Gastrointestinal tract in children
Usefulness of isotopic studies
**Gastrointestinal tract in children**

**Usefulness of isotopic studies**

**TRACERS**
- $^{99m}$Tc-pertechnetate
- $^{99m}$Tc-colloid sulphur
- $^{99m}$Tc-IDA derivates

**TECHNIQUES**
- SWALLOW SCINTIGRAPHY
- OESOPHAGEAL SCINT = DEGLUTITION
- GASTRO-OESOPHAGEAL SCINT = GER
- GASTRIC EMPTYING
- RBC LABELLED SCINT = GASTROINTESTINAL BLEEDING
- MECKEL’s DIVERTICULUM SCINT
- HEPATOBILIARY SCINT = NEONATAL JAUNDICE

**DIAGNOSIS**
- LUNG ASPIRATION
  - SALIVARY
  - STOMACH
- OESOPHAGEAL CLEARANCE
- GER
- GASTRIC EMPTYING
- GI BLEEDING
- NEONATAL JAUNDICE
GASTRO-OESOPHAGEAL SCINTIGRAPHIES

1. SWALLOW SCAN
   = SALIVOGRAM
2. ESOPHAGEAL SCINTIGRAPHY
   = ESOPHAGEAL TRANSIT
3. GASTRO-OESOPHAGEAL SCINTIGRAPHY
   = GASTRO-OESOPHAGEAL REFLUX DETECTION
4. GASTRIC EMPTYING
5. LUNG ASPIRATION
SWALLOW SCINTIGRAPHY = SALIVOGRAM

TECHNIQUE

1. Position of the baby: seating position or decubitus
2. Gammacamara: posterior detection
3. Tracer: $^{99m}$Tc-colloid sulphur
4. Dummy: 18-20 MBq $^{99m}$Tc-CS
5. Quick dynamic study
   • 1 frame/sec
   • 64x64
   • Byte
6. Lung aspiration detection: 15 minutes thorax
SALIVOGRAM
Delayed image
2 H

DYNAMIC STUDY: 1 FRAME/SEC
ESOPHAGEAL SCINTIGRAPHY
= ESOPHAGEAL CLEARANCE TECHNIQUE

1. Position of the baby: seating position or decubitus
2. Gammacamara: posterior detection
3. Tracer: $^{99m}$Tc-colloid sulphur
4. Syringe: Glucosmon© +$^{99m}$Tc-SC
5. Dose and volume: age/weight
6. Ultrafast dynamic study
   • 10 frames/sec
   • 64x64
   • Byte
7. Lung aspiration detection: 15 minutes thorax
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<thead>
<tr>
<th>AGE</th>
<th>VOLUME</th>
<th>ACTIVITY</th>
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<tbody>
<tr>
<td>&lt; 1 year</td>
<td>0.5 ml</td>
<td>18-20 MBq</td>
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<tr>
<td>2-3 years</td>
<td>1 ml</td>
<td>37 MBq</td>
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<td>3-7 years</td>
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<tr>
<td>adults</td>
<td>3-5 ml</td>
<td>74 mBq</td>
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CONDENSED IMAGE – ESOPHAGEAL CLEARANCE

Ultrafast dynamic study 10 imag/sec

Matrix 64 x 64

Addition x 64

Activity of each line

Column 1 x 64
CONDENSED IMAGE – ESOPHAEOAL CLEARANCE

Ultrafast dynamic study 10 imag/sec

Columns 1 x 64

Column juxtaposition 1 x 64

Condensed image
CONDENSED IMAGE – ESOPHAGAL CLEARANCE

MOUTH

OESOPHAGOUS

STOMACH

X axis: time representation

0 1 2 3 4 5 6 7 8 sec
OESOPHAGEAL SCINTIGRAPHY

NORMAL

Time
mouth-stomach < 5 sec

Good oesophageal clearance
OESOPHAGEAL SCINTIGRAPHY

GOR + OESOPHAGITIS

Delayed clearance in lower part oesophagus
> 30 sec
Multiple swallows

NO VALID repeat!
normal
GOR
ACHALASIA
Liquid deglutition
ACHALASIA
Puree deglutition
ACHALASIA
Quantification of the oesophageal clearance

**LÍQUID**

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<th>100 SEG</th>
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<td>44164.0</td>
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<td>12836.0</td>
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<td>%</td>
<td>78.7</td>
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**PUREE**

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<td>10947.0</td>
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<tr>
<td>%</td>
<td>80.3</td>
<td>78.8</td>
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GASTRO-OESOPHAGEAL SCINTIGRAPHY = GASTRO-OESOPHAGEAL REFLUX TECHNIQUE

1. Position of the baby: seating position or decubitus
2. Gammacamara: posterior detection
3. Tracer: \(^{99m}\)Tc-colloid sulphur
4. Syringe: Milk o juice + \(^{99m}\)Tc-SC
5. Dose and volume: age / weight
6. Dynamic study 30-60 min
   • 1 frames/ 5-10 sec
   • 64x64
   • Byte
7. Lung aspiration detection: 15 minutes thorax
OESOPHAGEAL TIME-ACTIVITY CURVES
GASTRIC EMPTYING TECHNIQUE

1. Babies and children: only liquid
2. Teenagers = adults (solid and liquid)

LIQUIDS
1. Milk / Juice
2. Gammarcamera: posterior position or anterior+posterior
3. Tracer: $^{99m}$Tc-colloid sulphur
4. Dose: age / weight
5. Volume: age / weight
6. Dynamic acquisition or multiple static frames during 90 min
   • 1 image/ 5-10 min
   • 64x64
   • Byte
7. Normal:
   • Gastric emptying > 50 % at 60-90 minutes
LUNG ASPIRATION DETECTION TECHNIQUE

1. Previous administration of a non-absorbable labelled colloid
2. Lung aspiration during deglutition:
   • Thorax: static frame 5-10 minutes OR addition of all the dynamic frames
   • Immediately after swallow / labelled dummy
   • 64x64, byte, saturated image
3. Lung aspiration of gastric content:
   • Thorax: static frame 5-10 minutes
   • Several images after labelled meat
   • REMEMBER: bronchial clearance 15 min in children !!!
   • 64x64, byte, saturated image

SENSITIVITY ↓↓↓ SPECIFICITY +++ 100%
GASTROINTESTINAL STUDIES IN PAEDIATRICS

TRACERS
- $^{99m}$Tc-pertechnetate
- $^{99m}$Tc-colloid sulphur
- $^{99m}$Tc-IDA derivates

TECHNIQUES
- SALIVARY SCINTIGRAPHY
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GASTRO INTESTINAL BLEEDING

- Meckel’s Diverticulum
- others
ACUTE GASTRO INTESTINAL BLEEDING

CLINICAL MANAGEMENT

- < 2 years:
  - Invagination
  - Meckel’s Diverticulum
- > 2 years:
  - Meckel’s Diverticulum

SCINTIGRAPHY

- < 2 years:
  - Meckel’s scan
- > 2 years:
  - Meckel’s scan
What happens if the 1st Meckel’s scan is negative?

**SCINTIGRAPHY**

**ACUTE GASTRO INTESTINAL BLEEDING**

- < 2 years
  - Meckel’s scan
- > 2 years
  - Meckel’s scan

**REPEAT THE MECKEL’S SCAN**
What happen if in case of recurrent GI bleeding?

1st Meckel’s scan

99mTc-RBC abdominal scintigraphy

negative or normal
• Detect very low GI bleeding
  0.05 ml/min
• Allows the bleeding detection during 24 hours
• Dynamic acquisition: essential
• barium and contrasts: NO

99mTc-RBC abdominal scintigraphy
• Blood sample: 3 - 5 ml en children

• Labelling: similar as in adults
  - DTPA / Sn chlorure: 0.022 ml/kg weight

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<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
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<tr>
<td>ml</td>
<td>0.44</td>
<td>0.66</td>
<td>0.88</td>
<td>1.1</td>
<td>1.32</td>
<td>1.54</td>
<td>1.76</td>
<td>1.98</td>
<td>2.2</td>
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</table>

  - Centrifuge
Dynamic acquisition: essential
- 1 frame / 30-60 sec during 30 minutes
- It allows us to value:
  - the dynamic cine
  - the 30 minutes added image

1. First dynamic study:
   - immediately after RBC injection
2. Second dynamic study: 2 hours later
3. More acquisitions: 4, 6, 8, 12 and/or 24 hours
   - optional, if no bleeding detection detection
**99mTc Meckel Diverticulum Scintigraphy**

**TRACER:**

99mTc-pertechnetate

**MECHANISM TO OBTAIN IMAGE:** pertechnetate uptake in parietal gastric cells

**DETECTS THE GASTRIC ECTOPIC MUCOSA**
only 30-50% of the Meckel diverticulum have gastric ectopic mucosa.

in case of Meckel Diverticulum with gastric ectopic mucosa the Meckel scan:

- specificity 95%
- accuracy 98%
MECKEL SCAN

PREPARATION

fasting 6 hours
minimum
4 hours
in babies
MECKEL SCAN

PHARMACOLOGY - PREPARATION

• Pentagastrine and Glucagon
• H2 Blockers
  Cimetidine / Ranitidine / Omeprazole

Pentagastrine + Glucagon

• Pentagastrine 6μg/kg SC
  – 5-15 min. before pertechnetate IV injection
  – Increases gastric secretion
• Glucagon 0.25-1.0 mg IM o IV
  – Disminish intestinal peristalsis
MECKEL SCAN

PHARMACOLOGY - PREPARATION

- Pentagastrine and Glucagon
- H2 Blockers
  - Cimetidine
  - Ranitidine
  - Omeprazole

**H2 blockers**: inhibit pertechnetate secretion from the parietal gastric cells to the stomach and intestinal tube

- **Cimetidine** 5 mg/kg with a maximum 300 mg
  - per or 4-6 hours before the tracer IV administration
- **Ranitidine** 1 mg/kg with a maximum 50 mg
  - IV slow administration, 20 min before tracer or
  - per or 60 min before tracer administration
- **Omeprazole** 5 mg/10 kg with a maximum 20 mg
  - per or 30-60 min before tracer administration
  - IV 15-30 min before tracer administration
OMEPRAZOLE PER OR
30 - 60 minutes before tracer administration

dose
20 mg adults
5 mg/10 kg weight in children

others:
cimetidine or ranitidine
MECKEL’S DIVERTICULUM
with gastric ectopic mucosa

TYPICAL FINDINGS

• point of increased uptake localized in lower right quadrant of the abdomen
• anterior
• uptake intensity: similar to gastric activity
• increasing activity during the 45-60 minutes study
UNFREQUENT LOCALIZATIONS OF THE MECKEL’S DIVERTICULUM

MECKEL SCAN

- retrovesical
- oesophageal
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<tr>
<td>1</td>
<td>5</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>20</td>
<td>25</td>
<td>30</td>
<td>35</td>
</tr>
<tr>
<td>40</td>
<td>45</td>
<td>ANT 60 min</td>
<td>R LAT 60 min</td>
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**DIVERTÍCULO DE MECKEL RETROVESICAL**

**CAUDAL**

**POST MICTURITION 60 MIN**
MECKEL SCAN

FALSE POSITIVES

- GI duplication
- inflammatory intestinal disease
- renal activity: ureter or pelvis
- tumor
- post laparoscopy
- Barret’s oesophagus
MECKEL SCAN

FALSE NEGATIVES

• RECENT GI BLEEDING:
  - mucosa cell destruction/disappearance

• SMALL AMOUNT of GASTRIC MUCOSA:
  - insufficient / not detectable uptake

• BARIUM:
  - Previous xRay exams: GE transit or enema

• TECHNICAL PITFALLS:
  - no fasting conditions
  - low injected activity
  - bad detection: positionning or movement

• TRANSIT of the DIVERTICULUM CONTENT
  +++ movement

• INCREASED GI TRANSIT:
  - no H2 blockers
  - active GI bleeding
FALSE NEGATIVES

- RECENT GI BLEEDING:
  - mucosa cell destruction/disappearance
FALSE NEGATIVES

• BARIUM:
  Previous xRay exams:
  GE transit or enema
MECKEL SCAN

FALSE NEGATIVES

- TECHNICAL PITFALL:
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  - low injected activity
MECKEL SCAN

FALSE NEGATIVES

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MECKEL SCAN

FALSE NEGATIVES

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  – SALIVARY
  – STOMACH
• OESOPHAGEAL CLEARANCE
• GER
• GASTRIC EMPTYING
• GI BLEEDING
• NEONATAL JAUNDICE
• CHOLEDOC CYST
• LIVER MASS
NEONATAL JAUNDICE

Differential diagnosis

- Neonatal Hepatitis
- Biliary Atresia
  - Choledoc Cyst, with obstruction
  - Cystic fibrosis
  - Syndrome of bilis
  - Alagille Syndrome (arterio-hepatic dysplasia)
  - alfa-1-antitripsina deficit
Hepatobiliary Scintigraphy
99mTc-IDA

IDA =
iminodiacetic acid
Hepatocit uptake
Competition with Bb

Dynamic study 45 min

Late images
1, 2, 4 i 24 hours
HEPATOBILIARY SCINTIGRAPHY INTERPRETATION

• The presence of GI activity
  DISCARD BILIARY ATRESIA

• The absence of GI activity
  DO NOT CONFIRM a Biliary Atresia
PREPARATION

- Fasting conditions: 4 hours in babies and young children
- 6-8 hours in older children
- Avoid fasting > 24 hours
- Avoid increased feeding
PREPARATION

PHENOBARBITAL

5 mg/ kg / day
from 5 a 7 days before the exam

BASIC!!!!
BILIARY ATRESIA

intrahepatic

eextrahepatic
BILIARY ATRESIA

- No irreversible LIVER DAMAGE before 2 months

- **1959: Dr. Morio Kasai – Portoenterostomy**

- Portoenterostomy before 2 months
  - 90% good biliary drainage

- Surgery after 2 months of age
  - 20% good biliary drainage
BILIARY ATRESIA

Hepatobiliary scintigraphy:
- Phenobarbital pre-medication
- good hepatic uptake
- no biliary excretion
- no intestinal drainage

Liver ultrasound:
- no gall bladder visualization

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<tr>
<td>sensitivity</td>
<td>97%</td>
</tr>
<tr>
<td>specificity</td>
<td>82%</td>
</tr>
<tr>
<td>accuracy</td>
<td>91%</td>
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<tr>
<td>FP</td>
<td>6%</td>
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<tr>
<td>FN</td>
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6 w old baby

Neonatal jaundice
BILIARY ATRESIA

- Hepatic uptake
  - N < 2 m
- Hepatic uptake
  - ↓ > 2 m
- NO GI activity 24 hours
- Cardiac activity <<<
  liver uptake at 5 min
IMAGE INTERPRETATION

→ good liver uptake
→ YOU CAN INTERPRET THE HEPATOBILIARY SCAN

→ bad liver uptake
→ YOU CANNOT INTERPRET THE HEPATOBILIARY SCAN
CYSTIC FIBROSIS

- 50% US and hepatobiliary scan abnormal
- Small gallbladder
- Hepatic or biliary duct retention
- Gallbladder
  - Lithiasis
  - Delayed emptying
2 m old boy, neonatal jaundice
BILE DUCT PAUCITY
NEONATAL HEPATITIS
LIVER SINTIGRAPHY

Colloid Sulphur

10 years
Chronic liver disease
AIDS
US: Right hepatic lobe

15 years old girl
ABDOMINAL MASS
FOCAL NODULAR HIPERPLASIA
WHICH IS YOUR DIAGNOSTIC?
HEPATIC TRAUMA
LEFT BILIARY DUCT LESION
LIVER TX

HEMATOMA
BILIARY ATRESIA + KASAI SURGERY 5 Y BEFORE
BILIARY DUODENO-GASTRIC REFLUX
CHOLEDOCAL CYST
CHOLEDOCAL CYST
ABDOMINAL SCINTIGRAPHY with LABELLED WBC TECHNIQUE

1. Blood volume:
   • Babies under 1 year 10 cc
   • Children 10-25 cc
   • Adults 50 cc
2. Labelled leucocytes $^{99m}$Tc-HMPAO
3. IV injection of $^{99m}$Tc-HMPAO-leucocytes
4. Abdominal detection : 30 minutes
5. Abdominal detection : 2 hours
   • Anterior
   • Posterior
   • Lateral
   • Caudal
   • SPET

recommended
11 year old girl
Crohn disease
11 year old boy
diarrhea and blood in faeces
16 year old girl
Crohn disease
10 year old boy
Inflammatory bowel disease

Terminal ileon?

Coronal

Transversal
15 years old girl
Still disease
Juvenile Rheumatoid Arthritis
ABDOMINAL SCINTIGRAPHY with LABELLED WBC

IBD – acute phase

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Thanks a lot for your attention !!!