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Laparoscopic Management of Complicated Appendicitis: Two years experience in a tertiary care hospital in Dhaka, Bangladesh

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Abstract
Background: *The role of laparoscopic appendectomy (LA) in complicated appendicitis (CA) remains debated due to concerns over infectious complications and operative difficulty. This study prospectively compared outcomes between laparoscopic and open appendectomy in CA.*
Methods: *Over two years, adults presenting with diagnosis of acute appendicitis were assigned to LA or open appendectomy (OA). Primary endpoint was postoperative intra-abdominal abscess (IAA). Secondary endpoints included operative time, conversion rate, hospital stay, wound infection, morbidity and cost.*
Results: *Of 90 patients, 62 underwent LA and 28 OA. IAA occurred in 6.7% of LA vs 10% of OA (p=0.34). Operative time was longer in LA (75±20 vs 60±18 min; p<0.01). LA group had shorter hospital stay (3.2±1.1 vs 4.8±1.5 days; p<0.001). Wound infection was lower in LA (4% vs 12.5%; p=0.03). Conversion to open was necessary in 11.3% of LA. Average procedural cost was 15% higher for LA.*
Conclusion: *Laparoscopic appendectomy in complicated appendicitis demonstrates favorable outcomes in terms of lower IAA rates, significantly lower wound infection, and shorter hospitalization compared to open surgery. LA should be considered first-line in CA when performed by skilled surgeons.*
Keywords: *Laparoscopic Appendicitis, complicated appendicitis, complications, Bangladesh*

I. Introduction

Laparoscopic appendectomy (LA) has become an increasingly preferred approach for managing appendicitis since its first report by Semm in 1983. LA offers enhanced visualization of the peritoneal cavity through small incisions, which facilitates precise surgical intervention while minimizing tissue trauma.[1] Complicated appendicitis (CA) encompassing appendiceal perforation, gangrenous appendix, abscess formation, phlegmon, or gangrenous changes poses a significant diagnostic and therapeutic challenge in acute care surgery. Traditionally, open appendectomy (OA) is the mainstay of treatment for CA.[2] OA for complicated appendicitis typically involves a larger incision, prolonged operative time, and increased surgical stress. This can lead to greater exposure of the wound to contaminated fluids, increasing the risk of postoperative infections. On other hand, LA is hypothesized to offer clinical advantages such as reduced wound contamination, improved access for peritoneal lavage, and a lower incidence of wound infections.[1] Despite these theoretical benefits, the role of LA in complicated appendicitis remains controversial. However, with the advancement of laparoscopic skills, instrumentation, and perioperative management, laparoscopic appendectomy (LA) has become increasingly accepted and practiced in management of CA. Multiple studies and meta-analyses now demonstrate that LA in CA results in shorter hospital stays, reduced postoperative pain, faster return to normal activity though post operative complication rates compared to open surgery remains in controversy, particularly regarding intra-abdominal abscess formation.[2,3] Patient and disease related factors—like elevated CRP or WBC, delayed surgery, advanced age, and appendicolith—have been shown to significantly increase complications, hospital stay,

conversion risk, and readmission rates. Moreover, surgeon experience, timing of intervention, and individualized preoperative optimization play crucial roles in determining patient outcomes.[3] The choice of technique for stump closure in gangrenous or perforated appendices (endoloop, laparoscpic clips, endostapler, or sutures like intracorporeal suturing—with or without purse-string) continues to be debated, although recent studies suggest that endoloops and clips offer safe, cost-effective alternatives to staplers, even in the context of severe inflammation.[4,5] Use of rational antibiotic is also a critical component of CA management. Contemporary protocols advocate for evidence-based, case specific antibiotic regimens with shorter durations to prevent infectious complications and reduce resistance, while ensuring adequate coverage for polymicrobial flora typical of appendiceal rupture.[6] As the surgical paradigm shifts toward minimally invasive approaches, understanding the shades of laparoscopic management in CA becomes essential. This study aims to consolidate current evidence on the laparoscopic treatment of complicated appendicitis, examining surgical techniques, perioperative care and clinical outcomes. The mode and extent of complications also has been studied to support best practices in modern emergency surgery. Despite longer operative times and higher costs for LA, its utility in CA is supported by growing evidence favoring minimally invasive approaches in suitable patients.[3]

II. Materials and Methods

Study Design and Setting

A prospective observational comparative study was conducted at Dhaka Community Medical College and Hospital, Moghbazar, Dhaka, Bangladesh, between January 2021 and December 2022, after obtaining institutional ethics approval and written informed consent from all participants.

Patient Selection

A. For LA group:

Inclusion criteria:

Adults ≥18 years diagnosed intraoperatively with CA (perforation, gangrene, abscess, or phlegmon).

Exclusion criteria:

Age <18, pre-operatively with CA (perforation, gangrene, abscess, or phlegmon), pregnancy, immunocompromised status, or refusal of consent.

B. For OA group:

Inclusion criteria:

Adults ≥18 years diagnosed pre-operatively with CA (perforation, gangrene, abscess, or phlegmon).

Exclusion criteria:

age <18, pregnancy, immunocompromised status, or refusal of consent.

Sample size:

Purposive sampling done. A total 90 patient were enrolled in the study. 62 patients were in LA group and 28 were in OA group.

Surgical Approach: Patient who were diagnosed as acute appendicitis without features of complication upon the basis of clinical and laboratory findings, were prepared for LA. LA comprised three-port technique. Upon creation of pneumoperitoneum, telescope was introduced and thorough peritoneal survey done. Patients diagnosed CA per-operatively were enrolled in the group of LA. Appendectomy done with peritoneal irrigation; stump closure applied via endoloop, suture or laparoscopic clip. In patient with per-operative findings of appendicular abscess with friable intestinal loop or base of the appendix, appendectomy not attempted rather irrigation and wide bore drain placement in the pelvic cavity was done. In case of conversion, lower midline incision were given. OA used standard McBurney's incision, Ratherford Morrison muscle cutting incision or lower midline incision according to the presentation, delay, body built and pre-operative diagnosis. In case of appendicular abscess, extraperitoneal drainage done and no appendectomy tried.

Antibiotic Protocol: All patients received preoperative broad-spectrum antibiotics (e.g. ceftriaxone + metronidazole), continued postoperatively for 7-10 days. Antibiotic changed, if required, according to the culture and sensitivity report of the pus from pelvic cavity or wound swab, if there was wound infection.

Outcomes: Primary outcome: IAA within 30 days post-surgery (confirmed via imaging). Secondary outcomes: operative time, length of stay (LOS), wound infection, conversion rate (LA group), reoperation, readmission, and in-hospital cost.

Data Collection and Statistical Analysis: Demographics, operative findings, and outcomes were recorded in a predesigned data collection sheet. Statistical analysis of the results was done by using computer based statistical software, SPSS 23.0 version. Comparative analysis employed Student's t-test or Mann–Whitney U test for continuous variables and chi-square or Fisher's exact test for categorical variables. A p-value <0.05 was considered significant at 95% confidence interval.

III. Results

Table 1: Baseline Characteristics (Age, Sex, BMI)

Parameter	Laparoscopic Appendectomy (LA)	Open Appendectomy (OA)	P value*
Age (mean ± SD)	33.5 ± 12.1 years	34.2 ± 11.8 years	0.67
Male (%)	66%	55%	0.91
Female (%)	34%	45%	
BMI (mean ± SD)	24.8 ± 3.5 kg/m²	25.2 ± 3.8 kg/m²	0.45

* chi-square test done

Table 2: Duration of Preoperative Symptoms

Parameter	LA (mean ± SD)	OA (mean ± SD)	P value*
Duration of symptoms (days)	2.3 ± 1.1	2.6 ± 1.3	0.36

*Student t test done

Table 3: Operative time and Hospital Stay Data

Parameter	LA (mean ± SD)	OA (mean ± SD)	P value*
Operation Time (minutes)	75.2 ± 20.3	60.1 ± 18.4	<0.001
Hospital Stay (days)	3.2 ± 1.1	4.8 ± 1.5	<0.001

*Student t test done

Conversion from LA to OA: Seven patients (11.3%) required conversion from LA to OA, mostly due to dense adhesions.

Table 4: Postoperative Complications

Complication	LA (%)	OA (%)	P value*
Intra-abdominal Abscess	6.7	10.0	0.34
Wound Infection	4.0	12.5	0.03
Readmission (within 30 days)	5.0	7.5	0.45

*Student t test done.

IV. Discussion

Over recent decades, the advancement in minimally invasive techniques leads laparoscopic appendectomy (LA) more favorable over open appendectomy (OA).[3] Several literatures demonstrate that LA is a safe and effective alternative to OA in patients with CA, offering several clinical advantages including reduced wound infection rates, shorter hospital stays, and comparable rates of intra-abdominal abscess (IAA).[5-7]

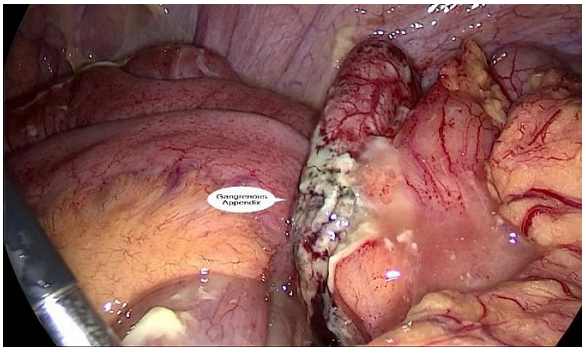

Figure 1: Gangrenous Appendix

Figure 2: Inflamed appendix with pus in pelvic cavity

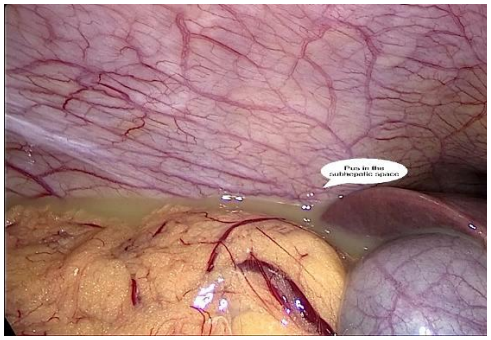

Figure 3: Pus in the subhepatic space

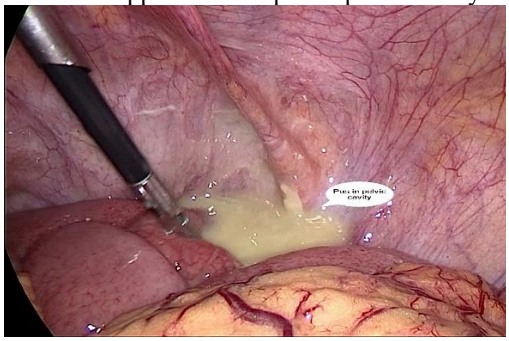

Figure 4: Pus in the pelvic cavity

In our study, the wound infection rate found significantly lower in the LA group than OA group (4% vs. 12.5%, $p = 0.03$). This is a well-documented benefit of minimally invasive surgery, attributed to smaller incisions and reduced tissue handling.[3,5,8] This is consistent with previous meta-analyses and large-scale database studies, which have consistently shown decreased wound-related complications in laparoscopic surgery. The minimally invasive nature of LA minimizes skin and soft tissue trauma, and the use of trocar incisions rather than a larger open incision likely contributes to this reduced risk. [2,7-9]

Postoperative IAA due to possible peritoneal contamination or incomplete lavage during minimally invasive procedures historically poses concern associated with LA in CA.[1,3,8] However, our data revealed no significant difference in IAA between LA and OA (6.7% vs. 10.0%, $p = 0.34$). Our study finding correlates with the findings of other researchers, that, in skilled hand, if performed correctly—ensuring proper irrigation and suction—LA does not increase IAA risk, even in perforated or abscess-forming appendicitis.[5-8] During OA, the incision usually placed in the lower abdomen which limits access to all the quadrants of abdomen sufficiently. In LA, all the quadrants, even in the deep pelvic cavity can be accessed and thorough peritoneal lavage can be done satisfactorily.

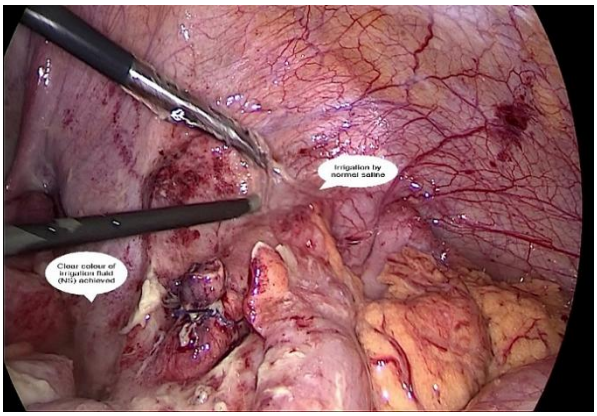

Figure 5: Irrigation to the paracolic region

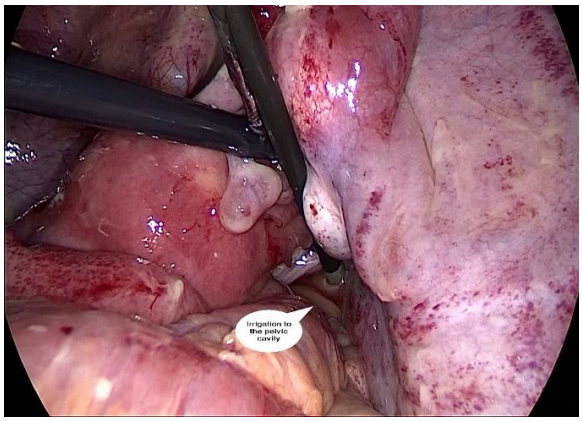

Figure 6: Irrigation to the deep pelvic cavity

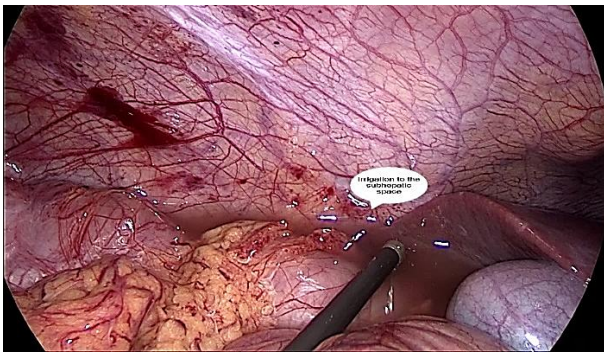

Figure 7: Irrigation to the subhepatic space

The mean operative time was longer in the LA group (75.2 vs. 60.1 minutes, $p < 0.01$) in our study. This trend of operating time frequently reported in other studies [1,3,7]. This likely reflects the technical demands of laparoscopy in complicated cases, where dense adhesions, distorted anatomy, and purulent contamination may prolong the procedure. However, it's notable that with increasing surgeon experience and standardization of techniques, operative time tends to decrease over time [2,4,9]. Significant difference observed in our study regarding hospital stay. It was shorter in LA group than in the OA group (mean 3.2 vs. 4.8 days, $p < 0.001$), which aligns with evidence from both randomized trials and large observational studies [7,10]. Faster postoperative recovery, reduced need for analgesia, and quicker return of bowel function are major factors behind earlier discharge following LA. Salminen et al. further emphasized this benefit in their trial comparing operative and non-operative management of uncomplicated appendicitis, highlighting the general trend toward less invasive, patient-centered care.[11] Conversion rate in our study from LA to OA is within the range reported in previous researches (5–15%) [1,2,9,10] Conversion was most often necessitated by dense adhesions or inability to clearly visualize the appendix base. While conversion itself is not a complication, it reflects the surgeon's intraoperative judgment prioritizing patient safety. In line with the findings of Yu MC et al; we recommend that the decision to convert should remain individualized and not be viewed as a failure, especially in CA where distorted anatomy is common.[3] Method of

appendiceal stump closure is another consideration in CA. In our study, the use of endoloop was the most common technique, followed by laparoscopic clips. Both methods were associated with comparable outcomes. This supports findings by other researchers who found no significant difference in complication rates between various stump closure techniques, including staplers, clips, and endoloop. However, staplers, while technically efficient, are costlier and may be best reserved for cases involving extensive necrosis at the base of the appendix [4,5,12,13].

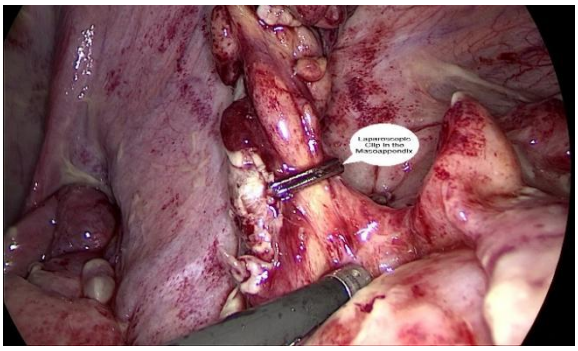

Figure 7; Laparoscopic clip in the masoappendix

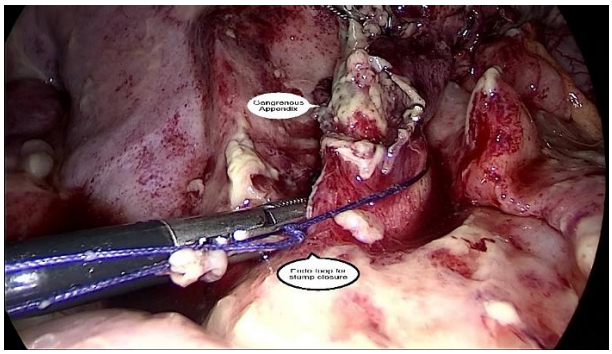

Figure 8; Gangrenous appendix with Endo-loop

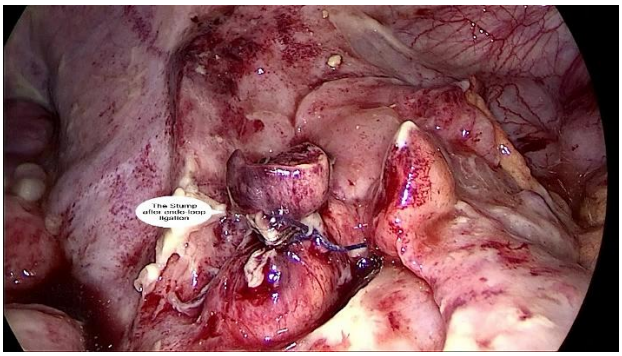

Figure 9; Stump closed by endo-loop

Another cornerstone of CA management is the appropriate use of antibiotics. The antibiotic protocol in our study aligns with recent studies advocating for shorter, targeted antibiotic courses following adequate source control [6,14]. Unnecessary prolongation of antibiotic therapy not only increases costs but also risks antimicrobial resistance and side effects. Multiple guidelines now support limiting postoperative antibiotics to 3–5 days, especially when the appendix is removed and no generalized peritonitis is present. [2,6,14] Regarding cost-effectiveness, although the LA approach had approximately 15% higher procedural costs, this was offset by the significantly shorter hospital stay and lower complication rate. Previous studies by Yu et al and Masoomi et al. have suggested that when these variables are factored in, the total cost of care for LA is often favorable compared to OA. [3,10] Our results also reaffirm that LA can be safely extended to select cases of phlegmon or localized abscess, especially when there is sufficient laparoscopic expertise. This agrees with Di Saverio et al. who advocate for individualized operative decision-making in CA, emphasizing that in experienced hands, LA is not only feasible but often preferable.[8]

V. Conclusion

Laparoscopic appendectomy in complicated appendicitis demonstrates favorable outcomes in terms of lower IAA rates, significantly lower wound infection, and shorter hospitalization compared to open surgery. Although operative time and procedural costs are higher, these are outweighed by clinical advantages. Endoloop-based stump closure remains appropriate in the majority of cases. LA should be considered first-line in CA when performed by skilled surgeons. Future multicenter randomized trials are warranted to solidify these findings.

Limitations

This study has several limitations. It is a single-center, non-randomized observational study, and although baseline characteristics were balanced, selection bias cannot be entirely excluded. Surgeon experience may have influenced the choice of technique. Additionally, long-term follow-up was limited to 30 days; therefore, complications such as late adhesive bowel obstruction were not assessed.

Clinical Implications and Future Directions

As evidence continues to favor LA in complicated appendicitis, training programs should emphasize laparoscopic skills in emergency general surgery. Moreover, larger multicenter randomized trials with cost-analysis and long-term outcomes—including quality of life metrics—are warranted to further solidify LA as the first-line approach for CA globally.

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