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ORIGINAL SCIENTIFIC REPORT

Laparoscopic Liver Resection: A South American Experience with 2887 Cases

J. Pekolj[1] · R. Clariá Sánchez[1] · J. Salceda[2] · R. J. Maurette[3] · P. B. Schelotto[4] · L. Pierini[5] · E. Cánepa[6] · M. Moro[7] · G. Stork[7] · N. Resio[8] · J. Neffa[9] · L. Mc Cormack[10] · E. Quiñonez[11] · G. Raffin[12] · L. Obeide[13] · D. Fernández[14] · G. Pfaffen[15] · C. Salas[16] · M. Linzey[17] · G. Schmidt[18] · S. Ruiz[19] · F. Alvarez[20] · J. Buffaliza[21] · R. Maroni[22] · O. Campi[23] · C. Bertona[24] · M. de Santibañes[1] · O. Mazza[1] · M. Belotto de Oliveira[25] · A. L. Diniz[26] · M. Enne de Oliveira[27] · M. A. Machado[25] · A. N. Kalil[28] · R. D. Pinto[29] · A. P. Rezende[30] · E. J. B. Ramos[31] · A. Talvane T. Oliveira[32] · O. J. M. Torres[33] · N. Jarufe Cassis[34] · E. Buckel[35] · R. Quevedo Torres[36] · J. Chapochnick[37] · M. Sanhueza Garcia[38] · C. Muñoz[39] · G. Castro[40] · H. Losada[41] · F. Vergara Suárez[42] · O. Guevara[43] · D. Dávila[44] · O. Palacios[44] · A. Jimenez[45] · L. Poggi[46] · V. Torres[47] · G. M. Fonseca[48] · J. A. P. Kruger[48] · F. F. Coelho[48] · L. Russo[49] · P. Herman[48]

Abstract

Background Laparoscopic liver resections (LLR) have been increasingly performed in recent years. Most of the available evidence, however, comes from specialized centers in Asia, Europe and USA. Data from South America are limited and based on single-center experiences. To date, no multicenter studies evaluated the results of LLR in South America. The aim of this study was to evaluate the experience and results with LLR in South American centers.

Methods From February to November 2019, a survey about LLR was conducted in 61 hepatobiliary centers in South America, composed by 20 questions concerning demographic characteristics, surgical data, and perioperative results.

Results Fifty-one (83.6%) centers from seven different countries answered the survey. A total of 2887 LLR were performed, as follows: Argentina (928), Brazil (1326), Chile (322), Colombia (210), Paraguay (9), Peru (75), and Uruguay (8). The first program began in 1997; however, the majority (60.7%) started after 2010. The percentage of LLR over open resections was 28.4% (4.4–84%). Of the total, 76.5% were minor hepatectomies and 23.5% major, including 266 right hepatectomies and 343 left hepatectomies. The conversion rate was 9.7%, overall morbidity 13%, and mortality 0.7%.

Conclusions This is the largest study assessing the dissemination and results of LLR in South America. It showed an increasing number of centers performing LLR with the promising perioperative results, aligned with other worldwide excellence centers.

✉ P. Herman
pherman@uol.com.br

1 HPB Surgery Section, General Surgery Service, Hospital Italiano de Buenos Aires, Buenos Aires, Argentina

2 Hospital Ramón Santamarina, Tandil, Argentina

3 Hospital Británico, Buenos Aires, Argentina

4 Fundación Favaloro, Buenos Aires, Argentina

5 Clínica Nefrología, Clínica Uruguay, Hospital Iturraspe, Santa Fe, Argentina

6 Hospital Privado de Comunidad, Mar del Plata, Argentina

7 Hospital Italiano - Regional Sur, Bahía Blanca, Argentina

8 Unidad HPB Sur, General Roca, Argentina

9 Hospital Italiano de Mendoza, Mendoza, Argentina

10 Hospital Alemán, Buenos Aires, Argentina

11 Hospital El Cruce, Buenos Aires, Argentina

12 Hospital Argerich, Buenos Aires, Argentina

13 Hospital Universitario Privado, Córdoba, Argentina

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Introduction

The development of minimally invasive liver surgery (MILS) was slow due several barriers to overcome. The first limit was technical; hence, the translation of conventional steps to the laparoscopic approach was needed. For instance, liver mobilization, palpation, vascular dissection and control, and parenchymal transection were steps to be adapted to the laparoscopic approach. Thus, surgeons with experience in liver surgery had to be trained in advanced laparoscopy to achieve development. Moreover, bleeding control during liver transection, gas embolism secondary to pneumoperitoneum, and oncological outcomes such as surgical margins, port site seeding, and long-term survival were obstacles of great concern in the early experience with MILS [1–4].

In the last two decades, there has been a huge evolution on MILS, and many reports emerged confirming the safety and feasibility of MILS [5–7] including complex procedures such as major hepatectomies and even graft harvesting for living donation [8–10]. Regarding oncological safety, several reports have shown similar survival rates comparing open and laparoscopic resection of colorectal liver metastasis and hepatocellular carcinoma [10–17]. In addition, port seeding has proved to be extremely rare [18–21].

Evidence supporting MILS comes from case or cohort series, retrospective comparative studies, and meta-analyses. Ciria et al. in a systematic review including 9527 laparoscopic liver resections (LLR) have shown growing safety when performed in selected patients by experienced surgeons suggesting that LLR may offer improved short-term outcomes when compared to open liver resections (OLR) [22]. Only recently, a randomized controlled trial (RCT) was published comparing the results of LLR with the open approach for colorectal liver metastasis showing less postoperative complications in the laparoscopic group [23]. Despite being the best scientific evidence for the results evaluation of MILS, RCTs are difficult to conduct in clinical practice. In this context, international registries and well-designed observational studies are appropriate ways to produce evidence supporting MILS.

In 2014, the 2nd International Consensus Conference on LLR in Japan demonstrated the progress, acceptance, and dissemination of the method worldwide [24]. However, the majority of publications on LLR come from developed countries from Asia, Europe, or USA; few studies from centers in other regions of the world are available. In South America, there are limited data from single-center studies [25–29]; however, to date, no multicenter efforts to assess the dissemination and results of LLR in South America was published.

[14] Clínica Pueyrredón, Mar del Plata, Argentina

[15] Sanatorio Güemes, Buenos Aires, Argentina

[16] Sanatorio 9 de Julio, Santiago del Estero, Argentina, Hospital Centro de Salud, San Miguel de Tucumán, Argentina

[17] Hospital Angel C. Padilla, San Miguel de Tucumán, Argentina

[18] Hospital Escuela Gral, Corrientes, Argentina

[19] Clínica Colón, Mar del Plata, Argentina

[20] Clínica Reina Fabiola, Hospital Italiano, Córdoba, Argentina

[21] Hospital Lagommagiore, Mendoza, Argentina

[22] Hospital Papa Francisco, Salta, Argentina

[23] Clínica Regional General Pico, Santa Rosa, Argentina

[24] Hospital Español, Mendoza, Argentina

[25] Hospital Sírio Libanês, São Paulo, Brazil

[26] A.C. Camargo Cancer Center, São Paulo, Brazil

[27] Ipanema Federal Hospital, Rio de Janeiro, Brazil

[28] Santa Casa de Porto Alegre, Universidade Federal de Ciências da Saúde, Porto Alegre, Brazil

[29] Hospital Santa Catarina de Blumenau, Blumenau, Brazil

[30] Hospital Mater Dei, Belo Horizonte, Brazil

[31] Hospital Nossa Senhora das Graças, Curitiba, Brazil

[32] Hospital Americas Medical City Hospital Samaritano, Rio de Janeiro, Brazil

[33] Hospital Universitario HUUFMA, Hospital São Domingos, UDI Hospital, Fortaleza, Brazil

[34] Universidad Católica de Chile, Santiago, Chile

[35] Clínica Las Condes, Santiago, Chile

[36] Hospital de Concepción, Concepción, Chile

[37] Clínica Santa María, Santiago, Chile

[38] Hospital Sotero del Río, Santiago, Chile

[39] Hospital de Talca, Talca, Chile

[40] Hospital de Arica, Arica, Chile

[41] Hospital de Temuco, Temuco, Chile

[42] Clínica Vida - Fundación Colombiana de Cancerología, Medellin, Colombia

[43] Instituto Nacional de Cancerologia, Bogotá, Colombia

[44] Clínica CES, Medellín, Colombia

[45] Hospital Clínicas, Asunción, Paraguay

[46] Clínica Anglo Americana, Lima, Peru

[47] Hospital Guillermo Almenara ESSALUD, Lima, Peru

[48] Hospital das Clínicas - University of São Paulo School of Medicine, São Paulo, Brazil

[49] Hospital Maciel, Casmu, Montevideo, Uruguay

The aim of this study was to evaluate the experience and results with LLR in South American centers.

Methods

A survey including 61 hepatobiliary groups in South America, including seven countries (Argentina, Brazil, Chile, Colombia, Paraguay, Peru, and Uruguay), was performed from February to May 2019. Contacts were done by e-mail or phone calls, and the survey was sent by e-mail, with a cover letter calling for participation.

Twenty questions as follows were presented: year of the beginning of the program; total number of liver resections; number of cases OLR and LLR; percentage of laparoscopic/open cases; conversion rate; percentage of benign and malignant cases; number of colorectal metastasis, hepatocellular carcinoma, other tumors cases; number of minor LLR; number of major LLR (resection of ≥3 segments); number of ALPPS (associating liver partition and portal vein ligation for staged hepatectomy) cases; number of right and left LLR; number of extended LLR; number of left lateral sectionectomies; transfusion rate, morbidity, and mortality.

All studied variables, except age, were categorical and presented as frequency (percentage).

Results

There were 51 (83.6%) answers from different centers, and seven different countries as follows: Argentina (23), Brazil (11), Chile (8), Colombia (3), Paraguay (2), Peru (2), and Uruguay (2). The results are summarized in Table 1.

The first program began in 1997 and the majority (31 programs = 60.7%) after 2010. All of the 51 groups that answered the survey perform MILS. A total of 2887 LLR were performed, as follows: Argentina (928), Brazil (1326), Chile (322), Colombia (210), Paraguay (9), Peru (75), and Uruguay (8).

From the 51 responding centers, nine were considered as high-volume centers (more than 50 total liver resections per year and more than 100 LLR performed) and 42 low-volume centers. Eleven centers (21.5%) were academical university centers, and 40 (78.5%) were peripheral/regional centers.

The median age of the patients was 44 years (28-70 years). Regarding the total number of cases per group, 31 groups (60.7%) did less than 50 cases, 11 (21.5%) did between 50 and 100 cases, six (11.7%) between 100 and 150 cases, and three groups (5.8%) did more than 200 cases (Fig. 1).

Table 1 Results of 2887 laparoscopic liver resections in South America

Variable	*N* (%)/% (range)
# centers	51
# cases	2887
% applicability	28.4% (4.4–84)
% benign disease	43% (0–70)
% malignant tumors	57% (0–100)
# minor resections	2209 (76.5%)
# major resections	678 (23.5%)
# right hepatectomies	266 (9.2%)
# left hepatectomies	343 (11.9%)
# left lateral sectionectomy	420 (14.5%)
# living related donors	18 (0.6%)
# ALPPS	24 (0.8%)
% conversion	9.7% (0–60)
% morbidity	13% (0–50)
% mortality	0.7% (0–5)

Regarding the indication for liver resection, 1241 cases (43%) were done for benign diseases and 1646 (57%) for malignant diseases. From the malignant group, 62% were for colorectal liver metastasis and 20% for hepatocellular carcinoma. The majority of resections (76.5%) were minor hepatectomies, and 678 resections (23.5%) were major hepatectomies. There were 266 right hepatectomies, 343 left hepatectomies, 420 left lateral sectionectomies, and 24 ALPPS.

The percentage of LLR over open resections was, in 57% of the centers, between 10 and 29% (Fig. 2). In only three groups, more than 70% of resections were done by minimally invasive approach.

Regarding the perioperative results, conversion rate was 9.7%; transfusion rate 13%, overall morbidity 13%, and mortality 0.7%. When considering morbidity and mortality according to the volume of operated patients per center, in high-volume centers (more than 100 LLR) the mean morbidity rate was 23% (4.6–45.6%), mean mortality rate was 0.7% (0-21%), and mean conversion rate was 10.9% (2.7–31.4%). In low-volume centers, the mean morbidity rate was 11% (0–50%), mean mortality rate was 0.8% (0–5%), and mean conversion rate was 9.2% (0–60%).

Discussion

Despite increasingly performed, MILS is employed in a small percentage of liver resections (5–30%), although some expert centers have reported higher rates, reaching 50–80% of liver resections done by laparoscopy [24, 30, 31]. An analysis including liver resections

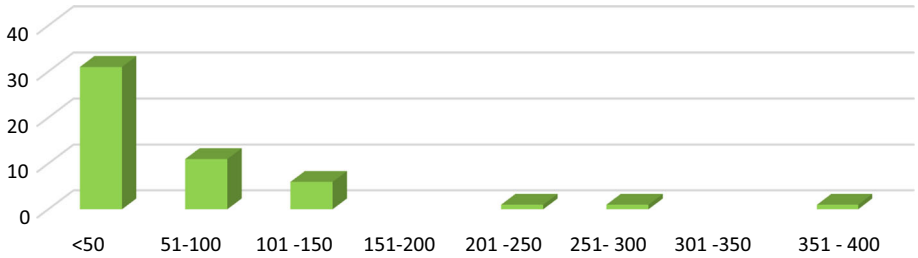

Fig. 1 Total number of laparoscopic liver resections per group in South America

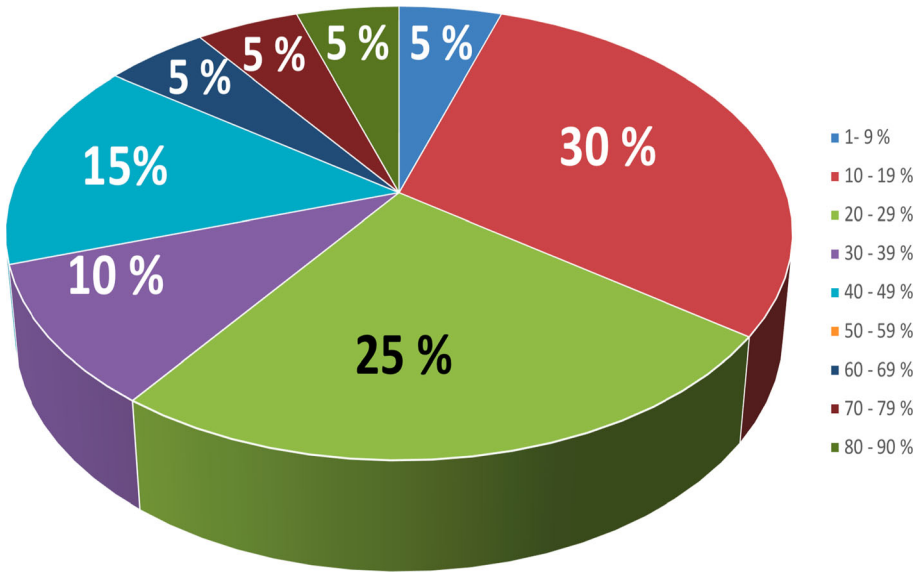

Fig. 2 Percentage of laparoscopic liver resections over open liver resections by group

performed in France along the year of 2013 showed that only 15% of liver resections were performed through minimally invasive approach [32]. Data from North American centers indicate that less than 10% of all liver resections done for benign conditions were done by laparoscopy [33]. The majority of reported cases are minor resections; however, the proportion of major liver resections is increasing in the last years [30].

In fact, there are few centers worldwide with extensive experience with LLR [30]. A recent survey involving 27 hepatobiliary expert centers worldwide showed different numbers according to the region: the proportion of LLR was 34.6% in Asia-Pacific, 35.6% in Europe, and 27.4% in North/South America [34]. Our objective was to map the use of MILS in South America.

In addition to the aforementioned issues regarding MILS acceptance, in developing countries there is still a barrier due to high equipment costs and difficult access to technology. In a meta-analysis by Limongelli et al., LLR was associated with lower ward stay cost than OLR (2972 USD vs. 5291 USD), but costs related to operation (equipment and theater) were higher in the group of patients undergoing LLR [35]. Despite these difficulties, LLR has spread widely throughout all South America. In a recent survey in Brazil, more than 90% of liver surgery groups perform LLR [36]. In the present survey, all groups that answered the survey perform LLR, and in the majority of groups (57%), the proportion of LLR over all liver resections ranged between 10 and 29%. Aldrighetti et al., in an Italian national survey on LLR, reported that the proportion of minimally invasive over the total number of liver resections was 10.3% of all resections, with a significant variety between ranging from 0.9 to 58%, with a median of 11% [37].

Indications for resection of malignant tumors in recent years have trespassed the indications for benign diseases, figures observed in the literature [22, 37] and in our study. The reasons for this inversion were based on data demonstrating the oncological effectiveness of MILS both in colorectal cancer metastasis and hepatocellular carcinoma [28].

One of the initial concerns in LLR, especially in major liver resections, was the risk of gas embolism. The incidence is low ranging between 0.2 and 1.45%; and no influence on postoperative morbidity and mortality was

reported [38, 39]. In this series, no cases of embolism were observed.

The major operative concern regarding LLR is massive intraoperative bleeding. Reported blood loss varies between series and is directly related to the type and difficulty of LLR [40–46]. In several meta-analyses, intraoperative bleeding tends to be lower with the laparoscopic approach than OLR resulting in decreased requirement for blood transfusions [28, 47–49]. In a recent review, 8.3% of the patients submitted to LLR received blood transfusion [22], and similar numbers were observed in the present survey where the transfusion rate was 13%.

In a large meta-analyses, Ciria et al. pointed out the safety of LLR showing that in minor-only resection series and in combined series, the overall rate of complications, estimated blood loss, rate of transfusions, and hospital stay are lower in laparoscopic group. In addition, in major-only resection series, the overall rate of complications, estimated blood loss, and hospital stay favor the minimally invasive approach [22].

The reported conversion rate ranges from 0 to 20% [14], varying mostly according to the indication and type of LLR. However, with the acquirement of surgical expertise the conversion rate can be reduced to less than 5% in expert centers [28, 50, 51]. In the present series, the 9.7% of conversion rate can be explained by the high number of groups (52.9%) with less than 50 LLR. Similarly, an Italian multicentric survey with 1677 patients showed a conversion rate of 10.7% [37].

Regarding the complexity of laparoscopic liver resections, in the South American data, 23.5% of the cases were major liver resections, numbers coincident with the world experience (24.2%) [22] showing the gain of experience and expertise of Latin groups. Of interest, is the large number of laparoscopic ALPPS procedures done in South America, numbers explained by the great enthusiasm with this new technique by groups from Argentina and Brazil [52–54].

Table 2 Total number of laparoscopic liver resections (LLR) performed per country or region and the relative number LLR/millions of inhabitants (population) in different places of the world

Place	# LLR	Population	# LLRs/million
Japan	20,000*	126,746,000	157.8
France	4509**	66,990,000	67.3
Italy	3302****	60,484,000	54.6
USA	5000***	329,970,000	15.1
South America	2887*****	422,500,000	6.8

*Estimated (Go Wakabayashi) first case 1993

**From 2000 to June 2018 (E. Vibert)

***From 2014 to 2019 (N. Rusonnniello)

****Estimated (Joe Buell)

*****From 1997 to April 2019 (J. Pekolj)

In large series, overall morbidity rate ranged from 3.2 [55] to 45%. Jackson et al. [49] analyzing 47 studies showed that patients who underwent LLR had lower postoperative complication rates when compared with open surgery. In a recent prospective trial comparing open and laparoscopic resection for colorectal liver metastasis, the postoperative complication rate was 19% in the laparoscopic group and 31% in the open surgery group [23]. In the present survey, postoperative complication rate was low (13%), probably because a possible selection bias for the minimally invasive procedure, which implies in a large number of minor resections (76.5%). Moreover, low-volume centers presented lower morbidity and conversion rates when compared to high-volume ones; this can also be explained by the higher number of minor and non-complex resections performed in low-volume centers.

Recent series from high-volume centers report mortality for LLR ranging from 0 to 2.4% [6, 20, 42, 44, 46, 50, 51, 56–66]. Jackson et al. pooled the results of 40 studies comparing mortality rates between LLR and OLR and found no significant difference in mortality between groups [49]. In fact, most individual-based studies failed to detect mortality differences between laparoscopic and open resection. However, significant lower 90-day mortality rates (1.3% vs. 5.8%, P = 0.006) in patients undergoing laparoscopic left lateral sectionectomy for primary liver malignancy were reported in a population-based study after adjustment for confounding [67]. In a recent review, mortality rate for LLR was 0.4% [22], and in the present series, 0.7%. This data is similar than in the Italian national survey where the mortality rate was 0.2% [36]. These excellent results could be explained by a possible selection bias in the LLR group; moreover, the complex resections were mostly performed in groups of expert surgeons.

A consensual observation is that LLR should be performed by surgeons with extensive training in hepatobiliary and advanced laparoscopic surgery [41]. Therefore, fellowships in specialized centers should offer high-level training in order to accomplish competence in both domains. Indeed, in the Morioka expert consensus in 2014, one of the conclusions of the working group was the need for a formal structure of education for those interested in performing major laparoscopic LLR [24]. In South America, besides some groups with large experience in LLR, there are training centers for minimally invasive liver surgery in Argentina (two), Brazil (three), and Chile (one).

LLR has evolved greatly over the past two decades and, despite initial difficulties and even skepticism, the excellent reported results made the minimally invasive approach

to be incorporated to the day-by-day surgical practice. Increased experience, especially in specialized centers, allowed more complex surgeries to be performed. The dissemination and interest in LLR were due to the technical challenge and excellent perioperative results. The visits of surgeons beginning their experience in minimally invasive liver surgery to centers of great expertise, in addition to the proliferation of training centers, enabled a great evolution of LLR worldwide.

This survey showed that South American hepatobiliary centers as well as Asian, European, and North American centers have incorporated LLR into their routine (Table 2). Nowadays, worldwide experience counts more than 35,000 cases of LLR and South American centers have made significant contribution for this scenario. Ours results showed a great number of centers performing LLR, dissemination of training centers, and favorable results with low perioperative morbidity and mortality, in accordance with other expert centers around the world.

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