Gastrointestinal and renal studies

Contents:
Salivary gland and thyroid imaging
Esophageal tract - stomach
Liver, spleen
Abdominal inflammations
Renal studies

Salivary gland scanning: technical details

Radiopharmaceutical: 99mTc-pertechnetate

Used mechanism: 99mTc-pertechnetate uptake and secretion into saliva

Scanning:
1. 80 MBq Tc-pertechnet. i.v.
2. 1 minute images for 25 minutes
3. ROI selection, time activity curve generation

Example:

<table>
<thead>
<tr>
<th>Gland</th>
<th>Uptake (%)</th>
<th>EF (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rt. parotis</td>
<td>0.29%</td>
<td>27.9%</td>
</tr>
<tr>
<td>Rt. submand.</td>
<td>0.15%</td>
<td>19.6%</td>
</tr>
<tr>
<td>Lt. parotis</td>
<td>0.27%</td>
<td>25.5%</td>
</tr>
<tr>
<td>Lt. submand.</td>
<td>0.21%</td>
<td>26.9%</td>
</tr>
</tbody>
</table>

Normal reference values (mean±S.D.):

<table>
<thead>
<tr>
<th>Gland</th>
<th>Uptake (%)</th>
<th>EF (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rt. parotis</td>
<td>0.33±0.14</td>
<td>41.3±5.2</td>
</tr>
<tr>
<td>Rt. submand.</td>
<td>0.28±0.11</td>
<td>32.5±3.7</td>
</tr>
<tr>
<td>Lt. parotis</td>
<td>0.33±0.13</td>
<td>43.8±4.9</td>
</tr>
<tr>
<td>Lt. submand.</td>
<td>0.28±0.11</td>
<td>34.9±3.9</td>
</tr>
</tbody>
</table>

Oesophageal transit studies

Radiopharmaceutical: 99mTc-DTPA solution

Used mechanism: Motor function of oesophagus

Scanning:
1. Supine position
2. Liquid bolus swallowing
3. Start 0.25 sec. image acquisition
4. ROI selection, time activity curve contraction

Eosophageal transit study: normal

(normal curves of upper, medial and lower part of oesophagus)

Esophageal transit – normal parametric image

Abnormal esophageal transit: achalasia
Esophageal transit curves in achalasia

Gastric emptying study

**Radiopharmaceutical:** 99mTc-DTPA solution (or colloid)

**Used mechanism:** Motor function of stomach

**Scanning:**
1. Supine position
2. Liquid meal ingestion (250 ml)
3. Start 1 min. image acquisition for 60 min.
4. ROI selection, time activity curve contraction

Gastric emptying depends on:

a. Volume of meal
b. Osmolarity of meal
c. Carbohydrate/fat content of meal
d. Solid/liquid components
e. Psychological factors

Example: Gastric emptying study

Stomach ROI and time - activity curve

Static colloid liver/spleen scintigraphy (normal)

Severe parenchymal liver disease (cirrhosis)
Data of bile production:

0.4 ml bile/min; 600 ml bile/day produces the liver.

Between meals 70% of bile go through the gallbladder 30% passes directly into duodenum.

The proportion is regulated by sphincter of Oddi.

Methods to reveal and types of biliary dyskinesias:

- **Invasive methods:** ERCP, manometry
  - Sphincterotomy - the rate of complications: about 10% but at SOS 23%
  - CCK cholecintigraphy is non-invasive to reveal biliary dyskinesias

**Types of biliary dyskinesias:**

- Cystic Duct Syndrome (CDS) (Spastic cystic duct, low EF of GB)
- Sphincter of Oddi spasm (SOS) (paradoxically spastic Oddi Sphincter, normal EF of GB)

Protocol of CCK cholescintigraphy

**Patient preparation:** minimally 4 hours fasting, (but no more than 8-10 hours!)

Withdraw drugs effecting bile production and emptying (Opioids, Ca antagonists)

**Radiopharmaceutical:** 99mTc-EHIDA 150-300 MBq iv. supine position

**Data acquisition:** with planar gamma camera
- **Hepatic phase:** 60, 1 min. frames (Calculation of hepatic excreting phase)
- **Gallbladder phase:** more 60, 1 min. frames
  - At 60 min. start of CCK solution infusion (dose: 1ng/kg/min) until 45 minutes/

Dynamic HIDA study

CCK provocations:

1. „short” provocation: (it isn’t used, side effects!)
   - (3ng/kg/min) 5 ml phys. saline for 2 minutes (placebo)
   - 10ng CCK (Sincalide, Kinevac) for 3 minutes
   - Normal gallbladder EF: 35%

2. „longer” (more physiologic provocation):
   - (1 ng/kg/min) 100 ml phys. sal. 5 microgram Takus (Ceruletide) infusions until 45 minutes
   - Normal gallbladder EF: more than 70%

Frame analysis:
- ROI’s on right liver lobe, common bile duct GB and duod.
- Time activity curve gener. (T max. T1/2 parameters)

Cystic Duct Syndrome (CDS):

Other names: chr. acalculous cholecystitis, acalculous gallbladder disease

First described by Cozzolino in 1963

**Scintigraphic signs:**
- hepatic transport parameters and gallbladder filling are normal
- after CCK the gallbladder contraction is poor, pain is felt
- gallbladder EF: is low
Example: Abnormal CCK response

**Sphinter of Oddi Spasm (SOS)**

Other names: papillary stenosis, Oddi sphincter dysfunction, biliary dyskinesia

**Manometrically:**
- after CCK, the Oddi sph. basic pressure increases
- number and height of phasic contractions increases
- the number of retrograde contractions increases: paradoxical reaction

**Dynamic HIDA, CCK provocation - paradox response**

**SOS: scintigraphic symptoms**

*If gallbladder persisting!*
- Hepatic transport parameters and gallbladder filling are normal
- after CCK provocation the gallbladder emptying is normal but retrograde filling of CBD (choledochus) is observed (paradox reaction with pain)
- after provocation or spasmolytics - pain relief

**There is no gallbladder:** (St. p. cholecystectomiam)
- after CCK provocation gallbladder emptying stops, or retrograde filling is observable (paradox answer)
- spasmolytics (Nitrates) increase in bile emptying

**Therapy of biliary dyskinesia**

*At SOS:* spasmolytics or later papillotomy

*At DCS:* if gallbladder EF is low: cholecystectomy

**Duodeno-gastric reflux**

**Crohn disease:**

(active inflammatory bowel disease)

(in vitro 99m Tc-HMPAO WBC labeling)
Intraabdominal abscess (after pancreatitis)

99mTc-MoAb in vivo labelling

In vivo WBC labeling

In vivo labelled Antigranulocyte 99mTc-MoAb

Intraabdominal abscess (SPECT transaxial slices):

Static renal scintigraphy

<table>
<thead>
<tr>
<th>Pharmaceutical:</th>
<th>[Tc-99m] DMSA (di-mercapto-succinic acid)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used phenomenon:</td>
<td>Accumulation in renal proximal tubular cells</td>
</tr>
<tr>
<td>Data acquisition:</td>
<td>3-5 hours after iv. injection</td>
</tr>
<tr>
<td>Projections:</td>
<td>P, A and oblique views</td>
</tr>
<tr>
<td>Calculated quantitative parameters:</td>
<td>Relative activity uptake (in %)</td>
</tr>
<tr>
<td>Abnormalities shown:</td>
<td>Intrarenal tumours (benign and malign) Local parenchymal defects, scars Congenital disorders (e.g., Horseshoe) or dystopic kidney</td>
</tr>
<tr>
<td>Diagnostic difficulties:</td>
<td>To separate space occupying lesions (tu. abscess, cysta)</td>
</tr>
</tbody>
</table>

Static renal scintigraphy: Indications

- Urinary tract infections: parenchymal involvement, renal scarring, follow-up
- To estimate functioning parenchymal mass (below 15%: non-functioning kidney)
- Congenital disorders: sigmoid or horseshoe kidney dystopic kidney

Static renal scan (99m Tc-DMSA)

Multifocal space-occupying lesions (polycystic left kidney)

Missing left kidney

Horseshoe kidney
Dynamic imaging: Radionuclides

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<thead>
<tr>
<th>Radiopharm.</th>
<th>Name</th>
<th>Used phenomenon</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Tc-99m] DTPA</td>
<td>Diethylene-triaminepentaacetic acid</td>
<td>Glomerular filtration</td>
</tr>
<tr>
<td>[Tc-99m] MAG3</td>
<td>Mercapto-acetyltriglycin</td>
<td>Tubular excretion</td>
</tr>
<tr>
<td>[Tc-99m] EC</td>
<td>Ethylene-dicisteine</td>
<td>Tubular excretion</td>
</tr>
<tr>
<td>[I-131] v. [I-123] OIH</td>
<td>Orthoiodohippuric acid</td>
<td>Glomerular+tubular excretion</td>
</tr>
</tbody>
</table>

Dynamic imaging: Variants

- Start with radionuclide angiography
- Provocation with ACE-inhibitor
- Dynamic study with diuretics

Dynamic study: Normal results

Dynamic study combined with Furosemide provocation - slow wash-out

Effect of ACE inhibitor

With ACE inhibitor

Without ACE inhibitor

Clinical applications:

- Measurement of renal function
- Obstructive uropathy: differential diagnosis of functional or organic obstruction
- Reflux nephropathy, reflux staging
- Renal failure
- Evaluate of renovascular hypertesion
- Differential diagnosis of renal transplant’s complications