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Laparoscopic Harmonic Appendectomy: A Novel Approach

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Abstract Introduction: Acute appendicitis is one of the most frequently encountered surgical emergencies, and over the years the surgical approach to which has undergone many changes. For decades, an open appendectomy was performed, until the 1990s when a laparoscopic approach gained popularity. Methods: A retrospective study was conducted to assess outcomes of 63 patients who underwent a laparoscopic appendectomy using a 3-port incision, where harmonic scalpel was utilized for the division of the appendiceal stump and mesoappendix. Results: None of our participants experienced any complications, 85.7% of appendixes were acutely inflamed at operation, the mean operative time was 31.4 minutes. Conclusions: Harmonic scalpel used for laparoscopic appendectomy is both safe and effective, and decreases morbidity compared to open appendectomies.

Keywords: *minimally invasive surgery, appendectomy, harmonic scalpel, laparoscopy, general surgery*

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1. Introduction

Acute appendicitis is an inflammation of the appendix. It is one of the most frequently encountered conditions in the surgical emergency. The incidence of acute appendicitis is 6.3% to 8% [1,2,3]. The most commonly used method for this procedure are either conventional open appendectomy or laparoscopic appendectomy. However the shift towards laparoscopic technique is relatively at a slower pace as compared to surgeries for other diseases [4]. K. Semm was the first one to perform a laparoscopic technique of surgical removal of the appendix in 1983 [5].

In routine laparoscopic appendectomy is performed by a three-port method in which a 1.0cm port is placed below the navel and CO2 is inflated in the abdominal cavity. The remaining two ports (both measuring 0.5cm) are placed in the suprapubic region on the left iliac quadrant of the abdomen. Feet of the patient are raised 15-30^{o} and patient is tilted towards the left. Mesentery of the appendix is separated and the appendix ligated and divided, this is achieved via different methods [6,7].

There are multiple methods described for the removal of the appendix laparoscopically, the safety of which have been described in the literature. One technique involves using the monopolar L-hook to separate the mesoappendix from the appendix and transfixing the appendiceal base before dividing it [8].

A technique has been described using straight stapler devices, to staple both the mesoappendix and the appendiceal base after creating a window before diving the appendix [9]. Endoclips, invaginting sutures, intra or extracorporeal ligatures, Roeder's loops, and endoloops are also widely accepted forms of minimally invasive appendectomy approaches [10].

A study performed analysed the results of endoclips, invaginating sutures and endoscopic staplers. Though the morbidity profile, average hospital stay and operating time were comparable in the three groups, invaginating sutures had a lengthier surgery time and higher post-operative complication rate. For endoclips and stapling, the average operating time was 62.9 minutes and 62.0 minutes; post-operative complication rate was 5.6% and 5.9% and average hospital stay was 3.6 days and 4.3 days [11].

Another study analysed the results of endostaplers, extracorporeal sliding knots and intracorporeal sutures and found a mean time of 56.4 minutes, complication rate of 6.6% and hospital stay of 1.73 days for endostaplers, mean operating time of 71.5 minutes and 84.3 minutes; complication rate 2.3% and 4.2%; average hospital stay 1.8 days and 2.3 days respectively for extracorporeal sliding knot group and intracorporeal suture group [12].

We must remember the context of this study being conducted, Pakistan being a developing country and like other developing countries has limited resources and limited facilities for minimally invasive surgery. This being said, there is no formal fellowship at the moment in the country for minimally invasive surgery and this would hold true for many other developing countries. However, in recent years there has been a shift towards minimally invasive surgery in developing countries from the

traditional open techniques with a generation of surgeons that have been trained in minimally invasive procedures abroad. We aimed to find both a technique that is safe and not technically handicapping and would be reproducible given the resource limitations and costs incurred in developing countries.

The laparoscopic appendectomy using an harmonic scalpel- where first the mesoappendix is divided using the harmonic scalpel followed by dividing the appendiceal base using the harmonic scalpel-in previously done studies showed that it was safe and saved operating time however studies done using this technique were limited. There are two studies done that have utilized the harmonic scalpel for appendectomies, which had similar outcomes in terms of an average of 37 minutes for surgical time, an average hospital stay of 3.5 days, 10% wound infection rate, in both studies there was only 1 reoperation, and 4 complications and no post-op leaks were identified [13,14].

Since there is limited data on this technique the aim of the study was to further validate the findings and reaffirm the safety of this technique which could gain popularity given the ease and safety of this technique.

2. Subjects and Methods

Data was retrospectively collected of all patients that had undergone an harmonic laparoscopic appendectomy between January 2018 and February 2020. Most patients had been first received in the emergency room and given that the tenderness was not excruciating, the patient was not sick, there was no appendicular mass palpable, there was no high index of suspicion on clinical examination of a perforated or gangrenous appendix and based on the patients choice when given an option for an open appendectomy versus a laparoscopic appendectomy with full informed consent, they were admitted and operated on laparoscopically on the elective list. Two patients underwent a laparoscopic interval appendectomy 6 weeks after receiving an Oschner-Sherren regime for an appendicular mass. Patients were not discriminated based on age, gender or comorbids. Patients were admitted from the emergency to the surgical floor. There was a lag time of 48 hours between surgery and admitting from the emergency room as the elective surgical list occurred the day after and laparoscopic facilities are not available in the hospital except on the elective surgical list. In the 48 hours that the patient was admitted on the surgical floor they received intravenous antibiotics, an intravenous proton pump inhibitor and intravenous analgesia.

Patients underwent a laparoscopic appendectomy using the harmonic scalpel, where an 11mm infraumbilical port is inserted first and then pneumoperitoneum is created. Following this two 5mm ports are inserted one in the right iliac fossa and one suprapubically ensuring triangulation is undertaken. The abdomen is sweeped and seen to ensure there is no abscess or gross pathology present, in women both the ovaries are visualized routinely.

The appendix is traced and mobilized and the harmonic scalped then used to first divide the mesoappendix, then the appendiceal base as is pictorially depicted in Figure 2. Hemostasis is ensured and ports retrieved.

3. Results

Of our 63 participants we found that the mean age was 22.8 years with a standard deviation of 4.80. The youngest was 12 years old and the oldest to be operated on was 36 years old.

We had a reasonable gender distribution with 52.4% males and 47.6% females.

None of our patients had any pre-existing co-morbidities such as diabetes, hypertension or any chronic illness.

Our mean Modified Avorado's Score was 5.73 with a standard deviation of 0.79. A Modified Avorado's Score of 6 was identified as the mode.

Neutrophilia in routinely run labs showed a mean of 63.4% neutrophil differential, with a standard deviation of 10.0% and white blood cell count had a mean of 11.9 with a standard deviation of 2.81.

Table 1. Intra-operative diagnosis of participants

Intraoperative Diagnosis		
Diagnosis	Frequency (n)	Percentage (%)
Acutely inflamed appendix	54	85.7
Fibrosed Appendix	1	1.6
Inflamed appendix with left ovarian cyst	1	1.6
Inflamed appendix with right ovarian cyst	3	3.2
Early mass formation	4	4.8
Total	63	100

We assessed how many of our patients received pre-operative antibiotics prior to surgery and the results are presented in Table 2.

Table 2. Pre-operative antibiotics

Pre-operative Antibiotics		
	Frequency (n)	Percent (%)
No Antibiotics	8	12.7
Ceftriaxone 1g twice daily pre-operatively	53	84.1
Oschner-Sherren Regime	2	3.2
Total	63	100.0

Of our participants, 69.8% (n=44) had an unremarkable ultrasound at the time of presentation, 1.6% (n=1) had features suggestive of acute appendicitis, and 15.9% (n=10) had a streak of fluid present in the right iliac fossa. 15.9% (n=10) had probe tenderness documented by the radiologist.

One patient underwent a conversion to an open appendectomy due to inability to identify the appendix laparoscopically, where the appendix was found to be fibrosed and wrapped in omentum as is demonstrated in Table 1. This patient had undergone an interval appendectomy after Oschner-Sherren regime.

The mean hospital stay was 3.13 days with a standard deviation of 0.34 days, that is 87.3% (n=55) had a 3 day hospital stay, and 12.7% (n=8) had a hospital stay of 4 days. This is in note that most operated on patients were

discharged the morning after surgery, and the lag time that was present from the emergency till the elective operating list amounted to most of the hospital stay time.

Operating time from the start of anesthesia induction till extubation had a mean time of 31.6 minutes with a standard deviation of 4.17 minutes as is shown in Figure 1.

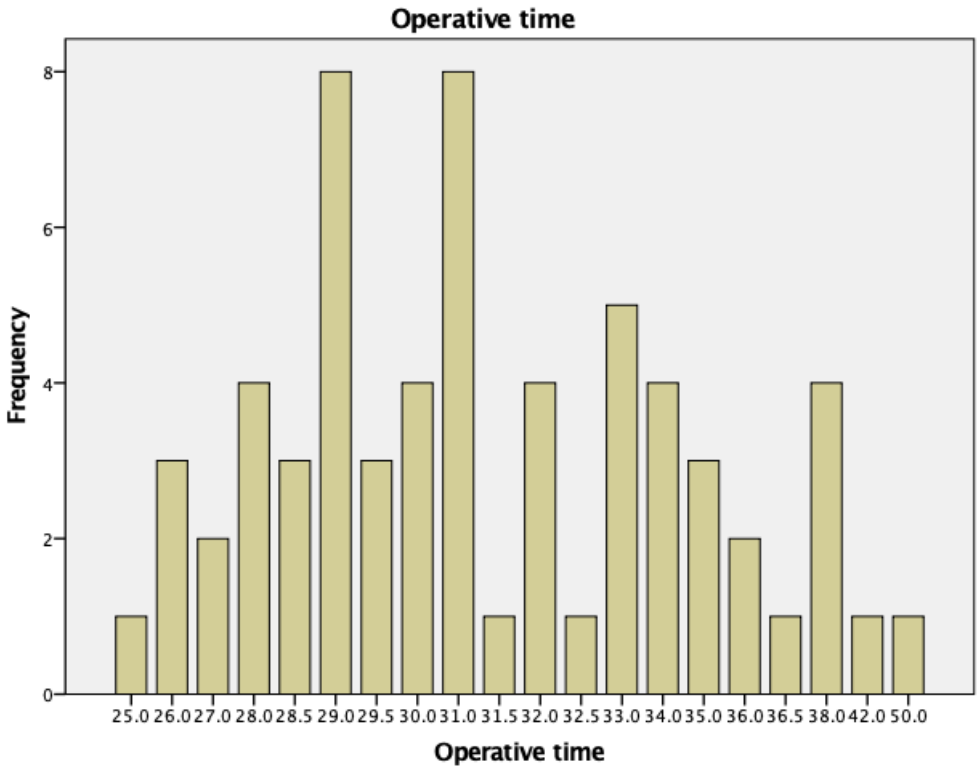

Figure 1. Operative time bar chart

All of our patients were doing well on follow up 1 month later in clinic, and there were no complications identified pertaining to the surgery.

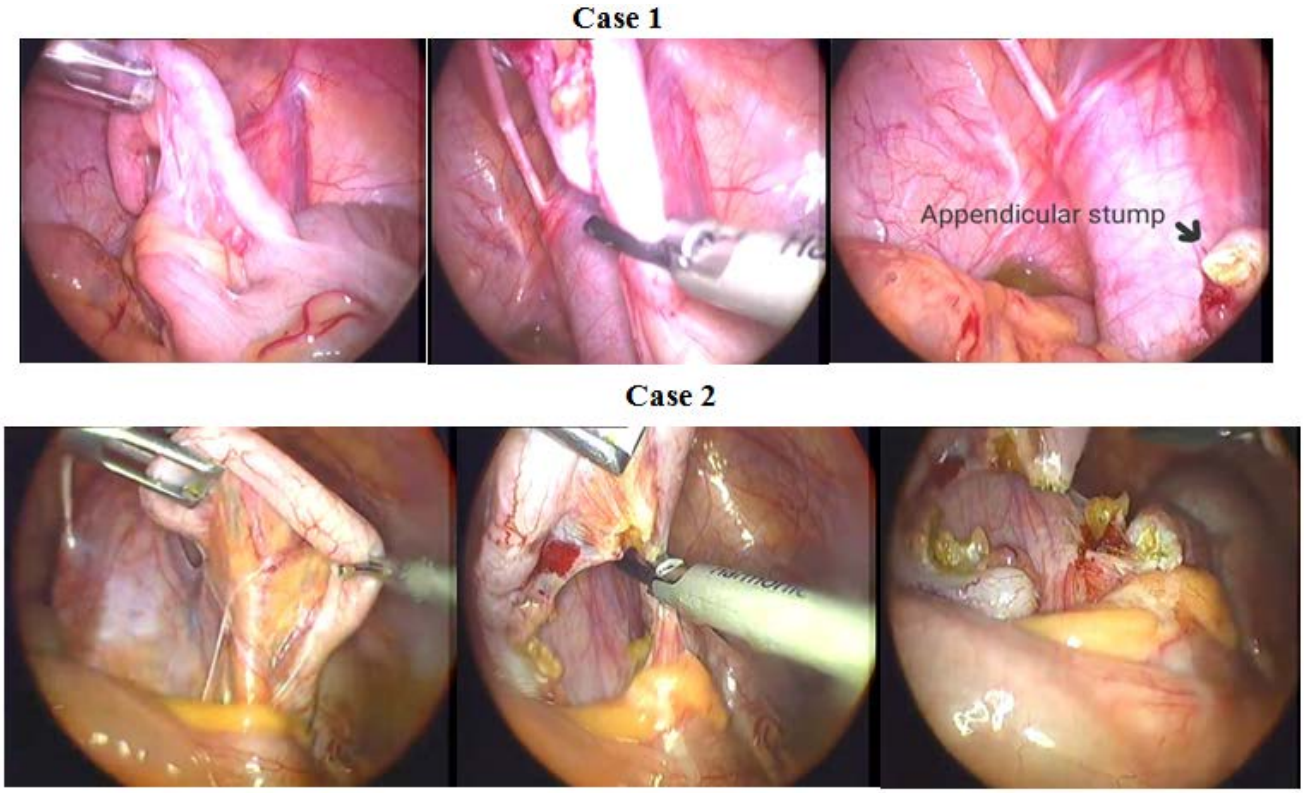

Figure 2, Per-operative pictures from two different cases

4. Discussion

Though our data was small, we managed to have good gender equity and the procedure was conducted on people of most ages who are likely to present with acute appendicitis to a general surgery unit, especially in a country like Pakistan where pediatric surgeons are found mainly in large tertiary care hospitals [15].

A definite limitation of our study was that patients who were operated on had to be brought to the elective list after admission to the emergency, thus patients experiencing exquisite pain, those who looked sick or were running high fevers and would not be able to comfortably tolerate a delay of 48 hours till surgery were preferentially taken to the emergency operating room and underwent an open appendectomy, this could potentially be the reason for an Avorado's score of 6 being commonly seen in our study group, rather than a higher score and early acute appendicitis was commonly found per-operatively. We also found that waiting for 48 hours in our study group was safe and acceptable, where a review found that waiting upto 24 hours to take an appendectomy to a laparoscopic appendectomy was acceptable [16], we pushed this by another 24 hours and found that in early acute appendicitis at least, this was safe and acceptable with perioperative antibiotics administered and good analgesia.

Using our technique of the harmonic scalpel to divide the mesoappendix and the appendix itself, we did not see any of the complications one would be wary off in appendiceal surgery such as stump leakage, inadequate stump length, mesoappendix bleeds or contamination [10]. Due to the smaller port incisions there were no wound infections, which is by far a large concern, as wound infections in countries like Pakistan with poverty, limited personal hygiene due to limited resources, usually uncontrolled co-morbid conditions such as diabetes, amongst other factors is a major morbidity for patients with open surgeries and larger incisions [17,18,19].

We found that our data was comparable to the other studies done using the harmonic scalpel, with a similar mean operating time 31.6 minutes for our study and an average of 37 minutes for the other two studies, and average hospital stay length of 3.13 days for our study and 3.5 days for the other two studies. We had a better morbidity rate and no re-operations. Compared to other techniques such as endostaplers, intracorporeal knotting and endoclips; our morbidity profile was acceptable and comparable and above all operating time was reduced by nearly upto 20 to 30 minutes in comparison. This clearly provides an advantage with less anesthesia time experienced by the patient [10,11,12,13,14].

A recent study published compared laparoscopic appendectomy using harmonic scalpel with endoloop. They found a significant difference between mean operating times, with endoloop having a mean of 43.34 minutes whereas with harmonic scalpel the mean operating time was 28.46 minutes. This is comparable to our study and the other studies we have reviewed. Both groups had four patients each who had a surgical site infection, however no patient had any complication on follow up [20]. In a very small study in the pediatric population, the harmonic scalpel was used to perform an appendectomy in three children, after anchoring the mesoappendix to the anterior abdominal wall using an extracorporeal suture, the mean operative time was 30 minutes, with all three children doing well on follow up [21].

The search for alternative methods to undertake a safe laparoscopic appendectomy has recently piqued interest, with shorter operative times and simpler laparoscopic handling being the prime objectives. A study explored using bipolar cautery for laparoscopic appendicectomy was done, where operative time had a median of 25 minutes, with a 3 day hospital stay [22].

With the body of literature growing on the harmonic scalpel laparoscopic appendectomy, it is imaginable with similar results in terms of complications; which were few in our study comparable to the other studies, and an average operating time of half an hour across the literature, with patients doing well on follow up and the feared complication of stump leakage being negligible, this method is sure to gain popularity and become a viable alternative to the existing, established norms.

Our study manages to provide a small yet significant contribution to the debatable approaches to appendectomies and how to proceed with one. It further shows that there is room to believe that the method is safe and reliable and thus there is reason to do larger studies to further validate and evaluate the harmonic scalpel method of appendectomy.

5. Conclusion

We found that with our results being comparable to the results from the two other existing studies that used the harmonic scalpel in a laparoscopic appendectomy to divide both the mesoappendix and the appendix to achieve its stump closure and division, provides reasonable evidence that this method is safe and effective. We further found that it decreased both operating time and hospital stay and in developing countries where the burden of surgical site infections carries a great burden, especially in the emergency surgery setting, a laparoscopic approach using the harmonic scalpel reduced this greatly.

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