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REVIEW ARTICLE

Has laparoscopy increased surgical indications for benign tumors of the liver?

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Abstract
Background We aimed to analyze the risk of an increased surgical indication rate in patients with benign tumors of the liver since the development of laparoscopy. Previous articles have reported increased numbers of laparoscopic procedures in different surgical fields.
Methods A literature search of MEDLINE (PubMed), Google Scholar, and The Cochrane Library was carried out. All articles that analyzed benign liver tumors (hemangiomas, focal nodular hyperplasia, and adenoma) were divided in two groups: group I included all manuscripts with open procedures between 1971 at 1990, and group II included all manuscripts with open or laparoscopic procedures between 1991 and 2010. Group II articles were divided into two subgroups. Subgroup IIA patients were treated by open or laparoscopic procedures between 1991 and 2000, and subgroup IIB patients were treated by open or laparoscopic procedures between 2001 and 2010.
Results Specific analysis of each kind of tumor observed in the two groups showed fewer surgically treated patients for hepatic hemangioma and hepatic adenoma in group II compared with group I and a greater number of patients for focal nodular hyperplasia. Fewer patients were treated with laparoscopic procedures in subgroup IIA than in subgroup IIB. A chi-square test with Yates' correction gave a P value of <0.001.
Conclusion Laparoscopy has increased the rate of hepatic resection for benign tumors with doubtful indications.

Keywords Laparoscopy · Benign hepatic tumors · Hemangioma · FNH · Focal nodular hyperplasia · Adenoma

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Introduction

Over the last 20 years, laparoscopic surgery has evolved to become the approach of choice for many abdominal procedures [1]. Excellent results in terms of hospital stay and quality of life has permitted this technique to become the gold standard for cholecystectomy and other procedures. Hepatic surgery has evolved dramatically with an improved understanding of the anatomic segments of the liver; enhanced imaging by CT and MRI scans; improved anesthesiology, critical care, postoperative nursing, and physical therapy; and technological advances and modifications in laparoscopy [2] for benign and malignant tumors. With the exception of hepatic adenoma (HA), surgical indications for hepatic hemangioma (HH), and focal nodular hyperplasia (FNH) of the liver remain controversial [3].

Laparoscopic liver surgery for benign hepatic tumors was first reported in 1991 [4]. More recently, increased experience in laparoscopic liver surgery and the contribution of improved technology have fuelled enthusiasm for this surgical approach. Increasing numbers of reports have now established that despite occasional longer operating times, laparoscopic liver surgery is associated with reduced blood loss, reduced postoperative morbidity, and shorter hospital stays [5].

As reported for other conditions, the advent of laparoscopy has increased the number of unexplained procedures with a negative impact on health care cost [6].

The aim of this study was to analyze the risk of an increased surgical indication rate in patients with benign tumors of the liver since the development of laparoscopy.

Patients and methods

An extensive search of relevant literature restricted to English, Italian, and French languages was performed using MEDLINE (PubMed), Google Scholar, and The Cochrane Library. The date of the last electronic search was March 31, 2011, and the period included 1970 to 2010.

The keywords used for the search were: 'benign liver tumor', 'laparoscopy', 'hepatic resection', 'liver resection', 'hemangioma', 'FNH', 'focal nodular hyperplasia', and 'adenoma'. These keywords were used individually or with the help of the Boolean operator 'AND'.

Inclusion criteria were patients with a benign tumor of the liver (only hepatic hemangioma, focal nodular hyperplasia, and hepatic adenoma) who underwent elective surgery without an indication for emergency surgery (e.g., hemorrhage or rupture). Articles that did not clearly meet the inclusion criteria were excluded at this stage.

All titles and abstracts were screened, and those related to the theme of this review article were selected. We collected all considered articles, number of patients, number of benign liver tumors, number of patients who underwent operations, and type of surgical procedure (open or laparoscopic surgery). We considered patients >18 years of age to ensure analysis of only adult patients. Age and sex were not considered for the present analysis because they did not influence the search or, consequently, the results.

All articles were then divided into two groups: group I included all manuscripts reporting patients who underwent an open procedure between 1971 and 1990, and group II included all manuscripts reporting patients who underwent an open or laparoscopic procedure between 1991 and 2010.

The amount and percentage of HH, FNH, and HA diagnosed, submitted to surgery, and not treated surgically were analyzed in the two groups. We divided all group II articles into two subgroups. In subgroup IIA, patients treated by an open or laparoscopic procedure between 1991 and 2000 were analyzed. The remaining patients treated by an open or laparoscopic procedure from 2001 to 2010 represented subgroup IIB. The percentage of procedures performed laparoscopically in the two groups was compared using a chi-square test with Yates' correction.

Results

A total of 10,584 reports were found and reviewed (Fig. 1). After examination of all titles and abstracts, 5,712 articles were immediately excluded as not pertinent on the basis of the title and aim of the manuscript; 3,975 articles were excluded because they were identified twice in two databases; 493 articles were excluded because using the Boolean operator, they involved primary liver tumors without any description of a benign liver tumor; and 128 articles were excluded for the same reason but concerned secondary liver tumors.

Of the remaining 276 articles, 49 were excluded due to the absence of a description of surgery, and 23 articles were excluded because they were case reports. The remaining 204 articles were fully reviewed, and 109 were excluded because they did not adhere to our protocol. At the end of the search, only 95 articles addressed all inclusion criteria and were used for the present study (Fig. 1).

A total of 5,480 patients with benign lesions of the liver were found from the final research of the literature articles meeting all criteria for the present study. A total of 1,071 (19.5 %) patients did not undergo surgery and were therefore excluded from the work, and 4,409 (80.4 %) patients underwent a surgical procedure and were analyzed in the present work. These included 2,492 (45.6 %) patients with HH, 942 (17.1 %) with FNH, 610 (11.1 %) with HA, and 1,436 (26.3 %) with other types of lesions. The majority of liver resections were performed in 1,661 (37.6 %) patients with HH, followed by 825 (18.7 %) with FNH, and 540 (12.2 %) with HA. The remaining 1,383 (31.5 %) patients had other benign liver lesions that were not considered for the present work. Thus, a total of 3,026 hepatic resections were ultimately considered for the present work (Fig. 2).

In the first group (group I [GI]) of articles, published between 1971 and 1990, we analyzed 13 articles, among which 545 patients were considered for the present study. Of these patients, 393 (72.1 %) underwent traditional surgery and 152 (27.9 %) were not submitted to surgery. There were 213 (54.2 %) patients with HH, 34 (8.7 %) with FNH, 71 (18 %) with HA, and 75 (19.1 %) with various kinds of lesions excluded from the present study (Fig. 2). Thus, in GI, we definitively analyzed only 318 patients affected by 213 (67 %) HH, 34 (10.7 %) FNH, and 71 (22.3 %) HA and undergoing an open surgical procedure (Table 1) [7–19].

In the second group (group II [GII]) of articles, published between 1991 and 2010, we analyzed 82 articles, among which 4,935 patients were affected by benign tumors. A total of 4,016 (81.4 %) of these patients underwent surgical procedures, and the remaining 919 (18.6 %) were not treated surgically. There were 1,448 (36.1 %) patients with HH, 791 (19.7 %) with FNH, 469 (11.7 %) with HA, and 1,308 (32.5 %) with different hepatic lesions

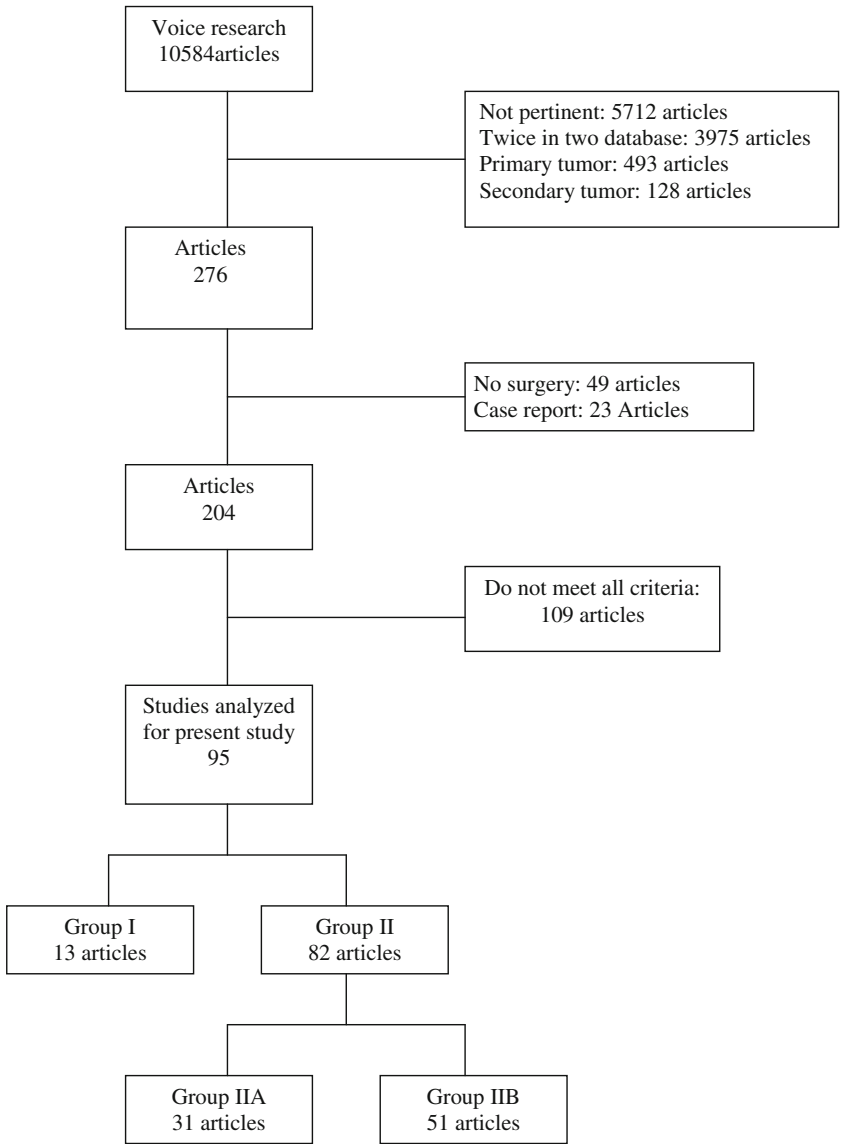

Fig. 1 Algorithm used to screen the literature

not useful for the present study (Fig. 2). Therefore, in this group, 2,708 patients affected by 1,448 (53.5 %) HH, 791 (29.2 %) FNH, and 469 (17.3 %) HA and undergoing a surgical procedure were studied (Table 2) [20–101]. In particular, 2,112 (78 %) patients were treated with open surgery and 596 (22 %) patients were treated with laparoscopic surgery.

Analysis of the two groups showed that the number of benign lesions of the liver diagnosed in GI was less than that in GII with a ratio of 1/9 (545 vs. 4,935, respectively). The increase in the diagnosis of benign lesions of the liver resulted in an increase in surgical procedures in GII compared with GI (4,935/4,016 vs. 545/393, 81.3 % vs. 72.1 %, respectively). The total number of diagnosed benign tumors of the liver vs the total number of only HH, FNH, and HA in GI was higher than that in GII (545/439 vs. 4,935/3,605, 80.6 % vs 73.1 %, respectively).

The total number of HH, FNH, and HA treated with surgical procedures related to the total number of HH, FNH, and HA diagnosed in GI was lower than that in GII (318/439 vs. 2,708/3,605, 72.4 % vs. 75.1 %, respectively).

Analysis of the number of surgical procedure for each kind of tumor (HH, FNH, and HA) in relation to the total number of surgical procedure for all these tumor in GII related GI showed a decrease for HH (1,448/2,708 vs. 213/318, 53.3 % vs. 67 % respectively) and HA (469/2,708 vs. 71/318, 17.2 % vs. 22.3 %, respectively) and an increase for FNH (791/2,708 vs. 34/318, 29 % vs. 9.7 %, respectively).

The last analysis concerns the two subgroups. In subgroup IIA (GIIA), a total of 31 articles were published between 1991 and 2000, and 917 patients reportedly underwent a surgical procedure (Table 3). In this group, 872 (95.1 %) patients underwent an open surgery and 45

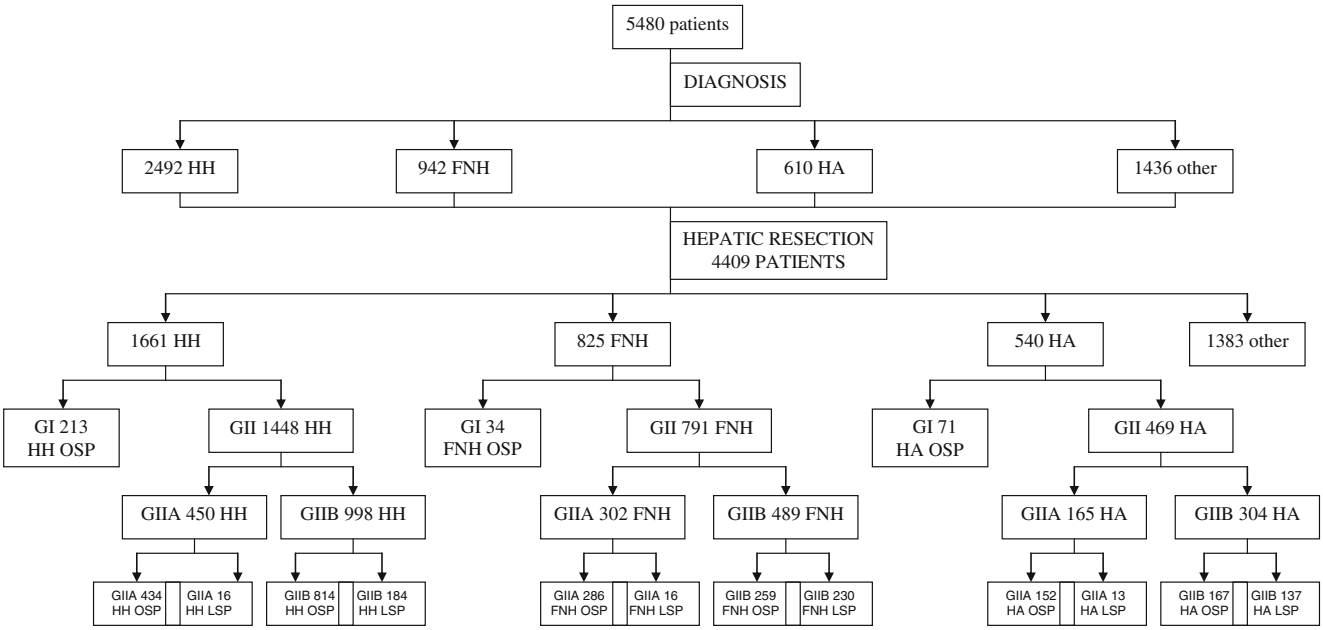

Fig. 2 Algorithm of patients undergoing hepatic resection. Patients are divided according to the type of period and method (open or laparoscopy surgery) used for their treatment

(4.9 %) underwent a laparoscopic procedure. In particular, 434 (49.8 %) patients with HH were treated with open surgery and 16 (35.6 %) with HH were treated with laparoscopic surgery, 286 (32.8 %) patients with FNH were treated with open surgery and 16 (35.6 %) with FNH were treated with laparoscopic surgery, and 152 (17.4 %) patients with HA were treated with open surgery and 13 (28.8 %) with HA were treated with laparoscopic surgery (Fig. 2).

In subgroup IIB (GIIB), a total of 51 articles were published between 2001 and 2010, and 1,791 patients reportedly underwent a surgical procedure (Table 4). In this group, 1,240 (69.2 %) patients underwent an open surgery and 551 (30.8 %) underwent a laparoscopic procedure. In particular, 814 (65.6 %) patients with HH were treated with open surgery and 184 (33.4 %) with HH were treated with laparoscopic surgery, 259 (20.9 %) patients with FNH were treated with open surgery and 230 (41.7 %) with FNH were treated with laparoscopic surgery, and 167 (13.5 %) patients with HA were treated with open surgery and 137 (24.9 %) with HA were treated with laparoscopic surgery (Fig. 2).

The percentage of patients treated with a laparoscopic procedure was less in GIIA than in GIIB (4.8 % vs. 30.8 %, respectively). A chi-square test with Yates' correction gave a P value of <0.001.

Discussion

Laparoscopy is slowly but definitively changing the course of surgery. It has benefits of a fast recovery and rapid return to activities because postoperative pain is less or nonexistent compared with open surgery. As for the majority of surgical diseases, hepatic surgery has been gently changed by laparoscopy during the last 20 years, and a great number of hepatic resections are now performed by laparoscopy.

The manuscripts in the present search were unequal during the 40 years included in the study in terms of the two groups of populations studied. This is due to the natural evolution of hepatic surgery: in the first two decades, the initial experience with few surgical teams has been progressively replaced with many teams, affirming this kind of surgery worldwide. The change from open to laparoscopic hepatic surgery by many of these teams or new laparoscopic teams has influenced hepatic surgery in the last two decades. This surgical evolution perfectly corresponds with the literature. The first few scientific reports concerning the initial experience of a few groups were replaced with an increasing number of scientific manuscripts corresponding to an increase in open hepatic surgery teams until the appearance of laparoscopic teams, which resulted in a gradual increase in not only laparoscopic surgeries, but also the related scientific articles.

This is the reason why the last period of 20 years have been divided in two subgroups; in the first period only few groups of very skilled hepatic surgeons and at the same time excellent laparoscopists have performed this surgery. On the opposite the second period (the last 10 years) represents the enormous spread of this techniques performed not only by hepatic surgeons devoted to laparoscopy but also by laparoscopic surgeons (frequently general surgeons) initiates to hepatic surgery.

Table 1 Articles of the GI group published between 1971–1990. Only open technique is used for the treatment of benign tumors of the liver in this group of patients

Years	Authors	Journal	NP	BTL	HH D	FNH D	HA D	LVK D	BTLSP	BTLNSP	HH SP	FNH SP	HA SP	LVK SP	BTL OSP	HH+FNH+HA OSP
1971	Yehuda [7]	Ann Surg	126	126	106		6	14	10	116	10				10	10
1974	Longmire [8]	Ann surg	53	53	9	5	5	34	34	19	8	4	5	17	34	17
1980	Hanks [9]	Ann Surg	4	4	4				4		4				4	4
1980	Starzl [10]	Surg Gynecol Obstet	3	3		1	2		3			1	2		3	3
1980	Starzl [11]	Ann Surg	15	15	15				15		15				15	15
1981	Balasegaram [12]	Am J Surg	5	5	5				5		5				5	5
1983	Iwatsuki [13]	Ann Surg	64	64	32	4	14	14	64		32	4	14	14	64	50
1983	Thompson [14]	Ann Surg	28	28	17	5	5	1	28		17	5	5	1	28	27
1987	Stimpson [15]	Am J Surg	11	11	5	2	4		11		5	2	4		11	11
1987	Schwartz [16]	Ann Surg	28	28	28				16	12	16				16	16
1988	Iwatsuki [17]	Ann Surg	182	182	100	17	22	43	182	0	100	17	22	43	182	139
1988	Leese [18]	Ann Surg	24	24			24		19	5			19		19	19
1989	Castaing [19]	Ann Surg	2	2		1	1		2		1	1			2	2
		Total	545	545	321	35	83	106	393	152	213	34	71	75	393	318

NP number of patients were considered for our article, *BTL* benign tumors liver, *HH D* hepatic hemangioma diagnosed, *FNH D* focal nodula hyperplasia diagnosed, *HA D* hepatic adenoma diagnosed, *LVK D* lesions of various kinds diagnosed, *BTL SP* benign tumors liver undergoing surgical procedure, *BTL NSP* benign tumors liver not undergoing surgical procedure, *HH SP* hepatic hemangioma undergoing surgical procedure, *FNH SP* focal nodular hyperplasia undergoing surgical procedure, *HA SP* hepatic adenoma undergoing surgical procedure, *LVK SP* lesions of various kinds undergoing surgical procedure, *BTL OSP* benign tumors liver undergoing at open surgical procedure, *HH+FNH+HA OSP* total patients affected by hepatic hemangioma, focal nodular hyperplasia, and hepatic adenoma undergoing at open surgical procedure

Table 2 Articles of the GII group published between 1991–2010. Open and laparoscopic technique were used for the treatment of benign tumors of the liver in this group of patients

Years	Authors	Journal	NP	BTL	HH D	FNH D	HA D	LVK D	BTLSP	BTLNSP	HH SP	FNH SP	HA SP	LVK SP	BTL OSP	BTL LSP	HH+FNH+ HA OSP	HH+FNH+ HA LSP
1991	Pain [20]	Gut	22	22		22			13	9		13			13		13	
1991	Yamagata [21]	Br J Surg	33	33	33				13	20	13				13		13	
1991	Savage [22]	Ann Surg	59	59	26	15	12	6	59		26	15	12	6	59		53	
1992	Lise [23]	World J surg	51	51	51				25	26	25				25		25	
1992	Belli [24]	Surg Gynecol Obstet	24	24	24				24		24				24		24	
1993	Belghiti [25]	Ann Surg	42	42	4	25	5	8	42		4	25	5	8	42		34	
1994	Paineau [26]	J Chir (Paris)	31	31	8	12	1	10	30	1	8	12	1	9	30		21	
1994	Belghiti [27]	Eur J Surg	144	144	13	33	15	83	144		13	33	15	83	144		61	
1994	John [28]	Ann Surg	6	6		2	1	3	6			2	1	3		6		3
1994	Eckhauser [29]	Am Surg	8	8			8		8				8		8		8	
1995	Habib [30]	Ann R Coll Surg Engl	7	7	5	1	1		7		5	1	1		7		7	
1995	Cunningham [31]	Surg Laparosc Endosc	2	2	2				2		2					2		2
1995	Gugenheim [32]	Minerva Chir	42	42	20	19	3		42		20	19	3		42		42	
1995	Farges [33]	World J Surg	163	163	163				8	155	8				8		8	
1996	Moreno Egea [34]	HGE	26	26	26				26		26				26		26	
1996	Kaneko [35]	Surgery	11	11	11				11		11					11		11
1997	Krug [36]	Eur Radiol	75	75	8	12	8	47	75		8	12	8	47	75		28	
1997	Brouwers [37]	Br J surg	28	28	28				28		28				28		28	
1997	Weimann [38]	World J Surg	437	437	238	150	44	5	173	264	69	61	39	4	173		169	
1997	De Carlis [39]	Liver Trasplant surg	38	38		19	19		27	11		8	19			27	27	
1998	Finch [40]	Br J Surg	31	31	2	6	1	22	31		2	6	1	22	31		9	
1998	Samama [41]	Surg Endosc	2	2		2			2			2				2		2
1998	Berney [42]	Br J Surg	17	17	6	7	1	3	17		6	7	1	3	17		14	
1999	Katkhouda [43]	Ann Surg	12	12		3	9		12			3	9			12		12
1999	Geraly [44]	Arch Surg	28	28	28				28		28				28		28	
2000	Cherqui [45]	Ann Surg	18	18	1	9	3	5	18		1	9	3	5		18		13
2000	Ozden [46]	Arch Surg	42	42	42				42		42				42		42	
2000	Closset [47]	HGE	29	29		13	16		29			13	16		29		29	
2000	Bengisun [48]	Langenbecks Arch Surg	2	2	2				2		2					2		2
2000	Herman [49]	World J Surg	23	23		13	10		20	3		10	10		20		20	
2000	Belghiti [50]	Jam Coll Surg	258	258	13	79	51	115	258		79	51	13	115	258		143	
2001	Terkivatan [51]	Arch Surg	74	74	25	26	19	4	74		25	26	19	4	74		70	
2001	Kammulla [52]	Intern J Gastroint Canc	28	28	10	3	8	7	28		10	3	8	7	28		21	
2001	Alfieri [53]	Digest liver dis	19	19	4	8	4	3	19		4	8	4	3	19		16	

Table 2 (continued)

Years	Authors	Journal	NP	BTL	HH D	FNH D	HA D	LVK D	BTLSP	BTLNSP	HH SP	FNH SP	HA SP	LVK SP	BTL OSP	BTL LSP	HH+FNH+ HA OSP	HH+FNH+ HA LSP
2001	Charny [54]	Br J Surg	155	155	97	42	12	4	68	87	39	18	8	3	68		65	
2001	Berends [55]	Surg Endosc	7	7	2	2		3	7		2	2		3		7		4
2002	Farges [56]	J Hepat Pancr Surg	42	42	34	4	4		42		4	34	4		21	21	21	21
2002	Takagi [57]	Surg Endosc	5	5	5				5		5					5		5
2002	Kalil [58]	HGE	6	6	1	1	3	1	6		1	1	3	1		6		5
2002	Jarnagin [59]	Ann Surg	134	134	56	22	17	39	134		56	22	17	39	134		95	
2003	Descottes [60]	Surg Endosc	87	87	13	48	17	9	87		13	48	17	9		87		78
2003	Tsai [61]	Dig Dis Scien	43	43	43				43		43				43		43	
2003	Yoon [62]	Am Coll Surg	115	115	115				52	63	52				52		52	
2003	Morino [63]	Surg Endosc	21	21	6	8	6	1	21		6	8	6	1	5	16	5	15
2004	Poon [64]	Ann Surg	188	188	22	20	7	139	188	0	22	20	7	139	188		49	
2004	Liu [65]	J Gastrointest Surg	45	45	12	17	2	14	45		12	17	2	14	45		31	
2004	Kim [66]	Am J Surg	72	72	21	30	11	10	72		21	30	11	10	72		62	
2004	Buell [67]	Surgery	12	12	2	1	1	8	12		2	1	1	8		12		4
2004	O'Rourke [68]	J Gastrointest Surg	2	2		2			2			2				2		2
2005	Mala [69]	J Hepat Pancr Surg	6	6	2	1		3	6		2	1		3		6		3
2005	Fioole [70]	BMC surgery	28	28	8	6	13	1	28		8	6	13	1	28		27	
2005	Herman [71]	J Gastrointest Surg	249	249	249				8	241	8				8		8	
2005	Di Carlo [72]	HGE	17	17	17				8	9	8				8		8	
2005	Dulucq [73]	Surg Endosc	13	13	2	5	3	3	13		2	5	3	3		13		10
2006	Wu [74]	Ann Surg	27	27	14	5	2	6	27		14	5	2	6	27		21	
2006	Schemmer [75]	WJS	43	43		13	7	23	43			13	7	23	43		20	
2006	Vibert [76]	Br J Surg	24	24	1	9	3	11	24		1	9	3	11		24		13
2006	Gourgiotis [77]	ANZ J Surg	15	15	15				15		15				15		15	
2006	Cai [78]	Surg Endosc	42	42	15	2		25	42		15	2		25		42		17
2006	Koffron [79]	Hepatology	230	230	43	29	42	116	230		29	43	42	116		230		114
2006	Learn [80]	J Gastrointest Surg	13	13	6	4	1	2	13		6	4	1	2		13		11
2006	Borzellino [81]	Surg Endosc	13	13	4		3	6	13		4	3		6		13		7
2007	Ardito [82]	Arch Surg	50	50	2	22	7	19	50		2	22	7	19		50		31
2007	Ibrahim [83]	Am J Surg	84	84	46	27	5	6	84		46	27	5	6	84		78	
2007	Dagher [84]	Surg Endosc	32	32	3	8	6	15	32		3	8	6	15		32		17
2007	Hompes [85]	Surg Endosc	5	5	3	1	1		5		3	1	1			5		5
2007	Lee [86]	Hong Kong Med J	8	8	4	4			8		4	4			2	6	6	2
2007	Bachellier [87]	Am J Surg	3	3	1	2			3		1	2				3		3
2007	Nissen [88]	Am Surg	7	7		5	2		7			5	2			7		7

Table 2 (continued)

Years	Authors	Journal	NP	BTL	HH D	FNH D	HA D	LVK D	BTLSP	BTLNSP	HH SP	FNH SP	HA SP	LVK SP	BTL OSP	BTL LSP	HH+FNH+ HA OSP	HH+FNH+ HA LSP
2007	Santambrogio [89]	Surg Endosc	5	5	1		3	1	5		1	3		1		5		4
2008	Cho [90]	Surgery	11	11	4	3	1	3	11		4	3	1	3		11		8
2008	Buell [91]	Ann Surg	174	174	46	21	25	82	144	30	42	19	20	63		144		81
2008	Chen [92]	Langenbecks Arch Surg	69	69	69				69		69				69		69	
2008	Troisi [93]	Surg Endosc	40	40	5	8	21	6	40		5	8	21	6	20	20	18	16
2008	Spencer [94]	Hindawi	23	23	7	5	1	10	23		7	5	1	10		23		13
2008	Abu Hilal [95]	Eur J Surg Oncol	5	5		5			5			5			1	4	1	4
2008	Alkari [96]	Surg Endosc	2	2		2			2			2				2		2
2008	Cho [97]	Ann Surg Oncol	41	41			41		41				41		32	9	32	9
2009	Huang [98]	Chin Med J	827	827	345	35	17	430	827		345	35	17	430	827		397	
2009	Zhang [99]	WJS	26	26	21	3	1	1	26		21	3	1	1		26		25
2010	Fu [100]	Br J Surg	10	10	8	1	1		10		8	1	1		10		10	
2010	Kazaryan [101]	Arch Surg	27	27	8	5	2	12	27		8	5	2	12		27		15
			4,935	4,935	2,171	907	527	1,330	4,016	919	1,448	791	469	1,308	3,065	951	2,112	596

NP number of patients were considered for our article, *BTL* benign tumors liver, *HH D* hepatic hemangioma diagnosed, *FNH D* focal nodula hyperplasia diagnosed, *HA D* hepatic adenoma diagnosed, *LVK D* lesions of various kinds diagnosed, *BTL SP* benign tumors liver undergoing surgical procedure, *BTL NSP* benign tumors liver not undergoing surgical procedure, *HH SP* hepatic hemangioma undergoing surgical procedure, *FNH SP* focal nodular hyperplasia undergoing surgical procedure, *HA SP* hepatic adenoma undergoing surgical procedure, *LVK SP* lesions of various kinds undergoing surgical procedure, *BTL OSP* benign tumors liver undergoing at open surgical procedure, *HH+FNH+HA OSP* total patients affected by hepatic hemangioma, focal nodular hyperplasia, and hepatic adenoma undergoing at open surgical procedure, *BTL LSP* benign tumors liver undergoing at laparoscopic surgical procedure, *HH+FNH+HA LSP* total patients affected by hepatic hemangioma, focal nodular hyperplasia, and hepatic adenoma undergoing at laparoscopic surgical procedure

Table 3 Articles of the GIIA sub group published between 1991–2000. Open and laparoscopic technique were used for the treatment of benign tumors of the liver in this group of patients

Years	Authors	Journal	NP	BTL	HH D	FNH D	HA D	LVK D	BTLSP	BTLNSP	HH SP	FNH SP	HA SP	LVK SP	BTL OSP	BTL LSP	HH+FNH+ HA OSP	HH+FNH+ HA LSP
1991	Pain [20]	Gut	22	22		22			13	9		13			13		13	
1991	Yamagata [21]	Br J Surg	33	33	33				13	20	13				13		13	
1991	Savage [22]	Ann Surg	59	59	26	15	12	6	59		26	15	12	6	59		53	
1992	Lise [23]	World J surg	51	51	51				25	26	25				25		25	
1992	Belli [24]	Surg Gynecol Obstet	24	24	24				24		24				24		24	
1993	Belghiti [25]	Ann Surg	42	42	4	25	5	8	42		4	25	5	8	42		34	
1994	Paineau [26]	J Chir (Paris)	31	31	8	12	1	10	30	1	8	12	1	9	30		21	
1994	Belghiti [27]	Eur J Surg	144	144	13	33	15	83	144		13	33	15	83	144		61	
1994	John [28]	Ann Surg	6	6		2	1	3	6			2	1	3		6		3
1994	Eckhauser [29]	Am Surg	8	8			8		8				8		8		8	
1995	Habib [30]	Ann R Coll Surg Engl	7	7	5	1	1		7		5	1	1		7		7	
1995	Cunningham [31]	Surg Laparosc Endosc	2	2	2				2		2					2		2
1995	Gugenheim [32]	Minerva Chir	42	42	20	19	3		42		20	19	3		42		42	
1995	Farges [33]	World J Surg	163	163	163				8	155	8				8		8	
1996	Moreno Egea [34]	HGE	26	26	26				26		26				26		26	
1996	Kaneko [35]	Surgery	11	11	11				11		11					11		11
1997	Krug [36]	Eur Radiol	75	75	8	12	8	47	75		8	12	8	47	75		28	
1997	Brouwers [37]	Br J surg	28	28	28				28		28				28		28	
1997	Weimann [38]	World J Surg	437	437	238	150	44	5	173	264	69	61	39	4	173		169	
1997	De Carlis [39]	Liver Trasplant surg	38	38		19	19		27	11		8	19			27	27	
1998	Finch [40]	Br J Surg	31	31	2	6	1	22	31		2	6	1	22	31		9	
1998	Samama [41]	Surg Endosc	2	2		2			2			2				2		2
1998	Berney [42]	Br J Surg	17	17	6	7	1	3	17		6	7	1	3	17		14	
1999	Katkhouda [43]	Ann Surg	12	12		3	9		12			3	9			12		12
1999	Geraly [44]	Arch Surg	28	28	28				28		28				28		28	
2000	Cherqui [45]	Ann Surg	18	18	1	9	3	5	18		1	9	3	5		18		13
2000	Ozden [46]	Arch Surg	42	42	42				42		42				42		42	
2000	Closset [47]	HGE	29	29		13	16		29			13	16		29		29	
2000	Bengisun [48]	Langenbecks Arch Surg	2	2	2				2		2					2		2
2000	Herman [49]	World J Surg	23	23		13	10		20	3		10	10		20		20	
2000	Belghiti [50]	J Am Coll Surg	258	258	13	79	51	115	258		79	51	13	115	258		143	
			1,711	1,711	754	442	208	307	1,222	489	450	302	165	305	1,142	80	872	45

NP number of patients were considered for our article, *BTL* benign tumors liver, *HH D* hepatic hemangioma diagnosed, *FNH D* focal nodula hyperplasia diagnosed, *HA D* hepatic adenoma diagnosed, *LVK D* lesions of various kinds diagnosed, *BTL SP* benign tumors liver undergoing surgical procedure, *BTL NSP* benign tumors liver not undergoing surgical procedure, *HH SP* hepatic hemangioma undergoing surgical procedure, *FNH SP* focal nodular hyperplasia undergoing surgical procedure, *HA SP* hepatic adenoma undergoing surgical procedure, *LVK SP* lesions of various kinds undergoing surgical procedure, *BTL OSP* benign tumors liver undergoing at open surgical procedure, *HH+FNH+ HA OSP* total patients affected by hepatic hemangioma, focal nodular hyperplasia, and hepatic adenoma undergoing at open surgical procedure, *BTL LSP* benign tumors liver undergoing at laparoscopic surgical procedure, *HH+ FNH+ HA LSP* total patients affected by hepatic hemangioma, focal nodular hyperplasia, and hepatic adenoma undergoing at laparoscopic surgical procedure

Table 4 Articles of the GIIB sub group published between 2001–2010. Open and laparoscopic technique were used for the treatment of benign tumors of the liver in this group of patients

Years	Authors	Journal	NP	BTL	HH D	FNH D	HA D	LVK D	BTLSP	BTLNSP	HH SP	FNH SP	HA SP	LVK SP	BTL OSP	BTL LSP	HH+FNH+ HA OSP	HH+FNH+ HA LSP
2001	Terkivatan [51]	Arch Surg	74	74	25	26	19	4	74		25	26	19	4	74		70	
2001	Kammulla [52]	Intern J Gastroint Canc	28	28	10	3	8	7	28		10	3	8	7	28		21	
2001	Alfieri [53]	Digest liver dis	19	19	4	8	4	3	19		4	8	4	3	19		16	
2001	Charny [54]	Br J Surg	155	155	97	42	12	4	68	87	39	18	8	3	68		65	
2001	Berends [55]	Surg Endosc	7	7	2	2		3	7		2	2		3		7		4
2002	Farges [56]	J Hepat Pancr Surg	42	42	34	4	4		42		4	34	4		21	21	21	21
2002	Takagi [57]	Surg Endosc	5	5	5				5		5					5		5
2002	Kalil [58]	HGE	6	6	1	1	3	1	6		1	1	3	1		6		5
2002	Jarnagin [59]	Ann Surg	134	134	56	22	17	39	134		56	22	17	39	134		95	
2003	Descottes [60]	Surg Endosc	87	87	13	48	17	9	87		13	48	17	9		87		78
2003	Tsai [61]	Dig Dis Scien	43	43	43				43		43				43		43	
2003	Yoon [62]	Am Coll Surg	115	115	115				52	63	52				52		52	
2003	Morino [63]	Surg Endosc	21	21	6	8	6	1	21		6	8	6	1	5	16	5	15
2004	Poon [64]	Ann Surg	188	188	22	20	7	139	188	0	22	20	7	139	188		49	
2004	Liu [65]	J Gastrointest Surg	45	45	12	17	2	14	45		12	17	2	14	45		31	
2004	Kim [66]	Am J Surg	72	72	21	30	11	10	72		21	30	11	10	72		62	
2004	Buell [67]	Surgery	12	12	2	1	1	8	12		2	1	1	8		12		4
2004	O'Rourke [68]	J Gastrointest Surg	2	2		2			2			2				2		2
2005	Mala [69]	J Hepat Pancr Surg	6	6	2	1		3	6		2	1		3		6		3
2005	Fioole [70]	BMC surgery	28	28	8	6	13	1	28		8	6	13	1	28		27	
2005	Herman [71]	J Gastrointest Surg	249	249	249				8	241	8				8		8	
2005	Di Carlo [72]	HGE	17	17	17				8	9	8				8		8	
2005	Dulucq [73]	Surg Endosc	13	13	2	5	3	3	13		2	5	3	3		13		10
2006	Wu [74]	Ann Surg	27	27	14	5	2	6	27		14	5	2	6	27		21	
2006	Schemmer [75]	WJS	43	43		13	7	23	43			13	7	23	43		20	
2006	Vibert [76]	Br J Surg	24	24	1	9	3	11	24		1	9	3	11		24		13
2006	Gourgiotis [77]	ANZ J Surg	15	15	15				15		15				15		15	
2006	Cai [78]	Surg Endosc	42	42	15	2		25	42		15	2		25		42		17
2006	Koffron [79]	Hepatology	230	230	43	29	42	116	230		29	43	42	116		230		114
2006	Learn [80]	J Gastrointest Surg	13	13	6	4	1	2	13		6	4	1	2		13		11
2006	Borzellino [81]	Surg Endosc	13	13	4		3	6	13		4	3		6		13		7
2007	Ardito [82]	Arch Surg	50	50	2	22	7	19	50		2	22	7	19		50		31
2007	Ibrahim [83]	Am J Surg	84	84	46	27	5	6	84		46	27	5	6	84		78	
2007	Dagher [84]	Surg Endosc	32	32	3	8	6	15	32		3	8	6	15		32		17
2007	Hompes [85]	Surg Endosc	5	5	3	1	1		5		3	1	1			5		5

Table 4 (continued)

Years	Authors	Journal	NP	BTL	HH D	FNH D	HA D	LVK D	BTLSP	BTLNSP	HH SP	FNH SP	HA SP	LVK SP	BTL OSP	BTL LSP	HH+FNH+ HA OSP	HH+FNH+ HA LSP
2007	Lee [86]	Hong Kong Med J	8	8	4	4			8		4	4			2	6	6	2
2007	Bachellier [87]	Am J Surg	3	3	1	2			3		1	2				3		3
2007	Nissen [88]	Am Surg	7	7		5	2		7			5	2			7		7
2007	Santambrogio [89]	Surg Endosc	5	5	1		3	1	5		1	3		1		5		4
2008	Cho [90]	Surgery	11	11	4	3	1	3	11		4	3	1	3		11		8
2008	Buell [91]	Ann Surg	174	174	46	21	25	82	144	30	42	19	20	63		144		81
2008	Chen [92]	Langenbecks Arch Surg	69	69	69				69		69				69		69	
2008	Troisi [93]	Surg Endosc	40	40	5	8	21	6	40		5	8	21	6	20	20	18	16
2008	Spencer [94]	Hindawi	23	23	7	5	1	10	23		7	5	1	10		23		13
2008	Abu Hilal [95]	Eur J Surg Oncol	5	5		5			5			5			1	4	1	4
2008	Alkari [96]	Surg Endosc	2	2		2			2			2				2		2
2008	Cho [97]	Ann Surg Oncol	41	41			41		41				41		32	9	32	9
2009	Huang [98]	Chin Med J	827	827	345	35	17	430	827		345	35	17	430	827		397	
2009	Zhang [99]	WJS	26	26	21	3	1	1	26		21	3	1	1		26		25
2010	Fu [100]	Br J Surg	10	10	8	1	1		10		8	1	1		10		10	
2010	Kazaryan [101]	Arch Surg	27	27	8	5	2	12	27		8	5	2	12		27		15
		Total	3,224	3,224	1,417	465	319	1,023	2,794	430	998	489	304	1,003	1,923	871	1,240	551

NP number of patients were considered for our article, *BTL* benign tumors liver, *HH D* hepatic hemangioma diagnosed, *FNH D* focal nodula hyperplasia diagnosed, *HA D* hepatic adenoma diagnosed, *LVK D* lesions of various kinds diagnosed, *BTL SP* benign tumors liver undergoing surgical procedure, *BTL NSP* benign tumors liver not undergoing surgical procedure, *HH SP* hepatic hemangioma undergoing surgical procedure, *FNH SP* focal nodular hyperplasia undergoing surgical procedure, *HA SP* hepatic adenoma undergoing surgical procedure, *LVK SP* lesions of various kinds undergoing surgical procedure, BTL OSP benign tumors liver undergoing at open surgical procedure, *HH+ FNH+ HA OSP* total patients affected by hepatic hemangioma, focal nodular hyperplasia, and hepatic adenoma undergoing at open surgical procedure, *BTL LSP* benign tumors liver undergoing at laparoscopic surgical procedure, *HH+ FNH+ HA LSP* total patients affected by hepatic hemangioma, focal nodular hyperplasia, and hepatic adenoma undergoing at laparoscopic surgical procedure

Liver resection represents the best treatment for a variety of malignant and benign hepatic tumors, and estimation of risk factors affecting the early outcome after hepatic resection is a goal shared by all high-volume centrals specialized in hepatobiliary surgery [102]. To achieve this goal, the right indication for each kind of hepatic tumor is mandatory to avoid unnecessary surgical procedures with related morbidity and mortality.

After the introduction of laparoscopic hepatic resection, many authors have detected a dramatic increase in the amount of surgical procedures performed in general hospitals [103]. Nguyen et al. used a laparoscopic approach in 25 % of cases in the last 6 years [2]. Koffron et al. shifted their practice from 10 % minimally invasive liver resections in 2002 to 80 % liver resections in 2007 as long as the patient met certain safety and oncologic requirements [103].

Despite the limitations and disadvantages of laparoscopic liver resection, which include a significant learning curve, bleeding that is more difficult to control laparoscopically, inadequate assessment of the liver for additional lesions, and increased risk for gas embolism, the increase in laparoscopic hepatic resections has been maintained; therefore, the explanation for this trend could broaden the indications for performance of such a technique. Surgical laparoscopic procedures are easy if they involve the anterior segments of the liver and are performed for benign lesions of the liver. In our review, among the manuscripts that reported these data, the majority of resections were minor. We can postulate that because all of the initial published experiences of laparoscopic hepatic resections were based on limited or minor hepatic resections, these procedures are easier to perform and they are chosen by novice laparoscopic teams because of decreased initial difficulties [104].

In the 1970s, ultrasonography used for diagnostic purpose permitted an increase and refinement of benign hepatic tumor diagnosis [104]. Together with a better knowledge of the natural course of these tumors, this helped decrease the total number of procedures in the second period permitting at the same time the avoidance of unnecessary liver surgery in asymptomatic patients. In fact, liver surgery for benign liver tumors may relieve complaints in a high percentage of symptomatic patients (80 %). However, in many patients, symptoms persist after resection of the tumor, and surgery-related complications might occur [51] so the right indications for surgery is mandatory.

MRI may be helpful when the diagnosis is dubious, while percutaneous biopsy is generally avoided. With this approach, most patients can be safely observed [54], but despite what, according to the increase in diagnosis of benign lesions of the liver, there was an increase in surgical procedures for such lesions. As in our study, Buell et al. found that the most common resected benign hepatic tumors were HH, followed by FNH and HA [84]. This was probably due to a better knowledge of the clinical course of patients with benign tumor of the liver, which led to surgeons operating on these patients to complete their learning curve.

The surgical indications for HH, FNH, and HA are reported in Table 5. In the majority of patients, HH remain asymptomatic and are incidentally discovered during a surgical procedure or imaging studies for unrelated problems. In GII of the present study, the number of resected HH was considerably decreased because of an improved understanding of the diagnosis, prognosis, and correct indications for surgery.

Ibrahim et al. found that in patients with FNH, the main indication was suspicion of malignancy. This not surprising because it is sometimes difficult to differentiate hepatocellular carcinoma from FNH by investigation [83]. However, the proportion of symptomatic FNH patients has remained stable or even decreased in GII because more and more cases of FNH are incidentally detected; thus, a steadily increasing number of laparoscopic liver resections are performed in asymptomatic patients.

The continuous improvement in diagnostic techniques, particularly MRI, has restricted the surgical indications for HA to the non-classic or mixed hyperplastic adenomatous form of FNH [105], for which the procedure has not only a curative goal, but also the need for a precise pathologic definition [106]. Our review shows that in GII, there was a reduction in the proportion of patients with HA who underwent a surgical procedure compared with that in GI.

But despite these results the global analysis of the GIIB shows a significative increase in laparoscopic hepatic resections for all three kind of tumors and this seems unjustified in a period in which the right indications for benign hepatic tumors of the liver were quite well established. This is also confirmed by the consensus conference in Louisville KY, USA called for an international position on laparoscopic liver surgery said stated that (1) incidental findings of benign asymptomatic liver lesions has become common, (2) HH and FNH can be diagnosed in most cases by imaging alone and rarely require surgery, (3) HAs are recognized to possess a potential for bleeding and malignant degeneration, and, most importantly, (4) the consequences of an adverse

Table 5 Indication for surgical treatment of patients with benign tumors of the liver

HH	FNH	HA
Spontaneous or traumatic rupture in patients with giant subcapsular HH	Increases in dimension with increasing pain	Risk of rupture
Progressive abdominal symptoms such pain, satiety or constipation	Impossibility to exclude the malignancy	Malignant transformation
Kasabach-Merritt syndrome		

event are magnified when a procedure is performed for asymptomatic benign lesions [1].

Formal general surgical residency training in laparoscopy techniques began in the early 1990s and, for several years, was largely limited to cholecystectomy. Subsequently, in the 1990s, this training was extended to include other general surgical procedures such as hepatic resection [103]. Hepatic resection was one of the last frontiers of the laparoscopic approach because of the particular expertise required to perform this technique. In effect, at the beginning of this translation from open to laparoscopic, only hepatic surgeons performed these procedures.

Training of the surgeons is essential because we have seen a 300 % increase in demand for operations. However, this must be evaluated based on the potential increase in operative costs, which can balance out a reduction in postoperative hospital costs [107]. In the present study, some authors reported an increase in laparoscopic lobectomy related to open surgery (28 vs. 8, respectively; P=0.001) [107].

In these authors' opinion, the indication did not change even when laparoscopy was requested. However, knowledge of possible adverse laparoscopic effects on malignant tumors has probably pushed toward operation on more codified benign tumors [107].

The initial factor in learning and moving toward laparoscopic hepatic lobectomy is to choose patients requiring wedge resections of superficially or peripherally located neoplasms and left lateral hepatectomies.

Small, focal, localized tumors on anterolateral segments (segments II–VI according to the Couinaud classification) are typically considered for easier resection [108]. The majority of published manuscripts concerning the initial experiences of a novice laparoscopic team concern limited or minor resection [45, 63, 67]. The increase in laparoscopic procedures in GII was probably caused by two factors. For benign tumors of the liver, no radical margins are requested [109], and wedge or limited resection of the anterior segment of the liver can be easily performed with the double advantage of easy resection and facilitation of training [110].

Moreover, normal parenchyma is more manageable than is cirrhotic liver and is another reason why benign tumors of the liver can be treated more easily [109].

There is no reason for modification of the management of patients suffering from benign liver tumors after the introduction of a laparoscopic procedure. Surgical indications for removal of these tumors should be based on their natural history and the ability of imaging techniques to ensure a precise diagnosis of the type of tumor [60]. Adequate selection of patients and liver tumors is a key factor for successful laparoscopic resectional surgery [60]. The procedure should be performed by surgical teams experienced in hepatobiliary and laparoscopic surgery [60]. Studies have shown that there are no financial disadvantages to the laparoscopic approach because the added costs of disposable equipment or devices in the operating room were offset by shorter operative times and lengths of stay [2]. Further reduction of abdominal wall damage and cosmetic advantages of the laparoscopic approach represent a clear benefit in patients with benign tumors of the liver. Of course, if indication of laparoscopic surgery is not mandatory, the procedure itself represents an important increase in health care costs.

No evidence is currently available to support or refuse the indication for laparoscopic surgery in elective patients with benign liver lesions. However, the present analysis shows that in the last 20 years, there has been an increase of 26 % in laparoscopic procedures for benign tumors of the liver.

A limitation of the present study concerns the factors that affect the apparent frequency of the procedure. This can be caused by referral bias of the patients affected by hepatic benign tumors. Luning showed that ultrasound had an accuracy of 69 %, CT had an accuracy of 73 %, and MRI had an accuracy of 80 % in demonstrating the type of lesion [110]. Another bias concern the absence of articles against laparoscopy, infact all published manuscripts discuss the advantages of this procedure. Thus, it is very difficult to analyze the real causes of the increase in laparoscopic procedures. Last bias may concern the change in incidence of tumors studied: the relationship between the tumors and one of their causes (oral contraceptives) can be considered because this treatment has increased during the last several years and may have also influenced the incidence of this tumor [110]. Finally, the postoperative course of the benign tumors with a normal liver is now well codified and does not need any particular expertise. Thus, in terms of other benign diseases, the patient can be discharged very quickly, resulting in personal satisfaction and appreciation for the technique.

In conclusion, the improvements in diagnostic techniques during the last few decades have permitted diagnosis of more benign tumors of the liver.

The indications for surgery were codified, and the surgical procedures remained stable for a period of time before the advent of laparoscopy; with the advent of this technique the hepatic resections for benign tumors of the liver has increased inexplicably.

Conflicts of interest None.

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