Bipolar sealing devices versus endoscopic vascular staplers during laparoscopic splenectomy in children with benign hematological diseases

Hisham F. Salama, Mohammad G. Khirallah, Mohamed I. Elsawaf and Mahmoud A. ELafify

Background **Splenectomy, whether open or laparoscopic, is considered a step of management in many children with benign hematological diseases such as immune thrombocytopenia, thalassemia, autoimmune hemolytic anemia, and spherocytosis. The major challenge during laparoscopic splenectomy (LS) is the rich blood supply of the spleen. Many techniques were considered to control the vascular supply of the spleen. Staplers, clips, either titanium or hemoclips, a bipolar sealing device (BSD), or ultrasonic shears were all used to complete LS. We aimed to compare the results of using BSD versus endoscopic staplers for vascular control of the pedicle during LS.**

Patients and methods **The study was carried out on 30 children with benign hematological diseases who presented to the Pediatric Surgical Unit. They were grouped randomly into two groups: group A and group B. Group A included 15 patients who were subjected to LS in which BSD was used for vascular control, whereas group B included 15 patients subjected to LS in which endoscopic staplers were used for vascular control of the pedicle.**

Results **The mean age of the children in group A was 9.60 years, whereas the mean age of the children in group B was 10.40 years. In group A, the mean estimated amount of blood loss was 72.27 ml. However, this was 80.67 ml in group B. In group A, the mean operative time required was 39.00 min, whereas it was 56.27 min in group B. The indications for splenectomy were thalassemia in 15 cases (seven for group A and eight for group B), idiopathic thrombocytopenic purpura in 13 cases (seven for group A and six for group B), and spherocytosis in two cases (one for each group). The mean splenic size in group A was 10.43 cm, whereas it was 11.73 cm in group B.**

Conclusion **LS has evolved over the last decade because of the advancements of BSDs and endoscopic staplers. According to our data the use of LigaSure reduces the overall operative time, operative blood loss, and associated complications compared with the use of staplers.** ***Ann Pediatr Surg*** **14:66–71 © 2018 Annals of Pediatric Surgery.**

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Introduction

Splenectomy, especially in children, highlights the role of the spleen in the hematological disorders, particularly that of cellular sequestration and destruction and antibody production [1].

Laparoscopic splenectomy (LS) has increasingly been used for the removal of spleen in children. It was introduced more than two decades ago by Delaitre in France, Carrol in USA, and Pouline in Canada. Since then, many experiences have been reported and indications for surgery have been expanded to include both normal and large-sized spleens in nontraumatic conditions [2].

The critical challenge in LS is the rich vascular blood supply of the spleen. Thus, there are different techniques that have been used to control splenic vascular supply including staplers, clips, bipolar sealing device (BSD) (LigaSure), suture ligature, monopolar electric devices, and ultrasonic shears [3].

The laparoscopic approach has several advantages such as fewer traumatic effects, less postoperative pain, earlier hospital discharge, and superior esthetic [4].

The introduction of LS has led to a gradual decrease in the indications for open splenectomy; however, both procedures are still essential components of spleen surgery.

We aimed to compare BSD and endoscopic staplers during LS in children.

Patients and methods

After obtaining approval from the local ethical committee, this study was carried out on 30 children with benign hematological diseases in need of LS. Children were grouped randomly using the closed envelop method into two groups: group A and group B. The study was carried out during the period from August 2015 to April 2017.

Group A included 15 patients who were subjected to LS in which BSD (LigaSure) was used for vascular control of the pedicle, whereas group B included 15 patients who were subjected to LS in which endoscopic staplers were used for vascular control of the pedicle.

All patients underwent routine preoperative measures including full laboratory investigations and pelviabdominal ultrasound, and provided informed consent. Also, all children received Pneumococcal Vaccine Polyvalent, which is a vaccine against capsulated organisms. Patients in both groups were operated in the right lateral position with the body of the patient at 60° to the operating table. There was more extension at the waist of the patients. In cases with normal-sized spleens, we used three ports: a telescopic port 10 mm at the umbilicus and then two ports 5 mm first at the left midclavicular line just below the costal margin and the second at the epigastric region. In cases of splenomegaly, we used four ports. The telescopic port at the umbilicus was 10 mm, the second port at the midclavicular line was at the level of umbilicus, the third one was in the epigastric region midway between the xephoid process and the umbilicus, and the fourth one was in the epigastric region just below the xephoid process. After the creation of pneumoperitoneum and ports placement, exploration of the abdominal cavity was performed. Search for accessory spleens was performed in the greater omentum and at the hilar of the spleen. The procedure started with the entry into the lesser sac and then attacking the short gastric vessels using BSD (LigaSure).

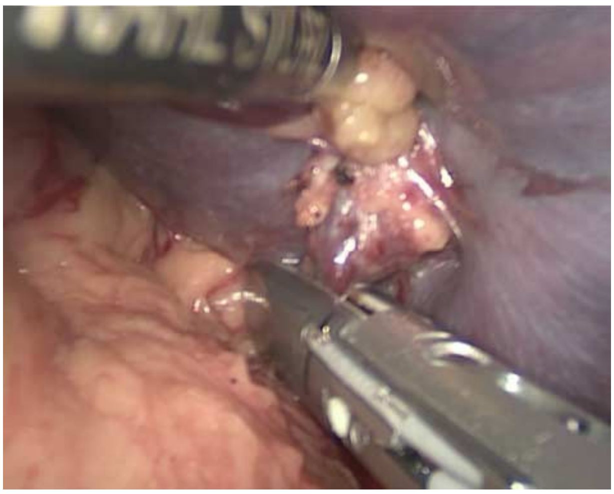
Dissection was then started at the hilum of the spleen to identify both the splenic artery and vein. Small vessels at the lower pole of the spleen were sealed and cut. At this stage, the splenic pedicle was secured by LigaSure in patients of group A (Figs 1 and 2).

In patients of group B, the pedicle was secured using an endoscopic stapler (Figs 3 and 4).

At this point in both groups, the spleen was still attached with the suspensory ligaments to the left kidney and splenic flexure of the colon and to the diaphragm. Dissection of the spleen from these ligaments was performed using BSDs (LigaSure). Delivery of small-sized spleens was performed within the retrieval bag at the umbilical port after moralization of the spleen was fragmented into small pieces and extracted. Extraction of the huge spleens was performed through a Pfannastiel incision. We inserted tube drains in all cases.

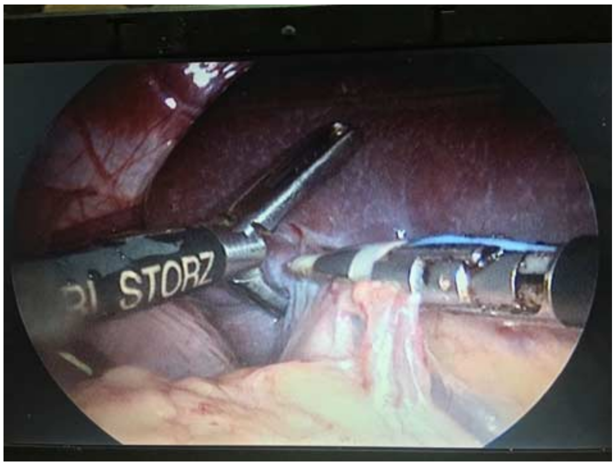
During the postoperative period, all patients received broad-spectrum antibiotics. Oral intake was initiated as

Fig. 1



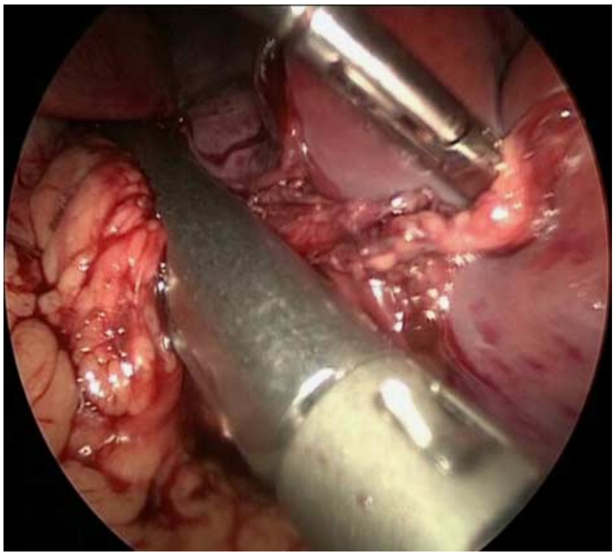
LigaSure sealing the pedicle.

Fig. 2



Ligasur sealing vessels at the lower pole of spleen.

Fig. 3



Stapling pedicle.

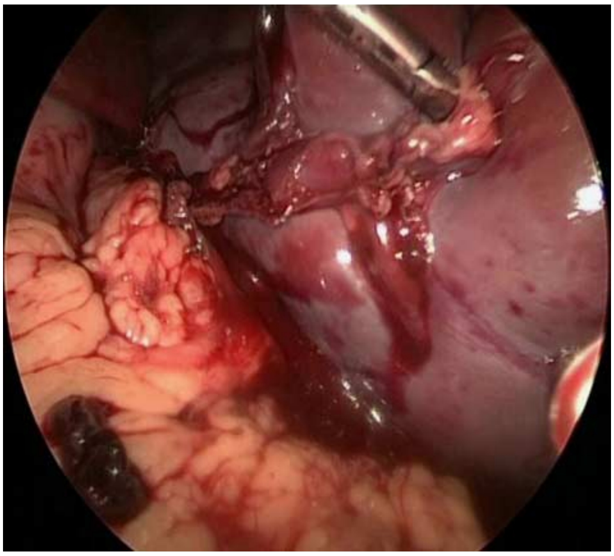
early as the patients could tolerate. Serum amylase and lipase were obtained in all cases to detect pancreatitis. Any complications that developed were documented.

Results

This study included 30 children with benign hematological disorders in need for LS. Children were categorized randomly into two groups according to the main method of pedicle control. Group A included 15 children who were subjected to LS in which a BSD (LigaSure) was used for vascular control of the pedicle. Group B included 15 children with benign hematological disorders subjected to LS in whom endoscopic vascular staplers were used for vascular control of the pedicle.

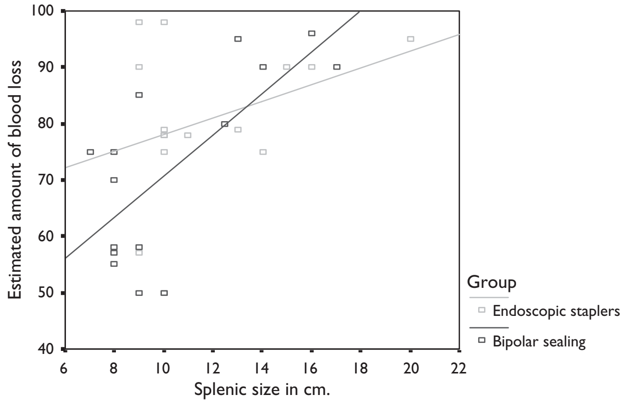
The mean age of the children in group A was 9.60 + 3.23 years, whereas in group B, the mean age was 10.40 + 3.04 years. There were 17 boys and 13 girls (group A

Fig. 4



Hilum after stapling.

Fig. 5



The relation between splenic size and the estimated amount of blood loss in both groups.

Table 1 Demographic and perioperative data

	All ($n = 30$)	Bipolar sealing ($n = 15$)	Endoscopic staplers ($n = 15$)
Age (years)			
Range	4–15	4–15	6–15
Mean ± SD	10 ± 0.7	9.60 ± 3.23	10.40 ± 3.04
Sex [*n* (%)]			
Males	17 (56.7)	9 (60)	8 (53.3)
Females	13 (43.3)	6 (40)	7 (46.7)
Splenic size (cm)			
Range	8–20	8–17	9–20
Mean ± SD	11.08 ± 4.95	10.43 ± 3.22	11.73 ± 3.21
Indications for splenectomy [*n* (%)]			
Spherocytosis	2 (6.7)	1 (6.7)	1 (6.7)
Thalassemia	15 (50)	7 (46.66)	8 (53.3)
ITP	13 (43.3)	7 (46.66)	6 (40)
Preoperative platelet count (×10^3)			
Range	80–250	80–250	88–230
Mean ± SD	140.4 ± 52.97	132.2 ± 56.63	148.6 ± 49.6

ITP, immune thrombocytopenia.

included nine males and six females, group B included eight males and seven females). The indications for splenectomy were thalassemia in 15 cases (seven for group A and eight for group B), 13 cases of idiopathic thrombocytopenic purpura (seven for group A and six for group B), and two cases of spherocytosis (one for each group). The mean splenic size in group A was 10.43 + 3.22 cm, whereas it was 11.73 + 3.21 cm in group B. Platelet count was determined as a routine preoperative investigation; in group A the mean platelet count was $132.2 \pm 56.63 \times 10^3/mm^3$, whereas it was $148.6 \pm 49.6 \times 10^3/mm^3$ in group B (Table 1).

In terms of operative data, the mean operative time in group A was 39.00 ± 8.27 min, whereas it was 56.27 ± 7.59 min in group B. The mean amount of estimated amount of blood loss in group A was 72.27 ± 16.65 ml. However, it was 80.67 ± 13.78 ml in group B. with no significant difference between both groups. There was no significant relation between the splenic size and both the operative time and the blood loss (Figs 5 and 6). Two cases in group A received blood transfusion, whereas in group B, three cases required blood transfusion. A total of 13 cases in group A tolerated oral intake 12 h postoperatively, whereas the remaining two cases tolerated oral intake within 24 h. In group B, 11 cases tolerated oral intake 12 h postoperatively, whereas four cases tolerated oral intake later over the next 24 h. Only one case in group A was converted to laparotomy (because of difficult control of the splenic pedicle), whereas no cases required conversion to laparotomy in group B.

The spleen was extracted through a Pfannenstiel incision in nine cases (four cases in group A and five cases in group B) and through retrieval bags in 21 cases (11 cases in group A and 10 cases in group B).

The duration of hospital stay ranged from 36 to 48 h; only one case in each group had a duration of hospital stay more than 48 h. Associated cholecystectomy was performed in only one case, which was in group A (Table 2).

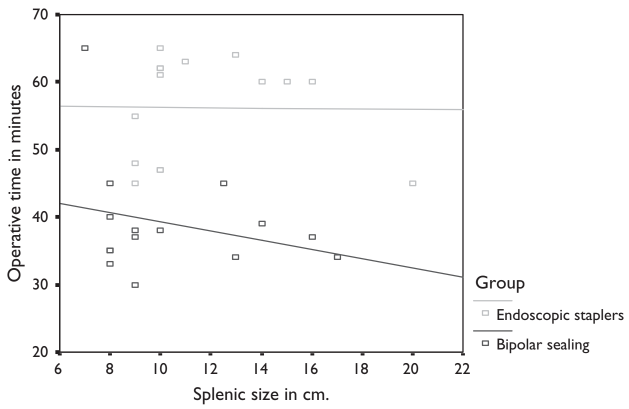
The mean lipase and amylase enzyme levels in group A were 50.33 + 22.84 and 35.80 + 21.65 U/l, respectively, whereas in group B, these were 45.66 + 20.17 and 41.66 + 19.10 U/l, respectively. The mean level of lactate dehydrogenase was 291.73 + 73.81 U/l in group A. In group B, it was 306.73 ± 109.14 U/l. The mean total leukocyte count in group A was $9.27 + 2.55 \times 10^3/mm^3$, whereas in group B, it was $9.609.60 + 2.41 \times 10^3/mm^3$, with no significant difference between both groups. In group A, no cases presented with subphrenic collection. However, only one case in group B presented with subphrenic collection (Table 3).

Discussion

Since the 1980s, minimally invasive surgical techniques have become popular in all surgical specialties and have gradually replaced conventional open surgery [5].

LS was first described in 1991 by Delaitre and Maignien; since then, many studies have shown that the advantages of the laparoscopic approach over open splenectomy include shorter hospital stay, lower blood loss, faster recovery, and better quality of life LS, and it has become the gold-standard approach for splenectomy in benign hematologic conditions, such as immune thrombocytopenia, thalassemia, and spherocytosis [6–8].

Fig. 6



The relation between splenic size and operative time in both groups.

The main concern related to LS is an increased risk of intraoperative bleeding because of both rich blood supply of that organ and sometimes technical difficulties in vascular control of splenic hilum, especially in cases of splenomegaly. There are several methods to achieve hemostasis and reduce blood loss, including clips, sutures, vascular staplers, and various energy devices, e.g. ultrasonic sealing as well as monopolar, bipolar coagulation, and BSDs [9,10].

Intraoperative bleeding is the main challenge and the leading cause for conversion during LS. The mean intraoperative blood loss reported in some series is high, between 138 and 524 ml, and the conversion rate ranges between 5 and 10% [11–13].

According to the study of Pugliese *et al.* [14], the estimated amount of blood loss was 160 ml and it was found that the amount increased with the increase in the size of the spleen. In cases of splenomegaly, Rosen *et al.* [15] reported

Table 2 **Operative data**

	All ($n=30$)	Bipolar sealing ($n=15$)	Endoscopic staplers ($n=15$)	*P* value
Estimated amount of blood loss				
Range	50–98	50–96	50–98	0.547
Mean ± SD	76.47 ± 15.61	72.27 ± 16.65	80.67 ± 13.78	
Operative time (min)				
Range	30–65	30–65	45–65	0.001*
Mean ± SD	47.63 ± 11.74	39.00 ± 8.27	56.27 ± 7.59	
Blood transfusion [*n* (%)]				
Received blood	5 (16.7)	2 (13.3)	3 (20)	0.458
Conversion to laparotomy [*n* (%)]				
Converted	1 (3.3)	1 (6.7)	0 (00.0)	0984
Mode of extraction [*n* (%)]				
Pfannenstiel	9 (30)	5 (33.33)	5 (33.33)	
Endobag	21 (70)	10 (66.66)	11 (73.33)	
Associated cholecystectomy [*n* (%)]				
Associated cholecystectomy	1	1	0	

Table 3 **Postoperative data**

	All ($n=30$)	Group A ($n=15$)	Group B ($n=15$)	*P* value
Lipase enzyme				
Range	14–150	14–100	20–150	0.457
Mean ± SD	70.3 ± 7.07	50.33 ± 22.84	45.66 ± 20.17	
Amylase enzyme				
Range	10–190	10–80	35–190	0.789
Mean ± SD	74.17 ± 10.6	35.80 ± 21.65	41.66 ± 19.10	
LDH				
Range	200–555	210–480	200–555	0.214
Mean ± SD	299.23 ± 91.86	291.73 ± 73.81	306.73 ± 109.14	
TLC ($\times 10^3$)				
Range	5–14	5–14	6–14	0.694
Mean ± SD	9.43 ± 2.44	9.27 ± 2.55	9.60 ± 2.41	
Subphrenic collection [*n* (%)]				
Collection	1 (3.3)	0 (00.0)	1 (6.7)	0.547
Postoperative platelet count ($\times 10^3$)				
Range	100–300	100–300	100–250	0.289
Mean ± SD	173.66 ± 53.40	172.66 ± 56.50	174.66 ± 52.08	
Oral intake [*n* (%)]				
12 h	24 (80)	13 (86.7)	11 (73.3)	0.478
24 h	6 (20)	2 (13.3)	4 (26.7)	
Hospital stay [*n* (%)]				
2 days	28 (93.3)	14 (93.3)	14 (93.3)	0.894
> 2 days	2 (6.7)	1 (6.7)	1 (6.7)	

LDH, lactate dehydrogenase; TLC, leukocytes count.

Table 4 **Review of different methods of controlling the pedicle of the spleen during laparoscopic splenectomy**

References	BSD	Stapler	Mean age	Mean operative time (min)	Mean blood loss ml	Conversion rate (%)
Current study ($n=30$)	15	15	9.6	39	72.27	0
			10.4	56.27	80.67	6
Khirallaha *et al.* [3] ($n=60$)	60	–	10.2	120	230	2
				85	125	Nil
				120	180	Nil
Aydin *et al.* [9] ($n=19$)	19	–	37	107	88	3
Misawa *et al.* [17] ($n=30$)	30	–	47	143	21.6	2
Machado *et al.* [18] ($n=12$)	12	–	28	126	70	Nil
Wang *et al.* [19] ($n=32$)	32	–	36	70	200	Nil
Romano *et al.* [20] ($n=74$)	74	–	32.8	137	257	5
Canda *et al.* [21] ($n=14$)	14	–	NA	84.7	NA	Nil
Barbarous *et al.* [22] ($n=29$)	29	–	35	71.3	85	1
Yuney *et al.* [23] ($n=10$)	10	–	36	93	60	Nil
Schaarschmidt *et al.* [24] ($n=23$)	23	–	9.8	86	No	Nil
Delaitre *et al.* [25] ($n=209$)	–	209	41	144	–	17.2
Brodsky *et al.* [26] ($n=100$)	–	100	51	170	181	5
Pomp *et al.* [27] ($n=131$)	–	131	45	170	–	6

BSD, bipolar sealing device.

an estimated blood loss of 376 ml and the amount increased with the use of the hand port for hand-assessed LS. Wang *et al.* [16], showed that the estimated blood loss in the laparoscopic approach was 350 ml. This amount increased to 550 ml with the use of the hand port.

In our study, the estimated amount of blood loss was 72.27 ± 16.65 ml in group A; however, it was 80.67 ± 13.78 ml in group B, with an insignificant difference between both groups. These differences in calculating the estimated amount of blood loss may be attributed to the fact that all our patients were children, whereas in other studies, there were many adult patients.

Another crucial factor that may play a role to reducing the overall estimated amount of blood loss is the use of BSDs during the entire procedure. In our study, this was associated with lower blood loss compared with cases where staplers were used (Table 4).

BSDs (LigaSure) can divide up to 7 mm diameter vessels safely, whereas the harmonic shears can only divide 3 mm diameter vessels [17].

Miles *et al.* [28], in their preliminary report of the use of endoscopic staplers, showed that they tend to shorten and facilitate hilar dissection compared with ligation or clipping.

However, stapling techniques for transecting the splenic pedicle require proper positioning of the device for the hilar vascular control and accurate hilar dissection with meticulous skeletonization to exclude extraneous tissues, positioning as close to the spleen as possible away from the tail of the pancreas. Prominent splenic vessels, perihilar fat, and relatively narrow jaw opening may lead to excess bleeding from the staple line. Moreover, the tail of the pancreas can be retained between the jaws of the stapler, causing pancreatic fistula or clinical pancreatitis [17,29].

In the same context, we found that the operative time was markedly reduced when LigaSure was used to control the pedicle compared with the use of the staplers.

Our results were close to those of Romano *et al.* [20], who reported that the use of LigaSure was safe, reducing blood loss, shortening the operative time, and resulting in lower costs than staplers.

However, we found no significant difference between both devices in terms of the amount of blood loss.

In this study, five cases needed blood transfusion (two cases in group A and three cases in group B); the need for transfusion was not related to the splenic size as only one patient with splenomegaly required blood transfusion in each group.

During the early postoperative period of the current study, we checked the levels of amylase and lipase in children of both groups to detect the effect of the hemostatic procedure on the nearby pancreas as the use of LigaSure or staplers required dissection of the pedicle close to the tail of the pancreas. Although there were no statistical differences between both groups, hyperlipasemia and hyperamylasemia were found in some patients of group B. However, frank pancreatitis did not develop in any of our patients.

Chand *et al.* [30], reported that the incidence of pancreatic injury during LS was 15% and this was characterized by isolated hyperamylasemia, peripanceatic fluid collections, and pancreatic abscess. This was mainly attributed to the use of stapling devices across the hilum during the procedure [30].

Conclusion

LS has evolved over the last decade because of the advances of BSDs and endoscopic staplers. According to our data, the use of LigaSure reduces the overall operative time, operative blood loss, and associated complications compared with the use of staplers.

Conflicts of interest

There are no conflicts of interest.

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