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Original Research Article

Predictors for conversion to open appendicectomy in patients undergoing laparoscopic appendicectomy: a prospective study

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ABSTRACT

Background: Laparoscopic appendicectomy is a common surgery performed by emergency surgeons now-a-days. The conversion from laparoscopic to open appendicectomy increases operating time and post-operative morbidity. Identifying the variables associated with the risk of conversion pre-operatively would avoid wasteful laparoscopic attempts by proceeding directly to an open surgery. Therefore, developing a pre-operative criterion to decide ideal operative approach for individuals may be useful.
Methods: Patients admitted to the Department of General Surgery with appendicitis, who got converted to open appendicectomy were studied prospectively based on the reasons for their conversion and were compared with primary open appendicectomy patients with respect to postoperative morbidity and mortality. There were 385 cases among which there were 307 (79.74%) laparoscopic appendicectomies, 42 (10.9%) primary open appendicectomies and 36 (9.35%) conversion appendicectomies.
Results: Fourteen significant predictors of conversion were identified by univariate analysis. Ten independent risk factors were identified by stepwise logistic regression.
Conclusions: The commonest reason for conversion was appendix mass. Post-operative pain, complications and duration of hospital stay were higher in conversion appendicectomy when compared to open appendicectomy. A conversion predicting score of >4 had good sensitivity and negative predictive value.

Keywords: Conversion appendicectomy, Conversion predicting score, Laparoscopic appendicectomy, Predictors of conversion

INTRODUCTION

Acute appendicitis is one of the most common differential diagnoses of acute abdomen and a common intra-abdominal condition requiring emergency surgery.[1]

Burney M described a right lower quadrant muscle-splitting (Gridiron) incision for appendicectomy.[2] Due to the simplicity of the procedure and low morbidity, the open technique remained the standard operation for the treatment of acute appendicitis for more than a century.[3] In 1982, Semm K performed laparoscopic appendicectomy.[4] Since then the laparoscopic technique has struggled to prove its superiority over the open technique.

In this era of advanced technology and minimal access surgeries, laparoscopic appendicectomy has gained much popularity, owing to its suggested advantages like less post-operative pain, faster recovery, lower wound infection rates, shorter hospital stay and higher cosmetic satisfaction.[5]

Laparoscopic appendicectomy may need to be converted to open appendicectomy if intraoperative complications or severity of the disease hinders with a safe laparoscopic

intervention. This may be in the form of abnormal position of appendix, adhesions due to previous inflammations, appendix mass/ abscess, perforated appendix and diffuse peritonitis, other pelvic or right iliac fossa pathologies or technical problems like lack of space for dissection. Even though these pathologies can be dealt with minimal access surgery, conversion to open surgery may become mandatory in a small number of cases.

Conversion from laparoscopic to open appendicectomy, known as conversion appendicectomy (CA), further increases the operative time, along with loss of benefits of minimal access surgery. Therefore, developing a preoperative criterion to decide ideal operative approach for individuals may be useful.

In this study, authors analysed the reasons for conversion appendicectomy and tried to identify the preoperative predictors of conversion. A comparative study was conducted between the patients who got converted and those who underwent primary open appendicectomy in terms of postoperative morbidity and mortality.

METHODS

Patients admitted to in-patient department of General Surgery, Jubilee Mission Medical College and Research Institute, Thrissur, Kerala with primary diagnosis of acute appendicitis and underwent appendicectomy and those who underwent interval appendicectomy were studied during a period of one and a half years, from March 2015 to September 2016.

This is a prospective, observational study. Based on history, clinical examination, laboratory investigations and ultrasound of abdomen and pelvis, appendicitis was diagnosed. The patients who underwent surgery were kept under the prospective study group and the cases who underwent conversion appendicectomy were studied based on the reasons for their conversion. The biodata and clinical details were recorded in a previously prepared proforma. The parameters studied include age, sex, BMI, previous history of acute appendicitis, any lower abdominal surgeries in the past, symptoms, duration of symptoms (≤5 days and >5 days), signs, WBC count, differential count of neutrophils, ultrasound abdomen and pelvis findings, ASA grading and intra operative findings including reasons for conversion.

BMI was grouped according to the World Health Organization (WHO) definition: for adults >20 years old, BMI <18.5-underweight, 18.5-24.9-normal weight, 25.0-29.9-overweight, and ≥ 30-obese. In 5-19 year olds the age cut-offs defined by the WHO: BMI <-2SD (standard deviations) =thin, between-2SD and +1SD=normal, >+1SD=overweight, and >+2SD=obesity. The thin, normal, overweight, and obesity groups used for 5-19 year olds were merged with the underweight, normal, overweight, and obese groups, respectively, in this analysis.

Incision in conversion cases were either transverse incision or midline vertical incision. Authors compared conversion appendicectomy patients with primary open appendicectomy patients with respect to their postoperative morbidity and mortality. Cases for this comparative study were selected in the order 'first done, first case'. In the immediate post-operative period, pain assessment was done using Verbal Pain Intensity Score (VPIS). Post-operative complications, if any, were noted. Patients were reviewed after 1 week and 1 month.

Inclusion criteria

All patients clinically diagnosed with acute appendicitis and underwent appendicectomy and those who underwent interval appendicectomy (all age groups), were included.

Exclusion criteria

All patients with a palpable mass in right lower quadrant of abdomen suggestive of appendix mass or abscess and the patients who refused to undergo surgery were excluded from the study.

Statistical analysis

The statistical software namely SPSS version 20.0 and Epi Info 7.0 were used for statistical data analysis. Microsoft word and Excel were used to generate graphs and tables. Descriptive and inferential statistical analysis were carried out in this study. Data were presented as a proportion or as the Mean±SD (Min-Max). Mann Whitney U test was used to compare mean values of duration of hospital stay between CA and OA. A p value of <0.05 was considered statistically significant. Univariate analysis was performed using Pearson's chi-square test to determine which clinical predictors were significantly associated with conversion from LA to OA. The odds ratio and 95% confidence interval (CI) were calculated. Fourteen clinical variables of potential significance identified by univariate analysis were chosen for forward stepwise logistic regression by which the independent predictors of conversion were identified. Receiver Operating Characteristic (ROC) Curve was used to derive a pre-operative conversion predicting criteria involving the independent predictors of conversion.

RESULTS

Authors studied 385 cases of appendicitis who underwent appendicectomy (open, laparoscopic and conversion) over a period of one and a half years. There were 307 (79.74%) laparoscopic appendicectomies, 42 (10.9%) primary open appendicectomies and 36 (9.35%) conversion appendicectomies. The conversion rate was 10.5%.

Mean age of the study group was 25.64 years (minimum 5-year-old, Maximum 88-year-old). Age>65 years (p=0.001), previous history of appendicitis and/ or lower

abdominal surgeries (p=0.008), diffuse tenderness (p=0.002), rebound tenderness (p=0.013), localized guarding (p=0.009) and diffuse guarding (p=0.001) were found to be significantly associated with conversion appendicectomy.

WBC count>15000 cells/ cumm (p=0.027), differential count of neutrophil ≥75% (p=0.027), ultrasound findings like acute appendicitis (13 CA out of 200, p=0.007), small bowel changes and abscess formation (2 out of 36 CA, p=0.010), abscess (8 CA out of 11, p=0.000), appendix not visualised (7 out of 36 CA, p=0.017), probe tenderness (4 CA out of 94, p=0.034) and ASA >1 (8 CAs out of 13 cases, p=0.000006) were other factors significantly associated with conversion appendicectomy.

Out of these significant predictors of conversion appendicectomy, ten independent predictors were identified by multivariate analysis (Table 1).

Table 1: Independent predictors of conversion.

Factors	p value	Odd's ratio (OR)	95% CI for OR	
			Upper limit	Lower limit
Demographic factors				
Age >65	0.001	12.667	2.714	59.122
History				
Previous history of appendicitis and /or lower abdominal surgeries	0.010	2.648	1.262	5.555
Signs				
Diffuse tenderness	0.002	9.469	2.259	39.685
Rebound tenderness	0.009	2.766	1.294	5.911
Localised guarding	0.006	3.528	1.444	8.619
Generalised guarding	0.001	12.667	2.714	59.122
Lab values				
WBC >15000cells	0.004	3.101	1.446	6.652
Differential neutrophil Count≥75%	0.030	2.386	1.086	5.243
USG findings				
Abscess	0.049	8.000	1.0006	63.962
Probe tenderness (without visualising appendix)	0.036	0.1333	0.020	0.880

p value<0.05 is statistically significant

Most common peri-operative diagnosis in converted cases was acute appendicitis with mass formation (n=10; 27.78%), followed by acute appendicitis with perforated appendix (n=8; 22.2%) (Table 2).

Table 2: Perioperative diagnosis of conversion appendicectomies.

Peri operative diagnosis	No. of cases	%
Acute appendicitis with mass formation	10	27.8
Appendicitis with perforated appendix	8	22.2
Appendicitis with adhesions	6	16.7
Acute appendicitis	4	11.1
Gangrenous appendicitis (sloughed off)	2	5.6
Acute appendicitis with abscess formation	2	5.6
Acute appendicitis with intestinal obstruction	2	5.6
Appendix abscess with caecal perforation	2	5.6
Total	36	100

The commonest reason for conversion was difficult dissection due to appendix mass (n=11; 30.56 % of all CAs) followed by dense adhesions (n=9; 25%) and perforated appendix (n=5;13.89%) (Figure 1). Intra-operative complication was 0.3% in LA, whereas 8.33% in CA.

Duration of surgery was>1 hour in 97.22% of CAs (p=0.001) with mean duration of CA 135.00±56.54 minutes. Mean duration of LA and OA were 71.42±26.95 minutes and 81.31±34.46 minutes respectively.

Post-operative complications were significantly more in CA (p=0.003). There was significantly higher chance of superficial surgical site infection in CAs (p=0.009). Post-operative pain was studied up to 5th post-operative day and was found to be more in CA than OA. On POD 5, the pain was significantly more in CA patients (p=0.000). Pain and post-operative complications lengthened hospital stay significantly in CA (p=0.000).

No statistically significant difference was seen between the transverse incision group and midline vertical laparotomy group in terms of post-operative pain and complications.

But duration of hospital stay was more for midline laparotomy patients (7.73±2.78 days against 5.93±2.13 days).

Peri-operative mortality was zero in present study.

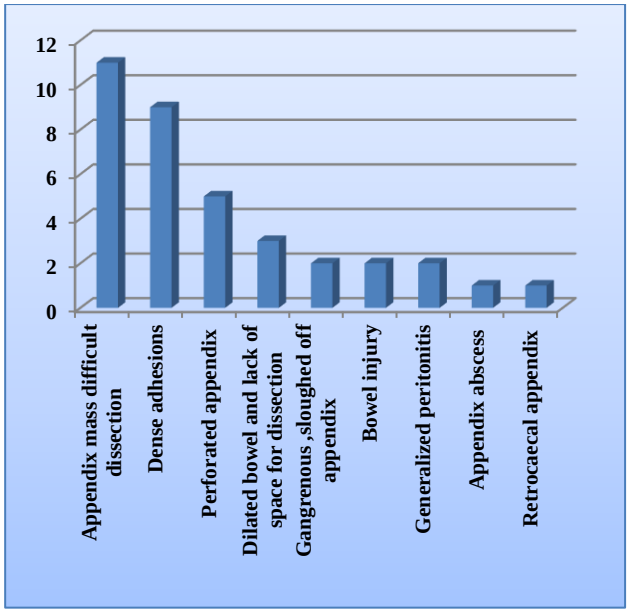

Figure 1: Bar diagram depicting reasons for conversion appendicectomy.

A preoperative criterion to decide ideal operative approach for individual patients with appendicitis was developed which showed that if the score was >4, the chance of conversion appendicectomy was 72.22%. The scoring system had a high Negative Predictive Value (NPV=93.97%), but low specificity (50.81%). Further research and validation of scoring system is necessary.

DISCUSSION

Many meta-analyses of randomized controlled studies and comparative studies have found that laparoscopic appendicectomy (LA) has several advantages over the open technique, including reduced postoperative pain, lesser wound infections, and shorter convalescence.[6-9]

LA has been reported to be associated with less analgesic use, early start of oral nutrient intake and shorter hospital stay.[10] In some patients, the cosmetic benefit is a strong reason to choose laparoscopic over open appendectomy.

In the present study, authors included 385 patients with appendicitis. 42 patients underwent primary open appendicectomy (OA).

343 patients underwent attempted laparoscopic appendicectomy out of which 36 got converted to open appendicectomy (CA). The OA patients and the CA patients were statistically comparable.

The rates of conversion reported in the literature are variable and may be attributed to a variety of patient, surgeon and technical factors.[11,12] Based upon this study and others, it appears that the conversion to the open technique lengthens the operative time and post-operative morbidity. In a study by Liu et al a conversion rate of 9.7% has been reported.[13] In this study, the conversion rate was 10.5%.

The study by Liu et al shows that age≥65 years is an independent predictor of conversion.[13] In this study, all age groups were involved (minimum 5 years and maximum 88 years). On evaluation of the clinical parameters, an age >65 was found to be an independent predictor of conversion (OR-12.667, 95% CI=2.714-59.122, p=0.001). Elderly patients often present with unusual, non-classical symptoms and signs and have delayed surgical intervention, perhaps explaining the increased risk of conversion in these patients.

Laparoscopic appendicectomy has been proposed as the preferred technique in obese patients with suspected acute appendicitis by Varela JE et al.[14] Liu et al showed no increased risk of conversion to open appendicectomy in obese, same as authors found in this study.[13]

Liu et al and Natasha G et al found that there is no significance in previous history of appendicitis or lower abdominal surgeries. But in present study, previous history of appendicitis and / or lower abdominal surgeries is found to be an independent predictor of conversion appendicectomy (OR-2.648; 95% CI=1.262-5.555, p=0.010).[13,15]

There is slight male predominance (Male:Female ratio 1.76:1) in this study. Clinical parameters like right iliac fossa pain, fever, nausea, vomiting, anorexia, dysuria and duration of symptoms did not show any statistical significance. There were 15 interval appendicectomies among the 343 patients out of which 2 (13.3%, p=0.714) were converted to open. Even though the prevalence of conversion of interval appendicectomy was found to be high, there was no statistical significance. Study by Liu et al had similar outcome regarding the above said parameters.[13]

Liu et al found that diffuse tenderness is associated with more chance of conversion.[13] In present study, diffuse abdominal tenderness (OR-9.469, 95% CI=2.259-39.685, p=0.002), rebound tenderness (OR-2.766, 95% CI=1.294-5.911, p=0.009), localised guarding (OR-3.528, 95% CI=1.444-8.619, p=0.006) and generalised guarding (OR, 95% CI=2.714-59.122, p=0.001) were found to be independent predictors of conversion.

Natasha G et al found that no direct correlation was seen between the WBC count and the conversion rate. However, a trend toward higher conversion (9.43% versus 4.63%) was seen when a WBC >20,000 was noted at initial presentation.[15]

In this study, WBC count >15000 cells/cumm (OR-3.101, 95% CI-1.446, 6.652, p=0.004) was found to be an independent predictor of conversion. Differential count of neutrophil ≥75% (OR- 2.386, 95% CI-1.086, 5.243,

p=0.030) was identified as another independent predictor of conversion in this study.

USG findings like acute appendicitis (p = 0.007), small bowel changes and abscess formation(p=0.010), abscess (p=0.000), appendix not visualised (p=0.017) and probe tenderness without visualising appendix (p=0.034) were significantly associated with conversion appendicectomy. Among these, USG findings like abscess (OR-8.000, 95% CI-1.006, 63.962, p=0.049) and probe tenderness without visualising appendix (OR-0.133, 95% CI-0.020, 0.880, p=0.036) were found to be independent predictors of conversion. Diameter of appendix had no association with conversion (p=0.409).

Liu et al compared surgeons performing ≤10 laparoscopic appendectomies with surgeons performing>10 LAs during their study period (4 years) and found that conversion was more for the former group (p=0.046).[13] In this study, surgeons performing ≤20 laparoscopic appendicectomies were compared with those performing>20 LAs but did not show any increased risk of conversion to CA.

Tomoyuki A et al found that there was a statistical difference in terms of the American Society of Anaesthesiologists (ASA) ratio, which was higher in CA than LA (an ASA ratio ≥3 was observed in 6 LA patients versus 4 CA patients; p= 0.002).[10] In this study, ASA of≥1 was observed in 13 patients (5 LA patients versus 8 CA patients; p=0.000) which was significant.

Liu et al found that most common perioperative diagnosis in CA was non-perforated appendicitis (n=37;64%), next was perforated appendicitis (n=14;24.1%). Most common perioperative diagnosis of CAs in this study was acute appendicitis with mass formation (n=10;27.78%) followed by acute appendicitis with perforated appendix (n=8;22.2%).[13]

In the study by Tomoyuki A et al most common cause for CA was severe adhesions (n=20;69% of all CAs), followed by appendicular base inflammation and necrosis (n=7;24.1%).[10] Liu et al also found that most common cause of CA was dense adhesions (n=21; 36.2%), followed by localised perforation (n=7;12.1%) and diffuse peritonitis (n=6;10.3%).[13] In the present study, the most common reason for conversion was difficult dissection due to appendix mass (n=11; 30.56 % of all CAs) (Figure 1). 25% (n=9) cases were converted due to dense adhesions. Difficulty in handling appendix base due to inflammation of caecum is one of the common reasons in converting laparoscopic procedure to open.[10,13] In this study there were 2 converted cases where the appendix was gangrenous and sloughed off.

There was no unexpected diagnosis other than complicated appendicitis. Bowel injury, which was the only intra operative complication which led to conversion to open procedure, occurred in 2 patients. Anesthesia complications or intolerance to pneumoperitoneum were not reasons for conversion in present study.

Intra-operative complication was 0.3% in case of LA, whereas 8.33% in CA. Iatrogenic bowel injury occurred in 2 patients who had to be converted to open appendicectomy and bleeding occurred in 2 patients where one had to be converted to open appendicectomy whereas the other one was managed laparoscopically.

In the Liu et al study, the operation time for patients converted to OA was 114±47 minutes, whereas for LA it was 62±24 minutes (p <0.01).[13] The Tomoyuki A et al study showed that LA has distinct superiority over CA, owing to the shorter operative time (81.6±32.1 minutes; p=0.0001).[10] In present study, duration of surgery was >1 hour in 97.22% of CAs (p=0.001) with mean duration 135±56.54 minutes . Mean duration of LA and OA were 71.42±26.95 minutes and 81.31±34.46 minutes respectively.

Kathowda N and colleagues studied pain assessment subjectively by the administration of a visual analogue scale test and objectively by the tabulation of pain medications.[16] There was no difference between the 2 groups.

In present study, post-operative pain was studied upto 5th post-operative day and was found to be more in CA than OA. On POD1, 5.5% (n=2) CA patients were having severe pain (score 3), 69.44% (n=25) were having moderate pain (score 2), 22.22% (n=8) were having mild pain (score 1), 2.7% (n=1) was not having pain (score 0), where as in OA patients, 9.5% (n=4) were having severe pain,23.8% (n=10) were having moderate pain, 66.67% (n=28) were having mild pain. On POD 5, the pain was significantly more in CA (p=0.000).

Gupta N and colleagues found that postoperative complications were statistically higher in the conversion group (9%) than in the LA group (4.7%).[15] In present study, post-operative complications were seen in 50% of CA patients and 7.69% of OA patients (p=0.003), which was statistically significant. On comparing the CA and OA groups, the complications observed were surgical site infection (superficial, deep and space SSI) (10 CA and 1 OA), post-operative ileus (2 CA) and respiratory infection (1 OA). The superficial surgical site infection was significantly higher in CA (p=0.009).

Tomoyuki A et al found that post-operative hospital stay is lengthened in case of CA patients (14.3±8.6 days; p= 0.0001).[10] In present study, the mean duration of hospital stay in CA and OA patients were 7.03±2.667 days and 5.00±2.024 days (p=0.000) respectively.

Assuming that they are comparable, the transverse incision group and midline vertical laparotomy group were compared in terms of postoperative morbidity. No statistically significant difference was seen between the

two groups. Duration of hospital stay was more for midline laparotomy patients than transverse incision patients (7.73±2.78 days against 5.93± 2.13 days).

Post-operative mortality was zero in this study.

Using the ROC curve (Figure 2), a preoperative criterion to decide ideal operative approach for individuals was developed. The area under curve (AUC) was 0.744 with a standard error of 0.048. The scoring system contains ten independent risk factors each with a score of 1. A score of >4 had a sensitivity of 72.22%, specificity of 50.81%, negative predictive value of 93.97% and accuracy of 46%. The scoring system needs further research and validation. Even though not statistically significant, surgeon's experience, skill and attitude are important factors which decides the conversion of procedure to open appendicectomy.

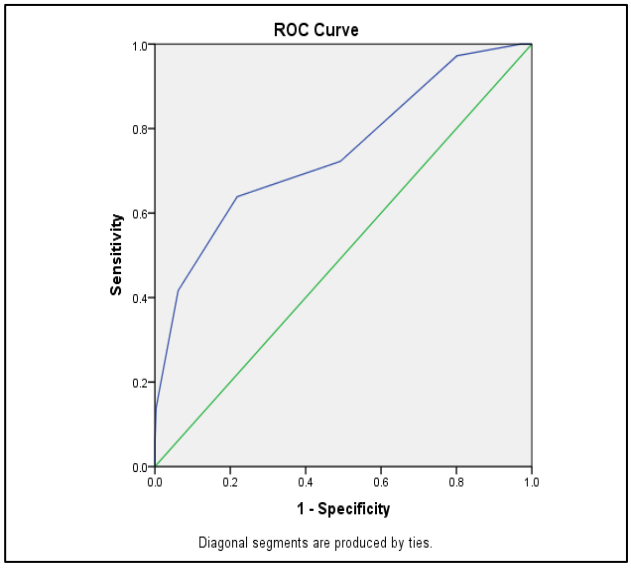

Figure 2: ROC curve indicating predictors of conversion appendicectomy.

The subjective nature of the decision to convert is a major drawback of the scoring system and this study. The transverse and vertical midline incision groups were not statistically analysed whether they are comparable. Long term complications of appendicectomy were not studied.

CONCLUSION

Fourteen predictors of conversion appendicectomy of potential significance were identified. Age>65, previous history of appendicitis and/ or lower abdominal surgeries, diffuse tenderness, rebound tenderness, localised guarding, generalised guarding, WBC>15000 cells, Differential Neutrophil Count≥75% and USG findings like abscess and probe tenderness without visualising appendix were the ten independent predictors of conversion. The commonest reason for conversion was appendix mass. Post-operative pain, complications and duration of hospital stay were higher in conversion appendicectomy when compared to primary open appendicectomy. Duration of hospital stay was more for midline laparotomy patients than transverse incision patients. A conversion predicting score of>4, based on the 10 independent risk factors for conversion, had good sensitivity and negative predictive value, but needs further validation.

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