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## Open Appendectomy vs Laparoscopic Appendectomy an Institutional Experience.

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### ABSTRACT

The appendix is crudely referred as “worm of the bowel” in ancient times and also called as abdominal tonsil” [1]. Acute appendicitis is one of the most common abdominal emergency and accounts for approximately 1% of all surgical operation [2]. The treatment depends upon the stage of the disease. In early appendicitis, appendicectomy is the treatment of choice. It can be done by open or laparoscopic approach. The study was consist of 100 patients with a diagnosis of appendicitis who undergone laparoscopic or open appendectomy at Dr. D. Y. Patil Medical College Pimpri, Pune from July 2012 to September 2014. The rate of infection, post-operative pain and duration of hospital stay was significantly lower in LA group. LA is cosmetically better than OA. Post operatively patient undergone laparoscopic appendectomy was found to resume oral diet earlier than open appendectomy. Quality of life was significantly better in laparoscopic appendectomy as compared to open appendectomy. Only the operative time was found to be more in laparoscopic appendectomy group. It can be safely concluded that LA has distinct advantage over OA.

**Keywords:** Acute appendicitis, McBurney’s point, McBurney’s incision, LA – Laparoscopic appendectomy OA – Open appendectomy

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## INTRODUCTION

The appendix a cul-de-sac is crudely referred as “worm of the bowel” in ancient medical books and also called as abdominal tonsil” [1].

Acute appendicitis is one of the most common abdominal emergency and accounts for approximately 1% of all surgical operation [2].

The lifetime rate of appendectomy is 12 percent in men and 25 percent for women with approximately 7 percent of all people undergone appendectomy for acute appendicitis during their lifetime [3].

The treatment is straight forward in most of the cases and depends upon the stage of the disease. In early appendicitis, appendectomy is the treatment of choice. It can be done by open or laparoscopic approach. The surgical treatment of appendicitis is one of the great public health advancement of the last 150 years. The treatment of acute appendicitis remained essentially unchanged since its first description by Charles MC Burney in 1889. Appendectomy by Mc Burney’s incision remained the procedure of choice for nearly a century until 1983 when Curt Semm offered an alternative “laparoscopic appendectomy” [5].

Traditional appendectomy using a muscle splitting incision has been the standard treatment in appendicitis. Since appendectomy is one of the most common surgical procedure in the world, its economic consequences to the community in terms of post-operative hospital cost, complications, and lost working days are significant .

Numerous prospective randomized studies,[7-27] metaanalyses,[29–32] and systematic critical reviews<sup>33-36</sup> have been published on the topic of LA, with a general consensus that the heterogeneity of the measured variables and other weaknesses in the methodology have not allowed to draw definitive conclusions and generalizations[34-35].

In the continuing debate about laparoscopic vs open appendectomy, the laparoscopic approach still has to prove efficacy and safety in clinical trials. With this in mind the aim of the study is to evaluate laparoscopic appendectomy in comparison with open appendectomy, with special emphasis on post-operative septic complication.

## MATERIALS AND METHODS

### Inclusion Criteria

1. All patients with appendicitis was included in the study.  
Diagnosis of appendicitis will be made on following criteria:

History of right lower quadrant pain or periumbilical pain migrating to the right lower quadrant with nausea or vomiting and Fever more than 38 degree and/or leukocytosis above 10,000 per dl and Right lower quadrant guarding and tenderness on physical examination.  
OR diagnosis of appendicitis confirmed by either USG or CT scan.  
All patients with age more than 16 years and older will be included in the study

### Exclusion Criteria

1. History of symptoms more than 5 days
2. Diagnosis of appendicular mass or perforation or appendicular abscess is established.
3. Any contraindication for Surgery or Anesthesia.
4. Patients less than 16 years.

**Patients Selection Criteria-**

- Patients was randomly distributed into two groups (open appendectomy and laparoscopic appendectomy) 50 each. One group will be subjected to open appendectomy and other to laparoscopic appendectomy. First patient was selected by lottery method and subsequent allotment of cases was done in alternate group.
- Patients were explained about risk and benefits of surgery in their language and informed consent was taken.

**Outcome Parameters**

Following parameters will be recorded

- Operative time skin to skin in minutes.
- Time until resumption of normal diet.
- Complication like wound infection ( Serous of pus discharge from wound. )
- Pain was assessed with Visual Analogue Scale(VAS) scoring from 1 to 10 , upto 5 th post-operative day.
- Hospital stay in days was recorded from the day of operation.
- Quality of life with SF-36 scale at pre operatively and 2 weeks was recorded.
- Set proforma was filled including baseline evaluation, detail findings, Selection of patient(preference/selection/capability).All post-operative events, Date of suture removal, date of discharge, follow up (2 weeks, 1 months, 3 months), Complications, conversion and readmissions were recorded.

Comparison of result of two procedures was done.

**Surgery**

Residents performed all operations with 4 attending surgeons experienced in open and advanced laparoscopic techniques. The level of expertise in the performance of the standardized LA technique was verified by the senior author before the beginning of the trial.

OA used a McBurney muscle-splitting incision 1.5 inches in the right lower quadrant. A double ligation of the stump was performed with an absorbable suture. If the appendix looked normal, it was removed, and the distal ileum was visualized to detect possible Meckel's diverticulitis. The abdomen and pelvis were irrigated with warm saline solution. The skin incision was closed with 3-0 nylon (Ethilon; Ethicon, Somerville,NJ). In the case of a perforated appendix, the skin wound was closed loosely.

LA was performed using 3 ports, with the laparoscope positioned at the umbilicus. Two 10-mm ports were inserted in the right and left lower quadrants. The abdominal cavity was explored to locate the appendix and rule out other possible diagnoses. The appendix and the meso appendix were divided with an Endolinear Cutter 45 with blue and vascular staples, respectively (Ethicon Endosurgery, Cincinnati, OH). The right lower quadrant, the right colic gutter and the sub hepatic space in the case of purulence were irrigated and the fluid was suctioned. The appendix was removed in a laparoscopic bag. Fascial defects in the port sites were closed using 0 Vicryl suture. The skin incisions were closed in every case using 3-0 nylon. Nonsuction drainage was left in situ in cases of abscess and residual cavity.

**Post-operative care:**

Patients were kept nil by mouth till the bowel sounds returns.

Post-operative antibiotics were given as per protocol.

Post-operative pain was noted as per VAS scale till 5 th post-operative day. Patients were administered non-steroidal anti-inflammatory drug (diclofenac sodium) as required.

Bowel sound was checked every 12 hourly Patients will be allowed liquids once bowel sounds are normal. Patient will be on regular diet once patient will start tolerating clear liquids and passed flatus.

Suture removal for open appendectomy was done on 7 th post-operative day, for laparoscopic appendectomy on 5 th post-operative day .

**Discharge-**

Patients were discharged once suture line is completely healthy and fit to do regular activity. In our setup most of the patients come from remote villages. So discharge prior to suture removal and follow up for suture removal is not very convenient .Hence patients were discharged after complete suture removal.

**Follow up:**

Follow up was done in the Opd after 2 weeks, 1months, and after 3 months. Follow up was for any post-operative complications and to assess quality of life.

**Method of surgery**

All operation will be performed with suitable anesthesia. All patients were asked to empty the bladder prior to entering the operation.

Inj Cefotaxime 1 gm i.v was given to all the patients prior to surgery.

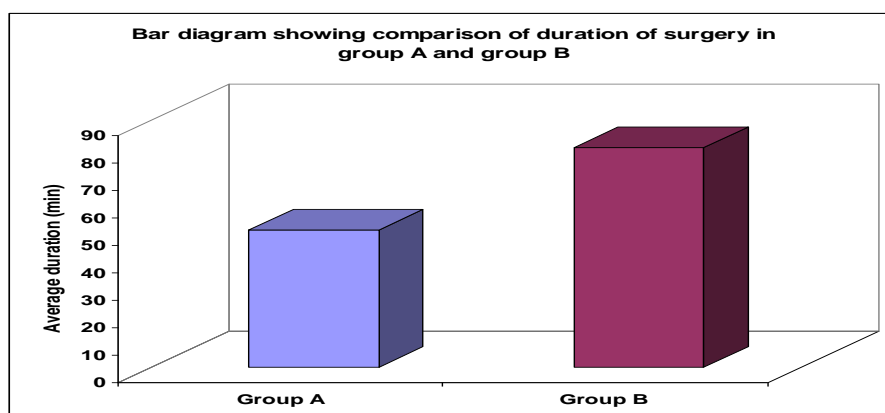
Post operatively I.V antibiotics was given for 3 days(Cefotaxime 1 gm i.v 12hrly, Amikacin 500 mg i.v 12 hrly, Metronidazole 500 mg i.v 8 hrly) followed by oral antibiotics (Tb.Taxim O 200 mg bd) for 3 days. I.V Analgesics (Inj.diclofenac sodium 75 mg i.v) was given 12 hourly and as per requirement. When pt started taking orally oral analgesia (Tb.Diclofenac sodium 50 mg) was given as per requirement.

**Statistical Analysis**

Data analysis was done using the SPSS (Statistical Package for the Social Science) Version 11 for window. The Z test, chi-square test, proportion test and MW test was used to find significance difference of demographic variables, Duration, post-operative pain, ROF, SSI and QOL between study groups. A probability value of 0.05 was accepted as the level of statistical significance.

**Table 1: Comparison of duration of surgery in group A and group B**

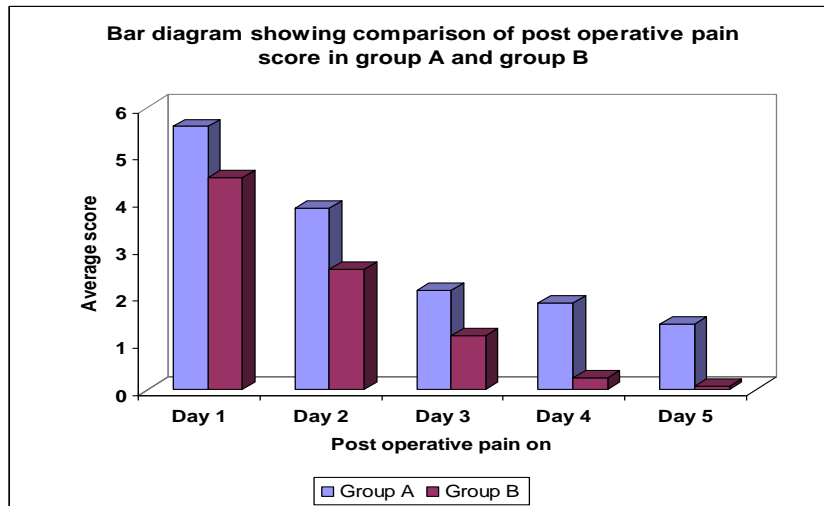
Parameter	Group A (n=50)		Group B (n=50)		Z Value	P Value
	Mean	SD	Mean	SD		
Duration (min)	50.16	7.96	80.16	7.53	19.36	<0.0001



The duration of surgery was calculated from skin incision to suturing.  
 The mean duration of Open appendectomy was found to be 50.16 minutes  
 The mean duration for laparoscopic surgery was found to be 80.16 minutes.  
 This difference was statistically significant.

**Table 2: Comparison of post-operative pain in group A and group B**

Post-operative pain on	Group A (n=50)		Group B (n=50)		MW test Z Value	P Value
	Mean	SD	Mean	SD		
Day 1	5.60	0.49	4.52	0.58	7.07	<0.0001
Day 2	3.86	0.35	2.56	0.50	8.53	<0.0001
Day 3	2.12	0.52	1.16	0.37	7.94	<0.0001
Day 4	1.84	0.37	0.26	0.44	8.87	<0.0001
Day 5	1.40	0.49	0.08	0.27	8.87	<0.0001

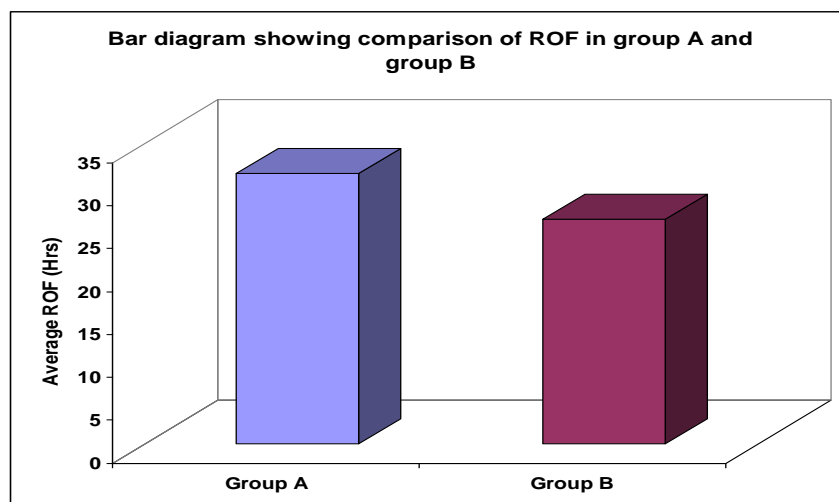


The post-operative pain was measured up to 5th post op day.

Mean post-operative pain in Open appendectomy was more compare to Laparoscopic appendectomy and the difference was statistically significant up to fifth post-operative day.

**Table 3: Comparison of resumption of feeds in group A and group B**

Parameter	Group A (n=50)		Group B (n=50)		Z Value	P Value
	Mean	SD	Mean	SD		
ROF (Hrs)	31.60	6.70	26.22	3.63	4.99	<0.0001

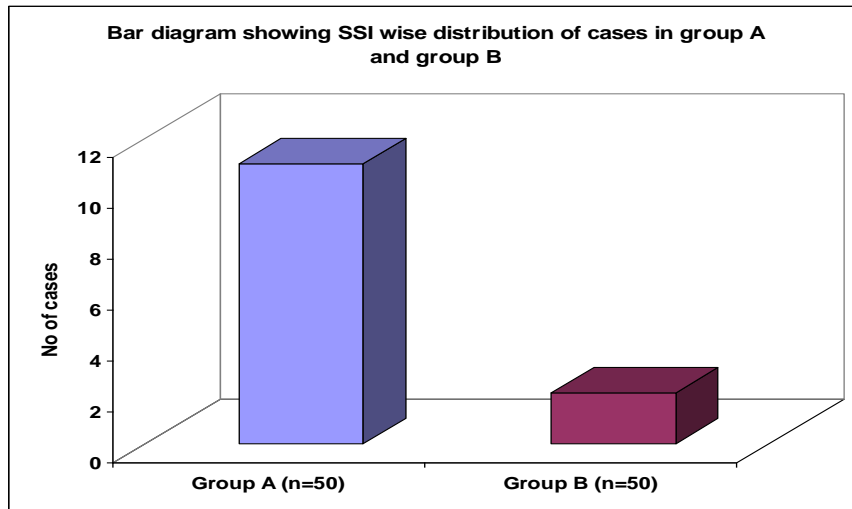


The mean duration of resumption of oral feed in Open Appendectomy group was 31.60 hours and 26.22 hrs in Laparoscopic Appendectomy group.

This difference was statistically significant.

**Table 4: Surgical sites infection wise distribution of cases in group A and group B**

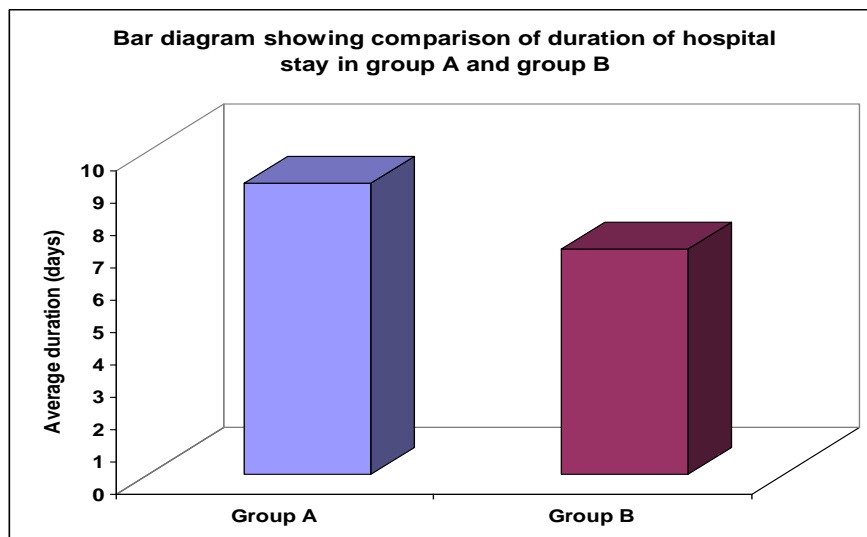
Parameter	Group A (n=50)	Group B (n=50)	Z Value	P Value
<b>SSI</b>	11 (22)	2 (4)	2.78	<0.01



11 patients from group A developed surgical site infection and 2 patients from group B developed SSI. This difference was statistically significant.

**Table 5: Comparison of duration of hospital stay in group A and group B**

Parameter	Group A (n=50)		Group B (n=50)		Z Value	P Value
	Mean	SD	Mean	SD		
<b>Duration (days)</b>	9.02	1.30	6.96	0.75	9.68	<0.0001

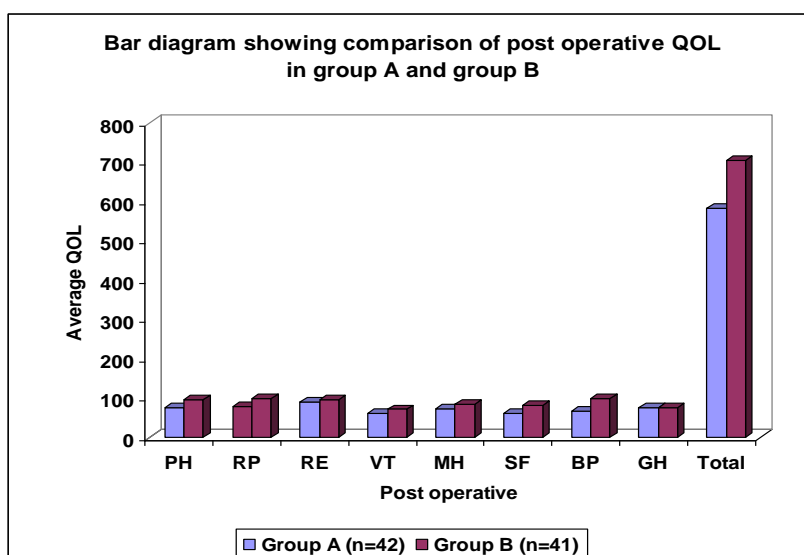


Mean duration of hospital stay in group A was 9.02 days and in group B was 6.96 days. This difference is statistically significant.

**Table 6: Comparison of post-operative QOL in group A and group B**

Parameter	Group A (n=42)		Group B (n=41)		Z Value	P Value
	Mean	SD	Mean	SD		
PH	76.43	29.37	97.07	7.16	4.37	<0.0001
RP	77.38	32.11	100	0	4.51	<0.0001
RE	89.29	20.76	96.78	14.39	1.91	>0.05
VT	60.79	10.83	71.07	14.54	3.66	<0.0001
MH	73.69	14.09	84.15	14.59	3.32	<0.001
SF	61.50	17.93	81.59	11.15	6.11	<0.0001
BP	66.17	17.51	97.90	8.29	10.51	<0.0001
GH	76.60	31.65	74.51	19	0.36	>0.05
Total	581.83	91.86	703.07	41.34	7.71	<0.0001

PH-Physical Health,RP-Role Play,RE-Role Emotional,VT-Vital energy,MH-Mental Health,SF-Social Functioning ,BP-Bodily Pain,GH-General Health



Post operatively at 2weeks 8 patient from open appendectomy group(A) and 9 patient form laparoscopic appendectomy group lost follow up. Comparison of QOL was done in between 42 patients from Group A and 41 patient from group B. At 2 weeks postoperatively Quality of life showed statistically significant difference for 6 out of 8 domains(physical health,role play,vital energy, mental health,bodily pain.)

**DISCUSSION**

Acute appendicitis is the most common intra-abdominal condition requiring emergency surgery. Although more than 20 years have elapsed since the introduction of laparoscopic appendectomy, there is no consensus on its advantages and disadvantages compared to the conventional technique.

More and more appendectomies are currently performed laparoscopically due to fact that the technique offers advantages to patients in terms of more accurate diagnosis, diminished wound infection .and more rapid recovery.

Always when a new technique is introduced to surgical community,the focus should be concentrated on the feasibility,safety,and clinical advantages of the method.further ,safety is highly dependent on how easily the new technique can be learned by surgeons. It is well acknowledgement that the implementation phase of new techniques is associated with an increased risk of complications emphasizing the importance of through training and education.

## AGE AND SEX DISTRIBUTION.

In this study the incident of appendicitis is maximally in the age range of 21-35 years. The mean age of open appendectomy was 28 years and that for lap appendectomy was 30 years.

In this study patient who underwent open appendectomy are mostly male (62%) and this ratio was equal in lap appendectomy.

In a study by Utpal de et al patient were on average 24.7 years old. Patient who underwent laparoscopic appendectomy were older (LA-25.1 years, OA-24.3 yrs) and more likely male (LA-61%, OA-58.1%) [46].

## Duration of Surgery

The average duration of surgery for open appendectomy was found to be 50 mins. The average duration of surgery for lap. appendectomy was found to be 80 mins. Thus the duration of surgery is about 30 mins longer for laparoscopic as compared to open appendectomy. In a review of 17 randomized control trial the operating time of laparoscopic appendectomy was found to be more. It took 31 percent longer to perform. The operating time also depends on the experience of the surgeon and competence of their team [58].

In considering operating time, the exact identification of the timing of the start of the procedure and its conclusion vary [57]. In general the time should be calculated from the insertion of first trocar to the end of skin suturing. Generally all laparoscopic procedures are more time consuming for the following reasons.

1. Inherent nature of slow maneuver of laparoscopic techniques
2. Time taken by careful slow insufflation.
3. Routine diagnostic laparoscopy before starting any laparoscopic procedure.

A meta-analysis of randomized controlled trial has been reported with outcomes for 2877 patients in which mean operating time was 16 minutes longer for laparoscopic appendectomy [32].

A prospective randomized trial comparing laparoscopic appendectomy with open appendectomy was conducted in 158 patients by Hansen et al. They reported that despite of longer operating time, (63 versus 40 minutes) the advantages of laparoscopy (such as fewer wound infection and earlier return to normal activity) make it a worthwhile alternative for patients with a clinical diagnosis of acute appendicitis [10].

**Utpal de et al** found that there was an insignificantly shorter operating time {OA: 25 min (median), LA: 30 mins (median),  $0.05 > P > 0.01$ } in patients undergoing open appendectomy compared to laparoscopic appendectomy [46].

Namir k et al in 2005 found that operative time was significantly longer in LA [49].

Kazemier et al in their report of a randomized clinical trial of 201 patients found that laparoscopic appendectomy is superior to open surgery regarding post-operative pain, and, post-operative complications, recovery time, and financial aspect [14].

B.V.Goudar et al noticed that operation time for LA and OA was 72 mins and 49 mins respectively [58]. The operative duration was 23 minutes longer in the LA group as compared to that in the OA group.

In 2013 Asrahf et al found that LA took longer to perform although use of analgesic was significantly low in LA [60].

## RESUMPTION OF NORMAL FEED

The average duration of resumption of normal feed in open appendectomy was 31.6 hours and LA was 26.22 hours.



This difference was found to be statistically significant.

In 2010 Li X et al concluded that Lap approach led to a reduction in the period as compared to Open appendectomy [56].

In 2013 Mani K et al found that oral feed was earlier in LA(.7days) as compared to OA(1.7days) days[59].

### **POST-OPERATIVE INFECTION**

The reduced wound infection and the post-operative paralytic ileus can be beneficial in so many ways: less pain, an early oral intake and early mobilization, all resulting ultimately in a reduced hospital stay. In this study 11 patient in OA group and 2 patients from LA group developed surgical site infection .

The difference was found to be statistically significant.

In 2012 Yong Joo et al concluded that SSI was significant in OA [52].

In 2013 Mani k et al concluded that wound infection is almost negligible in LA [59].

IN 2014 Vincenzo et al noticed that there was significant less wound infection in LA group [5].

### **POST-OPERATIVE PAIN**

The post-operative pain was qualitatively stratified into mild, moderate and severe, according to the visual analog scale (VAS).

In our study Post-operative pain was more in OA group than LA group upto fifth post-operative day and it was statistically significant.

In 2010 Li X et al noticed pain is less in LA than OA [56].

In 2011 B.V.Goudar et al found that even though the relatively early pain was more or less equal in the LA group than OA group [58].

In 2013 Mani k et al proved that LA causes less post-operative pain with significant reduction in post op analgesia [59].

### **DURATION OF HOSPITAL STAY**

In our study average duration of hospital stay in LA group was 9 days and 6.96 days in OA group. This difference was statistically significant in our study.

X Li et al's meta analyses (2010) showed a lot of controversies in the hospital stay before the year 2000, but after that, it became more significant. This discrepancy may be due to the social standards, the insurance system and the health care policies. Some authors argue that the appendiceal pathology was a major determinant of the length of the hospital stay. Patients with complicated appendicitis were most likely to require an extended hospital stay. An early return to full activity one week before in the LA group was observed in the study and it was comparable with the findings of other reported series. This was supported by the Cochrane Colorectal Cancer Group [56, 60-71].

In 2013 Mani k et al concluded duration of hospital stay was less in LA than OA[59].

In 2014 Vincenzo M et al found that mean duration of hospital stay was shorter in LA group[5].

### **QOL(Quality Of Life)**

In our study quality of life score at 2 weeks was significant in LA compare to open appendectomy.

In 2005 Namir k et al concluded that Physical Health(PH) and General Health(GH) score from QOL score were significantly better in LA [53].

## CONCLUSION

Laparoscopic appendectomy scores over open appendectomy in terms

1. Post-operative resumption of normal feed
2. Post-operative infection
3. Post-operative pain
4. Duration of hospital stay
5. Quality of life

All these advantages are at a cost of slightly increased duration of surgery .

Now a days there is an increasing trend in minimal invasive surgeries however by the time ,open appendectomy has improved greatly. More and More question are being raised as to the benefit of laparoscopic appendectomy. But going by our study we definitely find an overall advantage of laparoscopic appendectomy. Laparoscopic appendectomy is equally safe and can provide less post-operative complication in experienced hands as open appendectomy. Laparoscopic appendectomy is a better method for reducing hospital stay, complication and return to normal activity. With better training in minimal access surgery now available ,the time has arrived for it to take its place in the surgeon's repertoire.

## REFERENCES

- [1] Herrington J L Jr. The vermiform appendix :its surgical history. *Contemp Surg.*1991;39:36-43.
- [2] Schwartz's C.F. Principles of surgery "The Appendix" Bernard. 9<sup>th</sup> edition. New York. McGraw Hill publication; 2005.1075-85.
- [3] Ball CG, Kortbeek JB, Kirkpatrick AW, Mitchell P.: Laparoscopic appendectomy for complicated appendicitis: an evaluation of postoperative factors. *Surg Endosc.* 2004 Jun;18(6):969-73.
- [4] Addiss DG,Shaffer N,Fowler BS,Tauxe RV. The epidemiology of appendicitis and appendectomy in the united states. *Am J Epidemiol.*1990; 132(910):1-3.
- [5] Minutolo V, Licciardello A, Stefano BD, Arena M, Arena G, Antonacci V. Outcomes and cost analysis of laparoscopic versus open appendectomy for treatment of acute appendicitis: 4-years experience in a district hospital. *BMC Surgery*, 2014; 14(14):1-6.
- [6] Shirazi B, Ali N, MS Shamim .Laparoscopic versus open appendectomy.2010; (60):901-5.
- [7] Attwood SE, Hill AD, Murphy PG,Thorton J,Stephenes RB. A prospective randomized trial of laparoscopic versus open appendectomy. *Surgery.* 1992;112(3): 497–501.
- [8] Cox MR, McCall JL, Toouli J, Padbury RT, Wiison TG, Wattchon DA, et al. Prospective randomized comparision of open versus laparoscopic appendectomy in men. *World J Surg* 1996; 20: 263-6.
- [9] Frazee RC, Roberts JW, Symmonds RE,Synder SR,Hendrich JC,Smith RW ,et al. A prospective randomized trial comparing open versus laparoscopic appendectomy. *Ann Surg.*1994; 219:725–28.
- [10] Hansen JB, Smithers BM, Schache D, Wall DR, Miller BJ, Menzies BL. Laparoscopic versus open appendectomy: prospective randomized trial. *World J Surg.* 1996;20:17–20.
- [11] Heikkinen TJ, Haukipuro K, Hulkko A. Cost-effective appendectomy: open or laparoscopic? a prospective randomized study. *Surg Endosc.*1998 ;12(10): 1204 –8.
- [12] Hellberg A, Rudberg C, Kullman E, et al. Prospective randomized multicentre study of laparoscopic versus open appendectomy. *Br J Surg.* 1999;86:48 –53.
- [13] Ignacio RC, Burke R, Spencer D, Bissell C, Dorsainvil C, Lucha PA. Laparoscopic versus open appendectomy: what is the real difference? Results of a prospective randomized double-blinded trial. *Surg Endosc* 2004; 18: 334-7.
- [14] Kazemier G, De Zeeuw GR, Lange JF,Hop WC,Banjer HJ ,et al. Laparoscopic vs. open appendectomy: a randomized clinical trial. *Surg Endosc.* 1997;11: 336–40.
- [15] Klingler A, Henle KP, Beller S, Rechner J,Zerz A,Wetscher GJ et al. Laparoscopic appendectomy does not change the incidence of postoperative infectious complications. *Am J Surg.* 1998;175:232–35.
- [16] Kum CK, Ngoi SS, Goh PM,Tekant Y, Issac JR . Randomized controlled trial comparing laparoscopic and open appendectomy. *Br J Surg.* 1993;80:1599–600.
- [17] Laine S, Rantala A, Gullichsen R,Ovaska J,. Laparoscopic appendectomy: is it worthwhile? a prospective, randomized study in young women. *Surg Endosc.* 1997;11:95–97.

- [18] Larsson PG, Henriksson G, Olsson M, Boris J, Stroberg P, Tronstad SE. Laparoscopy reduces unnecessary appendectomies and improves diagnosis in fertile women: a randomized study. *Surg Endosc.* 2001;15:200–2.
- [19] Long KH, Bannon MP, Zietlow SP, Helgeson ER, Harmsen WS, Smith CD, Ilstrup DM, Baerga-Varela Y, Sarr MG. Laparoscopic Appendectomy Interest Group: a prospective randomized comparison of laparoscopic appendectomy with open appendectomy: clinical and economic analyses. *Surgery.* 2001;129:390–400.
- [20] Macarulla E, Vallet J, Abad JM, Hussein H, Fernandez E, Nieto B. Laparoscopic versus open appendectomy: a prospective randomized trial. *Surg Laparosc Endosc.* 1997;7:335–9.
- [21] Martin LC, Puente I, Sosa JL, Bassin A, Breslaw R, McKenney MG, Ginzburg E,
- [22] Sleeman D. Open versus laparoscopic appendectomy: a prospective randomized comparison. *Ann Surg.* 1995;222: 256–61.
- [23] Milewczyk M, Michalik M, Ciesielski M. A prospective, randomized, unicenter study comparing laparoscopic and open treatments of acute appendicitis. *Surg Endosc.* 2003;17: 1023–28.
- [24] Minné L, Varner D, Burnell A, Ratzler E, Clark J, Haun W. Laparoscopic vs. open appendectomy: prospective randomized study of outcomes. *Arch Surg.* 1997;132: 708–11.
- [25] Mutter D, Vix M, Bui A, Evrard S, Tasseti V, Breton JF, et al. Laparoscopy not recommended for routine appendectomy in men: results of a prospective randomized study. *Surgery.* 1996;120:71–4.
- [26] Ortega AE, Hunter JG, Peters JH, Swanstrom LL, Schirmer B: A prospective, randomized comparison of laparoscopic appendectomy with open appendectomy. Laparoscopic Appendectomy Study Group. *Am J Surg* 1995, 169:208–12.
- [27] Pedersen AG, Petersen OB, Wara P, Ronning H, Qvist N, Lauberg S e. Randomized clinical trial of laparoscopic versus open appendectomy. *Br J Surg.* 2001;88:200–205.
- [28] Reiertsen O, Larsen S, Trondsen E, Edwin B, Faerden AE, Rosseland AR. Randomized controlled trial with sequential design of laparoscopic versus conventional appendectomy. *Br J Surg.* 1997;84:842–47.
- [29] Tate JJ, Dawson JW, Chung SC, Lau WY, Li AK. Laparoscopic versus open appendectomy: prospective randomised trial. *Lancet.* 1993;342:633–7.
- [30] Chung RS, Rowland DY, Li P, Diaz J. A meta-analysis of randomized controlled trials of laparoscopic versus conventional appendectomy. *Am J Surg.* 1999;177:250–256.
- [31] Garbutt JM, Soper NJ, Shannon WD, Botero A, Littenberg B. Meta-analysis of randomized controlled trials comparing laparoscopic and open appendectomy. *Surg Laparosc Endosc.* 1999;9:17–26.
- [32] Golub R, Siddiqui F, Pohl D. Laparoscopic versus open appendectomy: a meta-analysis. *J Am Coll Surg.* 1998;186:545–553.
- [33] Sauerland S, Lefering R, Holthausen U, Neugebauer EA. Laparoscopic vs conventional appendectomy--a metaanalysis of randomised controlled trials. *Langenbecks Arch Surg* 1998; 383(3-4): 289-95.
- [34] Fingerhut A, Millat B, Borrie F. Laparoscopic versus open appendectomy: time to decide. *World J Surg.* 1999;23(8):835–45.
- [35] McCall JL, Sharples K, Jadallah F. Systematic review of randomized controlled trials comparing laparoscopic with open appendectomy. *Br J Surg.* 1997;84(8):1045–50.
- [36] Sauerland S, Lefering R, Neugebauer EA. Laparoscopic versus open surgery for suspected appendicitis. *Cochrane Database Syst Rev.* 2004;(1):CD001546.
- [37] Slim K, Pezet D, Chipponi J. Laparoscopic or open appendectomy? critical review of randomized, controlled trials. *Dis Colon Rectum.* 1998;41(3): 398–403.
- [38] Williams, G.R., 1983, A history of appendicitis. *Ann. Surg.*, 197:495f.
- [39] Glover JW. The Human Vermiform Appendix: A general surgeons reflections. *Journal of creation.* 1988;3(1):31-38.
- [40] Elbagir AA, Hamour OA. Minimally Invasive surgery: Can We See Inside the Future. *GJHS.* 2012;8(1).
- [41] Reynolds Jr W. The First Laparoscopic Cholecystectomy, *JLS.* 2001(5):89-94.
- [42] Ballantyne GH. Minimally invasive surgery for diseases of the colon & rectum: the legacy of an ancient tradition. <http://www.lapsurgery.com/history.htm> Accessed September 15, 2014.
- [43] Sauerland S, Lefering R, Neugebauer EA. Laparoscopic Versus open surgery for suspected appendicitis. *The Cochrane Collaboration review.* 2010; 1-2.
- [44] Geeta K.R., Kudva AB. Laparoscopic appendectomy Versus Laparoscopic appendectomy: a comparative study of clinical outcome and cost Analysis. *Indian Journal of Surgery. Manipal.* 2009;1-4.
- [45] Anena Mc OJ, Austin O, Oconnel PR, Hedermen WP, Gorey TF, Fitzpatric J. Laparoscopic versus open appendectomy prospective evaluation, *Br J Surg.* 1992; 79(8): 818-20.

- [46] Nguyen NT, Zainabadi K , Mavandadi S, Paya M , Stevens C M, Root J, et al. Trends in utilization and outcomes of laparoscopic versus open appendectomy. *Am J Surg* 2004; 188: 813-20.
- [47] Martin LC, Puente I, Sosa JL, Bassin A, Breslaw R, McKenney MG, et al. Open Versus Laparoscopic Appendectomy A Prospective Randomized Comparison. *Annals of Surgery*. 1995 : 222(3);256-62.
- [48] Marzouk M, Khater M, Elsedak M, Abdelmoghny A. Laparoscopic versus open appendectomy: a prospective comparative study of 227 patients. *Surg Endosc* 2003; 17: 721-4
- [49] De U. Laparoscopic versus open appendectomy: An Indian perspective. *Journal of Minimal Access Surgery*. 2005; 1:15-20.
- [50] Wei hb, Huang JL, Zheng ZH, Wei B, Zheng F, Qiu WS, et al. Surgical Endoscopy infection between open and laparoscopic appendectomy. 2010; 24(2): 266-9.
- [51] Kehagias I, Karamanakos SN, and Kalfarentzos F. Laparoscopic versus open appendectomy: Which way to go? *World J Gastroenterol*. Aug 21, 2008; 14(31): 4909–14.
- [52] Yagnik VD, Rathod JB, Pathak AJ .A Retrospective Study of Two port Appendectomy and its Comparison with Open Appendectomy and Three port Appendectomy. *The Saudi journal of gastroenterology*. 2010; 16(4):268-71.
- [53] Suh YJ, Jeong SY, Park KJ, Park GJ, Kang SB, Kim DW, et al. Comparison of surgical site infection between open and laparoscopic appendectomy. *The Korean Journal Society* 2012; 82:35-39.
- [54] Katkhouda N, Mason RJ, Towfigh S, Gevorgyan A, Essani R. Laparoscopic versus open appendectomy: a prospective randomized double-blind study. *Ann Surg* 2005; 242:439-48.
- [55] Al-mulhim AS, Al Muhim FM, Al-Auwaiygh AA, Al-Masaud AA. Laparoscopic versus open appendectomy in females with a clinical diagnosis of appendicitis. *Saudi Med Journal*. 2002; 23 (11): 1339-42.
- [56] Aziz O, Athanasiou T, Tekkis PP, Purkayastha S, Haddow J, Malinovski V, et al. Laparoscopic versus open appendectomy in children: A meta-analysis. *Annals of Surgery*. 2006; 243(1):17–27.
- [57] Li X, Zhang J, Sang L, Zhang W, Chu Z, Li X, Liu Y. Laparoscopic versus conventional appendectomy--a meta-analysis of randomized controlled trials. *BMC Gastroenterol*. 2010 ;10:129.
- [58] Tiwari MM, Reynoso JF, Tsang AW, Oleynikov D. Comparison of outcomes of laparoscopic and open appendectomy in management of uncomplicated and complicated appendicitis. *Ann Surg*. 2011 Dec; 254(6):927-32.
- [59] Gauder B V, Telkar S, Lamani YP, Shirbur SN, ME Shailesh . Laparoscopic versus Open Appendectomy: A Comparison of Primary Outcome Studies from Southern India. *Journal of Clinical and Diagnostic Research*. 2011;5(8): 1606-9.
- [60] Gundavda MK, Bhandarwar AH. Comparative study of laparoscopic versus open appendectomy. *Indian J Med Sci* 2012;66:99-115.
- [61] Mohamed AA and Mahran KM. Laparoscopic appendectomy in complicated appendicitis: Is it safe?. *J Minim Access Surg*. 2013; 9(2): 55–8.
- [62] Das S. *Clinical methods of Surgery*. 5<sup>th</sup> ed. Kolkata. S. Das; p: 382.
- [63] Ronan 'O' Conell, " The vermiform appendix,". *Bailey and Love Short practice of surgery*. 25th edition. London: Edward Arnold LTD; 2008. p.1204-18.
- [64] Moore , Persaud. *The developing human. The digestive system –part II*. Philadelphia. Elsevier health science. 2011. p-230-34.
- [65] GAG Decker, Cee McGregor's *Synopsis of Surgical Anatomy*. 3<sup>rd</sup> ed. Mumbai: KM Verghese company; 1999. p41-3.
- [66] Das. S. *Concise Textbook of surgery. The vermiform appendix*. 5th edition. Kolkata: S. Das; 2008. p 1022-3
- [67] Snell RS. *Clinical anatomy by Region*. 8<sup>th</sup> ed. Washington. Lippincott William Wilkins. The abdominal cavity part –II. 2012. p-232
- [68] Kumar, Abbas, Aster. *Robbins Basic Pathology*. 9ed. Philadelphia: Saunders. 2013; p600-1.
- [69] Al-Dowais A . Totally Trans-Umbilical Laparoscopic Appendectomy with "Dowais's technique". *The Internet Journal of Surgery*. 2009;21(2).
- [70] Kossi J, Luostarinen M. Initial Experience of the Feasibility of Single-Incision Laparoscopic Appendectomy in Different Clinical Conditions. *Diagnostic and Therapeutic Endoscopy*. 2010; p1-4. doi:10.1155/2010/240260
- [71] Ali VI, Maliekkal JI. laparoscopic appendectomy using endo ring applicator and fallope rings. *Saudi journal of the Saudi gastroenterology*. 2009;15(1):39-41.