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Original Research Article

A study of pre-operative predictors for conversion to open surgery in emergency laparoscopic appendectomy

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ABSTRACT

Background: Acute appendicitis is one of the most common emergencies encountered by surgeons. Although laparoscopic appendectomy is the preferred approach complicated appendicitis with a mass, abscess or perforation do present with a challenge to the operating surgeon compelling him to convert to open surgery. Our study aimed at identifying pre-operative factors that would help us predict the risk of conversion to open surgery.
Methods: This was a prospective analytical study. All cases admitted over a period of one year undergoing emergency appendectomy were included in the study. The duration of history, clinical presentation, laboratory and radiological investigations were noted. The reason for conversion to open surgery was recorded. The post-operative stay and complications were analyzed.
Results: A total of 160 patients fulfilling the inclusion criteria were included in the study. The mean age was 33.78 years with a male preponderance of 58%. The duration of history, clinical and radiological evidence of complicated appendicitis and peritonitis, total leucocyte count and serum bilirubin levels were identified as pre-operative predictors for risk of conversion to open surgery from laparoscopic appendectomy.
Conclusions: These predictors are useful in predicting conversion to open surgery in laparoscopic emergency appendectomy. In these cases, proceeding with an open surgical approach may be beneficial to the patient in reducing operative time, cost, hospital stay and complications as laparoscopic approach may prove to be unsuccessful. This would help in enhanced communication between the surgeon and the patient with respect to the outcome and prognosis.

Keywords: Acute appendicitis, Conversion, Laparoscopic appendectomy, Open appendectomy, Predictors for conversion

INTRODUCTION

Acute appendicitis is one of the most common emergencies encountered in surgical practice. The lifetime incidence of appendicitis is 8%. It was first described by Fitz in 1886 and its prompt treatment was emphasised to prevent the complications of perforation and peritonitis. Open appendectomy was the only approach for a long time till laparoscopic appendectomy was described by Kurt Semm in 1980.[1]

Laparoscopic appendectomy is now the surgery of choice for acute appendicitis and is one of the most frequently performed surgery in the emergency setting. Laparoscopic appendectomy has several advantages over open appendectomy including early recovery, shorter duration of hospital stay and lesser analgesics requirement. It also gives the opportunity to examine the entire peritoneal cavity for other possible pathologies.[2] It also has its disadvantages like the requirement of general anaesthesia, specialized equipment and surgeon with expertise. In complicated cases of appendicitis like mass,

abscess and perforation laparoscopic appendectomy may not be feasible requiring a conversion to open surgery. This may result in increasing the hospital stay and costs and a higher morbidity for the patient.[3]

Although the diagnosis of acute appendicitis is clinical, some cases may post a challenge in both diagnosis and management. In complicated appendectomies, conversion to open surgery may be required to perform a safe appendectomy and to avoid any surgical complications.[4] It would be ideal to have pre-operative predictors which will help us identify patients with high risk of requiring open surgery. This would help in enhanced communication between the surgeon and the patient with respect to the outcome and prognosis. It will be helpful for the surgeons to make a choice of the surgical approach and avoiding laparoscopic surgery in cases where it is unlikely to be successful. It will also help reducing the operative time and costs of laparoscopic surgery. Our study aims to identify such factors which will aid this decision making for the operating surgeon.

METHODS

The study was a prospective longitudinal study. It was conducted at SDM college of Medical sciences and hospital, Dharwad, Karnataka. All the patients diagnosed with acute appendicitis who underwent emergency appendectomy during the period of January 2019 to December 2019 fulfilling the inclusion criteria were included in the study. Patients undergoing laparoscopic and laparoscopy converted to open surgeries were included in the study. A written informed consent was taken from the participating patients. Institutional ethical clearance was taken from the ethical committee.

Inclusion criteria

Patients diagnosed with acute appendicitis and undergoing emergency appendectomy. Only patients above the age of 16 years were included in the study.

Exclusion criteria

Patients undergoing surgery where appendectomy was part of another procedure like a right hemicolectomy were excluded from the study. Patients who had undergone a previous abdominal surgery were also excluded from the study as post-operative adhesions from previous surgery would also add to the difficulty of the current surgery. Patients undergoing interval appendectomy were excluded from the study.

The diagnosis of acute appendicitis was done by a combination of clinical symptoms and signs and investigations. The data was recorded using a pretested standard proforma. Universal sampling was done and all patients satisfying the inclusion criteria were included in the study. Patient demographic details, signs and symptoms along with detailed history was recorded. Laboratory investigations including a complete blood count, renal profile, liver function test and serum electrolytes were done and data recorded. Initial radiological evaluation was done with ultrasonography in all patients. Further imaging was done with contrast enhanced CT in selected patients for further evaluation.

Surgery was performed by the consultant on-call on the day of presentation. This was to eliminate the surgeon bias. Standard laparoscopic technique was used to perform surgery. The choice of incision for converted appendectomy was based on the surgeon's choice. Vertical midline laparotomy was the preferred approach in most cases.

Data was entered and analyzed in Microsoft Excel. Relevant analysis was done using IBM SPSS version 25 for Microsoft Windows. Analysis of data was done using univariate analysis and multivariate analysis using multiple logistic regression.

RESULTS

During our study period a total of 160 cases of acute appendicitis fulfilling the inclusion criteria were admitted to the department of surgery at SDM college of Medical Sciences and hospital, our tertiary care hospital and underwent emergency appendectomy.

The age of the patients in the study ranged from 17 years to 71 years. The mean age of patients was 33.78±13.711 years. Among the patients 94 were male and 66 females. There was a male preponderance with 58.4% male patients.

Pain abdomen was the most common presenting feature seen in all the patients (100%). Fever was seen in 22.4% cases. On clinical examination right iliac fossa tenderness was present in all the cases. Guarding and features of peritonitis were present in 16.8% of the cases.

The duration of symptoms ranged from 1 day to maximum 10 days. Mean duration was 2.72±2.041 days. 78.1% patients presented with symptoms for less than 4 days.

The diagnosis was made based on clinical findings, laboratory values and radiological evaluation. Clinical history of pain abdomen with fever and signs of right iliac fossa tenderness were considered diagnostic of acute appendicitis. An elevated total leucocyte count (TLC) above 12,000 cells/mm^3 was another diagnostic indicator for the same. Other laboratory marker was serum total bilirubin. Its elevation was used as a marker of appendicular perforation. Radiological evaluation was done with ultrasonography in all cases and contrast enhanced CT scan in some cases. Ultrasonography findings of an inflamed appendix, a blind ending aperistaltic tubular structure with any complications like an abscess, mass or perforation was added to the diagnostic criteria. In cases where CECT was done the findings were also included in the diagnosis.

Table 1: Patients' profile.

Variable		Frequency (n=160)	Percentage
Age in years	15-24	49	30.6
	25-34	47	29.4
	35-44	30	18.8
	45-54	18	11.2
	55-64	9	5.6
	65-74	7	4.4
Sex	Male	94	58.4
	Female	67	41.6
Clinical features	Pain	160	100
	Fever	36	22.4
	Guarding	27	16.8
Duration of symptoms	<4 days	125	78.1
	≥4 days	35	21.9
TLC (cells/mm^3)	≤12,000	117	73.1
	>12,000	43	26.9
Total bilirubin in mg%	≤1.2	116	72.5
	>1.2	44	27.5
Histopathology report	Acute appendicitis	107	66.5
	Appendicular perforation	42	26.1
	Appendicular abscess	4	2.5
	Gangrenous appendicitis	4	2.5
	Acute suppurative abscess	4	2.5
Diagnosis	Acute appendicitis	123	76.4
	Appendicular perforation	12	7.5
	Appendicular abscess	7	4.3
	Appendicular mass	2	1.2
	Gangrenous appendicitis	2	1.2
	Peritonitis	15	9.3
Surgery	Laparoscopic appendectomy	118	73.8
	Laparoscopic converted to open appendectomy	42	26.2
Hospital stay	<5 days	110	68.8
	≥6 days	50	31.2
ICU admission	Required	11	6.9
	Not required	149	93.1

TLC was raised (>12,000 cell/mm^3) in 43 patients (26.9% patients). Total bilirubin was raised (>1.2 mg%) in 44 (27.5%) patients.

Based on the above diagnostic criteria 76.4% patients were diagnosed with acute appendicitis while remaining 23.6% were complicated appendicitis. The most common complication was appendicular perforation in 7.5% patients, abscess in 3.7% patients. Features of peritonitis were seen in 9.3% patients.

All the patients included in the study underwent emergency appendectomy. Laparoscopic approach was the preferred one in all cases. Laparoscopic appendectomy was done successfully for 118 (73.8%) patients. The remaining 42 (26.2%) patients, were converted to open appendectomy after an initial attempt laparoscopically. The reasons for conversion were difficult anatomy, dense omental and bowel adhesions, perforations at the base of the appendix, generalized peritonitis and retro-caecal and sub hepatic positions of the appendix. All these led to difficulty in continuing with the laparoscopic approach hence prompting the operating surgeon to convert to open surgery.

Histopathology report of the specimen revealed Simple acute appendicitis in 107 (66.5% patients and complicated appendicitis in the remaining 53 patients. Among these cases of complicated appendicitis, 42 (26.1%) patients report showed appendicular perforation. Appendicular abscess, gangrenous appendicitis, acute suppurative appendicitis was reported for 4 (2.5%) patients each.

Table 2: Association between clinical and laboratory profile with type of surgery.

Variable		Surgery		χ^2 value	OR (95% CI)	P value
		Laparoscopic appendectomy N (%)	Converted to open surgery N (%)			
Duration of symptoms	<4 days	112 (89.6)	13 (10.4)	74.153	41.641 (14.572-118.996)	0.00001
	≥4 days	6 (17.1)	29 (82.9)			
TLC (cells/mm^3)	≤12,000	108 (92.3)	9 (7.7)	77.445	39.600 (14.843-105.65)	0.00001
	>12,000	10 (23.3)	33 (76.7)			
Total bilirubin in mg%	≤1.2	108 (93.1)	8 (6.9)	81.611	45.900 (16.778-125.573)	0.00001
	>1.2	10 (22.7)	34 (77.3)			
HPR	Simple	100 (94.3)	6 (5.7)	68.776	33.333 (12.270-90.554)	0.00001
	Complicated	18 (33.3)	36 (66.7)			
Diagnosis	Simple	111 (91)	11 (9)	78.806	44.688 (15.988-124.909)	0.00001
	Complicated	7 (18.4)	31 (81.6)			

Table 3: Determining clinical and laboratory factors for deciding type of surgery by multiple logistic regression.

Variable		Surgery		aOR	95% CI	P value
		Laparoscopic appendectomy N (%)	Converted to open surgery N (%)			
Duration of symptoms	<4 days	112 (89.6)	13 (10.4)	13.322	3.493-50.813	0.001
	≥4 days	6 (17.1)	29 (82.9)			
TLC (cells/mm^3)	≤12,000	108 (92.3)	9 (7.7)	5.298	1.406-19.970	0.033
	>12,000	10 (23.3)	33 (76.7)			
Total bilirubin in mg%	≤1.2	108 (93.1)	8 (6.9)	12.346	3.287-46.372	0.001
	>1.2	10 (22.7)	34 (77.3)			

R^2=0.728.

The post-operative course was uneventful in majority 149 (93.1%) patients. 11 (6.9%) patients required ICU admission. The most common reasons for ICU admission were need for mechanical ventilation and haemodialysis. All 11 cases which had ICU admission had a conversion to open surgery. The average duration of ICU stay was 3 days. Mean duration of hospital stay was 5.25±4.038 days. There were no mortalities during the study. No patients were readmitted with any complications.

Among the patients who underwent conversion to open surgery certain parameters were observed. These patients had a history of pain abdomen of greater than or equal to 4 days. The total leucocyte count in these cases was more than 12000 cells/mm^3. The total bilirubin levels in all these cases was above 1.2 mg%. The radiological examination by ultrasonography or CECT revealed a complicated appendicitis in these cases.

Univariate analysis was done to assess various factors associated with conversion of laparoscopic appendectomy to open appendectomy. It was found that patients presenting with symptoms for 4 days or more were likely to have LCO surgery (p<0.00001). Laboratory parameters TLC>12,000 and TB>1.2 were also associated with conversion of laparoscopic appendectomy to open appendectomy (p<0.00001). Patients diagnosed with complicated appendicitis radiologically were also more likely to have LCO (p<0.00001). These findings have been shown in Table 2.

Multivariate analysis was applied to assess which of the preoperative indicators were independently related to the decision to conversion of surgery. The preoperative factors in our study were put in a regression model. After regression analysis the indicators which were determining for conversion of surgery were duration of symptoms (aOR: 13.322, 95% CI: 3.493-50.813), total leucocyte count (aOR: 5.298, 95% CI: 1.406-19.970) and total bilirubin (aOR: 12.346, 95% CI: 3.287-46.372) (Table 3). The regression model produced a R2=0.728 which is highly significant.

DISCUSSION

Acute appendicitis is one of the most common emergencies encountered by surgeons. Laparoscopic appendectomy is the preferred surgery for appendectomy. But complicated appendicitis with a mass, abscess or perforation do present with a challenge to the operating surgeon compelling him to convert to open surgery.[5] Our study aimed at identifying pre-operative factors that

would help us predict whether a patient with appendicitis would require conversion to open surgery. This would help the operating surgeon proceed directly with open surgery in these cases thereby reducing operating time, costs and morbidity for the patient.

A total of 160 patients were included in our study. All patients underwent emergency appendectomy. Laparoscopic appendectomy was the preferred approach in all the cases included in the study. Laparoscopic appendectomy was successful in 118 cases while the rest had a conversion to open surgery. The reasons for conversion were difficult anatomy, dense omental and bowel adhesions, perforations at the base of the appendix, generalised peritonitis and retro-caecal and sub hepatic positions of the appendix. All these led to difficulty in continuing with the laparoscopic approach hence prompting the operating surgeon to convert to open surgery. In cases where perforation was at the base of the appendix, the ligation of the base was not possible laparoscopically, and requiring ileo-cecal resection, hence the conversion. There was inadvertent injury to the adherent bowel during adhesiolysis in a few cases during laparoscopy. Bleeding was the cause for conversion in only two of the cases. However, the conversion rate among cases of simple appendicitis was 9%. Similar causes for conversion were observed in a study by Kumar et al.[6] In a study by Liu et al a conversion rate of 9.7% has been reported and another study by Peedikathara the conversion rate was 10.5%.[7,8] The overall conversion rate among all cases in this study was 26.2%. Many studies have reported such variable rates owing to severity of patients, technical factors and surgeon's experience. The cases which had a conversion to open surgery had significantly higher incidence of complications. The complications included increased operative duration (100 verus 70 minutes), length of hospital stay was more (8 days versus 5 days).[8]

Mean age of patients was 33.78±13.711 years. There was no statistically significant age or gender predilection among the cases which underwent conversion to open surgery in our study. In a study by Bui et al in Australia age more than 65 years was considered a significant predictor for conversion.[9] In a study by Finnerty et al, age more than 40 years was a risk factor for conversion. Other risk factors for risk of conversion according to their study were male gender, black race, obesity and complications like abscess and peritonitis.[10]

The mean duration of presentation was 2.72 days with maximum duration of 10 days. In all cases which underwent conversion to open surgery, the duration of history was above 4 days. In our study patients with ≥4 days duration of symptoms were more prone for conversion (OR: 13.322, 95% CI: 3.493-50.813, p=0.001). A study by Liu et al reported that patients with >5 days of symptoms had 20% chance for conversion (OR: 4.99, 95% CI: 0.97-25.80, p=0.067).[11]

In our study a pre-operative diagnosis of complicated appendicitis by a combination of clinical and radiological evaluation was also a significant predictive factor for conversion to open surgery (OR: 44.688 95% CI: 15.988-124.909 p=0.00001). Abe et al in a study in Japan concluded that features of peritonitis clinically and a CT inflammatory grade 4 or 5 are independent factors for conversion.[12] A study by Lai et al in Hong Kong used ACT score for diagnosis of Appendicular perforation which was used as a predictor for conversion.[13]

In our study TLC >12,000 was significantly associated as an independent factor for conversion (OR: 5.298, 95% CI: 1.406-19.970, p=0.033). Similarly, in a study by Peedikathara LM WBC count >15000 cells/mm^3 (OR: 3.101, 95% CI: 1.446, 6.652, p=0.004) was found to be an independent predictor of conversion. In another study conducted by Martin et al TLC for all conversion cases was estimated at 14.57±4.34 (p=0.5277). In a study by Wagner et al, apart from elevated TLC, an elevation of Neutrophils on differential leucocyte count was considered as an independent factor for predicting conversion to open surgery. They also included prolonged history, elderly patient, evidence of pneumoperitoneum on CT and ASA grade >2 points as risk factors. They also accounted for the inexperience of the operating surgeon.[14]

Hyperbilirubinemia has been used as a predictor for appendicular perforation. Elevation of total serum bilirubin without elevation of liver enzymes is considered as a predictive factor for appendicular perforation.[15] In our study elevation of total bilirubin above 1.2 mg% was considered significant [95% CI: 16.778-125.573, p=0.00001]. A study in Nagpur by Saxena et al had similar findings.[16] Ramu et al in their study concluded that elevation of total bilirubin above 1.3 mg% was suggestive of perforation while Reddy et al in Delhi had total bilirubin elevation above 2.25 mg% as significant.[17,18]

Gavriilidis et al in their meta-analysis concluded that total bilirubin alone is not helpful. It has to be used in conjunction with total leucocyte count and C reactive protein.[19] A study by Martin et al and a study by Jeon et al also used CRP as a predictive factor.[20,21] In our study CRP was not done as a routine in all the cases. Hence it was not included in the parameters for the study. However, it has been proven as a valuable investigation for complicated appendicitis and can be used as a predictor for conversion to open surgery.

Operative planning is key to the success of the procedure. Hence selecting the right procedure for the right patient is imperative. According to our study, a delayed presentation of more than 4 days of symptoms, clinical findings of localized or generalized peritonitis and radiological evidence of complicated appendicitis like an abscess, mass, perforation and peritonitis with an elevated total leucocyte count above 12000 cells/mm^3 and

total bilirubin above 1.2 mg% are all independent predictors for a conversion from laparoscopic to open surgery in emergency appendectomy. We believe that proceeding directly with an open approach in cases where the risk of conversion is high has several advantages like shorter operative time and lower risk of iatrogenic complications. But knowing the advantages of the minimal invasive approach like lesser pain, lesser chance of surgical site infections, shorter length of hospital stay and early resumption of work, surgeons should not be discouraged from attempting laparoscopic surgery in the emergency setting. However, these predictors help the operating surgeons in better communication and counselling the patients and relatives regarding the need for a conversion if required.

One of limitation of our study is the relatively smaller sample size. The radiological evaluation with CECT scan was done only in some cases. The other cases underwent only ultrasonography preoperatively. The long-term complications like post-operative adhesions and hernias in cases undergoing open surgery need to be accounted.

CONCLUSION

According to our study, a delayed presentation of more than 4 days of symptoms, clinical findings of localized or generalized peritonitis and radiological evidence of complicated appendicitis like an abscess, mass, perforation and peritonitis with an elevated total leucocyte count above 12000 cells/mm^3 and total bilirubin above 1.2 mg% are all independent predictors for a conversion from laparoscopic to open surgery in emergency appendectomy. We believe these predictors can help surgeons make a choice in choosing the right approach for the right patient in emergency appendectomy. It will also help in better communication and preoperative counselling regarding the risk of conversion to open surgery in a proposed laparoscopic appendectomy.

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