Morbidity of hand-assisted laparoscopic splenectomy compared to conventional laparoscopic splenectomy: a 6-year review

Abdulmalik M.S. Altaf, MD*
James Ellsmere, MD†
Hendrik Jaap Bonjer, MD†
Tarek H. El-Ghazaly, MD†
Dennis R. Klassen, MD†

From the *Department of Surgery, King Abdulaziz University, Jeddah, Saudi Arabia, and the †Queen Elizabeth II Health Sciences Centre, Dalhousie University, Halifax, NS

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Correspondence to:
D.R. Klassen
Department of Surgery
Dalhousie University
Room 8-028 Victoria Bldg.
1278 Tower Rd.
Halifax NS B3H 2Y9
klassend@cdha.nshealth.ca

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Background: Laparoscopic splenectomy (LS) has several advantages over the open procedure but can be technically demanding when performed in patients with massive splenomegaly. We hypothesized that patients who undergo hand-assisted LS (HALS) may experience the benefits of LS while having their enlarged spleens removed safely.

Methods: We reviewed the charts of patients who underwent HALS or LS between January 2003 and June 2008. Evaluated parameters included intraoperative and early postoperative morbidity and mortality, conversion to open surgery, need for blood transfusion, length of postoperative hospital stay, patient demographics, diagnosis leading to splenectomy, splenic weight and number of postoperative days to resuming normal diet. Differences were analyzed while controlling for splenic weight and malignant diagnosis using multiple linear and logistic regression analysis.

Results: In all, 103 patients underwent splenectomy (23 HALS, 80 LS). Patients who had HALS were older and had larger spleens, and a greater proportion had malignant diagnoses. We observed no significant differences in morbidity, conversion to open surgery or need for blood transfusion. The mean length of postoperative stay, duration of surgery and days to resuming full diet were longer in the HALS group. No patients died. No group differences were significant after controlling for splenic weight and malignant diagnosis.

Conclusion: The morbidity associated with HALS is comparable to that with LS. The longer duration of surgery and hospital stay for HALS patients was likely related to greater splenic weight, older age and greater proportion of malignant diagnoses. Hand-assisted LS is a viable alternative to open surgery in patients with massive spleens.

Contexte : La splénectomie laparoscopique (SL) comporte plusieurs avantages par rapport à la chirurgie ouverte, mais peut être exigeante sur le plan technique lorsqu'elle s'effectue sur des patients qui souffrent de splénomégalie massive. Nous avons formulé une hypothèse selon laquelle les patients soumis à une SL manuellement assistée (SLMA) pourraient bénéficier des avantages de la SL tout en subissant sans danger l'ablation de leur rate hypertrophiée.

Méthodes : Nous avons passé en revue les dossiers de patients qui ont subi une SLMA ou une SL entre janvier 2003 et juin 2008. Les paramètres évalués incluaient la morbidité et la mortalité durant l'intervention et le postopératoire immédiat, la conversion vers une chirurgie ouverte, le recours aux transfusions sanguines, la durée du séjour hospitalier postopératoire, les caractéristiques démographiques des patients, le diagnostic ayant mené à la splénectomie, le poids de la rate et le nombre de jours postopératoires avant reprise de l'alimentation normale. Les différences ont été analysées en tenant compte du poids de la rate et des diagnostics de cancer à l'aide d'analyses de régression linéaire multiple et logistique.

Résultats : En tout, 103 patients ont subi une splénectomie (23 SLMA et 80 SL). Les patients qui ont subi une SLMA étaient plus âgés, leur rate était plus hypertrophiée et ils étaient plus nombreux à présenter un diagnostic de cancer. Nous n'avons observé aucune différence significative sur le plan de la morbidité, de la conversion vers la chirurgie ouverte ou du recours aux transfusions. La durée moyenne du séjour postopératoire, la durée de la chirurgie et le nombre de jours avant la reprise d'une alimentation complète ont été plus longs dans le groupe soumis à la SLMA. Aucun patient n'est décédé. On n'a observé aucune différence significative entre les groupes après avoir tenu compte du poids des rates et du diagnostic de cancer.

Conclusion : La morbidité associée à la SLMA se compare à celle de la SL. La durée plus longue de la chirurgie et du séjour hospitalier chez les patients soumis à la SLMA a probablement été attribuable au poids plus élevé de la rate, à l'âge plus avancé des patients et à la proportion plus grande de diagnostics de cancer. La SL manuellement assistée est une solution de rechange viable à la chirurgie ouverte chez les patients souffrant de splénomégalie.

Since it was first described by Delaitre and Maignien,[1] laparoscopic splenectomy (LS) has been gaining popularity as the treatment of choice for different benign and malignant diseases.[2] Stemming from minimal abdominal wall trauma, LS has several advantages compared with the open technique. It hastens postsurgical recovery by reducing pain and improving pulmonary function, leading to diminished hospital stay and reduced disability.[3] In addition, it has a cosmetic advantage derived from the lack of a large, visible scar. The presence of splenomegaly, however, poses several technical obstacles for this minimally invasive procedure.

Initially cloaked with skepticism, the introduction of hand-assisted LS (HALS) has broadened the scope of LS to include cases of massive splenomegaly. With HALS, one of the surgical incisions is made wide enough to accommodate a special hand port allowing the surgeon's hand into the abdomen. The rest of the surgical incisions retain their same size as with conventional LS. Together with the laparoscopic instruments, having one of the surgeon's hands in the abdomen makes it possible to manipulate a large, heavy spleen, control its vessels and extract the specimen through the hand port incision.

Since the incision used for the hand port in HALS is only a few centimetres longer than the usual laparoscopic port incision, we hypothesized that patients who undergo HALS may experience the benefits of LS while having their enlarged spleens removed safely, potentially favouring a "conversion" to HALS as an alternative to classical open conversions when facing technical challenges related to the size of the spleen.

Methods

We reviewed the medical records of all the patients who underwent splenectomy using either LS or HALS at a tertiary care centre in Halifax, Nova Scotia, between Jan. 1, 2003, and June 30, 2008. Evaluated outcomes included intraoperative and early postoperative morbidity and mortality, conversion to open procedure, need for blood transfusion and length of postoperative hospital stay. Other measured parameters included patient demographic characteristics, body mass index (BMI), diagnosis leading to splenectomy, duration of surgery, estimated blood loss, splenic weight and number of postoperative days to resuming normal diet. The study protocol was approved by the hospital research ethics board.

Surgical technique

Conventional LS

The anterolateral approach was used for LS,[1] with some modifications. The patient was placed on a bean bag in a right lateral decubitus position at 60°, with the left arm supported and the legs kept together. The surgeon stood on the patient's right side, with the first assistant on the patient's left side and the camera assistant to the surgeon's left. The open Hasson technique was used to enter the peritoneal cavity and place the first port (12 mm), about 4–7 cm below the costal margin along the midclavicular line. Two 5-mm ports were then inserted under direct vision below the left subcostal margin. One was placed in the subxiphoid area and the other along the anterior axillary line (Fig. 1). A 5-mm 30° laparoscope was used for visualization. Dissection was performed using the Harmonic Scalpel (Ethicon Endo-Surgery). The splenocolic ligament was first divided along with inferior pole vessels. This was followed by dividing the gastrosplenic ligament

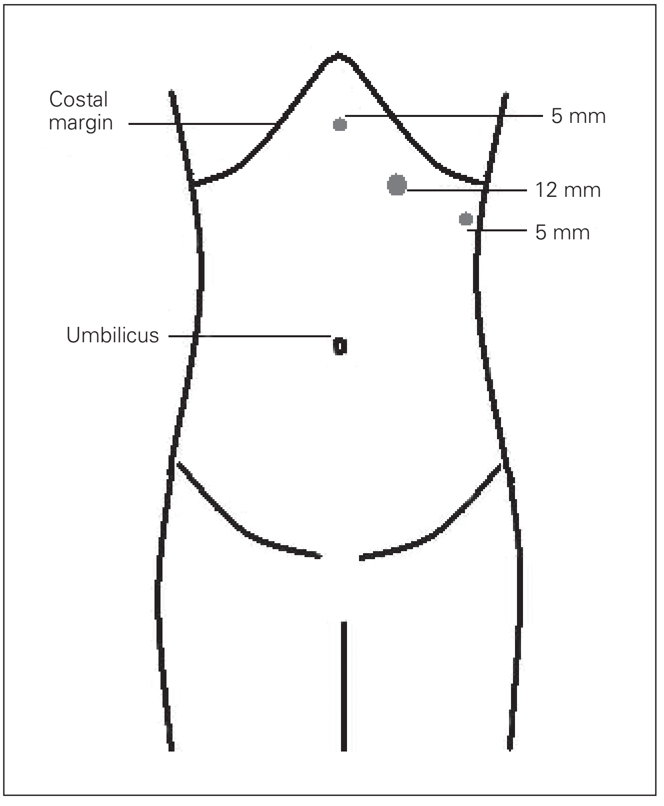

Fig. 1. Port location for laparoscopic splenectomy.

and short gastric vessels and then the splenorenal ligament. The splenic hilar vessels were divided using the vascular endostapler ATW45 (Ethicon Endo-Surgery) introduced through the 12-mm port. The superior and lateral phrenic attachments were also divided. The specimen was placed in a puncture-resistant LapSac pouch (Cook Medical, Inc.) introduced through the 12-mm port. The end of the closed pouch was brought out through the Hasson port incision, and the pneumoperitoneum was released. The spleen was morcellated within the bag using a pair of ring forceps and removed in large fragments through the Hasson port incision. In cases where the pathologist required an intact specimen, the 12-mm incision was enlarged to allow for the removal of the bag without the risk of tearing.

HALS

The HALS technique was used when an enlarged spleen was anticipated based on preoperative clinical examination. In the operating room, the patient was in the same position used for LS. A vertical 7–8 cm incision just cephalad to the umbilicus was used for primary abdominal access. The hand-assist device (GelPort laparoscopic system; Applied Medical) was fixed to this incision. A 10-mm port was passed through the GelPort into the abdomen, creating pneumoperitoneum. Then the laparoscope was inserted through the 10-mm port (via the GelPort) and used to visualize the insertion of 3 laparoscopic ports, as illustrated in Figure 2. The laparoscope was then shifted to the epigastric port. The surgeon introduced the left hand into the abdomen through the GelPort to manipulate and retract the enlarged spleen and other tissues in the operative field. The use of the GelPort device prevented loss of pneumoperitoneum during manipulation or hand removal. The Harmonic Scalpel was used to dissect the splenocolic ligament, divide the gastrosplenic ligament and short gastric vessels. The splenic artery was routinely identified along the superior border of the pancreas, and a metallic clip was used to ligate it and obstruct the blood flow to the spleen. Dissection then proceeded using the Harmonic Scalpel, following the same sequence described for LS. The specimen, which was larger in patients who underwent HALS, was placed in a 50 × 50 cm isolation bag (Medical Concepts Development), which was introduced and handled through the GelPort. The specimen was retrieved from the bag through the GelPort incision, usually divided into a few large pieces. When conversion to open surgery was needed, the hand port incision was extended in a cephalad direction to create an upper abdominal midline incision. A single surgeon (D.K.) performed all HALS procedures.

During all manipulations, caution was used to avoid spillage of splenic fragments into the abdomen from the retrieval bag. The surgeon thoroughly searched for accessory splenic tissue, which was excised when present. Drains were not placed except when the surgeon believed the pancreatic tail may have been taken with the specimen. The fascia at the hand-assist and Hasson port sites were closed using large absorbable sutures.

Statistical analysis

We analyzed and compared the differences between the HALS and LS groups using the Student *t* or Wilcoxon rank sum tests as appropriate for continuous variables and the χ^2 or Fisher exact tests as appropriate for binary variables. Log transformation was used for non-normally distributed variables. The statistically significant differences between the 2 groups were also evaluated while controlling for splenic weight and malignant diagnosis using multiple linear regression analysis. We considered results to be significant at $p < 0.05$.

Results

Patient demographic and basic clinical characteristics are summarized in Table 1. The HALS and LS groups were comparable in terms of sex (14 men in the HALS v. 35 in the LS group, $p = 0.15$) and BMI (mean 26.9 in the HALS v. 28.7 in the LS group, $p = 0.24$). The HALS group had significantly older patients than the LS group (mean age

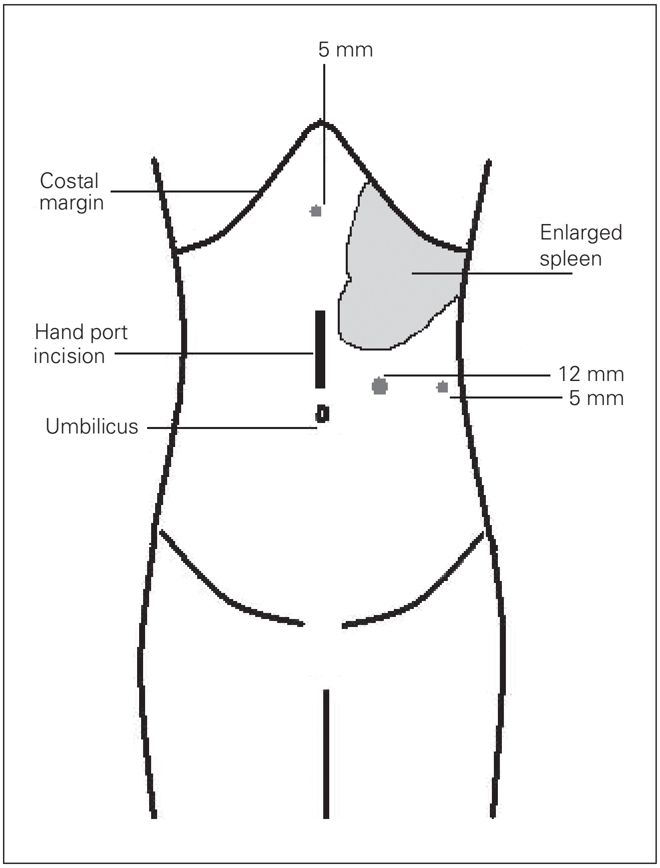

Fig. 2. Port location for hand-assisted laparoscopic splenectomy.

63.6 v. 53.2 yr, $p = 0.014$). The splenic weight was significantly greater in the HALS than the LS group (mean weight 2165.5 v. 209.2 g, $p < 0.001$). There were more patients with a malignant diagnosis in the HALS than the LS group (20 v. 16 patients, $p < 0.001$).

The diagnoses leading to splenectomy are listed in Table 2, and schematic presentations are provided in Figures 3 and 4. Chronic lymphocytic leukemia was the most common malignant diagnosis in both groups, constituting 50% and 69% of malignancies in the HALS and LS groups, respectively. Among the benign diagnoses leading to splenectomy, immune thrombocytopenic purpura was the most common in the LS group (80%) as well as being the most common overall indication for splenectomy in this group. In the HALS group, 3 patients had a benign cause for splenectomy, each with a different diagnosis.

Table 3 lists the intraoperative and early postoperative findings for both groups. There was no statistically significant difference between the HALS and LS groups in intra- or postoperative morbidity (8 v. 21 patients, $p = 0.42$), need for blood transfusion (4 v. 8 patients, $p = 0.46$) or conversion to open surgery (1 v. 0 patients, $p = 0.22$). The patient in the HALS group who had to be converted to open surgery had a firm, immobile spleen reaching down to the right iliac fossa and upper pelvis that was densely adherent to the left lobe of the liver.

The HALS group had significantly longer postoperative hospital stay (6.96 v. 3.46 d, $p < 0.001$), duration of surgery (171.9 v. 125.1 min, $p < 0.001$) and days to resuming full diet (3.5 v. 1.8 d, $p = 0.013$) than the LS group. Estimated blood loss was also greater in the HALS than the LS group (350.7 v. 84.4 mL, $p = 0.004$). No patients died. Complications observed in each group are listed in Table 4.

The statistically significant differences between the groups were recompared, controlling for splenic weight and malignant diagnosis using multivariate analysis. We found the differences in all these variables to be nonsignificant when controlling for splenic weight and malignant diagnosis (Table 5).

Discussion

Splenomegaly poses many technical challenges for LS. The size of the spleen occupies a much larger space in the

Table 1. Demographic and basic clinical characteristics of study participants

Characteristic	Group; mean (SD)* HALS, n = 23	LS, n = 80	p value
Age, yr	63.6 (14.2)	53.2 (18.3)	0.014
Male sex, no.	14	35	0.15
BMI	26.9 (4.8)	28.7 (6.8)	0.24
Splenic weight, g	2165.5 (1445.6)	209.2 (165.6)	< 0.001
Malignancy, no.	20	16	< 0.001

BMI = body mass index; HALS = hand-assisted laparoscopic splenectomy; LS = laparoscopic splenectomy; SD = standard deviation.
*Unless otherwise indicated.

Table 2. Diagnosis leading to splenectomy

Diagnosis	Group; no. (%) HALS, n = 23	LS, n = 80
Malignant	20 (87)	16 (20)
Chronic lymphocytic leukemia	10 (50)	11 (69)
Non-Hodgkin lymphoma	9 (45)	4 (25)
Hairy cell leukemia	1 (5)	1 (6)
Benign	3 (13)	64 (80)
Immune thrombocytopenic purpura	—	51 (80)
Thrombotic thrombocytopenic purpura	—	5 (8)
Pyruvate kinase deficiency	—	1 (2)
Autoimmune hemolytic anemia	—	3 (5)
Splenic cyst(s)	—	3 (5)
Hereditary spherocytosis	—	1 (2)
Splenomegaly	1 (33)	—
Systemic macrocystosis	1 (33)	—
Lymphoproliferative disorder	1 (33)	—

HALS = hand-assisted laparoscopic splenectomy; LS = laparoscopic splenectomy.

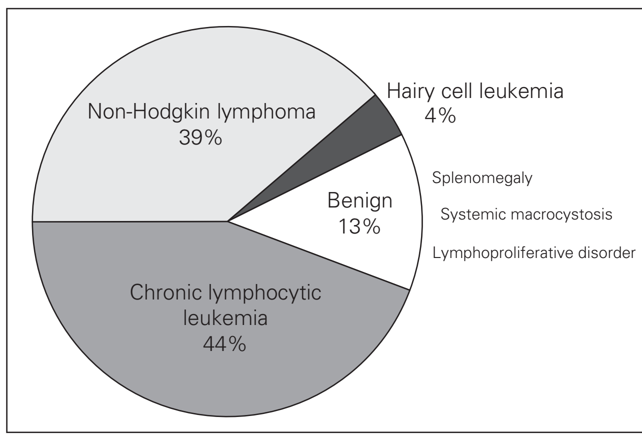

Fig. 3. Indications for splenectomy in the hand-assisted laparoscopic splenectomy group.

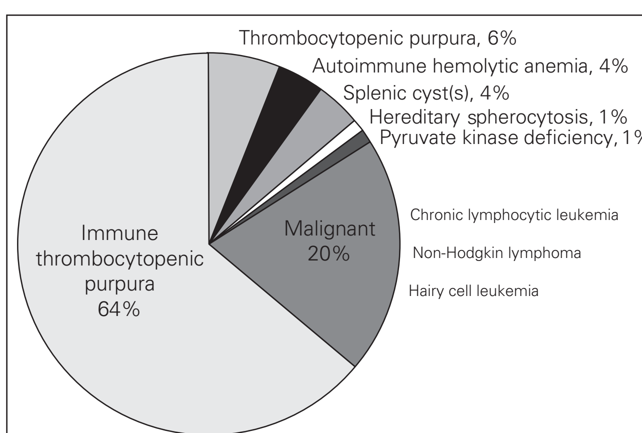

Fig. 4. Indications for splenectomy in the laparoscopic splenectomy group.

operative field while limiting the working space. There are often multiple dense adhesions around the enlarged spleen, which, together with the increased tissue vascularity, makes it challenging to safely expose, mobilize and manipulate the tissue. Moreover, steering a massively enlarged spleen into a retrieval bag can be difficult to perform laparoscopically. In addition, specimen removal from the abdomen may entail creating a larger incision. As such, the presence of splenomegaly might limit the application of the minimally invasive laparoscopic technique when performing a splenectomy.[2,4]

The HALS technique involves making a 7–8 cm mini-laparotomy incision that allows for the introduction of the surgeon's hand into the abdomen through commercially available hand port devices. These devices are designed to fit in the mini-laparotomy incision and help maintain the pneumoperitoneum while the surgeon's hand is in the abdomen, thus allowing the procedure to be performed laparoscopically. Hand-assisted laparoscopic techniques have been described for a variety of abdominal operations with variable acceptance.[5,6] For splenomegaly, the use of HALS directly addresses many of the aforementioned technical difficulties of LS. The HALS technique allows the surgeon's hands to manipulate the heavy-weighted spleen, enabling gentle retraction to obtain the required exposure. The hand can also be used to gain control of unexpected bleeding that might otherwise be difficult to adequately expose or control. Moreover, the massive spleen can be better maneuvered into the retrieval bag. The main drawback of HALS mentioned in the literature is that it requires an additional incision[6] for the placement of the hand port. However, in cases of splenomegaly, the hand port incision can be used to an advantage, facilitating the extraction of the large specimen from the abdomen. Other theoretical disadvantages of having the surgeon's hand in the abdomen include limiting the operative working space and predisposing to hand fatigue in long or complicated procedures.[6]

The feasibility of the HALS technique for cases of massive splenomegaly has been demonstrated in the literature.[7–10] Although LS has been shown to be feasible in cases of massive splenomegaly,[11] different studies have shown that the conventional laparoscopic approach in these patients is associated with a longer duration of surgery, increased blood loss, greater morbidity and a higher rate of conversion to open surgery.[12–15]

The definition of massive splenomegaly for the purpose of splenectomy varies. Targarona and colleagues[11] suggested that a palpable spleen tip below the costal margin indicates a massive spleen of 750–1000 g, or 3 times the normal size. Others used splenic weight to define splenomegaly, with weight thresholds varying between 500 and 1000 g.[4,14,16–18] In addition to splenic weight, Kercher and colleagues[19] used the craniocaudal length of the spleen (≥ 17 cm) on preoperative imaging to determine splenomegaly. As preoperative radiologic imaging of the spleen was not routinely performed in our patients, the threshold used in our study to consider the HALS was the presence of a palpable spleen tip 2 or more fingerbreadths below the costal margin on preoperative clinical examination. Using preoperative clinical abdominal examination solely to determine the presence of splenomegaly resulted in few

Table 3. Intraoperative and early postoperative characteristics of study participants

Characteristic	Group; mean (SD)* HALS, *n* = 23		Group; mean (SD)* LS, *n* = 80		*p* value
Duration of surgery, min	171.9	(53.8)	125.1	(49.3)	< 0.001
Blood transfusion, no. patients	4		8		0.46
Conversion to open surgery, no.	1		0		0.22
Complications, no.	8		21		0.42
Time to full diet, d	3.5	(2.7)	1.8	(3.0)	0.013
Postoperative hospital stay, d	6.9	(7.0)	3.5	(5.0)	< 0.001
Estimated blood loss, mL	350.7	(716.2)	84.4	(151.2)	0.001

HALS = hand-assisted laparoscopic splenectomy; LS = laparoscopic splenectomy; SD = standard deviation.
*Unless otherwise indicated.

Table 4. Type of intraoperative and early postoperative complications

Diagnosis	HALS	LS
Intraoperative		
Bleeding from splenic hilum	0	4
Bleeding (extrahilar)	2	5
Bowel injury	0	1
Postoperative		
Bleeding (intra-abdominal)	0	3
Portal vein thrombosis	4	2
Periorbital edema, conjunctivitis	0	1
Severe epiglottitis	0	1
Exacerbation of COPD	0	1
Clostridium difficile colitis	0	1
Pulmonary embolism	0	1
Cardiac arrhythmia	0	1
Pneumonia	1	0
Stroke	1	0

COPD = chronic obstructive pulmonary disease; HALS = hand-assisted laparoscopic splenectomy; LS = laparoscopic splenectomy.

Table 5. Comparison of univariate and multivariate analysis, controlling for splenic weight and malignant diagnosis

Characteristic	Univariate Difference* (SE)	Univariate *p* value	Multivariate Difference* (SE)	Multivariate *p* value
Duration of surgery	0.34 (0.08)	< 0.001	0.10 (0.13)	0.47
Estimated blood loss	1.00 (0.31)	0.001	0.39 (0.50)	0.44
Length of postoperative stay	0.84 (0.18)	< 0.001	0.35 (0.30)	0.24
Time to full diet	1.76 (0.70)	0.013	0.20 (1.12)	0.86

SE = standard error.
*Log-transformation used for non-normally distributed variables.

patients with splenomegaly undergoing LS. However, the mean splenic weight was significantly higher in the HALS group (Table 1). The indication for splenectomy in both groups followed that reported for such cases in the literature (Table 2).

The purpose of our study was to determine whether performing HALS for splenomegaly maintains the benefits of minimally invasive surgery by directly comparing the outcomes of HALS performed for splenomegaly to those of all conventional LS performed during the same period in the same centre by the same surgeon.

Our results demonstrate that HALS performed for splenomegaly has maintained the benefits of LS in the form of similar postoperative morbidity and mortality, rate of conversion to open surgery and need for blood transfusion. The significant differences in other variables that we observed in our univariate analysis could be a reflection of the dissimilarity of the 2 groups' basic clinical characteristics, particularly the presence of more patients with malignant diagnoses and larger spleens in the HALS group. To assess this possibility, we performed a multivariate analysis controlling for splenic weight and malignant diagnosis. The results of multivariate analysis showed that the differences in those variables were nonsignificant, confirming the contribution of splenic weight and malignancy to the observed difference seen in the univariate analysis (Table 5). In addition, patients in the HALS group were significantly older than those in the LS group, which might have contributed to the observed difference in some variables, such as the length of postoperative hospital stay.

Our results compare favourably with those of previous studies on HALS for splenomegaly,[4–8,16–18] demonstrating that this procedure is safe and feasible. In our experience, the theoretical downsides of the HALS technique did not limit its safe application, and we found that the advantages of this procedure in cases of massive splenomegaly outweighed its suggested drawbacks. In cases where conversion from LS to open surgery is needed because of technical difficulties related to a large spleen, our results raise the question of whether consideration should be given to convert to HALS rather than to the open technique, as our results demonstrate that the former preserves the benefits of minimally invasive surgery.

Conclusion

The morbidity associated with HALS is comparable to that with LS, as determined by the rates of postoperative complications, mortality and conversions to open surgery and the need for blood transfusion. The increased duration of surgery and length of postoperative stay in hospital in the HALS group are likely related to the increased splenic weights, patient age and proportion of patients with malignant diagnosis in this group. Hand-assisted LS should be considered a viable alternative to the open approach when facing technical challenges related to the laparoscopic removal of massive spleens.

Competing interests: None declared.

Contributors: Each author contributed to study design, data acquisition and analysis, article writing and review, and approved its publication.

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