Liver venous deprivation: CIO Miami 2021

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Liver deprivation: updates

Portal vein embolization (PVE)

- **Preoperative embolization** of portal vein branches of the hepatic segments to be resected

- **Rationale**: liver regeneration depends on hepatic portal perfusion

- **Goal**: induce hypertrophy of nonembolized liver segments (FLR) before resection to avoid post-operative liver failure
  
  - Complication rates for hepatectomy are linked to low volume FRL
  - Enables surgery for non-surgical candidates
  - Makes surgery safer for borderline candidates with better margins

- **Indications**:
  
  - If FLR < 25% in patients with otherwise normal liver
  - If FLR <40% in case of chronic liver disease

- **Technically**:
  
  - Better hypertrophy with glue (NBCA)
  - Ipsilateral versus contralateral

- **Safety**: most large series report **0% procedure-related mortality**!


Liver deprivation: updates

PVE: limitations

Insufficient liver regeneration:

Meta-analysis (37 studies; 1088 patients)

- Volume increase: 8-27%
- Non resection after PVE: 15%
  (50% tumor progression, 10% low hypertrophy)
- Post-operative transient liver insufficiency: 2.5%
- Death (acute liver failure): 0.8%

Liver regeneration after PVE is slow as compared to ALPPS:

- Max. regeneration: 3 weeks
- Identification of patients who will progress!
- Increase in liver function outpaces the increase in volume, which always lags behind.

Liver deprivation: updates
Liver venous deprivation (LVD)

• First described in 2003 in a case report

• LVD = portal vein embolization + hepatic vein(s) embolization

• Rationale for LVD:
  o Reducing residual hepatic inflow (hepatic artery, residual portal vein inflow) without ischemia
  o Pre-operative venous collateral development: limit post-operative congestion

• Goal: improving hypertrophy:
  – Faster
  – Bigger FLR volume

Liver deprivation: updates
Liver venous deprivation (LVD)

- **Sequential embolization of ipsilateral HVE after portal vein embolization** (2009)
  - Case report of limited liver regeneration after PVE
  - Safety: no complication (alternative to ALPPS)
  - Effectiveness:
    - 34.8% FLR
    - 39.7% FLR
    - 44.2% FLR

- **LVD**: Ipsilateral hepatic vein embolization performed *simultaneously* to PVE (2016)
  - Feasible, safe and effective

Hwang S. et al. Sequential preoperative ipsilateral hepatic vein embolization to induce further liver regeneration in patient with hepatobiliary malignancy. Ann Surg 2009
Hocquelet et al. Preoperative portal vein embolization alone with biliary drainage compared to a combination of simultaneous portal vein, right hepatic vein embolization and biliary drainage in Klatskin tumor. CVIR 2018
Liver deprivation: updates
Anatomy of Hepatic veins

• Modal anatomy:
  o 3 hepatic veins: right (largest), middle and left
  o Common trunk between middle and left hepatic vein (60 to 95%)

• Anatomic variants are frequent!

• Accessory right inferior hepatic vein (37%) draining the right posterior-inferior sector

<table>
<thead>
<tr>
<th>Description</th>
<th>Number of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>RHV variations</td>
<td></td>
</tr>
<tr>
<td>Single RHV</td>
<td>458 (91.6)</td>
</tr>
<tr>
<td>Early branching of RHV</td>
<td>201 (40.2)</td>
</tr>
<tr>
<td>2 RHV: common trunk; independent drainage</td>
<td>27 (5.4); 9 (1.8)</td>
</tr>
<tr>
<td>Accessory inferior RHV</td>
<td>185 (37)</td>
</tr>
<tr>
<td>Common trunk of MHV and LHV</td>
<td>405 (81)</td>
</tr>
<tr>
<td>Independent drainage of LHV and MHV into IVC</td>
<td>95 (19)</td>
</tr>
</tbody>
</table>

Segmental hepatic vein variations
- Segment IV vein
  - draining into LHV 333 (66.6)
  - draining into MHV 148 (29.6)
  - draining into IVC 19 (3.8)

- LMV
  - draining into LHV 497 (99.4)
  - draining into MHV 3 (0.6)

- ASSV
  - draining into MHV 443 (88.6)
  - draining into RHV 57 (11.4)
Liver deprivation: updates
LVD: percutaneous approach

a. Right PVE
b. Right HV 7F access
c. Amplatzer Vascular Plug II 18-22 mm is deployed 10 mm before the junction with the inferior vena cava
d. Verification of right HV occlusion
e. Embolization of the distal branches of the right HV (glue)
f. During sheath removal, track embolization

Main limitation of this approach: difficulty to obtain complete HV occlusion in case of (frequent) anatomic variants.
Liver deprivation: updates
LVD : transjugular approach

Technique :

1. **Internal jugular vein access** (Seldinger) : 9F 65 cm sheath (+/-angulated)

2. With the sheath or with a MPA2 catheter, **catheterism of the targeted hepatic vein**

3. Advance of the sheath **as distal as possible**

4. Check with **contrast medium injection**

5. Insert and release **plugs** (Amplatzer II 10-20 mm) (leave enough space (>10 mm) between IVC and plugs)

6. Repeat steps 2-5 for each veins/branches
Liver deprivation: updates
LVD : transjugular approach – case 1

Main steps of endovascular hepatic vein occlusion.

Liver deprivation: updates
LVD: transjugular approach – case 2


Occlusion of multiple accessory veins using a single femoral access in a 72-year old patient with liver metastasis from colorectal cancer.
Liver deprivation: updates
LVD: transjugular approach - Tips

• If the targeted hepatic vein is difficult to reach from jugular access: Try the femoral access!

• Not sure of the position of the material before plug placement? Insert an Amplatz Super Stiff 0.035’ guidewire and search it with ultrasound or CT!

• Difficulties for pushing the plug in the sheath? Mount coaxially the dilatator of the sheath on the guidewire liked to the plug and use it as a pusher!
Liver deprivation: updates
LVD: transjugular versus percutaneous

<table>
<thead>
<tr>
<th></th>
<th>Percutaneous approach</th>
<th>Transjugular approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>One access for all veins and</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>branches</td>
<td></td>
<td>(mostly)</td>
</tr>
<tr>
<td>More thorough embolization</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ultrasound limitations</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>(obesity, Chilaiditi, air after PVE, …)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Distal embolization</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Bleeding risk</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Tumor seeding</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>Risk of median HV embolization</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>(US/CT)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Difficult catheterism</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(femoral/jugular)</td>
</tr>
</tbody>
</table>
Liver deprivation: updates
LVD: liver volumetric changes

• FLR hypertrophy
  - 35% to 67%
  - Median FLR ratio increase up to 50%
  - Kinetic growth rate 2.9% to 4.2%/week

• Atrophy in the embolized liver
  - About 5%
Liver deprivation: updates
LVD : biological changes

- **Transient cytolysis** during the first week

- **No** cholestasis or liver failure
  - Total bilirubin stable or moderately reduced
  - PT stable or moderately increased

Kobayashi K et al. Liver venous deprivation compared to portal vein embolization to induce hypertrophy of the future liver remnant before major hepatectomy: a single center experience. Surgery 2020
Liver deprivation: updates
LVD : FLR hypertrophy

- **Greater** and **faster** FLR hypertrophy than with PVE alone
- Especially during the **first 3 weeks**

Volumetric FLR changes

Kobayashi K et al. Liver venous deprivation compared to portal vein embolization to induce hypertrophy of the future liver remnant before major hepatectomy: a single center experience. Surgery 2020

Guiu B et al. Liver venous deprivation versus portal vein embolization before major hepatectomy: future liver remnant volumetric and functional changes. Hepatobiliary surgery and nutrition 2020
Liver deprivation: updates

**LVD : FLR liver function**

- **Greater** and **faster** improvement of FLR liver function than with PVE alone
- Especially during the **first 3 weeks**

**LVD:**
- FLR volume increase
- FLR liver function increase
- Low morbidity/mortality

**ALPPS:**
- FLR volume increase
- Deceiving FLR liver function increase (immature hepatocytes)
- Clavien-Dindo ≥ IIIb in 27% of patients

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Guiu B et al. Liver venous deprivation versus portal vein embolization before major hepatectomy: future liver remnant volumetric and functional changes. Hepatobiliary surgery and nutrition 2020
Liver deprivation: updates
LVD: periperative impact

• Morbidity and mortality rates during and after surgery are similar compared to PVE alone:
  o Bleeding
  o Operative time
  o Medical and surgical complications

Table 1 Qualitative variables comparison between portal vein embolization (n=15) and liver venous deprivation (n=13)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Portal vein embolization, n (%)</th>
<th>Liver venous deprivation, n (%)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedicle clamping</td>
<td>No (66.7)</td>
<td>10 (76.9)</td>
<td>0.69</td>
</tr>
<tr>
<td></td>
<td>Yes (33.3)</td>
<td>5 (23.1)</td>
<td></td>
</tr>
<tr>
<td>Intraoperative RBC</td>
<td>No (66.7)</td>
<td>8 (61.5)</td>
<td>0.78</td>
</tr>
<tr>
<td></td>
<td>Yes (33.3)</td>
<td>5 (23.1)</td>
<td></td>
</tr>
<tr>
<td>Postoperative complications (Clavien-Dindo)</td>
<td>No (63.3)</td>
<td>3 (23.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes (46.7)</td>
<td>7 (53.8)</td>
<td>0.1</td>
</tr>
<tr>
<td></td>
<td>CD ≥ III</td>
<td>10 (76.9)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 (20)</td>
<td>1 (7.7)</td>
<td>0.6</td>
</tr>
<tr>
<td>PHBL</td>
<td>2 (13.3)</td>
<td>1 (7.7)</td>
<td>1</td>
</tr>
<tr>
<td>Grade A</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Grade B</td>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Grade C</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>PHILF</td>
<td>2 (13.3)</td>
<td>3 (23.1)</td>
<td>0.64</td>
</tr>
<tr>
<td>Grade A</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Grade B</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Grade C</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Data are presented as median (range) or n (%).

Table 2 Continuous variables comparison between portal vein embolization (n=15) and liver venous deprivation (n=13)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Portal vein embolization</th>
<th>Liver venous deprivation</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time to surgery (days)</td>
<td>45</td>
<td>46</td>
<td>0.86</td>
</tr>
<tr>
<td>Mean</td>
<td>37</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>18</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Pedicle clamping (min)</td>
<td>18</td>
<td>27</td>
<td>0.26</td>
</tr>
<tr>
<td>Mean</td>
<td>15</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>8</td>
<td>1089</td>
<td></td>
</tr>
<tr>
<td>Intraoperative bleeding (mL)</td>
<td>550</td>
<td>1200</td>
<td>0.96</td>
</tr>
<tr>
<td>Mean</td>
<td>4,142</td>
<td>4,180</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>4,250</td>
<td>4,000</td>
<td></td>
</tr>
<tr>
<td>Intraoperative RBC (mL)</td>
<td>763</td>
<td>656</td>
<td>0.42</td>
</tr>
<tr>
<td>Mean</td>
<td>622</td>
<td>594</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>230</td>
<td>325</td>
<td></td>
</tr>
<tr>
<td>Operative time (min)</td>
<td>270</td>
<td>330</td>
<td>0.34</td>
</tr>
<tr>
<td>Mean</td>
<td>270</td>
<td>330</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>270</td>
<td>330</td>
<td></td>
</tr>
</tbody>
</table>

RBC, red blood cell; PHBL, post hepatectomy biliary leak; PHH, post hepatectomy haemorrhage; PHILF, post hepatectomy liver failure.

Kobayashi K et al. Liver venous deprivation compared to portal vein embolization to induce hypertrophy of the future liver remnant before major hepcatectomy: a single center experience. Surgery 2020

Panaro F et al. Perioperative impact of liver venous deprivation compared to portal venous embolization in patients undergoing right hepatectomy: preliminary results from the pioneer center. Hepatobiliary surgery and nutrition 2019
Liver deprivation: updates
LVD: long-term outcomes

• Similar overall survival than after PVE
  - 12, 24 and 36 months OS about 95%, 81% and 81%

• Similar DFS than after PVE
  - 12, 24 and 36 months DFS about 66%, 44% and 33%

Kobayashi K et al. Liver venous deprivation compared to portal vein embolization to induce hypertrophy of the future liver remnant before major hepatectomy: a single center experience. Surgery 2020
Euro LVD Registry

- Patients' data collected **retrospectively** and **prospectively**

- **Secure web application**, in a REDCap® (Research Electronic Data Capture) database

- No personal detail will be recorded (**pseudoencryption**)

- Participating centers will have permission to **exclusively access their own data**

- **Wish to initiate a research project using all data**? Need to submit a request and upon approval anonymized data will be extracted

https://eurolvd.ch/