

ISLS 2023

ZURICH

5TH CONGRESS OF INTERNATIONAL
ADVANCED HBP SURGERY

October 18 (Wed) - 21 (Sat), 2023
Zurich, Switzerland



The Magic of ALPPS



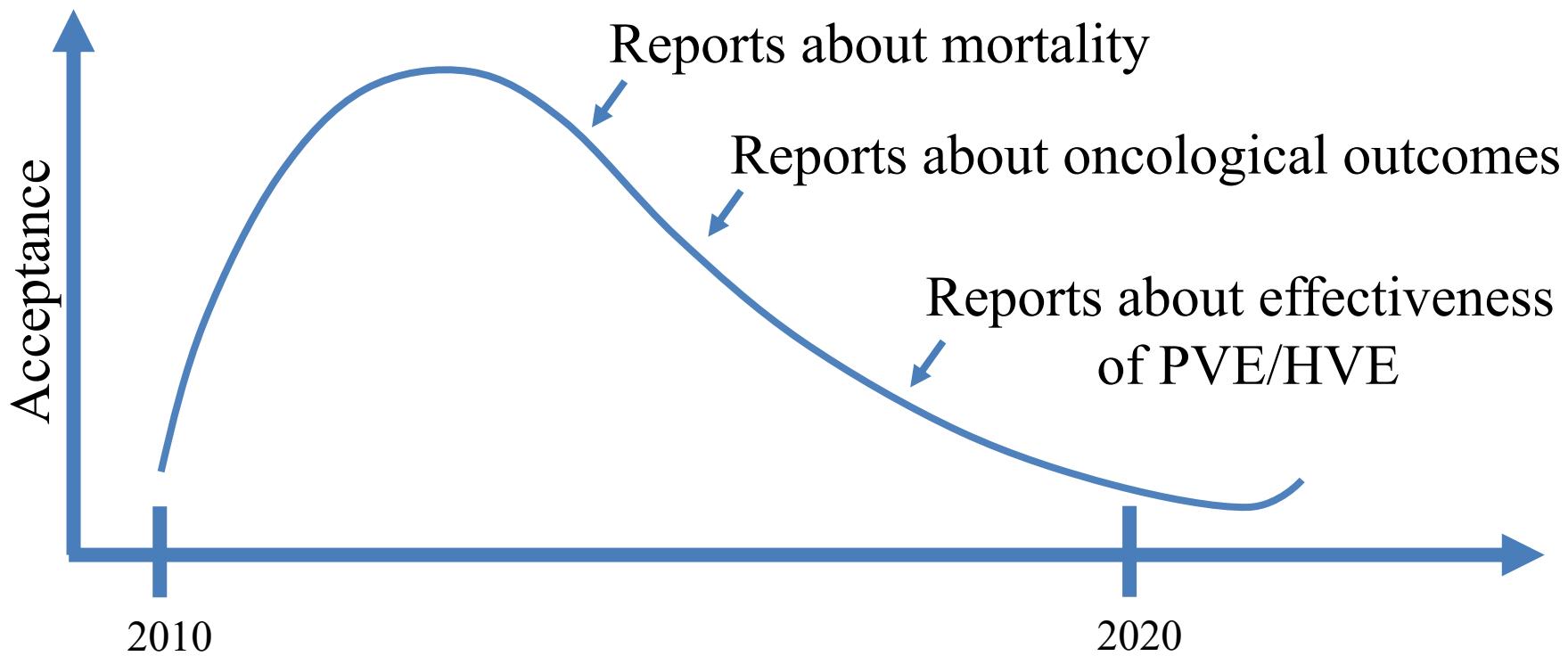
Orlando Jorge M. Torres MD, PhD

Full Professor and Chairman

Hepatopancreatobiliary Unit

Universidade Federal do Maranhão - Brazil

Development / Acceptance of ALPPS



Portal Vein Embolisation

Influence

Begin of ALPPS

➤ Ann Surg. 2012 Mar;255(3):405-14. doi: 10.1097/SLA.0b013e31824856f5.

Right portal vein ligation combined with in situ splitting induces rapid left lateral liver lobe hypertrophy enabling 2-staged extended right hepatic resection in small-for-size settings

Andreas A Schnitzbauer¹, Sven A Lang, Holger Goessmann, Silvio Nadalin, Janine Baumgart, Stefan A Farkas, Stefan Fichtner-Feigl, Thomas Lorf, Armin Goralcyk, Rüdiger Hörbelt, Alexander Kroemer, Martin Loss, Petra Rümmele, Marcus N Scherer, Winfried Padberg, Alfred Königsrainer, Hauke Lang, Aiman Obed, Hans J Schlitt

Affiliations + expand

PMID: 22330038 DOI: 10.1097/SLA.0b013e31824856f5

ABDDV/898

ABCD Arq Bras Cir Dig
2013;26(1):40-43

Original Article

ASSOCIATING LIVER PARTITION AND PORTAL VEIN LIGATION FOR STAGED HEPATECTOMY (ALPPS): THE BRAZILIAN EXPERIENCE

Ligadura da veia porta associada à bipartição do fígado para heptatectomia em dois estágios (ALPPS): experiência Brasileira

Orlando Jorge Martins **TORRES**¹, Eduardo de Souza Martins **FERNANDES**², Cassio Virgílio Cavalcante **OLIVEIRA**¹, Cristiano Xavier **LIMA**⁴, Fabio Luiz **WAECHTER**¹, Jose Maria Assunção **MORAES-JUNIOR**¹, Marcelo Moura **LINHARES**⁵, Rinaldo Danese **PINTO**⁷, Paulo **HERMAN**⁸, Marcel Autran Cesar **MACHADO**⁹

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ABSTRACT – **Background** - Postoperative liver failure consequent to insufficiency of remnant liver is a feared complication in patients who underwent extensive liver

Hepatic Vein Embolisation

Ongoing Trials:

Dragon-1 Trial: Training, Accreditation, Implementation and Safety Evaluation of Combined PVE/HVE (40 centers)

- In DRAGON 1 every center has to demonstrate the ability to enroll 3 patients in 12 months safely
- Ability of each center to enroll 3 patients for PVE/HVE in 12 months safely and perform the procedure including the liver resection without 90-day mortality after resection due to complications. If this goal is achieved center will be enrolled in **DRAGON 2**

DRAGON-2 Trial: Randomized controlled trial (PVE vs. HVE/PVE)

Mortality 12.8%

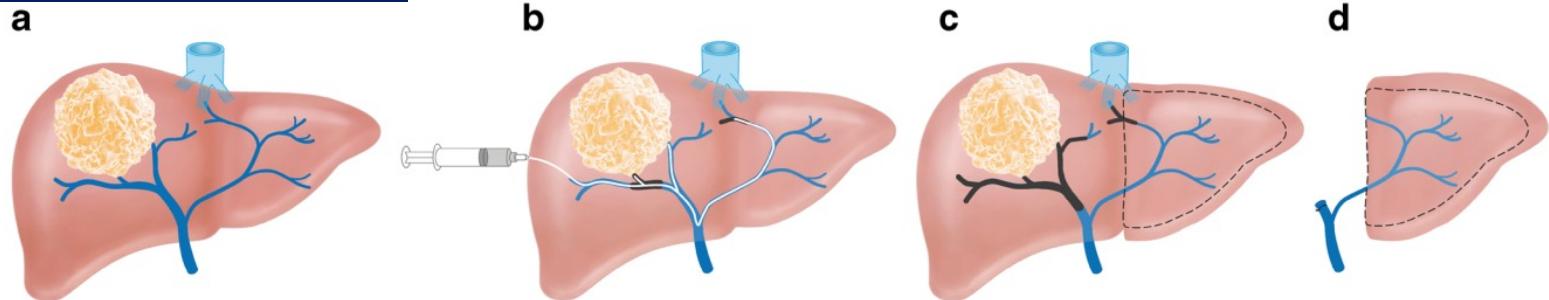
ALPPS Influence

Table 1 Key modalities of the associating liver partition and portal vein ligation for staged hepatectomy technique

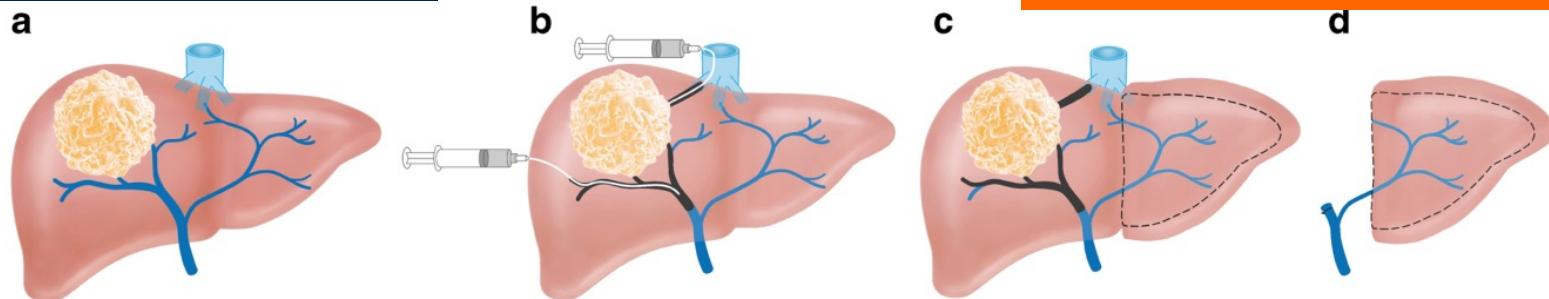
ALPPS strategies	Technical points
Classical ALPPS	Right portal vein ligation and right trisectionectomy
Rescue ALPPS	Failure of PVE with subsequent ALPPS
Laparoscopic ALPPS	Laparoscopy for stage 1 or both stages 1 and 2
PVE ALPPS	The intentional use of PVE as part of the first stage is stated by using PVE-ALPPS
Partial ALPPS	Transection at least 50% of the future transection plane at stage 1
Left ALPPS	Left portal vein ligation, left trisectionectomy
Tourniquet ALPPS	Tourniquet in the umbilical fissure and portal vein occlusion
Radiofrequency ALPPS	Radio-frequency-assisted liver partition
Microwave ALPPS	Microwave transection of the liver
Monosegment ALPPS	Extending hepatectomy, only sparing a single or adjacent segment

Patient selection

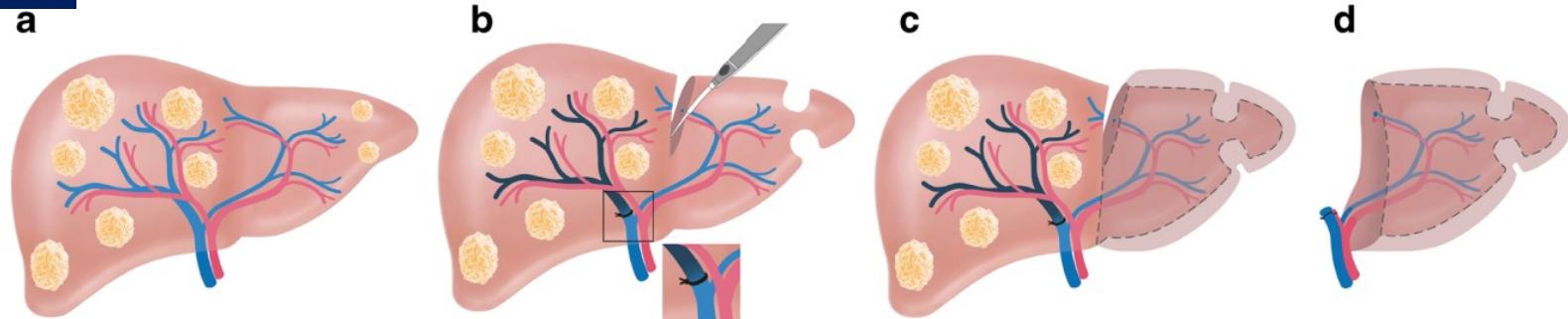
Portal vein embolization



Liver venous deprivation



ALPPS

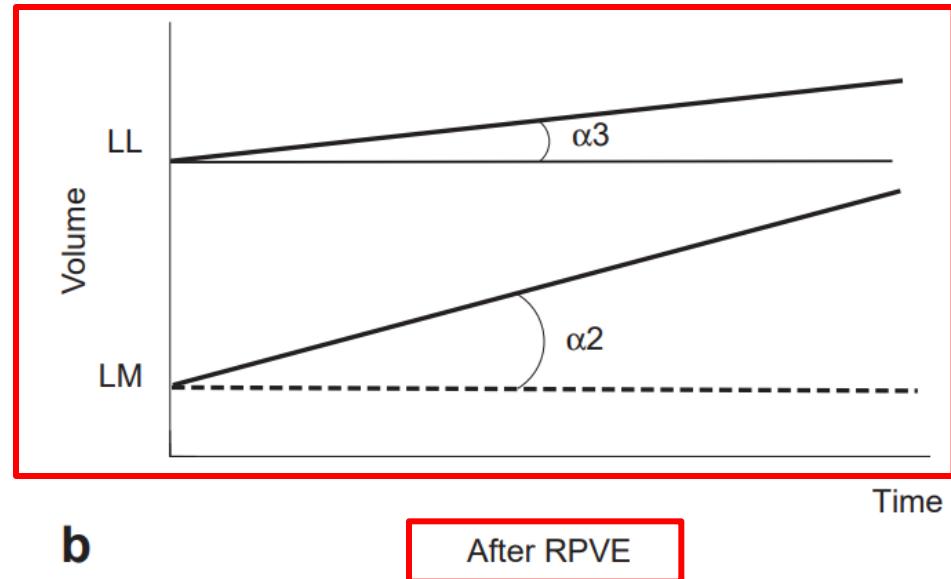
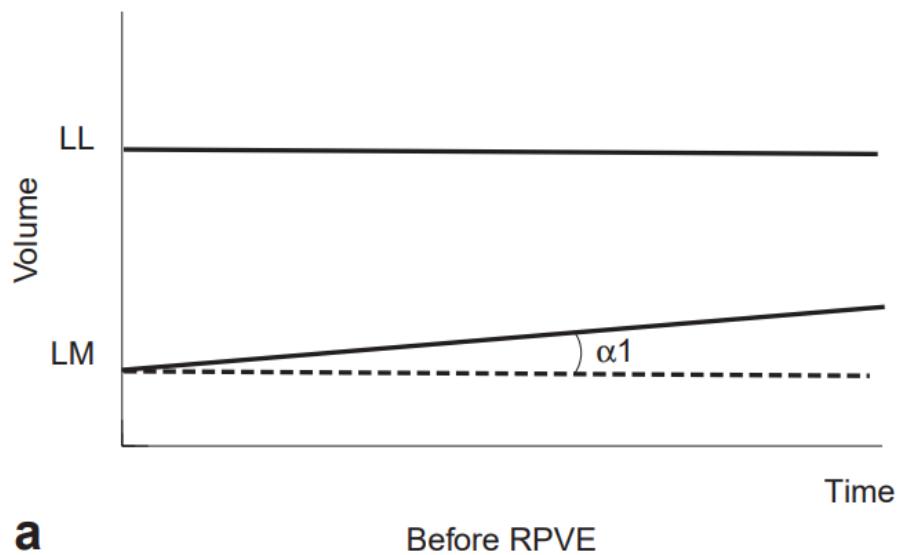


Patient selection

During liver regeneration following right portal embolization the growth rate of liver metastases is more rapid than that of the liver parenchyma

D. Elias, T. de Baere, A. Roche, M. Ducreux, J. Leclerc and P. Lasser

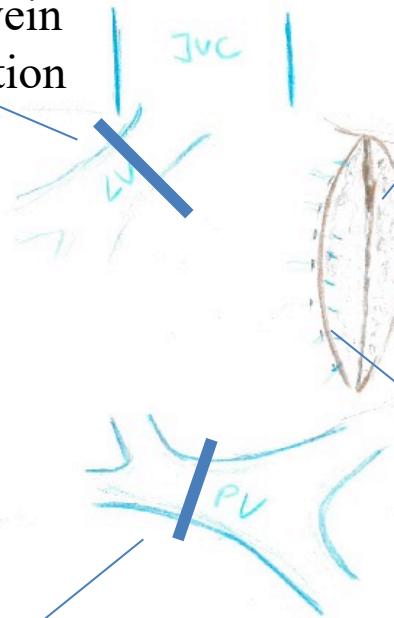
LL – Left lobe
LM – Liver mets



Volumetric increase
LL – Left lobe 59-127%
LM – Liver mets 60-970%

Hypertrophy Concepts: Mechanisms

Hepatic vein embolisation



„Tissue trauma“

Closure of
collaterals

Portal vein
embolisation

	PVE	PVE / LVE	ALPPS
Portal vein embolisation	+	+	+
Hepatic vein embolisation		+	+
Closure of collaterals			+
Tissue trauma			+



Patient selection

How should liver hypertrophy be stimulated? A comparison of upfront associating liver partition and portal vein ligation for staged hepatectomy (ALPPS) and portal vein embolization (PVE) with rescue possibility

Size of the FLR

Table 5 Successful resection rates for PVE depending on different sFLRs before PVE

Outcome	sFLR			
	<15%	15–20%	20.1–25%	>25%
Unsuccessful	4 (23.5)	7 (23.3)	8 (29.6)	8 (29.6)
Rescue ALPPS	7 (41.2)	8 (26.7)	3 (11.1)	0 (0)
PVE only	6 (35.3)	15 (50.0)	16 (59.3)	19 (70.4)

sFLR, standardized future liver remnant; PVE, portal vein embolization; ALPPS, associating liver partition and portal vein ligation for staged hepatectomy.

Preoperative Portal Vein Embolization for Liver Resection: An updated meta-analysis

Portal vein embolization

Feasibility of completion hepatectomy 76.3%

Table 1. Description of the 26 studies enrolled in the meta-analysis

Author	Year	Country	Inclusion period	Age	No. of patients	Resection patients	Interval between PVE and surgery
Okabe [46]	2011	Japan	1999-2009	58.8 (40-78)	24	19	28 (19-63)
Yamashita [2]	2013	Japan	1996-2009	61 (35-81)	64	49	NR
Shindoh [6]	2013	America	1995-2012	58 (24-86)	358	282	32 (5-385)
Fischman [37]	2014	America	2011-2013	59.9 (34-76)	35	27	41.6 (26-78)
Luz [41]	2017	Brazil	NR	56.5 (27-86)	50	31	NR
Alvarez [23]	2018	France	1993-2015	60 (24-86)	431	287	
Marti [24]	2017	America	2006-2014	61 (51.8-68)	82	69	
Tsurusaki [32]	2018	Japan	2010-2016	69.5 (45-86)	19	19	NR
Cotroneo [25]	2009	Italy	NR	66.2 (54-77)	31	24	NR
Giraudo [33]	2007	France	1997-2006	64 (44-88)	145	114	NR
Ribero [9]	2007	America	1995-2006	60 (36-78)	112	78	NR
Kakizawa [42]	2006	Japan	2001-2005	65 (35-81)	14	11	22 (14-37)
Beal [48]	2006	British	1999-2002	65 (52-74)	15	8	NR
Elias [16]	2001	France	1987-2000	NR	68	60	30 (24-65)
Madoff [36]	2003	America	1998-2001	59 (29-77)	26	16	NR
Jaberi [44]	2016	Canada	2008-2013	61.2 (38-84)	85	60	NR
Hemming [26]	2002	America	1996-2002	61 (31-82)	39	31	NR
Sofue [43]	2014	Japan	2007-2011	68 (45-82)	83	69	25 (14-55)
Geisel [38]	2013	Germany	2011-2012	NR	75	70	NR
Ratti [27]	2010	Italy	2006-2009	63 (37-82)	62	56	35 (13-57)
Radeleff [39]	2008	Germany	2001-2006	55 (31-68)	15	11	49 (34-72)
Cazejust [40]	2013	France	2009-2013	63 (38-80)	63	49	34 (28-49)
Kuo [17]	2012	Australia	1998-2007	60 (46-78)	25	19	36 (17-180)
Camelo [45]	2019	Portugal	2013-2017	64 (42-84)	64	44	NR
Loveday [28]	2018	America	2008-2015	61.8 (39-80)	31	23	8 (4-58)
Yamashita [29]	2017	Japan	1995-2013	63 (22-81)	319	256	NR

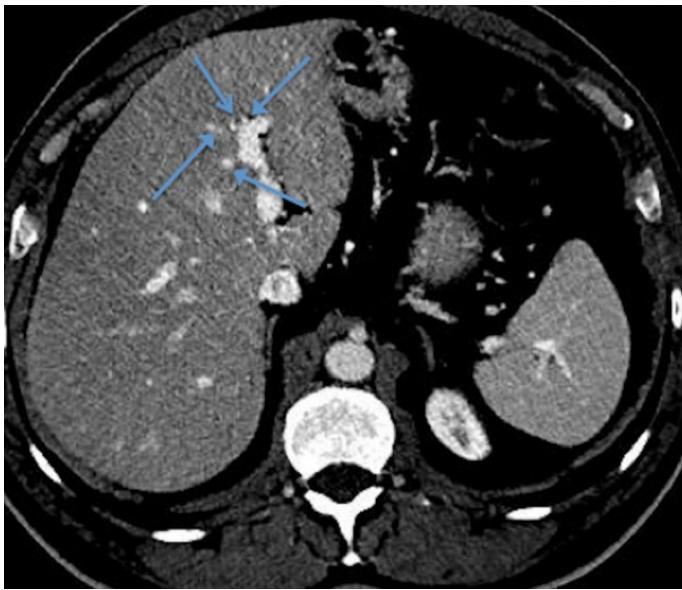
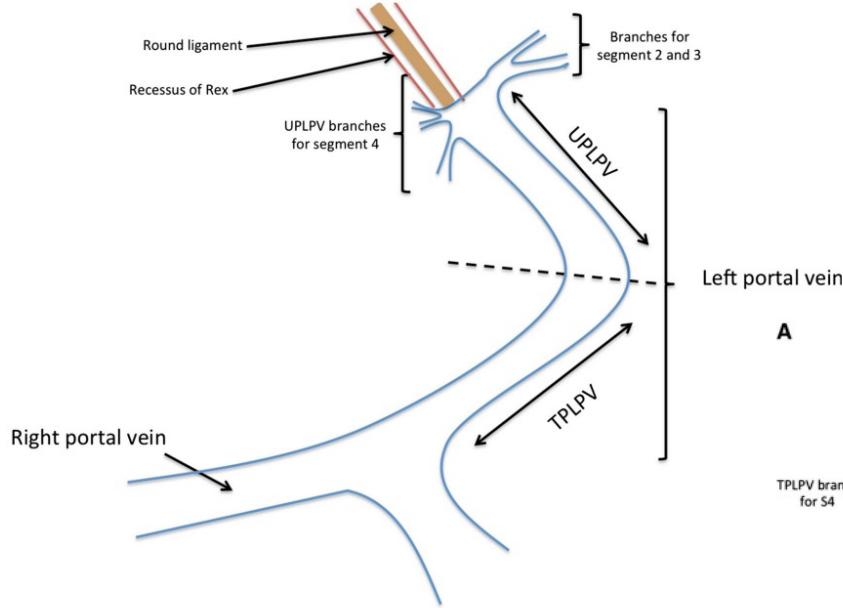
Resection rate 66.5%

Abbreviation: NOS: Newcastle-Ottawa Quality Assessment Scale Score; NR: not reported.

FEASIBILITY OF COMPLETION HEPATECTOMY

Resection rate

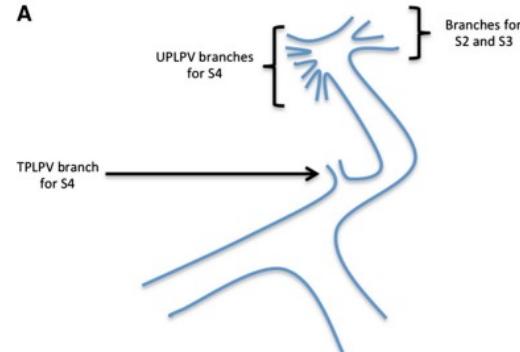
- PVE - 76.3% (Huang 2021)
- ALPPS – 98.4% (Schadde 2015)
- ALPPS – 100% (Hernandez-Alejandro 2014)
- ALPPS – 100% (Bjornsson 2015)
- ALPPS – 100% (Adam 2016)
- ALPPS – 100% (Herman 2014)



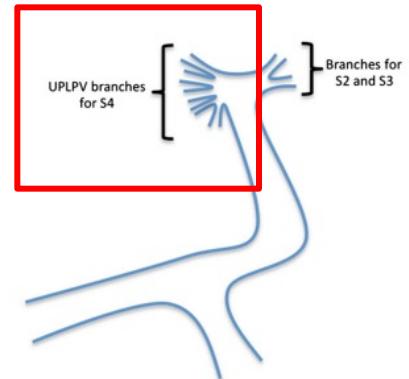
□ Segment 4

- 2-8 portal branches
- Embolization is challenging
- reproducibility questioned
- Thrombosis of the FLR (S2/S3)
- High number S4 - failure

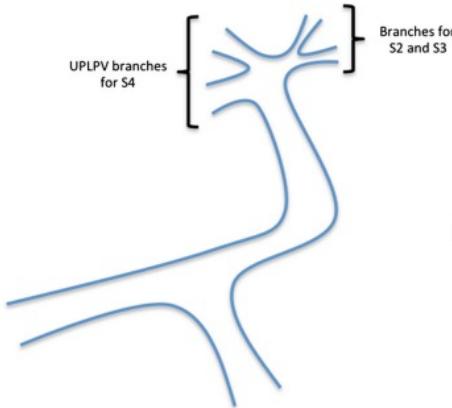
A



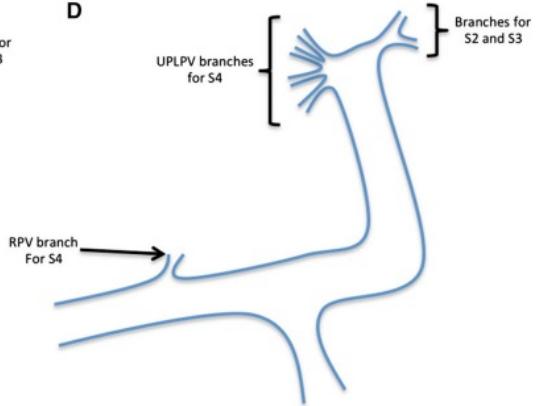
B



C



D



Patient selection

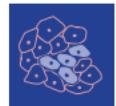
Article

Oncological Outcomes after Liver Venous Deprivation for Colorectal Liver Metastases: A Single Center Experience

Table 2. Liver volumes before and after liver venous deprivation (LVD). Median time between LVD and surgery was 39 days (IQR_{25–75} 25–56).

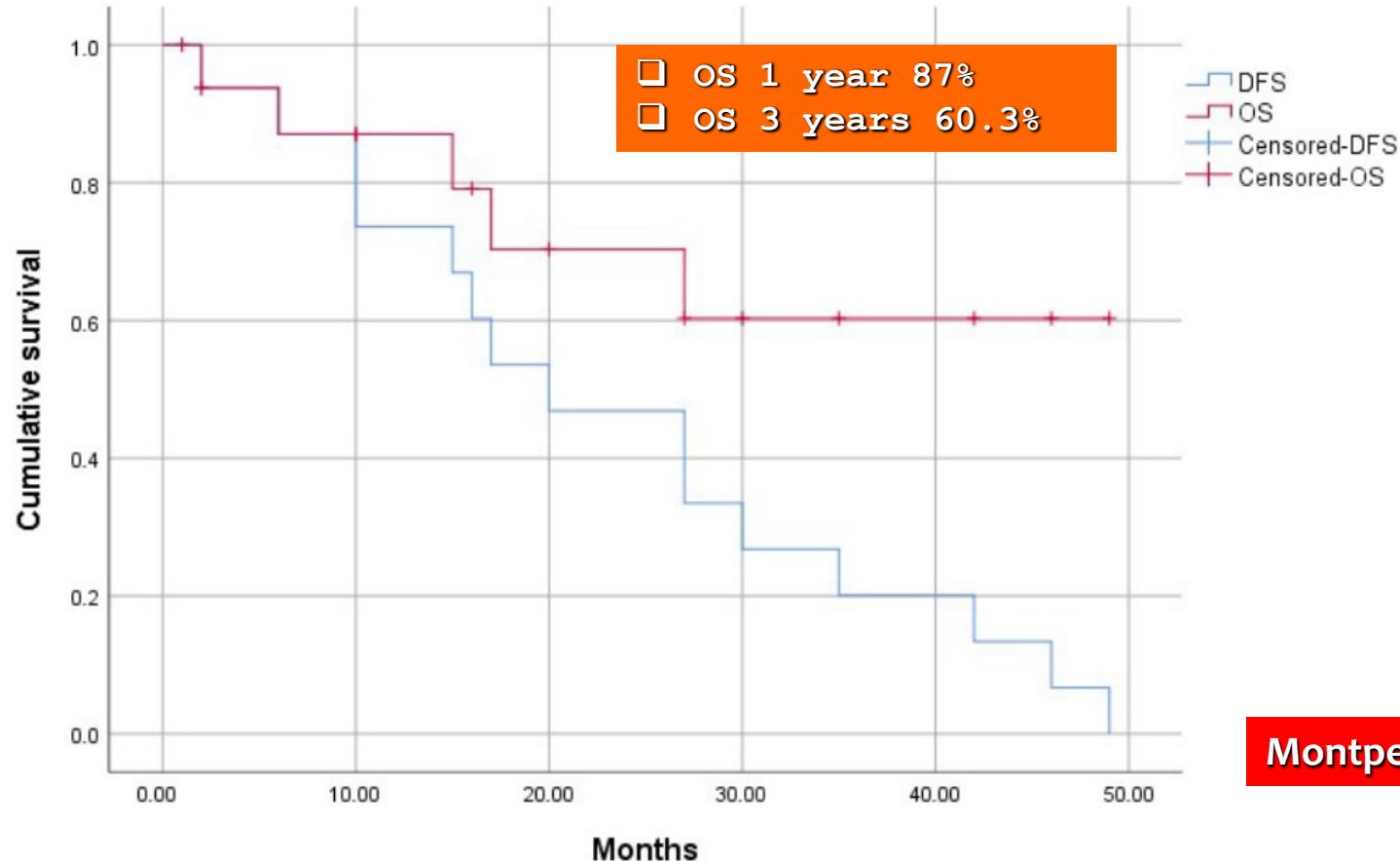
Liver Volumes	Before LVD	After LVD (7–10 Days Before Surgery)
Total Liver Volume (Median, IQR)	1803 mL (1496.5–2031)	2025 mL (1782–2191.5)
Future Liver Remnant Volume	451 mL (408.5–602)	761 mL (566–914)
% of FLR	29% (23.5–33)	39% (35.5–45.3)

Montpellier, France



Article

Oncological Outcomes after Liver Venous Deprivation for Colorectal Liver Metastases: A Single Center Experience



Montpellier, France

ORIGINAL ARTICLE



Liver Venous Deprivation Versus Portal Vein Embolization Before Major Hepatectomy for Colorectal Liver Metastases: A Retrospective Comparison of Short- and Medium-Term Outcomes

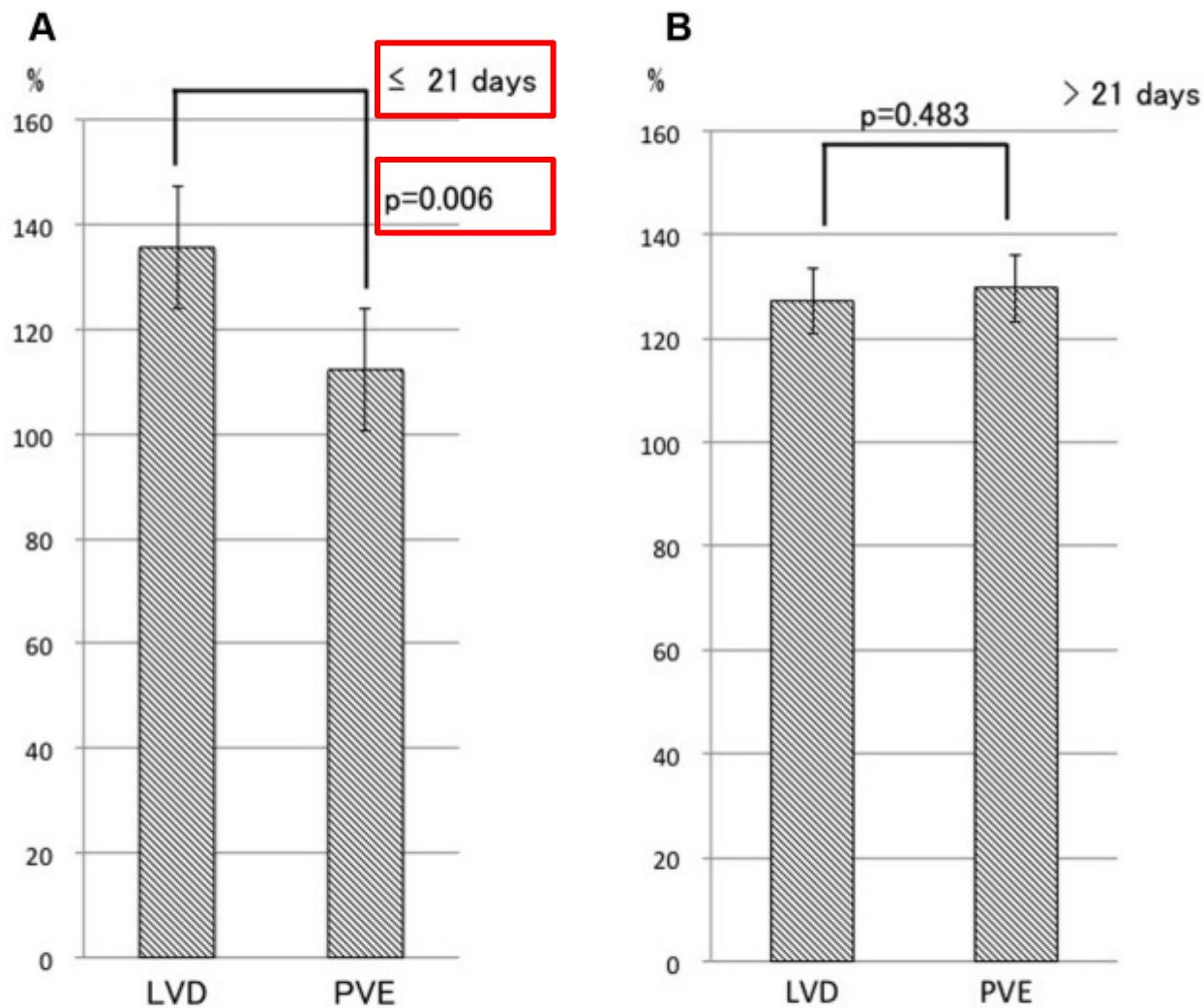
Table 3 Volumetric analysis

	LVD	PVE	p-value
Pre-procedural tumor volume, median (IQR _{25–75})	51 (35–121.5)	100 (34–154)	0.37
Pre-procedural FLR-V share %, mean (SD)	29.3 (6.8)	32.2 (9.7)	0.44
TLV gain in cc, mean (SD)	183 (271)	162 (303)	0.82
Pre-operative FLR-V %, mean (SD)	39 (9)	40.5 (11)	0.81
FLR-V increase %, mean (SD)	49 (29)	27 (18)	0.01
KGR % per day, mean (SD)	0.2 (0.2)	0.1 (0.1)	0.05
KGR in cc/day, mean (SD)	10 (8.7)	4.8 (4)	0.03
KGR % per week, mean (SD)	1.45 (1.3)	1.12 (1.1)	0.46

SD, standard deviations; IQR, interquartile range; TLV, total liver volume; FLR-V, future liver remnant volume; KGR, kinetic growth rate

Montpellier, France

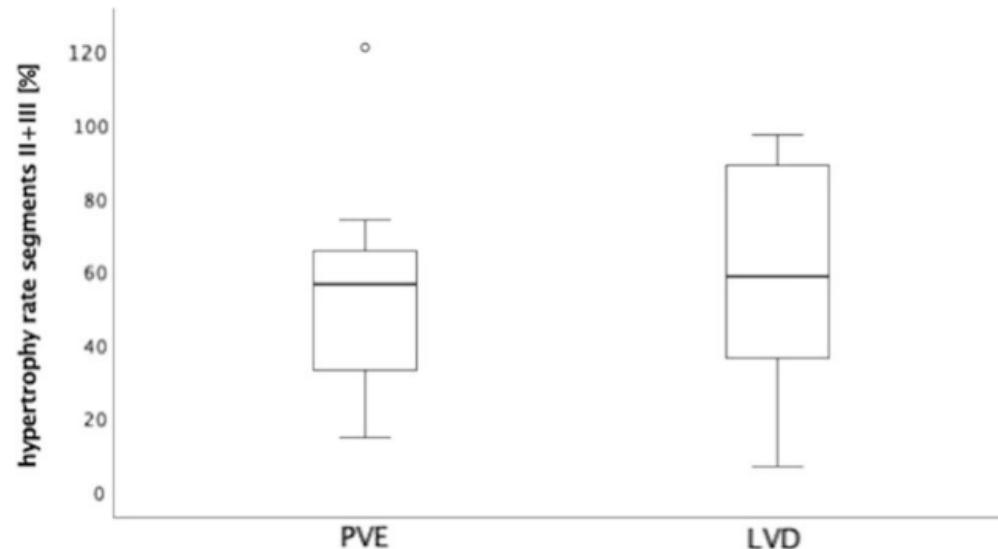
PVE vs LVD



Montpellier group? No

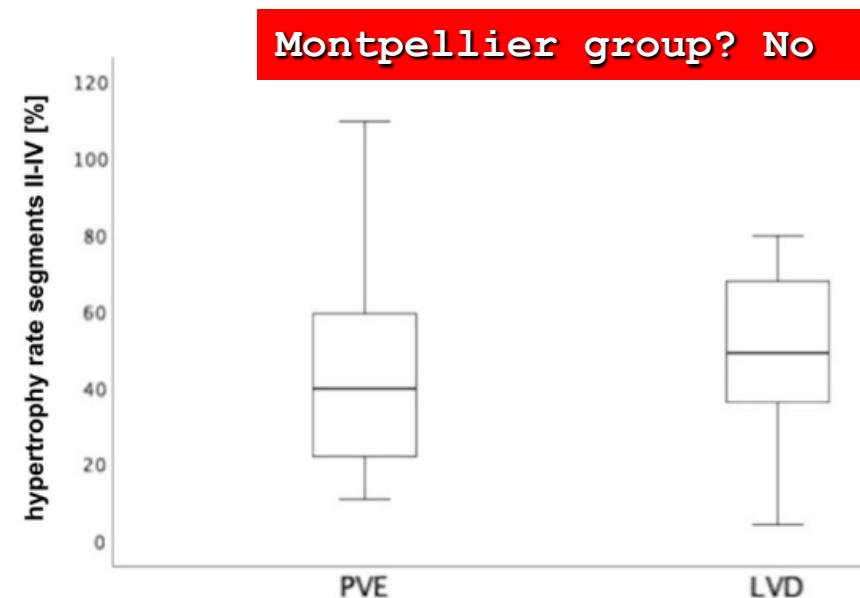
PVE vs LVD

Liver Venous Deprivation (LVD) Versus Portal Vein Embolization (PVE) Alone Prior to Extended Hepatectomy:
A Matched Pair Analysis



- Hypertrophy rate (II/III)
 - PVE $54.1 \pm 27.6\%$
 - LVD 59 ± 29.6

$P=0.637$



- Hypertrophy rate (II/III and IV)
 - PVE $44.9 \pm 28.9\%$
 - LVD 48.2 ± 22.2

$P=0.719$



REVIEW

Regeneration rate

Treatment Effect

PVE vs ALPPS



LVD vs ALPPS



LVD vs PVE

Mean with 95%CI

-55.25 (-65.24,-45.27)

-43.26 (-64.47,-22.05)

11.99 (-6.70,30.69)

- ALPPS - higher regeneration rate than LVD/PVE
- LVD and PVE - no difference

Montpellier group? No

REVIEW

Open Access



Efficacy and safety of different options for liver regeneration of future liver remnant in patients with liver malignancies: a systematic review and network meta-analysis

Time to hepatectomy

Treatment Effect

PVE vs ALPPS



Mean with 95%CI

32.79 (22.66,42.92)

LVD vs ALPPS



34.02 (20.20,47.85)

- ALPPS shorter than LVD/PVE
- LVD and PVE - no difference

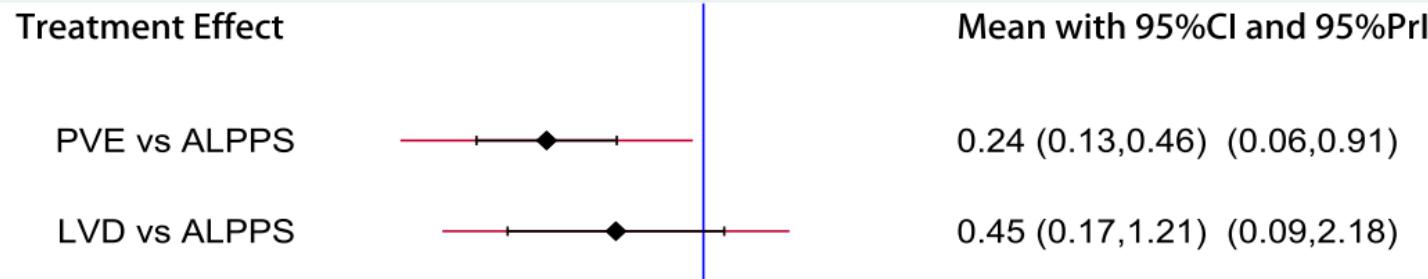
REVIEW

Open Access



Efficacy and safety of different options for liver regeneration of future liver remnant in patients with liver malignancies: a systematic review and network meta-analysis

Resection rate



- ALPPS - higher resection rate than PVE
- ALPPS and LVD – no difference
- LVD and PVE - no difference

REVIEW

Open Access

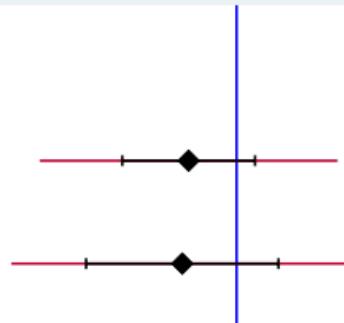


Efficacy and safety of different options for liver regeneration of future liver remnant in patients with liver malignancies: a systematic review and network meta-analysis

Clavien-Dindo $\geq 3a$ complication rate

Treatment Effect

PVE vs ALPPS



Mean with 95%CI and 95%PrI

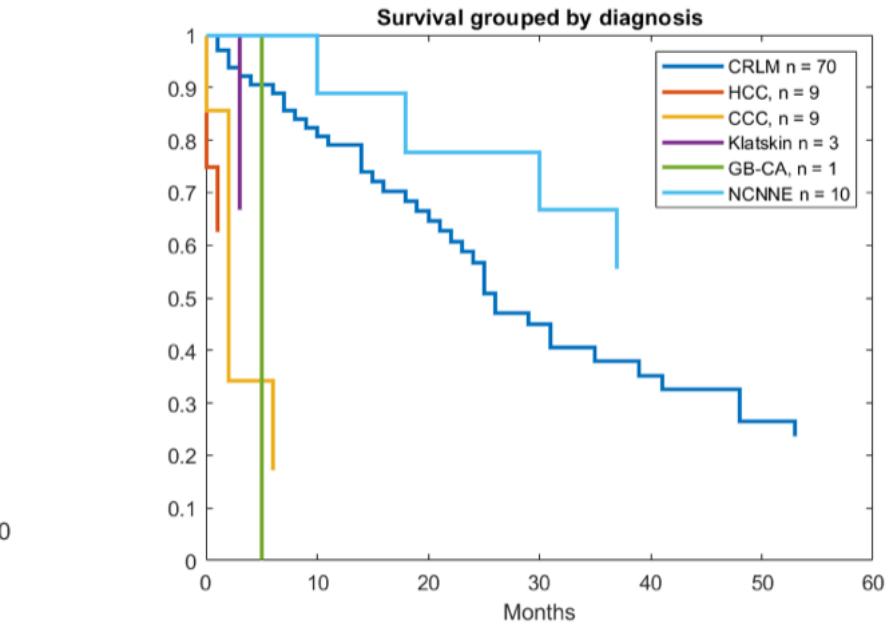
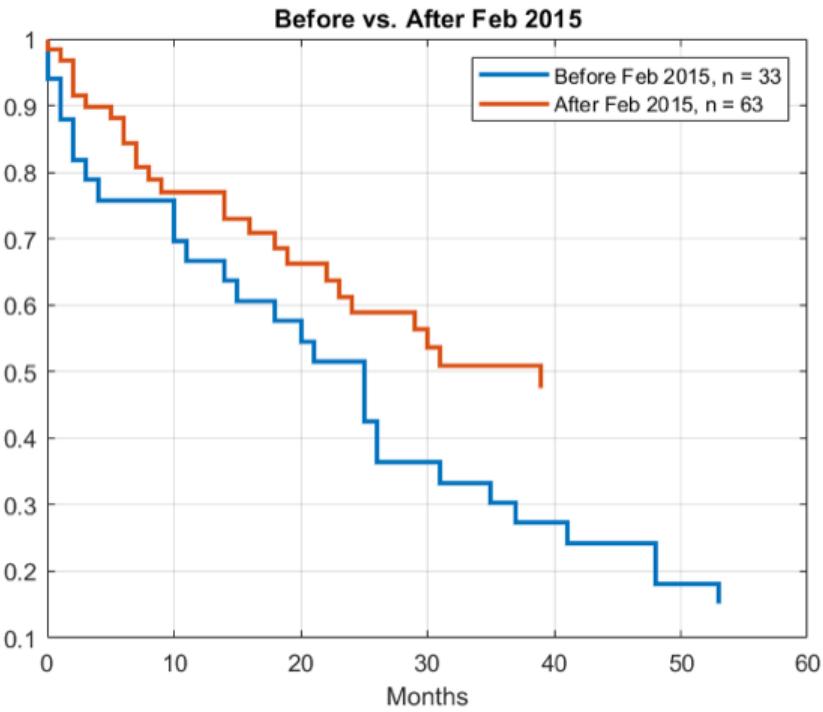
0.67 (0.39,1.17) (0.20,2.31)

LVD vs ALPPS

0.64 (0.29,1.42) (0.15,2.64)

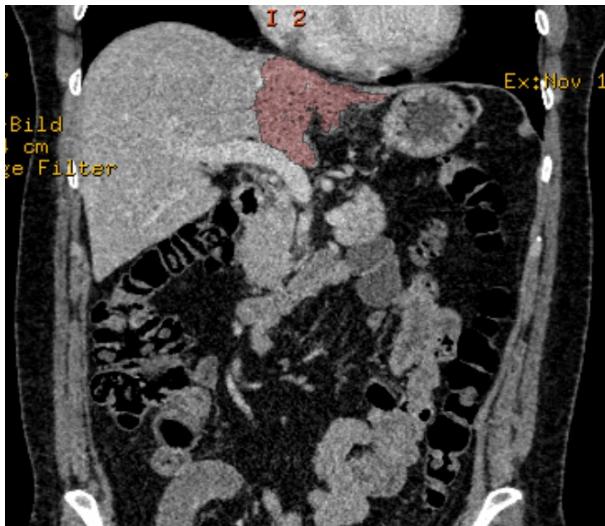
- No significant difference
- ALPPS – trend of a higher Clavien-Dindo $\geq 3a$ complication rate

Barmbek Experience 2010 – 2023: lessons learned



Prof. Karl Oldhafer (Hamburg – Germany)

Barmbek Experience 2010 – 2023: Rescue ALPPS

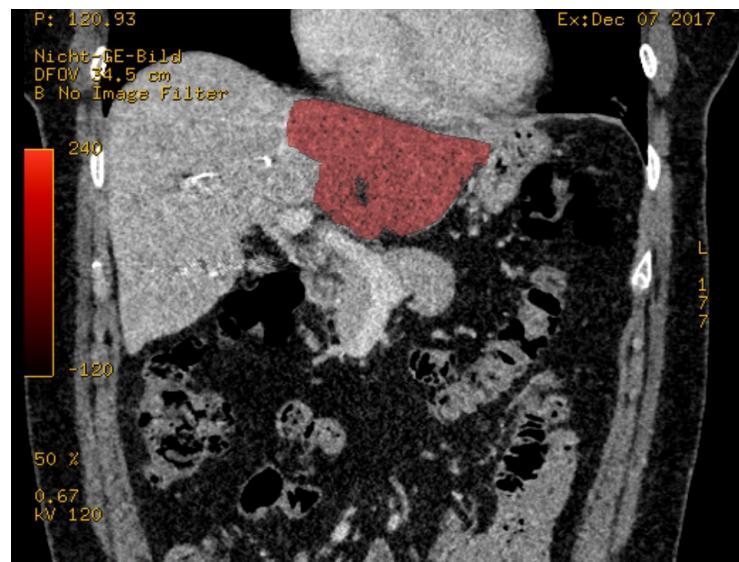


pre-intervention FLR [ml] 192

pre-intervention sFLR [%]

11,9

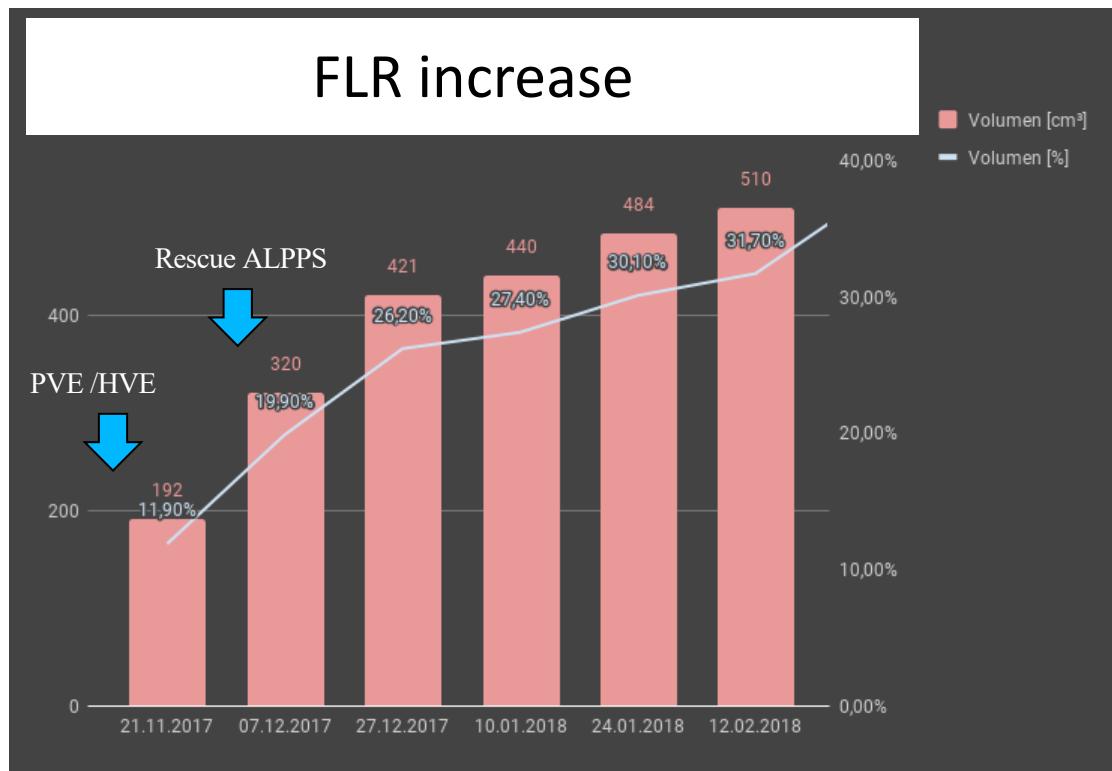
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post-intervention FLR [ml] 320

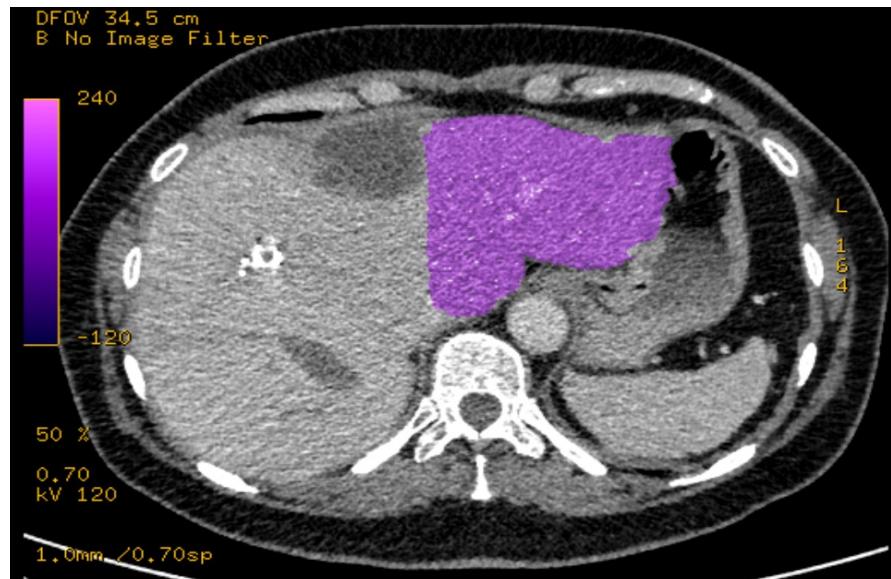
post-intervention sFLR [%] 19,9

Barmbek Experience 2010 – 2023: Rescue ALPPS



Barmbek Experience 2010 – 2023: Rescue ALPPS

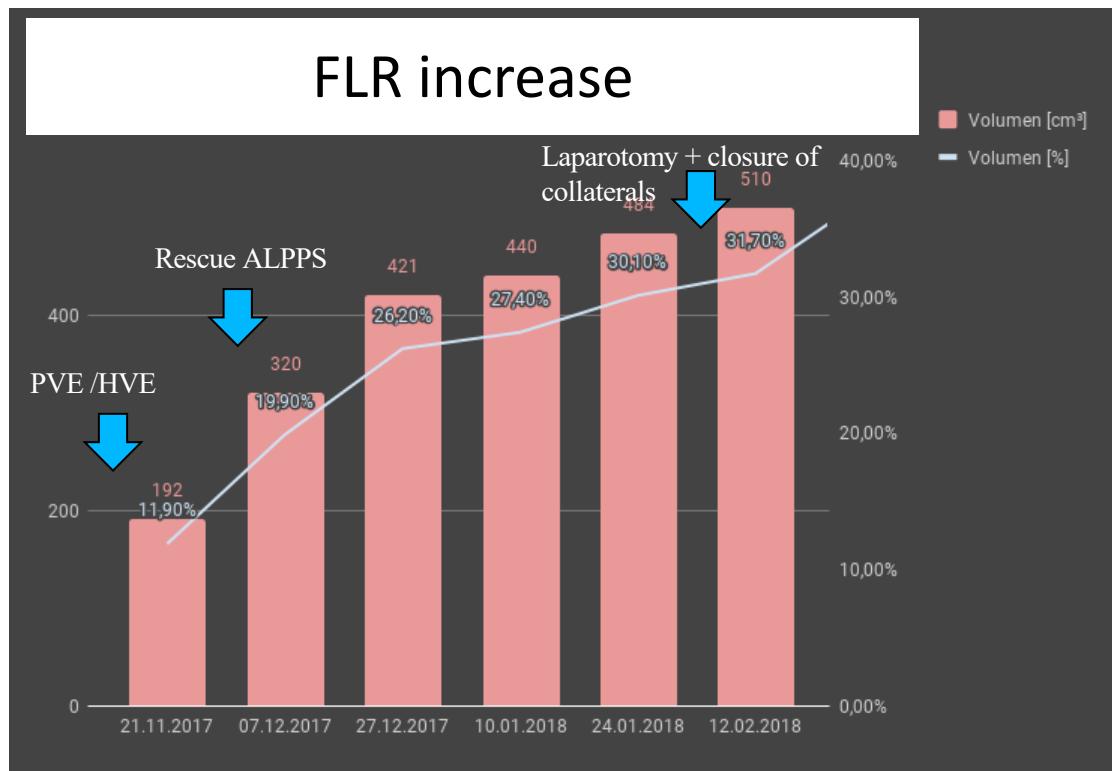
Volumetry 13 days after ALPPS



post-intervention FLR [ml] 421

post-intervention sFLR [%] 26,2

Barmbek Experience 2010 – 2023: Rescue ALPPS



Full-Robotic ALPPS

ALPPS Step I
15.01.2021

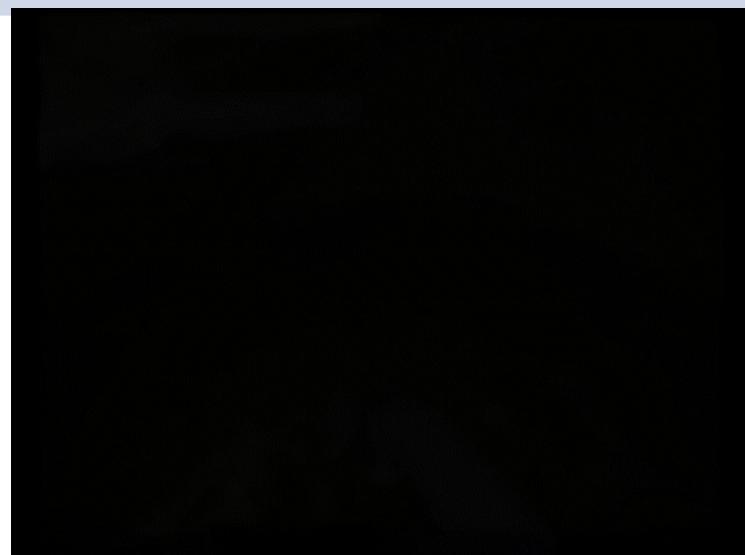
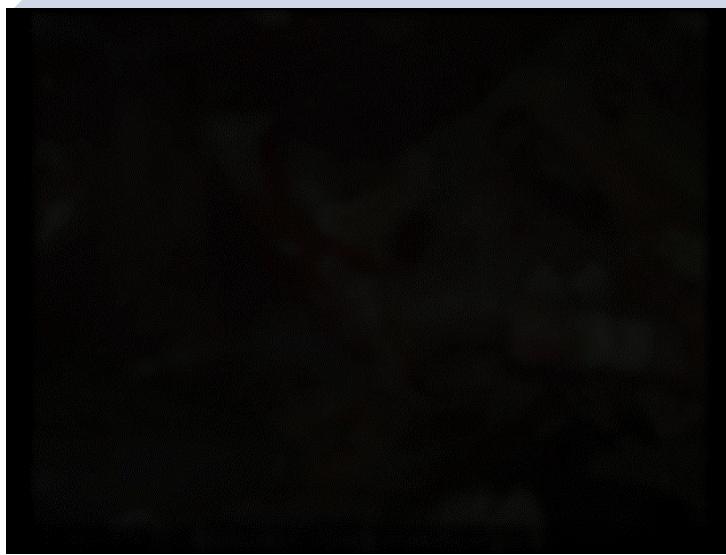
pre-intervention FLR 372 ml (22,5%)

TCT / ACT
25.01.2021

post-intervention FLR: 544 ml (33,0%)
FLRBWR (FLR to BW ratio): 0,76

ALPPS Step II
1.02.2021

post-intervention FLR: 600 ml (36,4%)
FLRBWR (FLR to BW ratio): 0,83



Prof. Karl Oldhafer (Hamburg – Germany)

Liver resection

2 Contiguous segments:
Portal vein
Hepatic artery
Bile duct
Outflow

Monosegment ALPPS

- 54-year-old male patient
 - Synchronous liver metastases
 - Left sided colon tumor
- Primary resected previously
 - Colostomy
- Chemotherapy
 - FOLFOX 12 cicles

KRAS Wild-type

CT

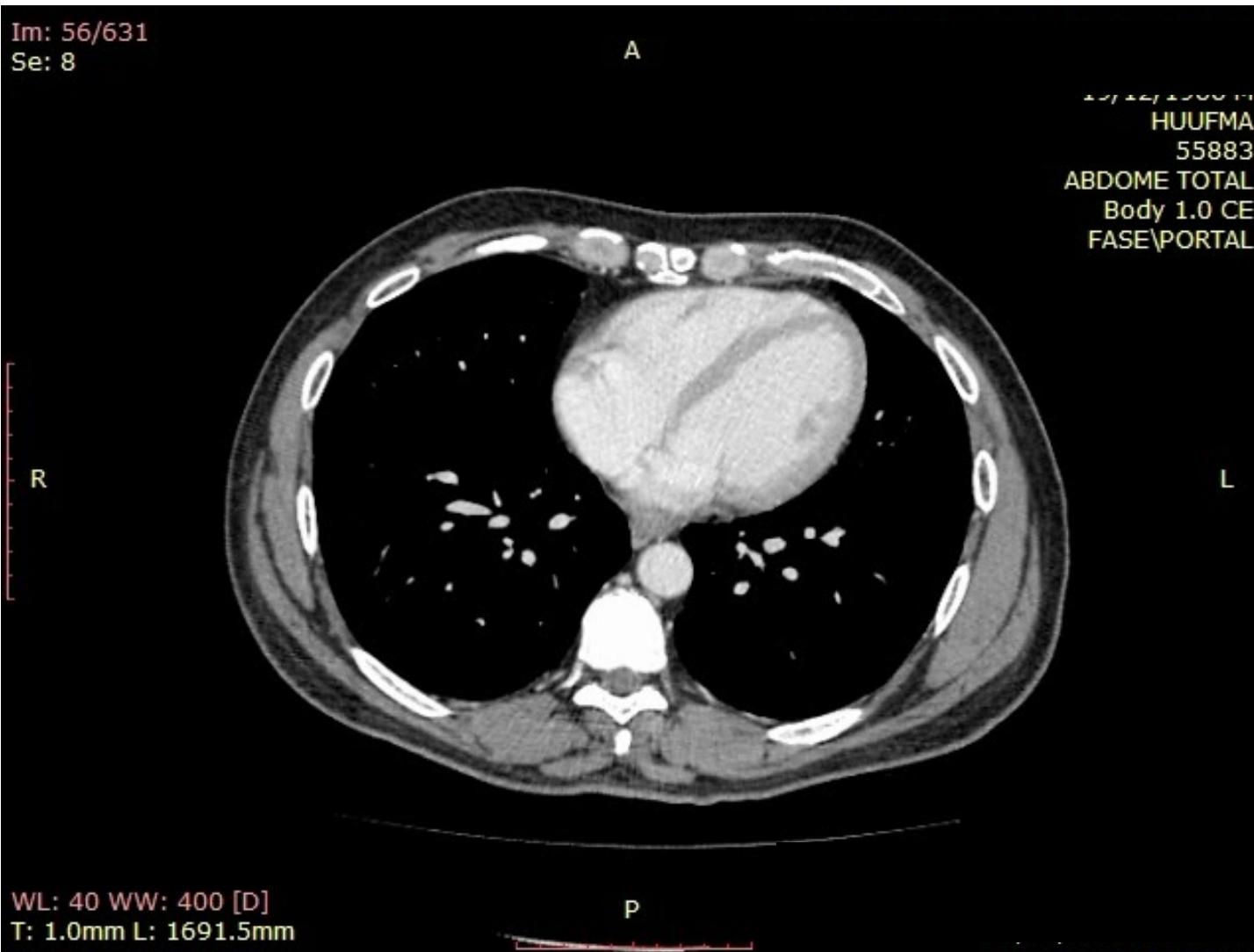
Liver metastases:

Segment II preserved

Im: 56/631
Se: 8

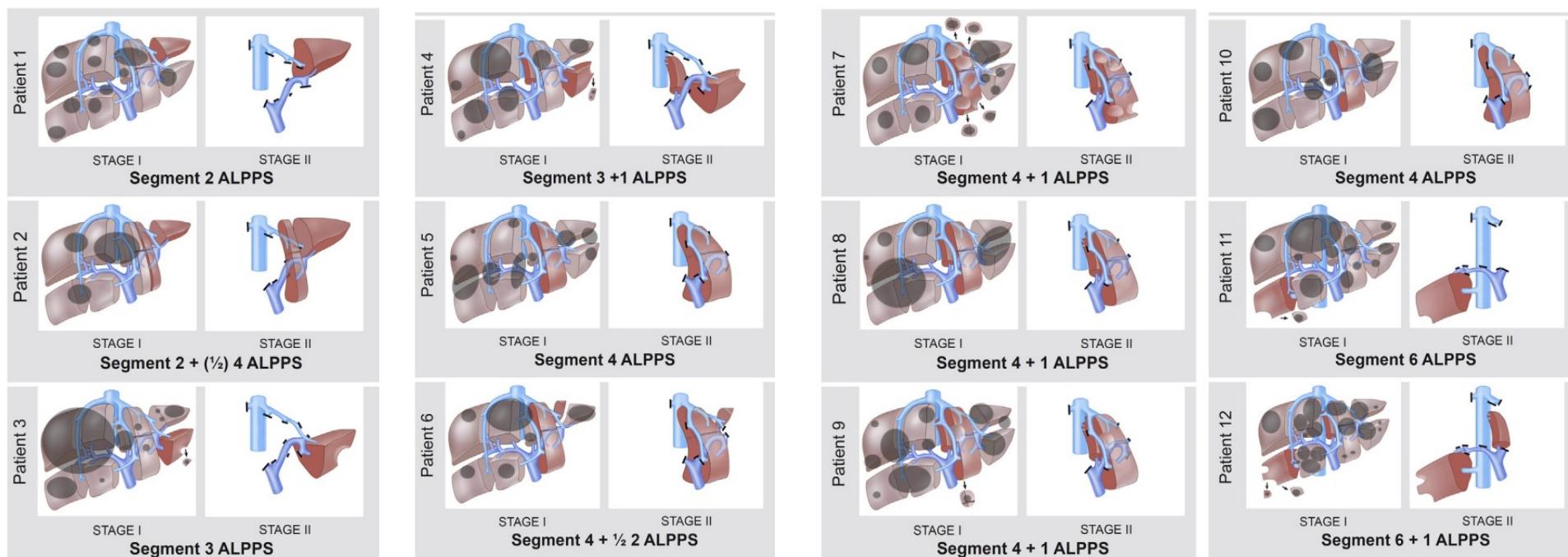
A

HUUFMA
55883
ABDOME TOTAL
Body 1.0 CE
FASE\PORTAL



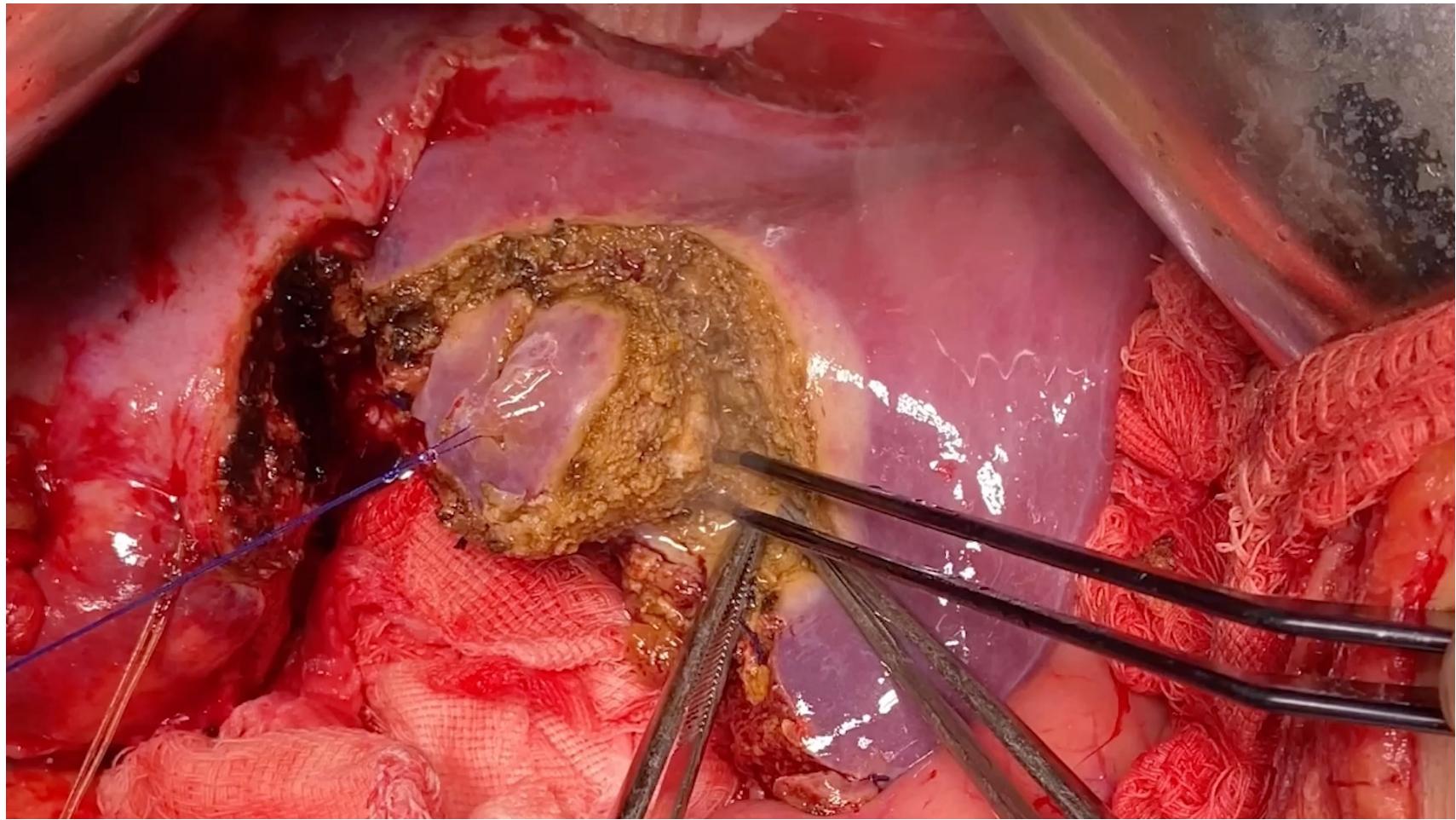
Monosegment ALPPS hepatectomy: Extending resectability by rapid hypertrophy

Erik Schadde, MD, FACS,^a Massimo Malagó, MD,^b Roberto Hernandez-Alejandro, MD, FRCSC, FACS,^c Jun Li, MD,^d Eddie Abdalla, MD, FACS,^e Victoria Ardiles, MD,^f Georg Lurje, MD,^{b,g} Soumil Vyas, MS, FRCS,^b Marcel A. Machado, MD, FACS,^h and Eduardo de Santibañes, MD, PhD, FACS,^f Winterthur and Zurich, Switzerland, London, UK, London, Ontario, Canada, Hamburg and Aachen, Germany, Beirut, Lebanon, Buenos Aires, Argentina, and São Paulo, Brazil



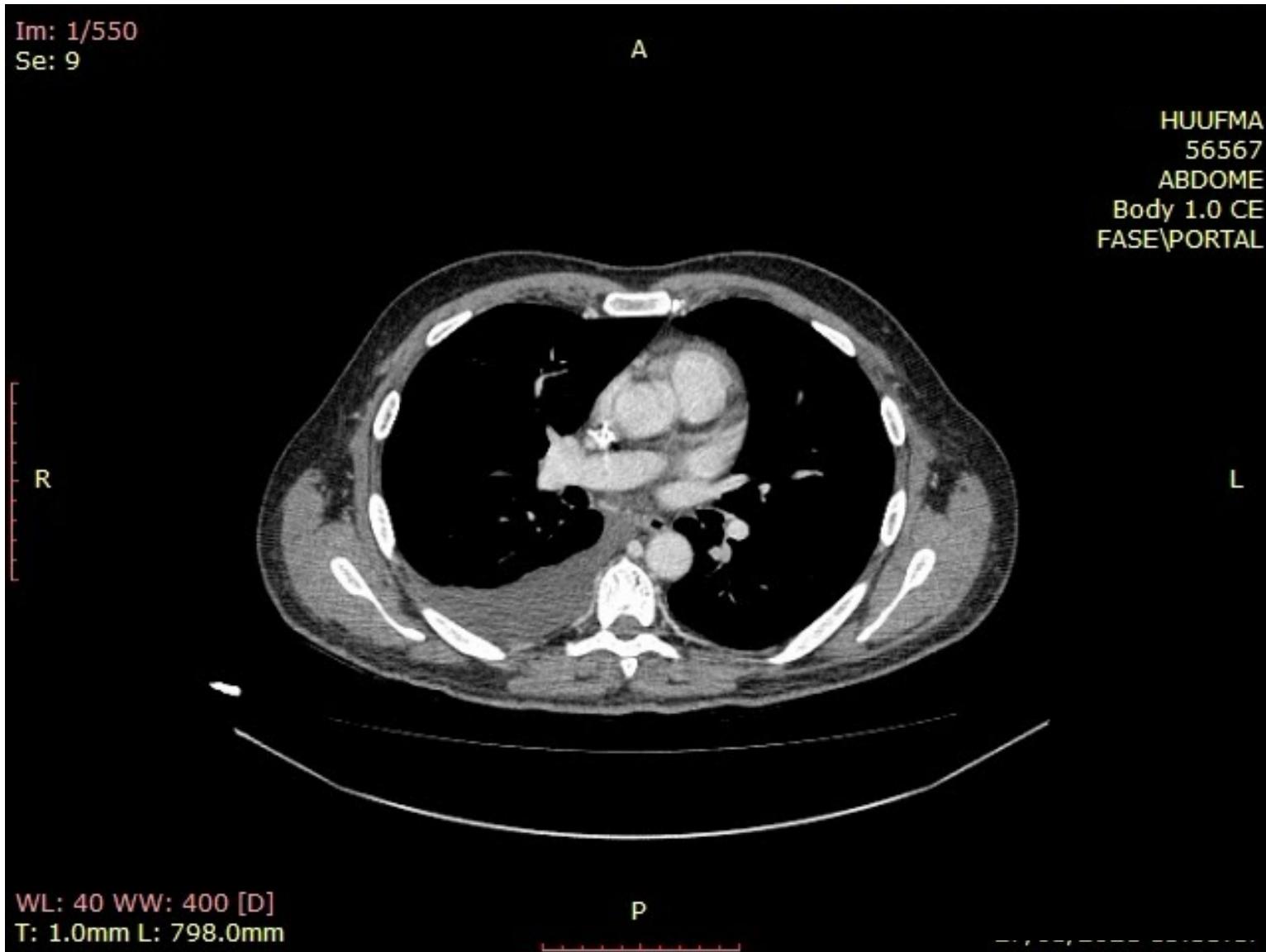
1st step

Decision (Tumor board)
ALPPS



CT scan

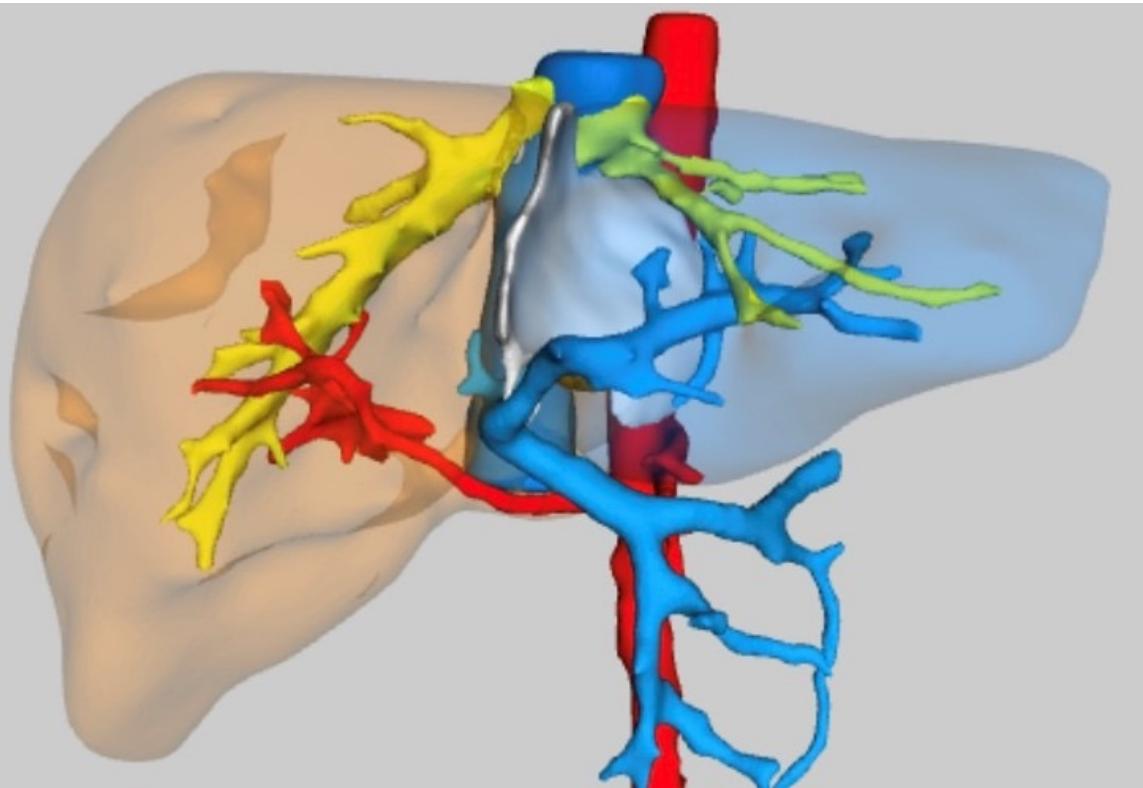
After 3 weeks
 Portal phase



VOLUMETRY

Segment 2

FLR 32.7%



Name

Gender, Age

Liver View

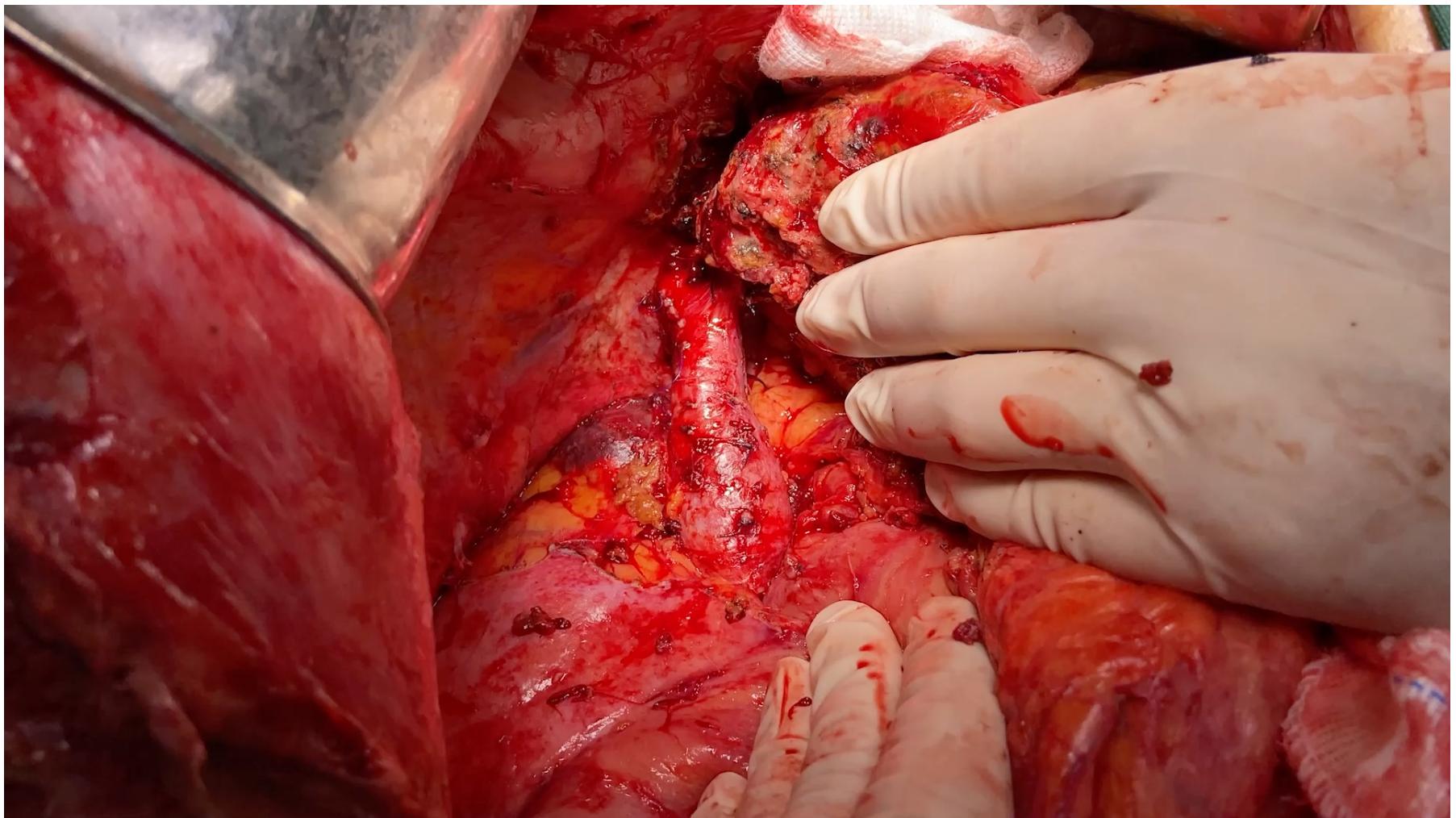


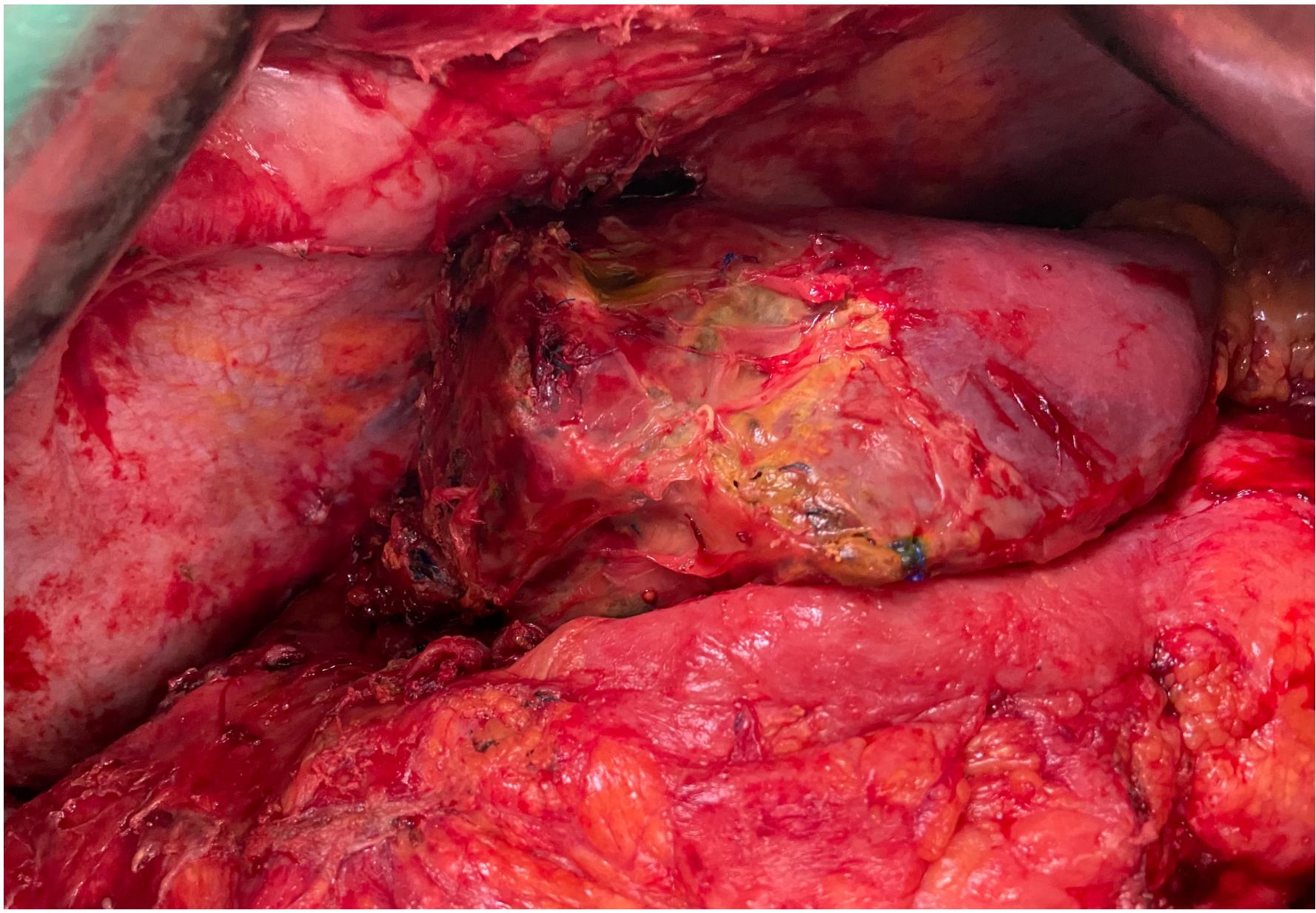
Serie/s View

Liver

Courtesy: Prof. Deniz Balci (Istanbul – Turkey)

□ 2nd step







SPECIMEN



POSTOPERATIVE COURSE

- ICU 9 days
- Complications $\geq 3b$ (clavien-dindo)
 - Reoperation (intestinal occlusion)
- Length of stay 34 days

~~2 Contiguous segments:~~

Portal vein

Hepatic artery

Bile duct

Outflow

ALPPS influence

1 segment

CONCLUSION



- Insufficient FLR: low need: PVE
- Insufficient FLR: intermediate need: PVE + HVE
- Insufficient FLR: large need: ALPPS
- Insufficient FLR plus Bilobar CRLM ALPPS
- “Fire-Break” for tumor progression ALPPS
- Rescue technique for insufficient hypertrophy after PVE or HVE ALPPS
- 1 liver segment ALPPS

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Zurich, Switzerland



Thanks !