Updates in Surgery
https://doi.org/10.1007/s13304-021-01100-9

ORIGINAL ARTICLE

The Italian Consensus on minimally invasive simultaneous resections for synchronous liver metastasis and primary colorectal cancer: A Delphi methodology

Aldo Rocca[1,2] · Federica Cipriani[3,4] · Giulio Belli[5] · Stefano Berti[6] · Ugo Boggi[7] · Vincenzo Bottino[8] · Umberto Cillo[9] · Matteo Cescon[10] · Matteo Cimino[11] · Francesco Corcione[12] · Luciano De Carlis[13] · Maurizio Degiuli[14] · Paolo De Paolis[15] · Agostino Maria De Rose[16] · Domenico D'Ugo[17] · Fabrizio Di Benedetto[18] · Ugo Elmore[4,19] · Giorgio Ercolani[20] · Giuseppe M. Ettorre[21] · Alessandro Ferrero[22] · Marco Filauro[23] · Felice Giuliante[16] · Salvatore Gruttadauria[24] · Alfredo Guglielmi[25] · Francesco Izzo[26] · Elio Jovine[27] · Andrea Laurenzi[20] · Francesco Marchegiani[9] · Pierluigi Marini[28] · Marco Massani[29] · Vincenzo Mazzaferro[30] · Michela Mineccia[21] · Francesco Minni[31] · Andrea Muratore[32] · Simone Nicosia[27] · Riccardo Pellicci[33] · Riccardo Rosati[4,19] · Nadia Russolillo[22] · Antonino Spinelli[35,36] · Gaya Spolverato[34] · Guido Torzilli[11] · Giovanni Vennarecci[37] · Luca Viganò[11] · Leonardo Vincenti[38] · Paolo Delrio[39] · Fulvio Calise[2] · Luca Aldrighetti[3,4]

Received: 3 May 2021 / Accepted: 12 May 2021

Abstract

At the time of diagnosis synchronous colorectal cancer, liver metastases (SCRLM) account for 15–25% of patients. If primary tumour and synchronous liver metastases are resectable, good results may be achieved performing surgical treatment incorporated into the chemotherapy regimen. So far, the possibility of simultaneous minimally invasive (MI) surgery for SCRLM has not been extensively investigated. The Italian surgical community has captured the need and undertaken the effort to establish a National Consensus on this topic. Four main areas of interest have been analysed: patients' selection, procedures, techniques, and implementations. To establish consensus, an adapted Delphi method was used through as many reiterative rounds were needed. Systematic literature reviews were conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses instructions. The Consensus took place between February 2019 and July 2020. Twenty-six Italian centres participated. Eighteen clinically relevant items were identified. After a total of three Delphi rounds, 30-tree recommendations reached expert consensus establishing the herein presented guidelines. The Italian Consensus on MI surgery for SCRLM indicates possible pathways to optimise the treatment for these patients as consensus papers express a trend that is likely to become shortly a standard procedure for clinical pictures still on debate. As matter of fact, no RCT or relevant case series on simultaneous treatment of SCRLM are available in the literature to suggest guidelines. It remains to be investigated whether the MI technique for the simultaneous treatment of SCRLM maintain the already documented benefit of the two separate surgeries.

Keywords Colorectal cancer · Synchronous colorectal liver metastases · Minimally invasive surgery · Consensus

Introduction

At the time of diagnosis, synchronous colorectal cancer liver metastases (SCRLM) account for 15–25% of patients, thus representing a significant, but challenging, clinical picture in terms of strategy of management [1–6]. If primary tumour and synchronous liver metastases are—or become—resectable, good results may be achieved performing surgical treatment well incorporated into the chemotherapy regimen [7–9].

Aldo Rocca and Federica Cipriani have equally contributed to the paper.

Paolo Delrio, Fulvio Calise, and Luca Aldrighetti have equally contributed to the paper.

✉ Aldo Rocca
aldo.rocca@unimol.it

Extended author information available on the last page of the article

Published online: 05 June 2021

There is a wide range of feasibility for simultaneous resections, but caution has been raised for major liver resections or colorectal cancer (CRC) complicated tumour considering that delayed surgery might be beneficial for patients in terms of post-operative risk and outcomes [10, 11].

Minimally invasive (MI) approach has changed the surgical scenario, since colorectal resection is routinely performed laparoscopically [12–15] and all liver segments may be now approached trough MI liver surgery [16]. The international position on the role of MI liver surgery has been extensively discussed and defined in the two expert consensus held in Louisville 2008 and Morioka 2014, and as dedicated guidelines in Southampton 2017 [17–19].

So far, the possibility of simultaneous MI surgery for SCRLM has not been extensively investigated. The Italian surgical community has, therefore, captured the need and undertaken the effort to establish a National Consensus on this topic using a modified Delphi method [20], currently the most available tool to analyse gross data in a large context.

Four main areas of interest have been analysed: patients' selection, procedures, techniques, and implementations.

Methods

The Consensus development process was endorsed by the Italian Society of Surgical Oncology (SICO), the Italian Group Of Minimally Invasive Surgery (IGOMILS), the Association of Italian Hospital Surgeons (ACOI), the Italian Society of Surgery (SIC) and the Italian Association of Hepato–Biliary and Pancreatic Surgery (AICEP).

To establish consensus, an adapted Delphi method was used through as many reiterative rounds were needed [20]. Systematic literature reviews were conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses instructions [21]. The Oxford Centre for Evidence-Based Medicine method was adopted to assess the study quality, the level of evidence and to assign the grade of recommendations [22].

The Consensus took place between February 2019 and July 2020. The project was conceived by three expert liver surgeons and two expert colorectal surgeons and led by two younger surgeons.

They covered the role of Project Coordinators during the whole period establishing the development methodology and involvement of expert professionals (Online Appendix 1).

The consensus coordinators were FC, LA, PD, MDG, RP, AR, and FeC.

Roles:

- Conception of the project.
- Establishment of the global methodology at the base of the process.
- Identification of experts to cover roles and develop tasks.
- Identification of relevant clinical topics.
- Approval of proposed clinical queries (CQs).
- Amalgamation of proposed statements, summary of voting agreement.

The Steering Committee (SC) and Review Committee (RC) were composed by surgeons of seven main centres devoted to MI surgery (Online Appendix 1).

Roles:

- Formulation of CQs.
- Literature review.
- Assessment of study quality and level of evidence.
- Formulation of recommendations.

The expert panel (EP) was composed by 15 senior surgeons (Online Appendix 1).

Role:

- Voting agreement to proposed recommendations.
- Highlighting critical issues of proposed recommendations.

Selection of members of the steering committee and the expert panel was made according to the case contribution from centres applying to the IGOMILS Registry.

More in detail, clinically relevant items were identified and grouped into four main areas of interest (Table 1). Each item was assigned to the SC to formulate the specific CQs. After approval of the CQs by the Project Coordinators, the SC and RC worked on the production of recommendations. Comprehensive systematic literature reviews were performed in PubMed, Scopus, EMBASE and Cochrane databases (until January 2020) using pertinent key searches (Online Appendix 2).

Considering the high specificity of topics and the low volume of available literature, no time frame was identified. Exclusion criteria were non-English articles and unavailable full-text. Each group produced evidence-based statements from the available literature, assigning the grade of recommendations.

Statements by the SC were addressed to the coordinators who built a questionnaire to get consensus by the EP. Based on an on-line survey platform, members of the EP individually expressed their level of agreement to each statement, thus providing a blinded evaluation. A voting scale from 1 (total disagreement) to 9 (total agreement) was adopted. Based on a selected published cutoff [23], <3 points were considered as disagreement, 5 points as neuter opinion, >7 points as agreement.

Consensus was reached if 75% of participants rated ≥ 7 or ≤ 3 [23].

Table 1 Main areas of interest

Patients' selection Items	Procedures Items	Techniques Items	Implementation Items
1. High-risk patients	3. Non-complex ColoRectal Cancer procedures	10. Outcomes: resection margins, harvested lymph nodes, mean hospital stay and complications	15. Training
2. Previous abdominal surgery	4. Complex ColoRectal Cancer procedures	11. Intra-operative staging techniques for liver resections	16. Registries and learned societies
	5. Right colon cancer anastomosis	12. Trocar placement	17. Surgeons
	6. Minor liver resections/left lateral sectionectomy	13. Bleeding and conversion	18. Centres
	7. Major liver resection/posterosuperior segments	14. Minimally invasive approaches and devices	
	8. Two-stage hepatectomies including ALPPS		
	9. Emergency and technically complex disease		

Statements not reaching consensus at the first Delphi round were readdressed to the members of the EP for comments on specific critical issues and consequent reformulation of statements by the SC. The modified statements entered a second Delphi round as previously stated. Statements failing to reach agreement after more than three rounds were removed, to provide only clear and shared recommendations.

Results

Twenty-six Italian centres participated in the consensus.

Four main areas of interests and 18 clinically relevant items were identified.

Thirty-six statements were produced. After a total of 3 Delphi rounds, 33 recommendations initially formulated reached expert consensus establishing the herein presented guidelines. Three statements were removed as failed to reach agreement.

Topic 1 patient selection

- High-risk patients

Q1: Is simultaneous colon and major/minor liver laparoscopic resection indicated in patients ≥ 75 years?

Age ≥ 75 years should not be considered an absolute contraindication to combined colon and liver laparoscopic resection. Minimally Invasive Simultaneous Colon/Rectal and Minor Liver Resection is safe and feasible in patients ≥ 75 year of age without major comorbidities. Simultaneous Major liver resection should be reserved to highly selected cases.

Level of evidence 4.

Grade of recommendation C.

Q2: Is simultaneous colon and minor liver laparoscopic resection indicated in fragile patients (ASA 4 and/or PS > 2)?

In fragile patients (i.e. ASA 4 and/or PS > 2), Colon and Minor Liver Resection should be preferably deferred, and simultaneous surgery indicated only in cases of low surgical complexity.

Level of evidence 4.

Grade of recommendation C.

It has long been recognised that advanced age can carry increased operative risk after surgery. However, Ferretti et al. demonstrated that frailty and operative time are better predictors of morbidity after combined MI Simultaneous Colon-Rectal and Liver Resection than chronological age [24]. Indeed, patients of the same age do not all have the same risk. Preoperative identification and assessment of frailty must be more detailed for identification of vulnerable surgical patients to choose the appropriate surgical management. In this context, age ≥ 75 years should not be considered an absolute contraindication to combined colon and liver laparoscopic resection. In real practice, MI Simultaneous Colon/Rectal and Minor Liver Resection is safe and feasible in patients ≥ 75 years of age without major comorbidities. However, minor hepatectomies encompass a wide range of procedures [25]. Therefore, evaluation of

the cumulative operative risk of both procedures (liver and colorectal resection) must also be considered when performing pre-operative assessment. Benefits of the MI approach could be nullified by excessive extended operating time. In fragile patients (i.e. ASA 4 and/or PS > 2) Colon and Minor Liver Resection should be preferably deferred, and simultaneous surgery indicated only in cases of very low surgical complexity.

Q3: Is simultaneous colon and major/minor liver laparoscopic resection indicated in patients with BMI > 30 kg/m^2?

The few data available concerning patients with BMI > 30 kg/m^2 do not allow to generate recommendations regarding safety and feasibility of Combined Minimally Invasive Colon and Major/Minor Liver Resection, but it should be not considered a contraindication. Likely robotic-assisted surgery may minimise conversion to laparotomy and complications.

Level of evidence 4.

Grade of recommendation C.

Obesity rates are increasing worldwide as a result of lifestyle changes. Obesity is generally considered to be associated with increased technical difficulties in surgery and increased operative risk. Ferretti et al. showed that BMI is poorly related to post-operative morbidity at univariate analysis, but this result was not confirmed in multivariate analysis where ASA and longer operative time outweigh BMI impact on post-operative morbidity [24]. In both laparoscopic colorectal and hepatic surgery, BMI is a predictor of longer operation times with high conversion rate, but benefits of the laparoscopic approach may overcome these limitations. Analysis of all series on MI Simultaneous Colon-Rectal and Liver Resection showed that less than 5% of patients analysed had a BMI > 30 kg/m^2. Therefore, it is not possible to generate recommendations regarding safety and feasibility of Combined MI Colon and Major/Minor Liver resection, but it should not be considered "per se" a contraindication. At the moment, there is no evidence of an improvement in results with the robotic approach; however, the promising results obtained in obese patients in other surgeries should recommend exploring this field in the context of clinical trials.

Q4: May we indicate a cutoff of severity of the underlying liver disease (metabolic disease, chemotherapy-related liver injury, and cirrhosis) for simultaneous colon and liver laparoscopic resection?

Few available data concerning patients with underlying liver disease do not allow to generate recommendations regarding safety and feasibility of Combined Minimally Invasive Colon and Major/Minor Liver Resection. Few investigations on chemotherapy-associated liver injury (CALI) are related to low liver burden disease of these patients, who do not need intensive neoadjuvant chemotherapy. The proposal recommendation is to adopt the same exclusion criteria recognised for open surgery.

Level of evidence 4.

Grade of recommendation C.

On this topic, too few patients have been analysed and this can explain the absence of data regarding the impact of CALI on post-operative outcome in patients undergoing Combined MI Colon and Major/Minor Liver Resection. In the international multicentre series reported by Ferretti et al., neoadjuvant chemotherapy was administered in only 17.6% of patients and among exclusion criteria are reported factors as decompensated cirrhosis, oesophageal varices grade > 1 and platelets count < 80×10^9/L are reported [24]. The strict selection of patients is moreover evident analysing the series reported by Tranchart et al. in which 92% of patients had undergone atypical liver resection or left lateral sectionectomy, and by Shin et al. who reported > 70% of patients with 1 or 2 liver segmental involvement [26, 27]. In a multicentre series comprising 788 patients who underwent hepatectomy for colorectal liver metastases, Zhao et al. (on behalf of the CALI consortium), recently showed an increase in post-operative major morbidity and liver failure in patients with severe sinusoidal dilatation and increase in liver surgery-specific complications in patients with steatohepatitis [28].

- Previous abdominal surgery

Q5: Is simultaneous colon and liver laparoscopic resection indicated in patients already undergone abdominal or pelvic surgery?

Previous abdominal or pelvic surgery should be not considered a contraindication in patients scheduled for Combined Minimally Invasive Colon and Major/Minor Liver Resection.

Level of evidence 4.

Grade of recommendation C.

As for obese patients, as of patients who have already undergone previous abdominal or pelvic surgery, there are no data in the literature that allow to generate recommendations. However, in real practice, previous surgery should

not be considered an absolute contraindication in patients scheduled for Combined MI Colon and Major/Minor Liver Resection.

Topic 2 procedures

- Non-complex CRC procedures

Q6: During simultaneous right/left colon and liver minimally invasive resections, is it recommended to perform liver surgery first?

It is recommended to start with the theoretically more difficult procedure based on patient specific characteristics and considering the expertise of the surgical team.

Level of evidence 4.

Grade of recommendation C.

Arguments in favour of liver resection performed before colon resection:

– The low central venous pressure needed to minimise the blood loss and not to interfere with the subsequent fluid resuscitation and colorectal resection;
– The opportunity to change surgical strategy from a simultaneous procedure to a "liver first" resection [29].

However, some authors argued that working first on the healthy colic tissue, avoiding the possible venous congestion of the colonic wall caused by a prolonged Pringle manoeuvre is safer [30].

Furthermore, the evaluation of the primary tumour and its resectability should be assessed before treating liver metastases [31].

In addition, the possibility of a symptomatic colorectal tumour requiring "a colon then liver" approach or a major liver resection requiring "a liver then colon" approach should drive the pre-operative decision [32].

A possible solution suggested by the literature could be to perform the liver resection after the mobilisation of the colon and before the colonic anastomoses (or diversion) [33].

Q7: Is it advisable to minimise the use of Pringle manoeuvre in case of simultaneous non-complex colorectal and liver minimally invasive resection?

A portal triad clamping (Pringle's manoeuvre) should be always prepared but it should be applied selectively, only in case of bleeding.

Level of evidence 4.

Grade of recommendation C.

The portal triad clamping (Pringle's manoeuvre) consists of intermittent cross-clamping of the hepatoduodenal ligament while performing liver transection.

Some authors claimed that the adoption of this manoeuvre during combined colon and liver resection can be cause of transient portal hypertension leading to an increased risk of anastomotic leakage because of the onset of intestinal oedema [34, 35].

The same authors showed in two systematic reviews that the portal triad clamping was frequently prepared but rarely adopted by the majority of surgeons [34, 35].

Furthermore, it was demonstrated that portal triad clamping was associated to increased risk for post-operative complications after combined colon and liver resection [24].

However, no adequate evidence is available to correlate the adoption of portal triad clamping with increased rate of colorectal anastomosis leakage, while a correlation between blood loss and worse clinical outcomes has been clearly demonstrated [36].

- Complex CRC procedures

Q8: Is diverting stoma recommended in simultaneous rectal and liver minimally invasive resection?

There are no evidences supporting an increased risk of intestinal complication during simultaneous MI rectal and minor liver resection. In these cases, the indications to a diverting stoma should be the same than in rectal surgery alone.

Level of evidence 2a.

Grade of recommendation B.

Data from meta-analysis of randomised controlled trials (RCT) showed that stoma may reduce the rate of anastomotic leak and reoperation after surgery for low rectal cancer [37, 38].

As reported by a recent meta-analysis, the rate of abdominal abscess and anastomotic leak after open simultaneous and delayed hepatectomy for synchronous colorectal tumours are similar [39].

In addition, the laparoscopic approach would seem not to increase the rate of intestinal complications as reported by a propensity score-matched study comparing 61 simultaneous laparoscopic colorectal and liver resections and 61 colorectal resections alone [40].

For these reasons, it is reasonable to conclude that there are no evidence supporting an increased risk of intestinal complication during simultaneous MI upper rectal surgery and minor liver resection. In these cases, the indications to a diverting stoma should be the same of rectal surgery alone.

Q9: Is there a role for the laparoscopic approach for simultaneous complex colon-rectal surgery and major/minor liver resections?

Simultaneous laparoscopic resection of upper rectal cancer and low burden liver metastases (requiring minor resection) is safe and associated to shorter hospital stay compared to open approach.

Level of evidence 3a.

Grade of recommendation B.

Numerous cases series showed the feasibility and safety of simultaneous colorectal and liver surgery with both open and laparoscopic approaches [26, 29, 32, 40–43]. However, the rate of rectal surgery in the main series is low/very low.

According to a case-matched series including more than five rectal resections, the advantages of the laparoscopic approach vs open seems to be confirmed in terms of blood loss and length of the hospital stay [29, 41–43].

No difference was reported concerning post-operative morbidity rate [26].

Contraindications to simultaneous mini-invasive rectal and major liver resections have been reported in high-risk patients (according to ASA score and performance status) [8].

- Right colon cancer anastomosis

Q10: Is intracorporeal anastomosis (IA) as safe and effective as extracorporeal anastomosis (EA) during simultaneous right colon and liver minimally invasive resection?

IA is safe as EA when performed by proficient surgeons in isolated right colectomy, IA could also be used in simultaneous laparoscopic resection of right colon cancer and liver metastases.

Level of evidence 4.

Grade of recommendation C.

One of the most debated items in MI right colon resection is certainly the IA versus EA. A total 76 patients are reported in the literature undergoing MI simultaneous IA and liver resections [36, 43–49]. IA is safe and effective in experienced hands and leakage might not be necessarily related to the anastomotic technique. Simultaneous liver procedures did not increase post-operative complication rate [45, 50–54].

- Minor liver resections/left lateral sectionectomy

Q11: Should all minimally invasive resections of anterior liver segments and left lateral sectionectomies combined with CRC resection be considered "easy" procedures? What criteria should be used to stratify their complexity?

The term minor resections of anterior segments and left lateral sectionectomy encompasses heterogeneous procedures at different complexity. To date, the IWATE criteria are the most reliable ones to stratify complexity of laparoscopic liver resections. Minor resections of anterior segments and left lateral sectionectomies with an Iwate score ≤ 3 may be considered as easy procedure in case of associated CRC resection.

Level of evidence 4.

Grade of recommendation C.

Q12: May "easy" minor liver resection/left lateral sectionectomy (IWATE score ≤ 3) combined with CRC resection be considered as a standard laparoscopic procedure?

Simultaneous laparoscopic "easy" minor resection/left lateral sectionectomy (Iwate score ≤ 3) associated with CRC resection is a standard procedure if not contraindicated by patient's condition and/or by complexity of CRC resection.

Level of evidence 4.

Grade of recommendation C.

Minor hepatectomies are the vast majority of procedures reported in the series of laparoscopic simultaneous resections, but they encompass a wide range of procedures having heterogeneous complexity and outcome [24–26, 36]. No RCT comparing simultaneous open and laparoscopic resections with open is available, but some propensity score matching analyses have been published.

Some classifications and scores have been proposed to stratify laparoscopic minor hepatectomies [55–59], but a difficulty index according to IWATE criteria ≤ 3 identifies the easiest resections [56].

Although no papers have been focusing on easy hepatectomies, we may assume the feasibility, safety, and oncological efficacy and the clinical benefits of easy synchronous laparoscopic resections with a difficulty index ≤ 3 [24, 26, 29, 36, 42, 60].

In all series, patients' characteristics and primary tumour data (staging and complexity of resection) were considered to select candidates for simultaneous laparoscopic resection.

- Major liver resections—posterosuperior segments

Q13: Is there a role for simultaneous minimally invasive liver resection on the posterosuperior segments and colorectal surgery?

Simultaneous colorectal and liver resection in the posterosuperior segments can be feasible with a MI technique. However, the evidence to support that this approach may produce similar or better results of the combined open is insufficient. Therefore, they have to be considered an option in experienced hands and for selected patients.

Level of evidence 4.

Grade of recommendation C.

Q14: Is there a role for simultaneous minimally invasive major hepatectomies and colorectal surgery?

Simultaneous colorectal and major liver resection may be feasible with a MI technique. However, the evidence to support that this approach may produce similar or better results of the combined open is insufficient. Therefore, it is not recommended an expansion of the indications compared to what is currently defined for the open approach.

Level of evidence 4.

Grade of recommendation C.

Major or posterosuperior liver resection combined with colorectal surgery is demanding. Retrospective comparative studies show that combined laparoscopic major liver and colorectal resections are feasible, with perioperative outcomes globally not inferior to open and some benefits [36, 61, 62]. However, the data are based on a limited number of treated patients. Existing oncosurgical consensus on SCRLM judge the evidence still controversial to recommend simultaneous major liver and colorectal resections [7, 8].

In addition, guidelines on laparoscopic liver surgery define insufficient evidence to support similar outcomes between laparoscopic and open combined major liver and colorectal resections [19]. Specific literature on laparoscopic combined posterosuperior liver and colorectal resections is absent: few treated patients have been described in mixed series of synchronous resections [30, 36, 63]. Therefore, the indications derive from the literature on laparoscopic posterosuperior liver resections [64–66]. Theoretically, the two laparoscopic operations should not increase perioperative risks with respect to open.

- Two-stage hepatectomies including ALPPS

Q15: In case of needed two-stage hepatectomy, is there a role for the minimally invasive first step liver treatment and simultaneous colorectal resection?

Simultaneous resection of primary tumour during the first step of a classic two-stage hepatectomy for SCRLM may be considered feasible and safe.

Level of evidence 4.

Grade of recommendation C.

The hepatic burden of disease and the pattern of SCRLM distribution may require two-stage liver resection strategy to achieve a free margin.

In the literature, only two retrospective observational studies have been published describing this subclass of patients [67, 68].

Evidences are LOW (case series, case reports) [69–72]. Collected data showed an acceptable complications rate (12.5%), overall morbidity (35.2%) and mortality rate (2.7%) [51, 73–86].

Q16: Is it safe to perform minimally invasive colorectal surgery and simultaneous ALPPS (first step)?

To date, we cannot recommend to perform combined primary tumour resection and first step of ALPPS for SCRLM.

Level of evidence 4.

Grade of recommendation C.

Data were collected from 1 case series including 31 patients and 4 case reports. Total complication rate was 50% with a 90-day mortality was 8% [68].

To date, associating ALPPS procedures combined with primary tumour resection is not recommendable. Evidences are

LOW (case series, case reports) [69, 71, 78, 80]. Therefore, more data are needed.

- Emergency and technically complex disease

Q17: Is there a role for minimally invasive colorectal surgery and simultaneous minor liver resection in the haemorrhagic patients?

"According to present evidence, there is no indication for simultaneous resection in the haemorrhagic patients".

Level of evidence 4.

Grade of recommendation C.

There are currently no reports in the literature about synchronous colorectal and liver resection in patients with bleeding CRC and liver metastasis. This may be influenced by several factors: low incidence of surgery for bleeding in patients with CRC (< 4%) [87, 88] and the non-optimal anaesthetic setting for simultaneous liver resection (i.e. haemodynamic instability, need of massive intra-venous fluid administration). There are few reports on emergency liver resection for ruptured hepatocellular carcinoma that show an increased mortality and morbidity rate of 12% and 40%, respectively, if compared to planned liver resection [89].

In the paper by the Association Française de Chirurgie, laparoscopic colorectal resection may have a mortality up to 30% when multiple of the following factors are present: emergency setting, synchronous liver metastasis, age > 70 years, vascular-respiratory-neurological comorbidities and malnutrition [90].

Q18: Is there a role for simultaneous colorectal and liver laparoscopic resection for Iwate score ≥ 4?

Synchronous Colorectal and Liver resection are safe and feasible in intermediate Iwate score 4–5–6. Advanced-Expert resections reserved to selected patients and high-volume centres.

Level of evidence 4.

Grade of recommendation C.

Iwate scoring system recognises four different levels of difficulty (low, intermediate, advanced, expert) in laparoscopic liver resections according to the sum of different items which include: tumour location, tumour size, proximity to major vessels, extent of liver resection, Hand Assisted Laparoscopic Surgery/Hybrid and liver function. A score ≥ 4 includes the intermediate, advanced and expert resections [55].

Among 422 synchronous resections reported in the literature, the rate of intermediate-advanced-expert liver resection is 21%, 14% and 0.5%, respectively [29, 30, 32, 33, 36, 44, 49–51, 62, 63, 91–95]. Simultaneous resections are safe and feasible, with a faster recovery and comparable outcomes. However, there are no subgroup analysis, no comparisons of results between Iwate score < 4 (i.e. left lateral sectionectomy) and ≥ 4 with no analysis of different types of Iwate ≥ 4 (i.e. segment 7 resection vs right hepatectomy) [55]. Therefore, synchronous resections (Iwate ≤ 6) are safe and feasible. Iwate > 6 resections are indicated only for highly selected patients and high-volume centres.

Topic 3 techniques

- Outcomes: resection margins, harvested lymph nodes, mean hospital stay and complications

Q19: Is minimally invasive surgical approach as adequate as open for lymphadenectomy during CRC resections and simultaneous liver resection?

Colorectal Lymphadenectomy during Combined Colon and Liver MI Resection is as effective as during open approach.

Level of evidence 3a.

Grade of recommendation B.

Q20: Is minimally invasive surgical approach as adequate as open for liver resection margin during simultaneous colorectal resection?

There are no differences regarding liver resection margin between simultaneous MI and open approach.

Level of evidence 3a.

Grade of recommendation B.

A review including several RCT has supported the effectiveness and similar oncologic outcomes of MI colectomy compared with open surgery in the setting of isolated colon cancer [96]. As of lymphadenectomy, revision of four case-matched studies comparing MI and open approach including a total of 75 matched patients, showed no significant differences regarding adequacy of lymphadenectomy (including harvested lymph nodes) between the two approaches [29, 36, 61, 97].

Recently, in the setting of hepatic surgery, two RCT supported the effectiveness and non-inferior oncologic outcomes of MI resection for colorectal metastasis [98, 99]. However, in both these RCT is evident that included patients

had low liver burden disease (one or two metastases). Looking at liver resection margin, 5 case-matched studies including a total of 162 matched patients, showed no significantly differences in R0 resection rate between MI and open approach [26, 29, 32, 36, 61].

Q21: Does laparoscopic approach for simultaneous colon and liver resection reduce complications rate compared to open?

Compared to open approach, combined Colon and Liver Laparoscopic Resection in selected patients reduces post-operative morbidity and severity of the complications whenever occurring.

Level of evidence 2a.

Grade of recommendation B.

Q22: Does laparoscopic approach for simultaneous colon and liver resection reduce post-operative stay compared to open?

Combined Colon and Liver Laparoscopic Resection in selected patients reduces post-operative stay compared to open approach.

Level of evidence 2a.

Grade of recommendation B.

A recent meta-analysis of 10 comparative studies including 502 patients showed that the surgical complications were fewer and post-operative stay shorter in the MI group than in the open one, emphasising safety and efficacy of the MI approach [100]. A lower morbidity rate (20.2% vs 33%) was also showed by Shin et al. in 109 patients after a propensity score matching analysis in a similar group of patients [27]. Interestingly, Ratti et al. showed that post-operative morbidity index was significantly lower in the laparoscopic group [36].

- Intra-operative staging techniques for liver resections

Q23: Intra-operative staging during minimally invasive approach for simultaneous colon and liver surgery: is it mandatory before liver resection?

IOUS should be performed in all patients undergoing surgery for colorectal liver metastases to improve pre-operative staging of hepatic disease.

Level of evidence: 3b.

Grade of recommendation B.

Several surgical series have reported the superiority of intra-operative liver ultrasound (IOUS) to stage hepatic disease in colorectal liver metastases compared with various imaging modalities [101–107]. The improvements of radiological techniques over the years (especially MRI) represent a challenge for the current role of IOUS. As expected, the rate of new metastases found by IOUS decreased in the most recent series but remains noteworthy, ranging from 8 to 21%. A recent paper confirms the superiority of IOUS in a large series of patients all studied with pre-operative MRI [108]. Most of the data on IOUS accuracy come from studies on open liver surgery [101–105]. Nevertheless, some authors suggested that the laparoscopic and open IOUS have a similar performance even if the learning curve of laparoscopic IOUS remains to be clarified [109]. In conclusion, IOUS should be performed in all patients undergoing surgery for colorectal liver metastases to improve pre-operative staging of hepatic disease.

Q24: Intra-operative staging during minimally invasive approach for simultaneous colon and liver surgery: may it change the combined strategy?

Intra-operative liver ultrasound can change the liver surgical strategy and accordingly the convenience to perform simultaneous colorectal and liver surgery. For this reason, the first step during simultaneous colorectal and liver surgery is supposed to be intraoperative liver ultrasound.

Level of evidence 3b.

Grade of recommendation B.

No studies analysing the need for conversion from a simultaneous to a staged approach due to intraoperative liver findings are available. The impact of IOUS on liver resection planning depends strongly on the attitude of the individual surgeon: the more a parenchyma-sparing policy is adopted, the more the operative strategy can be modified. For this reason, there is a wide variation on change in planned surgical strategy (from 1.4 to 72%). In conclusion, intraoperative liver ultrasound can change the surgical strategy on the liver and accordingly the convenience to perform simultaneous colorectal and liver surgery. For this reason, the first step during simultaneous colorectal and liver surgery is supposed to be IOUS.

- Trocar placement

Q25: What is the optimal trocar setting for a simultaneous colon and liver laparoscopic resection?

Laparoscopic simultaneous colorectal and liver resection can be feasible with a trocar configuration that depends on the laterality of both procedures, the patient's decubitus and the surgeon's position. The principles of triangulation between optical and operating ports should be taken as a general guidance to ensure comfortable instrument

ergonomics for both the first operator and assistant, as well as good exposure and adequate view during all the operation steps.

In general, not less than four active accesses for each resection are recommended.

Level of evidence 5.

Grade of recommendation D.

The number and the position of trocars varies depending on: the laterality and type of colorectal resection (left- or right-sided or rectal) and liver resection (left- or right-sided or posterosuperior segments, major or minor), which resection is performed first and the equipe's own technique including the position of both the surgeon and the patient (supine, semi decubitus, semi prone, partial tilting) (Fig. 1 shows an example of trocar placement based on the statement above).

The reported number of trocars varies from 4 to 9 in pure laparoscopic access [110, 111]. Hybrid techniques use a small laparotomy for hand-port placement and specimen extraction [112, 113]. In general, colorectal and liver resections in opposite abdominal quadrants (for example left colectomy and right-sided liver resection) require the highest number of trocars [110].

- Bleeding and conversion

Q26: What are the main causes of conversion during simultaneous colon and liver laparoscopic resections?

Bleeding seems to be the major cause of conversion during synchronous laparoscopic colorectal and liver resection. Accurate patients' selection remains the mainstay to reduce the conversion rate.

Level of evidence 3b.

Grade of recommendation B.

During laparoscopic liver resection, main conversion causes are due to intraoperative findings (i.e. poor access, oncological drawbacks) and unfavourable events (i.e. bleeding, damage to surrounding structures, cardiovascular instability) [59]. Further causes of conversions may be represented by difficult resection [57], previous abdominal surgery especially in upper-abdominal quadrants [114], obesity and tumour diameter > 10 cm [115].

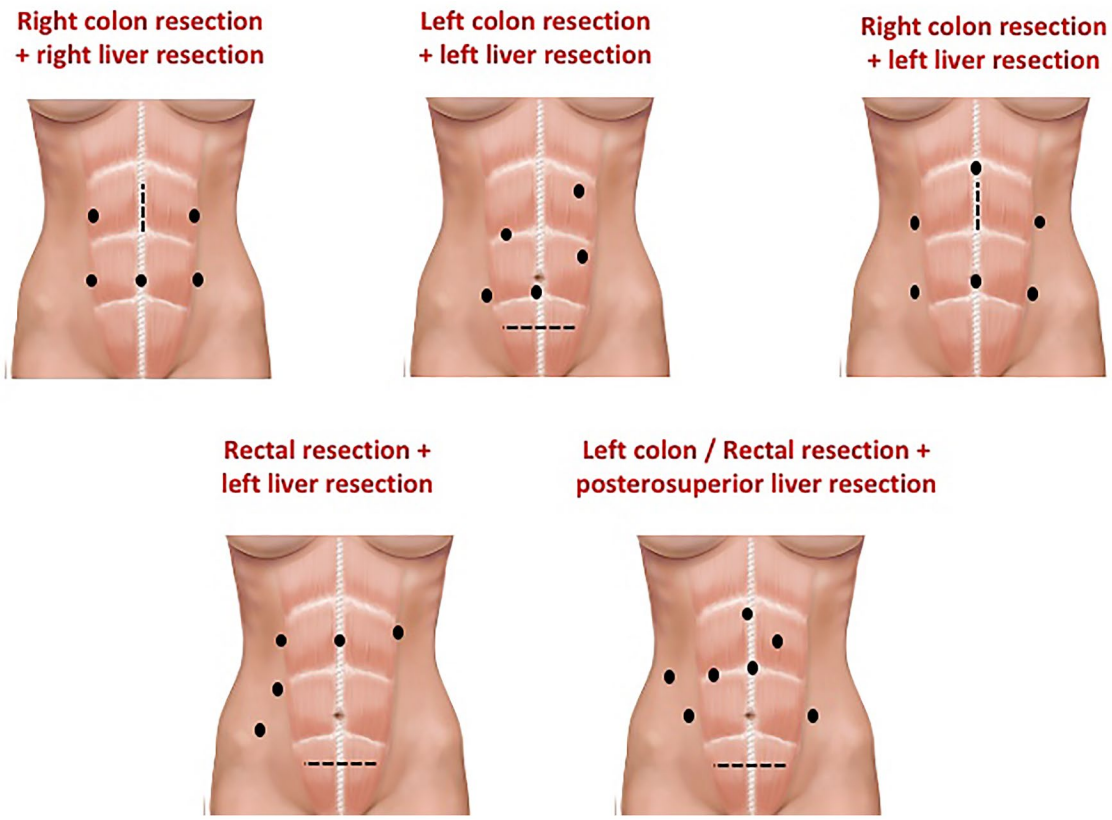

Fig. 1 Example of trocar placement to perform a combined resection

In case of synchronous laparoscopic colorectal liver resections, the conversion rate ranges between 0 and 14% [29, 30, 32, 33, 36, 44, 49–51, 62, 63, 91–95]. Bleeding is the main cause of conversion accounting for 33% of the patients [24, 36, 45, 116].

Accurate patient's selection remains the mainstay to reduce the conversion rate.

Q27: Is there an increased risk of bleeding during simultaneous colon and liver laparoscopic resection if compared to open?

Laparoscopic synchronous colorectal and liver resection is associated to an equal/reduced blood loss if compared to open surgery.

Level of evidence 3b.

Grade of recommendation B.

In a recent systematic review of the literature, the short-term outcomes between synchronous open and laparoscopic resection were analysed and compared in eight different studies. Four studies showed a non-statistically difference of estimated blood loss between the two different approaches ($p > 0.05$), while the remaining four ones showed a statistically significant reduction in estimated blood loss in the laparoscopic group ($p < 0.05$) [117].

- Minimally invasive approaches and devices

Q28: What is the best device for parenchymal transection in minimally invasive liver resections and simultaneous colorectal surgery?

Bipolar cautery may offer advantages in terms of blood loss during MI liver resection for combined CRC and hepatic metastases.

Level of evidence 2a.

Grade of recommendation B.

The use of Argon beam during laparoscopic haemostasis of liver's transection areas requires caution because of the risk of embolism.

Level of evidence 4.

Grade of recommendation C.

In the literature, there are seven case reports of embolism during coagulation with argon plasma systems [19, 136–143]. Two patients died [144]. Although no evidence of RCT is provided, the use of Argon Beam should cautiously avoided [144–146]. Looking at other energy devices, to date there are no comparative studies using different devices during combined colon and liver surgery [118–122]. Almost every laparoscopic liver resection is conducted using a dissection device [123–127]. Regarding haemostasis during liver transection, again the use of several devices is described [128–135]. A network meta-analysis of RCT showed the advantages of using bipolar cautery [136].

Topic 4 implementation

- Training, registries and learned societies

Q29: What should be the role of surgical societies in the development and implementation of minimally invasive approaches for simultaneous colon and liver surgery?

The importance of specific training programs and a stepwise learning is essential and should be promoted by learned societies.

Level of evidence 4.

Grade of recommendation D.

One of the aims of the surgical societies is to improve the progress of the surgical science [147]. Societies should help surgeons to build an ideal curriculum in both colorectal and liver surgery; or alternatively in either one of the field learning to work together. In addition, the learned societies should encourage to promote fellowships, courses and master classes on this specific ITEM; encourage certification system aimed to assess surgeons' proficiency; sustain registries on this specific matter [148].

Q30: Is it advisable, for simultaneous colon and liver minimally invasive surgery, to establish a specific public registry to guarantee data retrieval and analysis?

Registries for laparoscopic combined colon and liver surgery should be established to collect data over time and guarantee data analysis.

Level of evidence 4.

Grade of recommendation C.

Clinical registries collecting data on combined colon and liver resections could be useful to produce scientific evidence, to define outcomes and to advance surgical quality. The adoption of a registry guarantees that all the actions for

quality improvements are properly addressed [149]. It also may improve the quality of care thus providing a feedback to the surgeon on the surgical outcomes [150].

When compared to trials on a specific ITEM, registries require fewer resources, have stronger external validity and provide longer term outcome data [151]. The condition for a high-quality registry is the inclusion of the totality of patients as well as its completeness and correctness [152].

- Surgeons and centres

Q31: Is it advisable to reach a proper training in both colorectal and liver surgery before performing simultaneous colon and liver minimally invasive resections?

How many minor and major resections are necessary to complete training in minimally invasive liver surgery?

How many CRC resections are necessary to complete training in minimally invasive colorectal surgery?

Training in both colonic and liver surgery should be obtained before attempting a combined approach.

Level of evidence 4.

Grade of recommendation C.

Several definitions of the proper learning phase in both liver and colorectal surgery have been proposed. The advisable process consists of a step-up approach which starts from basic training followed by training on specific models (animal or cadaveric). Then, the surgeon should advance from simple to complex procedures, under the supervision of a mentor [153].

In a recent systematic review, it was suggested that the number of minor liver resection should be around 60 followed by 50 major resections [154]. Concerning colorectal resections, if considering multiple outcomes, the overall number of procedures to guarantee surgeon proficiency should be more than 200 [153].

To perform a combined resection, proficiency in both colorectal and liver surgery should be obtained. The exception is represented by the availability of two different surgical teams which should be present simultaneously at the operative table to design a proper operative plan.

Q32: Which centres should perform simultaneous colorectal and liver laparoscopic resections?

Centres performing simultaneous laparoscopic colorectal and hepatic resection should have the following requirements:

- A program of advanced laparoscopic surgery;
- A program of open liver surgery with an expertise in intraoperative hepatic ultrasonography;
- A multidisciplinary team for the management of these patients.

Low-volume centres can perform simultaneous laparoscopic resections when both colorectal and liver resection could be defined as easy procedures.

Complex procedures, either colorectal or hepatic or both, should be performed in high-volume centres as long as their outcome is associated with case volume.

Level of evidence 4.

Grade of recommendation C.

The outcome of complex surgical procedures is associated with the hospital volume [155–160]. One study demonstrated that low-volume centres (≤ 2 laparoscopic liver resections/month) perform laparoscopic easy hepatectomies with results similar to high-volume centres (> 2), achieving a worse outcome after complex resections [161]. A Delphi consensus-based position paper mentioned that hospital volume and standardised training are crucial to assure quality to laparoscopic colorectal surgery [12].

International consensus conferences about laparoscopic liver surgery stated that: centres must have expertise in both liver and laparoscopic surgery [17]; indications should be adapted to the local level of proficiency [19]. The Japanese Society for Cancer of the Colon and Rectum stated that, while training in standard laparoscopic colonic resections is introduced since surgical residency programs, advanced training is needed to face complex procedures [162].

Additional requirements to perform liver surgery are: an expertise in intraoperative hepatic ultrasonography and a multidisciplinary team for perioperative management [158].

Q33: Should simultaneous colorectal and liver minimally invasive resections be performed by a single surgical team or by two teams (one colorectal and one hepatic)?

The level of proficiency of a surgical team facing simultaneous resection should be evaluated separately considering laparoscopic colorectal and hepatic resections.

The choice between one-team or two-team surgery should rely on the technical complexity and the surgeons' expertise evaluating each surgical procedure (colorectal and hepatic surgery).

A single team with adequate expertise to face both the resections may perform the whole intervention. Whenever

complex and long operations are scheduled, the alternation of two teams is suggested.

Level of evidence 4.

Grade of recommendation C.

No study compared the outcome of procedures performed by one or two teams together. In only 14 of the 31 papers considered for the present analysis, the authors stated whether the surgical procedure was performed by one team ($n=6$) [44, 91, 112, 163–165]; two teams ($n=6$) [36, 41, 43, 94, 166, 167]; or by both ($n=2$, multi-institutional studies) [24, 26]. All series reported favourable outcome, independently of the adoption of one-team or two-team policy. The choice depends on the local organisation and team level of proficiency. The level of proficiency must be evaluated considering the two procedures separately. Laparoscopic major hepatectomies and complex minor hepatectomies should be performed by teams having high-volume laparoscopic liver surgery activity [19, 161]. Complex laparoscopic colorectal procedures, i.e. resection of transverse colon cancer or rectal cancer, resection of bulky tumours, and surgery in severely obese patients or patients with severe adhesions, should be performed by teams with advanced dedicated training [162].

Discussion

This consensus has involved all major Italian Centers dedicated to MI liver and colorectal surgery. Nearly 50% of the engaged centres have specific surgical teams dedicated to each specialty. As a consequence, SCRLM is performed synergistically in the operating theatre. It also means that hospitals are progressively adapting their organisation to the specialties run by teams working in an integrated way.

Regarding patient's selection, age, fragile patients, BMI ≥ 30 and previous surgery do not represent a formal contraindication to synchronous surgery, but attention should be paid to major comorbidities and underlying liver disease as in the open approach.

With regard to procedures, the question of sequence of surgical steps has been widely discussed: prepare always the Pringle manoeuvre and go for liver first in case of difficult/posterior resections.

In case of right colectomy, IA may be equally performed safely as EA if carried on by proficient surgeons. Interestingly, there is no evidence of increased risk of intestinal complication during simultaneous MI rectal and minor liver resection. In addition, indications to stoma diversion for rectal cancer should be the same as in open surgery.

Complex hepatic procedures, as major hepatectomies or resections for posteriorly located lesions, should be performed only by experienced hands and in selected patients.

Conversely, minor resections of anterior segments and left lateral sectionectomies with an Iwate score ≤ 3 may be considered easier and even standard procedures to associate with CRC resection.

Alternatively, no indications were found to operate with a simultaneous approach haemorrhagic colorectal patients.

In the classical two-stage procedures, it is possible to perform safely the first step together with the resection of the primary, but to date, no evidence exists to support the first step of ALPPS.

In the third area of interest "Techniques", no contraindication was found to achieve a correct lymphadenectomy and resection margin R0 in the synchronous approach. There is a reduced rate of post-operative complications in simultaneous procedures and less intraoperative bleeding and shorter hospital stay are found. Particularly intraoperative bleeding seems to be the most frequent cause of conversion to open surgery. In this respect, bipolar forceps seem to be the best device to achieve haemostasis during transection, whereas the use of argon beam should be forbidden to avoid possible embolic complications.

An intraoperative ultrasound exploration should be routinely performed before starting resections: in many studies [109, 110], laparoscopic IOUS has a performance similar to the open one, even if the learning curve of laparoscopic IOUS remains to be clarified.

Figure 1 shows an example of trocar placement, based on the statement above, to perform a combined resection.

In the implementation area of interests, the Consensus underlines that to get credits to perform such complex procedures training, registry of patients and education should be continuously carried on in a context of advanced MI approaches.

Conclusion

In the last 20 years, liver surgery has undergone a real revolution in the technical approaches and surgeons are more confident in MI liver surgery even when simultaneous resections are needed, as the consensus held in Louisville, Morioka and the guidelines in Southampton have clearly assessed.

The birth of the IGOMILS registry in 2014 is the result of this increased activity. Proctoring between Units with different expertise has been one of the crucial ways of spreading of competences and techniques setting a unique strategy to implement technical capacities of dedicated centres.

The Italian Consensus on MI surgery for SCRLM indicates possible pathways to optimise the treatment for these patients as consensus papers express a trend that is likely to

become shortly a standard procedure for clinical pictures still on debate. As matter of fact, no RCT or relevant case series on simultaneous treatment of SCRLM are available in the literature to suggest guidelines. Moreover, it remains to be investigated whether the MI technique for the simultaneous treatment of SCRLM maintain the already documented benefit of the two separate surgeries.

The use of Delphi method has indeed allowed strong cooperation and exchange among different centres. Five official multicentre meeting have been carried on in one and a half year to seal the recommendations presented in this paper. The level of evidence is generally not too high because of lack of literature indications and they often reflect the personal experience of surgeons. This the major limitation of this consensus, but it may represent a main stream for the years to come.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s13304-021-01100-9.

Author contributions Conceptualization: AR, FC, PD, RP, FC, and LA; methodology: AR, FC, FC, PD, and LA; writing: AR, FC, MC, AMDR, AL, SN, NR, GS, FC, and LA; writing—review and editing: AR, FC, LV, FC, LA, and PD; supervision: all the authors; formal analysis and investigation: FC, LA, and PD.

Funding The authors did not receive support from any organisation for the submitted work.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

References

1. Lykoudis PM et al (2014) Systematic review of surgical management of synchronous colorectal liver metastases. Br J Surg 101(6):605–612
2. Nordlinger B et al (2007) Does chemotherapy prior to liver resection increase the potential for cure in patients with metastatic colorectal cancer? A report from the European Colorectal Metastases Treatment Group. Eur J Cancer 43(14):2037–2045
3. Nordlinger B et al (2009) Combination of surgery and chemotherapy and the role of targeted agents in the treatment of patients with colorectal liver metastases: recommendations from an expert panel. Ann Oncol 20(6):985–992
4. Simmonds PC et al (2006) Surgical resection of hepatic metastases from colorectal cancer: a systematic review of published studies. Br J Cancer 94(7):982–999
5. Borner MM (1999) Neoadjuvant chemotherapy for unresectable liver metastases of colorectal cancer–too good to be true. Ann Oncol 10:623–626
6. Manfredi S et al (2006) Epidemiology and management of liver metastases from colorectal cancer. Ann Surg 244(2):254–259
7. Adam R et al (2012) The oncosurgery approach to managing liver metastases from colorectal cancer: a multidisciplinary international consensus. Oncologist 17(10):1225–1239
8. Adam R et al (2015) Managing synchronous liver metastases from colorectal cancer: a multidisciplinary international consensus. Cancer Treat Rev 41(9):729–741
9. Zalinski S, Mariette C, Farges O (2011) Management of patients with synchronous liver metastases of colorectal cancer. Clinical practice guidelines. Guidelines of the French society of gastrointestinal surgery (SFCD) and of the association of hepatobiliary surgery and liver transplantation (ACHBT). Short version. J Visc Surg 148(3):E171–E182
10. Reddy SK et al (2007) Simultaneous resections of colorectal cancer and synchronous liver metastases: a multi-institutional analysis. Ann Surg Oncol 14(12):3481–3491
11. Lambert LA, Colacchio TA, Barth RJ Jr (2000) Interval hepatic resection of colorectal metastases improves patient selection. Arch Surg 135(4):473–479 (**Discussion 479–480**)
12. Lorenzon L et al (2018) Achieving high quality standards in laparoscopic colon resection for cancer: a Delphi consensus-based position paper. Eur J Surg Oncol 44(4):469–483
13. Miskovic D et al (2015) Standardization of laparoscopic total mesorectal excision for rectal cancer: a structured international expert consensus. Ann Surg 261(4):716–722
14. Morino M et al (2015) Early rectal cancer: the European Association for Endoscopic Surgery (EAES) clinical consensus conference. Surg Endosc 29(4):755–773
15. You YN et al (2020) The American Society of Colon and Rectal Surgeons clinical practice guidelines for the management of rectal cancer. Dis Colon Rectum 63(9):1191–1222
16. Van Der Pas MH et al (2013) Laparoscopic versus open surgery for rectal cancer (COLOR II): short-term outcomes of a randomised, phase 3 trial. Lancet Oncol 14(3):210–218
17. Buell JF et al (2009) The international position on laparoscopic liver surgery: the Louisville Statement, 2008. Ann Surg 250(5):825–830
18. Wakabayashi G et al (2015) Recommendations for laparoscopic liver resection: a report from the second international consensus conference held in Morioka. Ann Surg 261(4):619–629
19. Abu Hilal M et al (2018) The Southampton consensus guidelines for laparoscopic liver surgery: from indication to implementation. Ann Surg 268(1):11–18
20. Dalkey NC (1969) The Delphi method: an experimental study of group opinion
21. Moher D et al (2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 6(7):E1000097
22. Clarke M, Oxman AD (2003) Cochrane Reviewers' Handbook 4.1.6. [updated January 2003]
23. Diamond IR et al (2014) Defining consensus: a systematic review recommends methodologic criteria for reporting of Delphi studies. J Clin Epidemiol 67(4):401–409
24. Ferretti S et al (2015) Laparoscopic simultaneous resection of colorectal primary tumor and liver metastases: results of a multicenter international study. World J Surg 39(8):2052–2060
25. Viganò L et al (2019) Minor hepatectomies: focusing a blurred picture: analysis of the outcome of 4471 open resections in patients without cirrhosis. Ann Surg 270(5):842–851
26. Tranchart H et al (2016) Laparoscopic simultaneous resection of colorectal primary tumor and liver metastases: a propensity score matching analysis. Surg Endosc 30(5):1853–1862
27. Shin JK et al (2020) Comparative study of laparoscopic versus open technique for simultaneous resection of colorectal cancer and liver metastases with propensity score analysis. Surg Endosc 34(11):4772–4780
28. Zhao J et al (2017) Systematic review of the influence of chemotherapy-associated liver injury on outcome after partial hepatectomy for colorectal liver metastases. Br J Surg 104(8):990–1002

29. Ivanecz A et al (2018) Simultaneous pure laparoscopic resection of primary colorectal cancer and synchronous liver metastases: a single institution experience with propensity score matching analysis. Radiol Oncol 52(1):42–53
30. Berti S et al (2015) Synchronous totally laparoscopic management of colorectal cancer and resectable liver metastases: a single center experience. Langenbecks Arch Surg 400(4):495–503
31. Cheung TT, R.T. (2013) Poon, synchronous resections of primary colorectal tumor and liver metastasis by laparoscopic approach. World J Hepatol 5(6):298–301
32. Gorgun E et al (2017) Laparoscopic versus open 1-stage resection of synchronous liver metastases and primary colorectal cancer. Gland Surg 6(4):324–329
33. Hu MG et al (2012) Outcomes of open versus laparoscopic procedure for synchronous radical resection of liver metastatic colorectal cancer: a comparative study. Surg Laparosc Endosc Percutan Tech 22(4):364–369
34. Lupinacci RM et al (2014) Simultaneous laparoscopic resection of primary colorectal cancer and associated liver metastases: a systematic review. Tech Coloproctol 18(2):129–135
35. Garritano S, Selvaggi F, Spampinato MG (2016) Simultaneous minimally invasive treatment of colorectal neoplasm with synchronous liver metastasis. Biomed Res Int 2016:9328250
36. Ratti F et al (2016) Impact of totally laparoscopic combined management of colorectal cancer with synchronous hepatic metastases on severity of complications: a propensity-score-based analysis. Surg Endosc 30(11):4934–4945
37. Mirnezami A et al (2011) Increased local recurrence and reduced survival from colorectal cancer following anastomotic leak: systematic review and meta-analysis. Ann Surg 253(5):890–899
38. Smith JD et al (2013) Anastomotic leak following low anterior resection in stage IV rectal cancer is associated with poor survival. Ann Surg Oncol 20(8):2641–2646
39. Gavriilidis P et al (2018) Simultaneous versus delayed hepatectomy for synchronous colorectal liver metastases: a systematic review and meta-analysis. HPB 20(1):11–19
40. Van Der Poel MJ et al (2019) Laparoscopic combined resection of liver metastases and colorectal cancer: a multicenter, case-matched study using propensity scores. Surg Endosc 33(4):1124–1130
41. Huh JW et al (2011) Comparison of laparoscopic and open colorectal resections for patients undergoing simultaneous R0 resection for liver metastases. Surg Endosc 25(1):193–198
42. Lin Q et al (2015) Comparison of minimally invasive and open colorectal resections for patients undergoing simultaneous R0 resection for liver metastases: a propensity score analysis. Int J Colorectal Dis 30(3):385–395
43. Ratti F et al (2015) Laparoscopic approach for primary colorectal cancer improves outcome of patients undergoing combined open hepatic resection for liver metastases. World J Surg 39(10):2573–2582
44. Dwyer RH et al (2018) Safety and efficacy of synchronous robotic surgery for colorectal cancer with liver metastases. J Robot Surg 12(4):603–606
45. Patriti A et al (2009) Laparoscopic and robot-assisted one-stage resection of colorectal cancer with synchronous liver metastases: a pilot study. J Hepatobiliary Pancreat Surg 16(4):450–457
46. Bizzoca C et al (2019) Simultaneous colon and liver laparoscopic resection for colorectal cancer with synchronous liver metastases: a single center experience. J Laparoendosc Adv Surg Tech A 29(7):934–942
47. Chen YW, Huang MT, Chang TC (2019) Long term outcomes of simultaneous laparoscopic versus open resection for colorectal cancer with synchronous liver metastases. Asian J Surg 42(1):217–223
48. Miyamoto Y et al (2015) Simultaneous laparoscopic resection of primary tumor and liver metastases for colorectal cancer: surgical technique and short-term outcome. Hepatogastroenterology 62(140):846–852
49. Ida S et al (2014) Pure laparoscopic right-sided hepatectomy in the semi-prone position for synchronous colorectal cancer with liver metastases. Asian J Endosc Surg 7(2):133–137
50. Chen CW et al (2013) Single-incision laparoscopic surgery using a homemade transumbilical port for synchronous colon and hepatic lesions: a case report. Surg Laparosc Endosc Percutan Tech 23(4):E164–E167
51. Polignano FM et al (2012) Totally laparoscopic strategies for the management of colorectal cancer with synchronous liver metastasis. Surg Endosc 26(9):2571–2578
52. Hayashi M et al (2011) Simultaneous laparoscopic resection of colorectal cancer and synchronous metastatic liver tumor. Int Surg 96(1):74–81
53. Nguyen KT et al (2009) Minimally invasive liver resection for metastatic colorectal cancer: a multi-institutional, international report of safety, feasibility, and early outcomes. Ann Surg 250(5):842–848
54. Trastulli S et al (2013) Robotic right colectomy for cancer with intracorporeal anastomosis: short-term outcomes from a single institution. Int J Colorectal Dis 28(6):807–814
55. Ban D et al (2014) A novel difficulty scoring system for laparoscopic liver resection. J Hepatobiliary Pancreat Sci 21(10):745–753
56. Wakabayashi G (2016) What has changed after the Morioka consensus conference 2014 on laparoscopic liver resection? Hepatobiliary Surg Nutr 5(4):281–289
57. Kawaguchi Y et al (2018) Difficulty of laparoscopic liver resection: proposal for a new classification. Ann Surg 267(1):13–17
58. Hasegawa Y et al (2017) A novel model for prediction of pure laparoscopic liver resection surgical difficulty. Surg Endosc 31(12):5356–5363
59. Halls MC et al (2018) Development and validation of a difficulty score to predict intraoperative complications during laparoscopic liver resection. Br J Surg 105(9):1182–1191
60. Xu HW et al (2017) Laparoscopic versus open liver resection for lesions adjacent to major vessels: a propensity score matched analysis. J Laparoendosc Adv Surg Tech A 27(10):1002–1008
61. Jung KU et al (2014) Outcomes of simultaneous laparoscopic colorectal and hepatic resection for patients with colorectal cancers: a comparative study. J Laparoendosc Adv Surg Tech A 24(4):229–235
62. Xu X et al (2018) Laparoscopic resections of colorectal cancer and synchronous liver metastases: a case controlled study. Minim Invasive Ther Allied Technol 27(4):209–216
63. Inoue A et al (2014) Short-term outcomes of simultaneous laparoscopic colectomy and hepatectomy for primary colorectal cancer with synchronous liver metastases. Int Surg 99(4):338–343
64. Bueno A et al (2014) Laparoscopic limited liver resection decreases morbidity irrespective of the hepatic segment resected. HPB 16(4):320–326
65. Scuderi V et al (2017) Outcome after laparoscopic and open resections of posterosuperior segments of the liver. Br J Surg 104(6):751–759
66. Xiao L et al (2015) Laparoscopic versus open liver resection for hepatocellular carcinoma in posterosuperior segments. Surg Endosc 29(10):2994–3001
67. Karoui M et al (2010) Combined first-stage hepatectomy and colorectal resection in a two-stage hepatectomy strategy for bilobar synchronous liver metastases. Br J Surg 97(9):1354–1362
68. Wanis KN et al (2017) Patient Survival after simultaneous ALPPS and colorectal resection. World J Surg 41(4):1119–1125

69. Choi YI, Moon HH, Shin DH (2017) Two cases of ALPPS procedure: simultaneous ALPPS and colorectal resection and ALPPS procedure for hepatic malignancy larger than 15 centimeter. Ann Hepatobiliary Pancreat Surg 21(3):151–156
70. Xiao N et al (2017) The paradigm of tumor shrinkage and rapid liver remnant hypertrophy for conversion of initially unresectable colorectal liver metastasis: a case report and literature review. World J Surg Oncol 15(1):148
71. Jackson T, Siegel KA, Siegel CT (2014) Rescue ALPPS: intraoperative conversion to ALPPS during synchronous resection of rectal cancer and liver metastasis. Case Rep Surg 2014:487852
72. Franchi E et al (2013) Two-stage hepatectomy after autologous CD133+ stem cells administration: a case report. World J Surg Oncol 11(1):192
73. Quénet F et al (2019) Two-stage hepatectomy for colorectal liver metastases: pathologic response to preoperative chemotherapy is associated with second-stage completion and longer survival. Surgery 165(4):703–711
74. Wanis KN et al (2018) Intermediate-term survival and quality of life outcomes in patients with advanced colorectal liver metastases undergoing associating liver partition and portal vein ligation for staged hepatectomy. Surgery 163(4):691–697
75. Griseri G et al (2017) Two-stage hepatectomy in two regional district community hospitals: perioperative safety and long-term survival. Tumori 103(2):170–176
76. Dupré A et al (2015) First clinical experience of intra-operative high intensity focused ultrasound in patients with colorectal liver metastases: a phase I-IIa study. PLoS ONE 10(2):E0118212
77. Xu HW et al (2017) Totally laparoscopic associating liver tourniquet and portal vein occlusion for staged hepatectomy combined with simultaneous left hemicolectomy for bilateral liver metastases of the primary colon cancer: a case report. Medicine 96(11):E6368
78. Fard-Aghaie MH et al (2015) ALPPS and simultaneous right hemicolectomy - step one and resection of the primary colon cancer. World J Surg Oncol 13:124
79. Cardona K et al (2014) Treatment of extensive metastatic colorectal cancer to the liver with systemic and hepatic arterial infusion chemotherapy and two-stage hepatic resection: the role of salvage therapy for recurrent disease. Ann Surg Oncol 21(3):815–821
80. Machado MA, Makdissi FF, Surjan RC (2013) ALPPS procedure with the use of pneumoperitoneum. Ann Surg Oncol 20(5):1491–1493
81. Turrini O et al (2012) Two-stage hepatectomy: who will not jump over the second hurdle? Eur J Surg Oncol 38(3):266–273
82. Muratore A et al (2012) Chemotherapy between the first and second stages of a two-stage hepatectomy for colorectal liver metastases: should we routinely recommend it? Ann Surg Oncol 19(4):1310–1315
83. Iida H et al (2011) Simultaneous bile duct and portal venous branch ligation in two-stage hepatectomy. World J Gastroenterol 17(30):3554–3559
84. Narita M et al (2011) Two-stage hepatectomy procedure to treat initially unresectable multiple bilobar colorectal liver metastases: technical aspects. Dig Surg 28(2):121–126
85. Shah JL et al (2017) Neoadjuvant transarterial radiation lobectomy for colorectal hepatic metastases: a small cohort analysis on safety, efficacy, and radiopathologic correlation. Int J Gastrointest Oncol 8:E43–E51
86. Fuks D et al (2015) Laparoscopic two-stage hepatectomy for bilobar colorectal liver metastases. Br J Surg 102(13):1684–1690
87. Moreno CC et al (2016) Colorectal cancer initial diagnosis: screening colonoscopy, diagnostic colonoscopy, or emergent surgery, and tumor stage and size at initial presentation. Clin Colorectal Cancer 15(1):67–73
88. Ghazi S et al (2013) Clinicopathological analysis of colorectal cancer: a comparison between emergency and elective surgical cases. World J Surg Oncol 11:133
89. Ou D et al (2016) Comparison of the prognostic influence of emergency hepatectomy and staged hepatectomy in patients with ruptured hepatocellular carcinoma. Dig Liver Dis 48(8):934–939
90. Panis Y et al (2011) Mortality after colorectal cancer surgery: a French survey of more than 84,000 patients. Ann Surg 254(5):738–743 (**Discussion 743–744**)
91. Tranchart H et al (2011) Laparoscopic major hepatectomy can be safely performed with colorectal surgery for synchronous colorectal liver metastasis. HPB 13(1):46–50
92. Spampinato MG et al (2013) One-stage, totally laparoscopic major hepatectomy and colectomy for colorectal neoplasm with synchronous liver metastasis: safety, feasibility and short-term outcome. Surgery 153(6):861–865
93. Slesser AA et al (2013) Outcomes of simultaneous resections for patients with synchronous colorectal liver metastases. Eur J Surg Oncol 39(12):1384–1393
94. Hatwell C et al (2013) Laparoscopic resection of colorectal cancer facilitates simultaneous surgery of synchronous liver metastases. Colorectal Dis 15(1):E21–E28
95. Takasu C et al (2014) Benefits of simultaneous laparoscopic resection of primary colorectal cancer and liver metastases. Asian J Endosc Surg 7(1):31–37
96. Wells KO, Senagore A (2019) Minimally invasive colon cancer surgery. Surg Oncol Clin N Am 28(2):285–296
97. Cheng X et al (2018) Successful treatment of colorectal liver metastasis harboring intrahepatic cholangiocarcinoma: a case report. Medicine 97(51):E13751
98. Fretland ÅA et al (2018) Laparoscopic versus open resection for colorectal liver metastases: the Oslo-Comet randomized controlled trial. Ann Surg 267(2):199–207
99. Robles-Campos R et al (2019) Open versus minimally invasive liver surgery for colorectal liver metastases (lapophuva): a prospective randomized controlled trial. Surg Endosc 33(12):3926–3936
100. Ye SP et al (2019) Mini-invasive vs open resection of colorectal cancer and liver metastases: a meta-analysis. World J Gastroenterol 25(22):2819–2832
101. Arita J et al (2015) Routine preoperative liver-specific magnetic resonance imaging does not exclude the necessity of contrast-enhanced intraoperative ultrasound in hepatic resection for colorectal liver metastasis. Ann Surg 262(6):1086–1091
102. Bonanni L et al (2014) A comparison of diagnostic imaging modalities for colorectal liver metastases. Eur J Surg Oncol 40(5):545–550
103. Ferrero A et al (2013) Intraoperative liver ultrasound still affects surgical strategy for patients with colorectal metastases in the modern era. World J Surg 37(11):2655–2663
104. Hata S et al (2011) Value of visual inspection, bimanual palpation, and intraoperative ultrasonography during hepatic resection for liver metastases of colorectal carcinoma. World J Surg 35(12):2779–2787
105. Hoch G et al (2015) Is intraoperative ultrasound still useful for the detection of colorectal cancer liver metastases? HPB 17(6):514–519
106. Zhu P et al (2018) Intraoperative ultrasonography of robot-assisted laparoscopic hepatectomy: initial experiences from 110 consecutive cases. Surg Endosc 32(10):4071–4077
107. Russolillo N et al (2020) Comparison of laparoscopic ultrasound and liver-specific magnetic resonance imaging for staging colorectal liver metastases. Surg Endosc. https://doi.org/10.1007/s00464-020-07817-9
108. Langella S et al (2019) Intraoperative ultrasound staging for colorectal liver metastases in the era of liver-specific

magnetic resonance imaging: is it still worthwhile? J Oncol 2019:1369274
109. Viganò L et al (2013) Comparison of laparoscopic and open intraoperative ultrasonography for staging liver tumours. Br J Surg 100(4):535–542
110. Ando K et al (2014) Simultaneous resection of colorectal cancer and liver metastases in the right lobe using pure laparoscopic surgery. Surg Today 44(8):1588–1592
111. Zhu Z et al (2013) The preliminary experience in simultaneous treatment of rectal cancer and synchronous liver metastases with laparoscopy. Turk J Gastroenterol 24(2):127–133
112. Hoekstra LT et al (2012) Initial experiences of simultaneous laparoscopic resection of colorectal cancer and liver metastases. HPB Surg 2012:893956
113. Kim SH et al (2008) Laparoscopic-assisted combined colon and liver resection for primary colorectal cancer with synchronous liver metastases: initial experience. World J Surg 32(12):2701–2706
114. Cipriani F et al (2018) Effect of previous abdominal surgery on laparoscopic liver resection: analysis of feasibility and risk factors for conversion. J Laparoendosc Adv Surg Tech A 28(7):785–791
115. Cauchy F et al (2015) Risk factors and consequences of conversion in laparoscopic major liver resection. Br J Surg 102(7):785–795
116. Lee JS et al (2010) Simultaneous laparoscopic resection of primary colorectal cancer and metastatic liver tumor: initial experience of single institute. J Laparoendosc Adv Surg Tech A 20(8):683–687
117. Moris D et al (2018) Management, outcomes, and prognostic factors of ruptured hepatocellular carcinoma: a systematic review. J Surg Oncol 117(3):341–353
118. Iida H et al (2020) Efficiency of a radiofrequency sealer (aquamantys) for parenchymal transection during laparoscopic hepatectomy. Asian J Endosc Surg 13(4):505–513
119. Baltatzis M et al (2019) Comparison of outcomes between open major hepatectomy using CUSA and laparoscopic major hepatectomy using "Lotus" liver blade. A propensity score matched analysis. Front Surg 6:33
120. Dong X et al (2019) 915-MHz microwave-assisted laparoscopic hepatectomy: a new technique for liver resection. Surg Endosc 33(2):395–400
121. Takahashi H et al (2018) A new technique for hepatic parenchymal transection using an articulating bipolar 5 cm radiofrequency device: results from the first 100 procedures. HPB 20(9):829–833
122. Badawy A et al (2018) Evaluation of a new energy device for parenchymal transection in laparoscopic liver resection. Asian J Endosc Surg 11(2):123–128
123. Yamamoto T et al (2017) Secure, low-cost technique for laparoscopic hepatic resection using the crush-clamp method with a bipolar sealer. Asian J Endosc Surg 10(1):96–99
124. Dural C et al (2016) Safety and efficacy of a new bipolar energy device for parenchymal dissection in laparoscopic liver resection. Surg Laparosc Endosc Percutan Tech 26(1):21–24
125. Scuderi V, Troisi RI (2014) Tissue management with tri-staple technology in major and minor laparoscopic liver resections. Int Surg 99(5):606–611
126. Itano O et al (2015) The superficial precoagulation, sealing, and transection method: a "bloodless" and "eco-friendly" laparoscopic liver transection technique. Surg Laparosc Endosc Percutan Tech 25(1):E33–E36
127. Berber E et al (2014) Initial experience with a new articulating energy device for laparoscopic liver resection. Surg Endosc 28(3):974–978
128. Sotiropoulos GC et al (2013) Totally laparoscopic left hepatectomy using the torsional ultrasonic scalpel. World J Gastroenterol 19(35):5929–5932
129. Nanashima A et al (2013) Usefulness of vessel-sealing devices combined with crush clamping method for hepatectomy: a retrospective cohort study. Int J Surg 11(9):891–897
130. Uchiyama H et al (2013) Pure laparoscopic partial hepatectomy using a newly developed vessel sealing device, biclamp. Surg Laparosc Endosc Percutan Tech 23(3):E116–E118
131. Buell JF et al (2013) Evaluation of stapler hepatectomy during a laparoscopic liver resection. HPB 15(11):845–850
132. Wang X et al (2013) Validation of the laparoscopically stapled approach as a standard technique for left lateral segment liver resection. World J Surg 37(4):806–811
133. Mbah NA et al (2012) Differences between bipolar compression and ultrasonic devices for parenchymal transection during laparoscopic liver resection. HPB 14(2):126–131
134. Akyildiz HY et al (2011) Techniques of radiofrequency-assisted precoagulation in laparoscopic liver resection. Surg Endosc 25(4):1143–1147
135. Fritzmann J et al (2018) Randomized clinical trial of stapler hepatectomy versus Ligasure™ transection in elective hepatic resection. Br J Surg 105(9):1119–1127
136. Kamarajah SK et al (2020) A systematic review and network meta-analysis of parenchymal transection techniques during hepatectomy: an appraisal of current randomised controlled trials. HPB 22(2):204–214
137. Tranchart H et al (2015) Bleeding control during laparoscopic liver resection: a review of literature. J Hepatobiliary Pancreat Sci 22(5):371–378
138. Moggia E et al (2016) Methods to decrease blood loss during liver resection: a network meta-analysis. Cochrane Database Syst Rev 10(10):Cd010683
139. Otsuka Y et al (2015) What is the best technique in parenchymal transection in laparoscopic liver resection? Comprehensive review for the clinical question on the 2nd international consensus conference on laparoscopic liver resection. J Hepatobiliary Pancreat Sci 22(5):363–370
140. Gotohda N et al (2015) Impact of energy devices during liver parenchymal transection: a multicenter randomized controlled trial. World J Surg 39(6):1543–1549
141. Scatton O et al (2015) What kind of energy devices should be used for laparoscopic liver resection? Recommendations from a systematic review. J Hepatobiliary Pancreat Sci 22(5):327–334
142. Wakabayashi G (2015) Systematic reviews from the 2nd international consensus conference on laparoscopic liver resection. J Hepatobiliary Pancreat Sci 22(5):325–326
143. Simillis C et al (2019) A systematic review and network meta-analysis comparing treatments for faecal incontinence. Int J Surg 66:37–47
144. Ikegami T et al (2009) Argon gas embolism in the application of laparoscopic microwave coagulation therapy. J Hepatobiliary Pancreat Surg 16(3):394–398
145. Reccia I et al (2017) A systematic review on radiofrequency assisted laparoscopic liver resection: challenges and window to excel. Surg Oncol 26(3):296–304
146. Wu T et al (2019) Laparoscopic hepatectomy assisted by a flexible 915 MHz microwave antenna: a safe and innovative device for hepatectomy. Surg Oncol 31:1–6
147. Società Italiana Di Chirurgia. https://www.sicplus.it/
148. American College of Surgeons. https://www.facs.org/
149. Stey AM et al (2015) Clinical registries and quality measurement in surgery: a systematic review. Surgery 157(2):381–395
150. The L (2016) How can registries and innovation improve surgical care? Lancet 388(10052):1349

151. Mandavia R et al (2017) What are the essential features of a successful surgical registry? A systematic review. BMJ Open 7(9):E017373
152. Hahnloser D (2015) Quality in colorectal surgery: more and more registries? Colorectal Dis 17(7):555–556
153. Gaitanidis A, Simopoulos C, Pitiakoudis M (2018) What to consider when designing a laparoscopic colorectal training curriculum: a review of the literature. Tech Coloproctol 22(3):151–160
154. Guilbaud T et al (2019) Learning curve in laparoscopic liver resection, educational value of simulation and training programmes: a systematic review. World J Surg 43(11):2710–2719
155. Luft HS, Bunker JP, Enthoven AC (1979) Should operations be regionalized? The empirical relation between surgical volume and mortality. N Engl J Med 301(25):1364–1369
156. Birkmeyer JD et al (2002) Hospital volume and surgical mortality in the United States. N Engl J Med 346(15):1128–1137
157. Richardson AJ et al (2013) The volume effect in liver surgery–a systematic review and meta-analysis. J Gastrointest Surg 17(11):1984–1996
158. Torzilli G et al (2016) Liver surgery in Italy. Criteria to identify the hospital units and the tertiary referral centers entitled to perform it. Updates Surg 68(2):135–142
159. Ghadban T et al (2019) Decentralized colorectal cancer care in Germany over the last decade is associated with high in-hospital morbidity and mortality. Cancer Manag Res 11:2101–2107
160. Jonker FHW et al (2017) The impact of hospital volume on perioperative outcomes of rectal cancer. Eur J Surg Oncol 43(10):1894–1900
161. Viganò L et al (2020) Multicentre evaluation of case volume in minimally invasive hepatectomy. Br J Surg 107(4):443–451
162. Watanabe T et al (2018) Japanese Society for Cancer of the Colon and Rectum (JSCCR) guidelines 2016 for the treatment of colorectal cancer. Int J Clin Oncol 23(1):1–34
163. Liu L et al (2014) Laparoscopic anterior approach of major hepatectomy combined with colorectal resection for synchronous colorectal liver metastases. Surg Laparosc Endosc Percutan Tech 24(6):E237–E240
164. Aljiffry M et al (2014) Laparoscopic-assisted one-stage resection of rectal cancer with synchronous liver metastasis utilizing a Pfannenstiel incision. Saudi J Gastroenterol 20(5):315–318
165. Casaccia M et al (2010) Simultaneous laparoscopic anterior resection and left hepatic lobectomy for stage IV rectal cancer. JSLS 14(3):414–417
166. Akiyoshi T et al (2009) Simultaneous resection of colorectal cancer and synchronous liver metastases: initial experience of laparoscopy for colorectal cancer resection. Dig Surg 26(6):471–475
167. Bretagnol F et al (2008) Benefit of laparoscopy for rectal resection in patients operated simultaneously for synchronous liver metastases: preliminary experience. Surgery 144(3):436–441

Authors and Affiliations

Aldo Rocca[1,2] · Federica Cipriani[3,4] · Giulio Belli[5] · Stefano Berti[6] · Ugo Boggi[7] · Vincenzo Bottino[8] · Umberto Cillo[9] · Matteo Cescon[10] · Matteo Cimino[11] · Francesco Corcione[12] · Luciano De Carlis[13] · Maurizio Degiuli[14] · Paolo De Paolis[15] · Agostino Maria De Rose[16] · Domenico D'Ugo[17] · Fabrizio Di Benedetto[18] · Ugo Elmore[4,19] · Giorgio Ercolani[20] · Giuseppe M. Ettorre[21] · Alessandro Ferrero[22] · Marco Filauro[23] · Felice Giuliante[16] · Salvatore Gruttadauria[24] · Alfredo Guglielmi[25] · Francesco Izzo[26] · Elio Jovine[27] · Andrea Laurenzi[20] · Francesco Marchegiani[9] · Pierluigi Marini[28] · Marco Massani[29] · Vincenzo Mazzaferro[30] · Michela Mineccia[21] · Francesco Minni[31] · Andrea Muratore[32] · Simone Nicosia[27] · Riccardo Pellicci[33] · Riccardo Rosati[4,19] · Nadia Russolillo[22] · Antonino Spinelli[35,36] · Gaya Spolverato[34] · Guido Torzilli[11] · Giovanni Vennarecci[37] · Luca Viganò[11] · Leonardo Vincenti[38] · Paolo Delrio[39] · Fulvio Calise[2] · Luca Aldrighetti[3,4]

1 Department of Medicine and Health Sciences "V. Tiberio", University of Molise, Campobasso, Italy

2 Center for Hepatobiliary and Pancreatic Surgery, Pineta Grande Hospital, Castel Volturno, Italy

3 Hepatobiliary Surgery Division, IRCCS San Raffaele Scientific Institute, Milan, Italy

4 Vita-Salute San Raffaele University, Milan, Italy

5 Department of General and HPB Surgery, Loreto Nuovo Hospital, Naples, Italy

6 Department of Surgery, Hospital S Andrea La Spezia, La Spezia, Italy

7 Division of General and Transplant Surgery, Pisa University Hospital, Pisa, Italy

8 Department of Obesity and Metabolic Surgery, Ospedale Evangelico Betania, Naples, Italy

9 Hepatobiliary Surgery and Liver Transplantation Unit, Department of Surgery, Oncology and Gastroenterology, Padova University Hospital, Padua, Italy

10 General Surgery and Transplant Unit, IRCCS AOU Sant'Orsola-Malpighi Hospital, University of Bologna, Bologna, Italy

11 Division of Hepatobiliary and General Surgery, Department of Surgery, Humanitas Clinical and Research Center, IRCCS, Humanitas University, Rozzano, MI, Italy

12 Department of Public Health, School of Medicine, University of Naples Federico II, Naples, Italy

13 Division of General Surgery and Abdominal Transplantation, ASST Grande Ospedale Metropolitano Niguarda, School of Medicine, University of Milano-Bicocca, Milan, Italy

14 Department of Oncology, Digestive and Surgical Oncology, San Luigi University Hospital, University of Torino, Orbassano, Italy

[15] General Surgery Department, Ospedale Gradenigo, Turin, Italy

[16] Hepatobiliary Surgery Unit, Fondazione Policlinico Universitario A. Gemelli, IRCCS, Catholic University of the Sacred Heart, Rome, Italy

[17] General Surgery Unit, Fondazione Policlinico Universitario Agostino Gemelli IRCCS, Catholic University, Rome, Italy

[18] Hepato-Pancreato-Biliary Surgery and Liver Transplantation Unit, University of Modena and Reggio Emilia, Modena, Italy

[19] Division of Gastrointestinal Surgery, San Raffaele Scientific Institute, Milan, Italy

[20] General and Oncologic Surgery, Morgagni-Pierantoni Hospital, Forli, Italy

[21] Department of General Surgery and Transplantation, San Camillo-Forlanini General Hospital, Rome, Italy

[22] Department of HPB and Digestive Surgery, Ospedale Mauriziano Umberto I, Turin, Italy

[23] General and Hepatobiliopancreatic Surgery Unit, Department of Abdominal Surgery, E.O. Galliera Hospital, Genoa, Italy

[24] Abdominal Surgery and Organ Transplantation Unit, Department for the Treatment and Study of Abdominal Diseases and Abdominal Transplantation, ISMETT, Palermo, Italy

[25] Unit of HPB Surgery, Department of Surgery, GB Rossi University Hospital, Verona, Italy

[26] Divisions of Hepatobiliary Surgery, Istituto Nazionale Dei Tumori IRCCS "Fondazione G. Pascale", Naples, Italy

[27] Department of Surgery, AOU Sant'Orsola Malpighi, IRCCS, Bologna, Italy

[28] The Department of General and Emergency Surgery, San Camillo-Forlanini Regional Hospital, Rome, Italy

[29] Department of Surgery, Regional Hospital of Treviso, Treviso, Italy

[30] Department of Gastrointestinal Surgery and Liver Transplantation, Fondazione IRCCS Istituto Nazionale Tumori di Milano, Milan, Italy

[31] Division of Pancreatic Surgery, Department of Medical and Surgical Sciences (DIMEC), Alma Mater Studiorum, University of Bologna, Bologna, Italy

[32] General Surgery Unit, E. Agnelli Hospital, Pinerolo, TO, Italy

[33] General Surgery Unit, Santa Corona Hospital, Pietra Ligure, SV, Italy

[34] Surgery Unit, Department of Surgical Oncology and Gastroenterology Sciences (DiSCOG), University of Padua, Padua, Italy

[35] Department of Biomedical Sciences, Humanitas University, Via Rita Levi Montalcini 4, 20090 Pieve Emanuele, MI, Italy

[36] Division of Colon and Rectal Surgery, IRCCS Humanitas Research Hospital, Via Manzoni 56, 20089 Rozzano, MI, Italy

[37] Laparoscopic, Hepatic, and Liver Transplant Unit, AORN A. Cardarelli, Naples, Italy

[38] Medical Oncology Unit, National Cancer Research Centre, Istituto Tumori Giovanni Paolo II, Bari, Italy

[39] Colorectal Surgical Oncology-Abdominal Oncology Department, Istituto Nazionale per lo Studio e la Cura dei Tumori, 'Fondazione Giovanni Pascale' IRCCS, 80131 Naples, Italy