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Laparoscopic versus Open appendectomy in young female patients

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Abstract: Background: Appendectomy is the most common surgical procedure performed in general surgery. For almost a century, open appendectomy, first described by Charles Mc Burney in 1889, has remained the gold standard treatment for acute appendicitis. The introduction of laparoscopic surgery has dramatically changed the field of surgery and laparoscopic surgery has been widely used as a minimally invasive surgery. **Objective:** Comparative evaluation of modified laparoscopic versus open appendectomy for the treatment of acute appendicitis. As regard surgical technique, operative time, hospital stay, post-operative morbidity and cost of both techniques in young females. **Patients and Methods:** This study was conducted in Ain Shams faculty of medicine, Ain Shams university hospitals, general surgery department from October 2018 to May 2019. The study was conducted on 40 female patients diagnosed with acute appendicitis. **Results:** The overall post-operative complications were different in the 2 group. The incidence of wound infection was less in laparoscopic group (5 % versus 10 %). The mean hospital stay was shorter in laparoscopic patients than open appendectomy patients (1.25 days versus 2.10 days). The post-operative analgesia was less in laparoscopic than open group. The mean time to return to normal activities was shorter in laparoscopic appendectomy patients (6.05 days versus 10.80 days). **Conclusion:** Laparoscopic appendectomy is safe and feasible. Despite that the operating time for laparoscopic appendectomy is still higher than that for open procedure, laparoscopic approach had several advantages over open appendectomy in that, it has lesser incidence of wound infection, shorter hospital stay, less need for post-operative analgesia and faster return of patients to normal activities. Moreover, it is very useful in reaching an exact diagnosis in equivocal cases in females during their childbearing period. We must convert laparoscopic procedure to open surgery when indicated for the safety of the patient. A larger further study to evaluate the cost, benefit of laparoscopic appendectomy is recommended.

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Keywords: Laparoscopic appendectomy, open appendectomy, right lower quadrant

1. Introduction

The appendix is a small tube-shaped pouch attached to the caecum and located in the lower right side of abdomen [(1)].

Appendicitis was first recognized as a disease in the sixteenth century and was called perityphlitis [(2)].

Appendicitis is the most common intra-abdominal condition requiring emergency surgery. Appendectomy continues to be one of the commonest procedures in general surgery, accounts for approximately 1% of all surgical operation [(3)]. The life time risk of acute appendicitis is 8.6% for males and 6.7% for females (male: female ratio is 1.4:1) [(4)].

The first appendectomy was performed in 1736 by Claudius Amyand, Surgeon of St. Georges Hospital, London, UK [(5)]. McBurney in 1889 described the clinical features of acute appendicitis. Open appendectomy has been the standard surgical treatment since the last century [(2)].

Diagnosis is founded upon well-recognized signs, symptoms as well as physician's practice. The signs & symptoms most prognostic of acute appendicitis is pain in right lower quadrant (RLQ) or pain around umbilicus and then transferring to RLQ presenting along with fever, nausea and vomiting. On abdominal examination there will be rigidity, tenderness and rebound tenderness in right iliac fossa [(6)].

The reported incidence of acute appendicitis has increased over the last few decades potentially due to the increased use of CT imaging, with the rate of complicated appendicitis representing 25% of all cases [(7)].

Several diseases such as pelvic inflammatory disease, endometriosis, ovarian cysts, ectopic pregnancy, cholecystitis and colonic perforation may mimic acute appendicitis so proper imaging is mandatory in diagnosis of acute appendicitis. [(8)].

The introduction of laparoscopic surgery has dramatically changed the field of surgery. With

improvement in the equipment and increasing clinical experience it is possible to perform almost any kind of procedure under laparoscopic visualization. Laparoscopic appendectomy was first reported by the gynaecologist Kurt Semm in 1982 [9].

The laparoscopic approach allows a full exploration of the peritoneal cavity, thus representing an important diagnostic tool in case there is only suspicion of acute appendicitis**.** Complicated appendicitis (CA) defined as gangrenous or perforated appendicitis with or without peritonitis has been increasingly managed laparoscopically. 67% of cases of CA performed laparoscopically in 2011 in the USA [7]**.** An accepted negative appendicectomy rate for presumed appendicitis ranges from 15% to 20%, even higher in women of childbearing age from 20% to 30% [8]**.**

Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) strongly recommends LA only for female patients of child-bearing age because the advantages of minimal invasive surgery such as shorter length of hospital stay, better cosmetic appearance, faster recovery and return to normal activities and less postoperative pain in patients with uncomplicated appendicitis in particular [10]**.**

The European Association of Endoscopic Surgeons (EAES) has recently released guidelines on appendectomy that clearly favour the laparoscopic approach [11]**.**

Criticism of LA includes increased operative cost, primarily due to the use of disposable laparoscopic instruments, increased operation time, and concerns about a higher incidence of intra-abdominal abscesses, particularly after perforated appendicitis [12]**.**

Aim of the Work

Comparative evaluation of modified laparoscopic versus open appendectomy for the treatment of acute appendicitis. As regard surgical technique, operative time, hospital stay, post-operative morbidity and cost of both techniques in young females.

2. Patients and Methods

This study was conducted in Ain Shams faculty of medicine, Ain Shams university hospitals, general surgery department from October 2018 to May 2019. The study was conducted on 40 female patients diagnosed with acute appendicitis.

Inclusion criteria: Female patients in child bearing period diagnosed with acute appendicitis.

Exclusion criteria: Hemodynamic instability. Chronic medical or psychiatric illness. Cirrhosis and / or ascites. Coagulation disorder. Previous laparotomy. Pregnancy. Appendicular mass or abscess.

The patients were randomly allocated into two groups 20 patients each: **Open group:** The patients were operated by open appendectomy, (OA) by gridiron incision at McBurney's point. **Laparoscopic group:** The patients were operated by laparoscopic appendectomy, (LA). All patients were followed up for 6 months postoperatively and were subjected to: History taking. Clinical examination including PR and PV. Laboratory investigations: CBC. Na and K in markedly dehydrated patients. Urine analysis in suspected cases of urinary tract infection.

Radiological investigation: Ultrasound (transvaginal or abdomino-pelvic) and gynaecological consultation.

Patients were fully informed about the risks and benefits of the 2 procedures. Informed consent was obtained from every patient.

Markedly dehydrated patients had fluid resuscitation and Foley catheter to ensure adequate urine output. Any electrolyte deficiencies were corrected prior to the induction of general anaesthesia.

Prior to the surgical incisions, all the patients received a standard regimen of intravenous antibiotics (1.5 gm of ampicillin, sulbactam and 500 mg of Metronidazole).

Technique of open procedure: The patient was placed in the supine position and underwent general anaesthesia with endotracheal intubation. While the patient was anesthetized and the abdominal musculature relaxed, the patient's abdomen was carefully examined. The skin incision on McBurney's point was carried through the subcutaneous tissue until the external oblique fascia was exposed.

A small incision was made in the external oblique fascia along the line of its fibres. The incision was sharply extended with scissors along the direction of the fibres. The underlying fibres of the internal oblique muscle and the treansversus abdominis muscle were identified, split and retracted along the direction of their fibres. Next, retractors were adjusted to expose the peritoneum. Then grasping the peritoneum with clamps was done, carefully verifying that intra-abdominal viscera had not been inadvertently grasped. A small incision was made in the peritoneum by scissors.

The caecum was delivered into the field gently grasping the caecum with moistened gauze and delivering it into the wound using a rocking movement and the anterior taenia of the caecum was followed till identification of appendix. Medial mobilization of the caecum was done bluntly with a finger combined with sharp or electro-cautery in cases of difficult retrocecal appendix. The mesoappendix was divided between clamps and ligated with an absorbable suture material. Purse string sutures were done in cases of inflamed base of the appendix. The

mucosa was obliterated to avoid the development of mucocele. The wound was closed in layers. If perforation or gangrene were present, the skin and subcutaneous tissue closure was by widely spaced sutures.

Technique of Laparoscopic appendectomy: In this study, we aim to present a simple modified technique to be used during laparoscopic appendectomy with the aim of reducing the cost. The patient was placed supine in a 15º Trendelenberg position with both arms tucked. Rotation to the left was done. The surgeon stood on the patient's left side. The first assistant stood on the surgeon's left side. The monitor was on the patient's right side. After the induction of general anaesthesia, a urinary catheter and a nasogastric tube were placed. A pneumoperitoneum was created in standard fashion, using either the Veress needle technique or the open technique according to the surgeon preference. The first trocar (10 mm) was introduced at the lower margin of the umbilicus. The intraperitoneal pressure was set to be 14 mmHg. Laparoscopy was then performed with "zero" angle viewing laparoscope to ensure the clinical diagnosis and identify the position of the appendix so as to determine the best site of insertion of the other trocars. A second 10 mm suprapubic trocar was inserted. A third trocar was inserted in the left iliac fossa. In 2 causes 4th trocar in the right upper quadrant was inserted to facilitate dissection of retrocecal appendix. After insertion of the ports, a quick diagnostic laparoscopy was performed in order to confirm the diagnosis and assess other pathologies. The surgeon's left hand held a Babcock grasper to retract the caecum and subsequently expose the appendix. Cautery scissors were used to incise the retroperitoneal attachments of the caecum in difficult cases. This will expose the mesoappendix and make it easy to create a window mesoappendix close to the base. The rest of the technique will be the same as in open appendectomy where we apply 2 ties in the mesoappendix and appendix then both are divided as in open method. We tried to avoid the use of clips, endoloops or Harmonic to reduce the cost in a frequently performed procedure. After transection the appendicular stump mucosa was carefully cauterized. The appendix was pulled into the umbilical port and withdrawn with the whole port or was placed in an impermeable retrieval bag before its removal. Irrigation and insertion of a drain were done only in complicated cases. Trocars were removed under direct vision. Fascia at the 10-mm trocar site was closed, and all wounds were closed primarily.

In patients with complicated appendicitis, antibiotics were not discontinued but were modified according to the culture results and continued for 7 to 10 days till the patient was afebrile.

Patients were given sips of water after passing flatus or faeces or after hearing intestinal sounds to avoid paralytic ileus from early introduction of food or liquids.

Postoperatively, all patients received analgesics in the form of NSAIDs for 24 hours, then analgesics were given upon the patient request.

The discharge criteria are met once the patients were a febrile, with audible bowel sounds and were able to tolerate a liquid diet and oral analgesia. The specimens were sent for pathology for assessing pathological diagnosis.

The comparison between the 2 groups was in the following criteria: **Intraoperative:** operative time (from skin incision to wound closure), intraoperative findings (normal, gangrenous, inflamed or perforated), intraoperative complications, conversion to open procedure, associated pathology and its management. **Postoperative**: early postoperative morbidity up to 4 weeks including wound infection, late postoperative complications up to 6 months including (pelvic abscess, incisional hernia and adhesive intestinal obstruction), postoperative hospital stay, postoperative pain (the need for analgesia), time needed to return to work and the cost.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0**.** **(**Armonk, NY: IBM Corp**)** Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level.

The used tests were: Chi-square test: For categorical variables, to compare between different groups. **Fisher's Exact or Monte Carlo correction;** Correction for chi-square when more than 20% of the cells have expected count less than 5. **Student t-test:** For normally distributed quantitative variables, to compare between two studied groups. **Mann Whitney test:** For abnormally distributed quantitative variables, to compare between two studied groups.

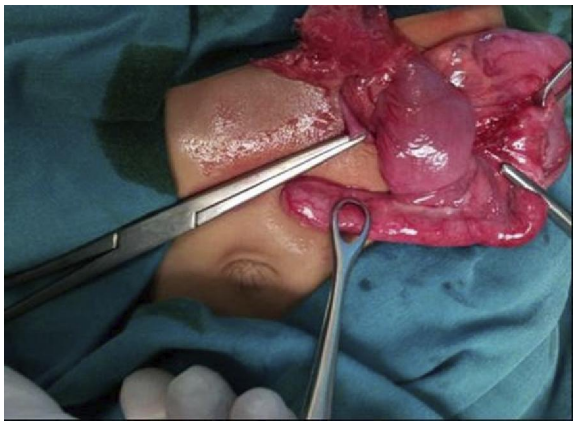

Figure (1): A case of catarrhal appendicitis

Figure (2): A case of gangrenous appendicitis

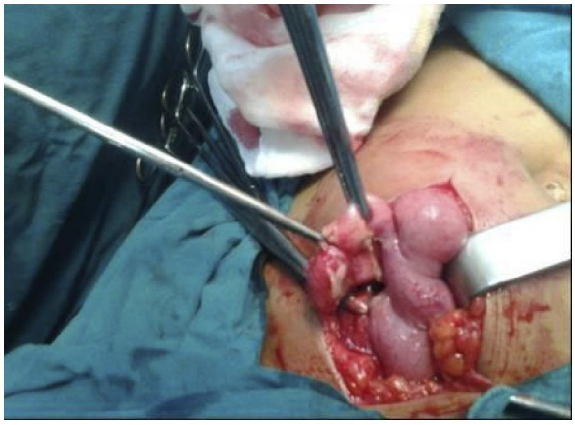

Figure (3): A case of suppurative appendicitis

Figure (4): Intraoperative detection of a cyst in the mesosalpinx, causing torsion of the fallopian tube producing abdominal pain

Figure (5): Double ligation the base of acute catarrhal appendicitis

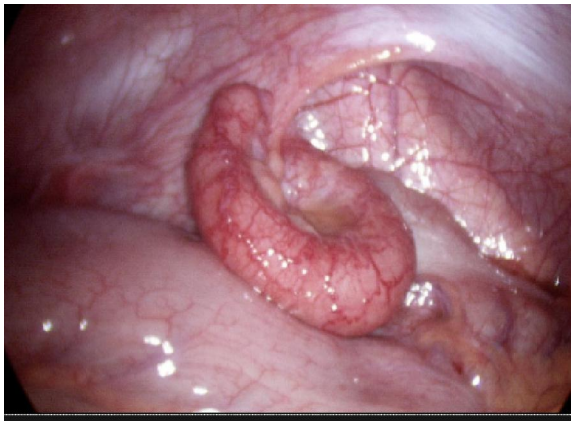

Figure (6): A case of acute catarrhal appendicitis

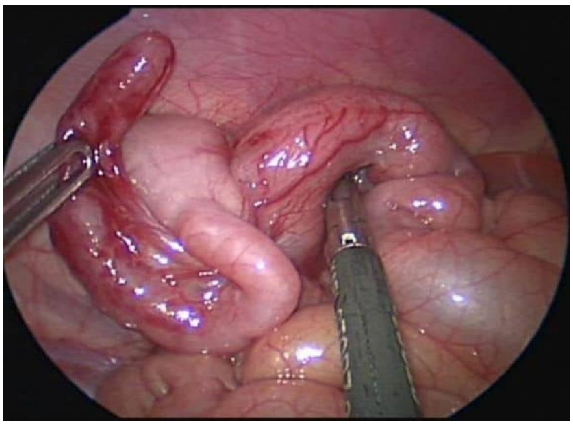

Figure (7): A case of acute suppurative appendicitis

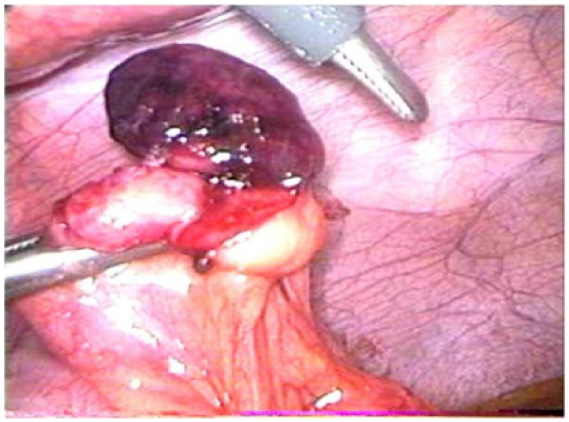

Figure (8): A case of gangrenous appendicitis

3. Results

Table (1): Comparison between the two studied groups according to age (years)

Age (years)	Group A (n = 20)		Group B (n = 20)		Test of Sig.	p
	No.	%	No.	%		
<20	1	5.0	3	15.0	χ^2= 2.233	^{MC}p= 0.303
20 – 30	10	50.0	12	60.0		
>30	9	45.0	5	25.0		
Min. – Max.	17.0 – 42.0		16.0 – 43.0		t=1.346	0.186
Mean ± SD.	29.25 ± 6.83		26.40 ± 6.56			
Median	28.50		25.50			

χ^2: Chi square test MC: Monte Carlo t: Student t-test
p: p value for Comparing between the two studied groups
Group A: undergo appendectomy via open approach.
Group B: undergo appendectomy via laparoscopic approach

Table (2): Comparison between the two studied groups according to intraoperative findings

Intraoperative findings	Group A (n = 20)		Group B (n = 20)		χ^2	^{MC}p
	No.	%	No.	%		
Grossly normal	2	10.0	3	15.0	1.424	0.923
Perforated	5	25.0	4	20.0		
Gangrenous	2	10.0	1	5.0		
Catarrhal	8	40.0	7	35.0		
Suppurative	3	15.0	5	25.0		

χ2: Chi square test MC: Monte Carlo p: p value for Comparing between the two studied groups
Group A: undergo appendectomy via open approach. Group B: undergo appendectomy via laparoscopic approach

Table (3): Comparison between the two studied groups according to operative time.

Operative time	Group A (n = 20)		Group B (n = 20)		Test of Sig.	p
	No.	%	No.	%		
≤60	17	85.0	9	45.0	χ^2= 7.033*	0.008*
>60	3	15.0	11	55.0		
Min. – Max.	35.0 – 90.0		45.0 – 110.0		U= 69.0*	<0.001*
Mean ± SD.	50.0 ± 13.05		64.35 ± 13.69			
Median	47.0		62.0			

χ2: Chi square test U: Mann Whitney test p: p value for Comparing between the two studied groups
*: Statistically significant at p ≤ 0.05 Group A: undergo appendectomy via open approach.
Group B: undergo appendectomy via laparoscopic approach

Table (4): Comparison between the two studied groups according to postoperative complications.

Postoperative complications	Group A (n = 20)		Group B (n = 20)		χ^2	^{FE}p
	No.	%	No.	%		
Absent	16	80.0	18	90.0	0.784	0.661
Present	4	20.0	2	10.0		

χ2: Chi square test FE: Fisher Exact p: p value for Comparing between the two studied groups
Group A: undergo appendectomy via open approach. Group B: undergo appendectomy via laparoscopic approach

Table (5): Distribution of the studied patients regarding the type of post-operative complications:

Type of post-operative complication	Operation				P value
	Group A (n=4)		Group B (n=2)		
	No.	%	No.	%	
• Wound infection	2	10.0	1	5.0	1.0
• Pelvic abscess	1	5.0	1	5.0	
• Adhesions	1	5.0	0	0.0	
• Incisional hernia	0	0.0	0	0.0	

p: p value for Comparing between the two studied groups *: Statistically significant at p ≤ 0.05
Group A: undergo appendectomy via open approach. Group B: undergo appendectomy via laparoscopic approach

Table (6): Comparison between the two studied groups according to time interval for needed analgesia

Time interval for needed analgesia	Group A (n = 20)	Group B (n = 20)	t	p
Min. – Max.	8.0 – 20.0	6.0 – 12.0	5.578*	<0.001*
Mean ± SD.	14.30 ± 3.96	8.80 ± 1.94		
Median	14.50	8.50		

t: Student t-test p: p value for Comparing between the two studied groups *: Statistically significant at p ≤ 0.05
Group A: undergo appendectomy via open approach. Group B: undergo appendectomy via laparoscopic approach

Table (7): Comparison between the two studied groups according to hospital stay.

Hospital stay	Group A (n = 20)	Group B (n = 20)	U	P
Min. – Max.	1.0 – 4.0	1.0 – 2.0	70.0*	<0.001*
Mean ± SD.	2.10 ± 0.72	1.25 ± 0.44		
Median	2.0	1.0		

U: Mann Whitney test p: p value for Comparing between the two studied groups *: Statistically significant at p≤0.05
Group A: undergo appendectomy via open approach. Group B: undergo appendectomy via laparoscopic approach

Table (8): Comparison between the two studied groups according to return to work.

Return to work	Group A (n = 20)	Group B (n = 20)	t	p
Min. – Max.	8.0 – 14.0	4.0 – 9.0	9.543*	<0.001*
Mean ± SD.	10.80 ± 1.77	6.05 ± 1.36		
Median	11.0	6.0		

t: Student t-test p: p value for Comparing between the two studied groups *: Statistically significant at p ≤ 0.05
Group A: undergo appendectomy via open approach. Group B: undergo appendectomy via laparoscopic approach

Table (9): Comparison between the two studied groups according to cost (L.E)

Cost (L.E)	Group A (n = 20)	Group B (n = 20)	t	p
Min. – Max.	200.0 – 550.0	1000.0 – 1250.0	27.022*	<0.001*
Mean ± SD.	401.3 ± 89.03	1120.0 ± 78.89		
Median	400.0	1112.5		

t: Student t-test p: p value for Comparing between the two studied groups *: Statistically significant at p ≤ 0.05
Group A: undergo appendectomy via open approach. Group B: undergo appendectomy via laparoscopic approach

4. Discussion

Approximately 6 % of the population develop appendicitis in their life time, with peak incidence between the ages of 10 and 30 years, thus making appendectomy the most frequently performed abdominal operation [13].

The treatment of acute appendicitis remained essentially unchanged since its first description by Charles Mcburney in 1889. Appendectomy by Mcburney's incision remained the procedure of choice for nearly a century until 1983 when Kurt Semm offered an alternative, "laparoscopic appendectomy", but as Mcburney's operation is well tolerated with less co-morbidity the benefits of laparoscopic appendectomy have been difficult to establish [(14)].

Several authors proposed that the new technique of laparoscopic appendectomy should be the preferred treatment for acute appendicitis. However, unlike laparoscopic cholecystectomy, laparoscopic appendectomy has not yet gained popularity. Laparoscopic cholecystectomy is now considered a standard method of performing cholecystectomy and has mostly replaced the old method throughout the world, while appendectomy has yet to achieve such popularity [(14)].

The putative advantages of the laparoscopic approach are quicker and less painful recovery, fewer postoperative complications and better cosmoses. It allows better assessment of other intra-abdominal pathologies. But because the validity of these points remains unconvincing and also because of shortage of laparoscopic sets in some hospitals, laparoscopic appendectomy is not practiced widely [(15)].

Laparoscopic appendectomy has emerged as a safe procedure, and its potential advantages of shorter hospital stay, early mobilization, early return of bowel function, acceptable complication rate along with the recent enthusiasm of minimally invasive surgery, has led some authors to advocate this approach as the procedure of choice for uncomplicated appendicitis [(16)].

There have been numerous retrospective and uncontrolled series of laparoscopic appendectomy (LA), as well as many prospective randomized studies published to date. Although most of these have concluded that the laparoscopic technique is as good as open appendectomy (OA), there has been considerable controversy as to whether LA is superior or not [(17)].

Clear and magnified visions of appendix with more space to manoeuvre through a small hole like incision are great advantages of laparoscopic surgery. Some surgeons with equal safety and ease in OA do "Button hole" surgery. Hence regarding incision any advantage to LA is likely to be small and difficult to prove. [(18)].

The role of laparoscopic appendectomy has not yet been clearly defined. Numerous factors need to be considered in deciding the ideal, and most appropriate surgical technique for acute appendicitis.

Meroao who studied a total of 50 patients: 25 (open appendectomy group) and 25 (Laparoscopic group), showed that the mean operative time for the laparoscopic group was significantly longer (79.6 min) than the open group (53.4 min) with $P<0.0001$ [(19)].

Similarly, **Kamal and Qureshi** [(18)] showed that the mean operative time was longer in LA (55 minutes) as compared with OP (30 minutes).

Another study done by **Katkhouda et al.** [(17)] showed that the operative time was significantly longer in the laparoscopic group (80 minutes versus 60 minutes with $P= 0.000$.

All the previous results of mentioned studies regarding operative time are comparable to this study as this study revealed that there was a significant difference regarding operative time with $PV=0.001$ (mean time was 64.35 minutes in the laparoscopic group and 50.0 minutes in the open group).

On the other hand, in the study done by **Alfredo et al.** [(20)]. There was no difference in the operative time between the laparoscopic group and open group, (mean time 51.1 and 51.5 minutes respectively). This may be related to the experience of the surgeon as the operative time decreased successively throughout this work with increase in the learning curve.

The postoperative pain is usually troublesome for the patients. In a study done by **Long et al.,** patients who had laparoscopic appendectomy required less parenteral analgesia than open surgery patients (1.6 versus 2.2 days' worth; 33.3 mg versus 53.5 mg of morphine or equivalent; $P>0.001$ for both measures). [(21)].

In another study done by **Ortega et al.** [(22)], linear analogue pain scores were recorded in 135 patients blinded to the procedure of operation by special dressing and pain score was less in laparoscopic group compared to open.

Also**, Alfredo et al.** [(20)]**,** reported that the analgesia used was significantly higher in the open group compared to the laparoscopic group with $P=0.001$.

All the previous results regarding the post-operative pain and need for analgesia can be compared to the present study as there were less post-operative pain and less need for analgesia in LA group. The difference was significant ($PV=0.001$).

On the other hand, the study done by **Katkhouda et al.** [(17)]**,** showed that the severity of pain experienced and its influence on activity were similar for both groups. Narcotic medication usage to control post-operative pain was also equivalent the 2 groups which cannot be compared to this study. These results may be related to different pain threshold and different pain perception among the studied groups of different authors.

As regards, fluid tolerance, return to normal diet and return to work, **Wei Hong-BO et al.,** reported that

laparoscopic appendectomy remained associated with a shorter time until return to normal diet (LA, 20.2 ± 12.4h vs. OA, 36.5± 10 h; *P*> 0.05), to normal activity (LA, 9.1 ± 4.2 days vs. OA, 13.7 ± 5.8 days; *P*> 0.05), and to work (LA, 21.2 ± 3.5 days vs. OA, 27.7 ± 4.9 days; *P*> 0.05) [23].

Similarly, in a study done by **Long et al.,** patients who had laparoscopic appendectomy were able to return to a regular diet faster (1.6 versus 2.3 days, *P*=0.002). However, no significant differences were found with regard to time to return to work or school or to full activity. [21].

In the present study, the return to work was comparable to the results of **Wei Hong-Bo et al.**, as the patients who had laparoscopic appendectomy returned to work in a shorter time (there was significant difference with *PV*=0.001).

The results of **Long et al.** cannot be compared to this study regarding both parameters. However, these differences between different authors may be related to the surgeon preference.

In all laparoscopic surgeries, the hospital stay after laparoscopic appendectomy was significantly lower than after open appendectomy in all of the reported studies.

In a study done by **Guller et al.**, laparoscopic appendectomy was associated with shorter median hospital stay (laparoscopic appendectomy: 2.06, open appendectomy: 2.88 days, *P* <0.0001 [24].

Another study done by **Yau et al.** revealed that mean hospital stay was 5 days and 6 days for LA and OA group respectively (*P*<0.001), [25].

In the work of **Alfredo et al.** [20], the hospital stay was significantly lower in the laparoscopic group (mean hospital stay was 27.2 hours) compared to the open group (53.1 hours), (*P*=0.001).

A study done by **Shirazi et al.** showed that the length of hospital stay ranged from 2 days to 9 days. The mean length of stay was significantly shorter after LA (3 days after LA, 5 days after OA, *P*<0.0001), [26].

Kamal and Qureshi [18], showed that the mean hospital stay was nearly 1/3rd in LA. The patients were discharged home after 24 hours in LA where as in OA the patient left the hospital on the 3rd day.

All previous results of mentioned studies regarding hospital stay are comparable to this study as this study revealed that there was a significant increase in hospital stay in the open group (mean hospital stay was 2.1 days), than the laparoscopic group (1.25days), (*P*<0.001).

In this study, although the overall post-operative complications were higher in the OA group (20%) than LA group (10%), the results was statically insignificant (*P*=0.661).

Similarly, **Katkhouda et al.** [17] showed that there was no significant difference in the overall complication rates (18.5 % in the LA group versus 17.1 % in the OA group), (P=1.00).

Also, **Long et al.** found that no significant difference regarding overall complications. [21].

Similarly, **Alfredo et al.** [20], showed that there was no significant difference regarding overall post-operative complications between OA group and LA group although the incidence of complications was higher in the OA group (8% in the OA versus 3.6 % in the LA).

On the other hand, a study done by **Shirazi et al.** reported that the rate of overall complications (LA: 15%, OA: 31.8%, *P* < 0.0001) was significantly lower in patients undergoing LA [26].

Similarly, Guller et al. showed that overall complications were significantly lower in laparoscopic group (*P*=0.002) [24].

This difference in the significance of overall post-operative complications may be related to number of studied cases and the pathology present in the appendix.

A meta-analysis of randomized controlled trials has been reported with outcomes of 2877 patients included in 28 trials. Overall complication rates were comparable, but wound infections were definitely reduced after laparoscopy (2.3 % to 6.1 %) [27].

A study by **Yau et al.** was done to evaluate wound infection. The results showed that there was one patient converted to OA (0.6%) in the LA group who suffered from wound infection, and there were seven (10%) wound infections in the OA group (*P*=0.001) [25].

Gullet et al. showed that there was lower rate of wound infections among laparoscopic group (*P*<0.0001). [24].

Sauerland et al. who included 67 studies of which 56 compared laparoscopic appendectomy (with or without diagnostic laparoscopy) versus open appendectomy in adults found that wound infections were less likely after laparoscopic than after open appendectomy [28].

Kamal and Qureshi compared 42 patients who had laparoscopic appendectomy to 53 patients who had open appendectomy. Wound infection regarding skin was zero in laparoscopic group and 3 wound infections in open group. [18].

All previous results of mentioned studies regarding wound infection are comparable to this study as this study revealed that there was a significant decrease in wound infection in LA group (*PV*=1).

Early reports centred on the use of the laparoscope to increase diagnostic accuracy and decrease the negative appendectomy rate which range in some series from 20 to 30 % [17].

Laparoscopy has a great diagnostic value especially in acute abdomen. It plays a significant role in young females where at times it is nearly impossible to differentiate between acute appendicitis and gynaecological clinical conditions like pelvic inflammatory disease, twisted ovary and ectopic pregnancy etc. [(18)].

Sauerland et al. showed that diagnostic laparoscopy reduced the risk of negative appendectomy, but this effect was stronger in fertile women (relative risk 0.20; confidence interval 0.11 to 0.34) as compared to unselected adults (relative risk 0.37; confidence interval 0.13 to 1.01). [(28)].

Even though laparoscopic appendectomy has been claimed to reduce post-operative pain, length of hospitalization, analgesic doses and surgery associated complication, many surgeons do not advocate this procedure on men because they do not find any superiority of laparoscopy over the open procedure [(29)].

Cox et al. conducted a prospective randomized comparison of open versus laparoscopic appendectomy exclusively in men and they reported that laparoscopic appendectomy in men has significant advantages in terms of more rapid recovery. [(30)].

Most surgeons agree on the use of laparoscopy when a patient is a young female with vague lower abdominal pain and its progress to appendectomy. There are innumerable reports showing that laparoscopy improves diagnosis and reduces unnecessary appendectomies in fertile women [(31)].

In this study, laparoscopy revealed gynaecological pathology in 3 patients (15%) and all of them were dealt with laparoscope.

While in open procedure, associated pathology was found in 1 patient (5%).

These results clarify the importance of laparoscopy as a diagnostic and therapeutic tool to deal with other causes of acute abdomen. This advantage permits the surgeons to manage even gynaecological cases without extending or changing incisions with the least post-operative complications.

5. Conclusion

Laparoscopic appendectomy is safe and feasible. Despite that the operating time for laparoscopic appendectomy is still higher than that for open procedure, laparoscopic approach had several advantages over open appendectomy in that, it has lesser incidence of wound infection, shorter hospital stay, less need for post-operative analgesia and faster return of patients to normal activities. Moreover, it is very useful in reaching an exact diagnosis in equivocal cases in females during their childbearing period. We must convert laparoscopic procedure to open surgery when indicated for the safety of the patient. A larger further study to evaluate the cost, benefit of laparoscopic appendectomy is recommended.

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