Liver Function Assessment in Patients Planned for Liver Resection and Liver Transplant

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Liver Quality Assessment

- The liver - spectrum of functions
  - Uptake function
  - Metabolism
  - Conjugation and
  - Excretion
  - Immunological

Various endogenous and foreign substances – Hepatic Transporters

There is no liver function test available that measures all components of liver function
Normal Liver 

- Steatosis 
- Fibrosis 
- Cirrhosis 
- Cholestasis 
- CASH 

Decreased Liver Function
Limitations of the liver function tests

- Serological tests
  - Reflect the degree of **Total liver damage or function**, but not the remnant liver function
  - Can not determine the safe extent of liver resection

- ICG and other metabolic quantitative tests
  - More accurate in predicting liver function
  - Can not accurately determine the safe extent of liver resection
  - Regional liver assessment not possible

- Liver Biopsy
  - Invasive
  - Sampling error
  - Inter observer variation
  - Inhomogenous distribution of liver parenchymal disease
### Limitations of the liver function tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Computed tomography (CT) volumetry</strong></td>
<td>Can provide anatomic information on the remnant liver volume but <strong>not on functional volume</strong></td>
</tr>
<tr>
<td><strong>HB scintigraphy combined with SPECT –CT</strong></td>
<td>May be a better qualitative and quantitative measure of <strong>Total and Regional liver function</strong></td>
</tr>
</tbody>
</table>
| **HVPG Assessment**                       | - **Invasive**  
- **Valid in CLD**  
- **Can not determine the safe extent of liver resection**  
- **Difficult to interpret in cholestatic livers (Obstructive jaundice )** |
Liver Quality Assessment - Liver Resection

Decision requires fine balancing

- Steatosis
- Inflammation
- Fibrosis
- Cirrhosis
- Cholestasis

UNWARRANTED SURGERY
Post Hepatectomy Liver Failure

UNNECESSARY AVOIDING SURGERY
Where Surgery is beneficial

Inflammation
Fibrosis
Cirrhosis
CASH
ICG retention

Liver Quality Assessment
ICG clearance Test

- Most widely used
- Reflects
  - Blood flow–dependent clearance and
  - Transporter capacity (cellular uptake, and biliary excretion)
- The results are expressed in:
  - The plasma disappearance rate (ICG-PDR)
  - The indocyanine green elimination rate constant
ICG clearance Test

- ICG-R15 >15% - high risk factor for serious post-hepatectomy complications


- A cutoff of 14% suggested by Lau et al

\textit{Lau H Br J Surg 1997;84:1255-1259}
ICG clearance Test

- ICG –R15 < 10% : Right Hepatectomy can be safely performed
- ICG- R15 10-19% :
  - Left Hepatectomy
  - Right Ant/ Posterior sectorectomy
  - Left Lateral segmentectomy
- ICG-R15 of 20%-29% : Monosegmentectomy
• Role of Nuclear Medicine Imaging

Liver Quality Assessment / FLR Reserve
Functional Liver STUDY- HBS

Hepatocyte mass scintigraphy (99mTc-GSA)
Hepatobiliary scintigraphy (99mTc-Mebrofenin)
99mTc-Galactosyl-Human Serum Albumin for Liver Function Scintigraphy

- Liver is the only site for 99mTc-GSA uptake, making an ideal agent for Functional Liver scintigraphy

- Hepatic uptake ratio and blood clearance ratio of 99mTc-GSA are the most commonly used parameters
99mTc-Galactosyl-Human Serum Albumin for Liver Function Scintigraphy…

- In 9% to 20% patients, a discrepancy with the ICG clearance test is found - in whom the histological severity of disease is better reflected by 99mTc-GSA scintigraphy
- Not influenced by hyperbilirubinemia, and can also be used in cholestatic patients
- Multiple studies have addressed the use of preoperative 99mTc-GSA scintigraphy for predicting postoperative complications
- Only available in Japan
Hepatobiliary scintigraphy (99mTc-Mebrofenin)
HBS (99mTc-Mebrofenin) – Procedure....

Dose - 200 MBq of 99mTc-mebrofenin

Early Dynamic Phase

Liver Uptake

Liver Uptake Rate (Total Liver Function – MUR in %/min/Sq mt)

0-150 sec

150-350 sec

SPECT Phase

Liver Uptake/ Regional Assessment/Volume Assessment (FLR – MUR)

350-710 sec

Mebrofenin Uptake Rate (TLF- MUR) Calculated by Ekman et al method (Modified)

On Fusion of SPECT and CT

FLR-MUR: TL-F (MUR) as %/min/Sq.mt x FRL-F / TL-F
HBS Procedure – Time Activity Curves

Counts

Time in Seconds

Liver Uptake
Blood Pool Clearance
Parenchymal liver disease had significantly less liver (uptake) function - gray box, 7.4±1.4%/min/m2.

Healthy liver parenchyma - white box, 8.5±1.7%/min/m2,
HBS (99mTc-Mebrofenin)-Literature

- Forty-six patients with and without parenchymal disease
- Patients with FRL cMUR > 2.7%/min/m2 - 3% postoperative liver failure and liver failure–related mortality.
- However, in patients with FRL cMUR < 2.7%/min/m2, the risk of postoperative liver failure increased to 56%. 

Br J Surg 2011; 98:825-834
## HBS (99mTc-Mebrofenin)-Literature

<table>
<thead>
<tr>
<th></th>
<th>After implementation of HBS, (n = 134)</th>
<th>Before implementation of HBS, (n = 55)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type of resection</strong></td>
<td></td>
<td></td>
<td><strong>0.055</strong></td>
</tr>
<tr>
<td><strong>Type of Tumour</strong></td>
<td></td>
<td></td>
<td><strong>0.392</strong></td>
</tr>
<tr>
<td>FRL-volume, % (IQR 25–75)</td>
<td>53.9 (37.4–73.5)</td>
<td>41.7 (35.3–61.6)</td>
<td><strong>0.028</strong></td>
</tr>
<tr>
<td>FRL-function, %/min/m² (IQR 25–75)</td>
<td>5.00 (3.49–7.10)</td>
<td>3.94 (2.69–4.85)</td>
<td><strong>0.005</strong></td>
</tr>
<tr>
<td>Postoperative liver failureb, n (%)</td>
<td>2 (1.5)</td>
<td>9 (16.4)</td>
<td><strong>&lt;0.001</strong></td>
</tr>
<tr>
<td>Mortality due to liver failure, n (%)</td>
<td>1 (0.7)</td>
<td>8 (14.5)</td>
<td><strong>&lt;0.001</strong></td>
</tr>
</tbody>
</table>

*Cieslak KP et al. HPB 2016*
Our Data
Medanta The Medicity, Gurgaon, Delhi NCR
Yashoda Hospitals, Hyderabad
## Our Data.

<table>
<thead>
<tr>
<th></th>
<th>Group A Normal Liver (n=17)</th>
<th>Group B (n=21)</th>
<th>Group C Pre Cirrhotic/CTPA (n=7)</th>
<th>P-value</th>
</tr>
</thead>
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<tr>
<td>Cholestasis (bilirubin 2-3 mg) (n=5)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Moderate (15-25%) steatosis (n=6)</td>
<td></td>
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<tr>
<td>Fibrosis Ishak F1-F4 (n=10)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLF-MUR %/min/Sqmt Mean±SD</td>
<td>8.9 ±0.8</td>
<td>7.0 ±0.92</td>
<td>6.9 ±1.49</td>
<td>7.10 ±0.75</td>
</tr>
<tr>
<td>Blood Pool Clearance Mean±SD</td>
<td>42.5±4.8%</td>
<td>32±4.8%</td>
<td>35±5.9%</td>
<td>34.4±3.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>22.6±4.3%</td>
</tr>
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</table>

*P*-value for comparison:
- Group A vs Group B
- Group B vs Group C
- Group A vs Group C
Our Data ...

**Mebrofenin Uptake**

- **Uptake per second**
- **Time in Seconds**

**Blood Pool Clearance**

- **Percentage**
- **Time in Seconds**
Our Data ...

Total scans - 45

Healthy Volunteers - 9

No Liver SOL - 5

Liver SOL - 31

Liver Resection

Resection Deferred - 3

LT - 3

Waiting for LT - 5

Liver Resection

Death - 2

Survived - 18
Mebrofenin Uptake Rate - MUR

Liver Resection

Moderate Impaired Liver

Mildly Impaired Liver

Normal Liver
HBS (Mebrofenin) Functional Scan – Hilar Chilangio Carcinoma Type 3a

- Dynamic Phase –
  - TLG cMUR: 5.39% min/Sq mt
  - Time Activity Graph

- Dynamic Phase –
  - TLG cMUR: 6.59% min/Sq mt
  - Time Activity Graph

HVPG – 5 mm Hg
HBS Functional Scan After PVE– Hilar Chilangio Carcinoma Type 3a : SPECT Phase

FLR : Seg 4a + Left Lateral Segment

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<th>FLR - CT volume</th>
<th>FLR- Functional Volume</th>
<th>FLR cMUR</th>
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<tr>
<td>Before PVE</td>
<td>40 %</td>
<td>38%</td>
<td>2.07 %/min/Sq.mt</td>
</tr>
<tr>
<td>After PVE</td>
<td>52%</td>
<td>53%</td>
<td>3.37 %/min/Sq.mt</td>
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Summary & Conclusion

- Non Invasive
- Reproducible
- HBS is a valuable technique in predicting liver quality (Total and segmental)
- Predicts the risk of post hepatectomy liver failure especially with uncertain quality of liver parenchyma
- Patients with adequate FLR CT volume but decreased FLR -MUR may benefit from PVE
THANK YOU