

The background of the slide is a blue-toned medical scan, likely a CT scan of a human torso, showing internal organs and structures. A semi-transparent white rectangle is overlaid on the right side of the image, containing the title, authors, and affiliation.

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

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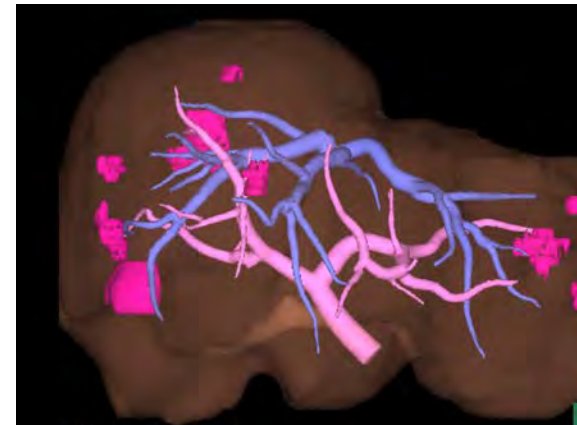
Interventional Radiology, CHUV (Lausanne)



# 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

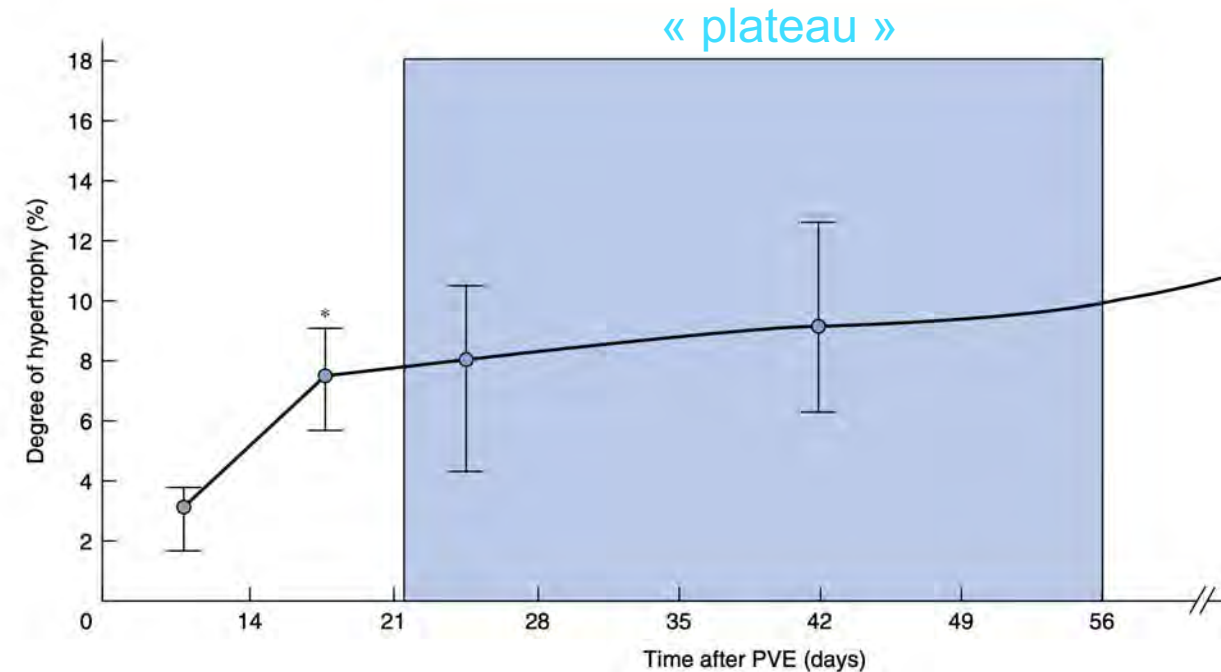
### Insufficient liver regeneration:

*Meta-analysis (37 studies ; 1088 patients)*

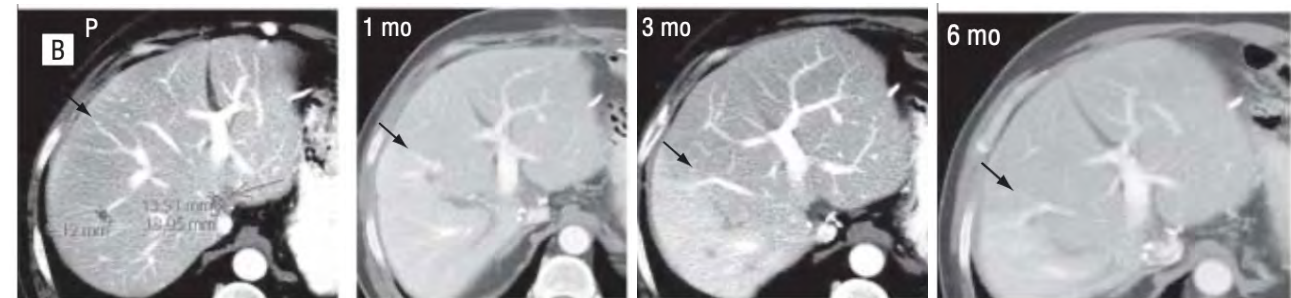
- Volume increase : 8-27%
- Non resection after PVE : 15%  
(50% tumor progression, 10% low hypertrophy)
- Post-operative transient liver insufficiency: 2.5%
- Death (acute liver failure): 0.8%

### 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.



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)

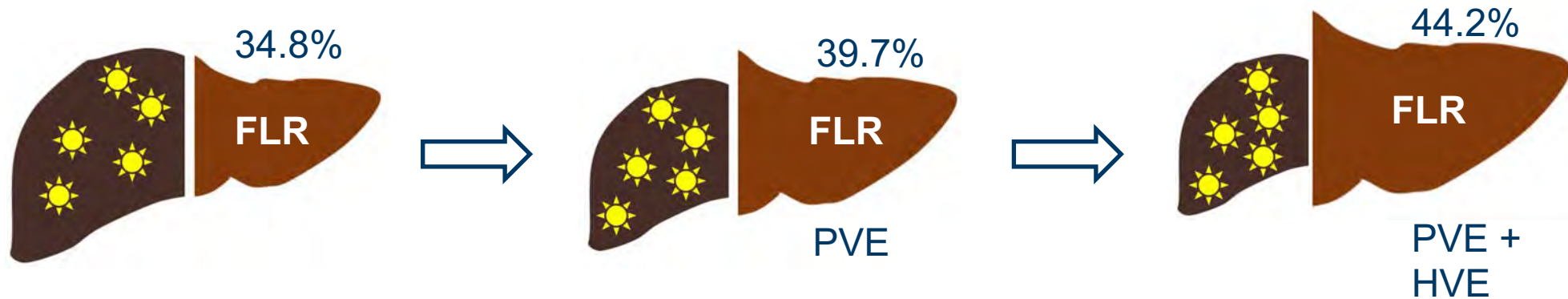
- First described in **2003** in a case report
- **LVD = portal vein embolization + hepatic vein(s) embolization**
- **Rationale for LVD:**
  - *Reducing residual hepatic inflow* (hepatic artery, residual portal vein inflow) without ischemia
  - *Pre-operative venous collateral development*: limit post-operative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

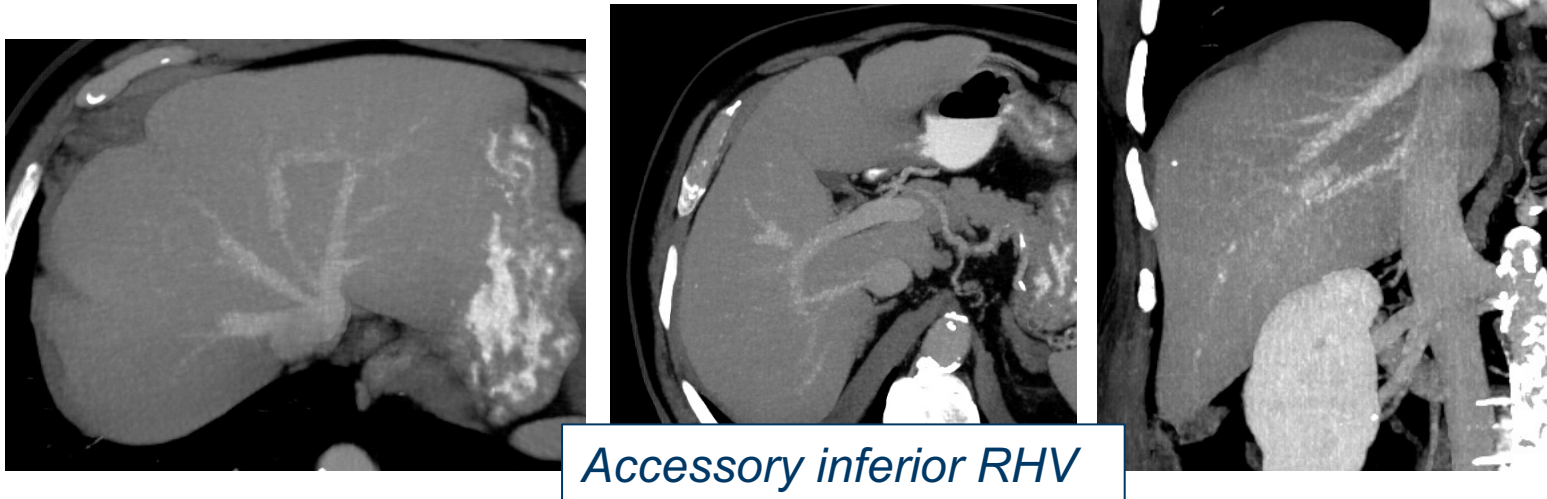


- **LVD : Ipsilateral hepatic vein embolization performed simultaneously to PVE (2016)**
  - Feasible, safe and effective

# 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

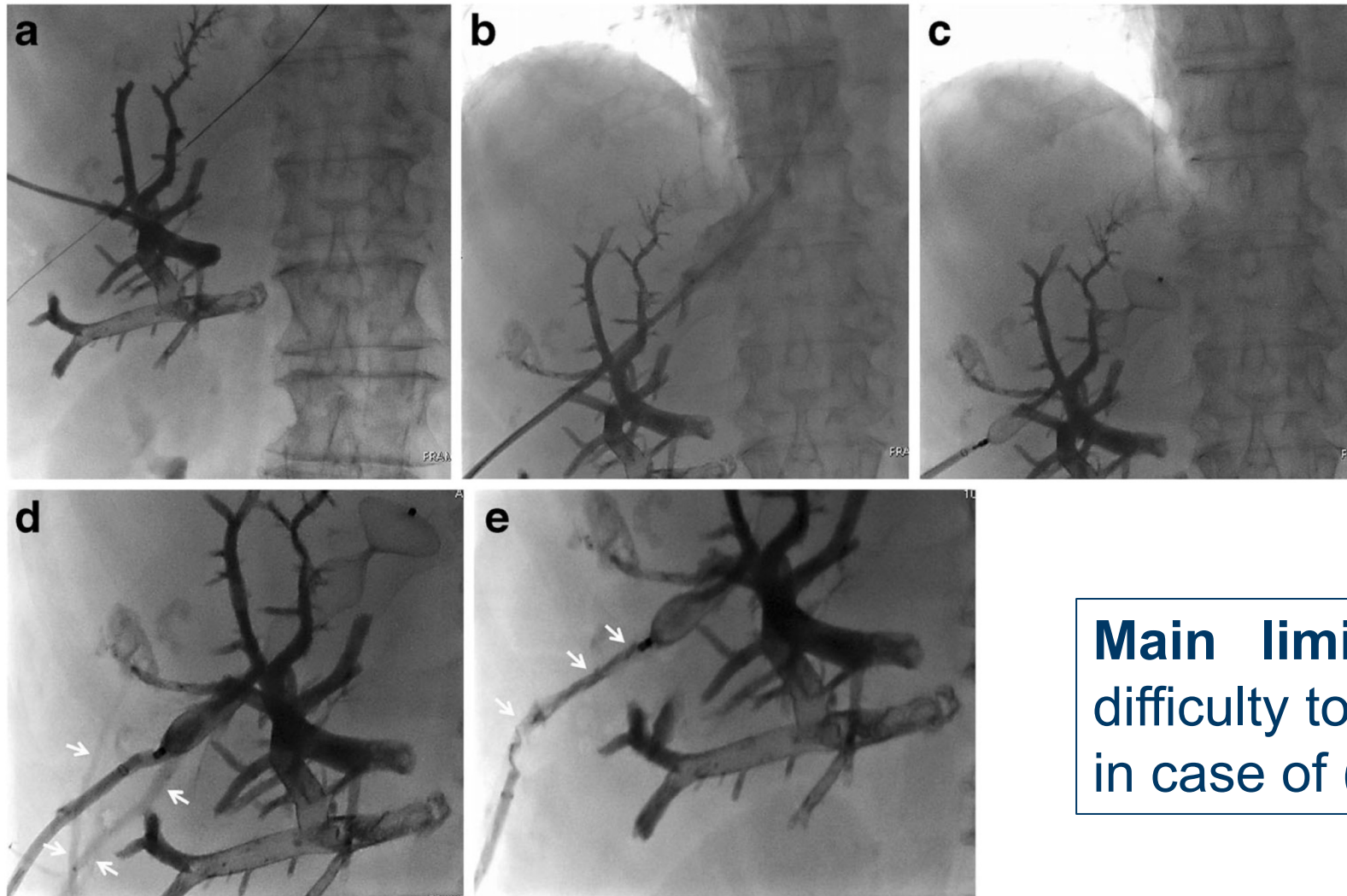


Description	Number of patients (%) N = 500
RHV variations	
Single RHV	458 (91.6)
Early branching of RHV	201 (40.2)
2 RHV: common trunk; independent drainage	27 (5.4); 9 (1.8)
Accessory inferior RHV	185 (37)
Common trunk of MHV and LHV	
Independent drainage of LHV and MHV into IVC	405 (81) 95 (19)
Segmental 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

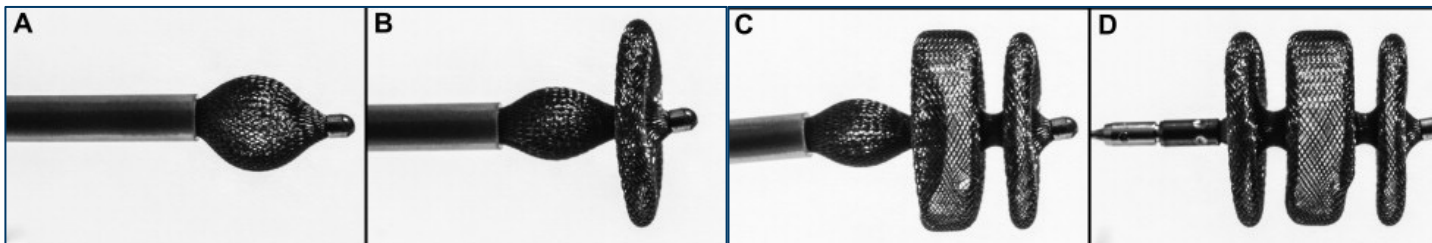
**Main limitation of this approach :**  
difficulty to obtain complete HV occlusion  
in case of (frequent) anatomic variants.

# Liver deprivation: updates

## LVD : transjugular approach

### Technique :

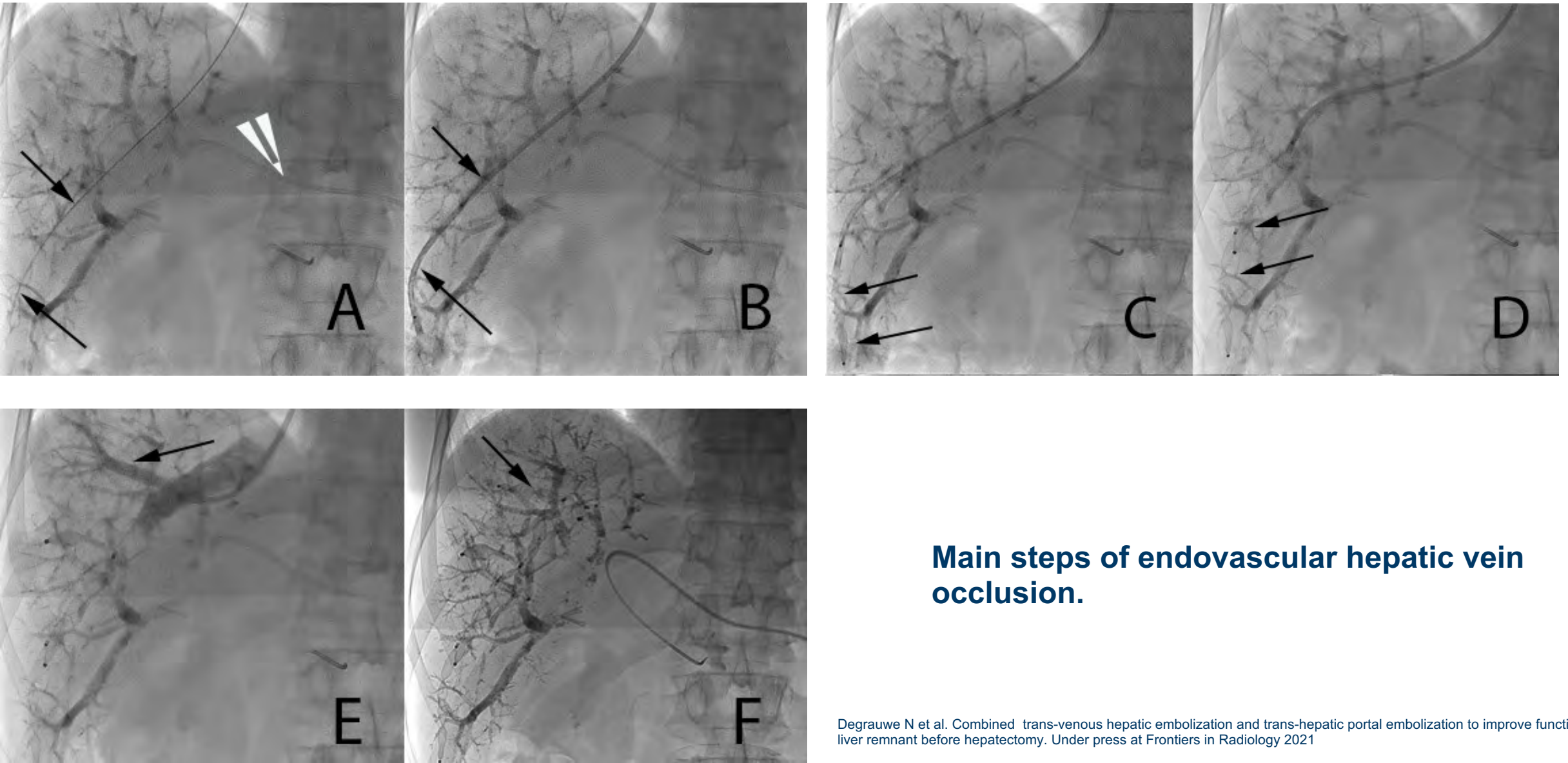
1. **Internal jugular vein access** (Seldinger) : 9F 65 cm sheath (+/-angulated)
2. With the sheath or with a MPA2 catheter, **catheterism of the targeted hepatic vein**
3. Advance of the sheath **as distal as possible**
4. Check with **contrast medium injection**
5. Insert and release **plugs** (Amplatzer 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

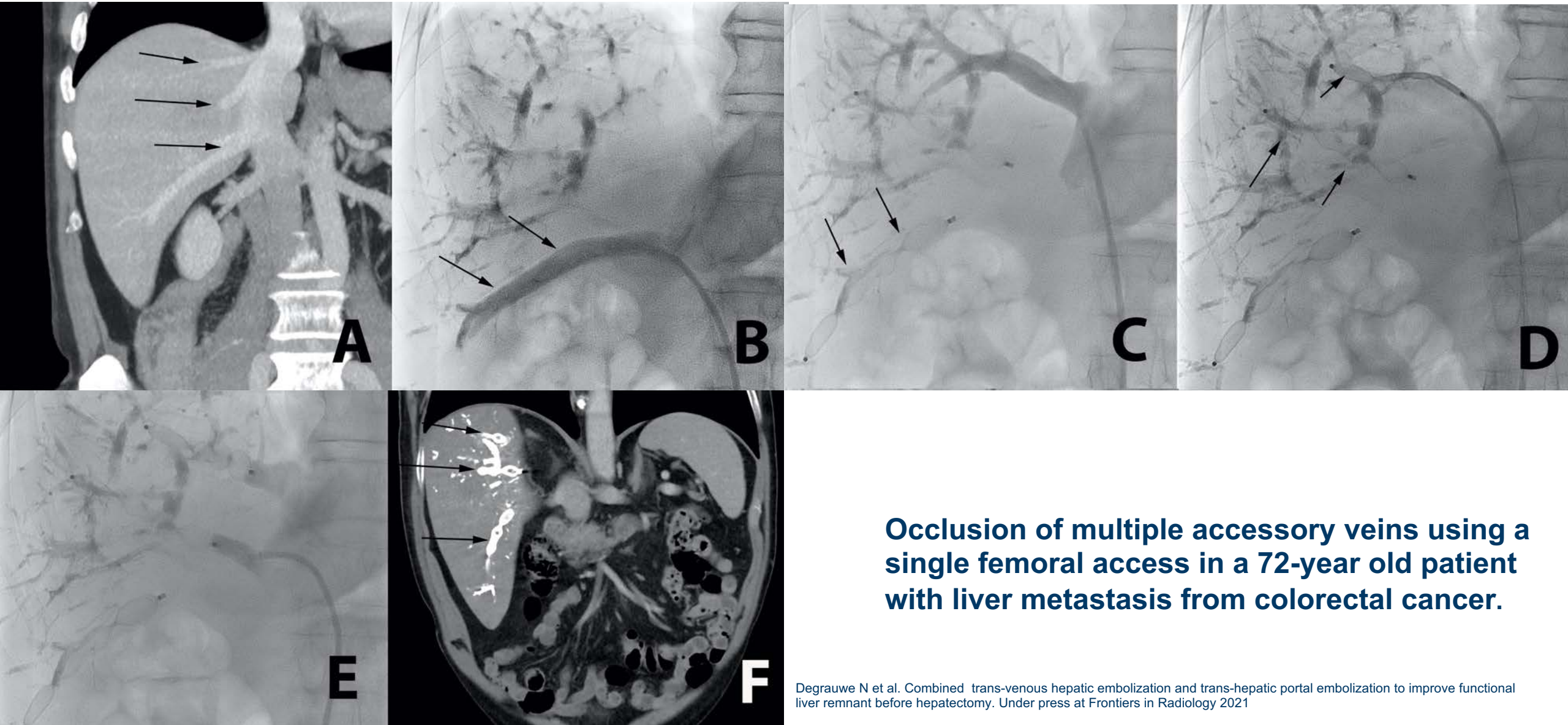
## **LVD : transjugular approach – case 1**



**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 linked to the plug and use it as a pusher !





# Liver deprivation: updates

## LVD : transjugular versus percutaneous

+ : in favor of ...  
- : in defavor of ...

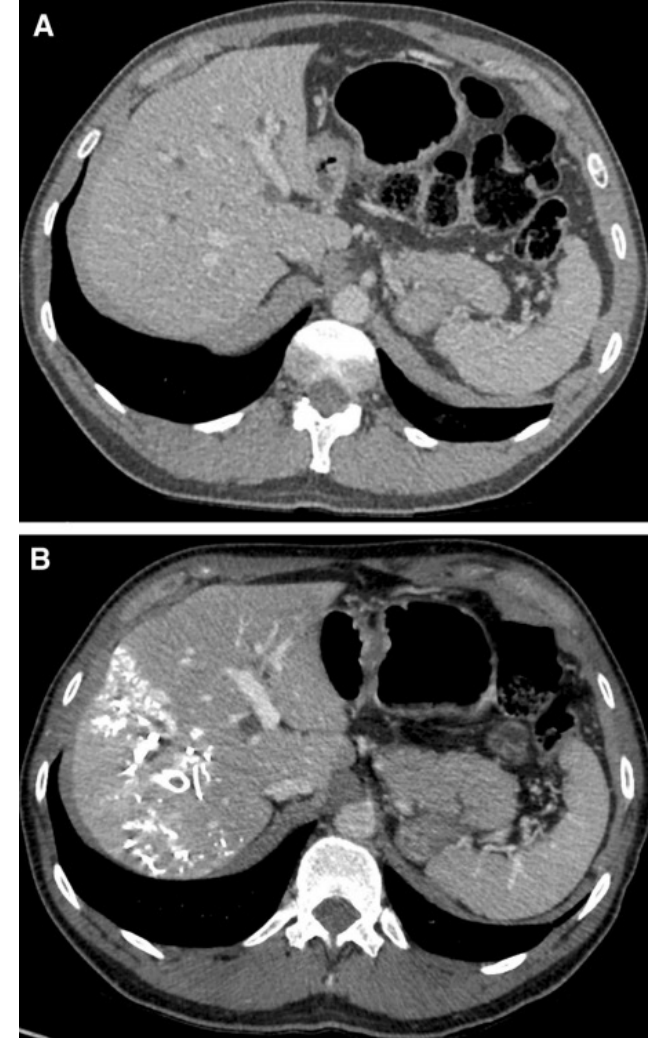
	Percutaneous approach	Transjugular approach
One access for all veins and branches More thorough embolization	-	+ (mostly)
Ultrasound limitations (obesity, Chilaiditi, air after PVE, ...)	-	+
Distal embolization	-	+
Bleeding risk	-	+
Tumor seeding	-	+
Risk of median HV embolization	+	- (US/CT)
Difficult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

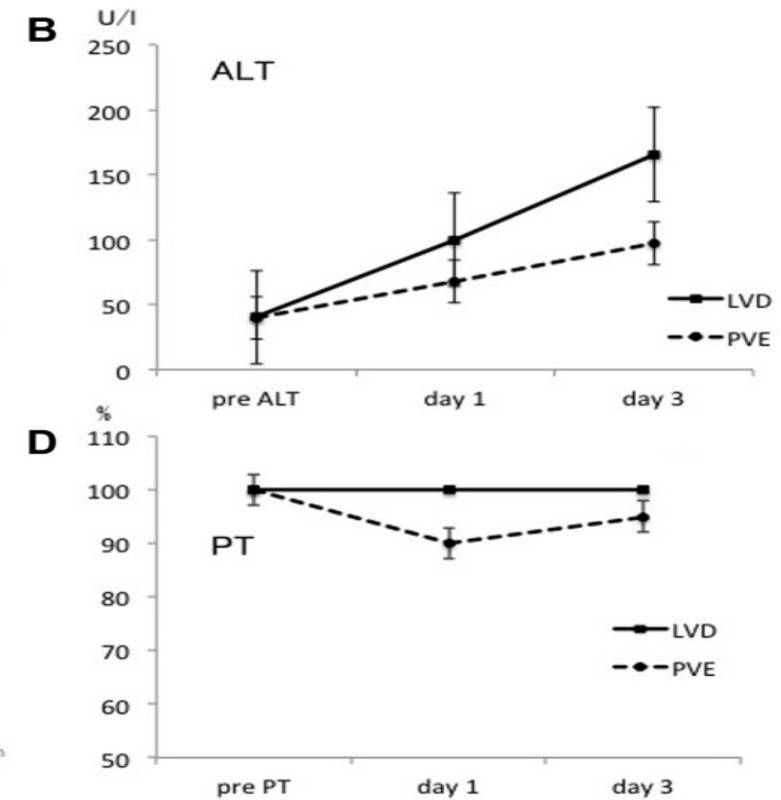
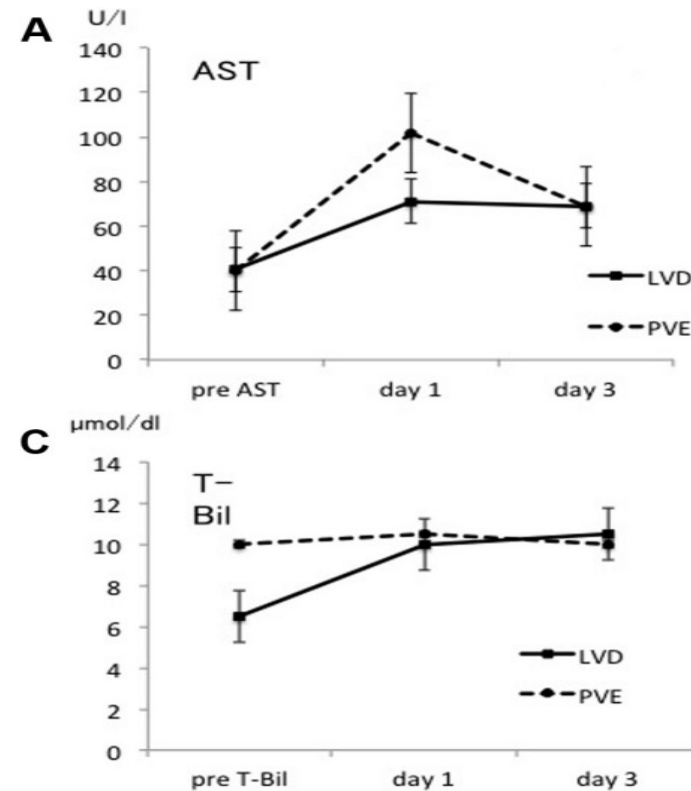
Kobayashi K et al. Liver venous deprivation compared to portal vein embolization to induce hypertrophy of the future liver remnant before major hepatectomy: a single center experience. Surgery 2020

Guiu 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 cytotoxicity** during the first week
- **No** cholestasis or liver failure
  - Total bilirubin stable or moderately reduced
  - PT stable or moderately increased



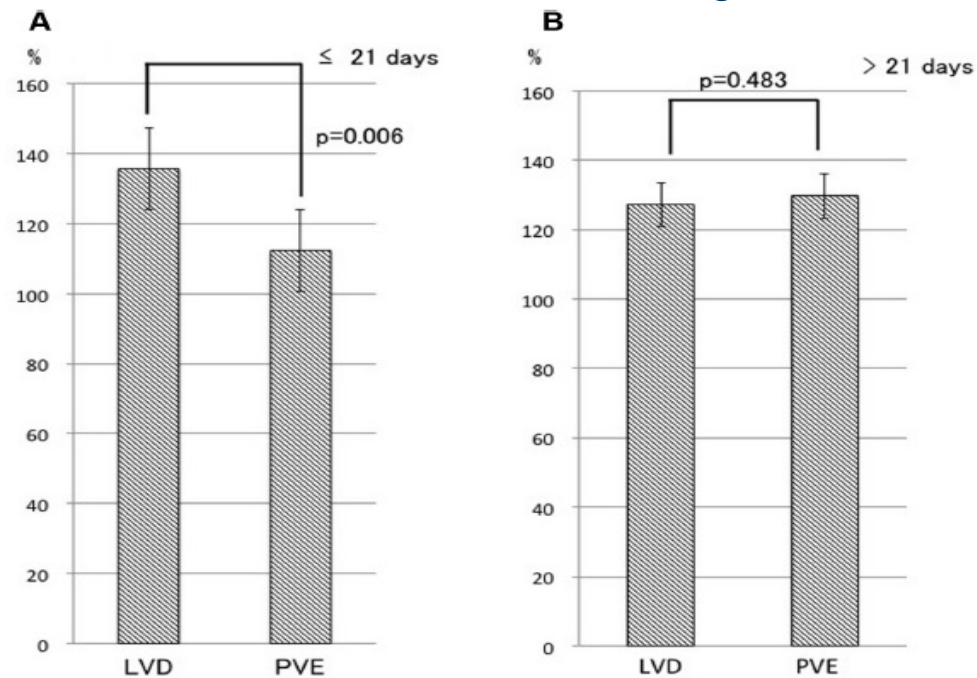


# Liver deprivation: updates

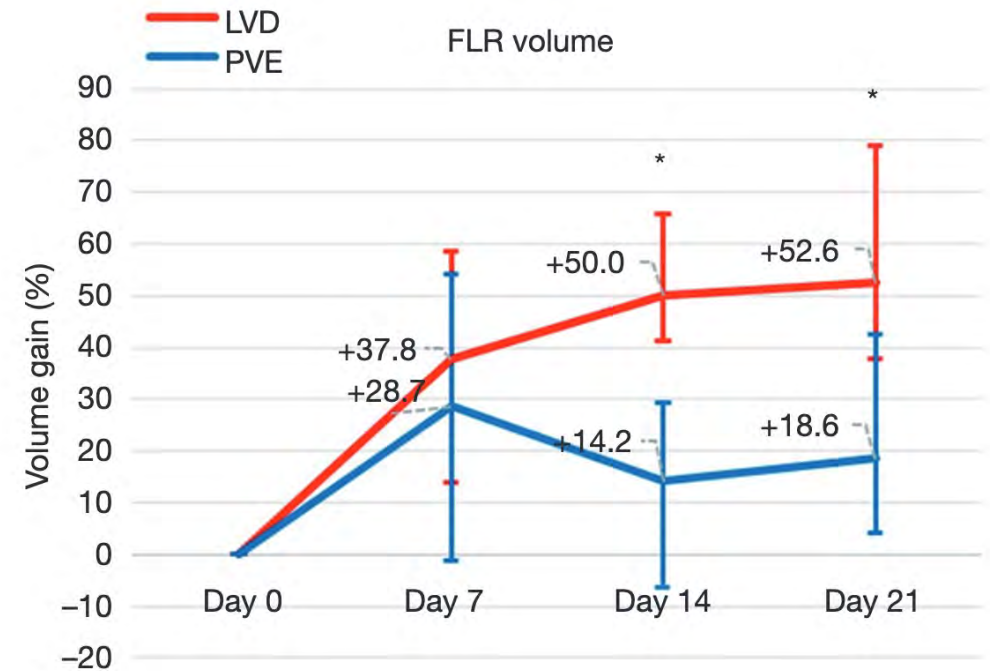
## LVD : FLR hypertrophy

- **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

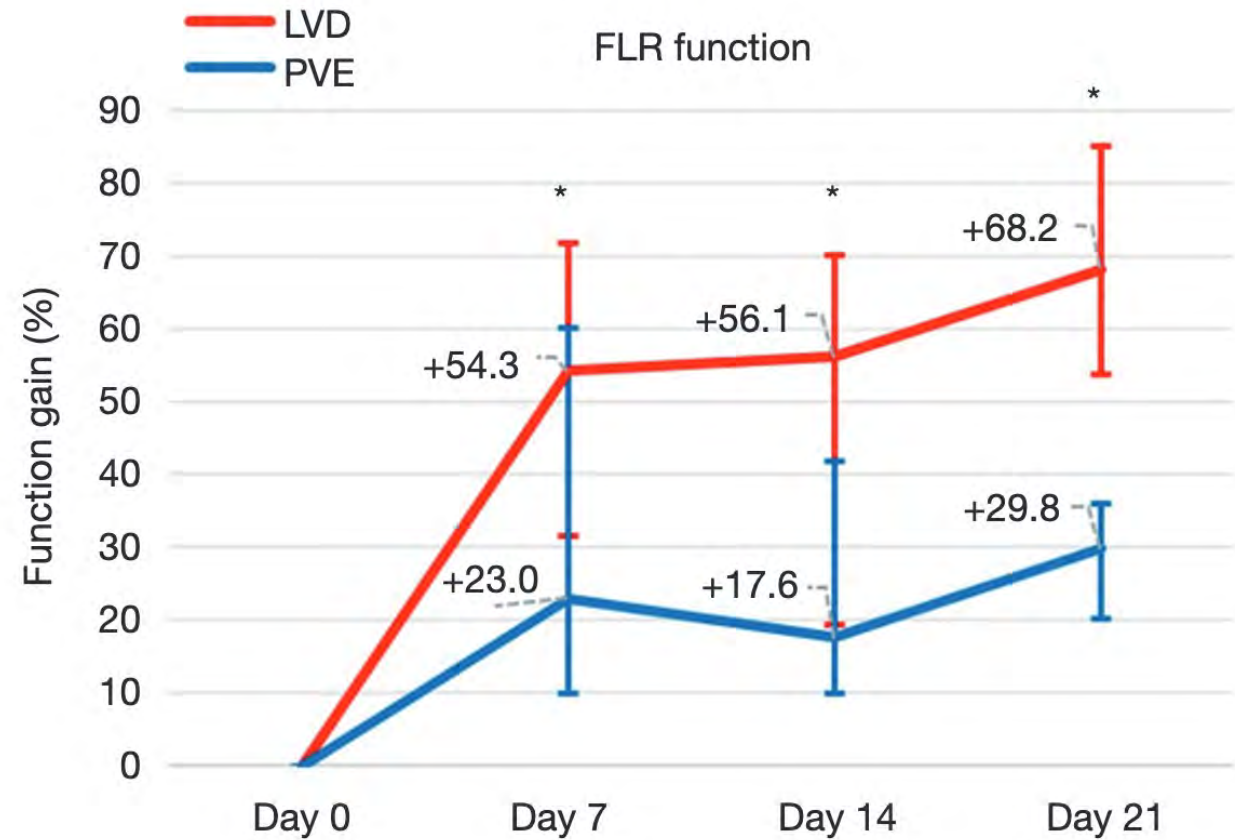


Guiu B et al. Liver venous deprivation versus portal vein embolization before major hepatectomy: future liver remnant volumetric and functional changes. Hepatobiliary surgery and nutrition 2020

# 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  $\geq$  IIIb in 27% of patients



# Liver deprivation: updates

## LVD: perioperative 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

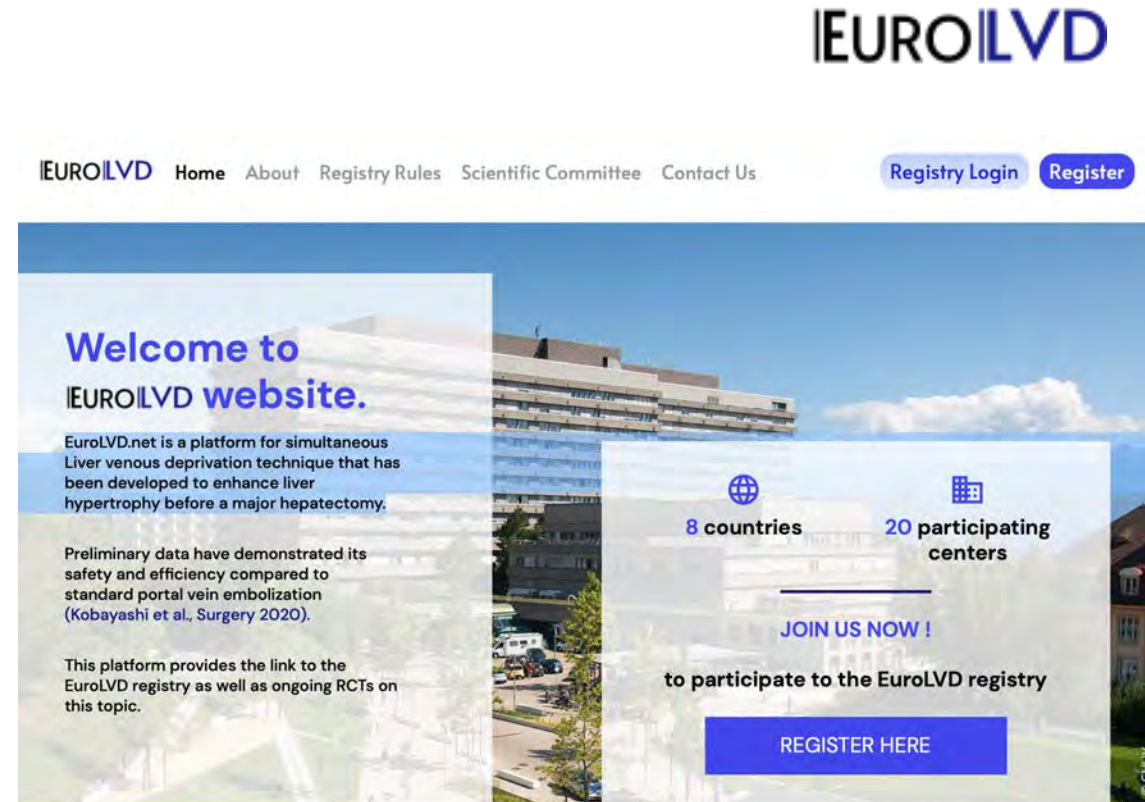
## LVD: long-term outcomes

- **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/>