SCIENTIFIC PAPER JSLS

# Laparoscopic Splenectomy in Children

Faisal G. Qureshi, MD, Orkan Ergun, MD, Vlad C. Sandulache, BS, Evan P. Nadler, MD, Henri R. Ford, MD, David J. Hackam, MD, PhD, Timothy D. Kane, MD

## ABSTRACT

**Background:** Laparoscopic splenectomy is being performed more commonly in children, although its advantages are not clear. We sought to determine whether laparoscopic splenectomy was superior to open splenectomy.

**Methods:** The records of all pediatric patients undergoing splenectomy without significant comorbidities over a 12-year period were examined. The patients were divided into those undergoing laparoscopic splenectomy and those undergoing open splenectomy. Demographics, operative time, estimated blood loss, spleen size, length of stay, and total charges were compared between the groups.

**Results:** Eighty-one (58%) children underwent laparoscopic splenectomy, and 59 (42%) children underwent open splenectomy. The groups were similar in age and sex; hereditary spherocytosis was more common in the LS group. Operating time was longer in the laparoscopic splenectomy group (231±10 min vs 138±9 min; $P<0.001$), but blood loss and complication rates were similar. Twelve (15%) conversions were necessary primarily due to spleen size. Although children undergoing LS had a shorter length of stay (2.4±0.1 vs 4.1±0.3 days; $P<0.001$), they incurred higher charges ($21199±664 vs $15723±1737; $P<0.002$).

**Conclusion:** Laparoscopic splenectomy is a safe procedure in children, resulting in shorter hospital stay, which may translate into earlier return to activity and a smaller burden on the child's caretakers.

Division of Pediatric Surgery, Children's Hospital of Pittsburgh, University of Pittsburgh, Pennsylvania, USA (all authors).

The authors have no conflict of interest or financial support in the preparation of this manuscript.

Presented at IPEG's 13th Annual Congress for Endosurgery in Children, Maui, Hawaii, USA, May 5–8, 2004

Address reprint requests to: Timothy D. Kane, MD, Assistant Professor of Surgery, Children's Hospital of Pittsburgh, Division of Pediatric Surgery, 3705 5th Ave, Pittsburgh, PA 15213, USA. Telephone: 412 692 7282, Fax: 412 692 8299, E-mail: Timothy.Kane@chp.edu



**Key Words:** Laparoscopic splenectomy, Children, Hereditary spherocytosis.

## INTRODUCTION

Laparoscopic splenectomy has been adopted as a standard procedure for treatment of hemolytic disorders in children.[1] Shorter hospital stay, earlier resumption of bowel function, better cosmesis, and quicker return to normal activities have been the primary reasons for the increased popularity of the procedure.[2,3] The aim of the current study was to compare our experience with open splenectomy and laparoscopic splenectomy in children over a 12-year period and to determine the advantages and the efficiency of the laparoscopic splenectomy procedure.

## METHODS

After obtaining Internal Review Board approval, the medical records of all children who had undergone nonemergent splenectomies between 1991 and 2002 were reviewed retrospectively. Patients undergoing splenectomies for trauma, staging laparotomies, and transplantation surgery were excluded. The patients were then divided into those undergoing laparoscopic splenectomy (LS) and those undergoing open splenectomy (OS). Laparoscopic splenectomy was performed using 4 ports: a 10- or 12- mm port through the umbilicus; a 12-mm port in the left mid-axillary line through the rectus muscle inferior to the umbilicus; a 5-mm port in the sub-xiphoid area; and a fourth 5-mm port in the left lateral subcostal area (between the level of the sub-xiphoid and mid-axillary port). Small vessels and ligamentous attachments of the spleen were divided with Harmonic scalpel devices, electrocautery, or hemoclips. The splenic vein and artery were controlled and divided using endovascular stapling devices or hemoclip application, or both of these. Cholecystectomy was performed before splenectomy in all cases with or without the addition of 1 or 2 additional 5-mm ports in the right upper quadrant. Patients were positioned supine with the left side elevated to 30° with a towel roll. Rotating the bed to the left facilitated cholecystectomy in the usual manner when indicated. Extraction of the spleen was achieved by placing the detached spleen into an endobag intraabdominally followed by piecemeal extraction from the bag via a slightly enlarged umbilical incision (1.5 cm). The search for accessory spleens was performed laparoscopically, before splenectomy, by assessing the splenic hilum, gastrosplenic ligament, omentum, and pelvis.

Demographic features, indications for splenectomy, operative time, estimated blood loss, spleen size, complications, length of stay, and total charges (adjusted for 2002) were recorded. Data for children undergoing laparoscopic splenectomy (LS) were compared with those undergoing open splenectomy (OS) by using the Student *t* and chi-square tests; a *P* value of less than 0.05 was considered statistically significant.

## RESULTS

Between 1991 and 2002, 140 children underwent splenectomy at the Children's Hospital of Pittsburgh. The mean age of the patients at the time of surgery was 11.3±0.4 years. There were 75 males and 65 females. The average time between the establishment of the primary diagnosis and surgery was 7.3±0.4 years. The most common diagnoses included hereditary spherocytosis (n=71; 51.1%) followed by idiopathic thrombocytopenic purpura (ITP, n=37; 26.2%) **(Table 1)**. All patients received preoperative vaccination and perioperative antibiotic prophylaxis.

Laparoscopic splenectomy was performed in 81 (58%) children, and 59 (42%) children underwent open splenectomy. The demographic features were similar between the 2 groups; however, hereditary spherocytosis was more common in the LS group (69% vs. 31%; *P*=0.002) **(Table 2)**. Mean operative time was found to be significantly longer in the LS group (231 minutes v. 138 minutes in the OS group; *P*<0.001). Estimated blood loss was comparable between the 2 groups.

**Table 1.**
Diagnosis in 140 Children Undergoing Splenectomy

| Diagnosis | Number of patients | % |
|---|---|---|
| Spherocytosis | 72 | 51.4 |
| ITP | 37 | 26.4 |
| Splenic Cyst | 6 | 4.3 |
| Infarcted/Wandering Spleen | 5 | 3.6 |
| Sickle Cell Anemia | 4 | 2.9 |
| Others | 16 | 11.4 |
| Total | 140 | 100 |

Spleen weights were similar in the 2 groups (308±46 g in the LS v. 509±110g in the OS; *P*>0.05); however, there seemed to be a trend towards higher spleen weights in the OS group. Twelve (15%) conversions were necessary in the LS group. The spleen weights were found to be significantly higher (750±225 g; *P*<0.05) in children who were converted to an open procedure than in those completed laparoscopically. No difference existed in the conversion rates early or late in the series.

Accessory spleens were identified and removed in 18 patients in the series, with no significant difference between the LS and OS group (LS: 12 (15%) vs OS: 6 (10%). The ratio of the patients with gallbladder disease was 33% and 24% in the LS and OS groups, respectively; concomitant cholecystectomy was performed for these patients. Complications included a pneumothorax in one patient in the LS group that resolved spontaneously without any further intervention. In the OS group, 2 children developed recurrence of the primary hematologic disease. One child developed an intracerebral hemorrhage leading to death 18 days postoperatively. No mortalities occurred in the LS group.

Total length of stay was significantly shorter in the LS group (2.4 days vs 4.1 days in the OS group; *P*<0.001); however, total costs was significantly increased in the LS group ($21,199 v*s* $15,723 in the OS group; (*P*=0.002).

## DISCUSSION

Recent advances in minimally invasive technology have led to the increased use of laparoscopic techniques in the pediatric age group.[4] Advantages including less postoperative pain and thus reduced need for postoperative narcotics, earlier resumption of feedings and activity, shorter hospital stay, and better cosmesis have contributed to the wide acceptance and use of laparoscopy in children.[1,5–8] However, these advantages have historically been offset by the need for advanced technical skills, longer operating time, and increased costs.

The use of LS was first performed in 1992 at our institution but was not routinely used until 1996. Eighty-one splenectomies have been performed using this technique over a 6-year period. This is one of the larger series of splenectomies in children, although Grosfeld et al[4] have recently reported on 112 laparoscopic splenectomies. Hematologic diseases were the most common indication for splenectomies. Laparoscopic splenectomies were associated with significantly shorter length of stay as compared with length of stay for children undergoing open splenecto-

**Table 2.**
Comparison of Children Undergoing Laparoscopic and Open Splenectomy

| Demographic | Laparoscopic n = 81 | Open n = 59 | *P* |
|---|---|---|---|
| Age (yrs) | 11.6±0.5 | 10.9±0.6 | 0.40 |
| Male:Female | 38:43 | 37:22 | 0.06 |
| Duration of Diagnosis (yrs) | 8.0±0.6 | 6.4±0.6 | 0.12 |
| Hereditary Spherocytosis (%) | 69.4 | 30.6 | 0.002 |
| Spleen Weight (g) | 308±45 | 509±110 | 0.06 |
| Estimated Blood Loss (mL) | 60.7±8.3 | 75.9±14.1 | 0.32 |
| Operative Time (minutes) | 231±9.8 | 138±8.5 | 0.001 |
| Length of Stay (days) | 2.4±0.1 | 4.1±0.3 | 0.001 |
| Costs (USD) | 21199±664 | 15723±1737 | 0.002 |
| Concomitant Cholecystectomy (%) | 33 | 24 | 0.30 |
| Operative Time (splenectomy alone) | 201±1 | 122±8 | 0.001 |
| Costs (splenectomy alone) | 20944±980 | 15708±2346 | 0.04 |

mies. The mean operative time and total costs were higher in the LS group. Several groups have reported that the higher costs associated with LS have been offset by the shorter length of stay, reducing total costs when compared with costs for OS.[1,5,9,10] In addition, the operative time and costs have been shown to decrease after the first 20 cases in the learning curve of performing LS in children.[11,12] However, shorter hospital stay did not actually result in reduced hospital charges in the present series. As our data were not stratified for early and later cases in our series, it would not be appropriate to discern a definite conclusion concerning the affect of the learning curve on the operative time and total costs. However, earlier return to activity and school, shorter hospital stay, and much better cosmetic appearance were appreciated as granting a lesser burden on the child's caretakers and therefore contributed to our preference of the technique.

Our experience has revealed that smaller spleens were better managed by LS. Although no statistical justification of the statement exists, there seemed to be a relative preference for use of OS in larger spleens **(Table 1)**. This was supported by the fact that 15% of the patients required conversion to open surgery due to the size of the spleen; in these patients, spleens weighed more than 500 grams (750±225 g). The conversion rate was similar to that in other studies involving children.[2,10,13] Others have also shown that massive splenomegaly was associated with higher peri-operative morbidity and conversion rates.[12,14,15] Therefore, spleen weight seems to be a very important variable during the determination of the most appropriate operative technique.

The management of associated gallstones during LS is another advantageous aspect of the laparoscopic approach in children with hematologic disorders. The removal of gallbladders during an open splenectomy requires either extension of the left subcostal incision to the right hypochondrium or a midline incision, which is not favored in children. Because cholecystectomy may be performed concomitantly without requiring an additional port insertion, utilization of LS may be beneficial in the presence of gallstones in children. Forty-one splenectomies were associated with concomitant cholecystectomies in our series. Our 15% incidence of accessory spleens were in the range reported by other authors and were managed successfully.[10,12]

No difference existed in intra- and postoperative complication rates between the LS and OS groups. Two hematologic recurrences and 1 mortality occurred during the perioperative period in the OS group. No recurrences or deaths in the LS group were noted.

## CONCLUSION

LS was found to be a safe and efficient procedure in children. Our overall complication rate (<1%) was very low compared with that reported in other studies.[5,13] Our conversion rate of 15% was directly related to splenic size, where spleen size greater than 500 grams was associated with a greater likelihood of conversion to an open technique. Shorter hospital stays and earlier return to activity/school remain important advantages despite the increased hospital costs. A prospective trial would be required to directly compare hospital stay, operative time, and costs. However, as laparoscopic splenectomy has so readily been accepted as standard care in children, a randomized controlled study would be difficult to justify.

**References:**


1. Zitsman JL. Current concepts in minimal access surgery for children. *Pediatrics.* 111(6 Pt 1):1239–1252, 2003.

2. Friedman RL, Hiatt JR, Korman JL, Facklis K, Cymerman J, Phillips EH. Laparoscopic or open splenectomy for hematologic disease: which approach is superior? *J Am Coll Surg.* 1997; 185(1):49–54.

3. Brunt LM, Langer JC, Quasebarth MA, Whitman ED. Comparative analysis of laparoscopic versus open splenectomy. *Am J Surg.* 1996;172(5):596–599; discussion 599–601.

4. Rescorla FJ, Engum SA, West KW, Tres Scherer LR, 3rd, Rouse TM, Grosfeld JL. Laparoscopic splenectomy has become the gold standard in children. *Am Surg.* 2002;68(3):297–301; discussion 301–292.

5. Rescorla FJ, Breitfeld PP, West KW, Williams D, Engum SA, Grosfeld JL. A case controlled comparison of open and laparoscopic splenectomy in children. *Surgery.* 1998;124(4):670–675; discussion 675–676.

6. Cordera F, Long KH, Nagorney DM, et al. Open versus laparoscopic splenectomy for idiopathic thrombocytopenic purpura: clinical and economic analysis. *Surgery.* 2003;134(1):45–52.

7. Reddy VS, Phan HH, O'Neill JA et al. Laparoscopic versus open splenectomy in the pediatric population: a contemporary single-center experience. *Am Surg.* 2001;67(9):859–863; discussion 863–854.

8. Walsh RM, Heniford BT, Brody F, Ponsky J. The ascendance of laparoscopic splenectomy. *Am Surg.* 2001;67(1):48–53.

9. Janu PG, Rogers DA, Lobe TE. A comparison of laparoscopic and traditional open splenectomy in childhood. *J Pediatr Surg.* 1996;31(1):109–113; discussion 113–104.

10. Minkes RK, Lagzdins M, Langer JC. Laparoscopic versus open splenectomy in children. *J Pediatr Surg.* 2000;35(5):699–701.

11. Bagdasarian RW, Bolton JS, Bowen JC, Fuhrman GM, Richardson WS. Steep learning curve of laparoscopic splenectomy. *J Laparoendosc Adv Surg Tech A.* 2000;10(6):319–323.

12. Cusick RA, Waldhausen JH. The learning curve associated with pediatric laparoscopic splenectomy. *Am J Surg.* 2001;181(5):393–397.

13. Farah RA, Rogers ZR, Thompson WR, Hicks BA, Guzzetta PC, Buchanan GR. Comparison of laparoscopic and open splenectomy in children with hematologic disorders. *J Pediatr.* 131(1 Pt 1):41–46, 1997.

14. Patel AG, Parker JE, Wallwork B, et al. Massive splenomegaly is associated with significant morbidity after laparoscopic splenectomy. *Ann Surg.* 2003;238(2):235–240.

15. Kercher KW, Matthews BD, Walsh RM, Sing RF, Backus CL, Heniford BT. Laparoscopic splenectomy for massive splenomegaly. *Am J Surg.* 2002;183(2):192–196.