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Erasmus University Rotterdam
Making Minds Matter

Harmonizing Definitions and Perspectives in Extreme Liver Surgery

A Delphi Experts Consensus

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Objective: The aim of this study was to propose to our community a common language about extreme liver surgery.

Background: The lack of a clear definition of extreme liver surgery prevents convincing comparisons of results among centers.

Methods: We used a 2-round Delphi methodology to quantify consensus among liver surgery experts. For inclusion in the final recommendations, we established a consensus when the positive responses (agree and totally agree) exceeded 70%. The study steering group summarized and reported the recommendations. In general, a 5-point Likert scale with a neutral central value was used, and in a few cases multiple choices. Results are displayed as numbers and percentages.

Results: A 2-round Delphi study was completed by 38 expert surgeons in complex hepatobiliary surgery. The surgeon´s median age was 58 years old (52–63) and the median years of experience was 25 years (20–31). For the proposed definitions of total vascular occlusion, hepatic flow occlusion and inferior vein occlusion, the degree of agreement was 97%, 81%, and 84%, respectively. In situ approach (64%) was the preferred, followed by ante situ (22%) and ex situ (14%). Autologous or cadaveric graft for hepatic artery or hepatic vein repair were the most recommended (89%). The use of veno-venous bypass or portocaval shunt revealed the divergence depending on the case. Overall, 75% of the experts agreed with the proposed definition for extreme liver surgery.

Conclusions: Obtaining a consensus on the definition of extreme liver surgery is essential to guarantee the correct management of patients with highly complex hepatobiliary oncological disease. The management of candidates for extreme liver surgery involves comprehensive care ranging from adequate patient selection to the appropriate surgical strategy.

Key Words: consensus, liver surgery, liver transplantation, vascular resection

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Current achievements in liver surgery, enhanced by technological advancements and combined with innovative chemotherapy and interventional radiology, has significantly expanded the horizons of resectability for patients with hepatic tumors.[1] These developments have increased the number of patients eligible for surgery and improved the oncological outcomes.[2] Complex liver surgery for hepatic tumors involves advanced surgical techniques, particularly when tumors affect major vascular structures like the hepatocaval confluence and the hepatic pedicle.[3–6] This type of surgery often requires extensive hepatectomies and intricate vascular reconstructions.[7–10] Due to the complexity and risks of significant morbidity and mortality, patient selection and meticulous surgical planning are crucial. In addition, meticulous monitoring and adjustment of hemodynamics are imperative for these surgical procedures to maintain sufficient blood flow and organ perfusion throughout the entire process.[11,12]

Nowadays, many groups debate the concept of extreme liver surgery, but there is no clear consensus for this term.[10,13–22] There are many aspects related to patient selection, surgical approaches, outcome auditing, hemodynamic management, and technical details that are integral to this approach.[23–25] Obtaining a consensus in extreme liver surgery is crucial to unify criteria, guarantee best practice and obtain optimal results for patients. Many of these patients are ruled out for surgery when they may have a chance to be operated on in specialized centers with expertise in hepatic surgery and transplantation.[26] The concept of extreme liver surgery is based on the individualized results of each center but there is significant heterogeneity. The objective of this consensus document is to establish a framework of reference in extreme liver surgery, compiling the wisdom and experience accumulated by an international group of experts in the field of highly complex liver surgery.

METHODS

Study Design

A panel of 51 experts was selected based on their recognized experience and publications in the field of complex hepatobiliary surgery and liver transplantation. Inclusion criteria for experts were at least 15 years of experience in the field and significant contributions to the relevant literature. All participants gave their consent before inclusion in the study.

Delphi Methodology

The first step was the formation of the steering committee. This committee was made up of surgical leaders in liver surgery (P.L., D.A, P.-A.C., K.O., E.S., R.H.-A., and R.R.-C.). This committee decided the items of the consensus. All questions were developed from a comprehensive literature review and preliminary consultations with leading experts in the field. We used a 2-round Delphi methodology to quantify consensus in the participating group. This was performed electronically using (Surveymonkey). Each expert received via email a link to an online questionnaire. All participants were asked to propose

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additional criteria or reflections that they considered important in free text fields in the first round.

Following the results of the first round, some questions from the second round were reformulated to reflect the specifications found. The questionnaires focused on exploring and refining key areas identified in the first round. A closed-ended questioning approach was used, asking experts to rate or prioritize certain items based on their experience and knowledge. Each round of questioning was conducted over a 2-week period.

Participants were asked to indicate their "agreement/disagreement" with the proposed parameters using the questionnaire comprised questions to be answered on a 5-point Likert scale: 1: "totally disagree," 2: "disagree," 3: "neither agree nor disagree," 4: "agree," and 5: "totally agree." For inclusion in the final recommendations, we establish consensus when the positive responses (agree and totally agree) exceed 70%. Preliminary findings were validated with all participants, ensuring the accuracy and representativeness of the results. The study steering group summarized and reported the recommendations within this manuscript based on the consensus results of the Delphi process.

Statistical Analysis

All data included were analyzed with a professional statistic package (R project, ver. 3.6.1; GLP). In general, a 5-point Likert scale with a neutral central value was used, and in a few cases multiple choice. Results are displayed as numbers and percentages. Quantitative variables were expressed as means and SD, if normally distributed and as medians and interquartile range (IQR) otherwise. To represent the Likert scale, we use a divergent bar graph centered on the neutral value so that agreement or disagreement with each question can be emphasized (Fig. 1). We also computed median and interquartile deviation (IQD) scores for this scale.

RESULTS

In the first round, 41/51 (80.39%) experts from 18 countries and 3 different continents responded, although the 2-round Delphi study was subsequently completed by 38 of them. The median age was 58 years (IQR: 52–63), median years experience was 25 years (IQR: 20–31) and the median of liver resections per year by each surgeon was 120 (IQR: 100–158). The median number of extreme liver surgeries performed by each surgeon according to their own definition was 25 (IQR: 10–50). Figure 1 and Supplemental Digital Content 1, Table 1 (http://links.lww.com/SLA/F177) show the results obtained on the Likert scale and the consensuses are highlighted (23 of the 34 aspects to be analyzed achieve consensus). Only 5.4% of the experts felt that it is not in fact necessary to reach a consensus on the definition of the concept of extreme liver surgery in the hepatobiliary surgical oncology community.

Definitions

Within the suggestions and definitions proposed during the Delphi process, the most widely accepted definition was the following: "Patients undergoing any type of liver surgery

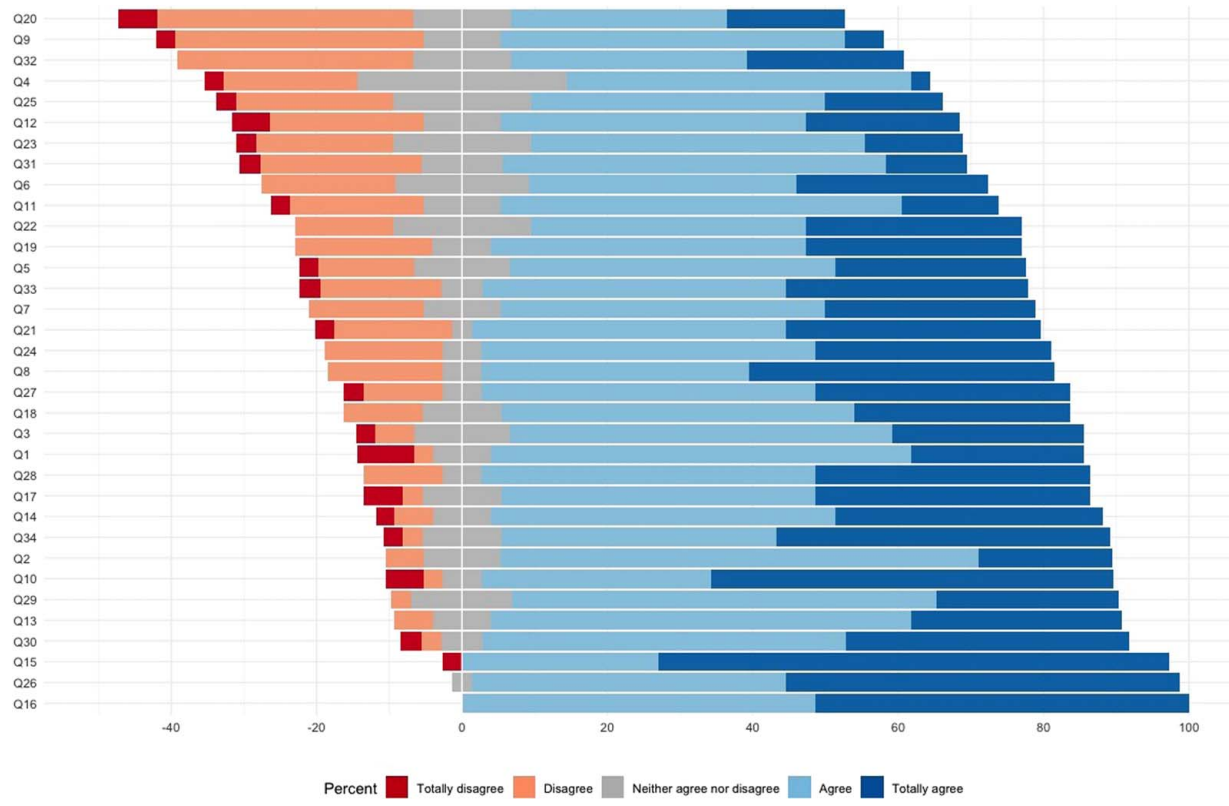


FIGURE 1. Divergent bar graph centered on the neutral value to represent agreement or disagreement with each question based on Likert scale expert´s consensus recommendations.

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who meet at least 2 of the following criteria: (1) need for an ex situ, ante situ, or in situ approach with or without hypothermic perfusion or normothermic machine perfusion; (2) vascular resection with reconstruction; (3) liver resection outside the established anatomic boundaries; and (4) future borderline liver remnant."

For the suggested definitions of total vascular occlusion (TVE), hepatic inflow occlusion and inferior vena cava occlusion, the degree of agreement was 97%, 81%, and 84%, respectively. In the event of the need for TVE during an extreme liver operation, 83% of the experts advise liver perfusion with a preservation solution, and 89% agree that the maximum ischemia time without using hypothermic perfusion should not exceed 45 to 60 minutes (Table 1).

Surgical Scenarios

The 2 main surgical scenarios considered by the majority as extreme liver surgery were an extended hepatectomy in an unhealthy liver with vascular reconstruction (78.3%) and a major liver resection for any etiology with 2 vascular reconstructions (78.3%). In contrast, according to the experts, the following surgical procedures were not considered an extreme liver surgery with a sufficient rate of agreement: (1) extended hepatectomy in healthy liver without vascular reconstruction (81%); (2) extended second stage hepatectomy (72.9%); and (3) major hepatic resection for liver trauma without vascular repair (78.3%). The remaining proposals did not reach a sufficient level of agreement (Table 2).

In situ liver resection (63.9%) was the preferred surgical approach, followed by ante situ (22.2%) and ex situ (13.9%). Autologous (51.35%) or cadaveric graft (37.84%) for hepatic artery or vein repair was the most recommended. A synthetic graft was most frequently recommended for inferior vena cava repairs (51.3%), followed by cadaveric (27%) and autologous (16.2%) grafts (Fig. 2). Portocaval shunt was mainly recommended in case of an ex situ approach (63.9%), and the use of veno-venous bypass was especially suggested for an ex situ (79.41%) and ante situ approach (70.59%) (Fig. 3).

Patient Profile and Indications

Overall, 81.6% of the experts agreed that chronological age alone is not a limit for performing an extreme liver surgery, while 84.2% considered that ASA 3 should be the upper limit. In patients with colorectal liver metastases or primary liver tumors and simultaneous extrahepatic disease (excluding single colorectal pulmonary metastases), most experts did not recommend performing an extreme liver surgery (71% and 73%, respectively). In contrast, in patients with noncolorectal non-neuroendocrine liver metastases and extrahepatic disease (excluding single pulmonary metastases) the degree of agreement was 63.1%. Some factors such as the presence of tumor markers above the values considered as poor prognostic factors or Child-Pugh A patients with portal hypertension (hepatic venous pressure gradient between 6 and 10 mm Hg) did not reach a sufficient degree of agreement (50% and 63.1%, respectively). The etiology (malignant or benign) influenced the decision-making in terms of surgical indication in 78.8% of respondents, and 86.9% recommended always performing a liver function testing before the procedure.

TABLE 1. Experts Agreement Regarding Suggested Definitions of Total Vascular Occlusion, Hepatic Inflow Occlusion or Inferior Vena Cava Occlusion, and Perfusion Recommendations Based on Ischemia Time

		n (%)						
	Questions	Median (IQD)	Totally disagree (1)	Disagree (2)	Neither agree nor disagree (3)	Agree (4)	Totally agree (5)	Agree+totally agree (%)
Q26	In your view, do you agree with the following total vascular occlusion definition? hepatic hilum+infra and suprahepatic inferior vena cava occlussion	5 (0.5)	0 (0)	0 (0)	1 (2.7)	16 (43.2)	20 (54.1)	97.3
Q27	In your view, do you agree with the following inferior vena cava occlusion definition? inferior vena cava occlusion preserving hepatic flow	4 (0.5)	1 (2.7)	4 (10.8)	2 (5.4)	17 (45.9)	13 (35.1)	81
Q28	In your view, do you agree with the following hepatic flow occlusion definition? occluding hepatic flow and hepatic veins without inferior vena cava occlusion	4 (0.5)	0 (0)	4 (10.8)	2 (5.4)	17 (45.9)	14 (37.8)	83.7
Q29	In your experience, would you recommend perfusion with a preservation solution during extreme liver surgery in a vascular occlusion scenario?	4 (0.38)	0 (0)	1 (2.8)	5 (13.9)	21 (58.3)	9 (25)	83.3
Q30	The maximum ischemia time without using hypothermic perfusion should not exceed 45-60 minutes	4 (0.5)	1 (2.8)	1 (2.8)	2 (5.6)	18 (50)	14 (38.9)	88.9
Q31	The maximum ischemia time with hypothermic perfusion should not exceed 120–150 minutes	4 (0.88)	1 (2.8)	8 (22.2)	4 (11.1)	19 (52.8)	4 (11.1)	63.9

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TABLE 2. Experts Agreement Regarding Suggested Definitions for the Main Surgical Scenarios Considered by the Majority as Extreme Liver Surgery

		n (%)						
	Questions	**Median (IQR)**	**Totally disagree (1)**	**Disagree (2)**	**Neither agree nor disagree (3)**	**Agree (4)**	**Totally agree (5)**	**Agree+totally agree (%)**
Q15	In your experience you do NOT consider an extended hepatectomy in a healthy liver without vascular reconstruction as an extreme liver surgery	5 (0.5)	2 (5.4)	1 (2.7)	4 (10.8)	16 (43.2)	14 (37.8)	81
Q16	In your experience, would you consider an extended hepatectomy in a non-healthy liver with vascular reconstruction as an extreme liver surgery?	5 (0.5)	0 (0)	4 (10.8)	4 (10.8)	18 (48.6)	11 (29.7)	78.3
Q17	In your experience you do NOT consider a second staged extended hepatectomy as an extreme liver surgery	4 (0.5)	0 (0)	7 (18.9)	3 (8.1)	16 (43.2)	11 (29.7)	72.9
Q18	In your experience, would you consider a major liver resection for any etiology with one vascular reconstruction (vein or artery) as an extreme liver surgery?	4 (0.5)	2 (5.4)	13 (35.1)	5 (13.5)	11 (29.7)	6 (16.2)	45.9
Q19	In your experience, would you consider a major liver resection for any etiology with two vascular reconstructions (vein and artery) as an extreme liver surgery?	4 (1)	1 (2.7)	6 (16.2)	1 (2.7)	16 (43.2)	13 (35.1)	78.3
Q20	In your experience you do NOT consider a minor liver resection for any etiology with one vascular reconstruction (vein or artery) as an extreme liver surgery	3 (1)	0 (0)	5 (13.5)	7 (18.9)	14 (37.8)	11 (29.7)	67.5
Q21	In your experience, would you consider a minor liver resection for any etiology with two vascular reconstruction (vein and artery) as an extreme liver surgery?	4 (0.5)	1 (2.7)	7 (18.9)	7 (18.9)	17 (45.9)	5 (13.5)	59.4
Q22	In your experience you do NOT consider a major liver resection for liver trauma without vascular repair as an extreme liver surgery	4 (1)	0 (0)	6 (16.2)	2 (5.4)	17 (45.9)	12 (32.4)	78.3
Q23	In your experience, would you consider any liver resection for liver trauma with vascular repair as extreme liver surgery?	4 (0.5)	1 (2.7)	8 (21.6)	7 (18.9)	15 (40.5)	6 (16.2)	56.7

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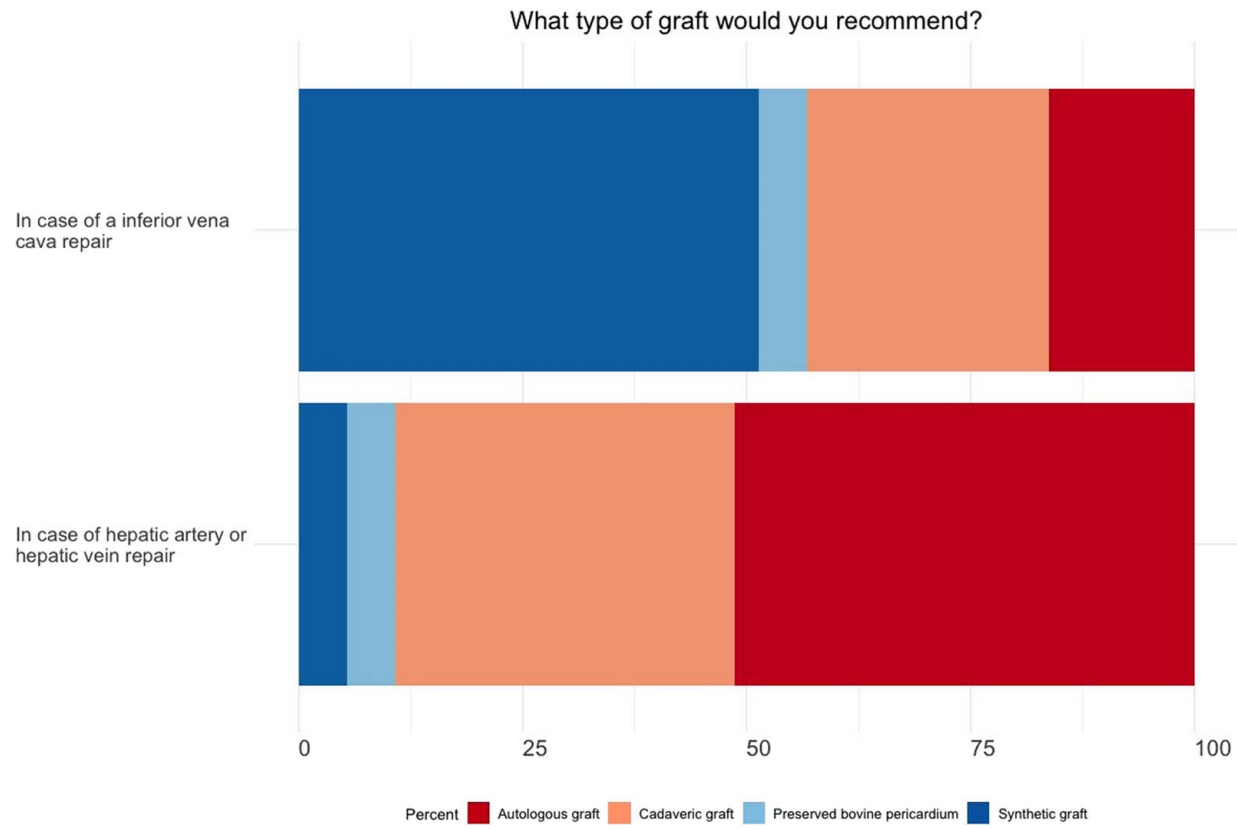


FIGURE 2. Expert recommendation regarding the type of graft to be used in case of the need to reconstruct the vena cava, hepatic artery, portal vein, or hepatic veins.

Short-term and Long-term Outcomes

Clavien-Dindo ≥3b complications ranging between 21% and 35% were considered by 41.46% of the experts as the maximum acceptable, followed by 36% to 50% (34.15%). In contrast, the most recommended maximum acceptable range of mortality was 6% to 10% by 39.02% of

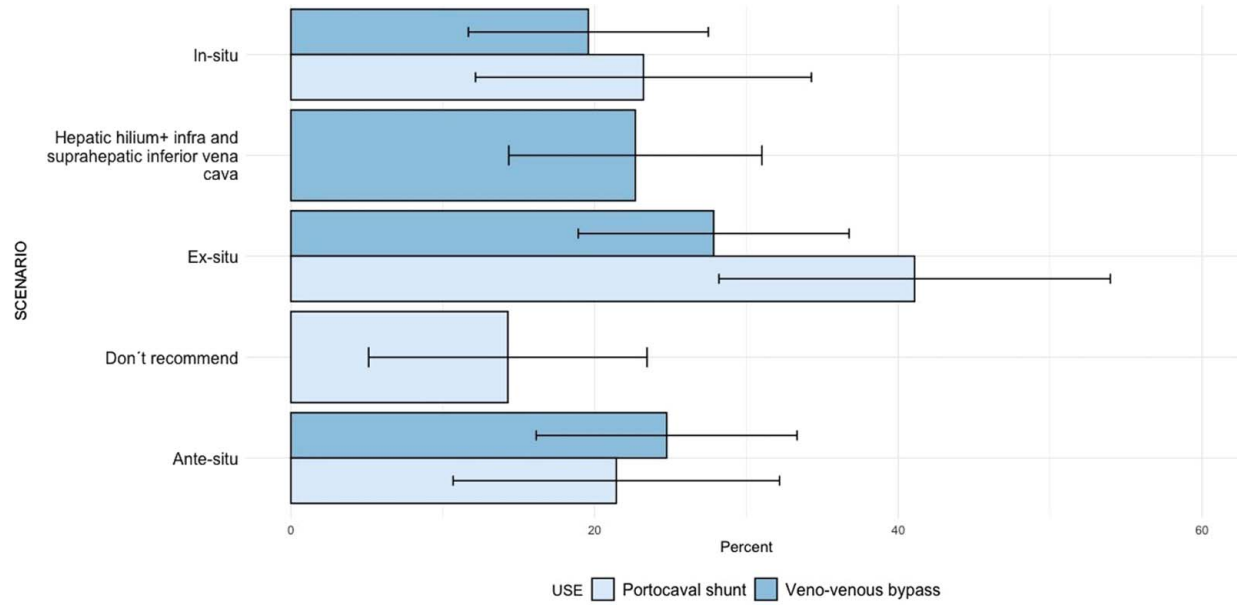


FIGURE 3. Expert recommendation on the use of portocaval shunt and veno-venous bypass according to the mains surgical approaches used in extreme liver surgery.

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respondents versus 11% to 15% or 1% to 5% by 26.83%, respectively. Even so, no $>70\%$ agreement was reached for a Clavien-Dindo $\geq 3b$ complication rate of 35% or a postoperative mortality of 10% as the maximum acceptable range for performing extreme liver surgery. Overall, 86.8% of respondents agreed that a minimum acceptable life expectancy of 12 to 24 months should be used to justify an extreme liver surgery, and 84.2% agreed that the post-operative quality of life should be taken into account.

Technical and Personality Surgical Limitations

For patients considered unresectable by centers with less experience in complex hepatobiliary surgery who may require extreme liver surgery, there was a 97.3% agreement that they should be referred to centers of reference in this type of surgical approach before abandoning in favor of palliative treatment. Furthermore, 100% of the experts agreed that the surgical expertise of the surgeon combined to the possibility to offer liver transplantation (always in case with no contraindication of liver transplant) in case of unexpected challenges influences the decision to perform an extreme liver surgery given the unique mental and physical demands of the procedure.

DISCUSSION

This is the first consensus of experts in highly complex hepatobiliary surgery on the definition of extreme liver surgery. To date, the use of this concept in patients with advanced hepatic disease has been examined on multiple occasions in the literature, but no unanimity has been obtained so far. This document lays the foundations for the main experts' recommendations on aspects of great relevance such as those related to a clear definition of extreme liver surgery, patient-specific profile, vascular occlusion concepts, perioperative outcomes, surgical approaches, and vascular graft selection.

The integration of hepatic and vascular resections for the removal of liver tumors represents a surgical option practised at a limited number of facilities specialized in hepatobiliary surgery and liver transplantation.[27–29] The implementation of this approach varies according to the surgical team's expertise. Consequently, the available evidence for this surgical approach is scarce and primarily derived from the individual experiences of each center.

The concept of futility related to tumor etiology in liver surgery refers to situations where surgical intervention is unlikely to provide significant benefit to the patient due to the nature and characteristics of the tumor. Decisions regarding liver surgery for tumors must be carefully balanced between the potential benefits and the risks. Determining the point at which extreme liver surgery is justified is complicated. The main aspects we have considered are the aggressiveness of the tumor (high grade and poor differentiation), rapid growth and early metastasis, advanced disease (multiple bilobar liver metastases or extrahepatic spread), cirrhosis, liver function, hepatic regenerative capacity, poor performance status, age and frailty, high likelihood of recurrence, lack of response to chemotherapy, or limited options for offering adjuvant therapy after surgery. Patients with an underlying liver disease and an insufficient future liver remnant ($<40\%$ standard liver volume) should not qualify for this type of surgery. Whether the tumor in question is malignant or benign also influences the surgical indication and in cases of extrahepatic malignant disease (with the exception of resectable limited colorectal pulmonary metastases) or unsurmountable invasion of hepatic structures, extreme liver surgery should not be performed.

For adequate selection of patients, benchmarking provides a comparative standard of best practices, outcomes and processes between different institutions and specialists. This process facilitates the identification of patients who are most likely to benefit from surgical procedures, ensuring that clinical decisions are based on robust evidence. Therefore, although there are no specific criteria for extreme liver surgery, the surveyed experts agreed that the benchmarking criteria that have been established for major liver resections including ALPPS (Associating Liver Partition and Portal vein ligation for Staged hepatectomy) or even liver transplantation should be followed until further evidence is obtained.[30–32]

The 3 mains surgical approaches used in extreme liver surgery are in situ, ante situ, and ex situ (Fig. 4). For the in situ approach, the liver is in its natural location. Techniques like vena cava clamping, ideal for lesions near major vascular structures are employed but are usually partial and of limited duration.[33] The ante situ technique involves mobilizing the liver by dividing the suprahepatic vena cava, therby obtaining better access to the hepatocaval confuence and the retro-hepatic space which allows removal of tumors, offering better hemodynamic stability.[14,21] Comparatively, ante situ demands more operating and bypass time than in situ. The ex situ technique, involves total hepatectomy for tumor excision on the back table, and any neccesary vascular reconstruction and then autotransplantation. It minimizes warm ischemia damage and facilitates bloodless tumor resection but increases risks due to longer surgery and external support needs. Literature indicates a shift away from ex situ due to high mortality rate, but recent studies note improved outcomes with higher resection rates and reasonable 1-year survival rates.[16]

Regarding the 3 techniques under consideration, our experts' recommendations manifested a trend to avoid using ex situ due to the greater risk of postoperative complications. Furthermore, as the majority of these surgeries can be performed without removing the liver, the experts felt that should be avoided whenever possible. The surgical approach is clearly determined by factors such as tumor characteristics, vascular invasion, liver function, and the experience of the surgical team. A careful, personalized choice of technique is vital to optimize patient outcomes while minimize risks.

Effective vascular control is crucial, especially for tumors near major vascular structures, where bleeding from injury can be life-threatening. Substantial bleeding and subsequent blood transfusions significantly increase morbidity and mortality risks following an extreme hepatectomy. The Pringle maneuver, which aims to control the inflow of blood, is ineffective against bleeding from the inferior vena cava or hepatic veins. Total hepatic vascular exclusion, involving clamping the inferior vena cava both above and below the liver along with occlusion of hepatic inflow is sometimes necessary, but may result in hemodynamic instability and its complications as well as a delayed recovery of liver and renal function.[34] An alternative, selective hepatic vascular exclusion, maintains inferior vena cava flow while occluding blood inflow and outflow, mitigating the drawbacks of TVE.[35,36]

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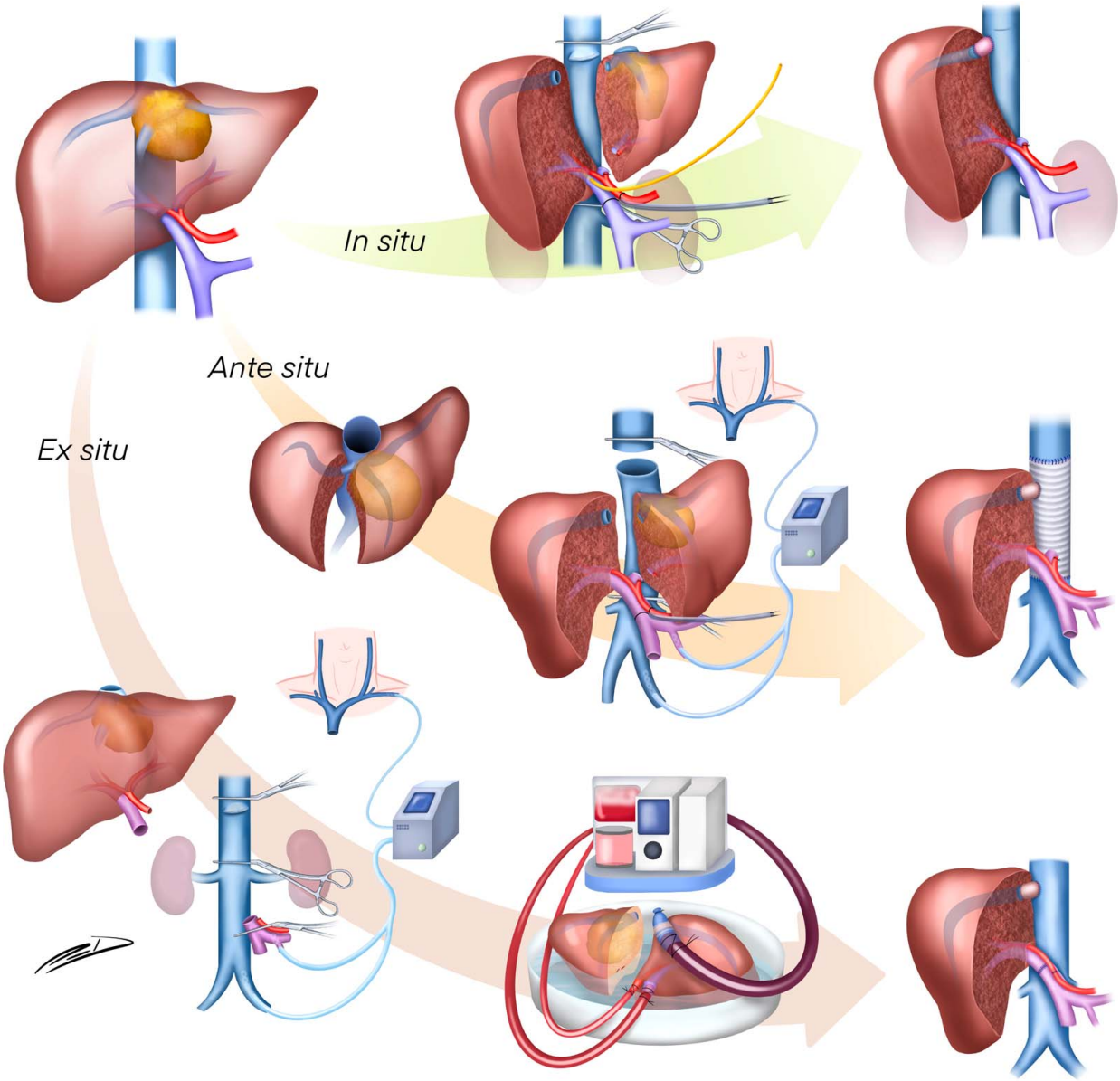


FIGURE 4. Summary of the different surgical strategies available for extreme liver surgery.

Hepatic inflow occlusion leads to liver warm ischemia-reperfusion injury (IRI), and the mechanisms are not fully understood. There is some evidence that ischemic preconditioning and intermittent clamping of the portal triad can provide protection against IRI in liver surgeries.[37] However, the additional clinical benefit of these strategies is under debate. Hypothermic liver perfusion via the portal vein was initially adopted to enhance ischemic tolerance of the liver. The duration for which the liver can endure TVE is reported to range from 30 to 120 minutes. Azoulay et al[33] described that prolonging TVE beyond an hour can lead to increased levels of postoperative bilirubin and transaminases, escalated complications, and mortality rates. The feasibility of withstanding even an hour of TVE is dubious, particularly when the remaining liver volume is limited, and liver function can be affected. This concern is shared by 88.9% of our experts who specify that when TVE exceeds 60 minutes, hypothermic liver perfusion should be used to safeguard the remaining liver. The potential benefit of using machine perfusion instead of simple cold perfusion solution has been recently described and raises new possibilities for improving the viability of the graft during surgery.[38]

In agreement with many reports, veno-venous bypass is deemed necessary to counter hemodynamic intolerance and splanchnic congestion, characterized by a drop in mean arterial pressure of over 30% or a decline in cardiac index by $>50\%$. The patient's hemodynamic status must be meticulously monitored, and veno-venous bypass should be employed whenever the patient can not endure hemodynamic fluctuations. In fact, a vast majority of surgeons recommended using veno-venous bypass when performing the ante situ and especially the ex situ approach, because it

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ensures hemodynamic stability of the patient. A portocaval shunt would be indicated mainly in the ex situ approach to avoid congestion of the splanchnic venous territory and the risk of hemorrhage when partial vascular occlusion is used.

When a vascular resection is indicated, autologous grafts are theoretically the first choice due to lower risk for thrombus and infection.[39] Even so, when a complete resection of the inferior vena cava is required, the use of synthetic grafts is the option most recommended by the majority of panelists according to their experience due to the low rate of infection, greater availability, and the technical simplicity of their placement. In contrast, in the scenario in which it is necessary to repair a smaller blood vessel in the hepatic remnant due to infiltration of the hepatic veins, hepatic artery or portal vein, autologous, and/or cryopreserved grafts are preferred by the experts. In some countries, a cadaveric graft cannot be used or for lack of donors or because rules do not allow to use cadaveric grafts for nontransplant patients. Alternatives would be peritoneal, bovine pericard, or synthetic grafts patches which are effectively employed in the replacement of vascular defects.

Extreme liver surgery should be performed in specialized hepatobiliary centers with a clearly structured unit dedicated to patients with HPB disease, dedicated staff, interventional radiologists, and gastroenterologists available 24/7, multidisciplinary boards specialized in HPB and the availability of a liver transplant team into the hospital or into another hospital within an established partnership.[40] Some centers may perform liver surgery, but performing liver surgery does not qualify for extreme liver surgery.

The concept of extreme liver surgery is not new, and the hepatobiliary surgery and liver transplant community has been referring to it for decades. The problem lies in the lack of unanimity regarding the criteria for what constitutes extreme liver surgery, its indications, outcomes, different approaches, and the standardization of the technique. A few years ago, this surgery was performed by a few groups, but nowadays, the evolution of modern oncological liver surgery has led more surgeons to propose this surgery for patients who previously did not have a surgical rescue option. This document should be used in the clinic by oncologic surgery departments to refer patients to specialized centers that perform this type of surgery, create clinical guidelines, and standardized protocols, help identify and define quality indicators, implement continuous improvement practices, minimize variability in clinical decision-making, define clear criteria for patient selection, and make recommendations that can reduce the incidence of surgical errors and improve patient safety.

The study has some limitations. In relation to the Delphi methodology, it is recognized that, despite efforts to include a wide range of opinions, the results may be subject to biases inherent to the selected expert panel. In addition, the qualitative approach to thematic analysis may introduce subjective interpretations. Selecting the appropriate experts for a Delphi consensus is a careful process that must consider the knowledge, experience, diversity, reputation, availability, impartiality, communication skills, and innovative capacity of the participants. In our case, the steering committee is composed of academic hepatobiliary surgeons who are highly esteemed in the hepatic surgery community. The participants had extensive experience and knowledge in the specific area under investigation. Experts who had published relevant articles, participated in international conferences, and received recognition in their field were valued. Diversity and representativeness were also considered, ensuring the participation of experts from different geographic regions to reflect a global perspective rather than being centered in one region. Those with previous experience in consensus or Delphi processes were also selected.

CONCLUSIONS

Many patients are often not considered for extreme liver surgery when, in fact, they could be suitable candidates for complex procedures performed at specialized centers. Reaching a consensus among experts on the treatment of patients with advanced liver disease affecting vascular structures is crucial, as it promotes the standardization of treatments, improves perioperative outcomes, and guides clinical practice towards the most effective and safe strategies. It also encourages collaborative research and prepares future generations while facilitating decision-making based on established knowledge. A collective agreement reduces treatment variability across different centers, optimizes resource use, and strengthens the confidence of both patients and health care professionals in the chosen therapies, thereby enhancing the quality of life of the patients. This present consensus in extreme liver surgery is vital to ensure the proper management of patients with highly complex hepatobiliary oncologic diseases based on adequate patient selection and allocation to the appropriate surgical strategy.

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