Surgical and anaesthetic outcomes of paediatric splenectomies at a tertiary care institution in South India: a retrospective cohort

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Abstract

Purpose  Splenectomies though well-established in the successful management of several resistant haemoglobinopathies, have not been studied in detail in the paediatric population to assess the outcomes. We conducted this review to primarily assess the surgical and anaesthetic outcomes of paediatric splenectomies and secondarily highlight factors predictive for a high-risk splenectomy.

Methods  A 5 year retrospective chart review was made, and patient follow-up was done jointly using the hospital electronic medical records and telephonic calls. A p value of < 0.05 was considered significant.

Results  Among the 69 splenectomised children, 61% were male and the overall mean age was 10.2 years. The cohort consisted of patients with thalassemia (46%), ITP (30%), haemolytic anemia (19%) and 1 child each with lymphoma, splenic cyst and Kassabach Meritt syndrome. Most (96%) were electively operated and 23% were performed laparoscopically. 61% received intravenous analgesia and the mean volume of fluid administered intra-operatively was 21 ml/kg. There was no documented OPSI, and there was one mortality. The mean follow-up period was 43 months and the overall survival rate was 98.5%.

Conclusions  Splenectomy was associated with a promising overall outcome. A greater pre-operative transfusion requirement, a larger sized spleen and increased fluid administration intra-operatively, were associated with a worse outcome.

Keywords  Splenectomy · Paediatric · Thalassemia · Paediatric anaesthesia · ITP · Hemolytic anemia

Abbreviations

TD  Transfusion dependent
NTDT  Non transfusion dependent thalassemia
ITP  Immune thrombocytopenic purpura
HA  Haemolytic anemia
TM  Thalassemia major
OS  Overall survival
OPSI  Overwhelming post splenectomy infection
G6PD  Glucose-6-phosphatase deficiency
PACU  Post anaesthesia care unit

Introduction

Paediatric nonmalignant haemoglobinopathies impose a significant strain on the healthcare system especially in lower middle income countries owing to lifelong transfusion dependency and lack of universal access to safe and cost effective blood products. Splenectomy has long been recognized as a therapeutic approach to manage patients severely affected with thalassemias (transfusion dependent (TD) and
non-transfusion dependent (NTDT)), haemolytic anemias (HA), Immune thrombocytopenic purpuras (ITP) and other miscellaneous haematological conditions based on the evidence that eliminating the splenic macrophage system will ease the disease burden.

Despite the well-established therapeutic potential, concerns remain regarding short and long-term infectious and thrombotic complications [1, 2]. The permanent immune impairment rendered by asplenia and susceptibility to severe bacterial infections, along with the increased risk of thromboembolic phenomena, make splenectomy a challenging decision to make especially in the paediatric population.

Copious amounts of literature exist on haematological outcomes of a splenectomy; however, data on surgical and anaesthetic concerns in the paediatric population are sparse. With the unavoidable ongoing debate on the risks versus benefits of paediatric splenectomies, we deemed it worthwhile to review the outcomes of the paediatric splenectomies performed at our institution.

Our primary aim was to assess the surgical and anaesthetic outcomes of paediatric splenectomies which included duration of hospital stay, identification of peri-operative events/complications, morbidity and mortality. The secondary aim was to identify factors to predict high risk splenectomies.

Materials and methods

After obtaining Institutional review board approval (Number 11826, approved on 30. 01. 2019), we reviewed 5 year data (2013–2018) on paediatric splenectomies performed at our institution. The study was performed in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. The study was exempted from requiring ethics approval, as it was retrospective in nature. We collected data including demography, the indications, co-morbid conditions, pre and post-operative investigations, peri-operative surgical and anaesthetic events, and survival of the patients from our hospital medical records system.

The co-morbid conditions were classified into major and minor based on whether medical intervention was required or not. The duration of hospital stay was sub-classified as short stay (3–4 days), regular stay (5–7 days) and long stay (>7 days). The final outcome was divided into the following groups: alive without transfusion, alive with transfusion, expired, or, lost to follow up. Overall survival (OS) was defined as the number of months from the day of splenectomy to the last day of follow-up or death.

Data was computed using Numbers software and descriptive statistics were reported using Mean ± standard deviation for continuous variables. Frequency, percentages and median were used for categorical variables. Comparison of mean between two groups was done using Mann Whitney’s U test, and more than two groups were reported using Kruskal–Wallis test. Correlation between the variables was reported using Pearson’s Correlation. Association was reported using $\chi^2$/Fisher’s exact test. Time to event analysis was carried out using Kaplan and Meier Curves. A p value of <0.05 was considered statistically significant. SPSS 21.0 (IBM, Bangalore) was used for the analysis.

Results

During the 5 year period, there were a total of 69 children who underwent splenectomy, with a mean of age of 10.2 years. Of these, 42 were boys and 27 were girls (Table 1).

Children in our study mainly belonged to haematological diseases, such as thalassemia (n = 32), ITP (n = 21) and HA (n = 13). There was one child each with lymphoma, Kasabach Meritt syndrome and a splenic cyst and these were excluded from the disease specific analysis.

Most of the surgeries were elective (96%) and performed open (71%). All patients were vaccinated against capsulated organisms according to the institutional protocol within 2 weeks prior to surgery when elective, and 2 weeks following surgery when emergency. When indicated, pre-operative transfusions and/or oral chelation were given (Deferasirox was preferred over Deferiprone). The mean operating times for open, laparoscopic and converted arms were 132, 212 and 199 min, respectively. No accessory spleens or splenunculi were recorded in any of the patients. All patients were administered general anaesthesia (GA) of which 39% received regional analgesia along with GA. The volume of fluid administered intra-operatively averaged at 21 ml/kg.

The entire cohort received post-operative antibiotic prophylaxis and education about overwhelming post splenectomy infections (OPSI). In 5% of patients we observed infections during the follow-up period; however, none of them fulfilled the criteria for OPSI. The median duration of hospital stay was 5.4 days.

We did not find any correlation between the duration of hospital stay and any of the demographic factors, type of disease, indication for surgery, co-morbidities, or mortality. There was a negative correlation between the duration of hospital stay and pre-operative values of haemoglobin and platelets; however, these were not statistically significant. The patients requiring more pre-operative transfusions (p = 0.007), increased administration of intra-operative fluid (p = 0.013) and larger spleen size (p < 0.01) had a statistically significant longer stay.
We did not find any difference between pre-operative haemoglobin and duration of stay in any of the groups, whereas in the HA group alone, there was a significant difference between pre-operative ferritin and duration of stay (longer) which was significant at a 6% confidence interval.

The OS for the entire splenectomy cohort was 98.5% with a mean duration of survival of 43 months. The OS rates were 96.9% in thalassemia, 100% in ITP and HA groups.

For clarity of results, we performed a sub-group analysis (Table 2).

### Thalassemia

All the 32 thalassemia patients underwent elective splenectomies. Of these, 15 had beta thalassemia major (TM), and 17 had NTDT (inclusive of thalassemia intermedia variants). The most common indication was transfusion dependency (75%) and each child received 78 packed cell transfusions on an average before surgery.

Ten children had major co-morbidities, 19 patients (59%) were on pre-operative chelation therapy and their mean ferritin values were 3284.8 ng/ml pre-operatively and 3513.7 ng/ml post-operatively.

Haemoglobin, platelet counts, and ferritin were routinely checked, whereas creatinine and potassium were checked when needed. The mean pre- and post-operative haemoglobin values were 7.7 g/dl and 10.8 g/dl, respectively. We found that the decision to transfuse packed cells was consultant based rather than based on a target number, as 62% of children with a haemoglobin of more than or equal to 8 g/dl were transfused.

Since thalassemic children had a uniformly large mean sonographic spleen size of 18 cm (range 12.6–32.5), all underwent laparotomies with a mean operating time of 129 min (range 60–270). Other significant sonographic findings were hepatomegaly (56%), portal (9%) and splenic (6%) vein enlargement. Cholecystectomy was performed in 19%. One patient had an iatrogenic pneumothorax requiring an intercostal drainage tube placement.

The mean volume of intra-venous fluid administered was 18.2 ml/kg and 47% of the patients needed an intra-operative packed cell transfusion. Both systemic and regional modalities of pain management were used almost equally with 47% receiving epidural catheters. Immediate post-operatively 41% of patients were started on anti-platelets for thrombocytosis.

Only 28% of the patients exceeded 7 days of hospital stay. At the end of the follow-up period, 38% were transfusion

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**Table 1** Demography

| Parameters               | Thalassemia (n = 32) | ITP (n = 21) | Haemolytic ane- | Others * (n = 3) |
|--------------------------|----------------------|--------------|-----------------|-----------------|
| Number of patients       | 32 (46%)             | 21 (30%)     | 13 (19%)        | 3               |
| Gender                   |                      |              |                 |                 |
| Male                     | 19                   | 11           | 10              | 2               |
| Female                   | 13                   | 10           | 3               | 1               |
| Age (years)              |                      |              |                 |                 |
| Median                   | 11                   | 9            | 8               | 13              |
| IQR**                    | 9–13.8               | 8–12         | 5.5–13          | –               |
| Native place             |                      |              |                 |                 |
| North India              | 4                    | 1            | 1               | 1               |
| South India              | 12                   | 11           | 9               | 2               |
| East India               | 14                   | 7            | 2               | 0               |
| West India               | 0                    | 1            | 1               | 0               |
| Outside India            | 2                    | 1            | 0               | 0               |
| Duration of hospital stay (days) | | | 5 | 5 |
| Median                   | 6                    | 5            | 4               | 5               |
| IQR**                    | 4–7                  | 4–6.5        | 3–5.5           | –               |
| Year of surgery          |                      |              |                 |                 |
| 2015                     | 5                    | 9            | 5               | 1               |
| 2016                     | 12                   | 5            | 1               | 1               |
| 2017                     | 7                    | 5            | 4               | 1               |
| 2018                     | 8                    | 2            | 3               | 0               |

- Not applicable/could not be calculated. Native place: Outside India (Bangladesh)
* Splenic cyst, Lymphoma, Kassabach Meritt syndrome, ** IQR—Interquartile range
| Parameters | Thalassemia ($n=32$) | ITP ($n=21$) | Haemolytic anaemias ($n=13$) |
|------------|----------------------|--------------|-----------------------------|
| Indications for surgery | Medical management failure | 0 | 20 | 1 |
| | Transfusion dependent | 24 | 1 | 8 |
| | Hypersplenism | 3 | 0 | 1 |
| | Transfusion dependent + Hypersplenism | 5 | 0 | 3 |
| Co-morbidities (more than 1 possible) | Major^^ | 10 | 3 | 2 |
| | Minor^^^ | 2 | 2 | 1 |
| | None | 26 | 16 | 10 |
| Duration of hospital stay (days) | 3–4 | 9 | 10 | 8 |
| | 5–7 | 13 | 6 | 3 |
| | >7 | 9 | 5 | 2 |
| Median/ Mean haemoglobin levels (g/dl) | Preoperative | 7.6/7.7 | 12.1/11.6 | 8/8.3 |
| | Postoperative | 10.9/10.8 | 10.9/10.9 | 9.8/10.8 |
| Median/ Mean platelet count (units/cc) | Preoperative | 1.3/1.5 | 0.13/0.19 | 1.7/2.3 |
| | Postoperative | 2.2/3.1 | 0.56/0.80 | 3.5/3.8 |
| Median/ Mean ferritin levels (ng/ml) | Preoperative | 1565/2270.4 | – | 749/985.5 |
| | At last follow-up | 2846/3286.6 | – | 2569/2569 ($n=2$) |
| Pre-operative disease specific medication | Desferrioxamine | 19 | 0 | 2 |
| | Hydroxyurea | 10 | 0 | 0 |
| | Ecospirin | 2 | 0 | 1 |
| | Steroid | 0 | 21 | 1 |
| | Azathioprine | 0 | 21 | 1 |
| | Dapsone | 0 | 20 | 0 |
| | Intravenous Immunoglobulins | 0 | 7 | 0 |
| | Danazol | 0 | 3 | 0 |
| | Tacrolimus | 0 | 1 | 0 |
| | Mycophenolate Mofetil | 0 | 1 | 0 |
| | Rituximab | 0 | 0 | 1 |
| Median/ Mean number of transfusions prior to making the surgical decision | Platelet concentrate | 0 | 5/12.3 | 0 |
| | Packed red cells | 78/91 | – | 14/29 |
| Requirement of pre-operative optimisation | None | 8 | 14 | 7 |
| | Packed red cells | 24 | 0 | 6 |
| | Platelet concentrate | 0 | 7 | 0 |
| Ultrasonography findings | Median/ Mean Spleen size (cm) | 18/18.7 | 8.6/9.3 | 13.7/14.2 |
| | Gallstones present | 6 | 0 | 4 |
| | Portal vein enlarged | 3 | 0 | 0 |
| | Splenic vein enlarged | 2 | 0 | 0 |
| | Hepatomegaly | 17 | 0 | 4 |
| Surgical approach | Open | 32 | 6 | 8 |
independent and 58% required transfusions though less frequent.

Six patients were lost to follow up and 2 patients had infections; however, none qualified as OPSI. In this subgroup we had a 10-year-old girl with thalassemia intermedia who succumbed to the surgery in the immediate post-operative period in the PACU (Post anaesthesia care unit). Excluding her, there was no mortality.

**Table 2** (continued)

| Parameters | Thalassemia \((n=32)\) | ITP \((n=21)\) | Haemolytic anaemias \((n=13)\) |
|------------|----------------|--------------|-------------------------------|
| Laparoscopic | 0 | 13 | 3 |
| Laparoscopy converted to open | 0 | 2 | 2 |
| Median/mean surgical duration (min) | | | |
| Open | 120/129 | 120/130 | 120/121 |
| Laparoscopic | – | 210/215 | 180/200 |
| Laparoscopy converted to open | – | 188/188 | 210/210 |
| Intra-operative analgesia | | | |
| Intra-venous morphine including patient controlled analgesia | 17 | 17 | 6 |
| Epidural continuous infusion | 15 | 4 | 7 |
| Intra-operative parameters | | | |
| Haemoglobin (g/dl) | 8.7*** \((n=1)\) | – | – |
| Potassium (mg/dl) | 2.9*** \((n=1)\) | – | – |
| IV Fluid administered (ml/kg) | 17.3/18.2 | 18/24.5 | 17.8/21.3 |
| Urine output (ml/kg/h) | 5/5 \((n=2)\) | – | 2/1.7 \((n=3)\) |
| Intraoperative transfusions | | | |
| Packed red cells | 15 | 5 | 5 |
| Platelet concentrate | 1 | 13 | 1 |
| Cryoprecipitate | 0 | 1 | 0 |
| Fresh Frozen Plasma | 1 | 3 | 0 |
| Reportable events | | | |
| Anaesthetic | 1* | 0 | 0 |
| Surgical | 1** | 2^ | 2^ |
| Post-operative ecospirin | | | |
| Yes | 13 | 0 | 7 |
| No | 19 | 0 | 6 |
| Median/Mean follow-up (months) | 12.5/14 | 23/21 | 15/14 |
| Final outcome | | | |
| Alive without transfusion | 10 | 17 | 10 |
| Alive with transfusion | 15 | 1 | 2 |
| Expired | 1 | 0 | 0 |
| Lost to follow up | 6 | 3 | 1 |

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*Elaborated in the discussion section, **Pneumothorax, ***Done on the patient who was brought in for emergency splenectomy in a critical condition, ^Bleeding, Pancreatic tail injury, ^^Hypothyroidism, Immunodeficiency, Malignancy, Seizures, Hyperuricemia, Cushings syndrome, Cardiac illness, Chronic liver disease, Posterior Reversible encephalopathy syndrome, ^^^Choledocholithiasis, Autism, Cef palate, Porcencophageal cyst, Hypovitaminosis, Hypogonadism

**ITP**

The indication for splenectomy was failure to respond to medical management in all 21 patients. 19 splenectomies were elective and the remaining 2 were emergencies due to massive transfusion requirement and an acute-intra-cranial bleed pre-operatively. Haemoglobin and platelets were routinely checked and 7 patients were transfused platelets prior to surgery based on clinical presentation and platelet values. An increase in the mean platelet count from 19,000/cc to 80,000/cc was noted post-operatively.

The mean sonographic spleen size was 9.3 cm. None had gallstones, hepatomegaly or an enlarged portal or splenic
vein. Fifteen spleens (71%) were approached laparoscopically, 2 of which required conversion to laparotomy in view of uncontrollable bleeding. The mean operating times were 215, 188 and 130 min in the laparoscopic arm, converted arm and open arms, respectively.

During surgery, 62% of the patients were transfused with platelet concentrates and 24% with packed red cells after ligation of the splenic hilum. The mean volume of intra-venous fluid administered intra-operatively was 24.5 ml/kg. Systemic analgesics were the mainstay of peri-operative pain management.

About half the children (48%) had a short stay, while a quarter (24%) had a long in-patient stay. The mean follow-up period was 21 months at the end of which 81% were transfusion independent. There were no surgical or anaesthetic events. One patient who underwent emergency splenectomy for massive transfusion requirements had a stormy peri-operative period, but has been transfusion independent for over 44 months. Three patients were lost to attrition.

**Haemolytic anemias**

All 13 patients with HA underwent elective splenectomy. This sub-set included hereditary spherocytosis and elliptocytosis, sickle cell anaemias, pyruvate kinase deficiency, autoimmune haemolytic anaemia, and G6PD (glucose-6-phosphate dehydrogenase) deficiency. The most common indication was transfusion dependency (61%).

The mean pre-operative haemoglobin and platelet levels were 8.3 g/dl and 2,30,000/cc, respectively. Packed red cells were transfused pre-operatively and intra-operatively in 46% and 38%, respectively. The ferritin levels were monitored in 69%. Chelation therapy was administered to 15% of patients.

The mean sonographic spleen size was 14.2 cm with 31% each having gallstones and hepatomegaly. The approach to surgery was made predominantly based on the spleen size. 62% underwent open surgery. Those with choledolithiasis (n = 4) underwent concurrent cholecystectomy. 5 patients with spleen size varying between 11.5 and 13.1 cm were planned for laparoscopy. 2 among these had to be converted to laparotomy in view of bleeding and pancreatic tail injury, respectively. The mean operating time in the open, laparoscopic and converted arms were 121, 200 and 210 min, respectively.

The mean intra-venous fluid administered was 21.3 ml/kg. Epidural (54%) and systemic analgesics (46%) were used with nearly equal frequency. There was no untoward anaesthetic event encountered and most of the patients had a short stay. In view of a rising platelet count following surgery, 54% were prescribed anti-platelets.

The mean follow-up period was 14 months. With the exception of 1 patient who was lost to follow up, 83% were transfusion independent and 17% were transfusion dependent (with less frequency). One patient had posterior reversible encephalopathy syndrome which normalised completely following surgery.

**Discussion**

The splenectomies performed at our institution were mostly for thalassemia’s, ITP’s and HA’s. These seem to be the universal indications as supported by Yacobovich et al. [1]. Our institute being one of the few tertiary referral centres for various paediatric haematological conditions expanded the study cohort to children hailing from pan Indian states and the Indian peninsula. A significant proportion of splenectomised patients achieve long-term control of their disease with minimal morbidity and mortality [1, 3, 4]. In keeping with current literature, our study too yielded impressive OS rates of 98%. The follow-up period being inconstant precluded calculation of event free survival rates (morbidity). Various factors have been implicated and studied in predicting the outcomes of splenectomies. We measured our surgical and anaesthetic outcomes in terms of duration of hospital stay, morbidity and mortality.

The mean duration of hospital stay in our study was 5.4 days as comparable with Rayaz Ahmed et al. (6 days) [3]. A greater pre-operative transfusion burden, increased intra-operative fluid requirement and a larger spleen were the three parameters that resulted in a longer duration of hospital stay in our study. We did not find other studies with similar findings. Interestingly, presence of co-morbidities, modality of surgery, surgical duration, or type of analgesia used, did not affect the duration of stay. Though laparoscopic splenectomy has been reported to result in a shorter duration of stay [5, 6] we did not find any significant difference in our study. Bhatt et al. found that intra cranial haemorrhage, gastro intestinal bleed, sepsis, thrombosis, and male sex were associated with a longer hospital stay [7]. Besides these studies, literature on duration of stay is sparse and as both these studies included only ITP patients, further comparison cannot be made.

The most dreaded complication following splenectomy, though infrequent, is OPSI. Most fatal post splenectomy infections occur within 2 years of surgery [5]. We had 1 patient with repeated infections on follow-up, but no documented OPSI. The overall follow-up duration, however, precludes comment on infections that could have developed later. Yacobovich et al. found no OPSI in 103 splenectomised children [1].

Following splenectomy, there is an increased risk of venous and arterial thromboembolism including acute pulmonary, splenic and portal vein thrombosis [2]. These along with the risk of pulmonary hypertension, leg ulcers, and silent cerebral infarctions are more in the NTDTD group due to the greater prevalence of a hyper-coagulable state [6, 8].
We did not encounter these complications probably due to early initiation of anti-platelets in patients who were at risk \((n=18)\).

The incidence of mortality associated with splenectomy varies the most common cause being OPSI. \([9]\). The unexpected peri-operative mortality in our study stimulated us to probe deeper into the possible red flag signs that could aid as precautionary markers for future splenectomies. As per literature, peri-operative mortality is rare and is usually associated with haemorrhage. Following an uneventful anaesthesia and surgery, a 10-year-old girl with NTDT had hypotension and arrested in the PACU in the immediate post-operative period. Though the exact cause of death could not be identified (primary haemorrhage was ruled out), she was at a high risk for venous and arterial thromboembolism being an NTDT patient. This incident probably reiterates that NTDT patients are at a higher risk of experiencing peri-operative complications and should be thoroughly investigated pre-operatively.

Splenectomy decreases the transfusion requirements and thereby the transfusion dependent iron overload as evidenced by 31% of our TM patients being transfusion independent and 47% requiring less frequent transfusions post splenectomy. Similar findings were reported by Graziano et al. \([10]\) and Cohen et al. \([11]\). In NTDT, however, transfusions are administered judiciously due to concerns regarding iron overload and alloimmunization and hence the threshold for splenectomy is lower in this group. This is supported by our study finding of a mean of 47 units of transfusion before surgery in NTDT as opposed to 140 in TM patients.

Iron overload in TM is due to frequent blood transfusions as opposed to increased gastrointestinal absorption in NTDT \([12]\), resulting in long term deleterious effects such as liver fibrosis, endocrine failure and myocardial damage in the absence of chelation. Assessment of liver iron concentration is the gold standard for quantification of total body iron \([13]\), but is infrequently employed in set ups like ours due to financial constraints of the patients. Spot measurements of serum ferritin as employed in our study, though utilised routinely, have the downside of underestimating the level of iron overload especially in NTDT patients. This limitation precluded making a fixed protocol for the ferritin level that would necessitate the initiation of chelation in our setup. Eight percent of the TM patients were on pre-operative chelation as compared with 41% in the NTDT group, supporting the evidence that iron overload in the latter group is a cumulative and more deliberate process \([13]\) necessitating a tighter and earlier control. As per guidelines in literature \([12, 13]\), chelation once started should continue post-operatively but in our study only 7/21 (Thalassemia) continued the chelation.

Cetin Ali et al. studied 50 children undergoing laparoscopic splenectomy and found that the spleen size did not make a significant difference to the outcome \([14]\). Conversely, a larger spleen in our study was associated with longer duration of hospital stay \((p<0.01)\) irrespective of the operative approach. This was likely due to larger spleen size in our cohort.

Four percent \((n=3)\) of our splenectomies were emergencies as compared with 21% as stated by Samuk et al. \([15]\). One of our patients from this group had an intra-cranial hemorrhage resulting in a longer duration of stay (20 days). Samuk et al. highlighted that the duration of hospital stay depends on the underlying disease \([15]\). Further comment on the outcomes of emergency splenectomies in our study cannot be made as the numbers for comparison are small.

Laparoscopic surgery has the downside of possible residual disease due to undetected accessory spleens \([16, 17]\); however, none of our patients in the laparoscopic cohort manifested signs of recurrent or residual disease during their follow-up period. Our rate of laparoscopy is much lower than the overall global rate \([16]\) owing to poor finances and lack of insurance coverage.

Our conversion rate (20%) was almost at par with Qureshi et al. \((15\%)\) \([16]\) and our laparoscopic operating time was comparable with that of Sandoval et al. \([17]\) and Qureshi et al. \([16]\).

Anaesthetic management is known to be challenging with unanticipated difficult airways, peri-operative high blood pressures, iron overload, endocrinological and cardiac abnormalities, restrictive respiratory patterns and pulmonary hypertension \([9]\) often being associated with the disease processes. We did not encounter any of the above mentioned challenges. Existing literature does not mention any specific effect of intra-operative fluid management on overall outcome. We, however, noticed a significant increase in the duration of hospital stay with increased administration of intra-operative fluid \((p=0.013)\). Both systemic and regional analgesia were effective and equivocal probably due to efficient acute pain care services at our centre.

Greater pre-surgical transfusion requirements, a larger spleen size and increased intra-operative fluid administration were the red flag signs we identified which existing literature does not mention. Yet, in-order to quantify the same, we would require having a prospective study design with a larger sample size.

The study being retrospective had the disadvantage of confounding and inability to determine causation. The relatively short follow-up period and smaller sample size when compared with other series precluded identifying patients with late relapses, recurrences and follow-up of delayed complications.
Conclusions

Paediatric splenectomies in our study were associated with a promising overall outcome with a survival rate of 98.5% at 43 months. A greater pre-operative transfusion requirement, a larger sized spleen and increased fluid administration intra-operatively, were associated with a longer duration of hospital stay.

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Declarations

Competing interests The authors declare no competing interests.

Conflict of interest The authors have no relevant financial or non-financial interests to disclose, and have no competing interests to declare that are relevant to the content of this article.

Ethics approval This retrospective chart review study involving human participants was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments. The institutional review board approved the study and waived off ethical clearance as the study was retrospective in nature and all the procedures were being performed as part of routine care.

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