Original paper

Meta- Analysis to find out an ideal treatment for Acute appendicitis

Hadi Awad Hmoud^*,
^Department of Surgery/ College of Medicine/ Kerbala University

Abstract

Background: Open appendectomy (OA) was the standard procedure for inflamed appendix. First laparoscopic appendectomy (LA) was done in 1980 since then Laparoscopic Appendectomy has been gaining more popularity and approval despite the controversies that surrounding its safety and universal applicability.
Aim: This is a comparative study to evaluate the safety, effectiveness and the superiority of LA vs OA in treating the acute appendicitis.
Materials and methods: This retrospective study was performed by examining huge number of literatures and huge number of clinical observations regarding treatment of acute appendicitis after applying new parameters like patient selection, operating time, hospital stay, cost effectiveness, intra and postoperative complications, needs for painkillers, role of antibiotics, operative technique and cosmetic issues.
Result: Large number of studies have showed that LA is highly beneficial for young age group females, it shortens the hospital stay time, minimizes the need for post- operative painkillers, and it bears good cosmetic outcome. On the other hand it carries serious complications, it is time consuming technique, and it impacts big financial burden. While antibiotics use and modifying the type of operative techniques can improve the overall outcome for both modalities.
Discussion: This study has found that both laparoscopic and open appendectomy have some advantages and disadvantages, but logical evaluation of these outcomes clearly shows that, the LA impacts more serious and devastating complication, which may outweigh its benefits.
Conclusion: By careful reviewing of all above parameters we can reach an important decision regarding the ideal approach for operating on acute appendicitis, such decision gives the superiority for the OA over the LA in treating acute appendicitis, especially in an attempt to avoid devastating complications.
Keywords: Appendicitis, Appendectomy, Laparoscopy,

Introduction

The open approach for acute appendicitis has remained the gold standard for decades, because it is a safe and efficacious procedure that results in minimal morbidity and near-zero mortality.
Kurt Semm, a German gynecologist, was the first to radically change McBurney's procedure when he performed the first laparoscopic appendectomy on May 30, 1980. [1,2] Rather than traumatizing the abdominal wall for exposure, Semm's technique used a laparoscope to visualize the appendix. Laparoscopic needle and suture (Endosutures) were used to secure the mesoappendix prior to division. Pretied Roeders loops were used to ligate the base of the skeletonized appendix. The appendix was amputated between the fixed loops. The technique was efficient, effective, and of course, minimally invasive.
Larson et al [3] elegantly iterated several reasons why a laparoscopic approach seems preferable to open appendectomy: superior visualization, identification of lesions in structures other than the appendix, reduced tissue trauma, the potential for more rapid return to normal activity, good exposure in obese patients, and decreased

*For Correspondence: E-Mail hmoudhadi@yahoo.com

wound surface area to serve as a focus for infection. Of particular importance is the capability of establishing a diagnosis in female patients of childbearing years, in whom the diagnosis may be less certain.[4]

The aim

This comparative study is performed to evaluate the safety and effectiveness OA Vs LA, and the reality and causes of post-operative complications for Laparoscopic vs. Open Appendectomy.

Methodology

This retrospective study represents a fair and comprehensive evaluation and judgement of the benefits and risks of using OAVs. LA for treating acute appendicitis according to the following parameters: patient selection, operating time, hospital stay, Cost effectiveness, intra-operative and post-operative complications, post-operative need for painkillers, Role of using antibiotics and their type and period, Operative technique and cosmetic issues, through reviewing hundreds of studies and documents regarding the evaluation of outcome of comparison between LA vs OA, coupled with huge number of live clinical observations in selected specialized institutes in Laparoscopic surgery and only standard methods of appendectomy were included.

Result

Using laparoscopy for appendectomy has proved to be of high benefit in young female with vague right lower quadrant pain, primarily as diagnostic tool, as it has reduced the unnecessary appendectomy and its complications in fertile females.
Regarding operating time, a study of 2 groups was similar in terms of age, sex, weight, Height, rate of complications, and histological features of the appendix, had given these results as shown in table 1.[5]

Table 1. shows the operating time difference between LA and OA

	LA	OA	mean	95% CI difference	P value
Operating time	42-+25	31-+14	11 minute	2-19 minute	0.02
Anesthesia time	62-+25	51-+14	11 minute	2-19 minute	0.02

Regarding hospital stay, a meta-analysis study had evaluated the hospital stay and found, as table 2 [6]
Another study shows the length of hospital stay by the degree of appendicular inflammation and surgical approach and as shown table 3. [7]
Regarding the cost-effectiveness, This study shows clear difference in the total Procedure Costs per Patient between Laparoscopic and Open Appendecectomy , as shown in table 4 [8]
Regarding the complications, this study shows the comparison of complication in both approaches, as shown in table 5 [9]
Another study shows that Laparoscopic usually associated with higher intra-pelvic abscess formation as follow, as shown in table 6 [10]
Also a systematic review of studies comparing LA vs OA was performed by Sauerland et al [11] and published in 2002. The meta-analysis of 39 separate investigations concluded that wound infections were significantly reduced in laparoscopic appendectomy (odds ratio 0.5), but abscess formation was significantly increased (odds ratio 2.8).
Intra-abdominal abscess remains one of the more feared complications of appendectomy, be it performed by laparoscopic or open techniques. The responsible organisms include those typically associated with the gastrointestinal tract.

Table 2. shows the hospital stay difference between LA and OA

	LA	OA	95%CI				
Study	Mean	SD	Total	Mean	SD	Total	
Al-Mulhim et al.Attwood et al.	2	0.75	30	2	1.25	30	0.00[-0.52,0.52]
Bruwer et al.	2.5	1.25	30	3.8	1.9	30	-1.30[-2.11,-0.4])
Clarke et al.	3	1.6	18	3.7	1.1	16	-0.70[-1.61, 021]
Hart et al.	2	1.75	23	4	2.25	14	-2.00[-330, -0.62]
Huang et al.	2.9	0.3	44	3.03	1.24	37	0.20[-1.49, 1.89]
Katkhouda et al.	2.8	1.4	23	3.6	1.8	23	-0.80[-1.73, 0.13]
Khalil et al.	2	0.5	113	3	0.5	134	-1.00[-1.13, -0.87]
Kouhia et al.	1.52	0.76	72	1.7	1.06	75	-0.18 [-0.48, 0.12]
Lintula et al.	1.5	1.5	47	1.5	2	52	0.00 [-0.69, 0.69]
Macarulla et al.	1.9	0.7	30	2.6	0.9	31	-0.70 [-1.10, -0.30]
Milewczyk et al.	3.42	1.86	106	4.75	2.65	104	-1.33 [-1.95, -0.71]
Moberg et al.	4.71	2.35	96	5.03	2.56	104	-0.32 [-1.00, 0.36]
Olmi et al.	2	2.5	81	2	5.5	82	0.00 [-1.31, 1.31]
Reiertsen et al.	3.4	1.5	150	5.5	2	138	-2.10 [-2.51, -1.69]
Shirazi et al.	3.5	0.4	42	3.2	0.42	42	0.30 [0.12, 0.48]
Tate et al.	1.5	0.06	30	4.1	0.8	30	-2.60 [-2.89, -2.31]

Table 3. shows the hospital stay per hours in connection with degree of inflammation of appendix.

Type	LA Stay/Hours	OA Stay/Hours	P Value
Normal	23.4	35.9	0.0001
Simple	22.8	29.5	0.04
Suppurative	26.5	42.6	0.0003
Gangrenous	63	82.5	FEW DATA
Ruptured	54	102.2	0.001

Table 4. Shows the cost difference between Laparoscopy Vs. open appendectomy

	LA	OA	mean difference 95%
Camera	16	NA	NA
Light source	4	NA	NA
Monitor	3	NA	NA
Telescope	10	NA	NA
Insufflators	17	NA	NA
Dissector 2	7	NA	NA
Scissors	4	NA	NA
Cauterizing hook	1	NA	NA
Suction – irrigation set up	2	NA	NA
Trocar3	3	NA	NA
PDS ties	24	NA	NA
Other suture materials	4	10	NA
Analgesia	8	12	0.75 – 7.3
Specimen bags	10	NA	NA
Anesthesia gas	9	7	1-3
Carbon dioxide	1	NA	NA
Reoperation	20	NA	NA
Readmission	NA	18	NA
Hospital stay	880	923	-163-250
Itemized total cost	1023	970	-83-247

Table 5. shows a comparison between the complications of both LA and OA

Complications	LA N=193	OA N=100	CONVERTED N=14
Small bowel obstruction	1	1	--
Ileus	--	5	2
Facials dehiscence	--	2	--
Pelvic abscess	1	--	--
Persistence fever	1	--	1
Persistence pain	2	--	--
Pleural effusion	1	--	--
Supraventricular tachycardia.	--	--	1
TOTAL	3.6 % (N=6)	8.0% (N=8)	28.6 (N=4)

Table 6. a randomised controlled trials of laparoscopic and open appendecectomies.

Reference	Number	Abscesses
Attwood et al	LAP 30 OP 32	-- --
Tate et al	LAP 70 OP 70	1 --
Kum et al	LAP 52 OP 57	-- --
Frazee et al	LAP 36 OP 37	1 --
Ortega et al	LAP 167	6
	OP 86	--

In one of the largest published series,[12] the overall rate of abscess formation was 0.4% in laparoscopic procedures, including perforated and gangrenous appendicitis. The rate of abscess formation in this and in many centers is comparable to abscess formation following open procedures.[13,14]
More recently, laparoscopy has been advocated in a Cochrane Database Systematic Review.[15]
Nordentoft et al [16] conducted a randomized study in 23 adult patients of bacteremia at the time of appendectomy. In this study, half of the patients who underwent laparoscopic appendectomy had culture-documented bacteremia, whereas none of the patients who underwent open appendectomy had bacteremia. The significance of these findings may be debated, as there was no increase in rates of abscess formation in the laparoscopic group, as well as the obvious size limitations of the study.

However, in a separate report, one patient developed a left-sided scrotal abscess following laparoscopic appendectomy. [17] This does implicate pneumoperitoneum as a possible causal factor in facilitating transit through a processus vaginalis and subsequent abscess development.
Wound infection, which can be as high as 30% following open appendectomy, is reported to be about 0.1% following laparoscopic procedures.[18] Strict attention to cleansing the umbilicus of all debris and proper sterilization of laparoscopic instruments may lessen this incidence even further. The majority of studies suggest that wound infections occur infrequently, at rates similar to those of open surgery, with most randomized studies demonstrating fewer infections in laparoscopic appendectomy than in the open cohort.[19,20]
Sub hepatic abscess due to retained fecalith is a rare complication following appendectomy. The incidence of this complication is probably going to increase

due to high rate of laparoscopic appendectomy. We report 2 cases of sub hepatic abscess 1 and 2 years after laparoscopic appendectomies. [21]

Impairment of immunity is a well-recognized complication related to Laparoscopic appendectomy rather than Open appendectomy, and this real effect takes three ways:

1- Direct effect, throughout enhancing of anaerobic media for bacterial growth, as the insufflation of CO2 is promoting media for the growth of these anaerobic bacteria. [22]
2- Indirection action through suppression of intra-peritoneal cell-mediated immunity, which has been demonstrated in a number of studies. This feature may be clinically important and should be acknowledged when considering laparoscopic surgery in patients with malignancy or sepsis [22]
3- Through induction of bacteremia by introducing intra-peritoneal bacteria into the blood, which was confirmed by huge Danish study and other lesser study were both have found conversions of negative pre-operative blood cultures to positive peri-and post-operative appendectomies

Regarding the need for analgesia, every surgeon or health care personnel can judge that the need for analgesia would be more for OA than LA , and this issue can be seen clearly in this study, as shown in table 7 and 8 [22]

Table 7. shows the need for analgesia according to the type of appendectomy

	Open Appendicectomy Group A (n=30)	Laparoscopic Appendicectomy Group B (n=30)	P-Value
Age Distribution (Years) Mean ± SD	25.8 ± 3.5	26.5 ± 4.2	P=0.485*
Sex Distribution			
Male	20	18	0.75
Female	10	12	0.67
Duration of Surgery (minutes) Mean ± SD	39.6 ± 5.6	51.8 ± 7.8	0.0001
Initiation of post op liquid intake (hours) Mean ± SD	10.4±2.3	6.6±1.3	0.001*
Initiation of post op solid intake (hours) Mean ± SD	15.4±1.8	8.8±1.9	0.02*
Intravenous analgesics (no. of doses) Mean ± SD	2.8±1.2	1.5±0.4	0.0001
Oral analgesics (no. of doses) Mean ± SD	5.9±1.3	2.7±0.7	0.0001
Antibiotics	6 post operative doses	2 post operative doses	
Hospital Stay (days) Mean ± SD	4.1±0.8	1.5±0.06	0.001

Table 8. also shows the needs for analgesia differences between LA and OA

Days	Time	Open Appendectomy (Group A) n=30	Laparoscopic Appendectomy (Group B) n=30	P-Values
		Pain Score(VAS) Mean ± SD (Range)	Pain Score(VAS) Mean ± SD (Range)	
Day 0	0900 hrs	-	-	-
	1300 hrs	-	-	-
	1800 hrs	7.5±2.4 (6-9)	5.6±2.1 (5-8)	0.0018
Day 1	0900 hrs	6.4±1.3 7-May	4.5±1.8 (4-6)	0.0001
	1300 hrs	5.8±0.8 (4-6)	3.2±0.6 (2-5)	0.0001
	1800 hrs	4.8±0.6 (4-5)	3.1±0.4 (3-4)	0.0001
Day 2	0900 hrs	4.6±0.8 (4-5)	1.5±0.6 (1-2)	0.0001
	1300 hrs	4.0±0.9 (3-5)	0.8±0.2 (0-1)	0.0001
	1800 hrs	2.3±0.5 (2-3)	0.24±0.03 (0-1)	0.0001

Regarding the role of antibiotics, in our practice we give some patients pre-operative dose of cefazolin 1 g Q8H and flagyl 500mg Q12H for simple

appendicitis and ciprofloxacin 400mg Q12H and flagyl 500mg Q12H followed by other doses for perforated and gangrenous appendicitis for both open and laparoscopic appendectomies this practice has showed great reduction in the post-operative wound infection and intra-abdominal abscesses formation for those whom given antibiotics.

Researchers at Bispebjerg Hospital in Copenhagen analyzed 45 controlled clinical trials in which antibiotics to fight wound infections following appendectomies were compared with placebo. Sixteen of the trials also included data on the development of an intra-abdominal abscess, or an infected pocket of pus formed by a ruptured appendix. In all, 9,576 patients were included in the analyses.

Another study found a total of 763 patients who underwent appendectomy for non-perforated appendicitis during the study period were identified. Five hundred seven of these patients had appropriate follow-up data and were the subjects of this study. Comparing patients who did and did not receive postoperative antibiotics, no significant differences in the rates, as shown in table 9.[23]

Table 9 shows the effect of using antibiotics in LA and OA

Type of complication	Antibiotics	No-Antibiotics	P value
All SSIs	10%	9%	0.64
Superficial SSIs	9.3%	5.4%	0.13
Deep SSIs	0.3%	0.5%	1.0
Organ space SSIs	2.8%	2.7%	0.87
UTI	0.6%	0.5%	1.0
Diarrhoea	2.5%	1.1%	0.34

SSIs (Surgical Site Infection)

Both studies were concerning non-perforated non-gangrenous appendicitis, but for complicated appendicitis there is different story and different options, which is obvious in this study:

Post-operative, parenteral antibiotic therapy should be given for 3 to 14 days in patients with perforated or gangrenous appendicitis. Hoelzer et al prospectively assessed the safety of 3 criteria for discontinuing antibiotics: eating, being afebrile (<38°C) for 24 hours and having normal WBC count with <3% band forms. Thirty-three consecutive patients, mean age 8.7 years (range 2–17 years), were enrolled in this study in Wilmington, Delaware; 32 met criteria for discontinuing antibiotic therapy, in 3 cases after requiring a second surgical. [24]

Regarding the role of technique for appendectomy practically means we are creating great media for intra-peritoneal infection and abscess formation by leaving infected, necrotic or even inflamed charred or ligated meso-appendix intra-peritoneal. And on the other hand even with irrigating and washing out the peritoneum still some clots left in there which will be another risk for flourishing of infectious agents, spreading the contamination.

Other most critical point is using Blake or JP drains with calibre ranging from 7mm-10mm which is practically not enough to clear necrotic tissues or even small clots. With flushing them sometimes with normal saline makes the situation worse by further dispersing the infected materials.

It is unbeatable that 5mm and 10mm ports leave less disfiguring scars and lesser chance of wound infection than midline and McBurney's incisions. But still the importance of having scars is mainly related to the life style of some communities.

Discussion

After careful judging and weighing the advantages and disadvantages of

Laparoscopic appendectomy, it seems clearly that:

a-Short hospital stay after LA will be paid by expenses of laparoscopic modality use and by occurrence of any complications during the course of treatment which are devastating.

b-In comparison between the complications of LA vs OA, we found laparoscopic complication is more serious and crippling than open appendectomy.

c-Proper and timely use of antibiotics can vastly minimize laparoscopic and open appendectomy post-operative infections to the same level.

d-By modifying the laparoscopic technique, through using larger drains, removing meso-appendix and performing meticulous hemostasis, we can reduce intra-abdominal abscesses formation.

e-Regarding cosmetic issue, it is less important for many communities, especially if we put in mind it is cost.

f-Laparoscopic appendectomy is unfit, but even serious for patients with malignancies and those with immune suppression as itself tremendously compromise the immunity.

g-Although painkillers use can be avoided to high extent through using laparoscopic technique, but we should weigh it with its adverse effect on immune system. Basically because it is unwise to concentrate on benefits of reducing analgesia, while we put patients with malignancies at risk of dissemination.

h-The Advantage of diagnostic benefit of laparoscopic modality in young fertile female with query appendicitis is restricted by many other contraindications, and can be replaced by many other non-invasive techniques e.g.: CT, US, MRI

Conclusion

By careful reviewing of all above parameters we can reach important decision regarding the ideal approach for operating on acute appendicitis, such decision gives the superiority for the OA over LA in treating acute appendicitis.

LA can be used only for personal interest after weighing and judging its cost and complications. Also in those clinical settings where surgical expertise and equipment are available and affordable, diagnostic laparoscopy seems to have various advantages over OA. Some of the clinical effects of LA, however, are small and of limited clinical relevance. In spite of the moderate quality of the available research data, we would generally recommend to limit the use laparoscopy and LA to patients with suspected appendicitis who are young female, obese, and employed patients seem to benefit from LA.

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