Original Research Article

PROSPECTIVE STUDY OF SURGICAL SITE INFECTION IN LAPAROSCOPIC APPENDECTOMY VS LAPAROSCOPIC CONVERTED INTO OPEN VS OPEN APPENDECTOMY

Rahul Kumar Giri[1], A.N Mhaske[2*], Subhash V Gadre [3]

[1] Resident, Department of General Surgery, Peoples College of Medical Sciences and Research Centre, Madhya Pradesh, India

[2] Professor, Department of General Surgery, Peoples College of Medical Sciences and Research Centre, Madhya Pradesh, India

[3] Assistant Professor, Department of General Surgery, Peoples College of Medical Sciences and Research Centre, Madhya Pradesh, India

Received: 14-10-2021 / Revised:25-11-2021 / Accepted: 08-12-2021

Abstract

Background: Previous literature comparing the results of open appendectomy with laparoscopic appendectomy have yielded conflicting results. The present study aimed to determine the surgical site infection in patients undergoing laparoscopic appendectomy, open appendectomy and laparoscopic converted into open appendectomy and to assess the factors associated with surgical site infections among such patients. **Methodology**: The study was conducted as an observational study on patients who underwent appendectomy for acute appendicitis at tertiary care center during 18 months period. All the surgeries were performed by single senior experienced surgeon. Decision regarding type of surgery performed was decided by operating surgeon based upon condition of patient. Patients were assessed for presence of SSI and their risk factors. **Results**: A total of 88 patients were enrolled, of them 44 cases underwent open surgery whereas 27 cases underwent laparoscopic and 17 cases underwent Lap converted to open. Deep surgical site infection was observed in 6.8% and 6.7% cases in open appendectomy group and laparoscopy converted to open group respectively. Maximum patients (>95%) had no surgical site infection in laparoscopic appendectomy group. The incidence of surgical site infection was observed to be higher in open appendectomy and laparoscopy converted to open group as compared to laparoscopy group but the difference was statistically insignificant ($p>0.05$) Irrespective of type of surgery, independent factors associated with risk of surgical site infection were evaluated. Among various factors CRP was most independent predictor of surgical site infections ($p<0.05$). **Conclusions**: The risk of surgical site infections was higher in laparoscopic converted to open surgery and open appendectomy as compared to laparoscopic surgeries. Surgical site infection is associated with superficial and deep infections as well as organ space infections. Irrespective of type of surgery, independent factors associated with risk of surgical site infection were evaluated. Among various factors CRP was most independent predictor of surgical site infections.

Keywords: appendectomy, surgical site infections, organ space infections, factors.

Introduction

Appendix is a hollow organ which is located at tip of caecum in right lower quadrant of abdomen. Inflammation of appendix is termed appendicitis and is one of the most commonly encountered condition in day-to-day surgical practice. The exact incidence of acute appendicitis is unknown; approximately 233 per 100000 population is estimated to be affected by acute appendicitis. Incidence in males and females is estimated as 8.6% and 6.7% respectively. The diagnosis of acute appendicitis is usually based upon typical sign and symptom i.e. pain in abdomen which is periumbilical or generalized initially and later localizes to right lower quadrant. Pain may be associated with other nonspecific symptoms such as anorexia, nausea, vomiting, fever, generalized weakness etc. However, patients may present with atypical signs and symptoms in few cases masking the clinical features of typical acute appendicitis. This leads to delay in diagnosis of acute appendicitis and development of complications such as appendicular perforation, small bowel obstruction, peritonitis, abdominal abscess, urinary retention, and peritonitis. These complications contribute to significant morbidity and mortality along with increased financial burden on the patients and their families. [1-4]

Appendectomy is one of the most common surgical proceedure performed worldwide. The rate of appendectomy has been reported as 7% for acute appendicitis during lifetime. The first appendectomy procedure was conducted by Claudius Amyand in 1736 whereas Hancock successfully drained abscess of appendix in 1848.Appendectomy can be performed via various procedure such as open appendectomy, laparoscopic appendectomy, single incision laparoscopic surgery (SILS)/single port laparoscopy (SPL) and via transvaginal route. The conventional open method is the most common method used appendectomy, but with the advent of laparoscopic surgical procedures, laparoscopic appendectomy is preferred. First laparoscopic appendectomy was performed by Semm in 1983. [5-8]

Though, open appendectomy is considered safe and effective method for management of acute appendicitis, it is associated with complications such as intestinal obstruction, ileus, and wound

*Correspondence

Dr. A.N Mhaske Professor,

Department of General Surgery, Peoples College of Medical Sciences and Research Centre, Madhya Pradesh, India.

E-mail: drmhaske4321@gmail.com

sepsis. However, laparoscopic appendectomy, being a minimally invasive surgery has been considered as an alternative option for management of patients with acute appendicitis. Laparoscopic appendectomy is associated with less post-operative pain, lower incidence of surgical site infection, early return of normal activity, significant shorter hospital stay and thus reduced hospital cost. The prevalence rate for conversion of laparoscopic appendectomy to open appendectomy are estimated to be ranging from 1 to 10%.Common reasons requiring conversion of laparoscopic appendectomy to open appendectomy include presence of adhesions or perforation of appendix.[9-11]

Previous literature comparing the results of open appendectomy with laparoscopic appendectomy have yielded conflicting results. To best of our knowledge, none of the previous studies have separately assessed the complication rates in patients whose laparoscopic appendectomy was converted to open appendectomy. With the above background, the present study was conducted at tertiary care center to determine the surgical site infection in patients undergoing laparoscopic appendectomy, open appendectomy and laparoscopic converted into open appendectomy and to assess the factors associated with surgical site infections among such patients. [12-15]

Materials and Methods

The study was conducted as an observational study on patients who underwent appendectomy for acute appendicitis at Department of Surgery, People's College of Medical Sciences and Research Centre and associated People's Hospital Bhopal during the study period of 18 months i.e. from 1st November 2019 to 30th April 2021. Patient that were diagnosed with appendicitis who underwent appendectomy and giving consent for taking part in study were included whereas **i**mmunocompromised patients and patients with incidental appendectomy in combination with another procedure were excluded.

After obtaining ethical clearance from institute's ethical committee, all the patients fulfilling inclusion criteria were enrolled and written consent was obtained. Detailed demographic data such as age, gender, socioeconomic status was obtained from all the study participants and entered in questionnaire. Detailed clinical history regarding their symptoms, its onset, duration etc. was enquired from all the study participants. History of previous surgery if any and its indication was noted. Further, all the patients were subjected to detailed general examination, local examination and systemic examination and findings were noted in questionnaire.

Preoperative workup was conducted for all the patients which included pre-anaesthetic examination, blood investigations such as CBC, RFT, RBS, HIV, HBsAg. Apart from this, Ultrasonography of abdomen, Chest Xray, abdominal Xray, ECG and CT abdomen (in selected cases).All the surgeries were performed by single senior experienced surgeon. Decision regarding type of surgery performed was decided by operating surgeon based upon condition of patient. Based upon type of surgery performed, patients were divided into three groups-

Group A- Laparoscopic Appendectomy

Group B- Laparoscopic converted to open appendectomy

Group C- Open Appendectomy

OUTCOME DIAGNOSIS OF SSI

- The standardized surveillance criteria for defining SSI as developed by the Centers for Disease Control (CDC) and Prevention of the National Nosocomial Infections Surveillance (NNIS) were used
- SSI within 30 days of surgery was categorized into:

A) Superficial SSIs Infection involving the skin and subcutaneous tissue of incision only.

- Purulent discharge, with/without laboratory confirmation.
- At least one of the following signs and symptoms: Pain, tenderness, local swelling, redness, or raised temperature

B) Deep SSIs Infection involving deep soft tissues (e.g. fascial and muscle layers) of incision.

1. Purulent drainage from the deep incision
2. Fever of more than 38 degrees celcius.
3. Localized pain.
4. An abscess or other evidence of infection involving the deep incision is found on direct examination, during re-operation or by histopathological or radiological examination.
5. Diagnosis of deep incisional SSI by a surgeon.

C) Organ SSI Involves any part of the anatomy other than the incision, occurs within 30 days postoperatively without implant, occurs within 1 year if implant is in place and infection appears to be directly related to surgical procedure, and must fulfill one of the following:

1 purulence from a drain that was placed via stab incision into the organ/space (infection of drain site is not an SSI)

1. isolated organisms from aseptically obtained fluid or tissue from the organ/space
2. abscess or other evidence of infection involving the deep incision is found during examination of incision, reoperation, or pathologic or radiologic exam

3. diagnosis of an organ/space SSI by a surgeon or attending physician.

Observation Chart

The study was conducted on a total of 88 patients with appendicitis undergoing appendectomy at study area. Out of 88 patients with appendicitis, maximum i.e. 44 (50%) patients underwent open appendectomy whereas remaining 44 (50%) patients underwent laparoscopic appendectomy. Out of 44 patients undergoing laparoscopic appendectomy, the procedure was converted to open in 15 (17%) cases.

Table 1: COMPARISON OF BASELINE VARIABLES BETWEEN THE GROUPS

Baseline variables		Laparoscopic appendectomy (=29)		Open appendectomy (n=44)		Laparoscopy converted to open (n=15)		P value
		n	%	n	%	n	%	
Age	≤20	0	0	4	9.1	1	6.7	0.09
	21-40	20	69	19	43.2	5	33.3	
	41-60	9	31	18	40.9	9	60	
	>60	0	0	3	6.8	0	0	
	Mean	34.41±0.06		40.14±12.58		37.93±11.50		
Gender	Male	23	79.3	35	79.5	11	73.3	0.87
	Female	6	20.7	9	20.5	4	26.7	
Diagnosis	Acute Appendicitis	28	96.6	26	59.1	9	60	0.001
	Appendicular Perforation	1	3.4	18	40.9	6	40	

Smoking	11	62.1	22	50	9	40	0.35
Alcohol	10	65.5	22	50	5	58	0.32

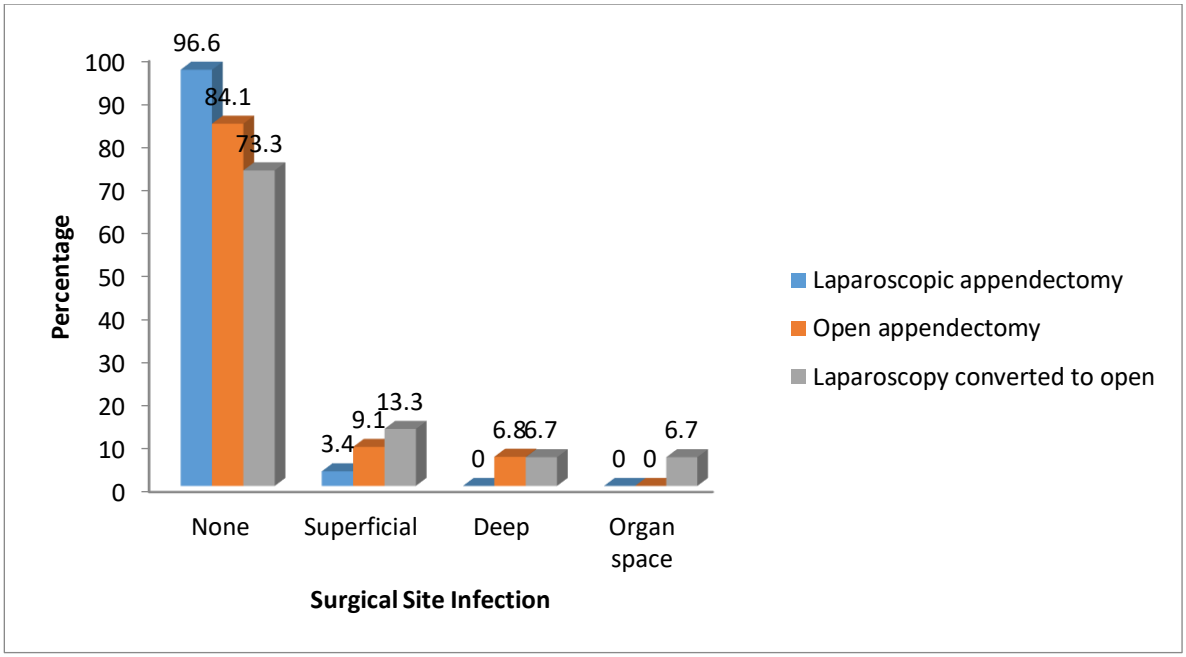

Fig. 1: Comparison of SSI between the group

Table 2: FACTORS ASSOCIATED WITH SURGICAL SITE INFECTION

Variables	Odds Ratio	95% CI	P value
Age >60	3.99	0.25-64.8	0.33
Gender (Male)	0.54	0.14-2.07	0.37
Perforation Peritonitis(Appendicular)	1.42	1.13-3.39	0.16
Smoking	2.06	0.57-7.5	0.27
Alcohol	1.53	0.86-2.76	0.30
Hemoglobin <11	0.78	0.03-1.34	0.89
TLC >11000	0.95	0.56-1.57	0.74
Platelet <1.5 Lakh/ >4 Lakh	1.12	0.66-1.86	0.43
CRP >25	2.4	1.4-3.4	**0.035**

Results

Mean age of patients who underwent Laparoscopic appendectomy, Open appendectomy and Laparoscopy converted to open appendectomy was 34.41±0.06, 40.14±12.58 and 37.93±11.50 years respectively. Majority of patients with appendicitis irrespective of the type of surgery were males (>70%). The age and gender composition among three groups was statistically insignificant (p>0.05). About 62.1% cases who underwent laparoscopic appendectomy were smokers whereas 60% cases in laparoscopy converted to open group were nonsmokers. We observed no significant difference in smoking and alcohol addiction between the groups (p>0.05). About 96.6% cases in laparoscopic appendicitis group were diagnosed as uncomplicated appendicitis whereas 40.9% and 40% cases in open appendectomy group and laparoscopy converted to open appendectomy respectively had appendicular perforation. The observed difference in diagnosis in patients undergoing different type of appendectomy was statistically significant (p<0.05).

Deep surgical site infection was observed in 6.8% and 6.7% cases in open appendectomy group and laparoscopy converted to open group respectively. However, there was only 1 case of organ space infection and superficial infection in laparoscopy converted to open group and laparoscopic appendectomy group respectively. Maximum patients (>95%) had no surgical site infection in laparoscopic appendectomy group. The incidence of surgical site infection was observed to be higher in open appendectomy and laparoscopy converted to open group as compared to laparoscopy group but the difference was statistically insignificant (p>0.05)

In present study, amongst various factors assessed, CRP was significantly associated with higher risk of surgical site infection (p<0.05).

Statistical Analysis

Data was compiled using MS Excel and analysed using IBM SPSS Software version 20. Categorical data was expressed as frequency and percentage whereas numerical data was expressed as mean and standard deviation. Chi square test was applied to compare the surgical site infection rates between three groups. Multivariate analysis was done to assess the independent risk factors associated with surgical site infections. P value less than 0.05 was considered statistically significant.

Discussion

Acute appendicitis is one of the most common condition for which patients seek care in surgical Department and thus, appendectomy is one of the most common surgical procedure performed worldwide. Open appendectomy is conventional surgery which is safe but carries the risk of complication especially the risk of surgical site infection is high. With the improvement and advancement of surgical technique, minimally invasive surgeries are preferred as this procedure has certain advantage over open procedure. The present study aimed to study of surgical site infection in laparoscopic appendectomy vs. open appendectomy vs. laparoscopic converted into open appendectomy. Though laparoscopic and open appendectomy was conducted in equal proportion of cases i.e. 44 cases each, laparoscopy was converted to open in 15 (17%) cases. [5-10]

Appendicitis may be observed in patients belonging any age and either gender. However, the incidence is reported to be highest in individuals belonging to 5 to 45 years of age. However, appendicitis is observed in higher proportions of males as compared to females with lifetime prevalence of 8.6% and 6.7% respectively in males and females. In present study, mean age of patients with appendicitis was approximately 37 years and >75% participants were males. Our study findings were similar to findings of Elhadidi et al in which mean age of patients with appendicitis was 38±11 years. Similarly, mean age of patients in a study by Nazir et al was 32±7 years and 34±7 years in the laparoscopic appendectomy and open appendectomy group respectively. Majority i.e.50.77% cases in laparoscopic group and 49.23% in open appendectomy group were males. [16-18]

We included both uncomplicated and complicated cases of appendicitis for analysis. Majority of uncomplicated cases were managed using laparoscopic appendectomy whereas about 40.9% and 40% cases were managed with open appendectomy and laparoscopic converted to appendectomy. Thus, in significantly higher proportion of complicated cases, open appendectomy was procedure of choice ($p<0.05$). Khiria et al documented that open appendectomy is the procedure of choice in complicated appendicitis especially in presence of clinical features of peritonitis and appendiceal mass. However, Quahet al documented the utility of laparoscopic appendectomy in complicated appendicitis cases and concluded that complicated appendicitis at the time of laparoscopy is not an indication for conversion to open appendectomy.[19,20]

Overall, the incidence of superficial infection was higher in laparoscopy converted to open group followed by open appendectomy group and laparoscopic appendectomy group. Deep infections and organ space infections could be observed in none of the patients undergoing laparoscopic appendectomy. Our study findings were concordant with the findings of Soltan et al, in which the authors suggested that laparoscopic technique is associated with significantly less intraoperative as well as postoperative complications as compared to open appendectomy group. Similarly, Sanwang et al also documented that open appendectomy (11.0 per 100 surgical procedures) are associated with higher incidence of SSI as compared to laparoscopic appendectomy (4.6 per 100 appendectomies) ($p=0.0002$). Our study findings were similar to findings of Deshpande et al, about 23.82% of cases following open appendectomy and none following laparoscopic appendectomy reported SSI.[7,21,22]

Amongst various factors, CRP was independently associated with high risk of surgical site infections. Similarly, These findings were supported with the findings of Giesen et al, in which body temperature >38℃, complex appendicitis as well as CRP>65. In another study by Garcell et al type of surgery, serum albumin, and timing of the surgery with respect to onset of symptoms were independently associated with the occurrence of SSI. However, Koumu et al documented type of surgery, duration of procedure and perforated appendix as significant predictors of surgical sit infections ($p<0.05$). [23-25]

Conclusion

The risk of surgical site infections was higher in laparoscopic converted to open surgery and open appendectomy as compared to laparoscopic surgeries. Surgical site infection is associated with superficial and deep infections as well as organ space infections. Irrespective of type of surgery, independent factors associated with risk of surgical site infection were evaluated. Among various factors CRP was most independent predictor of surgical site infections.

References

1. Jones MW, Lopez RA, Deppen JG. Appendicitis. [Updated 2020 Dec 7]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan-. Available from: https://www.ncbi.nlm.nih.gov/books/NBK493193/
2. Jones MW, Lopez RA, Deppen JG. History and Physical. Available from https://europepmc.org/books/n/statpearls/article-17784/?extid=29763183&src=med Last accessed on 15th Jan 2021.
3. Cusheiri A, Grace PA, Darzi A, Borley N, Rowley D. Disorders of small intestine and vermiform appendix. Clinical Surgery. 2nd ed. UK: Blackwell Publishing Ltd. 2003:405.
4. Andrén-Sandberg Å, Kørner H. Quantitative and qualitative aspects of diagnosing acute appendicitis. Scandinavian journal of surgery. 2004 Mar;93(1):4-9.
5. Kathare SS, Nandkishor DS, Ahmed F, Ahmed A. Comparative study of open versus laparoscopic appendicectomy. Int J Surg Sci. 2019;3(3):131-6.
6. Cuschieri A. The small intestine and vermiform appendix; In: Cuscheri A, G R Giles, R Mossa.(ed). Essential surgical practice. 3rded. London: Butter worth Heinman. 1995;1325-8
7. Deshpande A, Khade S. Laparoscopy superseding open appendectomy: a prospective view. IntSurg J 2020;7:3724-8.
8. Semm K. Endoscopic appendectomy. Endoscopy. 1983; 15: 59–64.
9. Grosso G, Biondi A, Marventano S, Mistretta A, Calabrese G, Basile F. Major postoperative complications and survival for colon cancer elderly patients. BMC Surg. 2012;12Suppl 1:S20.
10. Masoomi H, Nguyen NT, Dolich MO, Mills S, Carmichael JC, Stamos MJ. Laparoscopic appendectomy trends and outcomes in the United States: data from the Nationwide Inpatient Sample (NIS), 2004-2011. The American Surgeon. 2014 Oct 1;80(10):1074-7.
11. Sakpal SV, Bindra SS, Chamberlain RS. Laparoscopic appendectomy conversion rates two decades later: an analysis of surgeon and patient-specific factors resulting in open conversion. Journal of Surgical Research. 2012 Jul 1;176(1):42-9.
12. 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.
13. Milewczyk M, Michalik M, Ciesielski M. A prospective, randomized, unicenter study comparing laparoscopic and open treatments of acute appendicitis. SurgEndosc. 2003;17:1023–8.
14. Chung RS, Rowland DY, Li P, Diaz J. A meta-analysis of randomized controlled trials of laparoscopic versus conventional appendectomy. Am J Surg. 1999;177:250–6.
15. Hart R, Rajgopal C, Plewes A, Sweeney J, Davies W, Gray D, Taylor B. Laparoscopic versus open appendectomy: a prospective randomized trial of 81 patient. Can J Surg. 1996;39:457–62.
16. 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.
17. Elhadidi A, Taha A, Shetiwy M, Attia MS, Motawea A, Abdelhalim M. Laparoscopicvs open appendectomy in the

management of appendicitis complicated by generalized peritonitis: a prospective randomized trial. Egypt J Surg 2020;39:429-36.
18. Nazir A, Farooqi SA, Chaudhary NA, Bhatti HW, Waqar M, Sadiq A. Comparison of open appendectomy and laparoscopic appendectomy in perforated appendicitis. Cureus. 2019 Jul;11(7):4.
19. Khiria LS, Ardhnari R, Mohan N, Kumar P, Nambiar R. Laparoscopic appendicectomy for complicated appendicitis: is it safe and justified?: A retrospective analysis. Surgical Laparoscopy Endoscopy & Percutaneous Techniques. 2011 Jun 1;21(3):142-5.
20. Quah GS, Eslick GD, Cox MR. Laparoscopic appendicectomy is superior to open surgery for complicated appendicitis. Surgical endoscopy. 2019 Jul;33(7):2072-82.
21. Soltan HM, El-Tatawy AG, Alsegaey AH. Laparoscopic versus open appendectomy in complicated acute appendicitis. Menoufia Med J 2019;32:554-9
22. Danwang C, Bigna JJ, Tochie JN, et alGlobal incidence of surgical site infection after appendectomy: a systematic review and meta-analysisBMJ Open 2020;10:e034266.
23. Giesen LJ, van den Boom AL, Van Rossem CC, Den Hoed PT, Wijnhoven BP. Retrospective multicenter study on risk factors for surgical site infections after appendectomy for acute appendicitis. Digestive surgery. 2017;34(2):103-7.
24. Garcell G H, Villanueva Arias A, Pancorbo Sandoval CA, Bode Sado A, Alfonso Serrano RN, Gutierrez García F. Risk Factors for Surgical Site Infection After Appendectomy for Acute Appendicitis; Results of a Cross-Sectional Study Carried out at a Community Hospital in Qatar (2013-2016). Hospital Practices and Research. 2019 Apr 15;4(2):45-9.
25. Koumu MI, Jawhari A, Alghamdi SA, Hejazi MS, Alturaif AH, Aldaqal SM. Surgical Site Infection Post-appendectomy in a Tertiary Hospital, Jeddah, Saudi Arabia. Cureus. 2021 Jul;13(7):1.

Conflict of Interest: Nil Source of support: Nil