



# **Liver venous deprivation: CIO Miami 2021**

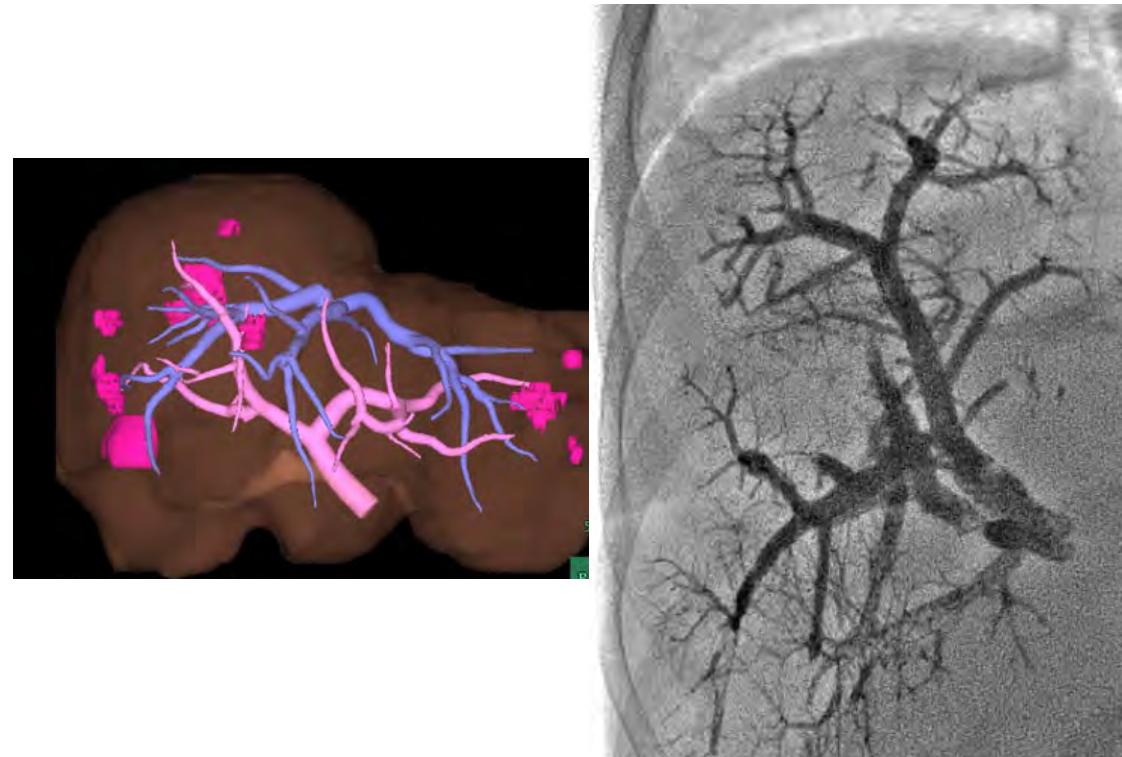
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# Liver deprivation: updates Portal vein embolization (PVE)

- **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 !**



Broedering DC et al. Portal vein embolization vs portal vein ligation for induction of hypertrophy of the future liver remnant. J Gastrointest Surg 2002

Hemming AW et al. Preoperative portal vein embolization for extended hepatectomy. Ann Surg 2003

Farges O et al. Portal vein embolization before right hepatectomy: prospective clinical trial. Ann Surg 2003

de Baere et al. Comparison of four embolic materials for portal vein embolization: experimental study in pigs. Eur Radiol 2009

# Liver deprivation: updates PVE: limitations

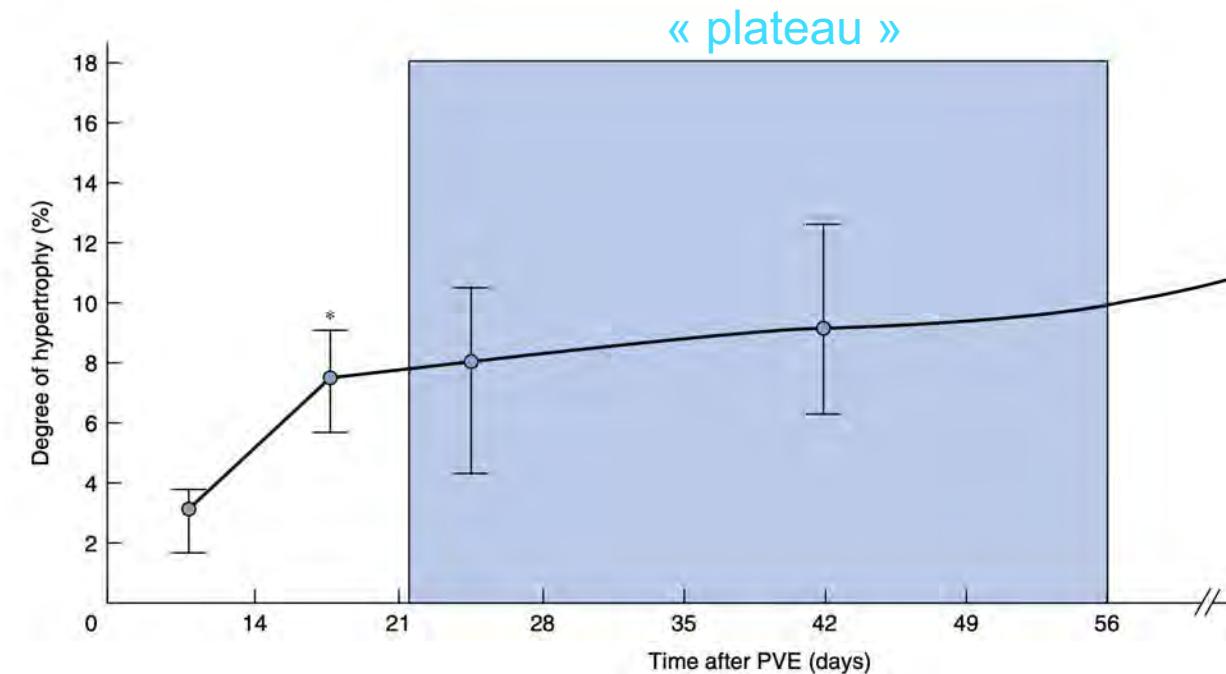
## Insufficient liver regeneration:

Meta-analysis (37 studies ; 1088 patients)

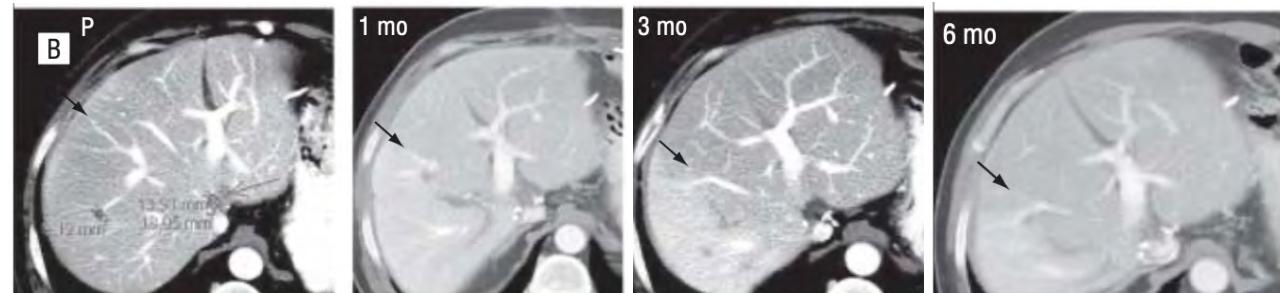
- Volume increase : 8-27%
- Non resection after PVE : 15%  
(50% tumor progression, 10% low hypertrophy)
- Post-operative transient liver insufficiency: 2.5%
- Death (acute liver failure): 0.8%

## 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.



Ribero D et al. Portal vein embolization before major hepatectomy and its effects on regeneration, resectability and outcome. Br J Surg. 2007



# Liver deprivation: updates

## Liver venous deprivation (LVD)

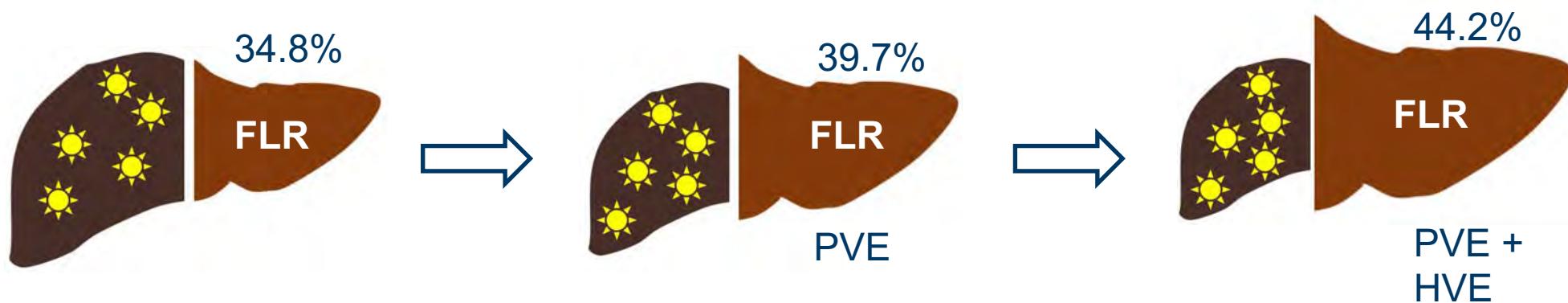
- First described in **2003** in a case report
- **LVD = portal vein embolization + hepatic vein(s) embolization**
- **Rationale for LVD:**
  - *Reducing residual hepatic inflow* (hepatic artery, residual portal vein inflow) without ischemia
  - *Pre-operative venous collateral development*: limit post-operative 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:

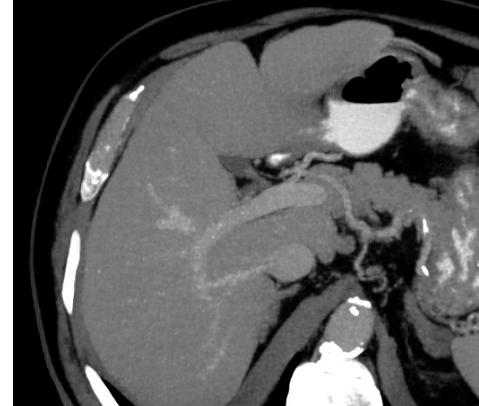
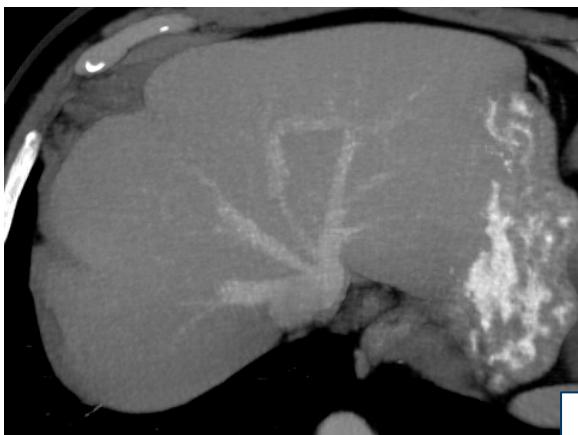


- **LVD : Ipsilateral hepatic vein embolization performed simultaneously to PVE (2016)**
  - Feasible, safe and effective

# Liver deprivation: updates

## Anatomy of Hepatic veins

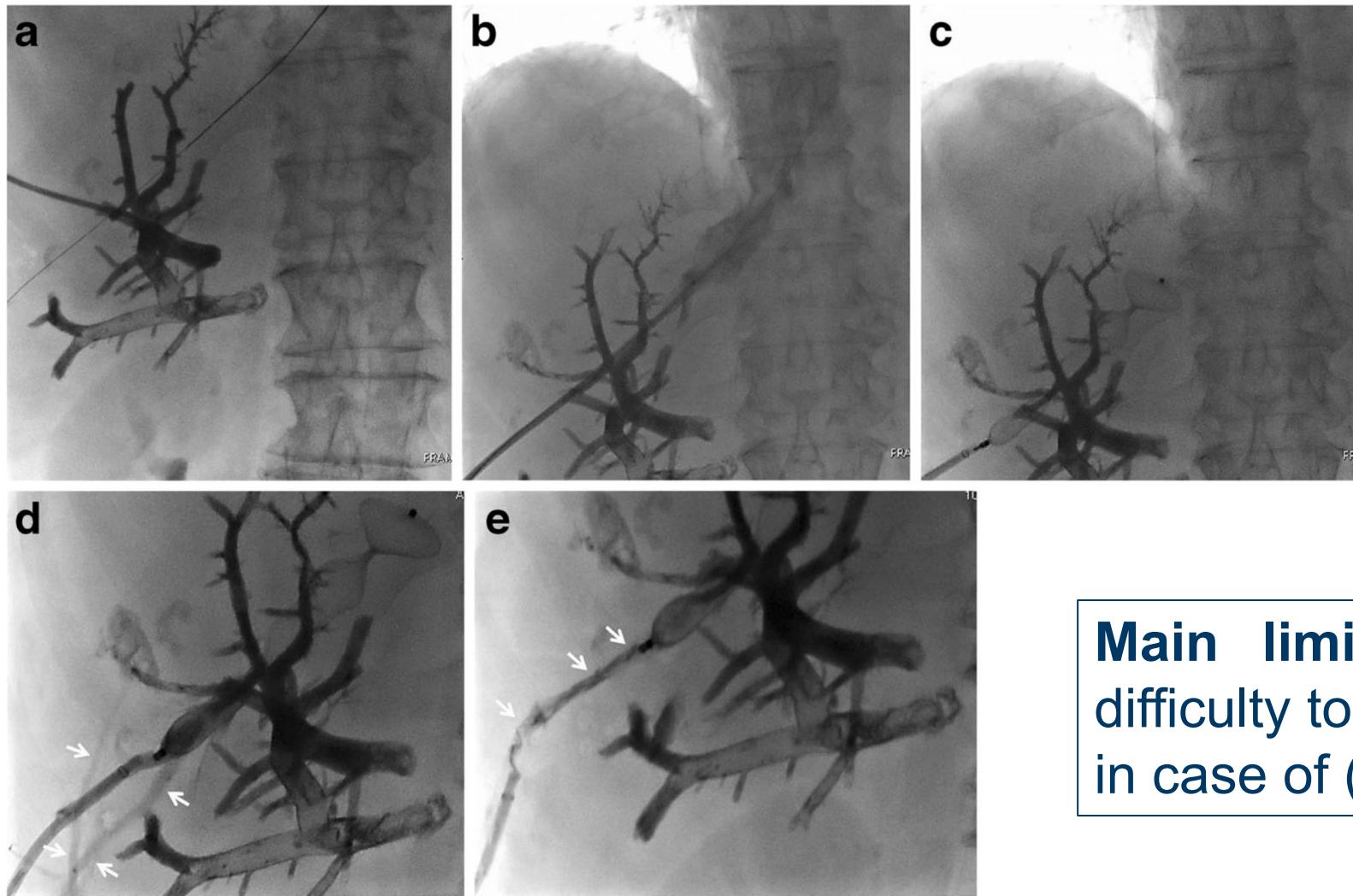
- **Modal anatomy :**
  - 3 hepatic veins : right (largest), middle and left
  - Common trunk between middle and left hepatic vein (60 to 95%)
- **Anatomic variants are frequent !**
- Accessory right inferior hepatic vein (37%) draining the right posterior-inferior sector



*Accessory inferior RHV*

| Description                                  | Number of patients (%)<br>N = 500 |
|--|-----------------------------------|
| RHV variations                               |                                   |
| Single RHV                                   | 458 (91.6)                        |
| Early branching of RHV                       | 201 (40.2)                        |
| 2 RHV: common trunk; independent drainage    | 27 (5.4); 9 (1.8)                 |
| Accessory inferior RHV                       | 185 (37)                          |
| Common trunk of MHV and LHV                  |                                   |
| Independent drainage of LHV and MHV into IVC | 95 (19)                           |
| 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



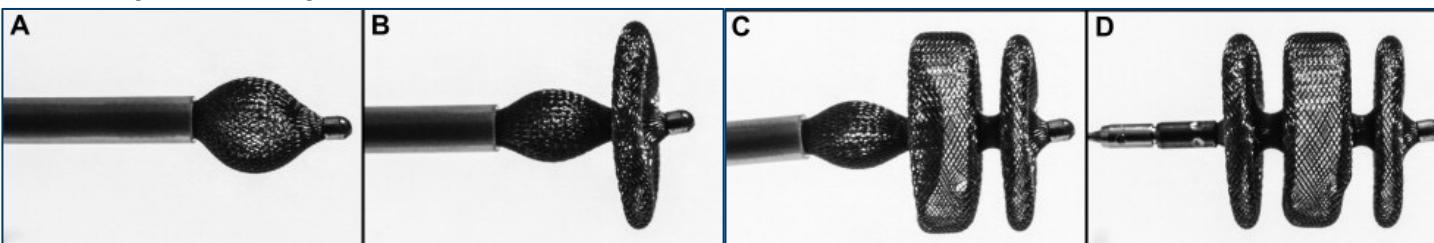
- a. Right PVE
- b. Right HV 7F access
- c. Amplatzer Vascular Plug II 18-22 mm is deployed 10 mm before the junction with the inferior vena cava
- d. Verification of right HV occlusion
- e. Embolization of the distal branches of the right HV(glue)
- f. During sheath removal, track embolization

**Main limitation of this approach :**  
difficulty to obtain complete HV occlusion  
in case of (frequent) anatomic variants.

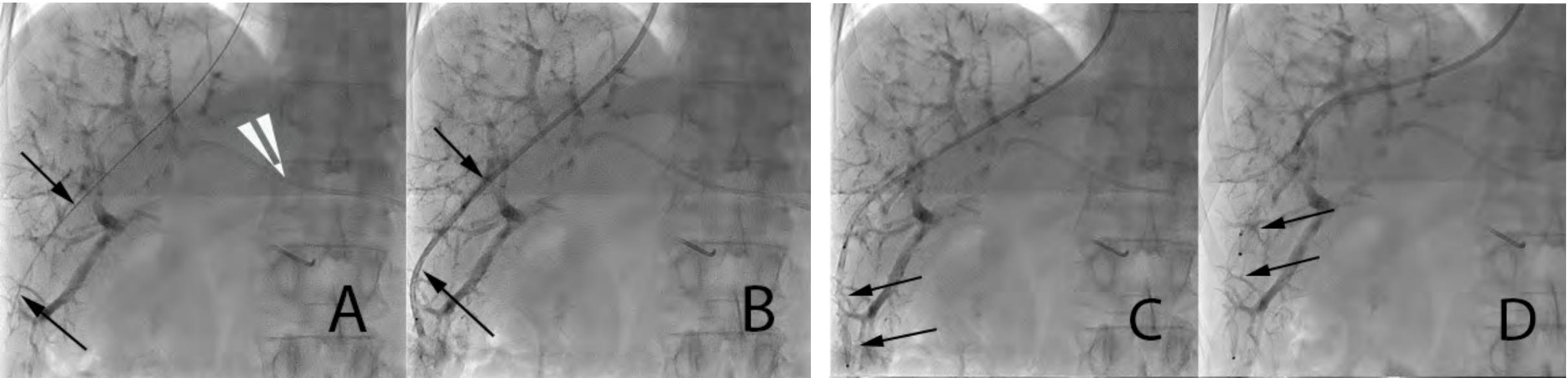
# Liver deprivation: updates LVD : transjugular approach

## 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

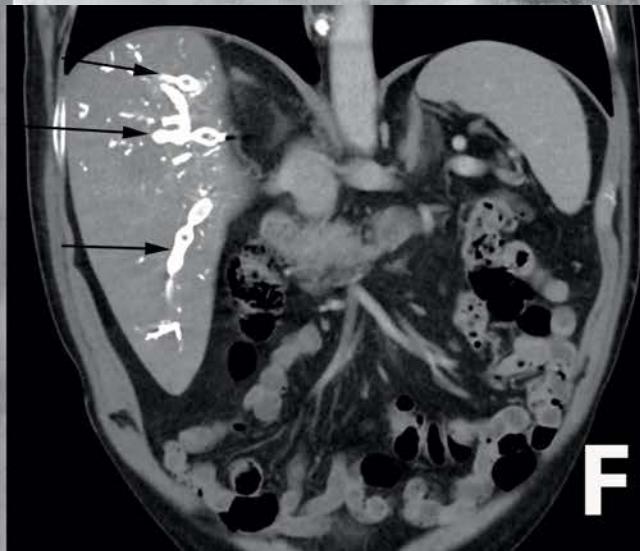
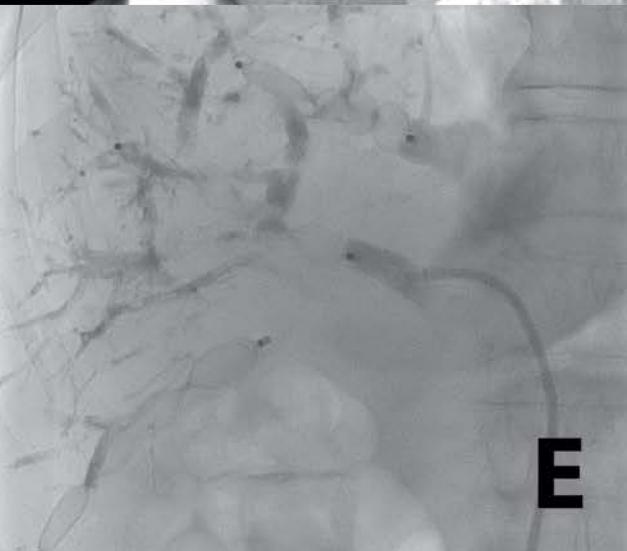
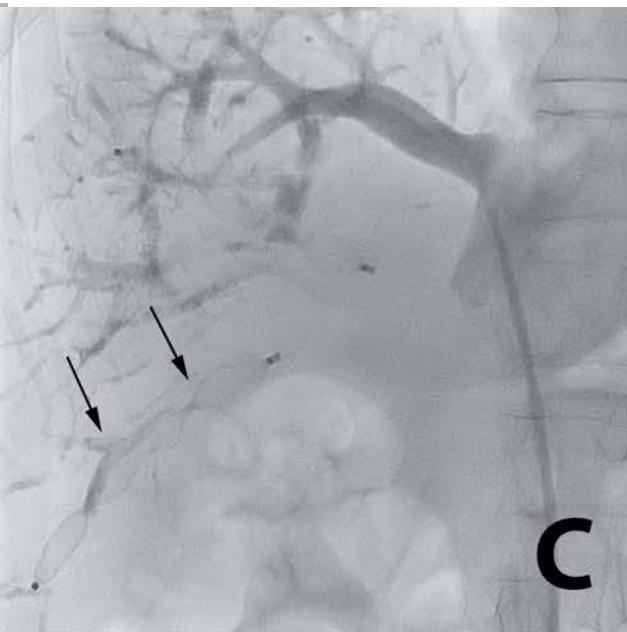
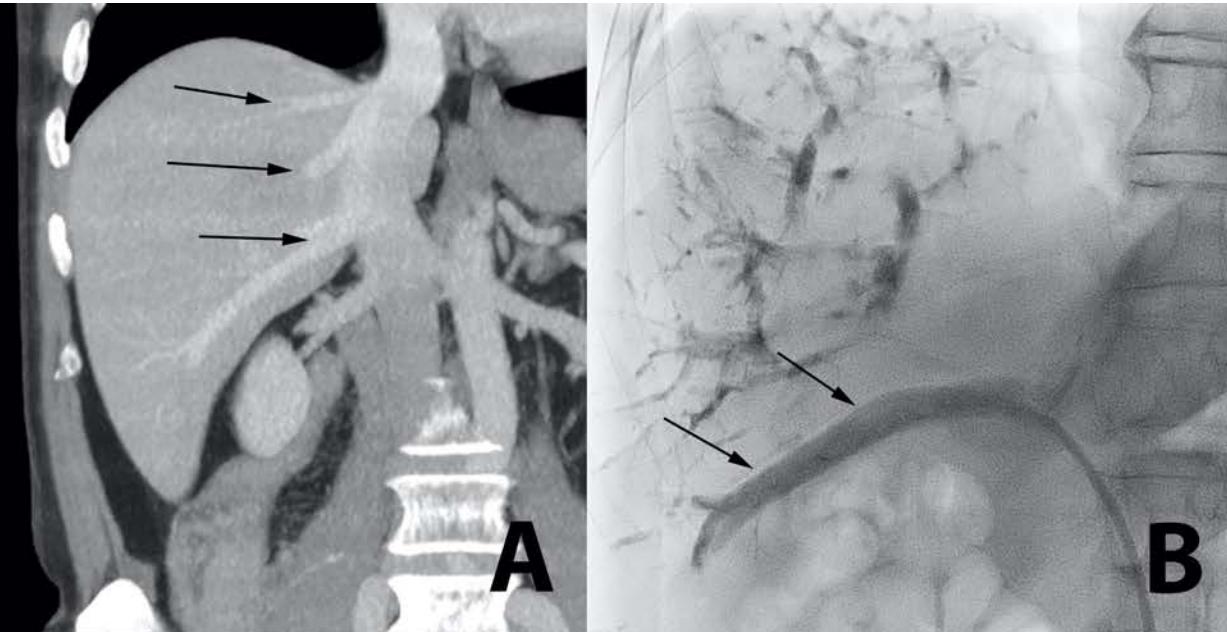


# Liver deprivation: updates LVD : transjugular approach – case 1



**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

+ : in favor of ...

- : in defavor of ...

|  | Percutaneous approach | Transjugular approach |
|--|-----------------------|-----------------------|
| <b>One access for all veins and branches</b>                               | -                     | + (mostly)            |
| <b>More thorough embolization</b>  |                       |                       |
| <b>Ultrasound limitations</b><br>(obesity, Chilaiditi, air after PVE, ...) | -                     | +                     |
| <b>Distal embolization</b>   | -                     | +                     |
| <b>Bleeding risk</b>   | -                     | +                     |
| <b>Tumor seeding</b>   | -                     | +                     |
| <b>Risk of median HV embolization</b>                                      | +                     | - (US/CT)             |
| <b>Difficult catheterism</b>   | +                     | - (femoral/jugular)   |



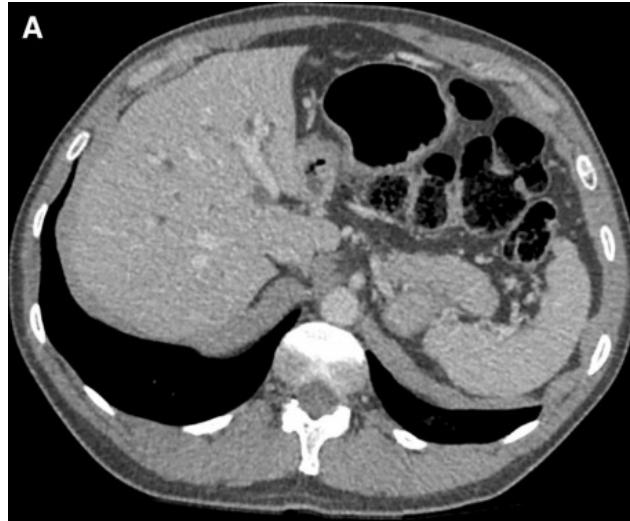
# Liver deprivation: updates LVD : liver volumetric changes

- **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%



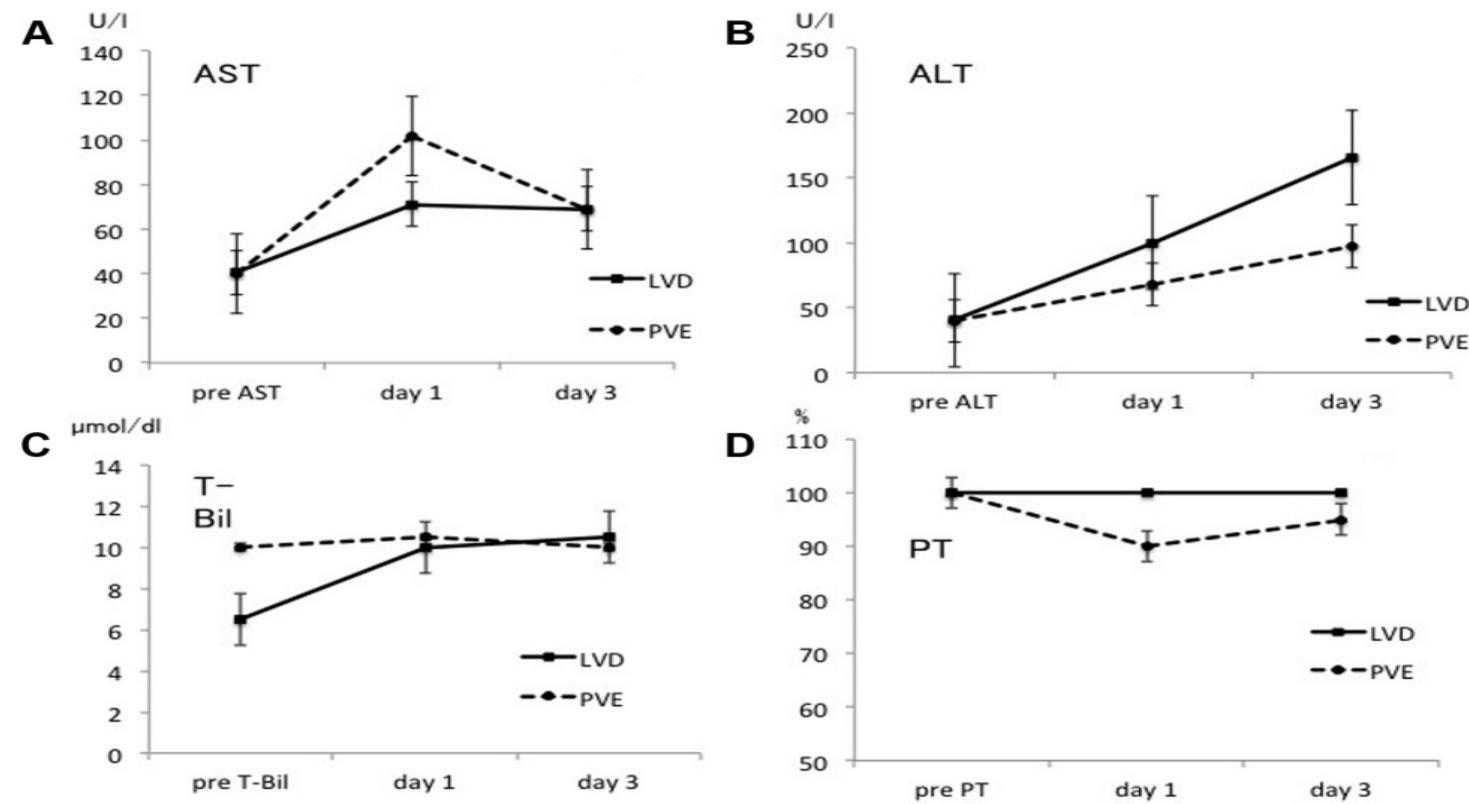
Hocquelet A et al. Preoperative portal vein embolization alone with biliary drainage compared to a combination of simultaneous portal vein, right hepatic vein embolization and biliary drainage in Klatskin tumor. CVIR 2018

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

Guu B et al. Simultaneous trans-hepatic portal and hepatic vein embolization before major hepatectomy: the liver venous deprivation technique. Eur Radiol 2016

# 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

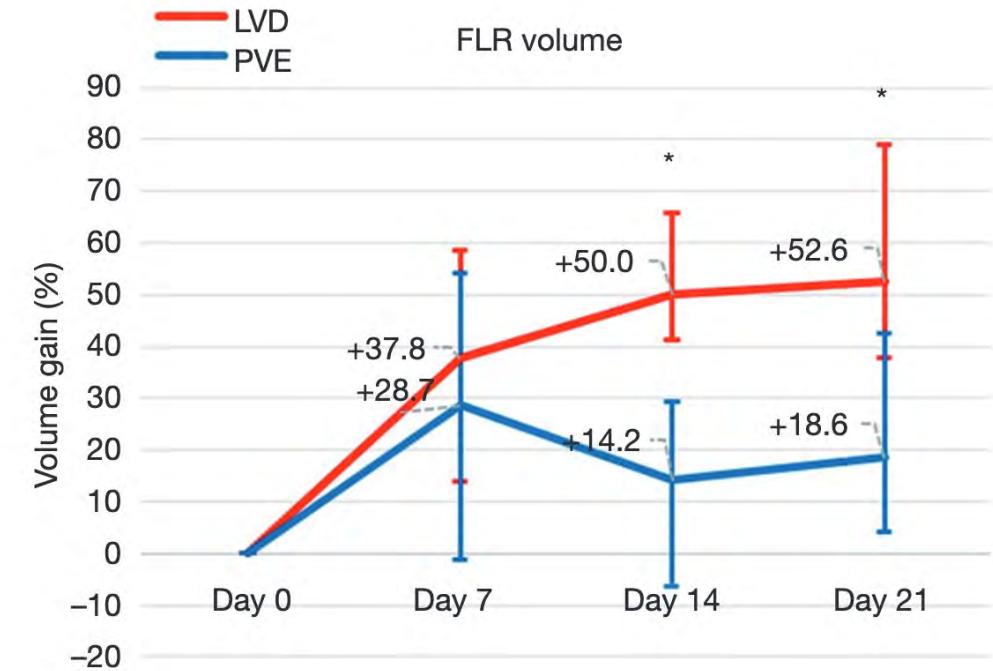
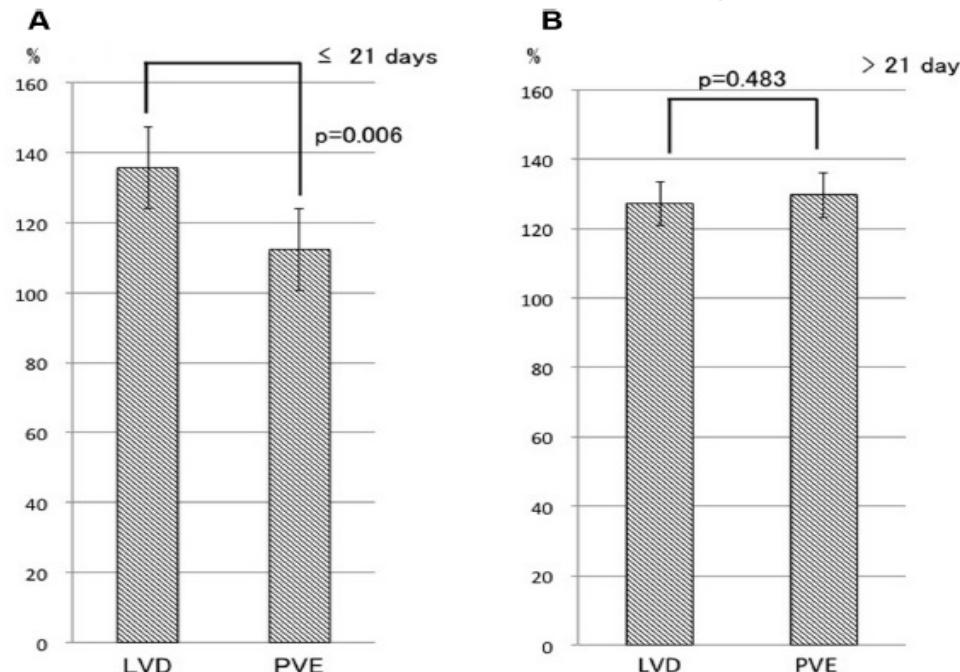


# Liver deprivation: updates

## LVD : FLR hypertrophy

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

Volumetric FLR changes



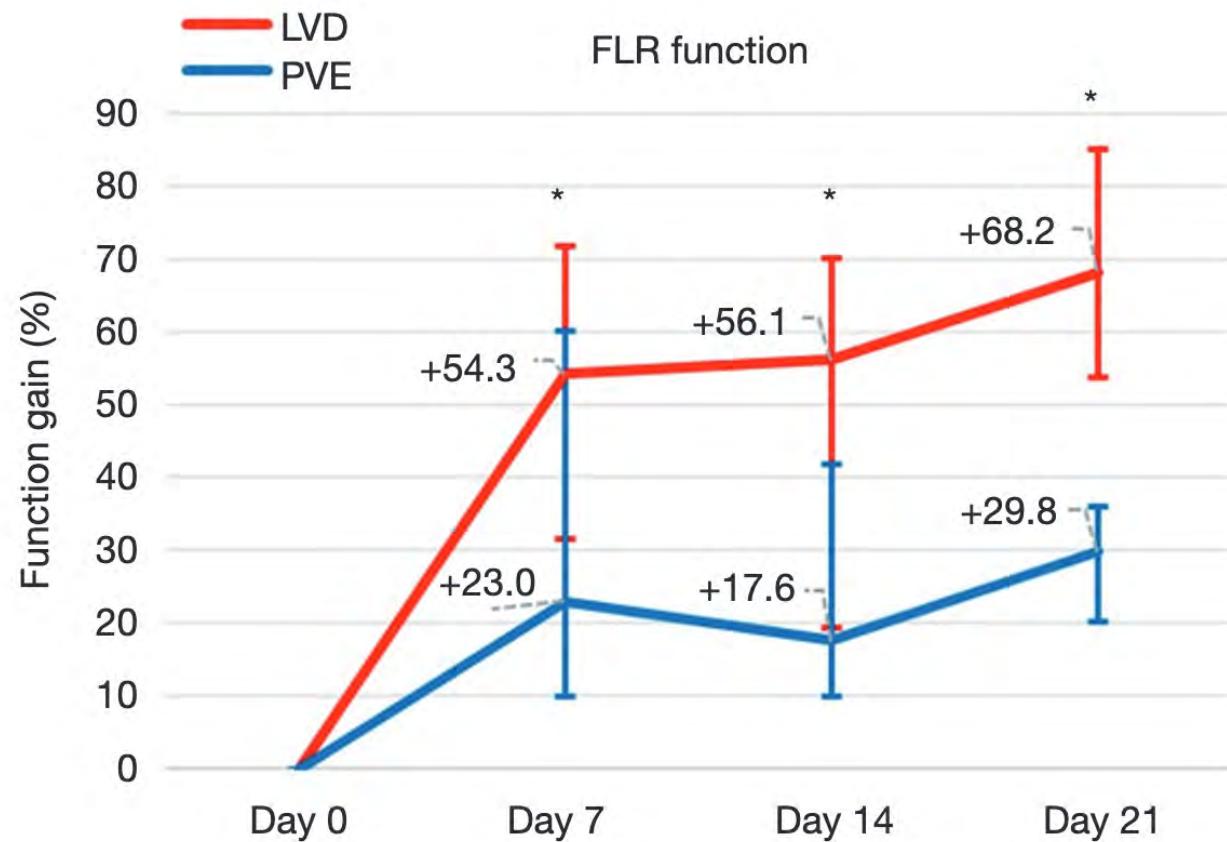
Kobayashi K et al. Liver venous deprivation compared to portal vein embolization to induce hypertrophy of the future liver remnant before major hepatectomy: a single center experience. *Surgery* 2020

Guia 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  $\geq$  IIIb in 27% of patients



# Liver deprivation: updates LVD: peroperative impact

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

**Table II**  
Intra and postoperative outcome

| Variables                                  | LVD (n = 20)    | PVE (n = 30)     | P value |
|--|-----------------|------------------|---------|
| <b>Intraoperative outcomes</b>             |                 |                  |         |
| Days between embolization and operation, d | 35 (23–109)     | 35 (20–181)      | .684    |
| Right hepatectomy                          | 9 (45.0%)       | 19 (63.3%)       | .205    |
| Extended right hepatectomy                 | 11 (55.0%)      | 11 (36.7%)       | .205    |
| Operative time, min                        | 363 (274–577)   | 344 (210–554)    | .235    |
| Estimated blood loss, mL                   | 850 (600–2,500) | 1000 (200–2,600) | .662    |
| Pringle maneuver                           | 19 (95%)        | 29 (97%)         | .414    |
| <b>Postoperative morbidity</b>             |                 |                  |         |
| Morbidity                                  | 11 (56%)        | 15 (50%)         | .731    |
| Clavien-Dindo classification I or II       | 4 (20%)         | 6 (20%)          | >.999   |
| Clavien-Dindo classification > III         | 7 (35%)         | 11 (30%)         | .713    |
| Comprehensive complication index           | 10.5 (0–65.6)   | 4.4 (0–57)       | .592    |
| Mortality                                  | 0               | 0                |         |
| Postoperative duration of stay, d          | 13 (6–57)       | 11 (5–69)        | .271    |

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

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

| Variable                                    | Portal vein embolization, n (%) | Liver venous deprivation, n (%) | P    |
|---|---------------------------------|---------------------------------|------|
| Pedicle clamping                            |                                 |                                 | 0.69 |
| No  | 10 (66.7)                       | 10 (76.9)                       |      |
| Yes   | 5 (33.3)                        | 3 (23.1)                        |      |
| Intraoperative RBC                          |                                 |                                 | 0.78 |
| No  | 10 (66.7)                       | 8 (61.5)                        |      |
| Yes   | 5 (33.3)                        | 5 (38.5)                        |      |
| Postoperative complications (Clavien-Dindo) |                                 |                                 |      |
| No  | 8 (53.3)                        | 3 (23.1)                        |      |
| Yes   | 7 (46.7)                        | 10 (76.9)                       | 0.1  |
| CD ≥ IIIa                                   | 3 (20)                          | 1 (7.7)                         | 0.6  |
| PHBL  | 2 (13.3)                        | 1 (7.7)                         | 1    |
| Grade A                                     | 1                               | 1                               |      |
| Grade B                                     | 1                               | 0                               |      |
| Grade C                                     | 0                               | 0                               |      |
| PHH   | 2 (13.3)                        | 5 (38.5)                        | 0.2  |
| Grade A                                     | 1                               | 2                               |      |
| Grade B                                     | 0                               | 3                               |      |
| Grade C                                     | 1                               | 0                               |      |
| PHLF  | 2 (13.3)                        | 3 (23.1)                        | 0.64 |
| Grade A                                     | 0                               | 0                               |      |
| Grade B                                     | 1                               | 2                               |      |
| Grade C                                     | 1                               | 1                               |      |

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

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

| Variable                     | Portal vein embolization | Liver venous deprivation | P    |
|------------------------------|--------------------------|--------------------------|------|
| Time to surgery (days)       |                          |                          | 0.86 |
| Mean                         | 45                       | 46                       |      |
| Median                       | 37                       | 38                       |      |
| Pedicle clamping (min)       |                          |                          | 0.26 |
| Mean                         | 18                       | 27                       |      |
| Median                       | 15                       | 30                       |      |
| Intraoperative bleeding (mL) |                          |                          | 0.36 |
| Mean                         | 783                      | 1,089                    |      |
| Median                       | 550                      | 1,200                    |      |
| Intraoperative FVA (mL)      |                          |                          | 0.96 |
| Mean                         | 4,142                    | 4,180                    |      |
| Median                       | 4,250                    | 4,000                    |      |
| Intraoperative RBC (mL)      |                          |                          | 0.42 |
| Mean                         | 763                      | 656                      |      |
| Median                       | 622                      | 594                      |      |
| Operative time (min)         |                          |                          | 0.34 |
| Mean                         | 290                      | 325                      |      |
| Median                       | 270                      | 330                      |      |

FVA, fluid volume administration; RBC, red blood cell.

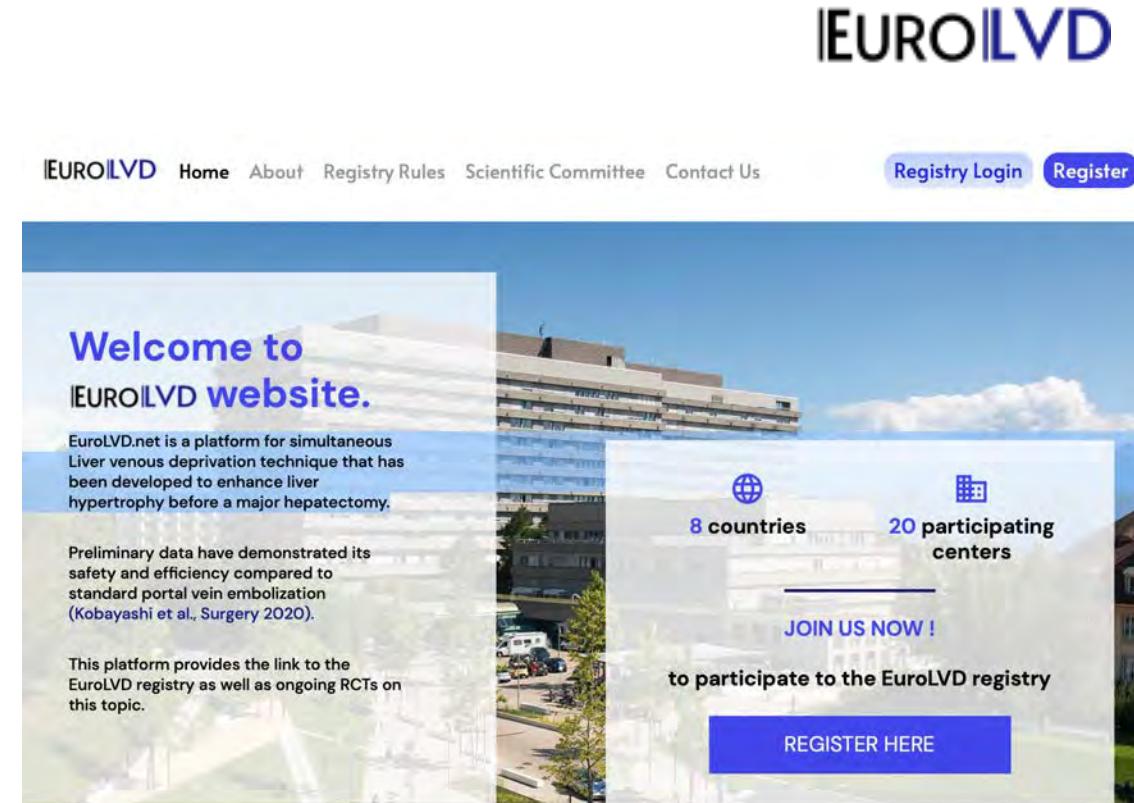
# Liver deprivation: updates LVD: long-term outcomes

- **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%



# 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/>