Egyptian Journal of Surgery Vol. 28, No. 4, October, 2009

ORIGINAL ARTICLE

LAPAROSCOPIC VERSUS OPEN SURGERY FOR CLINICALLY DIAGNOSED APPENDICITIS, EXPERIENCE OF A SINGLE ACADEMIC INSTITUTION IN WESTERN REGION, SAUDI ARABIA

By
Zuhoor Al Gaithy
Department of Surgery, King Abdulaziz University Hospital, Jeddah, Saudi Arabia

Email: zkngaithy@hotmail.com

Abstract

Aim: The role of laparoscopic appendectomy in surgical training is unclear. Although laparoscopic appendectomy as a therapeutic modality is potentially superior to open surgery, it has failed to become established as standard in training hospitals. The aim of This study to know approach to patients with suspected appendicitis in teaching institution at western region of Saudi Arabia, and to compare outcome of open versus laparoscopic appendectomy.

Methods: A retrospective study of 566 appendectomies performed at King Abdulaziz hospital over three years (January 2006-December 2008) was undertaken. Demographic, clinical, laboratory data were collected.

Results: During study period out of 566 patients; 441 (77.9%) patients underwent open appendectomy, 115 (20.3%) patients underwent laparoscopic appendectomy, and 10 (1.8%) patients converted to open with difference between them ($p<0.000$). Operative finding in open and laparoscopic appendectomy was mostly inflamed appendix (77.2%, 80.9%). In laparoscopic appendectomy, operative time was longer ($p<0.000$), while hospital stay was shorter ($p<0.000$) versus open appendectomy. Postoperative complications (wound infection, traumatic injury, intra-abdominal abscess) were not significantly differ between both groups, meanwhile, incisional hernia was only found in laparoscopic patients with difference ($p<0.05$).

Conclusions: laparoscopic appendectomy was under utilized as a teaching procedure. Time-to-train should not preclude institutions from adopting laparoscopic appendectomy.

Keywords: Open appendicectomy, Laparoscopic appendicectomy, Wound infection, Intra-abdominal abscess.

INTRODUCTION

Acute appendicitis is an extremely common surgical presentation and will affect 7% of the population during their life time.[1,2] For almost a century, open appendectomy (OA), as described by McBurney in 1894[3] was the gold standard treatment for appendicitis. Laparoscopic techniques have been applied to a variety

of abdominal procedures that were performed traditionally via an open technique. Laparoscopic appendectomies (LA) have been described for the first time by Semm in 1983.[4] Since its introduction, the role of laparoscopy for appendicitis has been controversial. Several retrospective and prospective studies have shown advantages for LA when compared with OA[5-7] meanwhile, others could not demonstrate superiority of the laparoscopic approach.[8,10,11] These studies reported minimal morbidity and a shortened recovery, and questioned the advantages of laparoscopic appendectomy because recovery time from open appendectomy is short meanwhile operative time is long in laparoscopic procedure due to the learning carve specially at teaching institution which is differing from a general surgical medical centers.

The aim of this retrospective study was to determine the institutional practice at King Abdulaziz university medical center, to evaluate the outcome of open verses laparoscopic appendectomies, and also to compare the approach and results with recent international stander practice in order to put recommendations out of this study.

PATIENTS AND METHODS

Retrospective analysis of 566 patients' records, aged (mean ± SD, 32.70 ± 10.10 years) who underwent appendectomy in Department of Surgery at King Abdulaziz University Hospital, Jeddah, Saudi Arabia from January 2006 up to December 2008 was studied.

Diagnosis of appendicitis was established using clinical features, laboratory and radiological results. Demographic and clinical data included age, sex, nationality, presenting symptoms and signs at time of admission, complete blood picture, operative procedure (laparoscopic or open) and conversion rate to open appendectomy, intra-operative findings, operative time, complications, hospital stay and mortality were collected from patients records and analyzed.

All patients received intravenous on induction of general anesthesia. LA was performed by a senior surgeon and his surgical trainees' surgeon, while OA was performed by surgical trainees with general surgical experience of not less than three years. Both LA and OA were done under general anaesthesia and all patients received preoperative intravenous antibiotics prophylactic (ceferoxame 1 g), and metronidazole (500 mg).

LA was performed using a 10-mm trocar at the umbilicus as a camera port, a 10-mm trocar in the right flank about the level of the umbilicus and a 5-mm trocar just above the pubic symphysis. The mesoappendix was dissected using ultrasonic dissector and the appendix stump was ligated using either an endoloop or intracorporeal knot. The position of the two working ports was slightly varied as per the operative findings after visualizations through the camera port. The appendix was extracted either within the right flank trocar or by use of a bag, when required. After removal of the ports, the fascia was sutured at the umbilicus to close the 10 mm trocar site. OA was performed as previously described [12] through a muscle-splitting incision in the right iliac fossa. The mesoappendix and appendix stump was ligated with Vicryl ligatures. The appendix stump was not routinely buried. This followed by primary closure of the abdominal wound. Both groups of patients underwent thorough peritoneal lavage using large volumes of warmed saline (1-1.5 liters). In both LA and OA techniques, the distal ileal loops were traced for about 15–20 cm. All visible interloop adhesions and exudates were cleared. Intraperitoneal drains were not used for both LA and OA in view of the good peritoneal lavage used in all cases and unreliability of such drains. After surgery, all patients received antibiotics either for a minimum period of five days or for at least 48 hours after the patient remained afebrile, whichever was longer. The antibiotics were initially given intravenously and changed to oral route when oral feeds were commenced. Oral feeding was resumed when bowel movements started. Analgesics with intramuscular pethidine and an oral pain-killer were provided on demand. The patients were followed up at least once after discharge.

Statistical analysis: Statistical Science for Social Package (SPSS Inc, USA) software computer program version 12 was used for data analysis. Data were presented as mean ± SD or number and percentage as appropriate. For comparison of two groups the nonparametric test for independent variables was used. Chi-square test was used to compare frequency of qualitative variables among different groups. For all tests a probability (p value) less than 0.05 was considered significant.

RESULTS

Table 1 showed the demographic characteristics of all appendectomy patients. The number of male were higher than females (57.1% versus 42.9%, $p<0.001$), Saudi were more than non-Saudi (35.7% versus 44.3%, $p<0.01$). The open procedure was done on 441 (77.9%) patients, while the laparoscopic procedure on 115 (20.3%) patients, meanwhile ten (1.8%) of the laparoscopic procedures was converted to open with a significant difference between groups ($p<0.000$). Selection of laparoscopy or open surgery was decided differently according to the treating surgeon at the time of patient admission to the hospital.

Table 1. Demographic characteristics of all appendectomy patients.

Parameters	Patients (n=566)	Significance
Age (years)		
Mean±SD	32.70±10.10	-
Range	(6.00-61.00)	
Gender (n, %)		p<0.001*
Male	323 (57.1%)	
Female	243 (42.9%)	
Nationality (n, %)		p<0.01*
Saudi	315 (55.7%)	
Non-Saudi	251 (44.3%)	
Type of operation (n, %)		p<0.000*
Opened	441 (77.9%)	
Laparoscopy	115 (20.3%)	
Laparoscopy converted to open	10 (1.8%)	

* Significant between groups were made using non parametric Chi-Square test.

Table 2. Demographic characteristics of open and laparoscopic appendectomy patients.

Parameters	Open (n=451)	Laparoscopic (n=115)	Significance
Age (years)			
Mean±SD	23.06±9.85	26.22±10.68	p>0.05
Range	(6.00-61.00)	(8.00-56.00)	
Gender (n, %)			p<0.001*
Male	278 (61.6%)	45 (39.1%)	
Female	173 (38.4%)	70 (60.9%)	
Nationality (n, %)			p<0.01*
Saudi	244 (54.1%)	71 (55.7%)	
Non-Saudi	207 (45.9%)	44 (38.3%)	

* Significant between groups (age) were made using student "t" test.
* Significant between groups (gender, nationality) were made using non parametric Chi-Square test.

Table 3. Clinical and laboratory finding of the patients.

Significance	Open (n=451)	Laparoscopic (n=115)	Parameters
Type of pain (n, %)			p<0.05*
Localized	358 (79.4%)	102 (88.7%)	
Generalized	93 (20.6%)	13 (11.3%)	
Pain duration (n, %)			p<0.000*
<12 hours	30 (6.7%)	20 (17.4%)	
12 hours	14 (3.1%)	7 (6.1%)	
>12hours	407(90.2%)	88 (76.5%)	
Fever (n, %)	229 (50.8%)	31 (27.0%)	p<0.000*
Anorexia (n, %)	324 (71.8%)	75 (65.2%)	p>0.05
Nausea (n, %)	240 (53.2%)	30 (26.1%)	p<0.000*
Vomiting (n, %)	347 (76.9%)	65 (56.5%)	p<0.000*
Diarrhea (n, %)	24 (5.3%)	4 (3.5%)	p>0.05
Dysuria (n, %)	13 (2.9%)	3 (3.6%)	p>0.05
White blood cells (K/UL)			
Mean±SD Range	13.32±5.13 (2.20-35.70)	12.03±4.95 (3.30-24.00)	p<0.05*
Neutrophils (K/UL)			
Mean±SD Range	10.33±4.97 (0.20-30.93)	8.95±5.50 (0.80-21.60)	p>0.05

* Significant between groups were made using non parametric Chi-Square test.

In opened procedure, males were more than females (61.6% versus 38.4%), while in laparoscopic group females were more than males (60.9% versus 39.1%) with significance difference between group (p<0.001). In open, and laparoscopic groups, Saudi were more than non-Saudi (54.1% and 55.7% versus 45.1% and 38.3%) with a significance difference between group (p<0.01) Table 2.

In open and laparoscopic groups, localized pain was more than generalized with a significance difference between group (p<0.05). Most of pain was more than 12 hours duration in both groups. Abdominal pain, vomiting, anorexia were the most presenting symptoms in both groups. The number of patients suffer from fever, nausea, vomiting were higher in open (50.8%, 53.2%, 76.9%) than laparoscopic procedure (27.0%, 26.1%, 56.5%) with significant difference between them (p<0.000 for all). Meanwhile, there were no significant differences in percentage of patients suffering from anorexia, diarrhea and dysuria between both groups of patients. The number of WBCs was higher in open than laparoscopic group (p<0.05) Table 3.

The operative findings, in open procedure mostly inflamed appendix, followed by perforated, normal and then gangrenous (77.2%, 14.4%, 4.9%, 3.5%) while in laparoscopy procedure, appendix was mostly inflamed, normal, perforated and lastly gangrenous (80.9%, 13.0%, 4.3%, 1.7%) with significant difference between groups (p<0.000). The pathology report of the operated normal appendix was no pathological diagnosis Table 4.

In open appendectomy, the operative complications were mostly wound infections, intra-abdominal abscess, traumatic injury (2.4%, 2.2%, 0.2%), meanwhile in laparoscopic appendectomy the complications were mostly intra-abdominal abscess, incisional hernia, wound infection, traumatic injury (3.5%, 2.6%, 1.7%, 0.9%). There were no significant difference in the incidence of complications between two groups except for incisional hernia that was higher in laparoscopy than open appendectomy (p<0.05). The operative time in both groups was mostly >1hour with significant increase in the operation time in laparoscopic group (p<0.000). The hospital stay was mostly, in open procedure >2 days (65.9%) and in laparoscopic group 2 days (45.2%) with significance difference between two groups (p<0.000). One (0.8%) patient on the laparoscopic appendectomy group died, the death was unrelated cause to the procedure Table 5.

Table 4. Operative findings.

Laparoscopic (n=115)	Open (n=451)	Parameters	Significance
15 (13.0%)	22 (4.9%)	Normal (n, %)	P<0.000*
93 (80.9%)	348 (77.2%)	Inflamed (n, %)	
5 (4.3%)	65 (14.4%)	Perforated (n, %)	
2 (1.7%)	16 (3.5%)	Gangrenous (n, %)	

* Significant between groups were made using non-parametric Chi-Square test.

Table 5. Comparison of complications, mortality, operative time and hospital stay of open and laparoscopy appendectomy.

Parameters	Open (n=451)	Laparoscopic (n=115)	Significance
Complication (n, %)	18 (3.4%)	7 (6.1%)	p>0.05
Wound infection	11 (2.4%)	2 (1.7%)	p>0.05
Traumatic injury	1 (0.2%)	1 (0.9%)	p>0.05
Intra-abdominal abscess	10 (2.2%)	4 (3.5%)	p>0.05
Incisional hernia	-	3 (2.6%)	p<0.01*
Operation time (n, %)			p<0.000*
< 1 hour	146 (32.4%)	24 (20.5%)	
1 hour	91 (20.2%)	13 (11.3%)	
> 1 hour	214 (47.5%)	78 (67.8%)	
Hospital stay (n, %)			p<0.000*
1 day	35 (7.8%)	22 (19.1%)	
2 days	119 (26.4%)	52 (45.3%)	
> 2 days	297 (65.9%)	41(35.7%)	
Mortality (n, %)	-	1 (0.9%)	p>0.05

* Significant between groups were made using non parametric Chi-Square test.

DISCUSSION

Appendectomies can be performed by open or laparoscopic technique, and it is unknown which procedure is superior. In this study, we report trends in the surgical treatment of appendicitis in King Abdulaziz University Hospital, Jeddah, Saudi Arabia and show associated complications. Most of our patients were underwent open appendectomy 77.9% while, only 20.3% underwent laparoscopy. The conversion rate was low 1.8%. Although more than a century has elapsed since McBurney first performed OA,[13] this procedure remains the treatment of choice for acute appendicitis for most surgeons as a result of its therapeutic efficacy and the associated low morbidity and mortality.[14] In this respect, Sporn et al., 2009[15] reported that marked increased in the usage of LA in USA during the study period (2000-2005). This trend was seen in both uncomplicated and complicated appendicitis. In addition, the conversion rate from LA to OA dropped, especially in patients with complicated appendicitis. This trend can be explained by the fact that surgeons are becoming more skilled in laparoscopic appendectomy and possibly more experienced in selecting patients for LA. But this has not resulted in a decreasing cost in LA relative to OA.

The reported lifetime risk of developing appendicitis approximates 7% with an increased tendency in men.[1,2] Our results also showed that the incidence of appendectomy is more in male than women. Acute appendicitis classically presents with initial periumbilical pain subsequently localizing to the right iliac fossa (RIF). As expected, our results have shown that most of the patients presented with localized pain.

Overall, the incidence of post operative morbidity did not statistically differ between LA and OA in this study. Our results also revealed that wound infection rate was higher while intra-abdominal abscess rate was lower in OA compared to LA but the difference did not reach significant level. Furthermore, incisional hernia was reported only in patients underwent LA. Most retrospective chart reviews, randomized controlled trials, and meta-analyses report similar occurrence in overall postoperative morbidity for LA and OA[16,5,17,18,6,19,20-26] whereas only a few investigations found statistically significant differences.[27,7,28,15] Some investigations found significantly higher postoperative wound infections after OA[29-33] whereas others reported similar rate.[27,16,34,18,35,36,37] In a meta-analysis, Golub and colleagues 1998[38] found a wound infection rate for LA was less than half the rate in patients undergoing OA. The reduction in the number of wound infections is possibly due to the small size of the individual port-site wounds compared with the longer wounds in OA. The multiple layers in the abdomen which are opened up in OA allow infected material to collect, thus promoting wounds infection. In LA, the appendix is taken out via a bag or through the laparoscopic cannula, in contrast to open delivery through the wound in OA. The suction and irrigation of the intraperitoneal collections are done via a suction device passed through the laparoscopic port in LA, whereas such maneuvers easily contaminate the wound of OA despite protection with.[39,37] One of the main controversies when comparing OA versus LA is the rate of intra-abdominal abscess formation. Golub and colleagues 1998[38] reported an increase in the rate of intraabdominal abscesses after LA, which failed, however, to reach statistical significance. Other metaanalysis confirm these findings.[25,40] The reason for the increase in the incidence of intraperitoneal abscesses following LA is perplexing as laparoscopy provides better access to all parts of the peritoneal cavity, enabling easier detection, effective drainage and irrigation of localized collections during appendicectomy.[38,39,37]

In this study, the operative time was longer and postoperative stay was shorter in laparoscopic than opened appendectomy. Several previous studies have confirmed that the operating times are similar[27,41,29,42] whereas others have found that LA takes a longer time to perform.[43,16] The main advantage of LA is more rapid recovery with reduced hospital stay. Sauerland and associates 1998[25] summarized the results of 28 randomized controlled trials and almost 3000 patients and reported a significant decrease in length of hospital stay in patients undergoing LA. Similar results were found by several investigators[27,41,44,16] whereas another meta-analysis study failed to show a statistically significant difference in length of hospital stay between LA and OA.[40] The heterogeneity of published results regarding length of hospital stay may be caused by a variety of factors as hospital factors[45,46] or social habits[47] rather than reflecting differences resulting from the operative technique itself.

In most of randomized clinical trials and chart reviews comparing LA versus OA, no mortality was reported in either group.[27,5,8,7,22] This is to be expected because appendicitis is a disease that disproportional strikes young, healthy people, and appendectomy is a low-risk surgical procedure. In the present investigation the overall mortality rate was 0.9 %. The reported mortality rate is large studies from Sweden was 0.24%[48] and Scotland was 0.16%.[49] In Univariate analysis Guller et al. (2004)[26] found a significantly lower percentage of death in patients undergoing LA as compared with OA patients.

In summary, LA has the advantage of providing better access and good visualization of the peritoneal cavity with relatively smaller incisions compared to open appendicectomy. Logically, LA should be beneficial in the management of complicated appendicitis which is often associated with inflammatory masses, omental adhesions and intraperitoneal abscesses. Laparoscopy also helps to correct preoperative diagnosis in clinically-doubtful cases of appendicitis.[38,37] The main advantages of laparoscopy include a decrease in wound infections, a reduction in postoperative pain, and a decrease in

hospital stay as well as earlier return to normal activities.[50,13] However, despite these advantages, the place of laparoscopy in appendicitis still remains a matter of debate.[40,37] This issue has also been complicated by some reports that LA may be associated with a higher risk of postoperative intraperitoneal abscess[37,38] and an increase in both the mean operating time and operating costs.[51,13]

At teaching and academic institutions, the LA was resisted because of learning carve. For this reason, the adaptation of laparoscopic approach for treating acute appendicitis is also resisted in our institution, as shown in this study only (20.3%) of appendectomies were done by laparoscopy, due to the felling of unaccepted prolonged operative time, and unclear advantage over the stander treatment of this commonly encountered surgical procedure which done mainly by the surgical registrar and the surgical trainees. On the other hand, others have shown that registrars can be trained in laparoscopic appendicectomy with equally good results as experienced surgeons, and suggested that appendicectomy can be done independently by registrars if they have gained laparoscopic training.[52]

In conclusions our findings demonstrate that laparoscopic appendectomy was under utilized as a teaching procedure. Its benefits are twofold, not only diagnostic but also therapeutic. It has been demonstrated to be comparable to open surgical interventions in terms of complications. Though the operating time was a little longer for LA than OA, both wound infection incidence and postoperative hospital stay were less for LA. There was no evidence of any increase in the intraperitoneal infective complications following LA, as suggested in some of the previous reports. Time-to-train should not preclude institutions from adopting laparoscopic appendectomy, especially in doubtful diagnosis, obese, and female patients.

REFERENCES

1. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and appendectomy in the United States. Am J Epidemiol. 1990;132:910-25.

2. Andersson R, Hugander A, Thulin A, Nyström PO, Olaison G. Indications for operation in suspected appendicitis and incidence of perforation. BMJ. 1994;308:107-10.

3. McBurney C. The incision made in the abdominal wall in cases of appendicitis, with a description of a new method of operating. Ann Surg. 1894;20:38-33.

4. Semm K. Endoscopic appendectomy. Endoscopy. 1983;15:59-64.

5. Cox MR, McCall JL, Toouli J, Padbury RT, Wilson TG, Wattchow DA, et al. Prospective randomized comparison of open versus laparoscopic appendectomy in men. World J Surg. 1996;20:263-6.

6. Bonanni F, Reed J 3rd, Hartzell G, Trostle D, Boorse R, Gittleman M, et al. Laparoscopic versus convention appendectomy. J Am Coll Surg. 1994;179:273-8.

7. Frazee RC, Roberts JW, Symmonds RE, Snyder SK, Hendricks JC, Smith RW, et al. A prospective randomized trial comparing open versus laparoscopic appendectomy. Ann Surg. 1994;219:725-31.

8. Richards KF, Fisher KS, Flores JH. Laparoscopic appendectomy: comparison with open appendectomy in 720 patients. Surg Laparosc Endosc. 1996;6:205-9.

9. Apelgren KN, Molnar RG, Kisala JM. Laparoscopic is not better than open appendectomy. Am Surg. 1995;61:240-3.

10. Hart R, Rajgopal C, Plewes A, Sweeney J, Davies W, Gray D et al. Laparoscopic versus open appendectomy: a prospective randomized trial of 81patients. Can J Surg. 1996;39:457-62.

11. Williams MD, Collins JN, Wright TF, Fenoglio ME. Laparoscopic versus open appendectomy. South Med J. 1996;89:668-74.

12. Cox MR, McCall JL, Wilson TG, Padbury RT, Jeans PL, Toouli J. Laparoscopic appendicectomy: a prospective analysis. Aust N Z J Surg. 1993;63:840-7.

13. Sauerland S, Lefering R, Neugebauer EAM. Laparoscopic versus open surgery for suspected appendicitis (Review). The Cochrane Collaboration. 2006;3.

14. Kehagias I, Karamanakos SN, Panagiotopoulos S, Panagopoulos K, Kalfarentzos F. Laparoscopic versus open appendectomy: Which way to go? World J Gastroenterology.2008;14:4909-14.

15. Sporn E, Petroski GF, Mancini GJ, Astudillo JA, Miedema BW, Thaler K. Laparoscopic Appendectomy—Is it Worth the Cost? Trend Analysis in the US from 2000 to 2005. J Am Coll Surg. 2009;208:179-85.e2.

16. Vallina VL, Velasco JM, McCulloch CS. Laparoscopic versus conventional appendicectomy. Ann Surg. 1993;218:685-92.

17. Heinzelmann M, Simmen HP, Cummins AS, Largiadèr F. Is laparoscopic appendectomy the new 'gold standard'? Arch Surg. 1995;130:782-5.

18. Martin LC, Puente I, Sosa JL, Bassin A, Breslaw R, McKenney MG et al. Open versus laparoscopic appendectomy. A prospective randomized comparison. Ann Surg. 1995;222:256-62.

19. Lejus C, Delile L, Plattner V, Baron M, Guillou S, Héloury Y, et al. Randomized, single-blinded trial of laparoscopic versus open appendectomy in children: effects on postoperative analgesia. Anesthesiology. 1996;84:801-6.

20. Moberg AC, Montgomery A. Appendicitis: laparoscopic versus conventional operation: a study and review of the literature. Surg Laparosc Endosc. 1997;7:459-463.

21. Macarulla E, Vallet J, Abad JM, Hussein H, Fernández E, Nieto B. Laparoscopic versus open appendectomy: a prospective randomized trial. Surg Laparosc Endosc. 1997;7:335-9.

22. Tate JJT, Chung SCS, Li AKC. Laparoscopic appendicectomy: a two-handed technique. Br J Surg. 1993;80:764.

23. Nazzal M, Ali MA, Turfah F, Kaidi A, Saba A, Pleatman M, et al. Laparoscopic appendectomy: a viable alternative approach. J Laparoendosc Adv Surg Tech A. 1997;7:1-6.

24. Fallahzadeh H. Should a laparoscopic appendectomy be done? Am Surg. 1998;64:231-3.

25. Sauerland S, Lefering R, Holthausen U, Neugebauer EA. Laparoscopic vs conventional appendectomy–a meta-analysis of randomised controlled trials. Langenbecks Arch Surg. 1998;383:289-95.

26. Guller U, Hervey S, Purves H, Muhlbaier LH, Peterson ED, Eubanks S, et al. Laparoscopic versus open appendectomy: outcomes comparison based on a large administrative database. Ann Surg. 2004;239:43-52.

27. Attwood SEA, Hill ADK, Murpshy PG, Thornton J, Stephens RB. A prospective randomised trial of laparoscopic versus open appendicectomy. Surgery. 1992;112:497-501.

28. Ozmen MM, Zulfikaroglu B, Tanik A, Kale IT. Laparoscopic versus open appendectomy: prospective randomized trial. Surg Laparosc Endosc Percutan Tech. 1999;9:187-9.

29. Kum CK, Ngoi SS, Goh PMY, Tekant Y, Isaac JR. Randomized controlled trial comparing laparoscopic and open appendicectomy. Br J Surg. 1993;80:1599-600.

30. 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;169:208-13.

31. 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.

32. Kazemier G, de Zeeuw GR, Lange JF, Hop WC, Bonjer HJ. Laparoscopic vs open appendectomy. A randomized clinical trial. Surg Endosc. 1997;11:336-40.

33. Merhoff AM, Merhoff GC, Franklin ME. Laparoscopic versus open appendectomy. Am J Surg. 2000;179:375-8.

34. Hebebrand D, Troidl H, Spangenberger W, Neugebauer E, Schwalm T, Günther MW. Laparoscopic or classical appendectomy? A prospective randomized study. Chirurg. 1994;65:112-20.

35. Henle KP, Beller S, Rechner J, Zerz A, Szinicz G, Klingler A. Laparoscopic versus conventional appendectomy: a prospective randomized study. Chirurg. 1996;67:526-32.

36. Mutter D, Vix M, Bui A, Evrard S, Tassetti V, Breton JF, Marescaux J. Laparoscopy not recommended for routine appendectomy in men: results of a prospective randomized study. Surgery. 1996;120:71-4.

37. Aziz O, Athanasiou T, Tekkis PP Purkayastha S, Haddow J, Malinovski V et al. Laparoscopic versus open appendectomy in children: a metaanalysis. Ann Surg. 2006;243:17-27.

38. Golub R, Siddiqui F, Pohl D. Laparoscopic versus open appendectomy: metaanalysis. J Am Coll Surg. 1998;186:545-553.

39. Meguerditchian AN, Prasil P, Cloutier R, Leclerc S, Péloquin J, Roy G. Laparoscopic appendectomy in children: A favorable alternative in simple and complicated appendicitis. J Pediatric Surg. 2002;37:695-8.

40. Garbutt JM, Soper NJ, Shannon WD. Meta-analysis of randomized controlled trails comparing laparoscopic and conventional appendectomy. Surg Laparosc Endosc. 1999;9:17–26.

41. McAnena OJ, Austin Q, O'Connell PR, Hederman WP, Gorey TF, Fitzpatrick J. Laparoscopic versus open appendicectomy: a prospective evaluation. Br J Surg. 1992;79:818-20.

42. Schirmer BD, Schmieg RE, Edge SB, Edge SB, Hanks JB. Laparoscopic versus traditional appendicectomy for suspected acute appendicitis. Am J Surg. 1993;165:670-5.

43. Tate JJT, Chung SCS, Dawson J, Leong HT, Chan A, Lau WY, et al. Conventional versus laparoscopic surgery for acute appendicitis. Br J Surg. 1993;80:761-4.

44. Tate JJ, Dawson JW, Chung SC, Lau WY, Li AK. Laparoscopic versus open appendicectomy: prospective randomised trial. Lancet. 1993;342:633-7.

45. Ramesh S, Galland RB. Early discharge from hospital after open appendicectomy. Br J Surg. 1993;80:1192–3.

46. Lord RV, Sloane DR. Early discharge after open appendicectomy. Aust N Z J Surg. 1996;66:361–5.

47. Millat B, Fingerhut A, Gignoux M, Hay JM. Factors associated with early discharge after inguinal hernia repair in 500 consecutive unselected patients. French Associations for Surgical Research. Br J Surg. 1993;80:1158–60.

48. Blomqvist PG, Andersson RE, Granath F, Lambe MP, Ekbom AR. Mortality after appendectomy in Sweden, 1987–1996. Ann Surg. 2001;233:455-60.

49. Bisset AF. Appendicectomy in Scotland: a 20-year epidemiological comparison. J Public Health Med. 1997;19:213–18.

50. Nguyen NT, Zainabadi K, Mavandadi BA. Trends in the utilization and outcomes of laparoscopic verses open appendectomy. Am J Surg. 2004;188:813-20.

51. Eypasch E, Sauerland S, Lefering R, Neugebauer EA. Laparoscopic versus open appendicectomy: between evidence and common sense. Dig Surg. 2002;19:518-22.

52. Tata MD, Singh R, Bakar AA, Selvindoss P, Kandasami P, Gurunathan R. Laparoscopic Appendicectomy: The Ideal Procedure for Laparoscopic Skill Training for Surgical Registrars. Asian J Surg. 2008;31:55-8.