Review Article

Minimally invasive right hepatectomy for living liver donation: a systematic review of the literature

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Abstract: Living donor liver transplantation (LDLT) has emerged as one of the possible solutions for improving the donor pool. However, mainly in case of adult-to-adult donation, performing a right hepatectomy (RH) in a healthy individual should represent a challenge. A way for reducing this shortcoming is the use of mini-invasive surgery. The aim of the present study was, then, to perform a systematic review of the literature investigating the results of the laparoscopic right lobe donation, mainly looking at the different surgical methodologies adopted and the donor complication rates. A systematic search was done following the Preferred Reporting Items for Systemic Reviews and Meta-Analysis (PRISMA) guidelines: 176 articles were initially screened: eventually, 32 articles were identified, with a total of 501 investigated cases. Pure laparoscopic and robotic right hepatectomies were done in 84 (16.8%) and 14 (2.8%) donors, respectively. Hybrid or assisted procedures were done in 199 (39.7%) and 204 (40.7%) cases, respectively. In the 464 cases in which the postoperative course was exhaustively described for each patient, a total of 85 (18.3%) subjects experienced at least one complication. Twenty-six (5.6%) individuals had a grade III according to the Clavien-Dindo classification: no cases of organ dysfunction nor death were experienced. After stratification of the entire population according to the type of laparoscopic approach adopted (pure-robotic *vs.* hybrid-assisted), it was interesting to observe that hybrid-assisted cases presented an increased risk of experiencing any complication after RH, with an odds ratio (OR) of 2.53 (P value=0.01). Laparoscopic RH for living donation is a safe procedure. After 501 reported procedures, no deaths have been described. Pure laparoscopic approaches look to consent a lower risk of donor complication respect to hybrid ones. More studies comparing the different laparoscopic approaches with the open procedure are required.

Keywords: Pure laparoscopy; robotic; hybrid; hand-assisted; liver resection; living donation

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Introduction

Liver transplantation (LT) represents the mainstay treatment for patients with the end-stage liver disease (1). Nevertheless, the long-lasting imbalance between graft availability and the increasing number of patients waiting for a LT requires the development of new strategies aimed at increasing the donor pool (2). Living donor liver transplantation (LDLT) has emerged as one of the possible solutions for this problem (3). The first reported LDLT series were adult-to-child transplants based on the use of a left lateral liver graft (4,5). Rapidly, adult-to-adult LDLT was also introduced in the clinical practice, with the first series reported in Hong Kong (6). However, performing

a right hepatectomy (RH) in a healthy individual should represent a challenge, with non-neglectable reported percentages of donor post-operative discomfort, morbidity, and even mortality (7).

A way for reducing all of these shortcomings has been connected with the introduction of mini-invasive surgery. After the first case of laparoscopic cholecystectomy reported in 1987 (8), mini-invasive approach rapidly became a reality also in the setting of liver surgery. The first laparoscopic anatomic hepatectomies were reported in 1996 (9,10). After the first pioneering laparoscopic major hepatectomies (11), several series reported structured case-series with results even favoring laparoscopy respect to open approaches (12-15). Growing evidence has been reported that mini-invasive liver surgery (MILS) is a feasible approach for a great number of liver diseases, as clearly reported in the Consensus Conferences of Louisville 2008 (16), Morioka 2014 (17) and Southampton 2017 (18). For example, laparoscopy is considered today as the approach of choice for performing a left lateral sectionectomy. However, although great benefits should be surely taken into account in using MILS for liver surgery, its use in the setting of living donation still raises several concerns about donor safety and graft integrity (19). These doubts are even increased in the specific setting of adult-to-adult right lobe donation (20).

A systematic review of the literature has been done specifically investigating the results of the laparoscopic right lobe donation, mainly looking at the different surgical methodologies adopted and the donor complication rates.

Methods

Search strategy

A systematic search was done concerning relevant studies focused on the use of MILS in the setting of living donor-related RH. The search strategy was done following the PRISMA guidelines, as well as PRISMA for abstracts (21). A search of the electronic databases MEDLINE-PubMed was conducted using the following research terms: (laparoscopy[th] OR laparoscopic[th] OR minimally invasive[th] OR hybrid[th] OR hand-assisted[th]) AND (hepatectomy[th] OR liver resection[th] OR hepatic resection[th]) AND (living donor[th] OR living donation[th] OR liver donor[th]).

Studies published before January 1, 2018, were taken into consideration.

Screening process

The present qualitative systematic review included a priori search criteria of journal articles among adult (age ≥18 years) human patients. Studies were limited to the English language.

All the studies in which a RH for living donation performed with any kind of mini-invasive approach (i.e., pure laparoscopic, hybrid, hand-assisted, laparoscopic-assisted, robotic) were selected. Exclusion criteria were: (I) studies reporting donor RH with open technique; (II) studies focused on laparoscopic RH not performed for living donation; (III) papers lacking sufficient statistical details; (IV) review articles; (V) nonclinical studies; (VI) expert opinions or commentaries; (VII) letters to editor; and (VIII) conference summaries. Case reports and case series were considered for the analysis, due to the scarcity of reported cases in the literature.

Study selection

Two reviewers (FG and QL) independently screened the identified studies and their extracted data. In case of disagreement, the paper was discussed by all the authors.

Quality assessment

Selected studies were reviewed based on the representativeness of the study population, comparability of cohorts, adequate assessment of outcomes, sufficient length of follow-up, adequacy of follow-up, and source of study funding. The quality of the papers was assessed using the Newcastle-Ottawa Quality Assessment Scale (NOS): studies with scores >6 were defined as high-quality studies (22).

Donor characteristics were collected in *Table 1*. The following features were reported: first author's name, year of publication, reference, number of reported donors, type of incision for graft extraction, kind of surgical approach, age, gender, body mass index (BMI), operation time, blood loss during operation in mL, estimated future liver remnant (FLR) expressed in percentage, graft weight in grams, graft-to-recipient weight ratio (GRWR), the incidence of complications, the number of complications stratified according to the Clavien-Dindo classification, and the hospital length of stay in days.

Recipient characteristics were collected in *Table 2*. The following data were collected: first author's name, reference, year of publication, number of reported recipients, gender,

Table 1 Donor characteristics reported in the selected studies

Author [year] (Ref)	N	Incision	Approach	Age (years)	Gender (M/F)	BMI	Operation time (min)	Blood loss (mL)	Estim FLR (%)	Graft weight (g)	GRWR	Complication, n [%]	CD	LOS
Eguchi [2018] (23)	43	Minilalap	Hybrid	44 [24–64]	9/34	NA	410 [314–581]	600 [130-1,800]	NA	NA	NA	5 [12]	NA	14 [8–30]
Han [2017] (24)	1	Pfannestiel	Pure	19	0/1	NA	410		NA	608	0.81	None	–	NA
Suh [2018] (25)	45	Pfannestiel	Pure	33	26/19	24	331	436	34	714	1.30	4 [9]	I=1/II=2/III=1	8
Kitajima [2017] (26)	41	Minilap	Hybrid	52 [20–67]	15/26	22 [17–29]	431 [310–651]	201 [10–1,559]	NA	668 [460–1,100]	NA	9 [22]	I=5/II=4	12 [8–27]
Hong [2017] (27)	1	Pfannestiel	Pure	50	1/0	26	443	–	NA	1146	1.88	None	–	8
Li [2017] (28)	1	Pfannestiel	Pure	40	1/0		480	–	NA	615	0.85	None	–	7
Takahara [2017] (29)	25	Minilap	Assisted	36±10	5/20	22±2	380±45	268±194	NA	651	NA	4 [16]	I=1/II=1/III=2	9±2
	5	Pfannestiel	Pure	40±9	2/3	22±2	480±54	91±69	NA	669	NA	1 [20]	III=1	9±2
Kim [2017] (30)	3	Pfannestiel	Pure	23	0/1	17	502	250	NA	580	0.93	None	–	7
		Pfannestiel	Pure	21	0/1	22	427	200	NA	540	0.78	None	–	8
		Pfannestiel	Pure	33	0/1	18	447	270	NA	550	0.89	None	–	7
Hong [2017] (31)	9	Pfannestiel	Pure	33±11	5/4	24±1	251±50	420±183	NA	NA	NA	NA	NA	8±1
Shen [2016] (32)	28	Minilap	Hybrid	40±11 [22–63]	15/13	23±2 [17–25]	386±50 [300–508]	384±180 [200–1,000]	NA	634±124 [409–869]	1.00±0.12 [0.80–1.23]	5 [18]	I=2/II=2/III=1	7±3 [6–14]
Chen [2016] (33)	13	Pfannestiel	Robotic	NA	4/9	22 [17–27]	596 [353–753]	169 [50–500]	37 [31–44]	618 [350–820]	1.25 [0.89-1.96]	1 [8]	III=1	7 [6-8]
Rotellar [2017] (34)	5	Pfannestiel	Pure	29	1/0	26 [21–28]	480	<100	38	1046	1.69	1 [20]	I=1	4
		Pfannestiel	Pure	27	0/1		450	<200	41	791	0.96	NA	NA	4
		Pfannestiel	Pure	48	1/0		480	<100	36	973	1.24	1 [20]	I=1	5
		Pfannestiel	Pure	21	1/0		420	<100	32	1,433	1.50	NA	NA	5
		Pfannestiel	Pure	51	1/0		476	<100	41	775	1.58	NA	NA	3
Suh [2016] (35)	2	Pfannestiel	Pure	57	0/1	NA	408	NA	40	601	0.80	None	–	9
		Pfannestiel	Pure	40	0/1		409		39	669	1.10	None	–	8
Li [2016] (36)	1	Pfannestiel	Pure	47	1/0	24	540	350	36	823	1.42	None	–	8
Chen [2016] (37)	1	Pfannestiel	Pure	19	1/0	NA	415	150	36	940	1.11	1 [100]	I=1	6
Brustia [2015] (38)	2	Pfannestiel	Pure	50±1	0/2	21±5	480	125±106	NA	590±127	NA	None	–	8
Soyama [2015] (39)	25	Minilap	Hybrid	41 [21–65]	12/13	22 [17–29]	411 [324–581]	600 [130–1900]	NA	NA	NA	2 [8]	I=1/III=1	NA

Table 1 (*continued*)

Table 1 (*continued*)

Author [year] (Ref)	N	Incision	Approach	Age (years)	Gender (M/F)	BMI	Operation time (min)	Blood loss (mL)	Estim FLR (%)	Graft weight (g)	GRWR	Complication, n [%]	CD	LOS
Makki [2014] (40)	26	Minilap	Assisted	28±9	13/13	24±4	703±124	337±89	NA	756±88	NA	4 [16]	I=3/III=1	NA
Choi [2014] (41)	2	Pfannestiel	Pure	25±7 [14–44]	1/24	21±4 [17–29]	678±110	1,000±283	35±5 [27–43]	617±113 [430–845]	NA	35*	I=32/II=1/ III=2	12 [10–14]
	9	Minilap	Hybrid				484±104	308±133						9 [8-18]
	14	Transverse incision	Assisted				334±60	266±127						9 [8–24]
Zhang [2014] (42)	25	Minilap	Hybrid	32±9 [22–57]	13/12	24±3	386±47	378±113	NA	630±129	0.99±0.20	4 [16]	I=3/II=1	7±1
Rotellar [2013] (43)	1	Pfannestiel	Pure	29	1/0	NA	480	<100	39	1,046	1.67	None	–	4
Ha [2013] (44)	20	Minilap	Assisted	25±6	11/9	23±4	336±94	290±67	NA	725±136	NA	1 [5]	I=1	11±3
Soubrane [2013] (45)	1	Pfannestiel	Pure	50	0/1	NA	480	100	44	620	0.91	None	–	7
Nagai [2012] (46)	28	Minilap	Hybrid	34±10	15/13	24±3	371±52	212±114	36±12	915±361	NA	7 [20]	II=4/III=3	6±1
Choi [2012] (47)	20	Minilap	Assisted**	32±10	23/17	23±3	279±72	450±316	NA	NA	NA	6 [30]	I=1/III=5	12±5
	40	Minilap	Assisted	30±10	12/8	24±3	384±42	870±653				6 [15]	I=4/III=2	12±3
Giulianotti [2012] (48)	1	Minilap	Robotic	53	1/0	NA	480	350	NA	1008	1.02	None	–	5
Thenappan [2011] (49)	15	Minilap	Assisted	34±9	7/8	NA	320±73	1033±1096	NA	NA	NA	9 [60]	II=2/III=7	6±2
Baker [2009] (50)	33	Minilap	Assisted	37±10	15/18	26±4	265±48	417±217	NA	900±215	1.17±0.31	7 [21]	I=5/II=2	5±1
Suh [2009] (51)	9	Pfannestiel	Pure	NA	0/1	17	765	NA	NA	NA	0.95	1 [11]	I=4/II=1/ III=1	10
		Pfannestiel	Pure		0/1	19	898				1.05	1 [11]		14
		Minilap	Assisted		0/1	19	575				0.91	1 [11]		9
		Minilap	Assisted		0/1	27	505				1.25	1 [11]		12
		Minilap	Assisted		0/1	29	460				0.94	None		9
		Minilap	Assisted		0/1	22	310				1.25	1 [11]		9
		Minilap	Assisted		0/1	18	545				0.74	None		8
		Minilap	Assisted		0/1	19	495				0.82	1 [11]		17
		Minilap	Assisted		0/1	24	535				0.84	None		8
Suh [2008] (52)	2	Pfannestiel	Pure	25	0/1	NA	765	NA	NA	560	0.95	None	–	10
		Pfannestiel	Pure	24	0/1		898			550	1.09	None		14
Koffron [2006] (53)	1	Minilap	Assisted	32	0/1	NA	235	150	NA	825	NA	None	–	7
Kurosaki [2006] (54)	3	Minilap	Assisted	39±12	2/1	23±3	363±3	302±91	NA	420±2.9	0.72±0.24	1 [33.3]	I=1	11±3

*Total number of complications (more than one complication for each case); **, single-port. Ref, reference; N, number; M, male; F, female; BMI, body mass index; FLR, future liver remnant; GRWR, graft-to-recipient weight ratio; CD, Clavien-Dindo; LOS, length of stay; NA, not available.

Table 2 Recipient characteristics reported in the selected studies.

Author	Year	N	Gender (M/F)	Age	Underlying liver disease	BMI	MELD	Complications	LOS
Eguchi (23)	2017	43	NA	NA	NA	NA	NA	NA	NA
Han (24)	2016	1	1/0	47	HBV	NA	NA	NA	NA
Suh (25)	2017	45	30/15	53	HBV 33, HCV 4, alcohol 2, others 6, HCC 32	24	11	Intra-abdominal bleeding 3, intra-abdominal fluid collection 4, wound problem 2, hepatic artery problem 1, portal vein or hepatic vein problem 4, biliary problem 1, cardiac problem 1, pulmonary problem 2, gastrointestinal problem 1	21
Kitajima (26)	2017	76	40/36	57 [23–69]	NA	23 [15–32]	16 [6–40]	Arterial complications 1, portal venous thrombosis 2, biliary leak 5; biliary stricture 5	NA
Hong (27)	2017	1	NA	NA	NA	NA	NA	NA	NA
Li (28)	2017	1	1/0	36	HBV-HCC	NA	11	NA	NA
Takahara (29)	2017	40	22/18	51±2	Cholestatic disease 8, HCC 24, vascular disease 1, neoplastic disease 2, acute liver failure 5	NA	18±10	Reoperation 9, hepatic artery thrombus 1, portal vein thrombus/stenosis 2, out flow block 3, biliary complications 4, renal dysfunction 6, rejection 7; mortality (1 month) 2, mortality (3 months) 5	NA
		14	9/5	52±3	Cholestatic disease 2, HCC 10, neoplastic disease 1, others 1	NA	15±5	Reoperation 3, hepatic artery thrombus 1, biliary complications 2, renal dysfunction 4, rejection 2; mortality (1 month) 2, mortality (3 months) 2	NA
Kim (30)	2017	1	1/0	20	Wilson	20	8	NA	16
		1	1/0	48	Alcohol	25	18	NA	18
		1	0/1	54	HBV	22	21	NA	24
Hong (31)	2017	9	NA	NA	NA	NA	NA	NA	NA
Shen (32)	2016	28	NA	NA	NA	NA	NA	NA	NA
Chen (33)	2016	13	NA	NA	NA	NA	NA	Artery thrombosis 1, biliary complication 1	NA
Rotellar (34)	2017	5	4/1	67 [44–69]	Primary biliary cholangitis 1, alcohol 1, HCC 3	NA	10 [9–16]	Biliary leak 1, biliary stenosis 2, arterial stenosis 1	NA
Suh (35)	2016	2	1/0	62	HBV and HCC	24	11	None	12
			1/0	42	HBV and HCC	21	12	None	12
Li (36)	2016	1	0/1	NA	Sclerosing cholangitis and HCC	NA	8	None	NA
Chen (37)	2016	1	1/0	NA	HBV and HCC	NA	10	Pneumonia	NA
Brustia (38)	2015	2	NA	NA	NA	NA	NA	NA	NA
Soyama (39)	2015	25	NA	NA	NA	25 [20–36]	15 [7–40]	NA	NA
Makki (40)	2014	26	NA	NA	HCV 10, HBV 5, HCC 3, Alcohol 3, others 8	NA	19±7	Biliary leak 1, biliary stricture 1	NA

Table 2 (*continued*)

Table 2 (*continued*)

Author	Year	N	Gender (M/F)	Age	Underlying liver disease	BMI	MELD	Complications	LOS
Choi (41)	2014	2	NA	NA	NA	NA	NA	NA	NA
		9	NA	NA	NA	NA	NA	NA	NA
		14	NA	NA	NA	NA	NA	NA	NA
Zhang (42)	2013	25	20/5	43±8	HBV and HCC 21, fulminant hepatitis 3, Budd-Chiari syndrome 1	NA	13±6	Biliary stricture 1, hepatic artery thrombosis 1, intra-abdominal bleeding 1, intra-abdominal abscesses 1, pulmonary infection 1	NA
Rotellar (43)	2013	1	1/0	69	Cryptogenetic cirrhosis with HCC	NA	15	Pseudomonas aeruginosa pneumonia	NA
Ha (44)	2013	20	NA	NA	NA	NA	NA	NA	NA
Soubrane (45)	2013	1	0/1	47	Primary biliary cholangitis	NA	22	None	15
Nagai (46)	2012	28	11/17	NA	HCV 11, alcoholic cirrhosis 2, autoimmune hepatitis 2, primary biliary cholangitis 3, primary sclerosing cholangitis 5, other 5	NA	11±6	Biliary stricture/leak 4, Hepatic artery thrombosis/stricture 2, Hepatic vein stricture 2, Intra-abdominal abscess 2	14±8
Choi (47)	2012	40	NA	NA	NA	NA	NA	NA	NA
		20	NA	NA	NA	NA	NA	NA	NA
Giulianotti (48)	2011	1	1/0	61	HCV	NA	NA	None	8
Thenappan (49)	2011	15	NA	NA	NA	NA	NA	NA	NA
Baker (50)	2009	33	24/9	52±14	HCV 3, HCC 6, cholangiocarcinoma 3	26±6	12±4	NA	NA
Suh (51)	2009	9	1/0	51	HBV and HCC	NA	15	Stroke (IIIA), biliary stricture (IIIA)	32
			0/1	62	HBV and HCC	NA	10	Bile leak (II), biliary stricture (IIIA)	39
			1/0	62	HBV and HCC	NA	12	Biliary stricture (IIIA)	17
			0/1	46	Budd-Chiari syndrome and HCC	NA	10	Biliary stricture (IIIA)	24
			1/0	58	HBV and HCC	NA	15	None	17
			0/1	14	Biliary atresia	NA	21	Seizure (I), ascending cholangitis (II)	26
			1/0	59	HBV	NA	16	Bile stricture (IIIA)	21
			0/1	55	HBV and HCC	NA	9	Tremor (I), bile leak (IIIA), HA stenosis (II), PV thrombosis (IIIB)	61
			0/1	51	HBV	NA	31	None	26
Suh (52)	2008	2	1/0	NA	HCC	NA	NA	None	NA
			0/1	NA	NA	NA	NA	None	NA
Koffron (53)	2006	1	1/0	NA	Progressive sclerosing cholangitis	NA	NA	None	NA
Kurosaki (54)	2005	3	1/2	49±14	Viral liver cirrhosis and HCC 3	NA	24±8	NA	NA

N, number; M, male; F, female; BMI, body mass index; MELD, model for end-stage liver disease; LOS, length of stay; NA, not available; HBV, hepatitis B virus; HCC, hepatocellular carcinoma; HCV, hepatitis C virus.

age, underlying liver disease, BMI, the model for end-stage liver disease (MELD) score, complications, and hospital length of stay.

Statistical analysis

Continuous variables were reported as mean ± standard error or median and ranges. Dichotomous variables were reported as number and percentages. A univariate logistic regression analysis was performed investigating the risk of post-operative donor complication. OR and 95% confidence intervals (95% CI) were reported. OR was considered statistically significant when the P was <0.05. OR and 95% CI >1 revealed a higher risk of postoperative complication, whereas a result <1 had the opposite meaning. SPSS statistical package version 23.0 (SPSS Inc., Chicago, IL, USA) was used.

Results

The selection process of the articles is explained in *Figure 1*.

As for the selection process according to the PRISMA guidelines, the various examined databases provided a total of 176 articles to screen. After carefully checking for the references of these articles, no papers more were identified reaching the characteristics established for the present study. Consequently, 176 articles were initially screened. After reading the title and the abstract, 111 articles were removed. Of the remaining 65 papers, 33 were not considered eligible after full-text evaluation. Eventually, 32 articles were identified, with a total of 501 investigated cases (*Tables 1*,*2*).

As for the quality of the reported studies, all the examined articles were only case reports or case series. Consequently, a NOS value was impossible to be correctly established, thus underlying the poor overall quality of the studies focused on this topic.

Only 8 (25.0%) articles coming from Western centers were reported, with only 59/501 (11.8%) cases performed.

As for the type of MILS, pure laparoscopic RH and robotic hepatectomy were done in 84 (16.8%) and 14 (2.8%) donors, respectively. Hybrid or assisted procedures were done in 199 (39.7%) and 204 (40.7%) cases, respectively. The type of incision done for extracting the graft was a mini-laparotomy in 381 (76.0%) cases, a transverse incision in 14 (2.8%) subjects, and Pfannenstiel incision in 106 (21.2%) donors, respectively. A total of 285 (56.9%) donors were females. In the 464 cases in which the postoperative course was exhaustively described for each patient, a total of 85 (18.3%) subjects experiencing at least one complication were reported. Twenty-six (5.6%) individuals had a grade III according to the Clavien-Dindo classification: no cases of organ dysfunction or death were experienced (*Table 1*).

After stratification of the entire population according to the type of laparoscopic approach adopted (pure-robotic *vs.* hybrid-assisted), it was interesting to observe that hybrid-assisted cases presented an increased risk of experiencing any complication after RH, with an OR of 2.53 (95% CI: 1.22–5.24; P value=0.01).

Recipient-related characteristics were less extensively reported (*Table 2*): only 17 articles reported post-operative recipient course, with a total of 113/291 (38.8%) cases reporting any complication.

Discussion

MILS for living donation has been introduced in the clinical practice with the intent to reduce the impact on donor's life. In fact, laparoscopy aims to reach several positive aspects, like (I) minimizing tissue trauma, (II) reducing postoperative pain, (III) decreasing morbidity and mortality rates, (IV) obtaining better cosmetic results, (V) consenting a faster return to work and normal physical activities.

Some evidence exists about the benefit of performing a laparoscopic left lateral sectionectomy for adult-to-pediatric transplantation (55,56).

However, no clear evidence exists on the benefits of performing such a procedure in the setting of adult-to-adult RH donation.

A recent meta-analysis comparing laparoscopy-assisted *vs.* open right lobe donation reported that the first approach was connected with a reduced intraoperative blood loss (weighted mean difference =−58 mL, 95% CI: −94−−21; P value=0.002). However, although the complication rate was inferior in both hybrid left and right lobe procedures respect to the open procedures (relative risk =0.70; 95% CI: 0.51–0.94; P value=0.02), in the subgroup analysis, comprehending only RHs no differences were observed (relative risk =0.95; 95% CI: 0.63–1.43; P value=0.80). Similar negative results were also found just investigating Clavien-Dindo grades ≥3 (57).

In the present analysis, no comparison has been made between open and laparoscopic procedures. On the opposite, the systematic collection of all the worldwide reported laparoscopic RH consented to perform an analysis aimed at comparing "pure laparoscopic" approaches

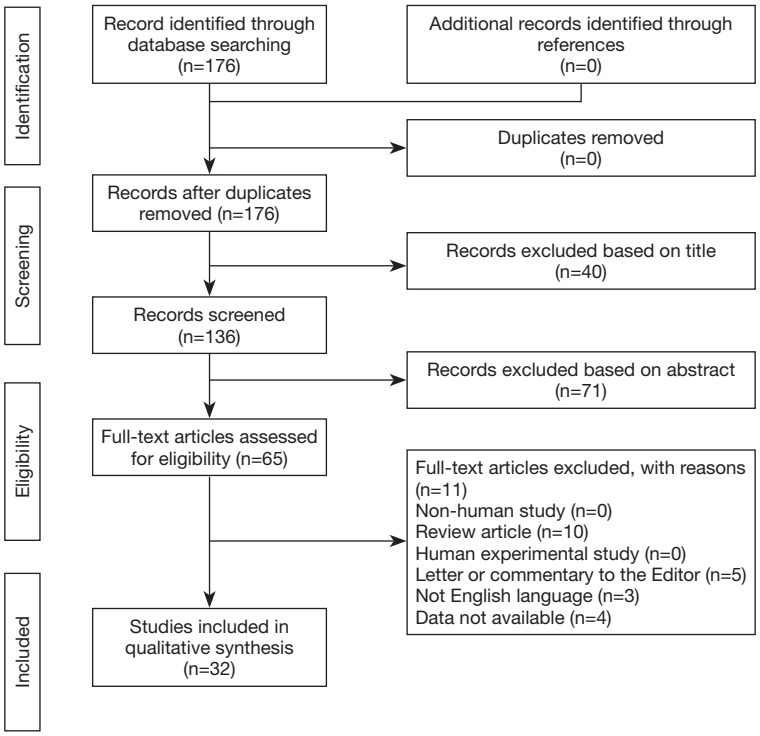

Figure 1 PRISMA flow-chart showing the selection process of the analysed articles.

(namely, robotic- or pure laparoscopy) with hybrid ones (namely hand-assisted or laparoscopic-assisted procedures). As for the overall incidence of intraoperative complications, a significant benefit in favor of pure approach was reported, with a 2.5-fold increased risk of any complication after hybrid approach. Such a result is significant, mainly because the previous meta-analysis investigating hybrid *vs.* open approach showed a slight reduction of the risk in case of the laparoscopic procedure. Indeed, we can postulate that a sort of gradient exists concerning improved safety for the donor, passing from open approach to hybrid to pure laparoscopic procedure.

Some doubts should be reported regarding the here observed results. Hybrid approach presents, in fact, some apparent benefits: for example, manual hand manipulation in the abdominal cavity gives to the surgeon tactile feedback of the liver. Moreover, the possibility to rapidly extract the graft is connected with a reduced warm ischemia time. We can only suppose that pure laparoscopy gives better results because it is typically approached in centers with very high laparoscopic expertise. As a consequence, the reduced number of complications is not directly connected with a real superiority of the procedure, but to the fact that centers at the beginning of their learning curve for major hepatectomy start their programs using hybrid approaches. Thus, we can postulate that a progressive reduction of the complications will be reported in the next future also in case of assisted procedures.

Of interest, no severe donor morbidity or mortality was reported in the reported series: in other terms, zero on 501 cases of donor death were reported respect to the 23/1,153 (0.2%) cases previously published in the open series (7).

Unfortunately, it was impossible to analyze if the different laparoscopic surgical approaches in the donor were also connected with different outcomes in the recipient: in fact, the vast majority of the series selected in the present study did not report detailed information on postoperative complications in the recipients. Consequently, it was not possible to see in detail if pure laparoscopy was connected with the more complex management of the dissection area.

Another critical shortcoming of the study was the tiny number of studies comparing the different laparoscopic techniques and the fact that possible heterogeneities should exist among donors treated with different approaches.

Conclusions

Laparoscopic RH for living donation is a safe procedure. After 501 reported procedures, no deaths have been described. Pure laparoscopic approaches look to consent a lower risk of donor complication respect to hybrid ones. More studies comparing the different laparoscopic approaches with the open procedure are required.

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Footnote

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