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"A Prospective Comparative Study of Laparoscopic Versus Open Appendectomy in Tertiary Care Referral Center"

Dr Manisha[1]; Dr, Souvik[2]

Abstract
Acute appendicitis is one of the most common surgical emergencies and appendectomy is the most common general surgical operation performed in the world. Despite the improvement of laparoscopic approach through the years and numerous studies comparing open and laparoscopic approach, it is still not proven as to which procedure is superior in the management of acute appendicitis. Our study was a prospective comparative study between laparoscopic and open appendectomy in terms of duration of surgery, intraoperative and postoperative complications, postoperative pain, days to resume oral diet and duration of hospital stay. In our study 200 patients who came with features of acute appendicitis to AJ Institute of Medical Science Hospital from August 2016 to September 2018 were divided into two groups, 100 patients who underwent open appendectomy and 100 patients who underwent laparoscopic appendectomy. After collection of data related to patient demography, preoperative evaluation, intraoperative and postoperative parameters, analysis was done and the two groups were compared. Laparoscopic approach was associated with a significantly less amount of post-operative pain ($p<0.001$), an early resumption oral diet ($p<0.05$), a shorter hospital stay ($p<0.001$) and a significantly less wound infection rate ($p < 0.05$). Laparoscopic appendectomy has significant less postoperative pain, early recovery, comparatively less complications, shorter hospital stay and earlier return to normal activities as compare to open appendectomy. It is of our view that Laparoscopic Appendectomy be contemplated in all cases of acute appendicitis.

Keywords: *Open appendectomy, Laparoscopic appendectomy*

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I. Introduction

The vermiform appendix is considered by most to be a vestigial organ, its importance in surgery due only to its propensity for inflammation, which results in the clinical syndrome known as acute appendicitis. Acute appendicitis is the most common cause of an "acute abdomen" in young adults[1]. Appendicitis is sufficiently common that appendectomy is the most frequently performed urgent abdominal operation.

The treatment of acute appendicitis was essentially unchanged for a long time since its first description by Charles Mc'Burney in 1889 before the New York surgical society[2]. Appendectomy by Mc'Burney's incision remained the procedure of choice for nearly a century until 1983 when Kurtv Semm[3] offered an alternative "Laparoscopic appendectomy". But as open appendectomy is well tolerated with less co-morbidity, the benefits of laparoscopic appendectomy have been difficult to establish.

The introduction of laparoscopic surgery has dramatically changed the approach in the management of surgery. With improvements in the surgical equipment and digitalization of instruments used in the field of surgery, accessing the site of problem with minimal usage of highly skilled equipments is the dictum in the present decade. It is possible to perform almost any kind of procedure under laparoscopic visualization.

Despite numerous randomized controlled trials published so far, comparing open and laparoscopic appendectomy, laparoscopic appendectomy unlike laparoscopic cholecystectomy is not yet considered the gold standard of managing acute appendicitis. In the developing countries only a few studies have been conducted comparing the two modalities in the treatment of acute appendicitis till date.

At present, although there is no consensus regarding the superiority of the laparoscopic approach over the conventional technique, there is trend towards greater utilization for laparoscopic appendectomy as an alternative operative modality of intervention. Bearing in mind that acute appendicitis is one of the commonest surgical emergency in our hospital, in this study we compared the efficacy of laparoscopic and conventional technique used in the treatment of appendicitis in hand in our tertiary care center.

*AP, *Bowring* and Lady Curzon *Medical* College & Research *Institute*

** Surgeon *Monideepa Nursing Home & Trauma Centre*

CONSERVATIVE MANAGEMENT OF ACUTE APPENDICITIS

Treves was an advocate of early nonoperative management of acute appendicitis, even prior to the advent of antibiotics. Since then several studies have debated or disputed the use of solely antibiotics for management of appendicitis.

Fitzmaurice and colleagues[36] in their recent article "***Antibiotics versus Appendectomy in the management of acute appendicitis: a review of current evidence***" reviewed all studies done in this area from 1999 to 2009. A number of authors have recently proposed that acute appendicitis may be managed conservatively with antibiotics[4-9.] Some authors advocate interval appendectomy owing to the potential for recurrent appendicitis and the possibility of a missed carcinoma; however, there appears to be a growing trend to the sole use of antibiotics and avoidance of surgery altogether[10-11].

Based on the high rate of failure with antibiotics alone, non-operative management of acute appendicitis cannot be recommended. Antibiotic treatment may be a useful temporizing measure in conditions where surgery is not possible due to lack of resources.

COMPLICATIONS OF APPENDECTOMY

Surgical site infections are the most common complications seen after appendectomy. About 5% of patients with uncomplicated appendicitis develop wound infections after open appendectomy. Laparoscopic appendectomy is associated with a lower incidence of wound infection; especially in patients with perforated appendicitis (14% versus 26%) [12].

Small bowel obstruction occurs in less than 1% of patients after appendectomy for uncomplicated appendicitis and in 3% of patients with perforated appendicitis [13]. About one half of these patients present with bowel obstruction during the first year.

The mortality rate after appendectomy is less than 1%. The morbidity of perforated appendicitis is higher than that of non-perforated cases and is related to increased rates of wound infection, intraabdominal abscess formation, increased hospital stay, and delayed return to full activity. Studies [14] show that appendicitis is only responsible for a small portion of the deaths after appendectomy. Comorbidity, diagnostic failure, and anaesthesia-surgical trauma may play an important role.

OPEN APPENDECTOMY

Open appendectomy is done either with a muscle splitting McBurney's or Lanz incision(Fig 1). The aponeurosis of the external oblique is opened in the direction of its fibres to reveal the muscular belly of the internal oblique muscle, just lateral to the rectus muscle at the semilunar line (Spiegel's line). The muscle fibers of the internal oblique and the transversus abdominis muscle are spread with parallel Kelly clamps and the transversalis fascia and the peritoneum are grasped together and cut using Metzenbaum scissors. The hard "wormy" appendix is palpated and delivered gently with a Babcock clamp.

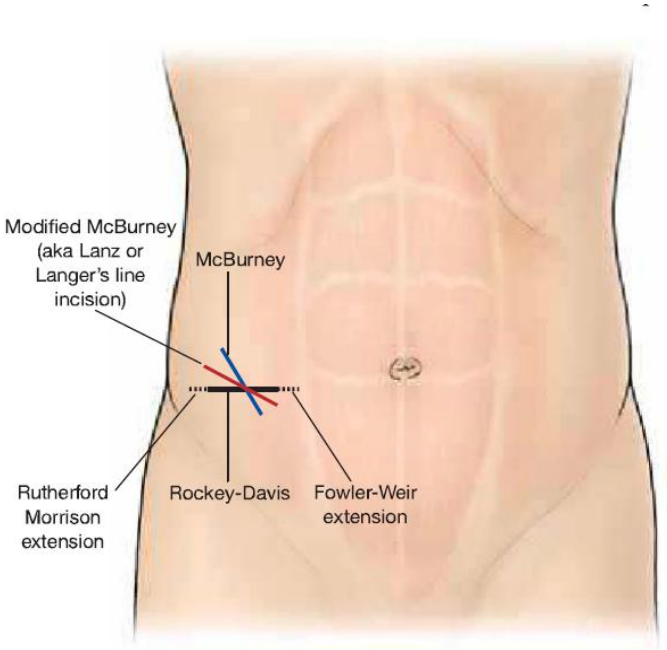


FIGURE 1: OPEN APPENDECTOMY (INCISIONS)

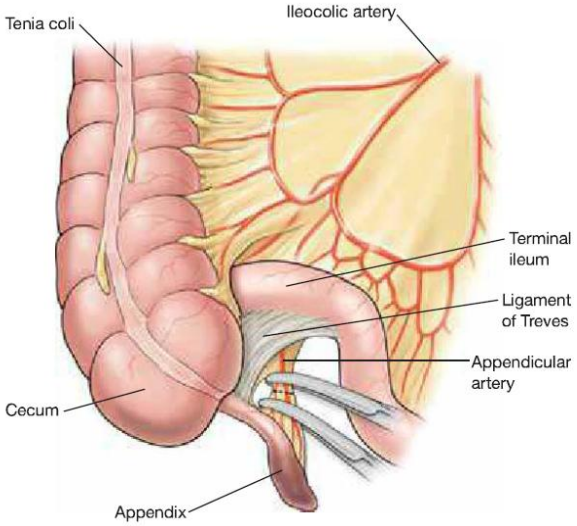


FIGURE 2 : LIGATION OF MESOAPPENDIX

Alternatively, the cecum is gently grasped and the taeniae coli are followed down to the appendix. The mesoappendix containing the appendiceal artery is ligated and divided with 2-0 absorbable suture. (FIGURE 2). The appendix is crushed at its base with a haemostat and then grasped just above the crush line. It is tied at the base with a 2-0 absorbable suture. The appendix is then removed and the appendiceal stump is often gently cauterized to fulgurate the remaining mucosa.

The peritoneum and external oblique is closed with 2-0 absorbable sutures, Skin closed with 3-0 non absorbable suture.

LAPAROSCOPIC APPENDECTOMY

After induction of general anaesthesia patient is positioned supine on the operating room table with both arm tucked at the side. A Foley's catheter, if needed, is placed under sterile conditions for decompression of the bladder. A monitor is placed on the opposite side of the surgeon, on the right side of the patient (Fig. 3). The surgeon and first assistant both stand on the left side of the patient.

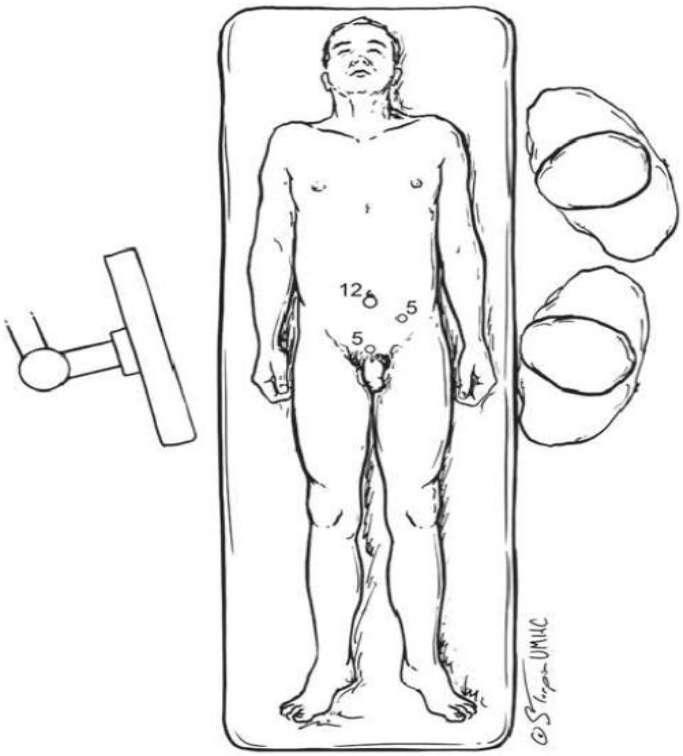


FIGURE 3: PATIENT POSITIONING AND PORT PLACEMENT

After making a vertical incison through the umbilicus, grasp the edges of the incision, and elevate the midline fascia. The midline fascia is dissected with two artery forceps and a 10 mm port is inserted, secured and pneumoperitoneum with carbon dioxide established with the help of a Veress needle.

The patient is then placed in Trendelenburg position and left tilt of the table was made. Two additional ports, usually of 5mm diameter, are inserted in the suprapubic position midway between umbilicus and pubic symphysisand the left lower quadrant just lateral to the rectus sheath 2cm above and medial to the left anterior superior iliac spine(ASIS)(Fig. 4).

A thorough inspection of the entire peritoneum is performed. After that all small intestine is mobilised in the right lower quadrent exposing cecum and terminal ileum. The base of the appendix can be found by following the taenia coli on the ascending colon proximally to the confluence of the cecal taenia.

Once the appendix is dissected free and elevated, the mesoappendix containing the appendiceal artery becomes readily visible. Then the mesoappendix is cauterized with bipolar cautery and cut.

Then the base of the appendix is clamped with endoloop and cut, Hemostatsis achieved. The appendix is placed into a bag and removed through the umbilical port. Any contaminated area was irrigated properly with normal saline. 10 mm port site was closed with 2-0 port vicryl. Skin closed with 3-0 non absorbable suture.

Fig. 4– THREE PORT TECHNIQUE PORT PLACEMENT FOR LAPAROSCOPIC APPENDECTOMY IN OUR INSTITUTION

FIGURE 5 –RESECTED SPECIMEN OF INFLAMMED APPENDIX

Post-surgery in both the procedures specimens were sent for histopathological examination (Fig. 5).All patients were observed in the post-operative recovery ward for 24 hours before shifting to general ward. Pain analysis was done by visual analogue scales[15].

II. Results

STUDY PROFILE

A total 200 patients were included in the study. Out of these, 100 patients (50%) underwent open OA and 100 patients (50%) underwent LA. There were two conversions of LA to OA. One due to bleeding due to slippage of ligature over mesoappendix and other one due to dense adhesion between appendix and caecum.

DEMOGRAPHICS

Descriptive statistics regarding the overall age of the study subjects (n=200)

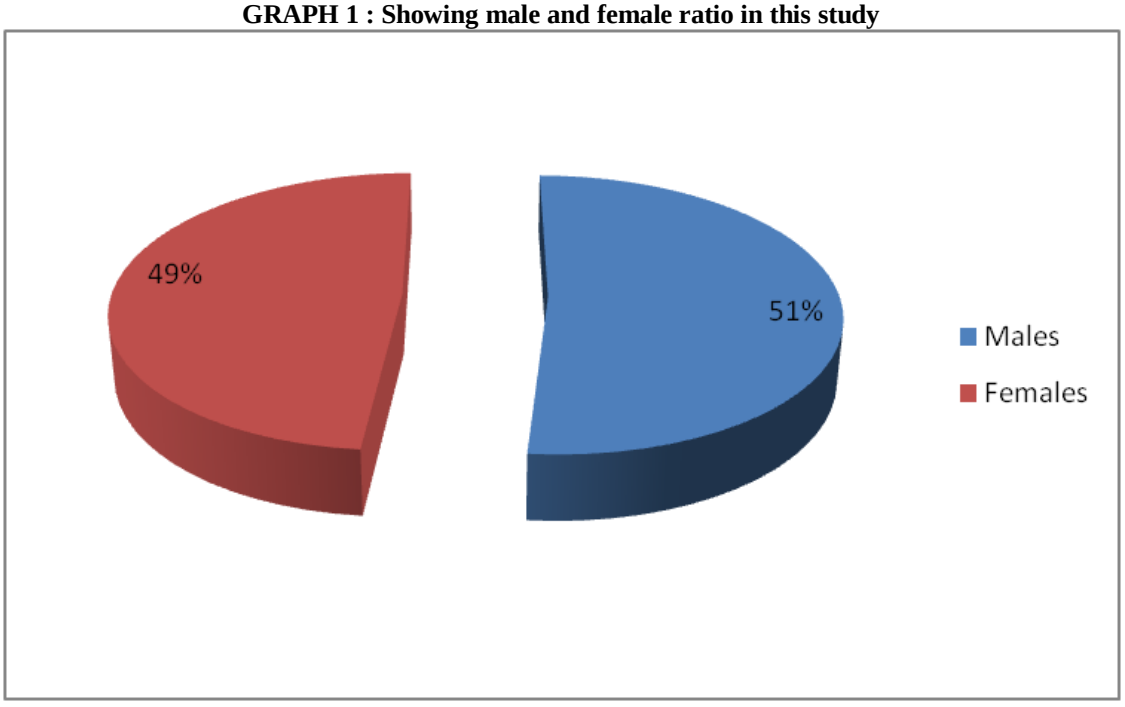
TABLE 1: Descriptive statistics of overall age of this study

	N	Minimum	Maximum	Mean	Std. Deviation
Age	200	15	80	30.72	13.190
Valid N (listwise)	200				

Among 200 individuals considered for the study, the minimum age of the patient is 15 and maximum age of the patient is 80. The mean age is 30.72 years with the standard deviation of 13.19 years.

Pie chart representing the gender wise distribution of the study subjects (n=200)

GRAPH 1 : Showing male and female ratio in this study



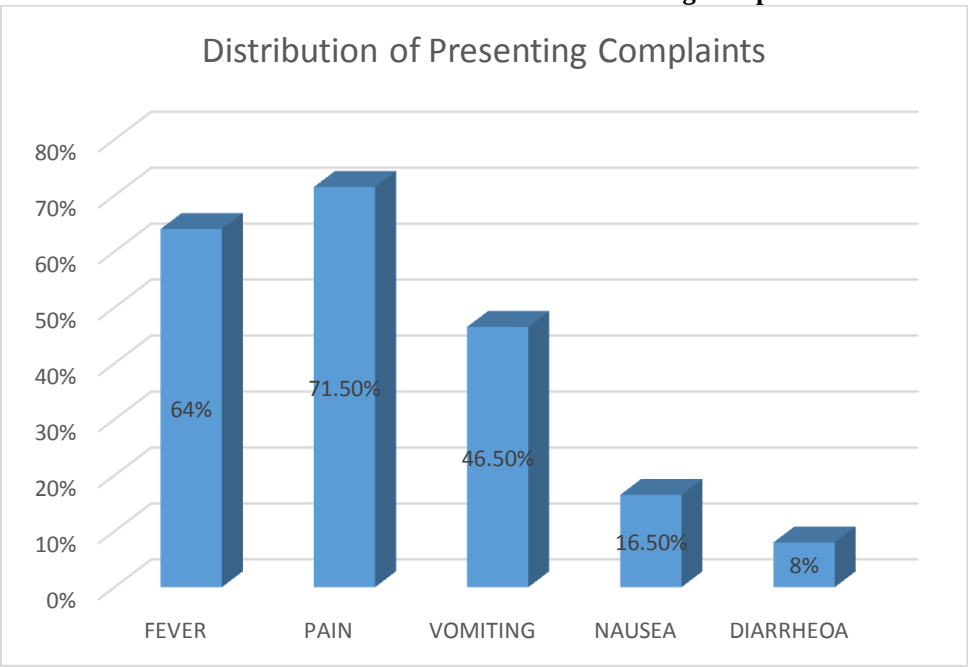
Among 200 patients operated on, 103 patients were male and 97 patients were female. Majority of the patient among who got operated are males 103(51%). The OA group consisted of more male (54%) while LA group consisted of more female (51%)

The mean age in OA is 30.96 years ranging from 15 to 65 years, On the contrary patients in LA group were between 15 and 80 years with the mean age of 30.48 years

PRESENTATION

During admission 143 patients (71.50%) came with pain in right iliac fossa, 128 patients (64%) presented with fever, 93 patients (46.50%) had vomiting, and 16 patients (8%) had diarrhoea. Only 11 patients (5.5%) had all three cardinal symptoms of pain, vomiting and fever.

GRAPH 2: Shows the Distribution of Presenting Complains



TOTAL COUNT AS AN INDICATOR OF ACUTE APPENDICITIS

In our study 114 patients (57%) had total leucocyte counts raised above 11000 cell/cumm. (Laboratory reference range: 4000-11000 cells/cumm). In other 43% although total leukocyte count was under normal limit, diagnosis was made on clinical examination and/or ultrasound confirmation. In these patients too intraoperatively, an inflamed appendix was found and subsequent histopathology of the appendiceal specimen showed features of appendicitis.

The total count, although a useful marker can provide only a clue to the diagnosis and a normal count can by no means preclude the diagnosis of acute appendicitis.

CLINICAL OUTCOMES

The clinical outcomes in both groups are illustrated in TABLE 2

TABLE 2: Clinical Outcomes

Group Statistics

	group	N	Mean	Std. Deviation	Std. Error Mean
Duration of surgery	1	100	75.29 (35-130)	20.586	2.059
	2	100	73.50 (35-160)	20.554	2.055
Duration of post Operative pain	1	100	4.35 (2-12)	2.199	.220
	2	100	1.61 (1-7)	.994	.099
Time to start oral diet	1	100	1.87 (1-4)	.774	.077
	2	100	1.04 (0-4)	.710	.071
Length of stay in hospital	1	100	8.23 (4-22)	3.879	.388
	2	100	3.08 (1-14)	1.768	.177

Group 1-OPEN APPENDECTOMY

Group 2- LAP APPENDECTOMY

DURATION OF SURGERY

Duration of surgery was noted from time of incision to placement of last suture. In OA the length of duration ranged from 35 to 130 minutes, where as in LA it ranged from 35 to 160 minutes. The mean duration in the OA was 75.29 with SD±20.586. On the contrary, in the LA the mean duration was 73.50 with SD±20.554. Here in our study the durations was clinically not significant($p>0.05$).

A. DURATION OF POST OPERATIVE PAIN

Post-operative pain was analysed using visual analogue scale. The duration was determined by the time patient complained of significant pain and needed round the clock injectable analgesics.

In the OA group patient had significant post-operative pain for a mean of 4.35 days compared to much lower mean of 1.61 days in the LA group. The p value here ($p<0.001$) is extremely significant.

B. RESUMPTION OF NORMAL DIET

The decision of starting oral feeds was made on the basis of presence of bowel sounds. First clear fluid was started after tolerating clear fluid, soft followed by normal diet was started. Resumption of normal diet was defined as the intake of solid food without undue nausea or vomiting.

In OA patients resumed normal diet after an average time of 1.87 days and in LA group patients started after an average of 1.04 days ($p<0.05$).

C. LENGTH OF HOSPITAL STAY

Length of hospital stay was defined as number of days until discharge following surgery. Since time between admission and surgery is dependent on several variables that cannot be randomised and are unrelated to mode of surgery, this period was excluded from the comparative analysis. In our study the mean length of stay after surgery in open appendectomy group is 8.23 days where as in laparoscopic appendectomy group the mean length of stay is 3.08 days. This difference is statistically very significant ($p<0.001$).

COMPLICATIONS

In our study there were no mortality. All complications were categorised according their relation to surgery intra operative and post-operative complications.

TABLE 3a-Intraoperative Complication

			Intra OP complications			
			NONE	UNABLE TO CONTROL BLEEDING	ADHESIONS	Total
Group	Open appendectomy	Count	100	0	0	100
		% within group	100.0%	.0%	.0%	100.0%
	Laparoscopic appendectomy	Count	98	1	1	100
		% within group	98.0%	1.0%	1.0%	100.0%
Total		Count	198	1	1	200
		% within group	99.0%	.5%	.5%	100.0%

TABLE 3b – Intraoperative Complications

			Intra op complications		
			No	Yes	Total
Group	Open Appendectomy	Count	100	0	100
		% within group	100.0%	.0%	100.0%
	Laparoscopic Appendectomy	Count	98	2	100
		% within group	98.0%	2.0%	100.0%

Total	Count	198	2	200
	% within group	99.0%	1.0%	100.0%

TABLE 3c – Intraoperative Complications (Chi-Square Tests)

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	2.020	1	.155	
Fisher's Exact Test				.497
N of Valid Cases	200			

Out of 200 patients in OA there was no intraoperative complications and in LA there were 2 complications out of which one patient had bleeding intraoperatively due to slippage of the ligature of the mesoappendix, after which the procedure was converted to OA. The other complication in LA was dense adhesions between caecum and appendix for which it was converted into OA. In our study, there was no significant difference observed in the intra op complications between laparoscopic appendectomy and open appendectomy (p>0.05).

TABLE 4a – Postoperative Complications

			Postoperative complication			
			NONE	WOUND INFECTION	ABDOMINAL ABSCESS	Total
group	OPEN APPENDECTOMY	Count	91	8	1	100
		% within group	91.0%	8.0%	1.0%	100.0%
	LAPAROSCOPIC APPENDECTOMY	Count	100	0	0	100
		% within group	100.0%	.0%	.0%	100.0%
Total		Count	191	8	1	200
		% within group	95.5%	4.0%	.5%	100.0%

TABLE 4b – Post-operative Complications

			Postoperative complication		
			No	Yes	Total
group	OPEN APPENDECTOMY	Count	91	9	100
		% within group	91.0%	9.0%	100.0%
	LAPAROSCOPIC APPENDECTOMY	Count	100	0	100
		% within group	100.0%	.0%	100.0%
Total		Count	191	9	200
		% within group	95.5%	4.5%	100.0%

TABLE 4c –Postoperative Complications (Chi-Square Tests)

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)
Pearson Chi-Square	9.424	1	.002	
Fisher's Exact Test				.003
N of Valid Cases	200			

In our study, a high significant difference has been observed in the Post op complications between laparoscopic appendectomy and open appendectomy ($p<0.05$).

III. Discussion

As a result of the excellent results gained in the laparoscopic cholecystectomy, and an easier availability of equipment, in recent years, laparoscopic appendectomy too has gained rising popularity.

However, the advantages of laparoscopic appendectomy are uncertain and haven't been firmly established.

Operative duration remains a controversial issue whenever OA and LA are compared. A significant variation in operative time was noted in various studies.

The longer duration of laparoscopic approach is due to the additional steps of gas insufflation, trochar entry and diagnostic laparoscopy. In our study difference in duration of surgery between both the groups did not differ much. The mean duration of surgery in OA was found to be 75.29 and in LA was 73.50 minutes. This could be attributed to the fact that ours is a teaching hospital where most open procedures are done by surgical trainees under supervision and all the laparoscopic procedures are done by experienced consultants and senior surgeons.

Our study shows that laparoscopic appendectomy is associated with a significantly shorter hospital stay, this is in corroboration with some recent retrospective cohort studies.

Some studies found that there wasn't a significant difference in the hospital stay between the two modalities of treatments. In our study, in LA the mean duration of stay was 3.08 days whereas in OA it was 8.23 days that was highly significant. In our study, patients were discharged faster in LA group compared to the OA group.

In our study, pain was assessed both subjectively and objectively by visual analogue score. Several studies have reported less pain in the first 48 hours after laparoscopic appendectomy. In our study too we made the same observation throughout the hospital stay. Smaller incisions and minimal tissue handling may be the reason for decreased postoperative pain sensation in LA.

In our study, the mean duration of the post-operative pain in LA was 1.61 days and OA was 4.35 days which was very highly significant. For most of the patients in LA group we were able to change to oral medications from intravenous medications by the first post op day.

In our study, patients undergoing laparoscopic appendectomy tolerated an oral diet much sooner than the open appendectomy group. In our study, some of the laparoscopic appendectomy patients were started an oral diet on the same day after 4 hours of surgery and they tolerated well enough.

In the present study, the mean days of NPO status was 1.04 days in LA group and 1.87 days in OA. This was highly significant since earlier return to normal food habits go hand in hand with earlier discharge. This result is both statistically and clinically significant.

In our study, the overall complication rates were 9% in open appendectomy group and 2% in the laparoscopic appendectomy group. These results are in agreement with the previous reports which vary from 5.7 to 25.8% for OA and 3% to 19% for LA[16-19].

In our study, in LA group 2 patients had intraoperative complications. One, intraoperative bleeding due to slippage of ligature, and the second one had dense adhesions between appendix and caecum. Both cases were converted to open appendectomy.

With respect to post-operative complications, the OA group had a wound infection rate which was much higher than LA group.

A meta-analysis of randomised control trials have been reported with outcomes of 2877 patients included in 28 trials [20]. Overall complication rates were comparable, but wound infection rates were definitely less after laparoscopy (2.3% to 6.1 %.) Rohr et al reported higher infection rates after laparoscopic

appendectomy, but most of the literature supports the view that wound infection is less common after a laparoscopic procedure.[21]

In OA, direct delivery of the appendix through the wound may risk contamination, whereas utilisation of laparoscopic port or bag for appendix retrieval may favour reduced frequency of wound infection in LA.

In our study, there was no case of wound infection following laparoscopic appendectomy. Wound infections may not be a serious complication, as such, but it can cause inconvenience to the patient, physically and mentally, reducing their quality of life and resulting in a longer duration of stay in the hospital. Hence this observation is one of the most important findings in our study.

In our study, there was no mortality. The minimal mortality is consistent with the majority of prior publications. It has been reported that the mortality rate is 0.5% and 0.3% in laparoscopic and open appendectomy[22]. The low mortality rates indicate that appendectomy is a safe procedure, regardless of the technique used.

Although there is no consensus with regard to the advantages of laparoscopic approach compared to the conventional technique, the use of LA has increased in the last several years and is used in several centres in India. In our present study, we were able to show the superiority of laparoscopic approach over the conventional technique in terms of significantly less post-operative pain, shorter hospital stay, and fewer post-operative complications.

Length of procedures was not significantly different between both groups.

In our tertiary care centre, which has good surgical expertise and modern equipments, laparoscopic appendectomy is safe and equally efficient when compared to the conventional technique. However, as long as there is no consensus to the best approach to appendicitis, the choice procedure will be left up to patients and surgeons choice.

IV. Conclusion

As appendectomy is the most common procedure done in the world, it is imperative to adopt the safest and the best approach for surgery, both for patient and the surgeon.

Our study showed that laparoscopic appendectomy has considerable benefits including a shorter hospital stay, less postoperative pain, earlier postoperative recovery and fewer complication rate, when compared with, open appendectomy. In addition to this, our study showed no considerable difference in the operative duration between LA and OA.

It is preferred by both patients and doctors to opt for open appendectomy when cost is a limiting factor. But it must be borne in mind that if the total expenditure is increased as a result of prolonged hospitalisation or wound infection, laparoscopic appendectomy may prove to be more cost effective. Hence laparoscopic appendectomy can be considered the procedure of choice in all cases of acute appendicitis unless laparoscopy is contraindicated.

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