Comparison of clinical outcomes of open, laparoscopic and single port appendicectomies

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ABSTRACT
INTRODUCTION Appendicectomy is the most common surgical procedure performed in general surgery. This study aimed to compare the outcomes of open appendicectomy (OA), laparoscopic appendicectomy (LA) and single port laparoscopic appendicectomy (SPLA).

METHODS Fifty consecutive patients with suspected acute appendicitis were studied (OA: n=20, LA: n=20, SPLA: n=10). Clinical outcomes were compared between the three groups in terms of operative time, blood loss, postoperative complications, length of hospital stay and cost.

RESULTS Patient demographics were similar among groups (p>0.05). SPLA was characterised by longer operative time (88.1 minutes vs 35.6 minutes in OA and 33.4 minutes in LA) and higher costs (12.84 thousand Chinese yuan [RMB] vs 8.41 thousand RMB in LA and 4.99 thousand RMB in OA). OA was characterised by more blood loss (9.8ml vs 7.5ml in SPLA and 6.8ml in LA), longer hospital stay (7.5 days vs 3.5 days in LA and 3.4 days in SPLA) and lower costs. The total number of complications was higher for OA (n=2) than for LA and SPLA (n=0) although this was not statistically significant.

CONCLUSIONS Where feasible, LA should be undertaken as the initial treatment of choice for most cases of suspected appendicitis.

KEYWORDS Laparoscopic appendicectomy – Single port laparoscopic appendicectomy – Open appendicectomy

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Appendicitis is one of the most common surgical emergencies requiring appendicectomy, with a lifetime risk of 6%.[1] It can be performed by open appendicectomy (OA), conventional laparoscopic appendicectomy (LA) or single port laparoscopic appendicectomy (SPLA). OA was introduced by McBurney in 1894 and has been the solid choice for appendicectomy for more than a century. However, the overall mortality rate of OA is around 0.3% and the morbidity rate is about 11%.[3]

In 1983 Semm described the first LA.[4] LA has been considered effective and safe in randomised comparisons with OA.[14] LA has improved diagnostic accuracy along with advantages in terms of fewer wound infections, less pain and faster recovery.[17] LA has become one of the most widely performed procedures using the laparoscope worldwide.[5,10] Despite this, it has not become the gold standard treatment for appendicectomy as with laparoscopic cholecystectomy for gallstone disease. LA consumes more operating time and is associated with increased hospital costs.[14] Some studies failed to demonstrate clear advantages for LA over OA.[15]

Along with the development of surgical instruments and technique, SPLA is being widely accepted, and has shown its technical feasibility and cosmetic results in several studies.[13,14] Nevertheless, SPLA has shown disadvantages such as more postoperative pain owing to the longer operative time and a large fascial incision compared with LA. The debate continues regarding whether the laparoscopic approach is better than the traditional open extirpation of the appendix. Numerous prospective studies have been published comparing LA and OA[15,16] as well as LA and SPLA.[13,14,15] However, no consensus has been reached for all patients with suspected acute appendicitis. In addition, studies comparing all three procedures are fewer in number, especially in developing countries. We therefore conducted a prospective study to compare the postoperative outcomes in terms of length of hospital stay, operating time, postoperative morbidity and cost.

Methods
All participants gave their informed consent prior to their inclusion in the study. The study was approved by the relevant ethics committee and performed in accordance with the ethical standards. All patients diagnosed at our hospi-
tal with acute appendicitis between 1 April 2011 and 1 April 2012 were enrolled in the study. Patients were diagnosed on a clinical basis with a history of right lower quadrant pain or periumbilical pain migrating to the right lower quadrant with nausea and/or vomiting, fever of more than 38°C and/or leucocytosis above 10,000 cells/ml, right lower quadrant guarding and tenderness on physical examination.

Fifty patients with the following conditions were included in our study: age between 15 and 60 years, diagnosis of acute appendicitis and completed follow-up study. The exclusion criteria included patients not diagnosed with acute appendicitis, those who had a palpable mass in the right lower quadrant or an appendiceal abscess and those who did not give consent. Patients were fully informed about the risks and benefits of the three procedures. By considering their request and our study design, the qualifying patients were divided into three groups (OA: n=20, LA: n=20, SPLA: n=10), for treatment purposes.

Surgical procedure
All operations were performed with patients in a supine position and under general anesthesia (Fig 1). In LA and SPLA, the mesoappendix was dissected using an ultrasonic knife, and the appendix base was tied and divided between two endoloops with laparoscopic scissors. An extraction bag was used to retrieve the specimen. The appendicular stump was not buried routinely (Fig 2). OA was performed through a gridiron incision in the standard fashion. The mesoappendix was ligated, and the appendix was divided at the base and removed without invagination. All specimens were sent intact for microscopic examination.

Postoperative management
All patients received a standard perioperative antibiotic regimen of intravenous cefuroxime and metronidazole. Pain management for both groups was achieved with intramuscularly injected non-steroidal anti-inflammatory drugs. Postoperative bowel sounds were checked every 12 hours. Patients were allowed to take a clear liquid diet once their bowel sounds were present. They were advanced to a regular diet when the liquid diet was tolerated and flatus passed. Patients were eligible for discharge when they tolerated a regular diet and had been afebrile for 24 hours.

Follow-up
Patients were invited to attend the outpatient clinic for three weeks. Stitches were removed on the first week. On the week 2 and week 3 appointments, patients were evaluated for any complications (eg intra-abdominal abscess formation, would infection). Patients were advised to report for development of any complications in the ten months following surgery.

Data collection
Data were collected on a specifically designed sheet where the patient’s demographic details, operative time, blood loss, postoperative complications, length of hospital stay and cost were recorded.

Statistical analysis
Statistical analysis was performed using SPSS® version 19.0 (SPSS, Chicago, IL, US). Frequencies and percentages of categorical parameters were calculated with a 95% confi-
Results

A total of 50 patients were enrolled in our study. There were no conversions in the LA or SPLA groups. The mean patient age was 39.7 years (standard deviation [SD]: 13.8 years), 34.0 years (SD: 7.3 years) and 32.5 years (SD: 8.0 years) in the OA, LA and SPLA groups respectively. No significant differences existed among the three groups in relation to age. Women preferred to undergo SPLA owing to the better cosmetic results. In all 50 eligible cases, surgical observation revealed an inflamed appendix. According to the histopathological report, all specimens had some degree of inflammation.

Operating time

The mean operative time was 35.6 minutes (SD: 10.2 minutes), 33.4 minutes (SD: 8.3 minutes) and 88.1 minutes (SD: 14.0 minutes) for the OA, LA and SPLA groups respectively. The mean operative time for SPLA was significantly longer than that of the LA and OA groups (both \( p < 0.05 \)). The difference of mean operative time between the LA and OA groups was not statistically significant.

Blood loss

The mean blood loss for the OA, LA and SPLA groups was 9.8ml (SD: 4.7ml), 6.8ml (SD: 4.1ml) and 7.5ml (SD: 4.5ml) respectively. Blood loss for the LA group was significantly lower than for OA patients (\( p = 0.04 \)).

Complications

There were no complications for LA or SPLA patients. In the OA group, two cases with complications (vomiting and paralytic ileus) were reported although the difference was not statistically significant (\( p = 0.15 \)).

Hospital stay

Length of hospital stay was significantly longer in the OA group with a mean of 7.5 days (SD: 3.7 days) compared with 5.5 days (SD: 0.6 days) for LA and 3.4 days (SD: 0.8 days) for SPLA patients (both \( p = 0.00 \)). There was no significant difference between the LA and SPLA groups (Table 1).

Costs

The mean costs for OA, LA and SPLA patients were 124.99 thousand Chinese yuan (RMB) respectively. There was a statistically significant difference between any two groups compared.

Discussion

Acute appendicitis is a common intra-abdominal inflammatory disease encountered in the general surgery department and surgical appendicectomy is the only treatment. OA had been the treatment of choice for more than a century before 1983, when LA was introduced by Semm.4 Multiple case series have now also described SPLA for the treatment of acute appendicitis.13–18 LA and SPLA are the major surgical advances in general surgery in the last two decades.

LA has been associated with several advantages including decreased pain, faster return to normal activities and lower incidence of complications.23,24 However, it also has disadvantages compared with OA, such as a longer operating time, increased costs and a higher incidence of intra-abdominal abscess.25,26 SPLA has the advantage of requiring only a single incision in the umbilicus, making it virtually scarless. A comparative study from 2011 suggested that operative time, doses of narcotics, surgical difficulty and hospital charges of SPLA were greater than those of LA.19 To date, no consensus has been reached on which procedure is the golden standard for acute appendicitis. Furthermore, few studies have been conducted in developing countries where minimally invasive surgery has not been established fully. This prospective comparative study aimed to compare

| Table 1 Comparison of variables among the three patient groups |
|-----------------|-----------------|-----------------|
|                | OA              | LA              | SPLA             |
| Mean age (yrs) | 39.7 (SD: 13.8) | 34.0 (SD: 7.3)  | 32.5 (SD: 8.0)   |
| Sex            | Male            | Female          |                  |
|                | 10 (50%)        | 10 (50%)        |                  |
|                | Female          | Male            | Female           |
|                | 7 (35%)         | 13 (65%)        | 0 (0%)           |
|                | 10 (50%)        | 10 (100%)       |                  |
| Mean operative time (mins) | 35.6 (SD: 10.2) | 33.4 (SD: 8.3)  | 88.1 (SD: 14.0)**|
| Mean blood loss (ml) | 9.8 (SD: 4.7)*  | 6.8 (SD: 4.1)   | 7.5 (SD: 4.54)   |
| Patients with complications | 2               | 0               | 0                |
| Mean length of stay (days) | 7.5 (SD: 3.7)** | 3.5 (SD: 0.6)   | 3.4 (SD: 0.8)    |
| Mean cost (thousand RMB)  | 4.99 (SD: 1.24)** | 8.41 (SD: 0.56) | 12.84 (SD: 0.72)**|

OA = open appendicectomy; LA = laparoscopic appendicectomy; SPLA = single port laparoscopic appendicectomy; SD = standard deviation; RMB = Chinese yuan

\*\( p<0.05 \); \**\( p<0.01 \) compared with LA
the postoperative outcomes of these procedures in clinically diagnosed acute appendicitis.

There was no conversion in the LA or SPLA groups in our study. Conversion among different procedures is subjective, based on the experience and expertise of the surgeon. Conversion rates from LA to OA range from 0% to upwards of 25%. Conversion from LA or SPLA to OA has a significant influence on the intraoperative and postoperative outcome assessment of the appendectomy. The most frequent reasons for conversion to OA were the technical difficulty in identifying the appendiceal base or a subjective failure to make progress during the procedure. Older patients have a higher likelihood of conversion, with severe acute inflammation being the most common reason for conversion. The lower incidence of conversion in our study may be due to the relative younger age (32.5 years for SPLA, 34.0 years for LA and 39.7 years for OA) and the smaller sample size.

The mean total operative time was significantly longer in the SPLA group than in the other two groups (p=0.00), this result is in line with a previous study. Longer operative time may translate to more stretching of the single umbilical wound and, consequently, more postoperative pain. Contrary to other reports that suggest the operative time for LA patients is significantly longer than for OA patients, our operative times were not statistically different between the LA and OA groups. This may be due to surgeon experience with LA at our institution. Laparoscopic operating time should improve with increasing experience.

Very few studies are available comparing blood loss among these three procedures. The mean blood loss in the OA group was significantly higher than that in LA patients (p=0.04). This is consistent with previous studies. In addition, the blood loss in the SPLA group was slightly higher than that in the OA group although there was no statistical difference (p=0.62). Our result is in agreement with a recent study. However, there are some reports that found that SPLA patients have a lower estimated blood loss.

Length of hospital stay is a very important variable but difficult to compare between studies because of the difference in surgical practices. The mean length of stay of the OA group in our study was double that of the LA and SPLA groups (7.5 days vs 3.5 days and 3.4 days respectively). Patients undergoing SPLA exhibited the shortest hospital stay. In our study, the appendiceal pathology was similar in the three groups. Similar to other authors, we found the length of stay was determined by surgical approach rather than the degree of appendiceal inflammation.

LA and SPLA have been attributed to a low incidence of complications compared with OA in many studies. Correspondingly, our study demonstrated two complications in the OA group with no complications in the LA and SPLA groups.

The majority of studies have concluded that wound infection is significantly less common after LA. In our study, there was no wound infection. Nevertheless, two patients in the OA group suffered from vomiting and paralytic ileus following surgery.

There are some limitations to our study. The first is the relatively small sample size, especially in the SPLA group. Moreover, we did not assess the pain after the three procedures. Further comparisons between these three procedures are still needed to draw more solid conclusions.

Conclusions

This study demonstrated that SPLAs and conventional LAs are safe and clinically beneficial operative procedures. They provide certain advantages over OA, including less blood loss, fewer complications and shorter hospital stay. However, the operative time and costs for the SPLA group are both higher than for LA patients if feasible, LA should be undertaken as the initial treatment of choice for most cases of suspected appendicitis. As the sample size in our study was relatively small, further comparisons based on a larger sample size are still needed in future.

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