fortune Journals

Research Article

JOURNAL OF SURGERY AND RESEARCH

ISSN: 2640-1002

Learning Curve of 150 Laparoscopic Liver Resections in a Single Center

Arrechea Antelo Ramiro*, Aragone Lucía, Veracierto Federico, Maurette Rafael José, Pirchi, Enrique Daniel

Abstract

Backround: The learning curve (LC) of laparoscopic liver resection (LLR) can be long, depending on the patient, tumor features, and surgeon training. Our aim was to evaluate LC in LLR performed by a self-taught "pioneer" surgeon and to analyze its evolution.

Methods: A retrospective analysis was conducted between December 2008 and February 2023.The series was divided chronologically into three equal groups. LC was evaluated by analyzing the surgical difficulty according to the IWATE criteria and intra- and postoperative results.

Results: 150 patients underwent LLR, which were divided into 3 periods. A significant increase in the difficulty of cases was observed, as reflected in the mean IWATE (p=0.00001). Conversion rate (p=0.117), "hand-assisted" resection rate (p=0.004), and median time adjusted by the number of resections (p=0.705) decreased. The number of resections per case (p=0.017) and mean blood loss (p=0.465) increased. Finally, there was a significant reduction in postoperative complications (p=0.024) and mean length of hospital stay (p=0.005).

Discussion: This study confirmed an improvement in LC after LLR. Although there was no significant reduction in the mean blood loss rate and mean surgical time, this may be a consequence of selecting more difficult cases and increasing the number of resections per case.

Keywords: Laparoscopic liver resections; Learning curve; Minimal invasive surgery

Introduction

The indications for laparoscopic liver resection (LLR) for the treatment of liver tumors have increased in recent years. Since the first consensus held in Louisville in 2008, 3 approaches in which LLR could be performed were defined: hybrid, hand assisted or totally laparoscopic [1]

In 2014, the Second International Consensus on LLR was held in Morioka, Japan, in which patient safety was determined as the main objective [2]. It was recommended to create a difficulty score to select patients according to the experience and skill of the surgeon, a LLR registry and an education system for young surgeons. These statements were reaffirmed in the Southampton Guidelines published in 2017 [3].

LLR is technically highly difficult, because it involves performing parenchymal resections in a limited space, especially in tumors close to the diaphragm. This determines the risk of major bleeding, either from the liver parenchyma itself, suprahepatic veins, or segmental pedicles, which can be difficult to control. Moreover, oncological margins may be difficult to achieve [4].

Affiliation:

[1]Department of General Surgery, British Hospital of Buenos Aires, Argentina

[2]Hepatobiliar Surgery Unit, Department of General Surgery, British Hospital of Buenos Aires, Argentina

***Corresponding author:**
Ramiro Arrechea Antelo, Department of General Surgery, Perdriel 74, 1280 Buenos Aires, Argentina

Citation: Arrechea Antelo Ramiro, Aragone Lucía, Veracierto Federico, Maurette Rafael José, Pirchi, Enrique Daniel. Learning Curve of 150 Laparoscopic Liver Resections in a Single Center. Journal of Surgery and Research. 7 (2024): 237-244

Received: May 07, 2024
Accepted: May 15, 2024
Published: May 29, 2024

Ramiro AA, et al., J Surg Res 2024
DOI:10.26502/jsr.10020365

Owing to the aforementioned difficulties, the LLR learning curve can be long and highly variable. It depends not only on the training and skill of the surgeon, but also on the patient's disease extension. Its analysis can be performed based on the surgical results of each case, including the conversion rate, operating time, estimated blood loss, "hand assistance" rate, hospital stay, and postoperative morbidity, among others.

Different publications have shown their experience in the course of this learning curve with very good results, demonstrating that LLR is applicable for the treatment of liver tumors, and that after a certain number of procedures the surgeon acquires the necessary skills and abilities to make it a safe and reliable procedure [5-8].

However, analysis of this progression in the learning curve can be difficult if the number of cases increases simultaneously with the complexity of the resection performed. The objective of our study was to analyze the learning curve in LLR performed by a self-taught pioneer surgeon, and its evolution in terms of indication, complexity and postoperative surgical results.

Material and Methods

A retrospective analysis was performed using a prospective database of patients who underwent LLR between August 2008 and May 2023 at the British Hospital in Buenos Aires. Preoperative evaluation, anesthesia, and postoperative care were the same in all cases. The final decision to perform laparoscopic liver resection was made by the surgeon in charge after a multidisciplinary evaluation. All of the cases were performed by a “pioneer” surgeon who had extensive experience in laparoscopy and liver transplantation. All patients who underwent liver resection were included regardless of the type of approach (hybrid, hand-assisted, or totally laparoscopic). Patients who underwent laparoscopic “unroofing” of the liver cysts and liver wedge biopsies were excluded.

Demographic data, ASA of Anesthesiologists scores, and history of previous abdominal surgeries were analyzed. The difficulty of each procedure was evaluated according to the IWATE criteria (Figure 1), as described by Wakabayashi et al [9]. The type of liver resection was defined according to the Brisbane classification; therefore, LLRs were grouped into non-anatomical resections, segmentectomies, and hepatectomies [10]. In cases where more than one resection was performed, the highest IWATE was used to estimate its difficulty. Pedicle clamping was performed using an intermittent Pringle maneuver. Foley catheter or an extracorporeal snare was chose depending on the availability and preference of the surgeon. Intraoperative ultrasound was performed in all cases using a 10-mm laparoscopic flexible linear transducer.

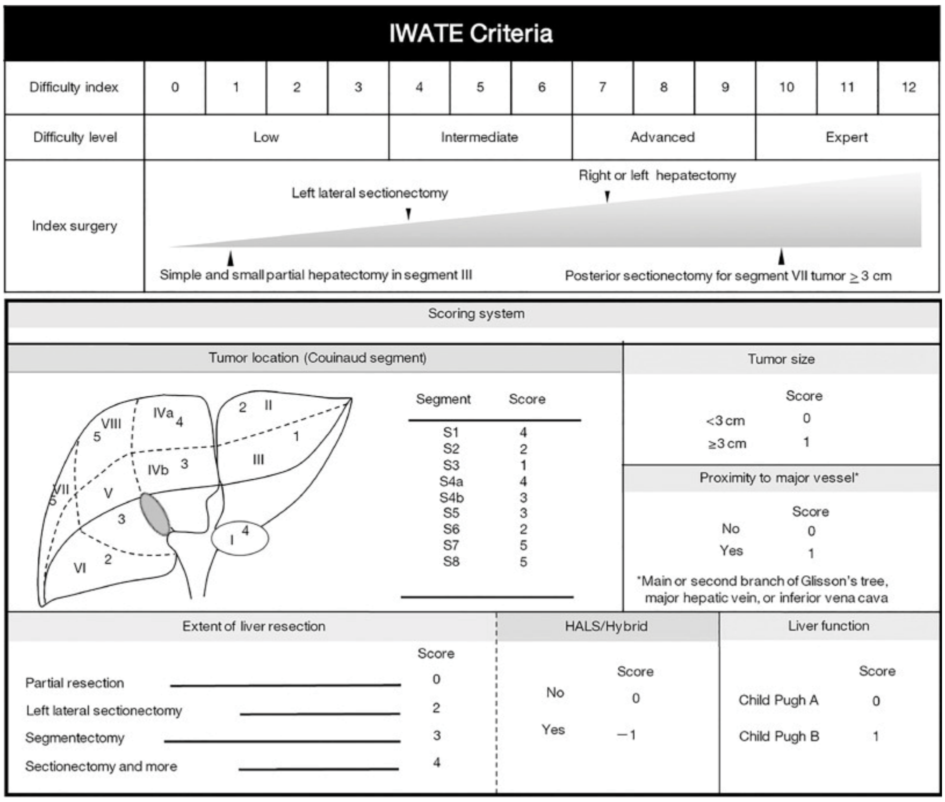

Figure 1: IWATE Criteria. Wakabayashi et al. 2016 [9].

Ramiro AA, et al., J Surg Res 2024
DOI:10.26502/jsr.10020365

The following intraoperative and postoperative variables were analyzed: conversion rate, hand-assisted resection rate, number of resections per case, intraoperative blood loss, red blood cell transfusions, surgical time, hospital stay, and intraoperative and postoperative morbidity for each case. These were classified according to the Clavien-Dindo [11]. We considered minor complications that corresponded to grades I and II, while major complications corresponded to grades III, IV, and V. Blood transfusion was indicated in cases of acute massive bleeding (1000 ml or higher) or hematocrit less than 21. To estimate surgical times with greater precision, an adjustment was made to the surgical time of each surgery according to the number of resections performed in the same surgery (median surgical time adjusted by the number of resections) regardless the type of LLR. This allowed us to homogenize each period and better estimate the operative time to resect each lesion.

To assess the evolution of the learning curve, cases were grouped chronologically into three periods with the same number of patients (Period I: 2008 – 2016; Period II: 2016 – 2020; Period III: 2020 – 2023).

To compare the results, the Chi-square and Fischer tests, Anova test and post hoc test (Kruskal Wallis) were used. Statistical analysis was performed with the Graph Pad Prism 7.01 program. Continuous variables were expressed as means with standard deviations (SD) or medians and ranges in parentheses. Categorical variables were expressed as N and/or percentages. Results were considered statistically significant at $p<0.05$.

Results

During the period studied, 150 LLR were performed, which were divided into three groups of 50 patients (Periods 1, 2 and 3). The average age was 59 years**,** there was a slight predominance of males and the most frequent ASA score was II. Demographic data and the number of patients with a history of previous surgeries did not vary significantly between the groups (Table 1).

71 non-anatomical resections, 62 segmentectomies, and 17 major hepatectomies were performed (Table 2). Colonic surgical procedures were performed simultaneously in 22% (33 patients), observing a significant decrease when comparing the 3 periods (p= 0.020).

Regarding the difficulty of the cases, we compared the three groups and observed that as the learning curve progressed, the number of cases with advanced or expert IWATE increased, as shown in table 2. This resulted in a statistically significant increase in the average IWATE in period 3 compared to periods 1 and 2 (5 vs. 5 vs. 7, p= 0.00001).

Of the total LLR, 86.7% were totally laparoscopic, 9.3% were hand-assisted and 4% were converted (Table 3). The Pringle maneuver was performed in 72% of cases, with an average of 50 minutes (15-150). Analysis of the periods revealed a significant increase in the use of this maneuver (96 vs. 52%, p= 0.00001).

Regarding the intraoperative and postoperative results, we observed a significant decrease in hand-assisted resections (p= 0.005), and a decrease in the conversion rate (p = 0.117) (Table 3). These results were accompanied by a significant increase in the number of total laparoscopic resections (p=0.0004).

There was a significant increase in the median surgical time (p= 0.023), but median time adjusted for the number of resections decreased (p= 0.705). The number of resections per case increased significantly during the course of the learning curve (p= 0.017). Moreover, the mean intraoperative blood loss rate decreased when comparing periods 1 and 2 (p= 0.029), but slightly increased when comparing periods 1 and 3 (p= 0.465). There was a significant decrease in the requirement for intraoperative red blood cell transfusions (p= 0.009). Optimal oncologic margins were managed in 95.3% of the global series, with no significant differences between periods (0.876).

Table 1: Demographic data per period.

	Total	Period 1	Period 2	Period 3	p
Mean Age (DS)	59 (13)	63 (11)	57 (13)	57 (14)	0.27
Male patients, N (%)	85 (56,6)	28 (56)	29 (58)	28 (56)	0.59
ASA, N (%)					
I/II	89 (59,3)	26 (52)	33 (66)	30 (60)	0.82
III/IV	61 (40,7)	24 (48)	17 (34)	20 (40)	0.14
Previous history of abdominal surgery, N (%)	85 (56,6)	25 (50)	32 (64)	28 (56)	0.19

DS: Standard desviation.

Citation: Arrechea Antelo Ramiro, Aragone Lucía, Veracierto Federico, Maurette Rafael José, Pirchi, Enrique Daniel. Learning Curve of 150 Laparoscopic Liver Resections in a Single Center. Journal of Surgery and Research 7 (2024): 237-244.

Ramiro AA, et al., J Surg Res 2024
DOI:10.26502/jsr.10020365

The overall rate of complications in the series was 36% (Table 4), with a predominance of abdominal collections, biliar fistula and fever (Table 5). When comparing the three periods, a significant reduction in postoperative complications was observed (p= 0.024). There were two cases of mortality (1.3%), one due to sepsis secondary to dehiscence of the ileocolic anastomosis and one due to status epilepticus. In both cases, the cause of mortality was unrelated to LLR. Finally, there was a significant reduction in the mean hospital stay (p= 0.005).

Table 2: Type of LLR and difficulty according to IWATE criteria.

	Total	Period 1	Period 2	Period 3	p
Type of LLR					
Non anatomical resections, N (%)	70 (46,6)	25 (50)	26 (52)	19 (38)	0.31
Segmentectomies, N (%)	63 (42)	20 (40)	20 (40)	23 (46)	0.78
Hepatectomies, N (%)	17 (11,4)	5 (10)	4 (8)	8 (16)	0.42
Simultaneous colon resection, N (%)	33 (22)	17 (34)	10 (20)	6 (12)	0.02
IWATE					
Low	16 (10,6)	8 (16)	4 (8)	4 (8)	0.32
Intermediate	78 (52)	32 (64)	30 (60)	16 (32)	0.002
Advanced	44 (29,4)	10 (20)	12 (24)	22 (44)	0.034
Expert	12 (8)	0 (0)	4 (8)	8 (16)	0.005
Mean IWATE (DS)	5,8 (2,17)	5,1 (1,9)	6 (2)	7,1 (2,1)	0.00001

DS: Standard desviation

Table 3: Intraoperative results.

	Total	Period 1	Period 2	Period 3	p
Laparoscopic, N (%)	130 (86,7)	36 (72)	45 (90)	49 (98)	0.0004
Hand assisted, N (%)	14 (9,3)	10 (20)	3 (6)	1 (2)	0.004
Conversion, N (%)	6 (4)	4 (8)	2 (4)	0 (0)	0.117
Pringle, N (%)	107 (71,3)	26 (52)	34 (68)	47 (94)	0.00001
Mean number of Pringle (DS)	2 (1)	1 (0,7)	2 (1,5)	4 (2)	0.00001
Mean number of resections per case (DS)	1.87 (1,39)	1.58 (1,21)	1.74 (1,09)	2.34 (1,7)	0.017
Median surgical time in minutes (IQR)	247 (176-340)	222 (150-290)	200 (163-303)	300 (204-360)	0.023
Median surgical time adjusted by number of resections (IQR)	152 (93-231)	155 (111-242)	162 (90-202)	135 (84-250)	0.705
Red blood cell transfusiones, N (%)	23 (15,3)	14 (28)	4 (8)	5 (10)	0.0093
Mean blood loss in ml (DS)	460 (463)	528 (360)	334 (308)	544 (564)	0,465 (1 vs 3) 0.029 (1 vs 2)

DS: Standard desviation. IQR: Interquartile range.

Table 4: Post operative morbidity, hospital stay and oncologic margins.

	Total	Period 1	Period 2	Period 3	p
Global complications, N (%)	53 (35,3)	24 (48)	18 (36)	11 (22)	0.024
Minor complications, N (%)	30 (20)	15 (30)	7 (14)	8 (16)	0.093
Mayor complications, N (%)	23 (15,3)	9 (18)	11 (22)	3 (6)	0.069
Mean hospital stay (DS)	7 (6,8)	7,6 (7,4)	8,5 (8,2)	4.8 (2,6)	0.0057
Safe oncologic margins, N (%)	143 (95,3)	48 (96)	47 (94)	48 (96)	0.86

DS: Standard desviation.

Ramiro AA, et al., J Surg Res 2024
DOI:10.26502/jsr.10020365

Table 5: Post operative complications, n (%)

Abdominal collection	9 (16,6)
Biliar fistula	7 (12,9)
Fever	6 (11,1)
Hospital-acquired pneumonia	6 (11,1)
Deep venous thrombosis	4 (7,4)
Colonic anastomosis dehiscence	4 (7,4)
Eventration/ Evisceration	3 (5,5)
Phlebitis	2 (3,7)
Intestinal perforation	1 (1,8)
Acute renal failure	1 (1,8)
Status epilepticus	1 (1,8)
Dehydration	1 (1,8)
Digestive intolerance	1 (1,8)
Urinary infection	1 (1,8)
Abdominal pain	1 (1,8)
Pneumothorax	1 (1,8)
Intestinal suboclusion	1 (1,8)
Intestinal ileus	1 (1,8)
Complicated pleural effusion	1 (1,8)
Hyperosmolar hypernatremia	1 (1,8)
Metabolic acidosis	1 (1,8)

Discussion

Since the Louisville Consensus in 2008 and the updates in Morioka and Southampton, LLR has undergone significant development, with a consequent increase in its indication [1-3]. Benefits compared with the conventional approach in terms of surgical time, blood loss, hospital stay and postoperative complications are well known [12,13]. Multiple factors, such as the experience of the surgical team and the hospital infrastructure, can influence the applicability of LLR and make it highly variable, as demonstrated in Pekolj et al. publication [14].

The aforementioned guidelines suggest starting the LLR curve with single, small lesions, preferably in the anterolateral segments. To manage more complex and challenging resections (posterior sectionectomies, major hepatectomies, ALPPS, etc.), guides recommend having a progressive training program, with surgical teams that have experience in liver surgery and laparoscopy.

The LLR learning curve can be affected by multiple variables, including the training and skills of the surgical team, patient and tumor characteristics, economic environment and availability of equipment in the centers where LLR is performed. In addition, it also depends on the formative moment in which the surgeon decides to go through the learning curve, since it has been shown that surgeons with a history of hepatobiliary surgery who decide to innovate their surgical techniques have a longer learning curve than young surgeons who start the curve in the early stages of its formation [15]. In our case, the curve was performed by a "pioneer" surgeon in a center with vast experience in laparoscopy, and has been part of a liver transplant team since 2010.

Several authors have published their experience. Vigano et al. were one of the first to carry out an analysis of the learning curve in 174 RHL cases using the risk adjusted cumulative sum (RA-CUSUM) and determined that 60 cases are needed to achieve an improvement in the results in terms of conversion, bleeding, time surgery, morbidity and hospital stay. Among its conclusions, it mentions that specific training is necessary in centers that routinely perform liver surgery [5].

Thomasini et al. performed a similar analysis of a surgeon's learning curve and highlighted three periods. The first where the initial experience is developed, the second where the surgeon pushes the limits and increases the complexity of the cases, and the third where the learning curve is completed. They concluded that after 50 cases a significant decrease in the bleeding rate is achieved, and that a surgeon needs at least 160 cases to complete his training and be able to safely perform any type of LLR [6]. Goh et al. published a series of 200 LLR performed by an innovative surgeon, in which they determined that after performing 65 cases an improvement was achieved in the surgical results analyzed. They concluded that this technique was reliable and reproducible, even for surgeons without specific experience or training in LLR [8].

In our study, there was a significant progression in the complexity of the cases reflected in the increase in the mean IWATE in period 3 compared to periods 1 and 2 (Table 2). In period 1, 80% of the LLRs corresponded to a low/ intermediate IWATE; in period 2, 84% corresponded to an intermediate/advanced IWATE; and finally, in period 3, 58% corresponded to an advanced/expert IWATE.

Comparing the bleeding rates, there was a significant decrease in period 2 compared to period 1 (334 ml vs. 528 ml, p= 0.029), probably because the increase in IWATE was slight and we learned to better control bleeding in these cases. In period 3, the bleeding rate increased again to values similar to those in period 1 (544 mL vs. 528 ml, p= 0.465). However, a significantly lower rate of red blood cell transfusion requirements was recorded, which may have been due not only to the experience of the surgical team but also to the incorporation of the team of anesthesiologists who perform transplants at our institution. However, surgical time was maintained despite the increase in the number of resections per case, which allowed us to infer that we achieved greater effectiveness in resections as the curve progressed.

Regarding the surgical technique, we observed that the vast majority of cases could be resolved laparoscopically.

Over the course of our learning curve, the hand assist/ conversion rates decreased significantly. Hand assistance was used in 9.3% of the cases, with a high prevalence in period 1. Lin et al. reported that this technique helps obtain better results in terms of postoperative morbidity and surgical time [16]. In addition, in period 3 we expanded the use of the Pringle maneuver to achieve better vascular control, which allowed us to obtain similar results in intraoperative blood loss rate despite an increase in the complexity of the cases. The usefulness of this maneuver has been proven by other authors, and its application in LLR has been adopted worldwide [17,18].

The number of simultaneous colonic resections decreased significantly during the three periods. The impact of surgical strategy in the management of synchronous colorectal liver metastasis has been a matter of discussion [19-21]. Some studies support the first-liver approach in patients who require multiple LLR or major hepatectomy, as it was associated with longer survival and lower morbidity than the alternative approaches [22,23]. Based on this evidence, the increasing complexity of the cases in our learning curve may explain this tendency.

Global morbidity in this series had a significantly decreasing tendency, as well as hospital stay. The fact these postoperative results were obtained in more complex cases allows us to infer that there was a clear advance in these results. With regard to mortality, as we saw that they were not related to the LLR technique, we did not consider it necessary to compare these events between the three periods.

Villani et al. published their experience in 150 LLR without performing a risk-adjusted analysis, observing an increase in the complexity of the cases, which was associated with an increase in morbidity, bleeding rate, and operating time [7]. With the hypothesis that the "ideal" learning curve usually occurs in other procedures is not fully applicable to LLR due to its difficulty and technical variability, they concluded that the "true" learning curve is better defined as an alternation between improvements and regressions as complexity increases, until mastery is achieved. When compared with the present work, we can see that our learning curve followed in certain aspects this alternating pattern described, and despite the fact that we increased the complexity of the cases and performed more challenging LLR with a greater number of lesions, our bleeding and surgical time rates were maintained at the same time that the conversion/assisted hand rates decreased.

This study had some limitations. First, this was a retrospective single-surgeon study. Reproducibility was related to the surgeon's skills, and training could not be defined or evaluated in this statistical analysis. Second, the IWATE criteria were used to predict the difficulty scale of each procedure, but unfortunately, this criterion does not consider the number of lesions to resect. We are aware that this could have caused some error in the measurement of the difficulty of cases with multiple resections. Nevertheless, we attempted to neutralize this fact by considering the highest IWATE and analyzing the number of resections per case. Third, we did not consider what contribution, if any, other members of the surgical team (e.g., anesthesiologists, nurses, residents) had on this particular LC.

In conclusion, this study determined that the pattern of evolution of the LLR learning curve is highly variable according to the complexity of the cases and initial experience of the surgeon. In the case of analyzing an initial series of LLR operated by a “pioneer” surgeon with previous experience in advanced laparoscopic surgery, the impact of indicating increasingly complex hepatectomies according to IWATE prevents us from affirming that there is a fixed limit of 50 cases to complete it. However, this series of three periods of 50 cases, with increasing complexity and a surgeon with such experience, demonstrated a relative reduction in operating times, conversion and hand assisted rate, bleeding, postoperative morbidity and hospital stay.

Abbreviations

LC: Learning curve.

LLR: Laparoscopic liver resection.

Acknowledgements

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Ramiro Arrechea Antelo, Lucia Aragone and Federico Veracierto. The first draft of the manuscript was written by Ramiro Arrechea Antelo and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Statements and Declarations

Dr. Ramiro Arrechea Antelo has no competing interest or funding ties to disclose.

Dra. Lucia Aragone has no competing interest or funding ties to disclose.

Dr. Federico Veracierto has no competing interest or funding ties to disclose.

Dr. Rafael Maurette has no competing interest or funding ties to disclose.

Dr. Daniel Enrique Pirchi has no competing interest or funding ties to disclose.

All methods were performed in accordance with the relevant guidelines and regulations.

Ramiro AA, et al., J Surg Res 2024
DOI:10.26502/jsr.10020365

Compliance with ethical standards

Conflicts of interest

Dr. Ramiro Arrechea Antelo has no conflicts of interest or financial ties to disclose.

Dra. Lucia Aragone has no conflicts of interest or financial ties to disclose.

Dr. Federico Veracierto has no conflicts of interest or financial ties to disclose.

Dr. Rafael Maurette has no conflicts of interest or financial ties to disclose.

Dr. Daniel Enrique Pirchi has no conflicts of interest or financial ties to disclose.

The research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit section.

Ethical approval

The ethical approval was carried out by the local Ethics Committee of the British Hospital of Buenos Aires.

Consent to participate

Due to the retrospective nature of this study, the Institucional Review Board of the British Hospital of Buenos Aires waived the requirements for written informed consent. However, all patients signed the surgical consent form.

Datasets

The datasets generated during and/or analysed during the current study are not publicly available due to patients identity protection, but are available from the corresponding author on reasonable request.

References

1. Buell JF, Cherqui D, Geller DA, et al. Position on laparoscopic liver surgery. Ann Surg 250 (2009): 825-830.
2. Chana P, Burns EM, Arora S, et al. A systematic review of the impact of dedicated emergency surgical services on patient outcomes. Ann Surg 263 (2016): 20-27.
3. Hilal MA, Aldrighetti L, Dagher I, et al. The Southampton Consensus Guidelines for Laparoscopic Liver Surgery: From Indication to Implementation. Ann Surg 268 (2018): 11-18.
4. Cherqui D. Laparoscopic liver resection. Br J Surg 90 (2003): 644-646.
5. Vigano L, Laurent A, Tayar C, et al. The learning curve in laparoscopic liver resection: Improved feasibility and reproducibility. Ann Surg 250 (2009): 772-780.
6. Tomassini F, Scuderi V, Colman R, et al. The single surgeon learning curve of laparoscopic liver resection: A continuous evolving process through stepwise difficulties. Med (United States) 95 (2016): 1-8.
7. Villani V, Bohnen JD, Torabi R, et al. “Idealized” vs. “true” learning curves: The case of laparoscopic liver resection. Hpb [Internet] 18 (2016): 504-509.
8. Goh BKP, Prieto M, Syn N, Koh YX, Lim KI. Critical appraisal of the learning curve of minimally invasive hepatectomy: experience with the first 200 cases of a Southeast Asian early adopter. ANZ J Surg 90 (2020): 1092-1098.
9. Wakabayashi G. What has changed after the Morioka consensus conference 2014 on laparoscopic liver resection? HepatoBiliary Surg Nutr 5 (2016): 281-289.
10. Manterola C, Del Sol M, Ottone N, et al. Radiological and surgical anatomy of the liver and fundamentals of the various options liver resections. Int J Morphol 35 (2017): 1525-1539.
11. Clavien PA, Barkun J, De Oliveira ML, et al. The Clavien-Dindo Classification of Surgical Complications. Ann Surg 250 (2009): 187-196.
12. Bhojani FD, Fox A, Pitzul K, et al. Clinical and economic comparison of laparoscopic to open liver resections using a 2-to-1 matched pair analysis: An institutional experience. J Am Coll Surg 214 (2012): 184-195.
13. Ciria R, Cherqui D, Geller DA, et al. Comparative short-term benefits of laparoscopic liver resection: 9000 cases and climbing. Ann Surg 263 (2016):761-777.
14. Pekolj J, Álvarez F, Merlo I, et al. Laparoscopic liver resections. Indications, technical aspects and results. Rev Argent Cir 107 (2015): 130-137.
15. Halls MC, Alseidi A, Berardi G, et al. A comparison of the learning curves of laparoscopic liver surgeons in differing stages of the IDEAL paradigm of surgical innovation: Standing on the shoulders of pioneers. Ann Surg 269 (2019): 221-228.
16. Lin NC, Nitta H, Wakabayashi G. Laparoscopic major hepatectomy: A systematic literature review and comparison of 3 techniques. Ann Surg 257 (2013): 205-213.
17. Cherqui D, Husson E, Hammoud R, et al. Laparoscopic liver resections: A feasibility study in 30 patients. Ann Surg 232 (2000):753-762.
18. Laurenzi A, Cherqui D, Figueroa R, et al. Totally intra-corporeal Pringle maneuver during laparoscopic liver resection. Hpb 20 (2018): 128-131.

Ramiro AA, et al., J Surg Res 2024
DOI:10.26502/jsr.10020365

19. Yoshioka R, Hasegawa K, Mise Y, et al. Evaluation of the safety and efficacy of simultaneous resection of primary colorectal cancer and synchronous colorectal liver metastases. Surg (United States) 155 (2014): 478-485.

20. Capussotti L, Ferrero A, Viganò L, et al. Major liver resections synchronous with colorectal surgery. Ann Surg Oncol 14 (2007): 195-201.

21. Hillingsø JG, Wille-jørgensen P. Staged or simultaneous resection of synchronous liver metastases from colorectal cancer - A systematic review. Color Dis 11 (2009): 3-10.

22. Giuliante F, Viganò L, De Rose AM, et al. Liver-First Approach for Synchronous Colorectal Metastases: Analysis of 7360 Patients from the LiverMetSurvey Registry. Ann Surg Oncol 28 (2021): 8198-8208.

23. Shubert CR, Habermann EB, Bergquist JR, et al. A NSQIP Review of Major Morbidity and Mortality of Synchronous Liver Resection for Colorectal Metastasis Stratified by Extent of Liver Resection and Type of Colorectal Resection. J Gastrointest Surg 19 (2015): 1982-1994.