Single site multiport umbilical laparoscopic appendicectomy versus conventional multiport laparoscopic appendicectomy in acute settings

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ABSTRACT

INTRODUCTION Although conventional multiport laparoscopic appendicectomy (CMLA) is preferred for managing acute appendicitis, the recently developed transumbilical laparoscopic approach is rapidly gaining popularity. However, its wide dissemination seems restricted by technical/technological issues. In this regard, a newly developed method of single site multiport umbilical laparoscopic appendicectomy (SMULA) was compared prospectively with CMLA to assess the former's efficacy and the technical advantages in acute scenarios.

METHODS Overall, 430 patients were studied: 212 in the SMULA group and 218 in the CMLA group. The same surgeon performed all the procedures using routine laparoscopic instruments. The SMULA technique entailed three ports inserted directly at the umbilical mound through three distinct strategically placed mini-incisions without raising the umbilical flap. The CMLA involved the traditional three-port technique.

RESULTS Both groups were comparable in terms of demographic criteria, indications for surgery, intraoperative blood loss, time to ambulation, length of hospital stay and umbilical morbidity. Although the mean operative time was marginally longer in the SMULA group (43.35 minutes, standard deviation [SD]: 21.16 minutes) than in the CMLA group (42.28 minutes, SD: 21.41 minutes), this did not reach statistical significance. Conversely, the mean pain scores on day 0 and the cosmetic outcomes differed significantly and favoured the SMULA technique. None of the patients developed port site hernias over the follow-up period (mean 2.9 years).

CONCLUSIONS The favourable outcomes for the SMULA technique are likely to be due to the three small segregated incisions at one place and better trocar ergonomics. The SMULA technique is safe in an acute setting and may be considered of value among the options for transumbilical appendicectomy.

KEYWORDS

Acute appendicitis – Laparoscopic appendicectomy – Single site appendicectomy – Umbilical surgery

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Although conventional multiport laparoscopic appendicectomy (CMLA) is preferred over the open technique, the current trend seems to favour the transumbilical approach with a reduced number of ports, in an attempt to obtain better results.¹ However, the technical challenges faced during the procedure are likely to hinder its wide acceptance. In this context, a recently developed method of single site multiport umbilical laparoscopic appendicectomy (SMULA) using three distinct ports inserted directly on the umbilical mound (without raising the umbilical flap) in a unique way was found to be feasible for acute appendicitis.² In an attempt to further assess its efficacy and advantages, this prospective observational study was conducted comparing SMULA and CMLA.

Methods

Between March 2009 and August 2011, 430 patients of a variety of acute appendicular pathologies underwent a minimally invasive appendicectomy by either the SMULA ($n=212$) or the CMLA techniques ($n=218$). Patients unfit for a laparoscopy and those with appendicular lump formation were excluded from the study. The type of operation performed was subject to patient preference. Informed consent was obtained from all patients. All were operated on by the same surgeon using routine laparoscopic instruments.

SMULA technique

The patient was placed supine with a 25–30° head-down and right-up tilt. The surgeon stood to the left of the

Figure 1 The single site multiport umbilical laparoscopic appendicectomy porting technique: The path of umbilical skin entry (AB) is turned outwards in the subcutaneous tissue (BC) before puncturing the anterior rectus sheath (CD) followed by the posterior rectus sheath and the peritoneum (DE). In presence of pneumoperitoneum, these peculiar 'lazy S' trocar pathways (ABCDE and FGHIJ) tend to obtain an adequate tissue purchase for optimum intertrocar distancing. Inset: The fascial entries (dotted lines) of the trocar are away from the respective skin entries (solid lines).

patient and the camera assistant stood to the left of the surgeon. A Veress needle was inserted at the 7 o'clock position on the umbilical mound for creating a pneumoperitoneum. A 10mm trocar was inserted through an adequate curvilinear incision placed at that site. This trocar travelled a peculiar 'lazy S' path before puncturing the fascia (Fig 1). Similarly, two 5mm trocars were inserted (at 3 and 11 o'clock) on the umbilical mound (Fig 2).

The camera trocar was kept withdrawn and the working trocars were advanced further by 8–10mm. The surgeon stood on a 15cm high wooden stool during the entire procedure. This entire assembly was planned so as to reduce collisions between the surgeon and the camera person, offering adequate 'elbow space' for both of them, and to achieve wide triangulation of the operating trocars.

Once the mesoappendix was dissected with monopolar electrosurgery, the appendix was excised after dividing the base between two catgut endoloops. The specimen was

Figure 2 Trocar assembly. Note that the 10mm trocar (A, 7 o'clock) along with the two 5mm trocars (B and C, 3 and 11 o'clock) form an ergonomic triangle on the umbilical mound. Inset: The post-pneumoperitoneum stretching of the umbilicus adds to the distance between the trocars while maintaining the triangulation.

extracted via an endobag. The fascial rents at all three ports were closed with 3/0 polyglactin sutures and the skin incisions closed with a monofilament subcuticular suture.

CMLA technique

The umbilicus was used for creating the Veress needle pneumoperitoneum. As per our institutional policy, two 10mm (umbilical and suprapubic) ports and one 5mm (right iliac fossa) port were used for better clarity of vision and to reduce instrument exchanges. On the other hand, depending on the surgeon's preference, one 10mm trocar and two 5mm trocars can be used. Further steps were in accordance with the traditional laparoscopic appendicectomy. The specimen was extracted through an endobag. All three fascial rents were closed with 3/0 polyglactin and the skin with monofilament subcuticular sutures.

Perioperative management

All patients received a 1.0g injection of cefotaxime at induction of anaesthesia and they continued to receive this antibiotic in oral form during the rest of their stay. Once no longer under anaesthesia, patients commenced liquids, followed by solids. Unsettled pain was dealt with by injecting non-steroidal anti-inflammatory drugs. Opioid analgesics were not used in this study. Patients were discharged when fully ambulatory and on a regular diet.

Data collection

Given the suboptimal educational and socioeconomic background of our rural patients, an easy-to-use scar grading scale was developed based on their subjective feeling

about the scars they received (1 = thrilled, 2 = happy, 3 = not bothered, 4 = unhappy). It assessed the cosmetic results on a gross scale. The visual analogue scale (VAS) was used to assess postoperative pain with a range of 0–10.

Local ethics committee approval was granted for this study. The data were collected prospectively, incorporating patient demographics and perioperative outcomes including operative time, intraoperative blood loss, time to ambulation, length of hospital stay, VAS pain score and scar grading score. Being a government institution that provides free treatment to patients, a formal cost analysis was not possible in this study.

Statistical analysis

Using SPSS® version 10.0 (SPSS, Chicago, IL, US), the Pearson's chi-squared test was applied to evaluate statistical differences between the variables. Differences were considered statistically significant if the *p*-value was <0.05. The variables were tested for normality using the Shapiro–Wilk test. If the data were not normally distributed, the Mann–Whitney U test was applied to assess the results.

Results

The patient cohorts of both the groups (SMULA: 49.3%, CMLA: 50.7%) were comparable. The mean age and comorbidities were slightly higher in the CMLA group than in the SMULA group. The mean body mass index (BMI) was slightly higher for the SMULA patients than for the CMLA patients. However, these differences were not statistically significant. The indications for surgery were similar (Table 1).

Table 2 shows the comparative clinical data. The differences in mean operative time (defined as the time interval between Veress needle entry and last port closure), blood loss, time to ambulation and length of hospital stay were not statistically significant. Similarly, although the mean postoperative requirement for analgesics was higher for CMLA (2.0 days) than for SMULA (1.7 days), this did not reach statistical significance.

The mean VAS pain scores on postoperative days 1, 7 and 30 were somewhat higher for CMLA than for SMULA but, again, this was not statistically significant. Nevertheless, the mean VAS pain score on day 0 for the CMLA group was significantly worse than that for SMULA patients (2.97 [standard deviation (SD): 1.11] vs 2.68 (SD: 0.90), *p*=0.0161) (Fig 3). Furthermore, the mean scar grading score was significantly better for the SMULA group than for the CMLA group (1.17 [SD: 0.42] vs 1.74 [SD: 0.58], *p*<0.0001) (Fig 4).

While the CMLA patients did not have viscus injuries intraoperatively, the SMULA group had two patients with electrosurgical injury to the caecum. Both were sutured successfully with the intracorporeal technique without adding an extra trocar. They recovered well postoperatively.

The conversion rate from SMULA to conventional laparoscopy was 1.9% (*n*=4). Two of the four converted cases were retrocaecal acute appendicitis patients, for whom a total appendicectomy was otherwise not possible. The

Table 1 Patient characteristics

	SMULA	CMLA
Cohort	212 (49.3%)	218 (50.7%)
Male-to-female ratio	148:64	165:53
Mean age (years)	33.79 (SD: 12.61)	35.30 (SD: 13.37)
Mean BMI (kg/m ²)	24.13 (SD: 2.02)	23.61 (SD: 2.40)
<i>Co-morbidities</i>		
HT	18	18
DM	16	34
COPD	11	7
HT + DM	9	11
Old MI	9	7
<i>Indications for surgery</i>		
Acute appendicitis	140	146
Perforated appendicitis	36	33
Gangrenous appendicitis	28	31
Appendicular mucocoele	8	8
<i>ASA grade</i>		
1	118	114
2	86	92
3	8	12
4	0	0
SMULA = single site multiport umbilical laparoscopic appendicectomy; CMLA = conventional multiport laparoscopic appendicectomy; BMI = body mass index; HT = hypertension; DM = diabetes mellitus; COPD = chronic obstructive pulmonary disease; MI = myocardial infarction		

other two were gangrenous appendicitis patients in whom conversion was necessary for adequate suturing of the appendix bases. Apart from these patients, no one needed an extra trocar.

In addition, the procedures for two patients (0.9%) from the SMULA group (both perforated) were converted to an open appendicectomy. One of them had an uncontrolled appendicular artery bleed and the other had dense retroperitoneal adhesions. Similarly, two patients (0.9%) from the CMLA group were converted to the open method owing to intense adhesions to the lateral parietes. Both of these were perforated appendicitis cases. In the SMULA group, a tube drain was inserted through the 11 o'clock 5mm port in five patients with a perforated appendix with surrounding pus. In the CMLA group, the tube drains were inserted via the 5mm right iliac fossa port in six patients; four of them had perforated and two had gangrenous appendices.

In terms of umbilical morbidity, seven patients (3.3%) from the SMULA group and five (2.5%) from the CMLA group developed umbilical seromas. All of them recovered well with close observation and monitoring. Although more patients from the SMULA group had a perforated appendicitis than from the CMLA group, the rate of umbilical sepsis was higher for the CMLA patients (1.4% vs 0.9%). All these patients had a good recovery with a five-day course of oral

Table 2 Comparative clinical data

	SMULA (n=212)	CMLA (n=218)
Mean operative time in minutes	43.35 (SD: 21.16)	42.28 (SD: 21.41)
Mean blood loss in ml	12.11 (SD: 11.50)	13.98 (SD: 17.50)
Mean VAS score on day 0	2.68 (SD: 0.90)*	2.97 (SD: 1.11)*
Mean VAS score on day 1	1.58 (SD: 0.81)	1.70 (SD: 0.82)
Mean VAS score on day 7	0.03 (SD: 0.23)	0.04 (SD: 0.19)
Mean VAS score on day 30	0	0
Mean time to ambulation in hours	4.80 (SD: 1.54)	4.89 (SD: 1.81)
Mean length of hospital stay in days	1.41 (SD: 1.06)	1.67 (SD: 1.54)
Scar grading score	1.17 (SD: 0.42)**	1.74 (SD: 0.58)**

SMULA = single site multiport umbilical laparoscopic appendicectomy; CMLA = conventional multiport laparoscopic appendicectomy; VAS = visual analogue scale; SD = standard deviation
* $p=0.0161$; ** $p<0.0001$

cefotaxime. Both the groups were comparable as regards these umbilical morbidities. Nobody from this study population developed umbilical ischaemic necrosis. No patients developed a port site hernia during the follow-up period (mean duration of 2.9 years). There was no mortality in this study.

Discussion

A meta-analysis of 13 studies (893 patients) published in 2013 supports single incision appendicectomy over CMLA owing to comparable results and better cosmesis.⁵ However, it is mainly suited to non-perforated acute appendicitis cases.⁴ Moreover, it needs a skin/fascial incision, which may extend even up to 3.5cm.^{5,6} Such a large cut significantly increases the postoperative pain⁷ and the rate of incisional hernias, thereby shadowing the advantages of minimally invasive surgery.⁸ Furthermore, the instruments used are expensive, require handling expertise and do not follow the triangulation principle.⁹ Further technological advancements are therefore necessary to abate its difficult ergonomics.¹⁰ In this context, the SMULA technique came up with measures that could reduce the interferences and collisions due to the closely placed trocars by increasing the interface between them as well as the surgeon and the camera holder.² This helped in carrying out appendicectomies successfully without many problems.

According to the available literature, the operative time for single incision appendicectomies varies widely

Figure 3 Mean visual analogue scale (VAS) scores at different time intervals for single site multiport umbilical laparoscopic appendicectomy (SMULA) and conventional multiport laparoscopic appendicectomy (CMLA) groups

(15–88 minutes).¹¹ Nevertheless, it can be reduced significantly by modifying the existing single port technique.¹⁰ Although our operative time for SMULA was slightly more than that for CMLA, this difference did not reach statistical significance. The longer duration of the initial procedures could be reduced gradually with increasing experience of our surgical team. Our learning curve levelled out after the initial 15 cases.

The requirement for additional ports and conversion to open appendicectomy is generally in the range of 0–41% and 0–21% respectively for patients undergoing single incision appendicectomy.¹¹ Our series did not require additional ports for any patient owing to our study policy of opting directly for conventional laparoscopy when indicated. Moreover, the rate of conversion to a standard laparoscopy in the SMULA group was 1.9%. This is likely to be a result of improved operative ergonomics of the technique.

Umbilical wound infection in single port surgery is reported in 0–14% of cases.¹¹ Both groups in our series showed low umbilical infection rates (0.9% and 1.4%). All these patients belonged to the perforated appendicitis group and recovered completely with a course of antibiotics. Preoperative meticulous umbilical cleaning with chlorhexidine and the use of endobags for all patients probably helped in reducing umbilical contamination in this series. Furthermore, as the step of raising the umbilical flap was circumvented, the rate of umbilical seroma formation (3.3%) and navel ischaemia (0%) could possibly be minimised. This, in turn, might have helped reduce the rate of umbilical infection.

An elegant microvascular dissection study by O'Dey *et al* emphasised the importance of the direct relationship between the integrity of the posterior loose areolar fascia covering the rectus abdominis and the blood supply of the papilla umbilicalis.¹² In that context, a large umbilical fascial incision employed in single incision umbilical surgery may damage the umbilical vascularity;¹² it may also subsequently lead to an increase in the rate of incisional hernias that can be quite alarming (even up to 8.4%).⁸

Although long-term monitoring is necessary, our study did not have any incisional hernias over the follow-up period (mean duration: 2.9 years). This could be a result of the following factors. First, instead of a single big cut, three mini-incisions were used that reduced access trauma. Second, the oblique trocar trajectories avoided overlapping of the entry and the exit punctures, and tended to protect the umbilical blood supply. Third, there was lower rate of umbilical infective complications. Finally, as per policy, all the ports (including the 5mm ports) were closed meticulously under direct vision.

Regarding surgical expenses, although we have not performed a cost analysis, we feel that SMULA has the potential to reduce the cost of surgery as follows:

- > **Direct factors:** (a) Unlike single port surgery, SMULA does not employ any special equipment such as the multichannel operating port and reticulating instruments, which are costly and not reusable. Instead, day-to-day laparoscopic instruments are used. This could potentially save on product costs as well as

sterilisation costs. (b) No special energy sources are used during SMULA. This also tends to save on costs.

- > **Indirect factors:** (a) Reduction in umbilical morbidity (by limiting umbilical seroma formation) may reduce the postoperative costs of treating morbidity. (b) Once the learning curve levels out (after around 15 cases), SMULA may be performed in an acceptable time-frame, which may save on operating room costs.

Study limitations

There are certain limitations to this study: (1) Although the patient cohort was fairly large, long-term follow-up is lacking, especially pertaining to port site hernia formation. (2) It was not a randomised trial. (3) As only a single surgeon from a single institute was involved, there remains a need for assessing the technique's reproducibility by other surgeons. For its wider acceptance, multicentre experience involving surgical teams with diverse laparoscopic expertise is required. (4) In the CMLA group, instead of using two 5mm trocars and one 10mm trocar, two 10mm trocars and one 5mm trocar were used. This may have been the reason for the difference in pain scores between the groups. (5) An assessment of the learning curve and a cost analysis are lacking. (6) The objective evaluation of cosmetic outcomes and patient satisfaction is deficient.

Consequently, supplementary large volume randomised trials comparing SMULA and CMLA with long-term results are needed to draw more definitive conclusions. Moreover, randomised trials involving the SMULA technique and single incision laparoscopy for complicated appendicitis scenarios will help in making a better choice.

Conclusions

Appendectomy is safe in an acute setting using the SMULA technique, and has better early postoperative pain scores and cosmesis than CMLA. As a result, SMULA may be considered a useful alternative to transumbilical appendectomy.

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