

# Analyzing the Outcomes of Laparoscopic Appendectomies in Children: Lessons Learned from 153 Consecutive Surgeries

Aniket Agrawal<sup>1</sup>, Vivek Viswanathan<sup>2</sup>, Gursev Sandlas<sup>3</sup>, Anoli Agrawal<sup>4</sup>

## ABSTRACT

**Introduction and discussion:** Appendicitis is one of the most common causes of acute abdomen presenting in the pediatric age-group. Surgical management is still the gold standard management for this condition. The introduction of the minimally invasive laparoscopic approach *vis-à-vis* the conventional laparoscopic and open approaches has overhauled the surgical management of this condition. The first laparoscopic appendectomy was performed by Semm in 1983 in an adult patient; however, it was not until 1992 when the first laparoscopic appendectomy was done in the pediatric age-group by Ure et al.

**Objective:** Our goal with this study was to analyze if laparoscopic surgery can be used as the standard of care for appendectomies, regardless of the type of appendicitis, complicated or uncomplicated.

**Results:** The results of our study suggest that in the pediatric age-group, males presented with appendicitis more commonly than females. We also found that the most patients had an average length of stay (ALOS) between 48 and 72 hours, regardless of the type of appendicitis, complicated or uncomplicated.

**Conclusion:** This study only reaffirms the fact that a pediatric laparoscopic appendectomy is a safe approach in all types of appendicitis, complicated or uncomplicated, but it does have a learning curve.

**Keywords:** Laparoscopic appendectomy, Laparoscopy, Minimally invasive approach, Open and Laparoscopic surgery, Pediatric laparoscopic surgery.

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## INTRODUCTION

Appendicitis is one of the most common causes for acute abdomen in the pediatric age-group. Surgical management is still the gold standard management for this condition. The introduction of the minimally invasive laparoscopic approach *vis-à-vis* the conventional laparoscopic and open approaches has overhauled the surgical management of this condition.

The first appendectomy was performed over 200 years later by Claudius Amyand in 1735, whereas the first laparoscopic appendectomy was done over two centuries later in 1983 in adults, and even later in 1992 is when the first pediatric laparoscopic appendectomy was done by Ure et al. However, it was Gilchrist et al. who first presented a paper explaining the benefits of laparoscopic appendectomy over open appendectomy.

Our goal with this study was to look at whether laparoscopic surgery can be used as the standard of care for any type of appendectomy, complicated or uncomplicated in pediatric patients.

## MATERIALS AND METHODS

We did a retrospective analysis of our prospectively maintained databases of pediatric patients who presented with acute appendicitis and underwent laparoscopic appendectomy in our tertiary care center. The data was collected prospectively from January 2015 to August 2021. The parameters compared were the age and sex of the patients, the ALOS, and the complications if any.

### Inclusion Criteria

- Diagnosed case of acute appendicitis
- Operated for appendectomy
- Less than 20 years of age

<sup>1,2</sup>Department of Paediatric Surgery, Kokilaben Dhirubhai Ambani Hospital and Medical Research Institute, Vadodara, Gujarat, India

<sup>3</sup>Department of Paediatric Surgery, Topiwala National Medical College and Bai Yamunabai Laxman Nair Charitable Hospital, Mumbai, Maharashtra, India

<sup>4</sup>Department of Public Health Dentistry, JMF's ACPM Dental College, Dhule, Mumbai, Maharashtra, India

**Corresponding Author:** Vivek Viswanathan, Department of Paediatric Surgery, Kokilaben Dhirubhai Ambani Hospital and Medical Research Institute, Vadodara, Gujarat, India, Phone: +91 8130156115, e-mail: vivek25486@gmail.com

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### Exclusion Criteria

- Any conversion to open procedure

## RESULTS

Our study aimed to look at three specific parameters, namely, the demographic in terms of age and sex distribution for appendicitis in the pediatric age-group, the ALOS, and complications if any.

### Demographics (Gender)

Figure 1 depicts the demographic distribution of the sex of the patients who presented with appendicitis at our institution. The

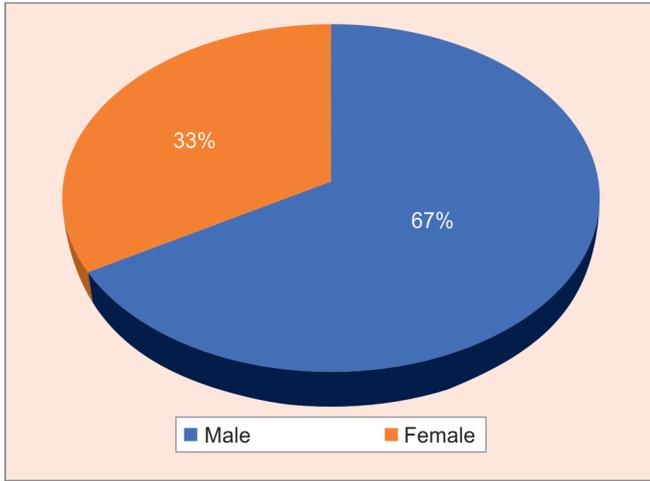


Fig. 1: Demographics (gender)

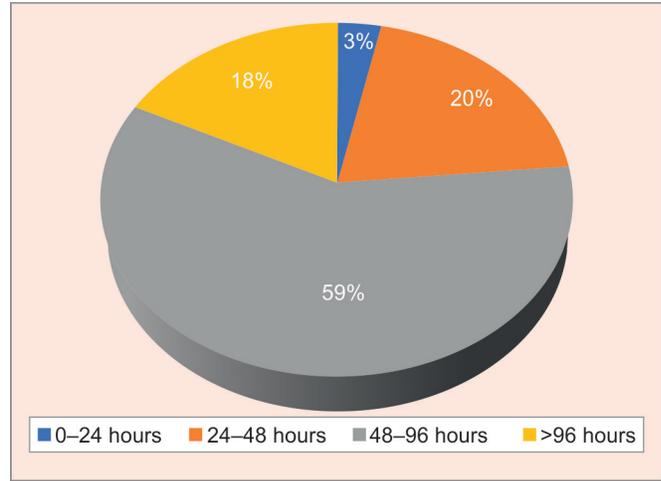


Fig. 3: Average length of stay

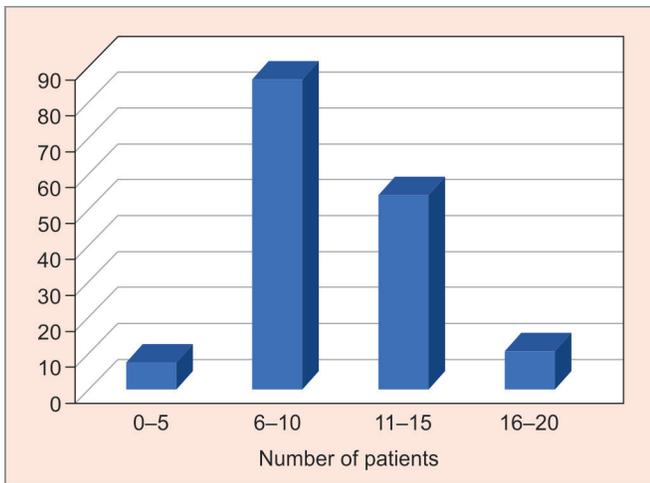


Fig. 2: Demographics (age)

pie chart suggests that males tend to have a higher incidence of appendicitis in the pediatric age-group compared to females, approximately in the ratio of 2:1 (males:females).

### Demographics (Age)

Figure 2 depicts the demographic distribution of the age of patients who presented with appendicitis at our institution. The graph suggests that patients presenting with appendicitis are most commonly in the age-group of 6–10 years old followed by 11–15-year old which was the second most common.

### Average Length of Stay

Figure 3 depicts the distribution of the ALOS of the patients [measured (in hours) from the time of admission to the time of discharge] irrespective of the type of appendicitis operated i.e., complicated or uncomplicated. The pie chart suggests that most patients were discharged from the hospital within 48–96 hours of admission for the surgery irrespective of the type of appendicitis operated, i.e., complicated or uncomplicated.

### Adverse Events

In our study cohort, we encountered adverse events in 12 patients. The adverse events were divided into two groups, namely,

complications and unrelated events. Out of the 12 patients, complications were encountered in 11 patients and 1 patient developed an unassociated event during the hospital stay. The complications were graded as per the Clavein–Dindo criteria and further divided into two groups, namely, minor (grades I and II) and major (grade  $\geq$ III).

- Complications
  - Minor (grades I and II): 6
  - Major (grade  $\geq$ III): 5
- Unrelated event
  - Testicular torsion: 1

An interesting point to be noted here is that out of the 11 patients who encountered complications, only 6 patients presented with and were operated on for complicated appendicitis while the other 5 patients had uncomplicated appendicitis, giving us more than 50% chance of patients with postoperative complications having a history of complicated appendicitis.

### DISCUSSION

Appendicitis is the most common acute abdominal emergency.<sup>1</sup> The mention of this condition can be dated back to as early as 30 AD, where its presence was recorded by Aretaeus the Cappadocean.<sup>2</sup> However, the first description of the appendix was given by the anatomist Berengario de Carpi in 1521, and the first appendectomy was performed over 200 years later by Claudius Amyand in 1735.<sup>2</sup> The term “appendicitis” was coined by the pathologist–physician Reginald Fitz in 1886;<sup>2</sup> however, it was Robert Tait who first diagnosed an appendicitis and then surgically removed the appendix in 1880, and in 1889, he also became the first one to split open and drain an appendix without removing it.<sup>3</sup>

The well-renowned Mcburney’s point as well as Mcburney’s incision were first described and named after Charles Mcburney, who proposed a muscle splitting incision in 1893, which was later modified by Robert Weir in 1900.<sup>3</sup>

The shortcoming of Mcburney’s, also known as Gridiron incision, that is, a non-cosmetic scar was overcome by Elliot of Boston and Otto Lanz. Lanz described an incision one-third of the way along the interspinal line, which paved way for a cosmetically acceptable scar which formed the principle behind a laparoscopic appendectomy.<sup>4</sup>

Appendicitis is a condition that does not just affect adults but is also very commonly seen in the pediatric age-group. In the pediatric age-group, the lifetime risk of appendicitis is about 7–9% and the mortality risk from the same is about 0.01% (non-perforated appendicitis) to 0.06% (perforated appendicitis).<sup>5</sup>

Thanks to surgical advancements, especially in the last 40 years, the approach for appendectomies has shifted from an open surgical approach towards a minimally invasive approach. The first-ever laparoscopic appendectomy was performed by Semm in 1983 in an adult patient,<sup>6</sup> and the first-ever laparoscopic appendectomy in a pediatric patient was done about a decade later in 1992 by Ure et al. However, it was Gilchrist et al. who first presented evidence explaining the benefits of laparoscopic appendectomies over the open surgical approach.<sup>7</sup> The one drawback that is still of concern is the cost of laparoscopic appendectomy over the open approach. However, the reduced postoperative pain, shortened length of hospital stay as well as recovery time along with minimal abdominal scarring with the former approach are the advantages that can help reduce the cost difference.<sup>8,9</sup>

The minimally invasive approach initially only included the conventional laparoscopic approach; however, in recent years, laparoscopic appendectomy *via* single incision has gained popularity, as it offers advantages such as less pain, better cosmetics, and an overall reduced operative time.

Canty Sr, et al. and Foulds et al., in their series of pediatric laparoscopic appendectomies, have mentioned that they found a significant improvement in terms of operative time and risk of conversion to open appendectomy after 5 years of laparoscopic experience.<sup>10,11</sup> This makes it reasonable to assume that the learning curve for laparoscopic appendectomies is ~20 procedures and as the experience increases, the proficiency of the surgeon also increases.<sup>12</sup> This has been shown in the study done by York et al., where they found that after the completion of the learning curve, laparoscopic appendectomies become comparable to the open approach in terms of operative time and the former has a decreased postoperative length of stay and faster recovery of bowel function to normal compared to the latter.<sup>12</sup>

In our study, we aimed to determine whether the laparoscopic approach can be used as a standard of care for any type of appendectomy, complicated or uncomplicated. We retrospectively analyzed a prospectively collected data of 153 consecutive laparoscopic appendectomies done at our institution over the course of 6.5 years, between January 2015 to August 2021. The various parameters that we looked into were the demographics of presentation in terms of age and sex of the patients, as well as the ALOS in hospital and postoperative complications if any.

After analyzing our data, we found that in our cohort of 153 patients, males ( $n = 102$ ) were twice as likely to present with appendicitis requiring appendectomies compared to females ( $n = 51$ ) (male:female = 2:1). Our data also suggests that out of 153 patients, most of the patients presenting with appendicitis were in the age-group of 6–10 years of age ( $n = 84$ ), followed by 11–15 years ( $n = 48$ ). Vernon et al. in their study on pediatric laparoscopic appendectomy in acute appendicitis in 200 patients reported that there was an equivalent number of patients presenting with appendicitis in both genders and that there was an equivalent number of patients of all ages up to the age of 16 years. They also found that laparoscopic appendectomy was used more in heavier patients and that patients treated with laparoscopic

approach had a shorter ALOS compared to those treated with an open approach.<sup>13</sup>

The common postoperative complications, within 30 days postoperative appendectomy, include drainage of surgical wound infections, intra-abdominal abscesses, and postoperative adhesions causing bowel obstruction. The rate of complications in our study was divided into 3 groups of 51 surgeries each, that is, 1–51 surgeries (first group), 52–102 surgeries (second group), and 103–153 surgeries (third group). In these 3 groups, we had 2 postoperative complications related to the appendix in the first 51 surgeries, whereas no postoperative complications in the second and third groups which demonstrates that with increased experience, the postoperative complication rates for laparoscopic appendectomies showed a decreasing trend.

Out of 153 patients, only 3 patients required reoperation, 1 of which was for a post-appendectomy abscess which was reoperated and treated with insertion of a pig-tail for drainage, the other was reoperated for postoperative adhesive obstruction and the third case was reoperated for removal of a retained fecolith. We have a strict policy regarding the use of disposable trocars and EndoCatch bags especially in cases of complicated appendicitis. In our view, the use of this equipment has contributed to and helped us achieve a lower postoperative complication rate in our study. Similar findings were seen, where the use of an endoscopic loop to retrieve the appendix to reduce the potential for wound infections by preventing contact of the specimen with the abdominal wall during removal, in the study done by Goudet et al. in their modified technique for laparoscopic appendectomy.<sup>14</sup> The use of these may increase the cost of surgery upfront but it may save the cost in terms of postoperative complications requiring re-operation, which have been seen to occur at a higher incidence rate when this equipment is not used.<sup>15</sup>

An important intraoperative complication was the rate of conversion from laparoscopic to open surgery. In our study, we had a 0% conversion rate, in both complicated as well as uncomplicated appendectomies. Gosemann et al. in their nationwide cohort analysis found that they had a conversion rate of 1.2% which was associated with increased risk of complication compared to individual laparoscopic or open surgery groups.<sup>16</sup> They also found a higher conversion rate in surgeries performed by pediatric surgeons, whereas in our study all the surgeries were performed by trained pediatric surgeons but had a 0% conversion rate. This could be attributed to increased surgical experience and the findings seen in Gosemann's study may be a confounding factor.

Markus Schäfer et al. also in their study reported a 6.8 and a 25.5% conversion rate in overall and perforated appendicitis cases.<sup>17</sup> They also reported an overall reoperation rate of 3%, which was close to our number of 1.96%.

## CONCLUSION

In conclusion, our study only reiterates the fact that a pediatric laparoscopic appendectomy is a safe approach in all types of appendicitis, complicated or uncomplicated, in reducing complications and ensuring a reduced rate of conversion, but it does have a learning curve, which when achieved, makes the laparoscopic approach comparable to open approach in terms of operative time and offers advantages over the latter in terms of postoperative pain, length of hospital stay and earlier return of bowel function to normal.

**ORCID**Aniket Agrawal  <https://orcid.org/0000-0002-2660-5118>Vivek Viswanathan  <https://orcid.org/0000-0001-8488-0145>Gursev Sandlas  <https://orcid.org/0000-0003-4890-9080>Anoli Agrawal  <https://orcid.org/0000-0003-1045-1377>**REFERENCES**

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