%, 46–91% and 58–86%, respectively, for extra capsular extension (T3 disease). For seminal vesicle involvement the sensitivity, specificity and accuracies are 22–60%, 88% and 78%, respectively [18]. This compares poorly with a sensitivity and specificity of MRI for staging of 91% and 96%, respectively.

2. Multiparametric MR, (mpMRI)

MP-MRI is the combination of various MRI sequences in order to furnish both anatomical and functional details about suspicious lesions, usually comprising of Axial T1-weighted MRI (T1W MRI), T2-weighted MRI (T2W MRI) in axial, coronal and sagittal planes, diffusion-weighted MRI (DW MRI), dynamic contrast-enhanced MRI (DCE MRI), and MR spectroscopy (MRSI). Based on the imaging findings from all the parameters and sequences, the accuracy of MP-MRI is enhanced and therefore permits assignment of tumour suspicion level [19].

3. Computed tomography (CT) and magnetic resonance imaging

Abdominal CT and T1-T2-weighted MRI indirectly evaluates nodal invasion by using diameter and morphology of lymph node. However, the size of non-metastatic lymph nodes usually varies and may overlap with the size of lymph node metastases, as microscopic invasion does not enlarge lymph nodes. Usually nodes with a short axis of > 8 mm in the pelvis and > 10 mm outside the pelvis are considered malignant [10]. Diffusion-weighted MRI may pick up metastases in normal-sized nodes, but a negative diffusion-weighted MRI cannot rule out the presence of nodal metastases [20].

4. Prostate-specific membrane antigen-based PET/CT

Indications: Possible role in initial staging, suspected disease recurrence and assessment of treatment response [21]
68Ga- or 18F-labelled prostate-specific membrane antigen PET/CT (PSMA PET/CT) is increasingly used as it provides excellent contrast-to-noise ratio leading to improved lesion detectability. Prostate- specific membrane antigen has specificity for prostate tissue which makes it an attractive target agent [22]. Patients with PSA levels > 10 ng/mL reveal significantly higher uptake than those with PSA levels < 10 ng/mL.

In a study conducted by Shrivastava et al, it is suggested that Ga-PSMA PET/CT is useful for lymph node and metastases staging in high-risk prostate cancers, whereas its utility for staging disease in the prostate is limited [23].

5. Bone scan

99mTc-Bone scan has been one of the the most widely performed modality for determining bone metastases of prostate cancer. A meta-analysis revealed combined sensitivity and specificity of 79% (95% CI: 73-83%) and 82% (95% CI:78-85%) at patient level and 59% (95% CI: 55-63%) and 75% (95% CI: 71-79%) at lesion level [24]. Bone scanning should be performed in symptomatic patients, independent of PSA level, Gleason Score or clinical staging [25].

CLINICAL INDICATION OF PROSTATE MRI:[3]

-Biopsy-naïve:

In biopsy-naïve patients, prostate MRI is used as an alternative to standard prostate biopsy alone for raising the detection of clinically significant cancer on prostate biopsy in patients with one or more of the following: PSA > 4.0, PSA density > 0.15, Other abnormal serum or urinary biomarker, Abnormal digital rectal examination, Family history of prostate cancer.

-Prior negative biopsy:

In patients with a previous negative prostate biopsy, MRI is considered necessary as an alternative to a repeat standard biopsy alone for increasing the detection of clinically significant cancer on prostate biopsy in those with a persistent clinically suspicious prostate cancer based on persistent rise in PSA or a persistent abnormality of another serum or urinary biomarker.

-Prior positive biopsy (local staging and active surveillance):

In patients with a prior positive prostate biopsy, MRI is considered necessary in either of the following two conditions:

- For assessment of the appropriateness of active surveillance
- For pre-surgical planning

PROFESSIONAL SOCIETY GUIDELINES FOR USE OF MRI IN PROSTATE CANCER [21]

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>Staging</th>
<th>Recurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>EAU[1] Year: 2016</td>
<td>Before repeat biopsy, perform mpMRI when clinical suspicion of prostate cancer is persistent in spite of</td>
<td>In case of intermediate- and high-risk prostate cancer use prostate mpMRI for local staging and as a decision making</td>
</tr>
</tbody>
</table>
## AUA [3]
**Year:** 2017

| Tool for selecting patients for nerve-sparing procedures. |
| candidates for local salvage therapy, for localization of suspicious areas and as an aid to guide biopsies.” |

MRI may potentially allow pre-biopsy risk stratification for individualized decision-making. It may be considered in men with uncertain clinical indications for biopsy. MRI should be strongly considered in any patient with a prior negative biopsy who has persistent clinical suspicion for prostate cancer and those who are undergoing a repeat biopsy.”

Staging patients with prostate cancer using MRI to assess possible lymph node metastasis can be considered in selected patients (T3/T4 and T1/T2 patients with nomograms predicting the risk of lymph node metastasis > 10%).” “mpMRI/TRUS may add important staging information when performed prior to definitive local therapy.”

### NCCN [2]
**Year:** 2016

| mpMRI is considered if anterior and/or aggressive cancer is suspected when PSA elevates and systematic prostate biopsies are negative [in patients with expected survival > 10 years].” |
| mpMRI may be performed in order to better risk stratify men who are considering active surveillance.” May be considered for initial evaluation of high-risk patients [including those with] T3 or T4 disease [or those with] T1 or T2 disease and nomogram-indicated probability of lymph node involvement > 10%”. |
| MRI may be considered in patients after radical prostatectomy when [PSA becomes detectable], or after radiation therapy for rising PSA or positive DRE if the patient is a candidate for additional local therapy.” |

### EUA = European Association of Urology; AUA = American Urological Association; SAR = Society of Abdominal Radiology; NCCN = National Comprehensive Cancer Network; mpMRI = multiparametric magnetic resonance imaging; DRE = digital rectal examination; PSA = prostate-specific antigen

## PROSTATE MR COILS AND EQUIPMENT:

- The combination of endorectal and pelvic phased array coil gives excellent SNR and remains state-of-art for staging of prostate cancer at 1.5T (minimal requirement)
- Prostate imaging at 3 T (desirable) benefits from higher SNR, and allows high quality imaging within a short time without the use of an endorectal coil.
- Limitations of 3 T MRI are: shorter T2 and longer T1 relaxation times, difficulties with susceptibility
are artefacts, specific absorption rate and homogeneity of the magnetic field. However, hardware, multi-channel coil, and parallel imaging technique improvements are presently solving most of these problems [8].

**ACQUISITION PROTOCOLS: MINIMUM REQUIREMENTS**

**A. Detection protocol**

Fast <30-min protocol is performed without an endorectal coil. Bowel preparation is done a night prior to the scan. Images must include the entire prostate and acquire T2WI, DWI and DCE-MRI.

**T2-weighted imaging:** T2WI axial, sagittal& coronal: 4 mm at 1.5 T, 3 mm at 3 T
Allows best depiction of the prostate’s zonal anatomy and capsule. Used for detection of prostate cancer, localization and staging.
Prostate cancer is typically seen as a round or ill-defined, low-signal-intensity lesion in the peripheral zone.
Lesion detection is specifically an issue in the transitional zone as benign prostate hyperplasia (BPH) mimics like cancer [26]. However, presence of an “erased charcoal sign” in a lenticular lesion is highly symbolic of cancer.
Helps in interpretation of findings in evaluation of the capsule, seminal vesicles and posterior bladder wall for extraprostatic tumour invasion.
Criteria for extra-capsular extension are: abutment; irregularity and thickening of neurovascular bundle; bulge, loss of capsule and capsular enhancement; measurable extra-capsular disease; obliteration of the recto-prostatic angle.
Seminal vesicle infiltration criteria are: expansion; low T2 signal intensity; filling in of the prostate–seminal vesicle angle; enhancement and impeded diffusion [8].

**Diffusion weighted MRI:** DWI axial: 5 mm at 1.5 T, 4 mm at 3 T;

- ADC map should be calculated and at least 3 b-values should be obtained: 0, 100 and 800–1000 s/mm2.
- It furnishes information about aggressiveness of the tumour, and improves specificity in cancer detection compared with T2WI alone. It also corresponds well with tumour volume of the index prostatic lesions.
- Prostate cancer displays high signal intensity on DWI at high b-values and low signal intensity/value on ADC maps [27]. For qualitative assessment high b-value (800–1000) DW images and ADC maps should be utilized. These should be evaluated in combination with T2WI for the anatomical detail. However, in some cases normal prostatic tissue especially in the transitional zone may reveal high signal intensity on DWI and low ADC, thus mimicking a tumour. To overcome this higher b-values (>1000 s/mm2) may be used.

**Dynamic contrast enhanced MRI** ,DCE-MRI axial: 4 mm at 1.5 T and 3 T.

- Following single dose of contrast agent, the maximum temporal resolution should be 15 s. For dynamic contrast study, acquiring images should be continued for 5 minutes in order to detect washout. To detect post-biopsy haematomas, non-contrast T1WI images from this sequence can be used.

- A study performed by Hara et al shows DCE-MRI plays an important role in prostate cancer detection, localisation, staging and recurrence detection and is able to determine clinically important prostate cancer in 93% of cases [28]. In patients with prior negative TRUS-guided biopsy sessions and elevating PSA level, DCE-MRI plays significant role in lesion detection.

- It is an important tool for MRI of prostate cancer, improving tumour localisation and local staging. But it should always be combined with T2WI and DWI, as differentiation among prostatitis, BPH and prostate
cancer in the transitional zone is more difficult with DCE-MRI alone.

MR spectroscopic imaging, MRSI:

- Magnetic resonance spectroscopic imaging (MRSI) in case of prostate cancer reveals lower levels of citrate and higher levels of choline when compared with benign tissue [43]. It is used to predict the presence or absence of cancer [29]. It also provides information about aggressiveness of the tumour, but however does not provide staging information because its poor spatial resolution.

- Despite being a valid tool for detecting cancer recurrence [30] and monitoring therapy response [31], it has been excluded from PIRADS v2 and PIRADS v2.1 as the results are not reliable. This is due to the fact that PI-RADS v1 does not delineate how the scores assigned in each of the sequences would contribute to the determination of the final overall assessment. While some radiologists just add individual scores together to obtain the final score ranging from 1 to 15 (or from 1 to 20 when using MR spectroscopy), others attempt to subjectively determine the overall score on a scale from 1 to 5. This variability and scoring subjectivity are in turn confusing to radiologists, referring clinicians, and patients which therefore have led to its omission from latest guidelines [32]. Being a research tool, as relevant data and experience becomes available consideration can be given to include it into future versions of PI-RADS.

B. Staging protocol

Images acquired should include entire prostate:

- T2WI axial, coronal and sagittal planes, 3 mm at 1.5 T and 3 T;

- DWI and DCE same as detection protocol.

- MRSI is optional.

C. Nodes and bone protocol

A 30-min protocol in order to assess nodal size and bone marrow metastases.

- T1WI coronal of lower lumbar spine plus pelvis (SE or f/T SE) with 3.0mm slices

- 3D f/T SE T2WI coronal of lower lumbar spine and pelvis; 1.0mm isometric voxels

- DWI coronal of lower lumbar spine and pelvis (b-values 0 and 600); slice thickness 3–4 mm, in plane resolution: 2.5–3.0 mm voxels

- T1WI sagittal sections of cervical and thoracic spine (SE or f/T SE)

- STIR or DWI of sagittal cervical and thoracic spine.

REPORTING AND IMAGING INTERPRETATION OF MULTI-PARAMETRIC MRI PROSTATE DATA

The data collected from multiparametric MRI must be presented to clinicians in a simple but meaningful way using
a structured reporting format, which consists of the following:

- PI-RADS score which depicts the probability of cancer risk and its aggression
- Location and probability of extra-prostatic disease.
- Incidental findings which are pertinent.
- Scoring system for mp-MRI (PI-RADS)

**Imaging Interpretation**

- The Prostate Imaging Reporting and Data System, Version 2.1 (PI-RADS v2.1) comprises of five assessment categories depending on the probability that an individual lesion corresponds to a clinically significant cancer, defined as a tumour with Gleason score ≥7:
  - PI-RADS 1 – very low; PI-RADS 2 – low; PI-RADS 3 – intermediate; PI-RADS 4 – high; and PI-RADS 5 – very high.
- The final PI-RADS category is determined by a combination of findings DWI, DCE, and T2W images, with different emphases placed on specific sequences for the peripheral (PZ) versus transition zones (TZ). Up to four lesions with an assessment category of 3 or greater may be reported, and a standard sector map be utilized to guide in biopsy targeting. Reporting lesions with a PI-RADS score of 1 or 2 is optional.
- PI-RADS v2.1 characterizes lesions in the peripheral zone differently from lesions in the transitional zone. Assessment of lesions in the peripheral zone depends almost entirely on its appearance on DWI. Contrast enhancement is useful for peripheral zone lesions in cases where characterization of the lesion on DWI is equivocal. Conversely, assessment of lesions in the transitional zone relies predominantly on the T2W score. Contrast enhancement is not utilized for evaluation of transitional zone lesions; however, DWI can be used to further characterize equivocal transitional zone lesions [21].

**INTERVENTIONS IN PROSTATE CANCER:**

**TRUS biopsy:**

- Indications for TRUS biopsy: a palpable nodule on digital rectal examination, clinical symptoms, suspicion for prostate cancer, high PSA value, or high PSA velocity (rate of change in PSA levels).
- The current standard for prostate biopsy under TRUS guidance is to obtain a 12–14 random cores, during which systematic sampling of tissue from the apex, mid, and base regions of the prostate is performed [19].
- Traditional methods of prostate cancer detection, including TRUS-guided biopsy in combination with serum PSA testing and digital rectal exams, have low sensitivity with only a 24–44% success rate of cancer detection, which may lead to over detection of low-grade tumours and underdiagnosis of large clinically significant tumours, particularly in the anterior prostate gland which is a difficult area to biopsy using the TRUS-guided technique[33].

**MRI TRUS fusion biopsy:**

- MRI-TRUS fusion guidance attains image registration between the MRI and ultrasound by automated segmentation with the chance for manual adjustment during the procedure to make up for movement of the prostate gland.
- The addition of MP-MRI to the biopsy strategy or, in select patients, using MP-MRI as a replacement for a
repeat biopsy improves detection of prostate cancer [34].

- By performing MP-MRI before TRUS-guided biopsy, lesions identified on MP-MRI can be targeted for biopsy rather than relying entirely on the systematic random sampling of the posterior prostate.
- MR-TRUS fusion allows the MRI to direct biopsy needles under TRUS guidance, thereby combining MRI’s high sensitivity for identifying suspicious lesions with the feasibility of TRUS biopsy procedures.
- MRI-US fusion targeted prostate biopsies helps to avoid detection of clinically insignificant tumours while allowing diagnosis of significant tumours, difficult to detect by conventional biopsy procedures, such as tumours in the anterior, midline, and apex of prostate, that are often under sampled by systematic biopsy procedures which only sample the lateral peripheral zone [35].
- Therefore MRI-TRUS fusion guided biopsies procures advantage of the sensitivity of MRI to improve prostate cancer diagnosis in an outpatient-based procedure.
- The advantage of using biopsy cores obtained from MR-TRUS fusion is that they have twice the detection rate than that of random TRUS biopsy and detect high risk cancers, with the targeted biopsies detecting 67% more Gleason ≥ 3 + 4 tumours. MR-TRUS fusion biopsy also enhances cancer detection rates in patients with enlarged prostates and patients with a history of multiple prior negative biopsies, in whom detection rates are lower via conventional random biopsy techniques [19].

**Cognitive prostate biopsy:**

- Here the biopsy operator reviews the MR images and constructs a mental three-dimensional picture of the prostate and that of the lesion within it. Then the operator will guide the biopsy needle in to the lesion of interest in the prostate, even if it is not seen on ultrasound.
- Cognitive guidance is simple and quick procedure requiring no additional hardware. On the contrary, there is possibility for human error in extrapolation of the US imaging plane from MRI images. Therefore, the operator should have a good understanding of the position of the lesion in the prostate to make an accurate biopsy. This can be obtained only by reviewing all MRI images. The operator must also be aware of systematic biases influenced by the fact that so-called “axial” MRI and US images are not obtained along the same plane (Figure 1). Using an end-fire probe, the relative symmetry of the prostate causes axial MRI and US planes to look similar despite large angulation differences which lead to erroneous targeting. During this procedure, cores targeting posterior lesions tend to be obtained in a plane that is located too close to the apex while cores directed at anterior targets tend to err toward the prostate base.
- However, the accuracy of cognitive biopsy is probably slightly inferior to that of fusion or in-bore biopsy and it is suggested that cognitive biopsies can be used for large lesions and fusion or in-bore biopsies for the rest [36].

**CONCLUSION**

- To summarize, MP-MRI prior to biopsy is useful tool for lesion detection and permits MP-MRI-targeted TRUS fusion biopsy procedures, which preferentially samples suspicious lesions, thereby allowing detection of significant cancers and also samples areas of the prostate such as the anterior prostate which are difficult to approach using traditional biopsy methods. MP-MRI can also help recognize patients with prostate cancer who are suitable candidates for active surveillance as an initial therapeutic management strategy.
- Innovations in prostate imaging utilize the biology of prostate cancer, thus offering potential for higher detection of the location, extent and aggressiveness of smaller volumes of prostate cancer.
- Active surveillance is gaining acceptance as a cancer management choice for patients with low-risk localized prostate cancer because it reduces the risk of overtreatment of patients with clinically insignificant disease [37].
- The risk of clinically significant disease in patients with a negative MP-MRI may be sufficiently low to consider delay in definitive treatment for active surveillance and further studies are warranted to confirm this.
REFERENCES:


PET-CT is Positron emission tomography and Computed Tomography. It is the important Hybrid Imaging technique which has wider applications in Oncology, Neurology, Cardiology and lot of emerging Newer applications.

PET is the diagnostic examination based on the detection of radiation from the emission of positrons. Positrons are tiny particles emitted from a radioactive substance which is administered to the patient. CT is the Computed tomographic technique which uses the Radiation for evaluation of the anatomical structures.

PET-CT has varied applications and depending on the applications whole body PET-CT or limited area scan to be done. In Oncology setup Whole body is the preferred protocol and in Neurology, Cardiology and some of the studies limited area PET-CT is advised.

**After appointment is scheduled**

- Doctor prescription with all relevant clinical records.
- Inform the doctor or technologist if you are pregnant/lactating or may be pregnant.
- Please inform any current medications if you are taking beforehand.

**Patient preparation**

- Patient should limit carbohydrate diet 24 hours before the scheduled appointment.
- Fasting for 6 hours before the exam. Can drink only water.
- Routine medications may be taken, but need to be verified. If patient diabetic can take diabetes medication no less than 4 hours prior to the exam.
- The technologist will verify identification and exam requested.
- To complete the consent form after short explanation of the procedure.
- Need to do Serum Creatinine as intravenous contrast will be administered.
- Will be given oral contrast for opacification of the oesophagus, stomach and small bowel loops as and when required. This will be decided case to case basis.
- Intravenous catheter will be put for administration of the intravenous contrast and to be kept after the scan also in case if emergency medicines to be administered.
- After administration of radioactive material patient to be kept in isolated room without attendee not allowed talking and walking also. Unless and until few cases where attendee is needed like Pediatric age group, sedated and anesthetized patient’s attendee can be allowed but strict instructions not to do any movements.

**Examination procedure**

- The duration of the exam will vary, but the average time is about 2 hours. If delayed scan advised it can be up to 4-5 hours also depending on the case to case basis variation.
- The various radiotracers used are FDG, DOTANOC,PSMA,AMMONIA etc the scan is ideally done within 45-60 minutes after injecting the radiotracer.
- The technologist will position you on the exam table, and give you instructions depending on the CT and PET scanning. Breath hold for CT and normal respiration for PET. In special circumstances like Valsalva maneuvered in puff cheek position in some of the head and neck pathologies.
- Any contraindications like elevated serum creatinine, patient not cooperative, paediatric age group patients, Unconscious, sedated and Anaesthesia administered patients to be taken special care.

**Post procedure instructions**

- Drink as much as water possible. Again, any fluid restrictions or any contraindications need not take.
- Nursing mothers should wait for 24 hours before resuming breast-feeding.
- If any symptoms such as nasal congestion, itchy eyes, hive, rashes, sneezing, restlessness, tremors, pain, nausea, vomiting, dizziness, diarrhea and other symptoms of probable contrast reactions please notify the staff immediately.
• Emergency management of any untoward incident to be ready and managed as per requirement of the patient.

IMAGING PROTOCOLS

Widely practiced Whole-body protocol and widely accepted worldwide is from Base of skull/vertex of skull to midthigh.

Limited PET-CT is for limited area evaluation.
Both lower limb or upper limb protocol is to done in certain cases where primary lesion or metastatic focus is suspected.

Majority of the protocols are done with administration of intravenous and oral contrast.
Intravenous contrast is preferably non-ionic.
Mostly Venous phase is the preferred phase of the IV contrast.
But in the settings of Neuroendocrine tumors and suspected liver lesions and some of the borderline cases TRIPHASIC IV contrast to be used to characterise the lesions. For example, HCC or Haemangioma Liver
Oral contrast is specific GI contrast but, in some cases, mannitol can be used.

Oropharyngeal and Oesophageal pathologies need specific oral contrast.
Stomach, small and large Bowel loops oral contrast mandatory if not plain water to distend the wall better.
In the clinical settings of the Recto sigmoid and Sigmoid colon rectal contrast can be administered for better and faster delineation of the bowel pathology.

In suspected cases of fistulous communications specific protocol to be followed as per the patient requirement.

Lasix can be given in special cases of urinary bladder pathology.
But this all above mentioned protocol cannot be followed in cases of Contraindications, non-cooperative patients, paediatric age group and unconscious patients.
ONCOLOGY

Whole body is the preferred protocol in Oncology setup for Staging, Restaging, and Response to therapy and Radiotherapy planning (IMRT).
But in certain cases, Limited PET-CT is also advised in cases of limited local disease for restaging, Response to therapy and Radiotherapy planning (IMRT).

NEUROLOGY

In Neuro-Oncology cases evaluation especially in Metastases to cerebral parenchyma whole body PET-CT is advised.
In rest of the Neurological applications limited PET-CT is advised.

CARDIOLOGY

Limited Cardiac evaluation done for various cardiac applications.

PUO PYREXIA OF UNKNOWN ORIGIN

Whole body protocol to be followed. If needed lower limb or upper limb or limited area imaging to be done.

MISCELLNEOUS APPLICATIONS

Limited area imaging like Joint Prosthesis evaluation or Vascular Graft rejection evaluation, Fibrous Dysplasia or Paget’s disease of the particular area

NEWER APPLICATIONS

Like Rheumatoid arthritis/Psoriasis/Collagen disorders etc evaluation needs whole body with upper limb /lower limb scan and limited delayed imaging of particular region of interest.

DUAL POINT IMAGING

Dual point imaging will be to differentiate between the Infective/Inflammatory and Malignant pathologies. Delayed scan of region of interest to be done after the primary first scan and delayed scan done after one, two and three hours and quantifying the SUV values.

DELAYED SCANS ARE TAKEN OTHER THAN MENTIONED ABOVE for relevant applications where needed.

RADIOThERAPY PLANNING

Limited area of interest scanning to be done where radiotherapy to be given.

AGAIN THE PROTOCOLS CAN BE ALTERED AS PER THE REQUIREMENT OF THE PATIENT AND RESOURCES AVAILABILITY.
REPORT TEMPLATES (Enclosed in other attachment separately)
ONCOLOGICAL EMERGENCIES

Version v1.2020

Bagyam Raghavan (Chennai)

Dayala Sundaram (Chennai)

Rasheed Arafath (Chennai)

Rakesh Prasad (Chennai)
PART 1 -Background Information

All Cancers together contributed 5.0% of the total DALYs (Disability adjusted Life Years) and 8.3% of the total deaths in India in 2016. Of these a small percentage of these patients will experience an emergent cancer-related complication at some point during the disease course. For some patients, an emergent complication is the first manifestation of the cancer.

- Oncological emergencies are defined as acute conditions that are caused by the disease itself or encountered during the diagnosis or treatment of the disease which require immediate intervention to avoid severe damage or death (1).
- Sometimes the initial presentation of a cancer itself may be an acute symptom like severe abdominal pain, breathlessness or seizures. In such cases the radiological investigations are done based on the symptoms and the primary malignancy diagnosed for the first time.
- Patients on treatment may present with acute symptoms due to the tumour response, progression, metabolic or hematologic complications of the chemotherapy or sepsis due to immunosuppressant.
- Immediate post-operative complications may present as emergency since many of the onco-surgeries are complex and the extent of the surgery is based on frozen section and per operative findings.
- Rarely patients who completed treatment long back may present with acute symptoms due to complications like post-operative adhesions or radiotherapy induced stricture.
- It should not be forgotten that cancer patients have equal or higher chances to have non oncologic causes of emergencies like acute cholelithiasis, appendicitis, ureteric colic etc.
- Causes of oncological emergencies are myriad and can be broadly classified as
  (i) Tumor related -Direct or Indirect
      Direct or structural effects include invasion or mechanical compression of structures adjacent to the tumour.
      Indirect complications include systemic manifestations
  (ii) Diagnosis related
  (iii) Treatment related
  (iv) Non oncologic causes.

I. Tumor related:
   o Structural – Obstruction / compression by the primary tumour or metastases.
     ▪ Neurological – Cerebral herniation (tumour/ haemorrhage), Spinal cord compression.
     ▪ Cardiovascular – Superior vena cava syndrome ,Cardiac tamponade
     ▪ Respiratory –Airway obstruction / Tracheoesophageal/ Bronchoesophageal fistula, Massive effusion, Pneumothorax, Massive hemoptyis.
     ▪ Abdominal –Bowel obstruction, perforation, Torsion (Ovarian tumors,GIST)
   o Metabolic causes:
     ▪ Tumor lysis syndrome - Presents with severe electrolyte abnormalities.
     ▪ Hypercalemia ,
     ▪ Syndrome of inappropriate antidiuretic hormone (SIADH)
     ▪ Paraneoplastic.
   o Hematologic causes:
     ▪ Hyperviscosity syndrome

II. Diagnosis related:
   o Pneumothorax- following lung/ mediastinal/pleural biopsies.
Perforation of hollow viscus – Endoscopic biopsy of highly fragile tumours.

### III. Treatment related:

- Neurological – PRES, infarct, haemorrhage, cerebral venous thrombosis.
- Hematologic – Neutropenia, Bowel ischemia due to thrombosis, Venous thromboembolism.
- Infection – Sepsis, Bacterial/ fungal sinusitis, pneumonitis, hepatic/spenic abscess, Neutropenic enterocolitis, meningoencephalitis.
- Post-operative - Bleeding, anastomotic leak
- Transfusion related lung injury (TRALI)

### IV. Non oncologic causes:

- Neurological - Intracerebral haemorrhage
- Abdominal - Duodenal ulcer perforation, Acute cholecystitis, pancreatitis, pyelonephritis, appendicitis, Ureteric colic.

Evaluation of the cause of Emergency in Oncology requires an exhaustive detailed analysis of the case history, clinical data, including details of therapy & drugs given. A meticulous look at the laboratory investigations is important before we look at the various Imaging findings. Triaging of the patient for the appropriate Imaging study is based usually based on the presenting symptoms (2).

- **A check list** for each investigation should be tailored based on the clinical inputs
  - Age and sex of the patient,
    - Primary malignancy,
    - Complete treatment history and
    - Current symptoms.

Treatment history is very important. Whether the patient is a known cancer patient or it is the first time he is presenting in the ER. If he is a known cancer patient, details of type of therapy surgery, radiotherapy, chemotherapy and duration of therapy is important.

Classic chemotherapy agents interfere with RNA and DNA synthesis or cell division, affect cell growth and target rapidly proliferating cells. The newer molecular targeted therapies target at the cellular level and intracellular molecules for regulating cell activities, the toxicities of the molecularly targeted agents are less predictable. And the onset and presentation of their toxicities may therefore differ. A list of Common Chemotherapy Toxicity by Organ and Drug (Not All-inclusive) is given (3)

**Pulmonary**
- Interstitial infiltrates: Bleomycin, methotrexate, gemcitabine, paclitaxel, oxaliplatin, everolimus and temsorilimus, gefitinib, erlotinib, rituximab
- Noncardiogenic pulmonary edema: All -trans retinoic acid, gemcitabine, interleukin 2, interferon
- Pulmonary haemorrhage: Bevacizumab

**Cardiovascular**
- Cardiac: Doxorubicin, cyclophosphamide, trastuzumab (when given with doxorubicin), sunitinib
- Hypertension: Bevacizumab, sunitinib, sorafenib
- Vascular:
  - Arteriothromboembolic - Cisplatin, gemcitabine, bevacizumab, sorafenib, sunitinib
  - Venous - Thalidomide, lenalidomide, interleukin-2, cisplatin, gemcitabine
Pericardial effusions - All-transretinoic acid, imatinib

Liver
Fatty liver: Irinotecan, oxaliplatin
Veno-occlusive disease: Bone marrow transplant regimens, oxaliplatin
Pseudocirrhosis: Any chemotherapy
Biliary stricture: Hepatic arterial infusion with floxuridine (FUDR)

Pancreas
Pancreatitis: L-asparaginase, sorafenib

Gastrointestinal:
Enteritis 5-FU, floxuridine, irinotecan, cetuximab, EGFR agents, VEGF receptor agents*
Neutropenic colitis: 5-FU, paclitaxel, docetaxel; any agent causing significant neutropenia
Pneumatosis or perforation: Bevacizumab
Megacolon: Vincristine

Genitourinary
Hemorrhagic cystitis: Cyclophosphamide, ifosfamide
Neurogenic bladder: Bortezomib

Peritoneum, mesentery, soft tissues
Ascites: Docetaxel, imatinib

Neurologic
Peripheral neuropathy: Vincristine, vinblastine, paclitaxel, cisplatin
Central nervous system: 5-FU, methotrexate

Laboratory Investigation

Metabolic cause (4) play a large role in Oncological Emergencies and it is important to check the various metabolic parameters.

Metabolic causes:
Hypercalcemia of Malignancy 80% is humoral due to tumour production of parathyroid hormone related peptide (PTHrP). The other causes are hypercalcemia from bone osteolysis from extensive bone metastases excess production of vitamin D analogues by the malignant cells.
Tumor Lysis Syndrome (TLS) are metabolic derangements resulting from the death of neoplastic cells which then release their intracellular contents into the circulation. The other metabolic causes
Lactic acidosis, Hypoglycaemia, Hyponatremia, Adrenal Insufficiency, are due to the tumour or treatment related.
In Haematological malignancies Hyper viscosity is due to increased production of monoclonal proteins such as in multiple myeloma and Waldenström macroglobulinaemia (WM) secondary to an excess of either cellular or cellular elements. Leucocytosis & Leucostasis are also commonly seen in Haematological malignancies and is due to rapid proliferation and disrupted cell adhesion result in the release of a large number of leukemic blasts from the bone marrow into the circulation leading to micro vascular occlusion resulting in tissue ischemia and infarction.

Imaging
Plain radiography and Ultrasonography (US) are generally performed initially in an urgent situation due to their wide availability, low cost, and minimal or no radiation exposure. However, depending on a patient’s symptoms, X-ray, ultrasound, echocardiogram or evaluation with cross-sectional imaging methods such as computed tomography (CT) and magnetic resonance imaging (MRI) and occasionally PET CT is often necessary.
PART 2 - PROTOCOLS

I. Protocol for chest symptoms:

- Chest x-ray - initial investigation in ambulant patient.
- USG – In case of suspected pericardial tamponade.
- Plain CT -
  - Requires when initial investigations are inconclusive or need further evaluation/ sick patient needs immediate evaluation.
  - To assess the severity of central airway obstruction.
  - To assess volume of pleural / pericardial effusion.
- **CECT / Pulmonary angiogram-**
  - Intravenous contrast should be cautiously administered in oncologic set up considering the nephrotoxicity of the chemo drugs and to avoid thrombosis of the peripheral veins which may be used for chemotherapy.
  - To evaluate SVC compression/ infiltration by the lung/ mediastinal mass.
  - To look for source of active haemorrhage in massive haemoptysis.
  - To assess pulmonary embolism.
- Oral contrast should be used if oesophageal leak/fistula to be demonstrated

- **Plain CT chest:**

<table>
<thead>
<tr>
<th>kVp</th>
<th>mA with AEC</th>
<th>Tube current mAs</th>
<th>Collimation</th>
<th>Pitch</th>
<th>Rotation time</th>
<th>Slice thickness</th>
<th>Matrix</th>
<th>Expected radiation dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>100(&lt;80 kg)</td>
<td>120(80-113 kg)</td>
<td>140 (&gt;113 kg)</td>
<td>35</td>
<td>lowest possible</td>
<td>1.2</td>
<td>0.5</td>
<td>1.2-1.5mm</td>
<td>512 x 512</td>
</tr>
</tbody>
</table>

- **Contrast CT :**

<table>
<thead>
<tr>
<th>Indication</th>
<th>CTPA (Pulmonary circulation)</th>
<th>CTA (Systemic Circulation)</th>
<th>Combined protocol- (Pulmonary + systemic circulation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area of coverage</td>
<td>Lung apex to level of diaphragm in all cases. Just above aortic arch to just below heart (in young or pregnant patients with normal CXR and minimal suspicion of PE)</td>
<td>Thoracic inlet to lower border of L2</td>
<td>Thoracic inlet to lower border of L2</td>
</tr>
<tr>
<td>Slice thickness For reconstruction</td>
<td>&lt;2mm</td>
<td>&lt; 1.5mm</td>
<td>&lt;1.5mm</td>
</tr>
<tr>
<td><strong>kVp</strong></td>
<td>For patients &lt;30 years and 30-60years:100 or 80 kVp depending on patient BMI or automatic tube voltage selection For patients &gt;60 years:120kVp</td>
<td>100kVp</td>
<td>Dual energy (80kVp and 140kVp)</td>
</tr>
<tr>
<td>---------</td>
<td>---------------------------------------------------------------------------------</td>
<td>--------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td><strong>mAs</strong></td>
<td>For patients &lt;30years: 150mA with tube current modulation. For patients 30-60years and &gt;60years:200mA with tube current modulation.</td>
<td>Automated tube current modulation</td>
<td>Automated tube current modulation</td>
</tr>
<tr>
<td><strong>Rate of contrast injection (where applicable)</strong></td>
<td>3-4ml/s (normal resting heart rate) 4-5ml/s (elevated cardiac output)</td>
<td>3.5-4ml/sec</td>
<td>3/4th contrast at 5ml/s 1/4th contrast at 3ml/s Saline chase at 3ml/s</td>
</tr>
<tr>
<td><strong>ROI position (where applicable)</strong></td>
<td>Pulmonary trunk or MPA or right atrium</td>
<td>Descending aorta</td>
<td>Ascending aorta</td>
</tr>
<tr>
<td><strong>Threshold HU (where applicable)</strong></td>
<td>60-100HU*</td>
<td>100HU</td>
<td>100HU</td>
</tr>
<tr>
<td><strong>Time delay/phase of acquisition</strong></td>
<td>4-5sec after bolus trigger time</td>
<td>6sec after bolus trigger time</td>
<td>5sec after bolus trigger time</td>
</tr>
<tr>
<td><strong>Reconstruction</strong></td>
<td>Contiguous image reconstruction at intermediate-spatial-resolution algorithm. View in cine mode at window width 450-600HU and window level 35-100HU (#) and maximum intensity projections (MIP)</td>
<td>Reconstruction interval 2.0mm or similar depending upon scanner, at standard mediastinal window (Window level 40HU, window width 400HU)</td>
<td>Axial image reconstruction at 1.5mm slice thickness and increment of 1.2mm at standard mediastinal and lung windows</td>
</tr>
</tbody>
</table>

*60 HU is used by several dual source DECT scanners. *Pulmonary embolism can be missed in an image with very bright contrast is viewed only on mediastinal window settings.
II. Protocol for Abdominal symptoms:

- Abdominal x-ray - initial investigation in ambulant patient.
- USG – initial investigation in bed ridden patient.
- Plain CT -
  - Requires when initial investigations are inconclusive or need further evaluation/ sick patient needs immediate evaluation.
  - Plain CT is enough in majority of the cases.
- CECT -
  - To look for active intraluminal haemorrhage, bowel wall enhancement and thrombus in mesenteric veins.

<table>
<thead>
<tr>
<th>Tube Current</th>
<th>120 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective mAs</td>
<td>105 mAs</td>
</tr>
<tr>
<td>Rotation Time</td>
<td>0.5 sec</td>
</tr>
<tr>
<td>Slice collimation</td>
<td>1.2 mm</td>
</tr>
<tr>
<td>Slice width</td>
<td>5.0 mm</td>
</tr>
<tr>
<td>Feed/Rotation</td>
<td>28.8 mm</td>
</tr>
<tr>
<td>Pitch Factor</td>
<td>1</td>
</tr>
<tr>
<td>Increment</td>
<td>5.0 mm</td>
</tr>
<tr>
<td>Kernel</td>
<td>B30s</td>
</tr>
</tbody>
</table>

Contrast Administration:

A. **Water**: Plain water used as neutral contrast for all routine studies.

B. **Oral Iodinated Contrast**: In necessary cases, based on the initial plain CT findings, positive contrast (30 ml of sodium diatrizoate diluted with 1000 ml of plain water) can be administered per orally (1000 ml) or

C. **Rectal Iodinated Contrast**: per rectally for the delineation of rectum and large intestine (300 ml).

D. **Intravenous contrast**: For I.V. contrast 60 – 80 cc of non-ionic water soluble iodinated contrast material to be injected with the help of a pressure injector at the rate of 3 - 3.5 cc/s.

<table>
<thead>
<tr>
<th>Arterial phase</th>
<th>20 – 25 seconds delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venous phase</td>
<td>50-75 seconds delay</td>
</tr>
<tr>
<td>Delayed images</td>
<td>180 seconds delay</td>
</tr>
</tbody>
</table>
III. Protocol for neurological symptoms:

- Plain CT -
  - Initial investigation in patients with neurological symptoms needs immediate evaluation.
  - Differentiates haemorrhagic infarct from the ischemic infarct.
  - Helps in identification of mass effect and herniation syndrome.

- CECT brain and CT angiogram and venogram-
  **Intravenous contrast**: 40 – 60 cc of non-ionic water-soluble iodinated contrast material to be injected with the help of a pressure injector at the rate of 3 - 3.5 cc/s.
  - To know the extent of the tumour.
  - Helps in identification in vascular thrombosis/occlusion.

<table>
<thead>
<tr>
<th>Tube Current</th>
<th>110 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>mA</td>
<td>350 mAs</td>
</tr>
<tr>
<td>Rotation Time</td>
<td>0.5 sec</td>
</tr>
<tr>
<td>Slice collimation</td>
<td>1.5 mm</td>
</tr>
<tr>
<td>Slice width</td>
<td>4.0 mm</td>
</tr>
<tr>
<td>Feed/Rotation</td>
<td>28.8 mm</td>
</tr>
<tr>
<td>Pitch Factor</td>
<td>1</td>
</tr>
<tr>
<td>Increment</td>
<td>5.0 mm</td>
</tr>
</tbody>
</table>

- CT angiogram protocol:
  **Intravenous contrast**: For I.V. contrast 50 – 80 cc of non-ionic water-soluble iodinated contrast material to be injected with the help of a pressure injector at the rate of 3 - 3.5 cc/s. The test bolus technique was performed to obtain accurate information about CM arrival time in the individual circulation.

<table>
<thead>
<tr>
<th>Tube Current</th>
<th>110 kV</th>
</tr>
</thead>
<tbody>
<tr>
<td>mA</td>
<td>350 mA</td>
</tr>
<tr>
<td>Rotation Time</td>
<td>0.3-0.5 sec</td>
</tr>
<tr>
<td>Slice collimation</td>
<td>1.5 mm</td>
</tr>
<tr>
<td>Slice width</td>
<td>3.0 mm</td>
</tr>
<tr>
<td>Feed/Rotation</td>
<td>28.8 mm</td>
</tr>
<tr>
<td>Pitch Factor</td>
<td>1-1.2</td>
</tr>
<tr>
<td>Increment</td>
<td>5.0 mm</td>
</tr>
</tbody>
</table>
**MRI Protocol:**

In general MRI techniques for the diagnosing brain tumors is time consuming and involves a lot of sequences MRI Techniques (21). In an emergent situations these sequences needs to be tailored depending on the clinical data.

MRI Techniques Their Purpose in Brain Tumor Imaging (21)

<table>
<thead>
<tr>
<th>MRI technique</th>
<th>Clinical utility</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>Evaluates tissue architecture</td>
</tr>
<tr>
<td></td>
<td>• Precontrast high intensity seen in blood products, mineralization, fat, melanin</td>
</tr>
<tr>
<td></td>
<td>• Post contrast enhancement reflects nonspecific breakdown of the blood–brain barrier</td>
</tr>
<tr>
<td>T2/FLAIR</td>
<td>Evaluates tissue architecture</td>
</tr>
<tr>
<td></td>
<td>• High intensity seen in peritumoral edema (vasogenic and infiltrative), non enhancing tumour, white matter injury, gliosis</td>
</tr>
<tr>
<td>T2* (SWI)</td>
<td>Sensitive to magnetic susceptibility</td>
</tr>
<tr>
<td></td>
<td>• Low intensity seen in blood products, tumoral vascularity, calcification, radiation-induced microhemorrhage</td>
</tr>
<tr>
<td>DWI</td>
<td>Probes random motion/diffusion of water, can be presented as ADC map</td>
</tr>
<tr>
<td></td>
<td>• Reduced (high signal intensity) in highly cellular tumour or regions of tumour with increased cellularity and in cytotoxic edema or postoperative injury</td>
</tr>
<tr>
<td>MRS</td>
<td>Assesses tumour biochemical/metabolic profile</td>
</tr>
<tr>
<td></td>
<td>• Tumor spectra include elevated Cho, decreased NAA; higher grade glioma show higher Cho/NAA and Cho/Cr ratios than lower grade gliomas</td>
</tr>
<tr>
<td>Modality</td>
<td>Description</td>
</tr>
<tr>
<td>-----------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Perfusion</td>
<td>DSC—main metric is cerebral blood volume</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>DCE</td>
<td>DCE—main metric is the volume transfer constant, a measure of permeability</td>
</tr>
<tr>
<td>ASL</td>
<td>ASL—main metric is cerebral blood flow</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>DTI</td>
<td>Analyzes direction of diffusivity and orientation of white matter tracts</td>
</tr>
<tr>
<td>fMRI</td>
<td>Assesses brain activation by detecting alterations in blood oxygenation level</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ADC, apparent diffusion coefficient; ASL, arterial spin labeling; Cho, choline; Cr, creatine; DCE, dynamic contrast enhanced; DSC, dynamic susceptibility contrast; DTI, diffusion tensor imaging; DWI, diffusion-weighted imaging; FLAIR, fluid-attenuated inversion recovery; fMRI, functional magnetic resonance imaging; MRS, magnetic resonance spectroscopy; NAA, N-acetylaspartate; SWI, susceptibility-weighted imaging.
Emergent MRI Protocols

- MRI Brain(plain):
  DWI- b0,b1000 with ADC map
  Axial and coronal T2WI
  Axial FLAIR
  Sagittal T1WI
  GRE

Additional (if required)
  Contrast – Dynamic EPI perfusion
  Post contrast 3D Axial TIFS
  Contrast: Gd (0.1 mmol / kg to max of 20 cc)

MR spectroscopy

<table>
<thead>
<tr>
<th>Complication</th>
<th>Typical drugs causing complication</th>
<th>Clinical syndrome</th>
<th>Treatment and prevention</th>
<th>Prognosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peripheral and cranial neuropathy</td>
<td>Vinca alkaloids (tubulin binding) vincristine, vinblastine</td>
<td>Sensorimotor neuropathy (axonal)</td>
<td>Drug withdrawal</td>
<td>Usually good with discontinuation</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Platinum compounds</td>
<td>DNA crosslink formation) (cisplatin, carboplatin, oxaliplatin) [53]</td>
<td>Sensory neuropathy; vestibulocochlear toxicity with cisplatin (hearing loss, dizziness, ataxia, vertigo)</td>
<td>Amifostine, carbamazepine to treat oxaliplatin neuropathy; calcium gluconate, magnesium sulfate, and oxcarbazepine prophylaxis for oxaliplatin neuropathy [51]</td>
<td>Variable for cisplatin; good with treatment for oxaliplatin [52*]</td>
</tr>
<tr>
<td>Taxanes: paclitaxel, docetaxel</td>
<td>(inhibition of microtubule function) [53]</td>
<td>Sensory neuropathy (numbness, tingling)</td>
<td>Vitamin E and N-acetyl carnitine</td>
<td>Good with drug discontinuation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Macrolide antibiotic: ixabepiline</td>
<td>(tubulin binding) [52*]</td>
<td>Sensory neuropathy (numbness, tingling)</td>
<td>Discontinue drug or reduce dose</td>
<td>Good with treatment</td>
</tr>
</tbody>
</table>

[51] [52] [53]
<table>
<thead>
<tr>
<th>Condition</th>
<th>Cause</th>
<th>Symptom(s)</th>
<th>Management</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory neuropathy</td>
<td>Thalidomide (antiangiogenesis) [53]</td>
<td>Sensory neuropathy</td>
<td>Discontinue drug/reduce dose</td>
<td>Good with treatment</td>
</tr>
<tr>
<td></td>
<td>Bortezomib (proteosome inhibitor) [52•]</td>
<td>Distal sensory axonal neuropathy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stroke</td>
<td>Bevacizumab [52•]; imatinib [52•]</td>
<td>Hemorrhagic or ischemic stroke (rare)</td>
<td>Discontinue drug</td>
<td>Variable</td>
</tr>
<tr>
<td>Seizures</td>
<td>Cisplatin (DNA crosslinks); cytosine arabinoside (pyrimidine antimetabolite) [56]</td>
<td>Seizures</td>
<td>Discontinue drug/reduce dose</td>
<td>Good with drug discontinuation</td>
</tr>
<tr>
<td></td>
<td>Cyclophosphamide</td>
<td>Seizures</td>
<td>Discontinue drug/reduce dose</td>
<td>Good with drug discontinuation</td>
</tr>
<tr>
<td></td>
<td>Nelarabine (purine nucleoside analog) [52•]</td>
<td>–</td>
<td>Discontinue drug/reduce dose</td>
<td>Good with drug discontinuation</td>
</tr>
<tr>
<td>Myelopathy</td>
<td>Cisplatin (DNA crosslinks); Ara-C (pyrimidine antimetabolite); MTX (dihydrofolate reductase inhibitor) [56]</td>
<td>Lhermitte’s sign with cisplatin; motor, sensory and bowel/bladder dysfunction with Ara-C and MTX.</td>
<td>Discontinue drug/reduce dose</td>
<td>Good with treatment (drug discontinuation)</td>
</tr>
<tr>
<td>Aseptic meningitis</td>
<td>MTX (dihydrofolate reductase inhibitor) [56]</td>
<td>Headache, neck stiffness, back pain and fever following intrathecal</td>
<td>Discontinue drug and reduce dose; corticosteroids</td>
<td>Usually good</td>
</tr>
<tr>
<td>Encephalopathy</td>
<td>Ifosfamide (alkylating agent) [56]</td>
<td>Confusion, hallucinations, drowsiness</td>
<td>Discontinue drug; benzodiazepines may hasten recovery</td>
<td>Good with drug withdrawal</td>
</tr>
<tr>
<td>------------------------</td>
<td>------------------------------------</td>
<td>--------------------------------------</td>
<td>------------------------------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Cerebellar syndrome</td>
<td>Methotrexate (dihydrofolate reductase inhibitor) [56]</td>
<td>Acute mental status change, seizures within 24 hours of high-dose.v administration</td>
<td>Discontinue drug</td>
<td>Good with drug withdrawal</td>
</tr>
</tbody>
</table>

Ara-C—cytosine arabinoside; MTX—methotrexate.

**PART3 - REPORT TEMPLATES**

**CT SCAN CHEST WITH / WITHOUT CONTRAST / PE PROTOCOL**

Clinical information: ......................

Comparison: None / CT performed on ........

Procedure: Chest with / without intravenous contrast / PE protocol

Findings:

**LINES, CATHETER AND STENTS:** Nil /Insitu / Malpositioned [Free text]

**TRACHEA AND BRONCHI:** within normal limits / Narrowed/ Obstructed / Fistulous communication. Site and severity [Free text]

**LUNG PARENCHYMA:** within normal limits / Collapse / Ground glass haziness / Mass / Nodules /
Consolidation. Site, extension and other parenchymal changes {Free text}

**PLEURA:** within normal limits / Pneumothorax / Pleural effusion / Thickening.

Site and estimate {Free text}

**VESSELS:** within normal limits / Narrowed / Obstructed / Filling defect / Dilated / Collaterals

Site, extension and severity {Free text}

**HEART:** Normal / enlarged in size. Pericardial effusion (Mild/ moderate/ Large/ Absent).

Pericardial thickening / nodule / Mass - Site and extension {Free text}

**MEDIASTINUM AND HILA:** within normal limits / Adenopathy / Haemo- or pneumo-mediastinum

/Mass(Present / Absent – Free text).

SVC: Normal / Narrowed / Obstructed / Filling defect / Dilated / Collateral

**CHEST WALL AND LOWER NECK:** within normal limits /

Mass. Site, extension and other changes {Free text}

**UPPER ABDOMEN:** within normal limits / Ascites / Pancreatitis / Pneumo- or Haemo – peritoneum.

Liver metastases: Present / Absent - Site, extension and other changes. {Free text}

**BONES:** within normal limits / lytic or sclerotic lesions / Vertebral collapse with paravertebral or epidural soft tissue component. Site, extension and other changes {Free text}

Impression====
CT SCAN ABDOMEN WITHOUT CONTRAST

Clinical information:

Comparison: None / CT/PET-CT/MRI performed on

Liver: □ Within normal limits □ Focal lesion □ Intrahepatic biliary radicle dilatation

Gall bladder: □ Within normal limits □ Cholelithiasis □ Features of cholecystitis.

Common bile duct: □ Within normal limits □ Dilated/calculi/ Stricture

Spleen: □ Within normal limits/ [Free text]

Pancreas: □ Within normal limits □ Features of pancreatitis / [Free text]

Adrenal glands: □ Within normal limits/ [Free text]

Right kidney: □ Within normal limits □ Calculi □ Hydroureteronephrosis □ Features of pyelonephritis/ [Free text]

Left kidney: □ Within normal limits □ Calculi □ Hydroureteronephrosis □ Features of pyelonephritis/ [Free text]

G.I Tract: □ Within normal limits □ Pneumoperitoneum (present/absent) □ Site of perforation □ Dilated bowel loops (present/absent) □ Transition zone (present/absent) □ Wall thickening at Transition zone (present/absent) □ Appendicitis/ Diverticulitis/ Epiplio appendagitis/ Omental infarct

Urinary bladder: □ Within normal limits □ wall thickening

Peritoneal cavity: □ Ascites □ loculated fluid collection □ abscess

Retroperitoneum: □ Within normal limits/ [Free text]

Pelvic organs: □ Features of Ovarian torsion

Skeletal system: □ Vertebral collapse / spinal canal compromise (Sagittal reconstruction)

Impression: 

Recommendations: 

Based on imaging

203
CT SCAN ABDOMEN WITH CONTRAST

Clinical information:

Comparison: None / CT/PET-CT/MRI performed on
Liver: [ ] Within normal limits [ ] Focal lesion [ ] Intrahepatic biliary radicle dilatation [ ] Portal vein (patent / thrombosed)

Gall bladder: [ ] Within normal limits [ ] Cholelithiasis [ ] Features of cholecystitis.

Common bile duct: [ ] Within normal limits [ ] Dilated/ calculi/ Stricture

Spleen: [ ] Within normal limits/[Free text]

Pancreas: [ ] Within normal limits [ ] Features of pancreatitis /[Free text]

Adrenal glands: [ ] Within normal limits/[Free text]

Right kidney: [ ] Within normal limits [ ] Calculi
[ ] Hydroureteronephrosis [ ] Features of pyelonephritis/ [Free text]

Left kidney: [ ] Within normal limits [ ] Calculi
[ ] Hydroureteronephrosis [ ] Features of pyelonephritis/ [Free text]

Mesenteric vessels: [ ] SMA (patent / thrombosed)
[ ] SMV (patent / thrombosed)

G.I Tract: [ ] Within normal limits
[ ] Pneumoperitoneum (present/ absent)
[ ] Site of perforation
[ ] Dilated bowel loops (present/ absent)
[ ] Bowel wall enhancement (Normal / lesser than adjacent loops)
[ ] Transition zone (present/ absent)
[ ] Wall thickening / serosal deposit at Transition zone(present/ absent)
[ ] Appendicitis/ Diverticulitis/ Epiploic appendagitis/ Omental infarct

Urinary bladder: [ ] Within normal limits [ ] wall thickening

Peritoneal cavity: [ ] Ascites [ ] loculated fluid collection [ ] abscess

Retroperitoneum: [ ] Within normal limits/[Free text]

Pelvic organs: [ ] Features of Ovarian torsion

Skeletal system: [ ] Vertebral collapse / spinal canal compromise (Sagittal reconstruction)

Impression: 

Recommendations: 
Based on imaging: 

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CT SCAN BRAIN WITH / WITHOUT CONTRAST / CT-ANGIOGRAM

Clinical information: ......................

Comparison: None / CT performed on ........

Procedure: CT SCAN BRAIN WITH / WITHOUT CONTRAST / CT-ANGIOGRAM

Findings:

CALVARIUM/SKULL BASE: within normal limits /lytic lesion/ sclerotic lesion/ mixed lytic sclerotic [Free text]

BRAIN PARENCHYM: within normal limits / focal lesion-a. well defined/ill-defined b. enhancing /non-enhancing c. perilesional edema-present/absent d. mass effect-present absent e. midline shift-present absent (free text) f. herniation -present/absent. [Free text]

Ventricular system: within normal limits / dilated- communicating hydrocephalus/no communicating hydrocephalus.

CT- Angiogram-

Anatomical variation- present/absent-free text

ACA/MCA/PCA- occlusion/stenosis.

ANEURYSM-absent/present- origin, size, thrombus

Impression =====

BRAIN WITH CONTRAST / PERFUSION SCAN

Clinical information: ......................

Comparison: None / MR performed on ........

Procedure: MRI BRAIN WITH CONTRAST / PERFUSION SCAN

Findings:

NEUROPARENCHYMA- NORMAL/ FOCAL LESION- ABSENT/ PRESENT

Number Lesion count to five supratentorial and up to five infratentorial

Location Involved anatomic structures:

lobes, gyri, corpus callosum, basal ganglia, thalami, ventricles, ependyma, meninges, brain stem, cerebellum, vermis, sella, cranial nerves, skull base, upper cervical spine

Eloquence Involvement of motor cortex, pyramidal tracts, sensory cortex, Broca’s area,
Wernicke’s area, visual pathway, auditory pathway, basal ganglia, thalami, hypothalami, brain stem, dentate nuclei

Diameter Three different diameters taken regardless of which plane or angulation of the contrast-enhancing tumors

**2D tumor size**

**T2w/fluid-attenuated inversion recovery (FLAIR)**

Two diameters measured in the largest FLAIR/T2w signal changes perpendicular to each other on axial plane

**Edema**

Maximum perifocal diameter of edema with grading: small (≤1 cm), moderate (≤3 cm), or extensive (≥3 cm)

**CSF circulation problems**

**Midline-shift:**

- **Compression:** ventricles, basal cisterns,
- **Herniation:** transfalcine, transtentorial, uncal, transforaminal
- **Blood:** Susceptibility weighted imaging signal changes and their space-occupying effect
- **DWI:** Diffusion changes: categorized as facilitated, restricted, or mixed
- **Perfusion:** Hyperperfused areas in the brain
- **Vessel pathologies:** e.g., stenosis, aneurysms

**White matter:**

**Brain volume:** Description of loss of brain volume

**Viscero-cranium:** Description of pathologies in orbits, paranasal sinuses, mastoids and any other part of included viscero-cranium

=====

**Impression:**
Sample Report – 1. Chest

Clinical information: Carcinoma esophagus, post chemoradiation. Presented with violent cough immediately after taking food.
Comparison: None

Procedure: Chest without intravenous contrast.

<table>
<thead>
<tr>
<th>LINES, CATHETER AND STENTS</th>
<th>Ryle’s tube is seen with its tip in distal esophagus.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRACHEA AND BRONCHI</td>
<td>Defect is seen in posterior wall of trachea and anterior wall of esophagus at D3 vertebral level suggesting a fistula. The fistula measures 4.5 mm in width and 5.2 mm in length. No abnormal wall thickening is seen in esophagus.</td>
</tr>
<tr>
<td>LUNG PARENCHYMA</td>
<td>Normal</td>
</tr>
<tr>
<td>PLEURA</td>
<td>Normal- no pleural effusion</td>
</tr>
<tr>
<td>VESSELS</td>
<td>Normal</td>
</tr>
<tr>
<td>HEART</td>
<td>Normal -no Pericardial effusion</td>
</tr>
<tr>
<td>MEDIASTINUM AND HILA</td>
<td>Normal - No mass or adenopathy</td>
</tr>
<tr>
<td>CHEST WALL AND LOWER NECK</td>
<td>Normal</td>
</tr>
<tr>
<td>UPPER ABDOMEN</td>
<td>Normal</td>
</tr>
<tr>
<td>BONES</td>
<td>Normal</td>
</tr>
<tr>
<td>IMPRESSION</td>
<td>CT imaging is suggestive of acquired tracheo-esophageal fistula with no features of aspiration pneumonitis.</td>
</tr>
</tbody>
</table>
Sample Report – 2. Chest with IV Contrast

**Clinical information:** 65 year female, recently diagnosed poorly differentiated adenocarcinoma with complains of acute dyspnoea and chest pain. Post four cycles of Bevacizumab.

**Comparison:** None

**Procedure:** Chest with intravenous contrast. The bolus is of good quality for diagnosis of pulmonary embolism.

![CT Scan Images]

<table>
<thead>
<tr>
<th>LINES, CATHETER AND STENTS</th>
<th>Nil.</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRACHEA AND BRONCHI</td>
<td>Normal</td>
</tr>
<tr>
<td>LUNG PARENCHYMA</td>
<td>Normal</td>
</tr>
<tr>
<td>PLEURA</td>
<td>Normal- no pleural effusion</td>
</tr>
<tr>
<td>VESSELS</td>
<td>Occlusive thrombus is seen at right main pulmonary artery extending to the lower lobar branches. There is complete thrombosis of posterior and medial basal segmental and sub segmental branches of right lower lobe. Partial thrombosis noted in superior, anterior basal and lateral basal segmental branches of right lower lobe and proximal. Partial thrombus is seen at the branching of left main pulmonary artery extending to the lower lobar branch. Distally thrombus is also seen extending into proximal superior lingular and superior segmental branch of left lower lobe. Rest of the segmental branches of left lower lobe is normally opacified with intravenous contrast. lateral segmental branch of right middle lobe.</td>
</tr>
<tr>
<td>HEART</td>
<td>Normal -no Pericardial effusion</td>
</tr>
<tr>
<td>MEDIASTINUM AND HILA</td>
<td>Normal - No mass or adenopathy</td>
</tr>
<tr>
<td>CHEST WALL AND LOWER NECK</td>
<td>Normal</td>
</tr>
<tr>
<td>UPPER ABDOMEN</td>
<td>Normal</td>
</tr>
<tr>
<td>BONES</td>
<td>Normal</td>
</tr>
</tbody>
</table>
Sample Report – 3. Abdomen without Contrast

Clinical scenario:
A53 -year-old man came to emergency department with c/o acute severe upper abdominal pain since evening. Patient is a known diabetic and hypertensive and CKD. No prior abdominal symptoms.

CT Findings:
(A) Axial CT scan through upper abdomen shows circumferential wall thickening in lower end of esophagus, OG junction and cardia of the stomach(arrow heads).(B) Linear defect is seen in the posterior wall of the stomach (arrow).(C) Minimal fluid collection with multiple air pockets is seen in the lesser sac(thick arrow).

<table>
<thead>
<tr>
<th>CT SCAN ABDOMEN WITHOUT CONTRAST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical information:</strong> 53 -year-old man- a known diabetic and hypertensive and CKD. C/o acute severe upper abdominal pain since evening. No prior abdominal symptoms.</td>
</tr>
<tr>
<td><strong>Comparison:</strong> None</td>
</tr>
<tr>
<td><strong>Findings:</strong></td>
</tr>
<tr>
<td><strong>Liver</strong></td>
</tr>
<tr>
<td><strong>Gall bladder</strong></td>
</tr>
<tr>
<td><strong>Common bile duct</strong></td>
</tr>
<tr>
<td><strong>Spleen</strong></td>
</tr>
<tr>
<td><strong>Pancreas</strong></td>
</tr>
<tr>
<td><strong>Adrenal glands</strong></td>
</tr>
<tr>
<td><strong>Right kidney</strong></td>
</tr>
<tr>
<td><strong>Left kidney</strong></td>
</tr>
<tr>
<td><strong>G.I Tract</strong></td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Urinary bladder</strong></td>
</tr>
<tr>
<td><strong>Peritoneal cavity</strong></td>
</tr>
<tr>
<td><strong>Retroperitoneum</strong></td>
</tr>
<tr>
<td><strong>Pelvic organs</strong></td>
</tr>
<tr>
<td><strong>Skeletal system</strong></td>
</tr>
<tr>
<td><strong>Impression</strong></td>
</tr>
<tr>
<td><strong>Recommendations</strong></td>
</tr>
<tr>
<td><strong>Based on imaging</strong></td>
</tr>
</tbody>
</table>
Sample Report – 4. Abdomen with Contrast

Clinical scenario:

A 52-year-old woman, a known case of chronic liver disease with hepatocellular carcinoma - on chemotherapy with. C/o marked abdominal pain and vomiting.

<table>
<thead>
<tr>
<th>CT SCAN ABDOMEN WITH CONTRAST</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Clinical information:</strong></td>
<td>52-year-old woman, a known case of chronic liver disease with hepatocellular carcinoma - on chemotherapy with. C/o marked abdominal pain and vomiting.</td>
</tr>
<tr>
<td><strong>Comparison:</strong></td>
<td>None / CT/PET-CT/MRI performed on</td>
</tr>
</tbody>
</table>

**Findings:**

<table>
<thead>
<tr>
<th>Organ</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td>Contracted with diffuse surface nodularity. 5 x 4 cm lesion in segment III (Not seen in the representative images). Portal vein - patent.</td>
</tr>
<tr>
<td>Gall bladder</td>
<td>Within normal limits</td>
</tr>
<tr>
<td>Common bile duct</td>
<td>Within normal limits</td>
</tr>
<tr>
<td>Spleen</td>
<td>Within normal limits</td>
</tr>
<tr>
<td>Pancreas</td>
<td>Within normal limits</td>
</tr>
<tr>
<td>Adrenal glands</td>
<td>Within normal limits</td>
</tr>
<tr>
<td>Right kidney</td>
<td>Within normal limits</td>
</tr>
<tr>
<td>Left kidney</td>
<td>Within normal limits</td>
</tr>
</tbody>
</table>
| Mesenteric vessels         | SMA - Patent  
SMV - Segmental thrombosis in jejunal branch of superior mesenteric vein. |
| G.I Tract                  | Short segment circumferential ileal loop wall thickening  
Bowel wall enhancement (Normal / lesser than adjacent loops)  
Pneumoperitoneum – absent.  
Dilated bowel loops - absent |
| Urinary bladder            | Within normal limits                                                        |
| Peritoneal cavity          | Moderate Ascites                                                            |
| Retroperitoneum            | Within normal limits                                                        |
| Pelvic organs              | Within normal limit                                                         |
| Skeletal system            | No Vertebral collapse / spinal canal compromise                              |
| Impression                 | Known case of chronic liver disease with hepatocellular carcinoma with Superior mesenteric venous thrombosis with bowel ischemia. |
| Recommendations based on Imaging | -                                                                          |
Clinical information: 50-year-old male patient, presented with headache for last 2 months & presented with loss of consciousness.
Comparison: None

<table>
<thead>
<tr>
<th>Number</th>
<th>Lesion</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>Lesion</td>
<td>supratentorial</td>
</tr>
<tr>
<td>Involved anatomic structures</td>
<td>Right parietal lobe, right basal ganglia</td>
<td></td>
</tr>
<tr>
<td>Eloquence</td>
<td>basal ganglia involved</td>
<td></td>
</tr>
<tr>
<td>Size - Diameter</td>
<td>5.6 cms, 4.9 cms and 5.8 cms</td>
<td></td>
</tr>
<tr>
<td>T1W, T2,</td>
<td>Hypo. Hyper</td>
<td></td>
</tr>
<tr>
<td>Edema- extensive more than 3 cms</td>
<td>Extensive &gt; 3 cms</td>
<td></td>
</tr>
<tr>
<td>CSF circulation problems</td>
<td>midline-shift and compression of right lateral and 3rd ventricle</td>
<td></td>
</tr>
<tr>
<td>Herniation:</td>
<td>descending transtentorial</td>
<td></td>
</tr>
<tr>
<td>Blood Susceptibility weighted imaging</td>
<td>signal loss</td>
<td></td>
</tr>
<tr>
<td>DWI- Diffusion changes</td>
<td>Diffusion restricted</td>
<td></td>
</tr>
<tr>
<td>Perfusion-Contrast enhancement</td>
<td>hyperperfused</td>
<td></td>
</tr>
</tbody>
</table>

Impression: Enhancing mass lesion with diffusion restriction and intratumoral bleed, involving right parietal lobe & basal ganglia with mass effect, mid-line shift & descending transtentorial herniation.
Sample Report – 5. Neurological Emergencies Treatment Related

Clinical information: A 52-year-old female patient of ALL on chemotherapy including Dasatinib came to ER with complaints of altered sensorium

Comparison: None

<table>
<thead>
<tr>
<th>Number of lesion</th>
<th>More than 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>supratentorial</td>
</tr>
<tr>
<td>Involved anatomic structures</td>
<td>Both occipital &amp; parietal lobes symmetrically</td>
</tr>
<tr>
<td>Eloquence</td>
<td>Not eloquent</td>
</tr>
<tr>
<td>Size</td>
<td>Small areas</td>
</tr>
<tr>
<td>T1W-, T2W-, FLAIR-</td>
<td>Iso, Hyper, Hyper intense</td>
</tr>
<tr>
<td>Edema</td>
<td>-</td>
</tr>
<tr>
<td>CSF circulation problems</td>
<td>-</td>
</tr>
<tr>
<td>Herniation</td>
<td>-</td>
</tr>
<tr>
<td>Blood Susceptibility weighted imaging</td>
<td>-</td>
</tr>
<tr>
<td>DWI- Diffusion changes</td>
<td>No Diffusion changes</td>
</tr>
<tr>
<td>Perfusion / Contrast enhancement</td>
<td>No enhancement</td>
</tr>
</tbody>
</table>

Impression: Features consistent with PRES. Advised follow-up. patient had complete recovery after few days.
References:

1. ESMO Hand book of oncolgical emergencies


