Optimising working space for laparoscopic pyeloplasty in infants: Preliminary observations with the SGPGI Protocol

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Abstract

Aims: This study aimed to test the efficacy of SGPGI protocol to minimise bowel distension and optimise working space for laparoscopic pyeloplasty in infants.

Methodology: All infants who underwent laparoscopic pyeloplasty for unilateral pelvi-ureteric junction obstruction (PUJO) between January 2017 and March 2020 were included in the study. The patient cohort was divided into two groups: Group A and B. Group A included patients who underwent routine pre-operative preparation. Group B included patients wherein the SGPGI protocol was used. The key features of the protocol were fasting for 8 h, enemas, inserting a nasogastric tube in the pre-operative period and decompressing the colon on the operation table. Demographic features, pre-operative, intraoperative and post-operative parameters were compared between the two groups.

Results: A total of 26 infants with unilateral PUJO underwent laparoscopic pyeloplasty during the study period. Group A included 12 patients and Group B included 14 patients. Both the groups were similar in age, weight and sex distribution. The median surgeon’s rating score for suturing conditions was 2 for Group A and 5 for Group B patients (P > 0.05). The operating time was significantly longer in Group A (196 ± 21 min) as compared to Group B (114 ± 18 min) (P < 0.05). In Group A, intra-abdominal pressure (IAP) varied between 9 and 14 mmHg (median 12 mmHg), while in Group B, IAP varied between 6 and 9 mmHg (median 8 mmHg) (P < 0.05). In Group A, in 2/12 cases (16.7%), conversion to an open procedure was necessary because of inadequate working space owing to gross intestinal distension. Two patients in Group A also had intraoperative injuries to adjacent structures due to poor working space.

Conclusions: Optimal working space is critical to the performance of advanced laparoscopic surgery like pyeloplasty in infants. SGPGI protocol significantly improves working space, which permits a faster and safer surgery with a lower intra-abdominal working pressure. This protocol is simple, safe and easy to replicate at most centres in our country.

Keywords: Infant, laparoscopy, pneumoperitoneum, pyeloplasty, working space

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INTRODUCTION

Laparoscopic pyeloplasty is one of the common laparoscopic procedures performed in infants at our centre. The working space in infants is limited due to a combination of various factors such as small body habitus, relatively large size of the liver and the spleen and shallow pelvis. This space is further compromised if the small or large bowel is dilated, severely limiting the ability to operate. This frequently requires manoeuvres such as increasing the depth of neuromuscular blockade or increasing the intra-abdominal pressure (IAP), which may cause haemodynamic or respiratory compromise in a small baby. To overcome these limitations in infants, we developed a protocol (Sanjay Gandhi Post Graduate Institute [SGPGI] protocol) and tested its efficacy to minimise bowel distension and optimise working space for laparoscopic surgery in infants.

METHODOLOGY

This study was performed under the department of paediatric surgery from January 2017 to March 2020 in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All infants undergoing laparoscopic pyeloplasty for unilateral pelvi-ureteric junction obstruction (PUJO) by a single surgeon during the study period were included in the study. The patient cohort was divided into two groups: Group A and B. Group A included patients during the study period January 2017 to June 2018, wherein the SGPGI protocol was not instituted and the patients underwent routine pre-operative preparation. Group B included patients during the study period July 2018 to March 2020, wherein the SGPGI protocol was used.

Routine pre-operative preparation (Group A patients)
All infants planned for laparoscopic pyeloplasty in Group A were admitted at least a day prior to surgery. The surgery was planned as the first case on the list as a protocol. No enemas were used routinely on the pre-operative day. The baby was kept fasting for 4 h prior to induction of anaesthesia and during this period, maintenance intravenous (IV) fluids were given. A nasogastric tube (NGT) was inserted after endotracheal intubation and kept on continuous drainage throughout the procedure. Before positioning the patient, a sump sucker at low pressure was gently inserted into the rectum to evacuate any residual faeces or air from the large bowel.

SGPGI protocol (Group B patients)
All infants planned for laparoscopic pyeloplasty in Group B were admitted at least a day prior to surgery. The surgery was planned as the first case on the list as a protocol. At our centre, the first case is wheeled in the operation theatre at around 9 AM on most days. Proctocolysis enema (1 ml/kg/dose) was given twice, first in the evening prior to the day of surgery (around 6 PM) and then, in the early morning hours (around 4 AM) on the day of surgery. The enemas were given by a soft Foley’s catheter (6/8 F) in the rectum to make it least traumatic for the baby. The infant was kept fasting for at least 8 h prior to induction of anaesthesia and during this period, maintenance IV fluids were given through an IV cannula secured at admission. An 8 French NGT was positioned in the stomach 5 h prior to induction (around 4 AM) and kept on continuous drainage. The position of the NGT in the stomach was doubly checked by the anaesthetist at the time of induction of anaesthesia and was kept on continuous drainage throughout the procedure. Before positioning the patient, a sump sucker at low pressure was gently inserted into the rectum to evacuate any residual faeces or air from the large bowel.

Surgical technique
All infants underwent laparoscopic Anderson Hynes pyeloplasty, as described previously.11 After endotracheal intubation and insertion of a urinary catheter, the baby was positioned at the edge of the table in a modified lateral decubitus position with the affected side up [Figure 1a]. A small roll was placed under the flank, all pressure points were padded adequately and the surgical field was prepared. The surgery started by insertion of the first port at the umbilicus by an open technique and establishing a pneumoperitoneum of 6–8 mmHg. The degree of bowel distension and adequacy of working space was assessed [Figure 2a and b]. The IAP was increased in a stepwise manner to 10–14 mmHg if the working space was deemed inadequate for surgery. We used a three-port technique with a 5 mm optical port at the umbilicus and two 3 mm working ports in the midline above and below the umbilicus [Figure 1a]. We reflected the colon medially.
for both right- and left-sided pyeloplasties and worked in the retro-colic plane. After the pelvi-ureteric junction (PUJ) was dissected and defined, a trans-abdominal ‘hitch’ stitch was taken to retract the pelvis [Figure 1b]. The PUJ with the redundant pelvis was excised and the ureter was spatulated. The posterior layer of the pelvi-ureteric anastomosis was performed with a running 5-0 polyglycolic acid suture. Then, a 3 or 3.5 F, 16 cm double-J (DJ) stent was placed across the anastomosis. The anterior layer of anastomosis was then completed with a running 5-0 polyglycolic acid suture. The remaining open pelvis was closed. We placed a perinephric drain in all cases. The NGT was removed after 6 weeks by cystoscopy under short anaesthesia.

Study parameters
The following parameters were recorded for all patients and the data were compared between both the groups:
• Demographic data: Age, sex and weight of the patient
• Anteroposterior diameter (APD) of the pelvis of the affected kidney: Pre-operative APD as measured on ultrasonography
• Split renal function (SRF) of the affected kidney: Pre-operative SRF on renal dynamic scan
• Surgical conditions while suturing: A surgeon’s rating (5-point rating scale) of surgical conditions during intracorporeal suturing[2,3] [Tables 1 and 2]. They are as follows:
(1) Extremely poor conditions; (2) Poor conditions; (3) Acceptable conditions; (4) Good conditions and (5) Optimal conditions
• Operating time: Duration of operating time from first incision to the last skin suture
• IAP: Maximum IAP used for pneumoperitoneum during the procedure
• Maximum small bowel diameter on laparoscopy: This was measured before proceeding with dissection by selecting the small bowel loop with the maximum diameter on inspection and measuring the diameter accurately with a suture measure.

- Intraoperative blood loss
- Conversion to open procedure
- Complications: Intraoperative or post-operative complications
- Time to full feeds (hours)
- Hospital stay (days)

Statistical analysis
Normally distributed variables were expressed by means and SD (standard deviation). Variables that were not normally distributed were expressed as medians and ranges. Student’s t-test was used for comparison of the normally distributed variables. The Mann–Whitney U-test was used to compare ordinal or continuous variables that were not normally distributed. Fisher’s exact test was used for the comparison of frequencies. P value less than 0.05 was considered significant.

RESULTS
A total of 26 infants with unilateral PUJO underwent laparoscopic pyeloplasty during the study period, and they were grouped according to the pre-operative protocol used. Group A included 12 patients between January 2017 and June 2018, wherein the SGPGI protocol was not instituted and the patients underwent routine pre-operative

Table 1: The 5-point rating scale used to assess the surgical conditions during intracorporeal suturing[2,3]

| Scale | Description |
|-------|-------------|
| 1: Extremely poor conditions | Unable to complete surgery without interventions* |
| 2: Poor conditions | Several minor adjustments needed to complete surgery (i.e. changes in patient positioning and surgeon’s position) |
| 3: Acceptable conditions | After few minor adjustments surgery can be completed |
| 4: Good conditions | Surgical overview is good; there is some interference, but no need for adjustments |
| 5: Optimal conditions | Surgical overview is optimal and the procedure can be completed without any interference |

*Interventions are defined as change in depth of neuromuscular blockade and/or increased pneumoperitoneum

Table 2: Rating scores for the surgical conditions during intracorporeal suturing

| Rating score for suturing conditions | Group A (n=12) | Group B (n=14) |
|-------------------------------------|---------------|---------------|
| 1: Extremely poor conditions | 3 | 0 |
| 2: Poor conditions | 5 | 0 |
| 3: Acceptable conditions | 2 | 2 |
| 4: Good conditions | 2 | 3 |
| 5: Optimal conditions | 0 | 9 |
| Median score | 2 | 5 |
preparation. Group B included 14 patients during the study period July 2018 to March 2020, wherein the SGPGI protocol was used. Both the groups were similar in age, weight and sex distribution [Table 3]. The left side was the predominantly affected side in both the groups. In Group A patients, the mean pre-operative APD and SRF of the affected kidney were 34.5 mm and 35.1%, respectively. Group B patients had a mean pre-operative APD and SRF of 36.2 mm and 32.7%, respectively (P > 0.05).

The median surgeon’s rating score for suturing conditions was 2 for Group A and 5 for Group B patients (P > 0.05) [Tables 2 and 3]. The operating time was significantly longer in Group A (196 ± 21 min) as compared to Group B (114 ± 18 min) (P < 0.05). As for the IAP, in Group A, IAP varied between 9 and 14 mmHg (median 12 mmHg), while in Group B, IAP varied between 6 and 9 mmHg (median 8 mmHg), the difference between the groups being significant (P < 0.05). The mean small bowel diameter as measured on laparoscopy was 3.5 cm in Group A and 1.5 cm in Group B patients, though the difference was not found to be significant (P > 0.05). In Group A, in 2/12 cases (16.7%), conversion to an open procedure was necessary because of inadequate working space owing to gross intestinal distension. In Group B, all procedures were completed laparoscopically.

The intraoperative blood loss was similar in both the groups [Table 3]. There were five complications in Group A, two intraoperative and three post-operative complications. During surgery, one patient had an accidental serosal injury of the small bowel with cautery. The injury was repaired with interrupted seromuscular suturing with no adverse consequences. Another patient had a mesocolonic tear during dissection which was repaired. We feel that both these intraoperative injuries were due to the limited working space owing to small bowel distension. Two patients had prolonged ileus postoperatively and one patient developed port-site infection. In Group B, none of the patients had any intraoperative complications. Four patients had post-operative complications, the most common being minor port-site infection seen in two patients. One girl had a premature expulsion of the DJ stent into the urethra at 14 days after surgery; the stent was removed with no adverse consequences.

In the post-operative period, full feeds were tolerated earlier in Group B patients as compared to Group A, though the difference was not found to be significant (mean: 12.5 h vs. 18.3 h, P > 0.05) [Table 3]. The duration of hospital stay was similar between both the groups. The mean follow-up duration for the whole cohort was 14 (2–39) months. Follow-up investigations showed a significant reduction in hydronephrosis and improved drainage in all kidneys.

**DISCUSSION**

Adequate working space is a prerequisite for safe and efficient minimal access surgery. Several factors influence working space, for example, age and size of the patient, obesity, bowel content, pneumoperitoneum pressure, positioning of the patient, use of systemic neuromuscular blocking agents and ventilation settings. The working space in infants is limited due to a combination of various factors such as small body habitus, relatively large size of liver and spleen and shallow pelvis. This space is further compromised if the small or large bowel is dilated, making

### Table 3: Comparative chart between Group A and Group B patients for various study parameters

| Study parameters | Group A (n=12) | Group B (n=14) | P |
|------------------|---------------|---------------|---|
| Age (months)     | 7.8±2.1       | 6.9±1.6       | >0.05 |
| Sex (male:female)| 8:4           | 9:5           | NA  |
| Weight (kg)      | 7.0±1.4       | 6.8±1.3       | >0.05 |
| Laterality (right:left) | 5:7 | 6:8 | NA |
| APD of the pelvis of the affected kidney (mm) | 34.5±7.6 | 36.2±8.4 | >0.05 |
| SRF of the affected kidney (%) | 35.1±6.4 | 32.7±7.2 | >0.05 |
| Rating score for suturing conditions | 2 (1-4) | 5 (3-5) | >0.05 |
| Operating time (mins) | 196±21 | 114±18 | <0.05 |
| IAP (mmHg)       | 12 (9-14)     | 8 (6-9)       | <0.05 |
| Maximum small bowel diameter on laparoscopy (cm) | 3.5±1.2 | 1.5±0.8 | >0.05 |
| Intraoperative blood loss (ml) | 15±5 | 12±4 | >0.05 |
| Conversion to open procedure (%) | 2 (16.7) | 0 | <0.05 |
| Complications (%) | 5 (41.7) | 4 (33.3) | >0.05 |

Small bowel thermal injury 1
Mesocolonic tear 1
Prolonged ileus 1
Wound infection 2
Prolonged ileus 2
DJ stent expulsion 1
Wound infection 1

Normally distributed variables are expressed as mean±SD. Variables that were not normally distributed are expressed as median (range).

APD: Anteroposterior diameter; SRF: Split renal function, IAP: Intra-abdominal pressure, SD: Standard deviation, NA: Not available
it virtually impossible to perform certain laparoscopic procedures like pyeloplasty.

In adult laparoscopic surgery, pre-operative bowel preparation is used to obtain two main goals: first the removal of bulky intraluminal contents to improve handling of the bowel, and then, the decrease of peri toneal and wound contamination by the intraluminal content in case of bowel opening. In adults, there is a large abdominal cavity and, in general, there are no problems of space to move working instruments. Instead, in paediatric patients, the abdominal cavity is very small and if the colon or intestinal loops are dilated, it is not possible to perform some laparoscopic procedures without increasing IAP.

A detailed review of literature revealed that there are almost no objective data about the effect of pre-operative bowel preparation/bowel decompression on working space in paediatric laparoscopic surgery. Esposito et al[6] studied the role of bowel preparation to optimise working space in infants undergoing laparoscopic inguinal hernia repair. The study used a protocol which included simethicone for 1 week before surgery; enemas with a probe for 2 days before surgery; minimal-residue diet (low fibre intake) at least 3 days before surgery and fasting at least 5 h prior to surgery. The authors concluded that ‘pre-operative bowel preparation represents an important additional benefit for infants undergoing laparoscopic inguinal herniorrhaphy in elective conditions as it increases working space by reducing bowel content and it permits a faster and safer surgery with a significant lower intra-abdominal working pressure. It is important to underline that pre-operative bowel preparation is a useful and safe method, it is well tolerated and can be performed easily by parents at home, without increasing the length of hospital stay’.

Masieri et al. recently compared mini laparoscopic versus open pyeloplasty in children <1 year. The authors stated that ‘before surgery it is advisable to perform a bowel preparation with simethicone and enemas to empty the intestinal loops that are commonly distended in infants. This bowel preparation allows us to obtain a larger working space and to accomplish the procedure, keeping the pneumoperitoneum pressure stable ~8–10 mmHg’.

We repeatedly encountered the problem of bowel distension when performing laparoscopic pyeloplasty in infants in the initial few years of our experience. We noticed that infants cry excessively due to hunger once they are nil by mouth for surgery. The crying is frequently exacerbated by IV cannulation, separation from parents, stranger anxiety, etc. Crying causes aerophagy and subsequently small bowel distension. We also observed that during induction of anaesthesia, a significant amount of air can enter the stomach during positive pressure ‘bag and mask’ ventilation before intubation. Once the air from the stomach passes beyond the duodenum into the small bowel, it cannot be evacuated by a NGT. We also tried inserting an NGT during the induction of anaesthesia in these infants. However, our anaesthesia colleagues advised us against it, as the insertion of NGT in a sedated infant can stimulate the gag reflex and may cause aspiration of gastric content into the trachea–bronchial tree. Hence, between January 2017 and June 2018, during our first 12 cases (Group A), the surgical conditions in terms of working space were poor (median score 2) and the operating time was significantly longer (mean 196 min). To complete the procedure, we also needed to keep the IAP higher (median 12 mmHg). We also had difficulty in manoeuvring the instruments in a small space, resulting in two intraoperative complications and two conversions [Table 3]. Although the difference between the two groups was found to be statistically significant for these parameters, the results have to be interpreted in the context of certain limitations of the study. As we have used historical cohorts, Group A patients were in the early part of the surgeon’s learning curve for doing laparoscopic pyeloplasty in infants. This may have contributed to the longer operative time, higher chances of conversion to open and intraoperative complications in these patients.

From July 2018, we devised a protocol (SGPGI protocol) and implemented it in subsequent cases to minimise bowel distension and improve working space. Enemas to evacuate large bowel preoperatively and use of a supple sucker in the rectum just before positioning decompressed the large bowel almost completely. An NGT, which is placed on continuous drainage from the time of fasting of the baby, continuously drains all the air from the stomach. This prevents the entry of air into the small bowel and allows the small bowel to be completely collapsed. We also increased the fasting duration from 4 h to 8 h, as this allows enough time for the small and large bowel to empty completely.

After instituting this protocol, between July 2018 and March 2020, during our next 14 cases (Group B), the surgical conditions (median score: 5) and the operating time (mean: 114 min) improved significantly. We could complete all the procedures with lower IAP (median 8 mmHg) and did not have any intraoperative complication. There was also an improvement in time to full feeds (mean 12.5 h) and duration of hospital stay (mean: 4.2 days), though the difference was not statistically significant. Our results suggest that SGPGI protocol significantly improves working space during infant laparoscopic pyeloplasty.
There are certain limitations of our study as mentioned earlier. As the primary surgeon was not blinded to the protocol being used, observer bias in scoring the surgical conditions cannot be ruled out. Second, as we have used historical cohorts, the improvement in operative and suturing times may be the result of improved surgical skills and technique. Furthermore, data on the effect of higher IAP on physiological parameters were missing and could not be analysed. Finally, the lack of randomisation between the groups limits the power of the results. However, the results of this study encourage us to plan a larger, randomised clinical trial in the future which may validate our protocol and results further. To the best of our knowledge, this is the first detailed study in literature which documents an improvement in working space for laparoscopy in children using objective criteria.

**CONCLUSIONS**

Optimal working space is critical to the performance of advanced laparoscopic surgery like pyeloplasty in infants. SGPGI protocol significantly improves working space, which permits a faster and safer surgery with a lower intra-abdominal working pressure. This protocol is simple, safe and easy to replicate at most centres in our country.

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**Conflicts of interest**

There are no conflicts of interest.

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