

Systematic review of laparoscopic versus open surgery in the treatment of non-parasitic liver cysts

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Abstract We conducted a systematic review of the literature on the electronic databases Medline, Embase, Ovid and Cochrane to identify studies from 1990 to 2011 regarding the surgical management of non-parasitic liver cysts treated with laparoscopy (LT) and/or laparotomy (OT) to identify short-term and long-term outcomes of the relative treatments. Two reviewers independently extracted data regarding the following parameters: first author, year of publication, type of journal, study design, number of patients operated on, male/female ratio, mean age, mean size of the cysts treated, laparoscopic conversion rate, morbidity, mortality and recurrence in both groups (LT and OT). A qualitative analysis was carried out using the Pearson Chi square test and the Fischer's exact test where necessary. The data analysis was conducted by dividing the sample into three periods in relation to the development of laparoscopic surgery: period 1 (P1), 1990–1995 “pioneering” period of laparoscopy; period 2 (P2), 1996–2000 period of the “development of laparoscopy”; period 3 (P3), 2001–2011 period of “diffusion of laparoscopy.” Thirty studies involving 948 patients comparing LT with OT were included in the final pooled analysis. Twenty-two studies were retrospective (73.3 %) and only 8 (26.7 %) were prospective. The number of publications increased during the three periods analysed. The correlation between the type

of journal and the year of publication showed an increase ($p = 0.048$) in journals dedicated to LT during the three periods. In P1, the preferred approach was open surgery (66.3 %) with only 11 cases treated with LT. The conversion rate was 18.1 %. The overall complication rate was 33.3 % with a substantial equivalence between the two approaches (27.2 % for laparoscopic surgery and 36.6 % for laparotomic). The overall recurrence rate was 18.1 % with 36.3 % in the laparoscopic group and 9.2 % in the laparotomic group. In P2, the preferred approach was laparoscopic (56.7 %). The conversion rate was 2.3 %. The overall complication rate was 5.8 % but with some differences between the two approaches (10.3 % for the laparoscopic approach and 0 % for open surgery). The overall recurrence rate was 14.4 % with 17.4 % in the laparoscopic group and 10.4 % in the laparotomic group. In P3, the preferred approach was laparoscopic (69.9 %). The overall recurrence rate was 11.1 %; it was 6.1 % for the laparoscopic approach while it was 11.5 % for laparotomic. In all three periods analysed, the laparoscopic approach showed a statistically significant reduction in operative time ($p = 0.009$) and hospital stay ($p = 0.001$) and a significant ($p < 0.05$) reduction rate in symptomatic recurrences in patients with polycystic liver disease (25 %) as compared with simple liver cysts (7.5 %). The current data in the literature show that the laparoscopic approach may be the treatment of choice in patients with symptomatic non-parasitic cysts of the liver, providing the short-term advantages of minimally invasive surgery. Recurrence rates were acceptable and comparable to those of conventional surgery. Long-term outcomes should be verified by additional randomised controlled trials and long-term follow-ups.

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Introduction

Non-parasitic cysts constitute the most common pathology found in the liver having a prevalence ranging from 2.5 to 5 % in the general population [1]. In the past 20 years, the widespread use of first and second level imaging studies, such as ultrasound (US) and computed tomography (CT) abdomen, has led to an increase up to 18 % in the prevalence of these lesions [2]. On the basis of embryological origin and relationship with the biliary system, non-parasitic hepatic cysts are classified as simple liver cysts (SLCs) which represent the most common form, polycystic liver disease (PLD), congenital liver cystic ectasia, ciliated hepatic foregut cysts, biliary cyst tumours (cystadenoma, biliary benign cystoadenoma (BCA), and biliary cystadenocarcinoma (BCAC)) and inflammatory and traumatic cysts [3]. Non-parasitic hepatic cysts can be treated surgically when symptomatic, when there is the suspicion of a neoplastic origin or when complicated. Various treatment procedures have been proposed, such as a simple US or CT-guided aspiration, injection of sclerosing agents, fenestration, enucleation, hepatic resection and transplantation [4, 5]. The recent development of laparoscopic surgery and the short-term benefits associated with it (reduced hospitalisation, better cosmetic results and quicker return to normal activities) has produced an increase in resection or fenestration in recent years. However, some authors have described a higher rate of recurrence after using the laparoscopic approach, up to 44 % [6, 7]. The purpose of this study was to compare the short- and long-term results in the surgical treatment of hepatic cysts using laparoscopy (LT) and laparotomy (OT) by means of a systematic review of the literature.

Methods

The research was conducted on the electronic databases Medline, Embase, Ovid and Cochrane to identify all studies regarding the surgical treatment of non-parasitic hepatic cysts using LT and/or OT.

The following Mesh search headings were used: “laparoscopy”, “open fenestration”, “non-parasitic hepatic cysts” and “surgery” and their combinations; similar headings were also searched such as “laparoscopic fenestration”, “laparoscopic resection” and “minimally invasive surgery”. Abstracts, letters to the editor, case reports and articles in languages other than English were excluded. The research was completed June 1, 2011.

Subsequently, two reviewers (RC and BS) independently extracted data regarding the following parameters: first author, year of publication, type of journal, study design, number of patients operated on, male/female ratio,

average age, average size of the treated cysts, laparoscopic conversion rate, complications, deaths in the postoperative follow-up period and number of recurrences. At the end of the data extraction, a 100 % agreement between the two reviewers was present.

Only the studies reporting more than five procedures in patients with cystic lesions of the liver, such as SLCs, PLD, BCAs and BCACs; those which clearly reported at least one of the results of the above parameters in patients treated surgically for hepatic cysts, those which clearly reported the indications for surgery and those which documented the technique used (OT and/or LT) were considered. When two studies had been published by the same author and/or by the same institution, the most recent study or that of the highest quality was included.

Studies were excluded from the analysis if the data were related exclusively to parasitic lesions, inflammatory or traumatic liver or congenital/cystic biliary ectasia, or if at least one of the outcomes of interest was not clearly reported, although it was impossible to extract or calculate the data of interest (mixed case studies where there were non-parasitic cystic lesions together with others) in data published before 1990.

A qualitative analysis was carried out using the Pearson Chi square test and the Fischer’s exact test where necessary. The data analysis was carried out by dividing the sample into three periods in relation to the development of laparoscopic surgery (P1: “pioneering” period of laparoscopy; P2: period of the “development of laparoscopy” and P3: period of the “diffusion of laparoscopy.” Data relating to discrete variables were reported as percentages and data relating to continuous variables as a weighted average.

Results

The preliminary qualitative analysis was conducted on 30 [4, 6–32] selected studies, all published between 1990 and 2011 and data of 948 patients were analysed. Twenty-two studies were retrospective (73.3 %) and only 8 (26.7 %) were prospective. None of the prospective studies provided any kind of randomisation. Only five studies (16.6 %) were comparative (two retrospective and three prospective) and only two of these had a proper “matching” of the groups compared. When comparing the number of publications regarding hepatic cysts an increase in the number of publications was evident in the periods 1990–1995 (P1), 1996–2000 (P2) and 2001–2011 (P3). The 30 publications were distributed as follows: P1, 3/30 (10 %); P2, 8/30 (26.7 %), 19/30 (63.3 %).

The correlation between the type of journal and the year of publication showed a statistically significant increase ($p = 0.048$) in the number of publications in journals

Table 1 Case matching of patient clinical data in articles from 1990 to 1995 (P1)

Author	Year	N	SLC (%)	PLD (%)	BCA (%)	BCAC (%)	M/F	Symptoms (%)	Age (years)	Size (cm)
Furuta et al. [8]	1990	8	8 (100)	–	–	–	0/8	8 (100)	59.1	12.5
Henne-Bruns et al. [9]	1993	14	6 (42.8)	8 (57.2)	–	–	–	14 (100)	–	–
Morino et al. [4]	1994	11	4 (36.6)	7 (63.4)	–	–	2/2	11 (100)	51.2	14.2
Total		33	18 (54.4)	15 (45.6)	–	–	0.2	33 (100)	54.4	12.1

SLC simple liver cyst, PLD polycystic liver disease, BCA biliary benign cystoadenoma, BCAC biliary cystoadenocarcinoma, M male, F female

Table 2 Case matching of patient surgical and postoperative data in articles from 1990 to 1995 (P1)

Author	N	L (%)	L–C	Tot. Morb.	L. Morb.	O. Morb.	Follow-up	Recurrences	Recurrences L	Recurrences O
Furuta et al. [8]	8	0 (0)	–	5 (62.5)	–	5 (62.5)	58.2	0 (0)	–	0 (0)
Henne-Bruns et al. [9]	14	0 (0)	–	3 (21.4)	–	3 (21.4)	–	2 (14.2)	–	2 (14.2)
Morino et al. [4]	11	11 (100)	2 (18.1)	3 (27.2)	3 (27.2)	–	–	4 (36.3)	4 (36.3)	–
Total	33	11 (33.3)	2 (18.1)	11 (33.3)	3 (27.2)	8 (36.6)	–	6 (18.1)	4 (36.3)	2 (9.2)

L laparoscopy, L–C laparoscopy converted to open, Tot. Morb. overall morbidity, L. Morb. laparoscopic morbidity, O. Morb. laparotomic morbidity, O laparotomic

devoted to LT during the three periods (P1: 0–12.5 %, P2–P3: 26.3 %) as compared to journals dedicated to liver surgery (P1: 66.7 %, P2: 12.5 %, P3:16.5 %). It also noted an increase in the percentage of prospective studies in the three periods considered (P1: 0 %, P2: 12.5 %, P3: 36.8 %) with a trend toward statistical significance ($p = 0.098$). Finally, the number of comparative studies also increased in relation to the period considered (0 % in P1 and P2, 26 % in P3) with a trend to statistical significance ($p = 0.093$).

Analysis of samples per period

Period 1990–1995 (P1)

Three publications [4, 8, 9] suitable for the study were identified with a total of 33 patients (Tables 1, 2). All the studies were retrospective without comparison between laparoscopic and open surgery; their median impact factor was 1.6 (range 0.6–7.5) with a median citation rate of 21 citations (range 0–93). The average age of the patients was 54.4 years, with a male/female ratio of 0.2. The indication for surgery was the presence of symptomatic cysts in all cases. The pathology most commonly treated was SLCs (54.4 %). No cases of BCAs and BCACs were identified. The average size of the hepatic cysts was 12.1 cm. The preferred approach was open surgery (66.3 %). Only one study [4] reported 11 cases treated with LT (in all cases a fenestration of the cyst was performed). The conversion rate was 18.1 %. All patients with PLD were converted. The overall complication rate was 33.3 % with a substantial equivalence between the two approaches (27.2 %

for LT and 36.6 % for open surgery; $p = 0.60$). The overall recurrence rate was 18.1 %. It was 36.6 % in the laparoscopic surgical group and 9.2 % for traditional surgery ($p = 0.07$).

Period 1995–2000 (P2)

Eight publications [10–17] suitable for the study were identified with a total of 222 patients (Tables 3, 4). Seven studies were retrospective and one was prospective; the median impact factor was 3.4 (range 0–7.5) with a median citation rate of 43 citations (range 10–164). The average age of the patients was 56.2 years with a male/female ratio of 0.25. The indication for surgery was the presence of symptomatic cysts in 95.3 % of cases. In 4.8 % of cases, however, the procedure was performed as the result of an incidental finding in the course of other surgical procedures. The diseases treated were: 58.6 % SLCs, 40.5 % PLD and 0.9 % BCAs. The average size of the hepatic cysts treated was 11.4 cm. The preferred approach was laparoscopic (56.7 %). The conversion rate was 2.3 %, and two out of three (66.6 %) patients with PLD were converted to open surgery. In the laparoscopic group two types of intervention were performed: deroofing in 55 % of cases and fenestration in 45 %. The laparotomic group of interventions included 61.4 % fenestrations, 17.1 % resections and deroofing and 3.1 % cystojejunostomies. The overall complication rate was 5.8 % but with some differences between the two approaches (10.3 % for the laparoscopic approach and 0 % for laparotomic surgery; $p = 0.03$). The overall recurrence rate was 14.4 %; in the case of a laparoscopic approach, it was 17.4 % while it was 10.4 % for

Table 3 Case matching of patient clinical data in articles from 1995 to 2000 (P2)

Author	Year	N	SLC (%)	PLD (%)	BCA (%)	BCAC (%)	M/F	Symptoms (%)	Age (years)	Size (cm)
Kabbej et al. [10]	1996	13	–	13 (100)	–	–	0/13	13 (100)	–	–
Emmerman et al. [11]	1997	18	18 (100)	–	–	–	0/18	16 (88.8)	57	12.1
Koperna et al. [12]	1997	79	31 (39.2)	48 (60.7)	–	–	16/63	81 (100)	–	–
Hansen et al. [13]	1997	19	17 (89.5)	2 (10.5)	–	–	–	19 (100)	65	–
Kazizaki et al. [14]	1998	9	6 (66.6)	3 (33.4)	–	–	0/9	9 (100)	61	–
Martin et al. [15]	1998	38	23 (60.5)	15 (39.5)	–	–	35/3	38 (100)	58	13.2
Kathkouda et al. [16]	1999	25	16 (64)	9 (36)	–	–	–	–	–	11.8
Zalaba et al. [17]	1999	21	19 (90.4)	–	2 (9.6)	–	5/16	13 (61.9)	42.3	7.2
Total		222	130 (58.6)	90 (40.5)	2 (0.9)		0.25	187/197 (95.3)	56.2	11.4

SLC simple liver cyst, PLD polycystic liver disease, BCA biliary benign cystadenoma, BCAC biliary cystadenocarcinoma, M male, F female

Table 4 Case matching of patient surgical and postoperative data in articles from 1995 to 2000 (P2)

Author	N	L (%)	L–C	Tot. Morb.	L. Morb.	O. Morb.	Follow-up	Recurrences	Recurrences L	Recurrences O
Kabbej et al. [10]	13	13 (100)	0 (0)	6 (46.1)	6 (46.1)	–	26	8 (53.3)	8 (53.3)	–
Emmerman et al. [11]	18	18 (100)	1 (5.5)	3 (16.6)	3 (16.6)	–	19	2 (11.1)	2 (11.1)	–
Koperna et al. [12]	79	10 (10.9)	1 (10)	–	–	–	–	8 (8.7)	1 (10)	7 (10.1)
Hansen et al. [13]	19	19 (100)	(0)	0 (0)	0 (0)	–	32	2 (10.5)	2 (10.5)	–
Kazizaki et al. [14]	9	0 (0)	–	0 (0)	–	0 (0)	43	0 (0)	–	0 (0)
Martin et al. [15]	38	20 (52.6)	0 (0)	–	–	–	–	9 (23.6)	6 (30)	3 (16.6)
Kathkouda et al. [16]	25	25 (100)	1 (4)	4 (16)	4 (16)	–	–	1 (4)	1 (4)	–
Zalaba et al. [17]	21	21 (100)	0 (0)	0 (0)	0 (0)	–	12.5	2 (9.6)	2 (2.6)	–
Total	222	126 (56.7)	3 (2.3)	13 (5.8)	13 (10.3)	0 (0)	24	32 (14.4)	22 (17.4)	10 (10.4)

L laparoscopy, L–C laparoscopy converted to open, Tot. Morb. overall morbidity, L. Morb. laparoscopic morbidity, O. Morb. laparotomic morbidity, O laparotomic

conventional surgery ($p = 0.14$). Of all of the BCAs treated, 17 experienced a recurrence and in 50 % of cases, at the time of recurrence, a BCAC was observed. Instead, in the laparotomic group no recurrence was observed in the cases of resection, but it was frequently associated with PLD (70 %).

Period 2001–2011 (P3)

Nineteen publications [6, 18–35] suitable for the study were identified with a total of 693 patients (Tables 5, 6). Twelve studies were retrospective (63.1 %) and seven were prospective (36.9 %); five studies (26.3 %) were comparative but only two had proper patient matching. The median impact factor of the studies was 2.1 (range 0–4.5), with a median citation rate of 17 citations (range 1–79). The average age of the patients was 56.5 years, with a male/female ratio of 0.2. The indication for surgery was the presence of symptomatic cysts in 98.2 % of cases. In 1.8 % of cases, however, the procedure was performed as the result of an incidental finding

of SLCs in the course of other surgical procedures. The diseases treated were 81.3 % SLCs, 15.6 % PLD and 3.1 % BCAs/BCACs. The average size of the hepatic cysts treated was 11.5 cm. The preferred approach was laparoscopic (69.9 %). The conversion rate was 5.6 %, most commonly related to the location of the cyst in the posterior-lateral hepatic segment (S7) and less frequently for massive bleeding. In the laparoscopic group, three types of procedures were performed: deroofing (79.6 %), fenestration (20.1 %) and only one case of liver resection (0.3 %). The laparotomic group included 16.2 % fenestrations, 45.3 % deroofing and 24.1 % resections and finally 2.3 % cystojejunostomies. The overall complication rate was 11.1 % with a substantial equivalence between the two approaches (9.7 % for the laparoscopic approach and 12.8 % for open surgery; $p = 0.20$). The overall recurrence rate was 11.1 %; it was 6.1 % in cases of laparoscopic surgery while it was 11.5 % for conventional surgery ($p = 0.01$). In the laparoscopic group the recurrence rate was 11.3 and 3.6 % after fenestration and deroofing, respectively. Instead, in the OT group, the recurrence rate was

Table 5 Case matching of patient clinical data in articles from 2001 to 2011 (P3)

Author	Year	N	SLC (%)	PLD (%)	BCA (%)	BCAC (%)	M/F	Symptoms (%)	Age (years)	Size (cm)
Hansman et al. [18]	2001	40	28 (70)	4 (10)	7 (17.5)	1 (2.5)	–	38 (95)	–	12.1
Gigot et al. [35]	2001	24	22 (91.6)	2 (8.4)	–	–	1/23	24 (100)	54.5	31
Regev et al. [19]	2001	66	57 (86.3)	0 (0)	8 (12.2)	1 (1.5)	10/56	58 (87.8)	62.7	12.2
Tocchi et al. [20]	2002	34	34 (100)	0 (0)	–	–	8/26	34 (100)	42.2	15.0
Petri et al. [6]	2001	106	–	–	–	–	–	–	–	–
Pitale et al. [21]	2002	9	6 (66.6)	3 (33.4)	–	–	2/7	9 (100)	61.8	–
Fiamingo et al. [22]	2003	16	9 (56.2)	6 (37.5)	1 (6.3)	–	3/13	16 (100)	57.1	9.7
Tan et al. [23]	2005	40	39 (97.5)	(0)	1 (2.5)	–	11/29	40 (100)	58.5	12.3
Kornprat et al. [24]	2004	19	0 (0)	19 (100)	–	–	3/16	19 (100)	50.2	11.3
Szabó et al. [25]	2006	25	21(84)	4(16)	–	–	9/16	25 (100)	54.4	6.9
Neri et al. [26]	2006	15	12 (80)	3 (20)	–	–	6/9	15 (100)	54	–
Palanivelu et al. [27]	2006	27	27 (100)	0 (0)	–	–	5/22	27 (100)	48.6	16.2
Caetano-Júnior et al. [28]	2006	12	9 (75)	3 (25)	–	–	0/12	12 (100)	56	9.8
Garcea et al. [29]	2007	25	19 (76)	6 (24)	–	–	6/19	25 (100)	55.5	10
Bai et al. [30]	2007	44	34 (77.3)	10 (22.7)	–	–	14/30	40 (90.9)	57	12.3
Keipema et al. [31]	2008	12	0	12 (100)	–	–	0/12	12 (100)	45	–
Loehe et al. [32]	2010	99	77 (77.7)	22 (22.3)	–	–	13/86	99 (100)	59	10.5
Treckman et al. [33]	2010	59	52 (88.1)	7 (21.9)	–	–	7/52	59 (100)	62	10.9
Donati et al. [34]	2010	21	21 (100)	(0)	–	–	–	21 (100)	–	9.7
Total		693	467 (81.3)	101 (15.6)	17 (2.8)	2 (0.3)	0.2	577 (98.2)	56.5	11.5

SLC simple liver cyst, PLD polycystic liver disease, BCA benign cystoadenoma, BCAC cystoadenocarcinoma, M male, F female

1.1 % after resection, 18.4 % after deroofting and 35.7 % after fenestration. Recurrence in 75 % of the patients was associated with PLD.

The trend towards the different periods for recurrence and complication rates was then analysed. The overall recurrence rate was similar among the three periods, with no statistical differences between P1 and P2, P2 and P3 or P1 and P3 ($p = 0.57$, $p = 0.19$ and $p = 0.22$, respectively) as were recurrences in the open approach group for the various periods of time ($p = 0.85$, $p = 0.76$ and $p = 0.74$, respectively). On the other hand, when only the recurrence rate of the laparoscopic approach group was considered, it was noted that the rate of recurrence was significantly lower in P3, with 6.1 versus 36.3 % for P1 and 17.4 % for P2 ($p = 0.002$ and $p < 0.001$, respectively). No statistical difference was recorded between P1 and P2 (36.3 and 17.4 %, $p = 0.088$).

Concerning the overall complication rate, a statistical difference was found between P1 and P2 (33.3 and 5.8 %; $p < 0.001$) as well as for complications in the open approach group (36.6 and 0 %; $p < 0.001$) while no difference was recorded in the laparoscopic group (27.2 vs. 10.3 %; $p = 0.11$). In analysing periods P2 and P3, the same scenario was found, with a statistical difference for overall and open approach complications (5.8 and 11.1 %; $p = 0.020$ and 0 and 12.8 %; $p = 0.020$, respectively). As before, the complication rate in the laparoscopic group did

not differ between P2 and P3 (10.3 and 9.7 %; $p = 0.85$). Finally, analysing P1 and P3, there was a statistical difference for overall complications (33.3 vs. 11.1 %; $p = 0.004$) and open approach complications (36.6 vs. 12.8 %; $p = 0.004$) while no differences were seen in laparoscopic approach complications (27.2 vs. 9.7 %; $p = 0.07$).

Discussion

A review of the literature on the surgical treatment of hepatic cysts showed the presence of low-quality studies with no randomised studies, few prospective studies (27 %) and only five comparative studies (17 %). Only two comparative studies (7 %) had an adequate “matching” of patients, but they were not homogeneous enough to allow a meta-analysis of the data reported. Overall, however, the studies analysed showed growing interest in the surgical treatment of non-parasitic hepatic cysts. In fact, we observed an increase in the number of patients treated in the three periods considered (P1: $n = 33$, P2: $n = 222$, P3: $n = 693$). This is probably due to the wide diffusion of diagnostic imaging such as US and CT which have allowed the identification of an increasing number of hepatic cysts with an estimated prevalence of 4.5–7 % in the general population. In all three periods considered, the main surgical indication was the presence of symptomatic cysts (P1:

Table 6 Case matching of patient's surgical and postoperative data in articles from 2001 to 2011 (P3)

Author	N	L (%)	L-C	Tot. Morb.	L. Morb.	O. Morb.	Follow-up	Recurrences	Recurrences L	Recurrences O
Hansman et al. [18]	40	6 (15)	0 (0)	1 (2.5)	0 (0)	1 (2.9)	–	5 (12.5)	0 (0)	5 (12.5)
Gigot et al. [35]	24	19 (79.1)	4 (21.1)	4 (16.6)	4 (21.1)	0 (0)	130	1 (4.1)	1 (5.2)	0 (0)
Regev et al. [19]	66	18 (27.2)	0 (0)	0 (0)	0 (0)	0 (0)	–	3 (4.5)	0 (0)	3 (6.2)
Tocchi et al. [20]	34	8 (23.5)	0 (0)	6 (18)	–	–	–	13 (38.2)	2 (25)	11 (17.8)
Petri et al. [6]	106	34 (32.1)	–	21 (19.8)	3 (8.8)	18 (25)	–	17 (16.1)	7 (19.4)	10 (13.2)
Pitale et al. [21]	9	0 (0)	–	2 (22.2)	–	2 (22.2)	32	0 (0)	–	0 (0)
Fiamingo et al. [22]	16	16 (100)	1 (6.3)	3 (18.7)	3 (18.7)	–	34	3 (18.7)	3 (18.7)	–
Tan et al. [23]	40	10 (25)	0 (0)	9 (22.5)	0 (0)	9 (30)	20	6 (15)	3 (30)	3 (10)
Kornprat et al. [24]	19	8 (42)	1 (12.5)	4 (21.1)	0 (0)	4 (36)	49	1 (5.2)	–	–
Szabo et al. [25]	21	21 (100)	2 (9.5)	2 (9.5)	2 (9.5)	–	48.7	2 (9.5)	2 (9.5)	0 (0)
Neri et al. [26]	15	15 (100)	0 (0)	5 (33.3)	5 (33.3)	–	18	0 (0)	0 (0)	–
Palanivelu et al. [27]	27	27 (100)	0 (0)	3 (11.1)	3 (11.1)	–	86.4	0 (0)	0 (0)	–
Caetano et al. [28]	12	12 (100)	1 (8.3)	–	3 (25)	3 (25)	–	0 (0)	0 (0)	–
Garcea et al. [29]	25	–	–	–	–	–	–	5 (20)	–	–
Bai et al. [30]	44	44 (100)	0 (0)	5 (11)	5 (11)	–	57	4 (9.1)	4 (9.1)	–
Keipema et al. [31]	12	12 (100)	0 (0)	3 (25)	3 (25)	–	–	–	–	–
Loehe et al. [32]	99	77 (77.7)	2 (2.5)	4 (4.1)	4 (5.1)	0 (0)	69	11 (11.1)	–	–
Treckman et al. [33]	59	42 (71.2)	3 (7.1)	5 (8.4)	3 (7.1)	2 (11.7)	34	5 (8.4)	2 (4.7)	3 (1.7)
Donati et al. [34]	21	21 (100)	0 (0)	0 (0)	0 (0)	–	–	1 (3.4)	–	–
Total	693	390 (69.9)	14 (5.6)	77 (11.1)	38 (9.7)	39 (12.8)	55	77 (11.1)	24 (6.1)	35 (11.5)

L laparoscopy, L-C laparoscopy converted to open, Tot. Morb. overall morbidity, L. Morb. laparoscopic morbidity, O. Morb. laparotomic morbidity, O laparotomic

100 %, P2: 95 %, P3: 99 %). The demographic data reported a higher prevalence of cystic disease in females with a ratio of 0.2, and the average age of onset of symptoms was the fifth decade of life. Overall, the presence of single SLCs remained the main indication for surgery with an increase in percentage over the three periods analysed (P1: 54.4 %, P2: 58.6 %, P3: 81.3 %). This is probably due both to the wide diffusion of diagnostic imaging and to the increased development of the minimally invasive approach which could have resulted in an increase in the number of patients undergoing surgery.

The data also confirmed the rarity of BCAs/BCACs with 21 cases out of 948 (2.2 %) patients with an extremely low percentage of malignancy (0.2 %).

However, the number of BCAs removed increased over the three periods (P1: 0 %, P2: 0.9 %, P3: 2.8 %). This finding confirmed an increase in surgical indications in patients with liver cysts rather than a real increase in its incidence. With regard to the approach (laparoscopic vs. open surgery) and the results over the short- and long-term periods, the preliminary qualitative analysis clearly showed a trend toward LT. This was clearly stated comparing the number of studies published in the three periods in different types of journals. In fact, the correlation between the type of journal and the year of publication showed a

statistically significant increase ($p = 0.048$) in the number of publications in journals devoted to laparoscopic surgery during the three periods analysed (P1: 0 %, P2: 12.5 %, P3: 26.3 %). On the contrary, the rate of publications on liver cysts in journals dedicated to liver surgery showed a progressive reduction during the three periods (P1: 66.7 %, P2: 12.5 %, P3: 16.5 %). During the first period (P1: 1990–1995), only 18 % of patients [4] were treated with a minimally invasive approach. These were exclusively simple fenestrations in selected patients; the conversion rate reported was higher (18.8 %) but the overall morbidity was lower than the laparotomic group [8] (27.2 vs. 36 %, respectively).

However, these results should be interpreted with caution; indeed, the two groups of patients considered (laparoscopic/laparotomic) are strongly dishomogeneous due to the different treatments received; the patients in the laparoscopic group were treated only with simple fenestration procedures while one-third of the patients in the laparotomic group underwent liver resection. The percentage of overall recurrence appeared low (18 %) with a higher rate of recurrence in the laparoscopic group as compared to the laparotomic group (37 vs. 9 %, respectively). However, even these data appeared to be influenced more by the type of treatment (simple fenestration) than by the type of

approach used (laparoscopic vs. laparotomic) and also by the operative difficulties related to the use of a completely new technique.

During the second period (P2:1996–2000) [10–17], widespread use of the laparoscopic approach (58.6 %) was recorded. Five studies out of a total of eight reported the use of LT (62.5 %). The effect produced by the technological innovation of the instrumentation and the completion of the learning curves in LT was also evident. In fact, the conversion rate was reduced as compared to the previous year (2.3 vs. 18.8 %); the overall morbidity for the laparoscopic approach dropped to 10.3 %, even with an increase in surgical procedure complexity. Deroofing was performed in 55 % of cases and simple fenestration in 45 %. Once again, the comparison between the laparoscopic and the open surgery groups appeared to be affected by heterogeneity mainly due to the poor quality of the studies analysed. The recurrence rate was even higher in the laparoscopic group when compared to the open surgery group (17.4 vs. 10.4 %, respectively). Even in this case, it could be attributed to the higher number of simple fenestrations performed in the laparoscopic group than in the open group.

In fact, in the laparotomic group, no recurrence was observed in cases of resection but it was observed in 70 % of the patients treated for PLD. All cases of BCAs treated laparoscopically experienced a recurrence and, in 50 % of cases, a BCAC was observed at the time of recurrence. However, neither a cytologic examination of the cystic fluid, nor intraoperative biopsies or histopathological examination of the cystic wall was carried out in any of these procedures; this would have allowed proper diagnosis and treatment with complete resection of the cyst. These data are probably related to the widespread diffusion of LT among surgeons who are not experienced in liver surgery. Intraoperative examination of the cystic fluid and the cystic wall is of vital importance due to the well-known malignant evolution of BCAs.

During the third period (P3: 2001–2011) [6, 18–35], almost 70 % of the patients were treated using a laparoscopic approach (Fig. 1). Only one study did not include cases laparoscopically treated while 8/18 studies reported the use of only LT. The conversion rate was 5.6 % and the most common causes were the location of the cyst in the right postero-lateral liver segments and less frequently for bleeding. Compared to the previous period, there was an increased number of laparoscopic deroofings (79.6 vs. 55.5 %, respectively) and resections (0.3 %). The overall complication rate was 33.3 % with substantial equivalence between the two approaches (27.2 % for the laparoscopic approach and 36.6 % for open surgery). The apparent increase in the rate of complications as compared to the previous period can be attributed to improvement in the quality of studies leading to a better extraction of data and

to the increased complexity of the laparoscopic procedures performed. The overall recurrence rate was 11.7 %; it was 11.8 % for the laparoscopic approach while it was 14.4 % for conventional surgery. The reduction in the recurrence rate after laparoscopic resection as compared to the previous period could be attributed to the more complex procedures performed (in fact, the number of fenestrations decreases from 45.5 to 20.1 %).

This finding was confirmed by analysis of the recurrence rates related to the procedure performed in P3: 11.3 versus 3.6 % after fenestration and deroofing, respectively. In this period, only three BCAs were treated with laparoscopic resection (0.7 %). The first [31] of the two comparative studies with appropriate patient matching showed the potential benefits of the laparoscopic approach with statistically significant reduction in operative time ($p = 0.009$) and hospital stay ($p = 0.001$). Furthermore, the study failed to demonstrate a correlation between the number of cysts, type of procedure (deroofing vs. fenestration) and approach (laparoscopic vs. laparotomic) in relation to the onset of recurrence. The study by Tan et al. [23] confirmed the potential benefits of the laparoscopic approach (lower morbidity and shorter hospital stay). Finally, the study of Lohe et al. [32] showed a significant ($p < 0.05$) rate of symptomatic recurrences in patients with PLD (25 %) as compared with those having SLCs (7.5 %).

In conclusion, despite the absence of high-quality studies, the data in the literature which were analysed suggested that the laparoscopic approach could be the treatment of choice in patients with non-parasitic liver cysts. Indeed, this approach would ensure the typical advantages of minimally invasive surgery, such as reduced hospital stay and less postoperative pain. The recurrence rates are acceptable and comparable to those of conventional surgery. Recurrence seemed to be associated with the presence of PLD rather than with the type of technique used. Intraoperative histological examination of the cystic wall should always be performed to exclude a BCA/BCAC which requires a resection with clear margins.

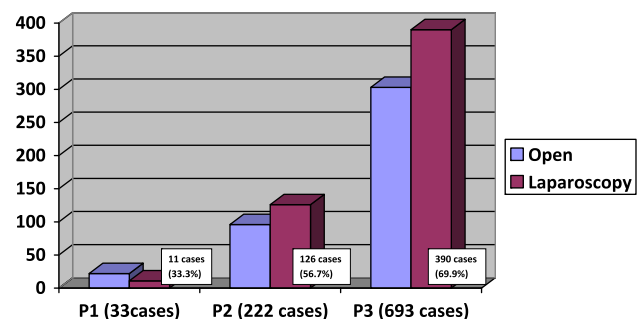


Fig. 1 Graphic representation of the increasing use of laparoscopy during the different periods

Conflict of interest None.

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