Risk factors for complicated appendicitis among pediatric population

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ABSTRACT

Context: Appendicitis is the most common surgical emergency in children. In children, it is difficult to diagnose appendicitis due to atypical presentation. Various risk factors have been mentioned in literature leading to complicated appendicitis. **Aims:** Our study was to determine the risk factors for complicated appendicitis in children. **Methodology:** The children who underwent appendectomy with a clinical diagnosis of acute appendicitis from 2015 to 2018 were studied retrospectively at Kempegowda Institute of Medical Sciences and Hospital, Bengaluru. The pre-operative, operative, and post-operative data were analyzed. Statistical analysis was performed and variables analyzed were age, sex, location of patient, duration of symptoms, total leukocyte count, and fecolith. **Statistical Analysis Used:** Categorical variables were analyzed by applying Chi-square test and continuous variables were analyzed by applying independent t-test. **Results:** A total of 220 children presented with appendicitis during the study period, of which 60 children had complicated appendicitis. Mean age of presentation was 10.38±2.84 years. On statistical analysis, patients having pain of duration >48 h ($p=0.017$), patients with leukocyte count >15000/mm^3 ($p<0.0001$), and patients with fecolith ($p=0.00075$) were more likely to have complicated appendicitis. However, the age, rural location, and sex of the patient were not associated with complicated appendicitis. **Conclusion:** Appendicitis is a common cause of abdominal pain in children. High leukocyte count, delayed presentation, and appendicolith are possible markers of complicated appendicitis. Sex, rural location, and age did not have any association with complicated appendicitis.

Key words: *Appendicitis, Complicated, Risk factors*

Appendicitis is the most common surgical emergency in children [1]. The lifetime risk of developing appendicitis is approximately 9% in males and 7 % in females. Nearly 30% of children present with complicated appendicitis [2]. Appendicitis is most commonly seen in the second decade of life [3]. Acute appendicitis is divided into two subgroups. They are simple appendicitis (early, inflamed, and uncomplicated) and complicated appendicitis (gangrenous, perforated appendicitis with abscess/phlegmon or perforated appendicitis without abscess/phlegmon) [4,5]. A common type of appendicitis is simple or uncomplicated appendicitis. In case of perforation of appendix, it presents as generalized peritonitis or the appendicular perforation gets walled off. Walled off appendicular perforation presents either as simple inflammatory mass consisting of inflamed appendix, adjacent viscera, and greater omentum or present as pus-containing mass (appendicular abscess).

In pediatric population, it is challenging to diagnose appendicitis, due to atypical presentation, non-specific symptoms, and wide range of differential diagnosis. The initial misdiagnosis rate of appendicitis in older children varies from 28% to 57% [6]. Delay in diagnosis leads to complicated appendicitis with increased morbidity, prolonged hospitalization, and morbidity.

Complicated appendicitis has got a good overall prognosis. The overall mortality rate of complicated appendicitis is <1% [7,8]. However, it is associated with higher morbidity than simple appendicitis. Appendectomy is the most common surgical procedure done worldwide [8]. The management of simple appendicitis is straightforward and it's appendectomy, either open or through laparoscopic approach. The objective of the present study to analyze risk factors associated with complicated appendicitis.

METHODOLOGY

This was a retrospective observational study conducted by the Department of Pediatric Surgery, Kempegowda Institute of Medical Sciences and Hospital, Bengaluru, from January 2015 to March 2018. All children who underwent appendectomy for appendicitis during this period were reviewed. Those patients with interval appendectomy and negative appendectomy were excluded from the study. The data of children with respect to sex, age, address, symptoms, and their duration were tabulated. The clinical, biochemical, and imaging findings were documented. In all the children, blood counts and renal function test were done. Initially, all children had an ultrasonography (USG) of the

abdomen and pelvis. In children where USG was inconclusive, computed tomography of the abdomen was done.

Children underwent surgery within 24 h of admission after all the routine investigations. Informed consent about the procedure was taken. The children underwent either open or laparoscopic appendectomy. In few children, laparoscopy had to be converted to open in view of adhesions. According to the intraoperative findings, patients were divided into two groups, complicated appendicitis and simple appendicitis. Open appendectomy was done by infraumbilical transverse incision. In case of abscess/perforation, the pus was drained, and appendectomy was done followed by a thorough lavage. Laparoscopic appendectomy was done by standard three-port technique. Port sites were infraumbilical, left and right iliac fossa. Similar to open technique, pus was drained followed by appendectomy and lavage. In all the children, a drain was placed which was subsequently removed in the post-operative period.

The intraoperative findings of complicated appendicitis were reviewed. The variables recorded were the type of complicated appendicitis, position of appendix, presence of appendicolith, and site of perforation. Postoperatively, the duration of intravenous antibiotics and the length of stay were tabulated. The follow-up period ranged from 6 months to 3 years. All the collected data were entered into Microsoft Excel spreadsheet. All the categorical variables were analyzed by applying Chi-square test and continuous variables were analyzed by applying independent t-test.

RESULTS

There were 220 patients operated with the diagnosis of acute appendicitis in the study period. Of the 220 children, 160 (72.7%) had simple and the remaining 60 (27.3%) had complicated appendicitis. In complicated appendicitis group, 40 children were males and 20 children were females (Table 1). Sex of the child did not have any relation with complicated appendicitis (p=0.9). Mean age of the presentation of complicated appendicitis children was 10.38±2.84 years. Age distribution of the children is shown in Table 2.

Equal numbers of patients were seen from both rural and urban backgrounds (Table 3). There were no significant differences between patients with complicated appendicitis and simple appendicitis with regard to age, sex, or locality of patient.

The symptoms and their duration are depicted in Table 4. The most common presentation was abdominal pain, followed by vomiting and fever. 60% of the patient had abdominal pain for 2 days (48 h) or more in complicated appendicitis group (Table 5). This was statistically significant when compared with simple group (p=0.017).

Total leukocyte count of >15,000 was seen in about 50% of the children (Table 6) with complicated appendicitis. This finding was statistically significant when compared to children with simple appendicitis (p<0.0001).

Of the 60 children, 37 (62%) children underwent laparotomy, and 18 (30%) underwent laparoscopic appendectomy. In 5 cases, laparoscopy had to be converted to open for the completion of surgery. Intraoperatively, perforation of the appendix with generalized abscess was the most common finding seen in 38.3% of the children followed by perforation with localized abscess seen in 33.3%. Fecolith was present in 35% of the cases (Table 7) with complicated appendicitis, whereas only 12% of children in simple appendicitis had fecolith (p=0.0001). The most common position of appendix was retrocecal (Table 8). Postoperatively, children required intravenous antibiotics for a mean duration 7 days. Mean duration of stay was 7.46 days in complicated appendicitis group.

Table 1: Sex-wise distribution of appendicitis

Sex	Simple	Complicated	Total
Male	108 (67.5)	40 (66.7)	148 (67.27)
Female	52 (32.5)	20 (33.3)	72 (32.7)
Total	160 (72.7)	60 (27.27)	220 (100)

p value is 0.96 not statistically significant: Figure in parenthesis is in percentage

Table 2: Age-wise distribution

Age (years)	Simple	Complicated	Total
<5	0 (0)	0 (0)	0 (0)
5–10	65 (40.6)	30(50)	95 (43.18)
>10	95 (59.4)	30 (50)	125 (56.8)
Total	160 (72.72)	60 (27.27)	220 (100)

p value is 0.211 not statistically significant: Figure in parenthesis is in percentage

Table 3: Distribution of appendicitis with location

Locality	Simple	Complicated	Total
Rural	76 (47.5)	26 (43.3)	102 (46.36)
Urban	84 (52.5)	34 (56.7)	118 (53.64)
Total	160 (72.72)	60 (27.27)	220 (100)

p value is 0.58 not statistically significant: Figure in parenthesis is in percentage

Table 4: Distribution of complicated appendicitis as per symptoms (multiple responses)

Symptom	n (%)
Abdominal pain	60 (100)
Pain duration (days)	
<2	24 (40)
2–5	23 (38.33)
>5	13 (21.66)
Nausea and vomiting	49 (81.66)
Fever	36 (60)
Others*	13 (21.66)

Table 5: Duration of pain and complicated appendicitis

Duration of pain	Simple	Complicated	Total
<48 h	95 (59.3)	24 (40)	119 (54.1)
More than 48 h	65 (40.7)	36 (60)	101 (45.9)
Total	160 (72.72)	60 (27.27)	220 (100)

p value is 0.017 statistically significant: Figure in parenthesis is in percentage

DISCUSSION

Appendicitis is the most common surgical condition. In the present study, the incidence of complicated appendicitis was

Table 6: TLC and appendicitis

TLC >15000	Simple	Complicated	Total
Present	25 (15.62)	28 (46.66)	53 (24.1)
Absent (<15,000)	135 (84.38)	32 (53.34)	167 (75.9)
Total	160 (72.72)	60 (27.27)	220

p=0.00002 significant: Figure in parenthesis is in percentage. TLC: Total leukocyte count

Table 7: Fecolith and complicated appendicitis

Fecolith	Simple	complicated	Total
Present	19 (11.8)	21 (35)	40 (18.18)
Absent	141 (88.2)	39 (65)	180 (81.81)
Total	160 (72.72)	60 (27.27)	220

p value is 0.00075 significant: Figure in parenthesis is in percentage

Table 8: Distribution of complicated appendicitis patients based on surgery and intraoperative finding

Intraoperative finding	n (%)
Perforation with local abscess	20 (33.3)
Perforation with generalized abscess	23 (38.3)
Mass/Phlegmon	08 (13.3)
Gangrene	09 (15)
Fecolith	
Present	21 (35)
Absent	39 (65)
Position of appendix	
Retrocecal	28 (46.66)
Pelvic	18 (30)
Paracecal	10 (16.66)
Pre-ileal	04 (6.66)

27.3%. In literature, the perforation rates vary from 5% to 62%, respectively [6,9]. Diagnosis of acute appendicitis in children may be difficult, especially in those having atypical symptoms and signs. Delay in diagnosis may lead to complicated appendicitis with an increase in morbidity and mortality. Various risk factors have been studied for the increased risk of perforation. These include extremes of age, male sex, rural locality, delayed presentation, delay in diagnosis, presence of appendicolith, and elevated blood parameters, namely, neutrophils [10-14]. If the above-mentioned risk factors are correlated to this study, we find the following results. 66% of children with complicated appendicitis were male. However, when compared to simple appendicitis, the sex of child did not influence the chances of complication. Equal numbers of children were from both rural and urban localities. Earlier people living in a rural locality took a longer time to reach the medical facility, hence leading to complication. However, with the improvement in transportation, such is not the case now. Hence, no difference was found with respect to the area of living.

In younger children, the symptoms are non-specific. The other factor is poorly developed omentum, leading to the rapid progression of complication. These factors result in younger children presenting more with complications. None of the children were <5 years in our study. Age has a risk factor which was not statistically significant in our study. However, in literature, perforation rates were as high as 82% in children <5 years and 100% in children <1 year [1,15].

Abdominal pain of >2 days' (48 h) duration was seen in 60% of children presenting with complicated appendicitis. A study conducted in America found that perforation risk is <2% if the presentation is <36 h and beyond 36 h risk of perforation rose by 5% every 12 h [13]. A study done by Singh *et al*. in India, where 102 cases were analyzed, found that complicated appendicitis was associated with a delay in presentation >72 h and children age<5 were more likely to have complications [16]. Another study done by Narsule *et al*. where 202 patients were examined found that the perforation rate rose in a linear fashion from 10% by 18 h to 44% by 36 h [17]. If symptoms were present for >2 days, the risk of perforation was >40%. On the contrary, a study by Augustine *et al*. found that there is an early risk of perforation even in first 36 h [18].

About 50% of the children with complicated appendicitis had a leukocyte count of >15,000 cells/mm compared to only 18.5% in uncomplicated appendicitis. No difference in white cell count was found by a study conducted by Narsule *et al*. On the contrary, leukocyte count of >15,000 cells/mm^3 was significantly associated with complicated appendicitis in a study conducted by Poudel and Bhandari [19]. Appendicolith is well-established risk factor for complication. Appendicolith obstructs the lumen of appendix causing appendicitis. Appendicitis caused by appendicolith is commonly associated with perforation and abscess [20,21]. In this study, appendicolith was present in 32% of children with complicated appendicitis compared to only 12% of patients with uncomplicated appendicitis. Appendicolith has a risk factor which was also found in a study by Singh *et al*.

Few limitations of our study are the retrospective design and study population being from a single medical center.

CONCLUSION

Appendicitis is the most common surgical condition. Complicated appendicitis is associated with high morbidity. High leukocyte count, delayed presentation, and appendicolith are reliable indicators of complicated appendicitis. There should be a higher index of suspicion of complicated appendicitis in patients who present late and have a higher leukocyte count.

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