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# The "diamond port configuration": A standardised laparoscopic technique for adolescent intestinal resection and anastomosis

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## ABSTRACT

**Background:** Familiarity with technique and repetition enhance efficiency during laparoscopic surgery. This is particularly important when undertaking complex bowel resections. We report a standardised protocol that includes theatre layout, patient position and port insertion, which we believe facilitates excellent abdominal access and ergonomics and has the potential to shorten the duration of the team-learning curve. **Materials and Methods:** A strategic unit development plan led to the commencement of a laparoscopic service for adolescents with bowel disorders. A standardised protocol for intestinal resections was agreed upon at a monthly Paediatric Minimal Access Group meeting. This covered patient position, port insertion, technical aspects of intestinal resection and perioperative management. In particular, a diamond configuration for ports was agreed upon. Data were prospectively collected, and included patient demographics, operative times, conversion rates and postoperative outcomes. Unless otherwise indicated, data are presented as medians with ranges. **Results:** Seven procedures were carried out in six patients (three female) aged 14 (11–14) years. Access to the entire abdominal cavity, vision and ergonomics were excellent in all. There were no conversions to open surgery. In all procedures, the technique was considered safe and effective. The length of hospital stay was 6.5 (5.8–14) days. **Conclusion:** A standardised protocol including the use of the diamond port configuration has several putative advantages for laparoscopic bowel resections and anastomoses. These include efficiency, reproducibility, predictability, good visibility and excellent ergonomics. We recommend this approach as a means to shorten the procedure-specific learning curve of the laparoscopic team.

**Key words:** Inflammatory bowel disease, laparoscopic colorectal surgery, laparoscopy, learning curve, standardisation

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## INTRODUCTION

The role of laparoscopy in children who require small bowel or colonic interventions has evolved from diagnostic[1] to resectional surgery.[2] Although minimal access surgery has been shown to be effective in this cohort of patients, the approach has not yet gained the same popularity in paediatric as it has in the adult practice.

The reluctance to perform laparoscopic bowel resections and anastomoses may, in part, reflect a lack of training opportunities and the perception that the laparoscopic approach involves a steeper learning curve, longer operating times and greater equipment costs. Laparoscopic surgery for inflammatory bowel disease (IBD) may be technically challenging. For example, the presence of thickened mesentery and friable bowel may increase the difficulty and prolong operating times when compared with open surgery. However, minimal access surgery can offer improved short- and long-term outcomes for patients.[3,4] Recent series from the adult and paediatric literature report quicker return to diet, reduced time to first bowel motion and shorter postoperative length of stay.[2-4]

Familiarity with technique and repetition enhance laparoscopic efficiency. Standardisation of operating equipment, technique and perioperative care can help to overcome challenges and diminish variation in results. The process also affords the ability to provide benchmarks for mastering the operative procedure and minimising adverse outcomes.[5]

A number of standardised port site configurations for minimally invasive surgery have been described. The "Baseball Diamond" concept has been used in laparoscopic cholecystectomy[6] and thoracoscopic surgery,[7] where this trocar arrangement aims to give 60° instrument angles, facilitating triangulation. When applied to a "fixed target" such as the prostate, laparoscopic surgery and, in particular, robotic-assisted

surgery is enhanced by standardising port positions.[8-11] Many surgeons modify trocar placement based on intuition, experience and individual patient geometry. However, for less-experienced surgeons, the flexible approach may lead to operator indecision, unprepared theatre staff and longer operating times and inefficient utilisation of theatre resources. By standardising the laparoscopic technique in the same way as has been successfully done with open colorectal surgery, the team-learning curve may be shortened and technical challenges overcome without compromising patient safety and outcome.[5,12-14]

We have developed and utilised a standardised protocol for theatre layout and perioperative care in adolescents undergoing bowel resections and anastomoses. In particular, the port site arrangement is predetermined. The aim of this paper is to evaluate and report our early experience with this standardised arrangement.

## MATERIALS AND METHODS

A strategic service development plan led to the commencement of a laparoscopic service for adolescents with bowel disorders. Members of a steering group for developing paediatric laparoscopy [Paediatric Minimal Access Group (PMAG)] included surgeons, anaesthetists and nursing staff. Procedures routinely carried out within the group included laparoscopic hernia, cholecystectomy and fundoplication. No paediatric team members had previously carried out laparoscopic colectomy. An adult colorectal surgeon (JNM) provided procedure-specific surgical mentorship to the team. Nursing mentorship was provided by the theatre lead for minimal access surgery. A standardised protocol for intestinal resections was agreed upon at a monthly PMAG meeting. This covered patient position, port insertion, technical aspects of intestinal resection and perioperative management. In particular, a diamond configuration for ports was agreed upon.

From January 2009 to June 2010, adolescents who underwent elective laparoscopic intestinal resection and/or anastomosis at King's College Hospital were entered into the study. The data were collected prospectively, and included patient demographics, disease-specific characteristics, intraoperative variables, conversion rates and postoperative outcomes. Unless otherwise indicated, data are presented as median with ranges.

### Operative Technique

Procedures were performed with the patient under general anaesthesia, with muscle relaxant and an endotracheal tube in the supine or lithotomy position. Placement of a nasogastric tube and urinary catheter was routine. A Force Triad Energy Platform Valleylab™ (Tyco Healthcare UK Ltd., Hampshire, UK), a 5-mm disposable LigaSure™ and two laparoscopic stacks (Karl Storz Endoscopy UK Ltd., Slough, UK), one on either side of the patient were utilised and arranged in the theatre in a standard configuration [Figure 1].

The patients were secured to the table using broad Elastoplast® at two or three points: The top of the chest and shoulders, across the hips and across the legs below the knees [Figure 2]. This allowed exaggerated table rotation and tilts, facilitating excellent access to the pelvis, hepatic or splenic flexures and both paracolic gutters [Figure 3]. The abdomen was prepared with povidone iodine and surgical drapes were placed.

A "diamond port configuration" (DPC) was utilised [Figure 4]. Where an extraction incision to remove the diseased bowel was anticipated, a periumbilical cut-down was made in the skin prior to insertion of a blunt 5–12 mm port through the rectus fascia. Pneumoperitoneum was established at 10–15 mmHg using a flow rate of 0.5–2 L/min. A minimum of two additional 5 mm ports were inserted in the appropriate part of the diamond under direct vision with a 30° camera. If the planned operation was a right hemicolectomy or a small bowel resection, the right lower quadrant port was not used. Where a left-sided colonic, rectal resection, subtotal colectomy or proctocolectomy with ileoanal pouch was planned, a 5–12 mm port was inserted in the right lower quadrant to accomodate an endoscopic linear stapler for bowel transaction (Endopath® ETS Ethicon Endo-Surgery, Wokingham, UK). The entire laparoscopic procedure was performed with the ports in these positions.

The principles of bowel mobilisation include minimal, nontraumatic bowel handling, appropriate tension, traction and counter traction to facilitate identification of tissue planes and precise use of the energy source. When the diseased segment of the bowel was mobilised sufficiently, the umbilical camera port was removed and the defect was enlarged to allow exteriorisation of the bowel. An Alexis® (Applied Medical, London, UK) wound retractor could then be inserted through the umbilical defect, providing circumferential atraumatic retraction, to allow delivery and bowel resection or stapling of the affected segment of the bowel [Figure 5]. When indicated, a stapled anastomosis was performed using the TLC 75 stapler (Ethicon Endo-Surgery, UK) and the stapled layer was oversewn with a 4.0 PDS and the bowel returned to the abdomen via the Alexis.

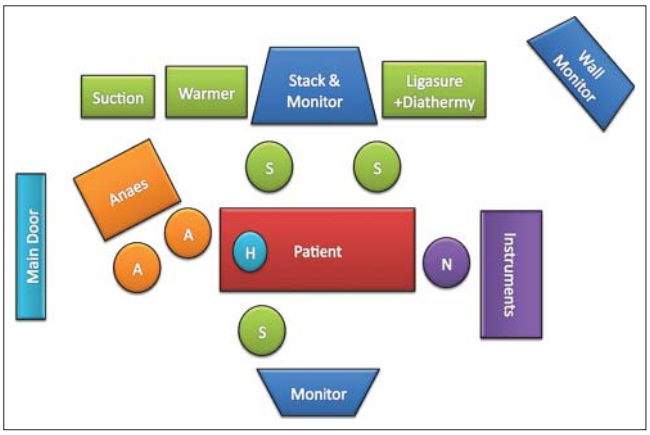



**Figure 1: Schematic representation of the theatre set-up for bowel resections**



**Figure 2: Secure patient strapping**



**Figure 3: Exaggerated patient position to facilitate laparoscopic access**



**Figure 4: Diamond port position marked out on the skin**

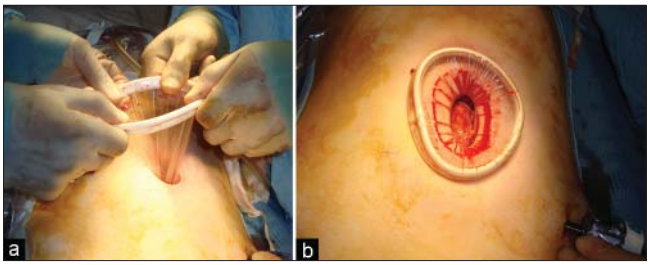



**Figure 5: (a and b) Application of and exteriorisation of the bowel with the "Alexis" wound retractor**

To complete the procedures, the peritoneal cavity was irrigated with warm normal saline and the umbilical incision was closed with 1.0 and 4.0 Vicryl (Polyglactin 910, Ethicon, London, UK). Port sites were closed with 4.0 Vicryl (Ethicon, UK) and Dermabond® (Ethicon, UK). Nasogastric tubes were removed postoperatively. All patients had opiate analgesia delivered via patient-controlled analgesia and were offered a clear liquid diet on postoperative day 1. The patients were advanced to a solid diet as tolerated.

## RESULTS

Six adolescents aged 14 (11–14) years underwent surgery in the study period. Three were female. Three patients had Crohn's disease, two had ulcerative colitis and one patient had familial adenomatous polyposis (FAP). Four colorectal resections (including a procto-colectomy and ileo-anal pouch), two small bowel resections and one ileo-rectal anastomosis were performed. The patient demographics, procedure, operative time and postoperative course are detailed in Table 1. The diamond port technique was used successfully in all procedures without the requirement for placement of additional ports or conversion to open surgery. Access to all areas of the abdomen and pelvis and ergonomics were excellent. There were no intraoperative bleeding complications, anastomotic leaks or mortality.

The mean operative time for a right hemicolectomy was

**Table 1: Demographics and surgical data**

| Age | Sex | Diagnosis | Procedure | Operative time (mins) | Hospital stay (days) |
|---|---|---|---|---|---|
| 14 | F | Crohn's disease | Right hemicolectomy | 208 | 7 |
| 14 | M | FAP | Procto-colectomy and ileoanal pouch | 365 | 15 |
| 13 | F | UC | Total colectomy and ileostomy | 252 | 6 |
| 10 | M | UC | Total colectomy and ileostomy | 262 | 13 |
| 11 | F | Crohn's disease | Ileal segmental resection | 190 | 5 |
| 15 | M | Crohn's disease | Right hemicolectomy | 175 | 6 |

187 min. One patient had a suspected but unconfirmed pulmonary embolus and one patient required ileostomy revision on postoperative day 8. The length of hospital stay for all procedures was 6.5 (5.8–14) days.

## DISCUSSION

The importance of the learning curve in the development of a minimal access programme is well established. The majority of the reports, however, refer to a generic learning curve for the lead surgeon. The importance of the whole team or institutional learning curve (ILC) has received scant attention. In addition, it is clear that even for experienced teams, there is a procedure-specific learning curve. The results presented in this report suggest that outcomes approximating those of teams more experienced at performing adolescent colectomy can be achieved by careful multidisciplinary planning, collaboration with mentors who have procedure-specific experience and the development of clear protocols.

Adolescents with IBD usually require surgical intervention after prolonged periods on anti-inflammatory and immunosuppressive drugs or symptomatic treatments that have failed to control their disease process. Those with familial adenomatous polyps (FAP) have usually been symptomatic for long periods prior to surgery. Minimising postoperative pain, incisional scarring, the risk of adhesions and time off school is very important in this group of patients. While intestinal resection for adolescents is at the complex end of the laparoscopic spectrum, putative benefits may outweigh the risks in a carefully designed and well-supported programme.

Based on the available evidence, a strategic service development plan was agreed with managers and led to the commencement of a laparoscopic service for adolescents with bowel disorders. In order to mitigate the risks, plans were made to ensure that the ILC would be as short as possible. At the start of the programme, PMAG requested procedure-specific mentorship from an adult colorectal surgeon (JNM) and the lead theatre nurse for minimal access. Following discussions with the mentors, a standardised protocol for intestinal resections was agreed upon during the PMAG meetings. This covered staff, patient and instrument positions, port insertion, technical aspects of intestinal resection and perioperative management. In particular, a diamond configuration for ports was agreed upon.

Protocols for setting up and performing the procedure were colour printed, laminated and displayed prominently in the theatre, ensuring that each member of the team had appropriate and ready access to information regarding their specific role.

Comparative adolescent data for paediatric laparoscopic colorectal procedures is limited and the results of this study are also compared with those of recent adult reports. The operative time and number of days to discharge after laparoscopic right hemicolectomy as well as total colectomy and ileostomy using the DPC compare favourably with results reported in recent series.[15,16]

Specific advantages of the laparoscopic approach to segmental Crohn's disease in children include discharge 2.2 days earlier than those undergoing open surgery (5.4 vs. 7.6; $P<0.05$).[17] Von Allmen also demonstrated a shorter time to discharge, with a median of 5.5 days in the laparoscopic group and 11.5 days in the open group,[18] in addition to a shorter duration of parenteral medication use in the laparoscopic group (3 vs. 5 days) and a shorter time to full diet (3 vs. 5 days). Both studies concluded that the laparoscopic approach could be safely and effectively applied to the paediatric population.

There are few reports comparing laparoscopic with open approaches for the surgical treatment of ulcerative colitis in children. However, results favouring the laparoscopic approach have been demonstrated in adult patients by an American group from the Cleveland Clinic Association in Ohio. Here, they performed a case-matched comparison of open versus laparoscopic restorative proctocolectomy for ulcerative colitis and FAP. The median operative times were longer (100 min) in the laparoscopic group, but bowel function returned more quickly (2 days vs. 4 days) and length of stay

was shorter (6 days vs. 8 days) in the laparoscopic cases.[19] Procter demonstrated longer laparoscopic operating times (280–145 min in the open group). In this report, there was no difference between the two groups in length of postoperative stay or intravenous analgesia use, although ileostomy output occurred earlier (2.5 days vs. 3.8 days), with a trend towards earlier oral intake. They concluded that laparoscopic subtotal colectomy can be performed safely in children with improved cosmesis and earlier return to normal bowel function.[20]

Increased hospital costs have been cited as a potential disadvantage of laparoscopic colorectal procedures, largely as a result of longer operating times and expensive, often disposable, equipment. However, with many trials demonstrating an earlier time to discharge in patients following laparoscopic procedures, a group from the Mayo clinic (Rochester, MN, USA) performed a case–control study looking at total costs following laparoscopic and open ileo-colic resection for Crohn's disease.[21] They demonstrated that patients in the laparoscopic group had less postoperative pain, tolerated a regular diet sooner by 1–2 days and had a shorter length of hospital stay by 3 days (4 vs. 7 days). Despite higher operative costs, they demonstrated that the patients in the laparoscopic group had overall mean costs that were more than $3000 less than those in the open group. Other groups have since found similar results.[22]

A standardised protocol including the use of the DPC has several putative advantages for laparoscopic bowel resections and anastomoses. These include efficiency, reproducibility, predictability, good visibility and excellent ergonomics. We recommend this operational and technical approach as a means to shorten the procedure-specific learning curve of the laparoscopic team.

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