Imaging of GI malignancies for diagnosis & contouring

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Introduction

- Examination and visualization of anatomy and pathology of GI tract is mandatory for diagnosis.

- Traditional imaging techniques played a leading role.

- Introduction & advances in non-invasive imaging techniques.

Revolutionized GI tract imaging.
Advances in imaging

- Imaging data
- 3D acquisition
- Tools for filtering
- Enhancement
- Segmentation
- Tissue classification
Advances in imaging

• Co registration techniques.

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• Multimodal data acquisition techniques.

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• Improved classification of tissue pathology
• Distinct profile of favourable & unfavourable features.

Technique used is dependent on

Availability

Accuracy

Usefulness

Safety

Costs
Diagnostic performance

- Specific method & equipment used.
- Part of GI investigated.
- Patient constitution and preparation.
- Pathology being studied.
- ‘Gold standard’ compared with.
Diagnostic imaging for GI Malignancies.

GI Imaging

Invasive
- Upper GI endoscopy
- Colonoscopy
- Endoscopic ultrasound
- Conventional, CT, MRI enteroclysis
- Angiography

Non-invasive
- Ultrasound Abdomen
- CECT
- CEMRI
- PET scan
- SPECT
- Virtual colonography

+ Biopsy

CT-PET
MR-PET
Primary GI malignancies

- Adenocarcinoma
- Lymphoma
- Carcinoid
- Mesenchymal tumours
- Squamous cell carcinoma
Transluminal ultrasound

• Safe procedure with no radiation exposure.

• Excellent soft tissue imaging capabilities.

• Allows visualization of intestinal wall fluid, filled intestinal segments & surrounding environment.

• Helps in detecting
  wall thickening
  disturbed wall morphology
  surrounding oedema
  lymphadenopathy
Computed Tomography

- MDCT
- Fast acquisition of thin slices
- Multi-planar reconstructions.
- Valuable in the study of intestinal loops.
- NCCT abdomen is replacing plain radiography
- CECT is valuable in diagnosing inflammatory and neoplastic intestinal lesions
2D versus 3D imaging
CT imaging features: benign versus malignant
Bowel wall thickening

Normal bowel wall thickening is ≤ 3mm.

Frequent cause of pseudo thickening – Incomplete distention

Adequate luminal dilatation with wall thickening connotes pathology.

CT features that help in diagnosis
1. Bowel wall attenuation & enhancement.
2. Degree of wall thickening.
3. Length of involvement.
Bowel wall attenuation & enhancement

• Bowel wall stratification- target or double halo sign.

• Smooth alternating low and high attenuation layers conforming to the circumferential strata of bowel wall- benign.

• Exception- Scirrhus adenocarcinoma.

• Heterogenous wall attenuation not conforming to bowel wall- malignant
Degree of bowel wall thickness

- Bowel wall thickness < 1cm – Benign
- Bowel wall thickness > 2 cm – Malignant

Thickened bowel wall can be seen in benign conditions also
- Ulcerative colitis
- Crohn’s disease
- Mycobacterial infection
- Cytomegalo virus infection
Length of involvement

- Pathology affecting > 20 cm of bowel – benign
- Wall thickening involving < 5 cm – malignant
- 5-20 cm – non specific

- Segmental involvement

  - Non Hodgkin’s lymphoma
  - Granulomatous diseases
  - Bowel haemorrhage
Bowel wall morphology

- Homogenous, symmetric, smooth & tapered wall thickening - Benign
- Irregular, asymmetric, eccentric & abrupt wall thickening – Malignant.
Cavitary masses

• Uncommon but important morphological pattern.

• Differential diagnosis
  Adenocarcinoma.
  Non Hodgkin’s lymphoma.
  GIST.
  Metastasis.
  Diverticulitis with abscess formation.
Adenocarcinoma- Imaging features.

- Irregular asymmetric wall thickening.
- Luminal narrowing with tendency for obstruction.
- Short segment involvement
- Abrupt transition from unaffected bowel wall to mass- Shouldering
- Locoregional lymph node involvement.
- Lobulated polypoidal mass
- Superficial nodular mass
- Deep ulcerative mass
- Rigid fixed appearance- Linitis plastic.
- Calcification – mucinous adenocarcinoma
Lobulated polypoid mass
Krukenberg tumour
Lymphoma- Imaging features

- Circumferential homogenous smooth bowel wall thickening without obstruction.
- Mid to long segment bowel involvement
- ‘mesenteric sandwich’
- Aneurysmal dilatation of involved bowel
- Splenomegaly
Lymphoma stomach

Circumferential homogenous smooth bowel wall thickening
Lymphoma Ileum
Smooth bowel wall thickening - colon
Carcinoid – Imaging features

• Submucosal tumour of neuroendocrine origin.

• Commonest site- Appendix (35%) Distal Ileum (16%)

• Highly malignant & metastatic.

• Primary mass usually undetectable.

• Bull’s eye lesion- sub mucosal mass with central ulceration.
Carcinoid- Imaging features

Metastatic node in regional mesentery
Heamatogenous Liver metastasis. ‘Hypervascular’
Mesenchymal tumours

• GIST

• Leiomyoma

• Leiomyosarcoma

• Gastrointestinal lipomas

• Liposarcoma

• Nerve sheath tumours
GIST

• Most common mesenchymal tumour of GI tract

  Stomach- 70%
  Small bowel- 20-30%
  Anus/rectum- 7%

• EGIST- infrequent
Gastrointestinal stromal tumours (GIST)

Bulky heterogeneously hyper enhancing mural masses
Gastrointestinal lipoma

- Most often involve Ileum & Colon
- Well defined fat attenuating mass is diagnostic
Miscellaneous primary tumour

- Appendiceal mucoceles
- Mucinous cystadenoma
- Mucinous cystadenocarcinoma
Pseudomyxoma peritonei
Metastasis to GI Tract

• Heamatogenous
  Lung, Breast, Kaposi’s sarcoma, Melanoma
  Anti mesenteric border.
• Peritoneal seeding
  Ovary & GI primaries.
  Mesenteric border

• Cavitating metastasis- Melanoma.

• Complications – Intersusception, Obstruction, Perforation
Bull’s eye lesions

- Metastases from melanoma or lymphoma
- Kaposi sarcoma
MDCT Colonography

- Non-invasive screening examination
- Large intestine studies.
- Large intestine is distended after colonic preparation.
- Prone & supine position.
- Reviewed with multi planar views & virtual endoscopy
- Allows detection of polyps > 6 mm
- Allows detection of extra-colonic pathology is possible
1. Colonoscopic picture of large bleeding mass obstructing rectum

2. Virtual colonoscopic image after enhancement.

3. Ray-sum image

4. Polypoidal occlusive carcinoma rectum
Magnetic Resonance Imaging

• No long term & short term hazards
• Excellent soft tissue imaging capabilities for GI tract.
• Limitations
  Long acquisition times.
  High risk of motion artefacts.
• Recent technological advances
  Parallel imaging faster and higher quality image acquisition.
MR Colonography

70% more abnormalities detected than CE

Sensitivity of MRE

- Superficial ulcers- 40%
- Fold distortion- 30%
- Fold thickening- 62.5%
- Deep ulcers- 89.5%
- Cobble stoning pattern- 92.3%
- Stenosis & prestenotic dilatation- 100%
Imaging & Oesophageal carcinoma

- Endoscopic Ultra Sonography
- CE Computed Tomography
- Integrated PET-CT
Imaging & Gastric carcinoma

Endoscopic ultrasound
CE computed tomography
MRI & Small intestine

• Provides cross sectional imaging without radiation hazards.

• Visualization of entire bowel - high specificity & sensitivity.

• Detection of other relevant abdominal pathology.

• Luminal - Stenosis, cobble stoning & fissures

• Mural - Wall thickening & wall enhancement

• Exocentric pathologies - Mesenteric inflammation, fibrofatty proliferation, Lymphadenopathy, hypervascularity, abscesses & fistulas.
Diffuse large B-cell lymphoma of Ileum
MRI & Pelvis

• Gold standard in oncologic pelvic examination.
• Provides morphological & functional data.

• Offers accurate evaluation of cancer stage.

  Degree of tumor infiltration.
  Involvement of internal & external sphincter
  Intersphincteric plane
  Lymph node status

Granata et al. Infectious Agents and Cancer (2016) 11:52
MRI & Rectum

- Gold standard for staging
- Pelvic MRI with endorectal coils
- Excellent soft tissue imaging.
- Gives exact visualisation of infiltration of rectal wall & perirectal fat.
MRI Anal Canal tumours
TSE T2W in axial plane
Post contrast sequences
### Anal canal imaging - 3D EAUS & CEMRI

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<tr>
<th>Technique</th>
<th>3D EAUS</th>
<th>MRI</th>
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<tr>
<td><strong>Advantages</strong></td>
<td>Easier; quicker; low cost and better tolerated by patients</td>
<td>MRI is the gold standard in oncological pelvic examination, providing morphological and functional data</td>
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<td><strong>Disadvantages</strong></td>
<td>The accuracy of US varies according to the operator skill; small field of view</td>
<td>Expensive, poorly tolerated by the patient, long time for the examination</td>
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<td><strong>T stage</strong></td>
<td>More accurate for T1 than MRI and to assess relationship between lesion and sphincteric plan</td>
<td>MRI is a valuable diagnostic tool in anal cancer staging, although the major limitation is an incorrect detection of T1 patients</td>
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<td><strong>N stage</strong></td>
<td>Only N1, so EAUS should be supplemented by MRI since US has a limited field of view.</td>
<td>Effective assessment of lymph nodes status thanks to morphological and functional data by DWI.</td>
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<td><strong>Post Treatment Assessment</strong></td>
<td>EAUS did not provide any advantage over DRE in identifying local recurrence, and should not be recommended for routine surveillance</td>
<td>MR imaging plays an important role in therapeutic assessment, properly stratify patients into responders or non responders to neoadjuvant treatment, surveillance after surgery, and evaluation of suspected disease fall-out</td>
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Positron Emission Tomography (FDG-PET)

- High accuracy in the diagnosis and follow up oesophageal, gastric, colorectal and stromal cancers.
- Excellent for evaluation beyond local lymphadenopathy and metastatic disease.

FIGURE 1: A 63-year-old man with a primary mid-esophageal adenocarcinoma.
Radiomics: Images are more than Pictures. They are data

- The conversion of digital medical images into mineable high dimension data
- Motivated by the concept that biomedical images contain information that reflects underlying pathophysiology and that these relationships can be revealed via quantitative image analysis.
Take Home Message

• Imaging plays a key role in diagnosis & staging of GI tumours.

• Corner stone for appropriate patient selection in oesophageal cancer- EUS, CECT & PET/CT.

• Advanced CECT techniques with optimal contrast & multiplanar reformation & PET/CT for gastric cancer.

• MRI – Gold standard for small intestine, rectal & anal cancer cancers.

• Imaging supplemented by clinical history, Good clinical examination will lead to accurate diagnosis & staging and hence to accurate contouring.
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