

# Laparoscopic Splenic Procedures in Children

## Experience in 231 Children

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**Objectives:** The purpose of this report is to evaluate the efficacy of and complications observed after laparoscopic splenic procedures in children.

**Methods:** Review of a prospective database at a single institution (1995–2006) identified 231 children (129 boys; 102 girls; average age 7.69 years) undergoing laparoscopic splenic procedures.

**Results:** Two hundred twenty-three children underwent laparoscopic splenectomy (211 total; 12 partial) by the lateral approach. Indication for splenectomy was hereditary spherocytosis (111), immune thrombocytopenic purpura (36), sickle cell disease (SCD) (51), and other (25). Four (2%) required conversion to an open procedure. Eight additional laparoscopic splenic procedures were performed: splenic cystectomy for epithelial (4) or traumatic (2) cyst, and splenopexy for wandering spleen (2). Average length of stay was 1.5 days. Complications (11% overall, 22% in SCD patients) included ileus (5), bleeding (4), acute chest syndrome (5), pneumonia (2), portal vein thrombosis (1), priapism (1), hemolytic uremic syndrome (1), diaphragm perforation (2), colonic injury (1), missed accessory spleen (1), trocar site hernia (1), subsequent total splenectomy after an initial partial (1), and recurrent cyst (1). Subsequent operations were open in 3 (colon repair, hernia, and missed accessory spleen) and laparoscopic in 2 (completion splenectomy, and cyst excision). There were no deaths, wound infections, or instances of pancreatitis.

**Conclusions:** Laparoscopic splenic procedures are safe and effective in children and are associated with low morbidity, higher complication rate in SCD, low conversion rate, zero mortality, and short length of stay. Laparoscopic splenectomy has become the procedure of choice for most children requiring a splenic procedure.

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Laparoscopic splenectomy (LS) was initially reported in adults by Delaitre and Maignien<sup>1</sup> in 1991 and subsequently in children by Tulman et al, in 1993.<sup>2</sup> The technique

has evolved over time influenced by the development of smaller instrumentation, advancements in technology and surgeon experience. The reported advantages of LS have included decreased pain medication use, shorter length of stay (LOS), decreased complications and improved cosmesis. Concerns have however been raised concerning missed accessory spleens, management of splenomegaly, and hemorrhage. In this series, the largest single institution series of laparoscopic splenic procedures in children, we evaluate prospective operative and perioperative data, review complications and describe lessons learned and the evolution of the surgical technique. This study was approved by the IUPUI/Clarian Institutional Review Committee.

### PATIENTS AND METHODS

From August 1995 to November 2006, 231 children underwent a laparoscopic splenic procedure at our institution. Two hundred eleven children underwent total splenectomy, 12 partial splenectomy, 6 splenic cystectomy, and 2 splenopexy for wandering spleen. The demographics are listed in Table 1. Patients with hereditary spherocytosis (HS) were managed medically until at least 4 to 6 years of age unless they developed severe aplastic crisis requiring transfusion. Most children with idiopathic thrombocytopenic purpura (ITP) do not require splenectomy; however, if they were dependent on medical management with steroids for over 6 months, they were considered for splenectomy. Children with sickle cell disease (SCD) required splenectomy for sequestration of red cells or platelets and were a slightly younger subset of patients (mean age 5.5 years). Children with SCD were prepared for surgery with simple transfusions to bring the hemoglobin level to at least 10 g/dL. The patients listed under other in Table 1 included thalassemia, autoimmune hemolytic disorder, leukemia, and myeloproliferative disorders.

Partial splenectomy has been popularized for preservation of splenic function in young children with HS.<sup>3,4</sup> The median age of our patients undergoing partial splenectomy was 6 years. Eleven partials were for HS and 1 for splenomegaly of unknown cause. Splenic cysts were detected in evaluation of abdominal pain or in follow-up of a splenic injury. Both children with wandering spleens presented with abdominal pain and an abdominal mass and the diagnosis confirmed by ultrasound and computed tomography.

Children with hemolytic disorders underwent preoperative ultrasound to evaluate for cholelithiasis, and if present, underwent concomitant cholecystectomy. Preoperative vac-

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**TABLE 1.** Preoperative Clinical Characteristics

|                          |                |
|--------------------------|----------------|
| Sex, male/female         | 129/102        |
| Mean age (range)         | 7.69 (0.75–19) |
| Hematologic condition    |                |
| Hereditary spherocytosis | 111            |
| ITP                      | 36             |
| Sickle cell anemia       | 51             |
| Other                    | 25             |
| Splenic cyst             |                |
| Epithelial               | 4              |
| Traumatic                | 2              |
| Wandering spleen         | 2              |

cination included pneumococcal, *Haemophilus influenza*, and meningococcal and children with ITP received preoperative steroids or intravenous immunoglobulin to achieve a preoperative platelet count over 50,000 mm.<sup>3</sup>

## Surgical Approach

### Splenectomy

LS was performed by a lateral approach with the left side of the patient elevated 30 to 45 degrees and a small roll under the right flank. (Fig. 1) The operating room table was tilted to the patients left for trocar placement and then to the right to achieve a right lateral decubitus position. In our early experience, we placed a midline supraumbilical (5 mm) port, umbilical (15 mm), left lower quadrant (12 mm), and left posterior flank (5 mm) with the midline and posterior trocars used for splenic elevation and traction on other structures. This was soon modified to our current method with 2 midline

supraumbilical openings to allow the first assistant to elevate the spleen with one instrument and provide traction on other structures with the other. The surgeon holds the camera with the left hand and the active instruments (clip applier, scissors, and energy device) with the right hand. A 5 mm, 30-degree angled telescope is placed through the umbilical opening. The method of division of the ligaments, short gastric vessels, and hilar vessels has evolved as newer technology has been introduced. Initially ligaments were divided with cautery, short gastric vessels with clips and the hilar vessels either with clips or an Endo GIA stapler 30 to 2.5 mm (United States Surgical Corp, Norwalk, CT). With the introduction of the Ultracision Harmonic Scalpel (Ethicon Endosurgery, Inc, Cincinnati, OH) in the mid 1990s, the ligaments, short gastric, and in small children, the polar or segmental vessels could be divided by the same device thus allowing the surgeon to keep the right hand in the abdomen for nearly the entire procedure. With the introduction of the LigaSure (Valleylab, Tyco Healthcare Group, Boulder, CO) even larger hilar vessels can be safely divided. These instruments also allowed us to downsize the left lower quadrant trocar to a 5 mm size. Smaller instruments also have allowed the midline trocar to decrease to a 3 mm size for smaller children and in most of these, because the instruments are not removed during the procedure, they are placed through a small incision without the use of a trocar.

The stepwise approach of splenectomy includes division of the splenocolic ligament with minimal colonic mobilization, short gastric division, and division of the splenophrenic ligament. The lower pole segmental vessels are divided with the LigaSure or Harmonic Scalpel, usually with

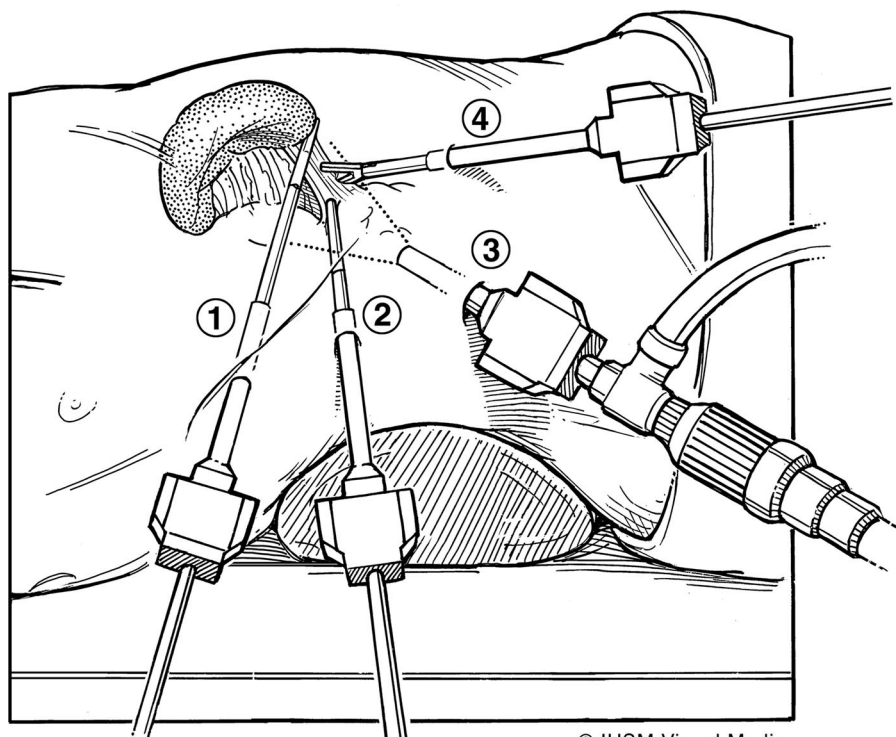


**FIGURE 1.** Patient position and trocar location. Ports 1 and 2, 3 to 5 mm for spleen elevation and retraction of adjacent structures; port 3, 15 mm for telescope, stapling device, and Endo Catch II device; and port 4, 5 mm for Harmonic scalpel, LigaSure, clip applier, and telescope.

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one treatment application proximally without vessel division and another distally with vessel division. The remaining vessels are usually divided in a similar fashion; however, occasionally if a large artery or vein is very close to the hilum, the Endo GIA stapling device is used. In this situation, the splenorenal ligament is divided before vessel division to allow complete splenic elevation with a posterior space for the stapling device. The telescope is placed in the left lower quadrant site to allow use of the stapler and the 15 mm specimen pouch (Endo Catch II, United States Surgical Corp) through the umbilical site. A systematic search for accessory spleens is performed before completion of the procedure. After the spleen is placed in the retrieval pouch a finger and ring forceps removes the spleen fragments. If a cholecystectomy is performed, one of the midline trocars is redirected to the right upper quadrant and an additional trocar placed low on the right side for retraction of the dome of the gallbladder.

### Partial Splenectomy

Partial splenectomy usually involves preservation of the most superior segmental vessel along with the superior portion of the splenophrenic and splenorenal ligaments. The other vessels are divided in the standard fashion with the LigaSure or Harmonic scalpel. A clear demarcation between viable and devitalized spleen usually exists at this point, with the goal to preserve approximately 15% of the original splenic volume. The parenchyma in our experience is divided 1 cm inferior to the demarcation line thus dividing devitalized spleen. We have used both the Harmonic scalpel and LigaSure for this portion of the procedure. Cautery is frequently needed on the splenic surface. The omentum is placed over the cut surface at the end of the procedure.

### Splenic Cystectomy

Epithelial and traumatic cysts are excised using either the Harmonic scalpel or LigaSure usually excising a small rim of normal spleen with the edge of the cyst. The base of the cyst is then treated with cautery. Inadequate excision in which the spleen-cyst edges are allowed to oppose can lead to cyst recurrence.

### Wandering Spleen

The laparoscopic approach included an umbilical, upper midline, and left lower quadrant trocars. The spleen was mobilized into the left upper quadrant and detorsed. Two square sheets of Vicryl mesh were sutured together on 3 sides and the mesh bag was then rolled tightly together and placed into the abdominal cavity. The spleen was placed in the bag with the open end of the bag towards the hilum. Clips were used to close the edges of the open end of the bag superior and inferior to the hilar vessels. The bag was then secured to the diaphragm with metal clips.

## RESULTS

Two hundred thirty-one laparoscopic splenic procedures were performed (Table 2). Four (1.7%) required conversion to open for splenomegaly in 2, bleeding in 1, and adhesions related to a ventriculoperitoneal shunt in 1. Con-

**TABLE 2.** Procedure and Perioperative Data

|                                     |              |
|-------------------------------------|--------------|
| Procedures                          |              |
| Total splenectomy                   | 211          |
| Partial splenectomy                 | 12           |
| Splenic cystectomy                  | 6            |
| Splenopexy                          | 2            |
| Conversion to open                  | 4 (1.7)      |
| Concomitant cholecystectomy         | 39           |
| Accessory spleen (splenectomy)      | 43 (19%)     |
| Operative time mean and range (min) |              |
| LS                                  | 98 (37–240)  |
| LSC                                 | 155 (80–675) |
| Lap partial                         | 113 (90–200) |
| Length of stay (days, mean)         |              |
| Hereditary spherocytosis            | 1.23         |
| ITP                                 | 1.20         |
| Sickle cell disease                 | 2.37         |

LSC indicates laparoscopic splenectomy and cholecystectomy.

comitant cholecystectomy was performed in 39 children with cholelithiasis and HS, SCD, or other hemolytic anemias. Thirty-six of the 39 were in children with HS for a cholecystectomy rate in this subset of 33%. In children with HS 10 years of age or older the rate of cholelithiasis was 56% compared with a rate of 27% for those less than 10 years of age ( $P = 0.0197$ ). One hundred sixty-two patients (70%) were released on postoperative day number 1. To evaluate different eras reflective of surgeon's increased experience and technologic advances we compared our first 50 laparoscopic total splenectomies (without cholecystectomy) with the most recent 50. This compared the time period from August 1995 to February 1998 to the later period of October 2003 to November 2006. During this time the operative time decreased from a mean of  $110 \pm 36$  minutes to  $86 \pm 35$  minutes ( $P = 0.0014$ ). The LOS was a mean of 1.54 in the early period and 1.7 in the later period ( $P = 0.79$ ). This was primarily due to the increased number of sickle cell children in the later group (19 vs. 9). In evaluating LOS between the early and the later group by diagnosis it was HS, 1.4 versus 1.1 ( $P = 0.07$ ); ITP, 1.0 versus 1.4 ( $P = 0.36$ ); and sickle cell 2.55 versus 2.6 ( $P = 0.92$ ).

The perioperative and technical complications are listed in Table 3. The overall complication rate was 11%; however, it was 22% among the children with SCD and 8.3% among those with other conditions ( $P = 0.0083$ ). There were no wound infections, instances of pancreatitis, or deaths. Both diaphragm injuries were immediately noted and repaired laparoscopically. Subsequent procedures were open in 3 (colon repair, hernia, and missed accessory spleen) and laparoscopic in 2 (completion splenectomy and cystectomy). The 1 partial splenectomy patient that required a completion splenectomy was a 12-year-old boy with splenomegaly of unknown etiology. A partial splenectomy was performed for abdominal pain and to allow contact sports. Unfortunately splenomegaly recurred and a completion LS was performed. One other child with a partial splenectomy developed symptomatic cholelithiasis and underwent a laparoscopic chole-

**TABLE 3.** Complications

|                                 |   |
|---------------------------------|---|
| Ileus                           | 5 |
| Bleeding requiring transfusion  | 4 |
| Acute chest syndrome            | 5 |
| Pneumonia                       | 2 |
| Portal vein thrombosis          | 1 |
| Priapism                        | 1 |
| Hemolytic uremic syndrome       | 1 |
| Diaphragm perforation           | 2 |
| Colonic injury                  | 1 |
| Missed accessory spleen         | 1 |
| Recurrent cyst                  | 1 |
| Trocar site hernia              | 1 |
| Total splenectomy after partial | 1 |

cystectomy 1 year after the original procedure. Both children with laparoscopic splenopexies had follow-up ultrasound examinations at 1 year demonstrating the spleen in the left upper quadrant.

## DISCUSSION

Since the initial reports in 1991<sup>1</sup> and 1993,<sup>2</sup> LS has rapidly evolved into the technique of choice compared with open splenectomy (OS) in both children and adults. The advantages of LS have included decreased use of pain medication, shorter LOS, and improved cosmesis. Disadvantages include longer operative time and increased operative cost. Splenic trauma remains an exception and in some cases of splenomegaly, alternative techniques such as a hand-assisted procedure may allow preservation of some of the advantages of the laparoscopic technique. Concerns have been raised about the adequacy of accessory spleen detection<sup>5,6</sup> and the ability to complete the procedure in cases of splenomegaly.<sup>7</sup>

A prior comparison study from our group demonstrated a 50% reduction in postoperative narcotic pain requirement with the laparoscopic versus open procedure along with a shorter LOS (1.4 vs. 2.5 days).<sup>8</sup> The operative time was longer with LS compared with OS and this is consistent with other series.<sup>9</sup> In the current series the operative time decreased from the first 50 LS to the last 50 procedures with the later mean operative time (86 minutes) longer but close to the 83 minutes with OS.<sup>8</sup> With the short LOS, these patients are brought into the hospital on a 23-hour stay basis and managed on a ward with the anticipation of discharge for the following morning.

Splenomegaly has been one cause for concern in adults with reports of a higher failure rate in these cases.<sup>7</sup> Park et al<sup>10</sup> in the largest adult series were able to laparoscopically excise all spleens less than 25 cm and failed in all greater than 30 cm. Children with HS have splenomegaly; however, these spleens do not usually achieve the giant size of adults with myeloproliferative disorders although the splenic size relative to the patient size is high with many of these children. Although we did not routinely evaluate splenic size in our series the largest spleen that we measured preoperatively was 22 cm in length. In addition, one of our conversions to open was due to splenomegaly. Adult series have demonstrated that pa-

tients with splenomegaly benefit from the laparoscopic procedure in terms of LOS, blood loss, and complications.<sup>11</sup> Although the use of hand-assisted procedures has been popularized in these cases<sup>12–14</sup> we have not found it necessary in children.

The detection of accessory spleens with the laparoscopic technique has been a concern of several authors.<sup>5,6</sup> Most series have noted comparable accessory spleen detection rates between LS and OS, including our initial study.<sup>8</sup> The 19% rate in our series is similar to other series<sup>10</sup> although we did miss 1 accessory spleen in a patient with autoimmune hemolytic anemia who had undergone a previous laparotomy. Winslow and Brunt<sup>9</sup> in a review of 51 series noted an 11% accessory spleen rate in both OS and LS.

A meta-analysis involving 2119 LS patients and 821 OS patients noted longer operative time with LS compared with OS but shorter LOS with the laparoscopic technique.<sup>9</sup> In addition the complication rate was 15.5% for LS compared with 26.6% for OS. The laparoscopic patients had fewer pulmonary, wound, or infectious complications, however, had more hemorrhagic complications when including patients converted from LS to OS. Our series identified children with sickle cell anemia as a subgroup with a higher complication rate and as a result a longer LOS.

The role of partial splenectomy is controversial with the procedure adopted at few institutions in the United States. The procedure involving preservation of 15% to 25% of the original splenic volume has been used in younger patients with HS in an attempt to preserve splenic function. Regrowth of the spleen has been noted in most series although this has not usually been of clinical significance.<sup>3,4</sup> A recent report advocated a near total splenectomy leaving 10 cm<sup>3</sup> as a cylindrical remnant.<sup>15</sup> Continued hemolysis can lead to symptomatic gallstones<sup>3</sup> as noted in one of our patients.

Wandering spleen is an unusual condition often presenting with volvulus. In cases in which it is identified without splenic compromise, splenopexy is the preferred procedure.<sup>16</sup> Various techniques have been reported with some authors advocating laparoscopic retroperitoneal splenopexy.<sup>17,18</sup> Our technique is dependent upon the development of adhesions between the spleen and the left upper quadrant as the mesh absorbs.

Laparoscopic splenic procedures by the lateral approach are effective and safe in children for hematologic and other disorders. Refinement of the techniques through surgeon experience and advancement in instrumentation and technology has allowed splenic procedures to be performed laparoscopically with a short LOS and a reasonable rate of complications.

## REFERENCES

1. Delaitre B, Maignien B. Splenectomy by the coelioscopic approach: report of case. *Presse Med.* 1991;20:2263.
2. Tulman S, Holcomb GW, Karamanoukian HL, et al. Laparoscopic splenectomy. *J Pediatr Surg.* 1993;28:689–692.
3. Rice HE, Oldham KT, Hillery CA, et al. Clinical and hematologic benefits of partial splenectomy for congenital hemolytic anemias in children. *Ann Surg.* 2003;237:281–288.
4. Bader-Meunier B, Gauthier F, Archambaud F, et al. Long-term evaluation of the beneficial effect of subtotal splenectomy for management of hereditary spherocytosis. *Blood.* 2001;97:399–403.

5. Targarona EM, Espert JJ, Balagué C, et al. Residual splenic functions after laparoscopic splenectomy: a clinical concern. *Arch Surg.* 1998;133: 56–60.
6. Gigot JF, Jamar F, Ferrant A, et al. Inadequate detection of accessory spleens and splenosis with laparoscopic splenectomy: a shortcoming of the laparoscopic approach in hematologic diseases. *Surg Endosc.* 1998; 12:101–106.
7. Kathkouda N, Hurtwitz MB, Rivera RT, et al. Laparoscopic splenectomy. Outcome and efficacy in 103 consecutive cases. *Ann Surg.* 1998;228:568–578.
8. Rescorla DJ, Breitfeld PP, West KW, et al. A case controlled comparison of open and laparoscopic splenectomy in children. *Surgery.* 1998; 124:670–676.
9. Winslow ER, Brunt LM. Perioperative outcomes of laparoscopic versus open splenectomy: a meta-analysis with an emphasis on complications. *Surgery.* 2003;134:647–653.
10. Park AE, Birgisson G, Mastrangelo MJ, et al. Laparoscopic splenectomy: outcomes and lessons learned from over 200 cases. *Surgery.* 2000;128:660–666.
11. Park A, Marcaccio M, Sternbach M, et al. Laparoscopic versus open splenectomy. *Arch Surg.* 1999;134:1263–1269.
12. Kusminsky RE, Boland JP, Tiley EH, et al. Hand-assisted laparoscopic splenectomy. *Surg Laparosc Endosc.* 1995;5:463–467.
13. Greene AK, Hodin RA. Laparoscopic splenectomy for massive splenomegaly using a Lahey bag. *Am J Surg.* 2001;181:543–546.
14. Grahn SW, Alvarez J III, Kirkwood K. Trends in laparoscopic splenectomy for massive splenomegaly. *Arch Surg.* 2006;141:755–761.
15. Stoehr GA, Stauffer UG, Eber SW. Near-total splenectomy: a new technique for the management of hereditary spherocytosis. *Ann Surg.* 2005;241:40–47.
16. Hirose R, Kitano S, Bando T, et al. Laparoscopic splenopexy for pediatric wandering spleen. *J Pediatr Surg.* 1998;33:1571–1573.
17. Hedeshian MH, Hirsh MP, Danielson PD. Laparoscopic splenopexy of a pediatric wandering spleen by creation of a retroperitoneal pocket. *J Laparoendosc Adv Surg Tech.* 2005;15:670–672.
18. Martínez-Ferro M, Elmo G, Laje P. Laparoscopic pocket splenopexy for wandering spleen: a case report. *J Pediatr Surg.* 2005;40:882–884.

## Discussions

DR. GEORGE W. HOLCOMB, III (KANSAS CITY, MISSOURI): I would like to ask a few questions. First, I noticed that 1 patient developed portal vein thrombosis, and I was interested in how you follow patients following laparoscopic splenectomy for this complication. I noticed a number of my patients have a marked thrombocytosis, up to 1 million, and have been concerned about splenic vein thrombosis. It has been my own practice to put these patients on a baby aspirin once the platelet count reaches 500,000. However, my hematology colleagues have told me that this is unnecessary. Therefore, due to your large breadth of experience, I would like to ask how you follow the platelet count and, if so, do you use any prophylaxis for thrombocytosis?

Second, I noticed that there were 2 patients with diaphragmatic perforation. I assume that this complication occurs with dissecting under the spleen and, inadvertently, the diaphragm is lacerated with one of the energy devices. Is this correct and how do you teach your Fellows to prevent this problem?

I generally perform laparoscopic total splenectomy for patients with spherocytosis and would like your thoughts about partial splenectomy for this disease. I noticed that 12

patients have undergone laparoscopic partial splenectomy, and 11 were for hereditary spherocytosis. With this large experience, do you think that partial splenectomy is a reasonable option for patients with spherocytosis and very large spleens?

Fourth, I would like to ask you to comment on how large is too large for a laparoscopic splenectomy. In other words, do you measure the spleens routinely preoperatively and what linear length do you feel is too large for an attempted laparoscopic splenectomy in a child?

Also, do you do anything to reduce the size of the spleen such as occluding the artery preoperatively by using interventional radiology for large spleens or ligating the artery early in the course of the dissection?

DR. FREDERICK J. RESCORLA (INDIANAPOLIS, INDIANA): We do not routinely image patients for the development of portal vein thrombosis. Our 1 child with this complication developed abdominal pain out of proportion with the usual postoperative state and imaging confirmed the diagnosis. Our hematologists have also discouraged us from administering prophylactic aspirin for thrombocytosis. Splenic vein and portal vein thrombosis has been a risk after this procedure related to splenomegaly, thrombocytosis and myeloproliferative disorders, and I suspect that we may be under recognizing this complication.

To avoid a diaphragm injury I try to make sure that we have a clear plane at the top of the spleen when dividing the splenophrenic ligament as well as the superior portion of the splenorenal ligament and that we do not let the energy device touch the diaphragm.

I think partial splenectomy has a role in younger children with hereditary spherocytosis, primarily in children under 5 or 6 years of age.

The largest spleen that we are aware of in our series was 22 cm in length. However, we did experience 2 conversions related to this problem. In general, I would use 25 cm or less as the limit to attempt a laparoscopic splenectomy. If it was over 25 cm I would consider a hand-assisted procedure.

We have not utilized splenic artery embolization or any of the other techniques to splenic blood flow and decrease the size of the spleen preoperatively.

DR. ROBERT J. TOULOUKIAN (NEW HAVEN, CONNECTICUT): I would like to limit my discussion to a subset of your patients. First, the group of patients with sickle cell disease, which you have identified as being the most challenging and having the highest risk of complication.

For this group of patients, I think we need to employ some special management both in the preoperative and the postoperative period to reduce complications, and I will ask you a little bit more about management of their transfusion requirements. I think that evidence would show that with

hypertransfusion we can reduce the circulating sickle cell population significantly enough so the incidence of acute chest crisis and severe pain in some of these patients may be limited.

We have also found that sickle cell patients require special postoperative pain control and tend to stay in the hospital a little bit longer. We have found that these patients often require intravenous pain management. Was this true in your patient population as well? Will intravenous pain management reduce the incidence of acute chest crisis, which I think is related to poor pain control to a large extent.

The second group of patients I want to comment on are those that you have already discussed, those with a splenic cyst. We can discuss whether these were true cysts, but that is a different discussion. You pointed out that they need a wide excision of the cyst, and I would suggest that packing of that space with omentum is also useful to avoid cyst recurrence. I think this is probably being employed generally in most of those patients.

Finally, let me ask you about your exclusion criteria for operation. You did describe the fact that the very large spleens are probably ones that you would not want to treat this way. But I did not hear you say anything about Gaucher disease or thalassemia patients that also do come to operation, and are those the ones that you might consider performing open or are there nice methods now for doing these laparoscopically?

DR. FREDERICK J. RESCORLA (INDIANAPOLIS, INDIANA): The sickle cell population, as you noticed, is a high-risk group with a 22% complication rate. We have generally gone by some of the adult sickle cell studies that demonstrated that a simple transfusion to a hemoglobin level greater than 10 gm/d

is equal to a transfusion program to decrease the hemoglobin S fraction to a specific level. However, these series also recommended preoperative fluid administration, which we have not accomplished in our series because our patients come in the morning of the procedure.

Postoperative management is also important, and we offer them intravenous pain management to try to minimize the complication of acute chest syndrome; however, even with this treatment our acute chest syndrome rate is 10%.

In terms of the splenic cyst, we do pack the base of the cyst with omentum if possible, and we also treat the cyst base either with cautery or one of the energy devices to destroy the cyst base.

We would consider a child with thalassemia or Gaucher for the laparoscopic approach and would only utilize an open procedure if it was over 25 cm in length.

DR. H. BIEMANN OTHERSEN, JR. (CHARLESTON, SOUTH CAROLINA): I would just like to ask you a little bit about technique. Often the biggest problem is getting the big spleen out. Would you just comment on your technique of morcellation, or whatever you used to get the spleen out, after you have divided all the vessels?

DR. FREDERICK J. RESCORLA (INDIANAPOLIS, INDIANA): We use the Endocatch II device, which has a ring diameter of 13 cm and a length of 23 cm. We place the spleen within this device, close the neck of the device and then bring the neck out the umbilical site. We then generally place our finger through the site as well as a ring forceps and break up the spleen into small pieces and remove it piece by piece, a process that can take considerable time in cases of splenomegaly.