

## Original Research Article

# A comparative study on surgical site infection in cases of open and laparoscopic appendicectomy

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### ABSTRACT

**Background:** Diagnosis of acute appendicitis is mostly based on clinical features pointing towards appendicitis. Several biochemical parameters, such as the white blood cell (WBC) count, and neutrophil percentage, are currently used to aid clinical diagnosis. Without immediate surgery, appendicitis may progress to perforation of the appendix. This study was carried out to determine rate of SSI in open versus laparoscopic appendicectomy for acute appendicitis and to identify independent risk factors for SSI.

**Methods:** Appendicitis is a common cause of pain in right iliac fossa worldwide. The present study was carried out in the Department of General Surgery, Acharya Vinoba Bhave Rural Hospital, affiliated to Jawaharlal Nehru Medical College, Sawangi, Wardha, from August 2015 to July 2017. This study was conducted after the due clearance from Institutional Ethical committee. Total 132 patients admitted to the surgery ward with acute lower abdominal pain with clinical features of acute appendicitis on clinical examination, were studied prospectively.

**Results:** In the present study, maximum patients were seen in less than 20 years of age and next commonest age group of presentation was 21-30 years. The male to female sex ratio was 1:1.3 in the laparoscopic appendectomy group while in the open appendectomy group was 1.81:1. The incidence of complicated intra-operative findings and mean white blood cell count was more in the open appendectomy group. The mean operative time, days for use of analgesics, time taken to return to soft diet and length of hospital stay for laparoscopic appendectomy group was less than the open appendectomy group. There were more cases of surgical site infection in the patients operated by open approach than laparoscopic approach.

**Conclusions:** Wound class II versus III and NNIS index were found to be significantly associated with surgical site infection.

**Keywords:** Laparoscopic appendectomy, NNIS index, Open appendectomy, Surgical site infection

### INTRODUCTION

Diagnosis of acute appendicitis is mostly based on clinical features pointing towards Appendicitis. Several biochemical parameters, such as the white blood cell (WBC) count, and neutrophil percentage, are currently used to aid clinical diagnosis. Without immediate surgery, appendicitis may progress to perforation of the appendix. Therefore, an appendicectomy should be

performed urgently, irrespective of the time of day. Many studies support emergency appendicectomy.<sup>1-4</sup>

Laparoscopic surgery, as mentioned in many studies, allows for safe and aesthetic operations and can shorten the length of hospital stay, accelerate postoperative recovery and produce less pain. However, Laparoscopic Appendectomy may necessitate higher medical costs due to the use of specialized equipments and instruments and

may show a higher possibility of intra-abdominal abscess, especially in severe appendicitis, such as perforated appendix. Surgical site infection (SSI) is known to be a representative healthcare-associated infection and may impose serious economic burden on patients as well as increase morbidity and mortality rates. The present study compared and analyzed Laparoscopic and Open Appendectomy especially in terms of SSI.

Surgical site infection (SSI), which can be divided into incisional SSI and organ/space SSI, is the most common complication after the overwhelming majority of general surgeries, which may lead to prolonged hospitalization, increased medical expense, and compromised overall patient outcomes.<sup>5-7</sup>

The identification of risk factors of postoperative SSI is the first step in implementing measures that may help improve perioperative outcome. Appendectomy is the treatment of choice for acute appendicitis, and also accounts for the leading procedure in general surgical emergencies.<sup>8,9</sup> SSI was the most common complication after appendectomy, regardless of surgical procedure.<sup>10-13</sup>

The aim of this study was to determine rate of SSI after open and laparoscopic appendectomy and identify independent risk factors of overall, incisional, and organ/space SSI after appendectomy of acute appendicitis, respectively.

## METHODS

The present study was carried out in the Department of General Surgery, Acharya Vinoba Bhave Rural Hospital, affiliated to Jawaharlal Nehru Medical College, Sawangi, Wardha, from August 2015 to July 2017. This Prospective observational study was conducted after the due clearance from Institutional Ethical committee. Total 132 patients admitted to the surgery ward with acute lower abdominal pain with clinical features of Acute Appendicitis on clinical examination, were studied prospectively.

The inclusion criteria included patients of any age group and both sexes presenting to surgery department with acute lower abdominal pain, having clinical suspicion of acute appendicitis, patient that were diagnosed with acute appendicitis and underwent appendectomy (both OA and LA) and patients who had given consent for taking part in study. Those patients were excluded who underwent a negative appendectomy and patients who had an incidental appendectomy in combination with another procedure.

### Method

The diagnosis of acute appendicitis before operation was done on clinical history and physical examination, and it was confirmed by postoperative pathologic examinations.

The choice of surgical procedure, either open or laparoscopic, was the chief surgeons' preference and patients' motivation. OAs was performed with suitable incision (McBurney-McArthur incision, Lanz incision, Paramedian incision) and after ligation and division with scissors of the mesoappendix, the base of appendix was ligated with an absorbable suture and the appendix was divided with a scalpel.

All laparoscopic procedures were performed by experienced laparoscopic surgeons according to a standardized technique. Abdominal incisions were primarily closed with absorbable sutures in most instances, except for those with definite dirty/infected wound. Local antibiotics and subcutaneous drains were not used on the wounds. Intravenous antibiotic, which consisted of either a broad-spectrum penicillin or a second- or third generation cephalosporin will be uniformly given.

The antibiotic, at a dosage of 1-2 g, was given intravenously at induction of anesthesia. Postoperative antibiotics were continued for 1-5 days after surgery in general.

### Diagnosis of SSI and follow up

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:

#### Superficial SSIs

Infection within 30 days after operation, involving the skin and subcutaneous tissue of incision only.

- And at least Purulent discharge, with/without laboratory confirmation.
- At least one of the following signs and symptoms: Pain, tenderness, local swelling, redness, or raised temperature and the Surgeon deliberately opens superficial incision, unless incision is culture negative.

#### Deep SSIs

Infection within 30 days of operation if no implant left in place or within 1 year if implant is in place.

- And involves deep soft tissues (e.g. fascial and muscle layers) of incision.
- And at least purulent drainage from the deep incision
- A deep incision spontaneously dehisces or is deliberately opened by a surgeon when the patient has at least one of the following signs/symptoms:
  - a) Fever of more than 38 degrees Celsius.
  - b) Localized pain.

- c) 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.
- d) Diagnosis of deep incisional SSI by a surgeon.

#### *Organ/space SSIs*

Infection within 30 days after operation involves any part of the anatomy (e.g. organs or spaces) other than the incision, which was opened or manipulated during an operation.

- And at least purulent drainage from a drain placed through a stab wound into the organ/space.
- Organisms isolated from an aseptically obtained culture of fluid or tissue in the organ/space.
- Patients will be asked to contact on given contact number if he /she develops sign and symptoms of SSI within 30 days of operation or if the patient is readmitted within 30 days will be examined under study protocol.

#### **Risk factors of SSI**

The patient-related and operative variables of potential risk factors will be collected using a standardized data collection form. The patient-related variables are age; sex; preoperative white blood count; active tobacco use; American Society of Anesthesiologists (ASA) score; the presence of co-morbid illness (including diabetes mellitus, cardiovascular disease, hypertension, chronic obstructive pulmonary disease, and renal dysfunction);

The operative variables included surgical procedure, wound class (I-clean, II-clean/ contaminated, III-contaminated, and IV-dirty), operative time, and use of abdominal drainage. For each patient, the National Nosocomial Infection Surveillance (NNIS) system risk index is computed on the basis of an ASA score two or more, a wound class of contaminated or dirty/infected (III or IV), and the duration of procedure (75<sup>th</sup> percentile of standard operative time for appendicectomy). The 75<sup>th</sup> percentile assigned time for open appendectomy was 90 minutes and for laparoscopic appendectomy was 67 minutes, with each criterion met adding one point to the index.

#### **Outcome endpoints**

The primary outcome endpoints were overall, incisional (superficial/deep), and organ/space SSI. The secondary outcome endpoints were hospital death, postoperative overall complications and length of hospital stay.

#### **Statistical analysis**

Comparisons between two groups, such as the OA and LA groups, was done using the  $\chi^2$  test or t-test as appropriate. For those potential risk factors associated

with SSI, significant variables ( $P \leq 0.10$ ) in the univariate analyses were entered into a multivariate logistic regression model using a criterion of  $P \leq 0.05$  to assess the independent associations of risk factors of SSI. A level of  $P \leq 0.05$  was considered as statistically significant.

#### **RESULTS**

In the present study, maximum patients were seen in less than 20 years of age i.e. 16 in laparoscopic and 45 in open appendectomy and next commonest age group of presentation was 21-30 yrs with a mean age of 20.20 years in laparoscopic and 24.42 in cases of open appendectomy.

Out of 30 patients of laparoscopic appendectomy 13 (43.33%) were male and 17 (63.73%) were female with a male to female ratio of 1:1.3 while out of 102 cases of open appendectomy 65 patients were male and 37 were females with a ratio of 1.81:1.

Among laparoscopic group, 1 case (3.33%) was of diabetes mellitus and 2 cases (6.67%) of hypertension and in the open appendectomy group, 6 cases (5.88%) were of diabetes mellitus, 3 cases (2.4%) were of hypertension and 1 case (0.98%) was of COPD.

The mean white blood cell count in laparoscopic appendectomy was 10,400 and for open appendectomy it was 12,086.27 with a significant p value of 0.033.

Out of 30 cases of laparoscopic appendectomy 27 (90%) cases were under the ASA score I, 02 (6.67%) cases of ASA score II and 1 (3.33%) of ASA score III, while in open appendectomy out of 102 cases 92 (90.20%) were in ASA score I, 07 (6.86%) cases of ASA score II and 03 (2.94%) of ASA score III.

In the present study, among laparoscopic group, there was 14 (46.67%) case of normal looking appendix, 10 (33.33%) of inflamed appendix, and 5 (16.67%) of suppurative appendicitis and 01 (3.33%) of gangrenous cases whereas in open appendectomy there were 35 (34.31%) case of appendix with normal finding, 30 (29.41%) of inflamed appendix, and 28 (27.45%) of suppurative appendicitis and 04 (3.92%) of gangrenous cases and 05 (4.90%) cases of perforated appendicitis.

There were 24 (80%) cases of class II wound class and 6 (20%) cases of class III wound class while in open appendectomy there were 65 (63.73%) cases of class II wound class cases and 37 (36.27%) with class III wound class.

The mean time for laparoscopic appendectomy was 52.50 minutes with a standard deviation of 11.42 minutes while for open appendectomy the mean time was 59.70 minutes with a standard deviation of 16.04 minutes with a significant p value. In the laparoscopic appendectomies done there was only 1 case of superficial surgical site

infection and no cases of deep or organ space SSI. Whereas in cases of open appendectomy there were 7 (63.63%) cases of superficial SSI, 3 (27.27%) cases of deep SSI and 1(9.09%) case of organ space SSI. In the laparoscopic group there were 23 (76.67%) patients with NNIS risk index score 0 and 0 cases of Surgical site infection, 5 (16.67%) cases with NNIS score 1 and 0 incidence of SSI, 1 (3.33%) case of NNIS score 2 and 0 cases of SSI and 1 (3.33%) case of NNIS score 3 with 1 (100%) of SSI incidence. Among the cases of open appendectomy, a total of 6 (60.78%) cases were of NNIS index score 0 with 0 incidence of SSI, 23 (22.55%) cases with NNIS score 1 and 3 cases of SSI, 14 (13.73%) cases with NNIS score 2 and 6 (42.86%) cases of SSI, 3 (2.94%) patients with NNIS score 3 and 2 (66.67%) cases of SSI.

## DISCUSSION

Despite the clinical benefits of LA, like cosmetic appearance and excellent outcomes regardless of disease severity or patients age the optimal surgical approach for patients with appendicitis is still debated.

### *Distribution of patients in two groups according to ASA Score*

Out of 30 cases of laparoscopic appendectomy 27(90%) cases were under the ASA score 1, 02 (6.67%) cases of ASA score II and 1 (3.33%) of ASA score III, while in open appendectomy out of 102 cases 92 (90.20%) were in ASA score I, 07 (6.86%) cases of ASA score II and 03 (2.94%) of ASA score III. In Minutolo et al study in the laparoscopic group 48 cases (34.5%) were in the ASA risk score 2 category and 6 (4.3%) were in the ASA score 3 category whereas in open appendectomy group there were 28 (30.7%) in the ASA score 2 category and 5 (5.4%) in the score 3 category.<sup>14</sup>

Xiao Y et al stated that out of 3422 patents in the laparoscopic group the patients with ASA score 2 or more were 739 (21.6%) and in the open appendectomy cases out of 12,841 cases the total number with ASA score 2 or more were 2966 (23.1%).<sup>15</sup>

In a study by Baek HN et al out of 77 patients the mean ASA scores were 1.7±0.7 in open appendectomy and 1.6±0.6 in laparoscopic appendectomy.<sup>16</sup>

Lim SG et al stated that out of 38 patients there were 2 patents of ASA score 2 and 3 patients of ASA score 3 in the laparoscopic group and out of 22 patients, 1 patent with ASA score 3 in the open group.<sup>17</sup>

### *Intraoperative findings associated with laparoscopic appendectomy versus open appendectomy*

In the present study, among laparoscopic group, there was 14 (46.67% ) case of normal looking appendix, 10 (33.33%) of inflamed appendix, and 5 (16.67)% of

suppurative appendicitis and 01 (3.33%) of gangrenous cases. Whereas in open appendectomy there were 35 (34.31%) case of appendix with normal finding, 30 (29.41%) of inflamed appendix, and 28 (27.45%) of suppurative appendicitis and 04 (3.92%) of gangrenous cases and 05 (4.90%) cases of perforated appendicitis.

In a study by Minutolo et al out of 139 cases of laparoscopic appendicitis there were 39 (28%) of complicated appendicitis, 15 cases of abscess formation, 17 cases of gangrenous and 7 cases of perforated appendicitis.<sup>14</sup> In the open appendectomy group out of 91 cases there were 24 (26.3%) cases of complicated appendicitis, 8 cases of abscess formation, 12 cases of gangrenous and 4 cases of perforated appendicitis.

Suh YJ et al the intraoperative findings in his study in the laparoscopic group were 17% of the appendix were hyperaemic, 42.5% suppurative, 11.6% gangrenous and 28.9% perforated/abscess formation while in the open group there were 16.7% of hyperaemic cases, 39% of suppurative, 8.6% gangrenous and 35.7% perforated/abscess formation.<sup>18</sup>

Baek HN et al stated that his intra-operative findings mainly consisted 8 cases of exudative, 9 cases of suppurative appendicitis, 5 cases of gangrenous appendicitis and 8 cases of perforated appendicitis in the laparoscopic group and 9 cases of exudative, 16 cases of suppurative 7 cases of gangrenous and 15 cases of perforated appendicitis in the open group.<sup>16</sup>

### *Comparison of operative time (minutes) in two groups*

In the present study, the mean time for laparoscopic appendectomy was 52.50 minutes with a standard deviation of 11.42 minutes while for open appendectomy the mean time was 59.70 minutes with a standard deviation of 16.04 minutes with a significant p value.

Xiao Y stated that the mean operating time for laparoscopic appendectomy was 48±29 mins and for open appendectomy was 45±23 mins.<sup>15</sup> Minutolo et al studied that the mean operating time was 52.2 mins (range 20 min to 155 min) mins in laparoscopic cases and 49.3 mins (range 20 min to 110 min) in open appendectomy cases.<sup>14</sup>

In a study by Tsai CC et al the mean operating time was 69.6±16.1 min in laparoscopic cases and 43.7±17.8 in open appendectomy cases.<sup>19</sup>

Studies by Suh YJ with mean operative time 65.93±31.55 in laparoscopy group and 60.14±33.55 in the open group and Wei H et al with 30±15.2 in the laparoscopic group and 28.7±16.3 in the open group also showed similar findings in which the mean time taken for laparoscopic appendectomy was more than time taken for open appendectomy.<sup>18,20</sup> Study by Bondi A et al stated that mean operating time for laparoscopic appendectomy was



more than time taken for open appendectomy (54.±14.7 mns in laparoscopic group and 31.36±11.43 mins in the open group).+21 Present study was in concordance with Suh YJ et al and Wei H et al.

**NNIS risk index and SSI in cases of open and laparoscopic appendectomy**

In the present study in the laparoscopic group there were 23 (76.67%) patients with NNIS risk index score 0 and 0 cases of Surgical site infection, 5 (16.67%) cases with NNIS score 1 and 0 incidence of SSI, 1 (3.33%) case of NNIS score 2 and 0 cases of SSI and 1 (3.33%) case of NNIS score 3 with 1 (100%) of SSI incidence.

Among the cases of open appendectomy, a total of 6 (60.78%) cases were of NNIS index score 0 with 0 incidence of SSI, 23 (22.55%) cases with NNIS score 1 and 3 cases of SSI, 14 (13.73%) cases with NNIS score 2 and 6 (42.86%) cases of SSI, 3(2.94%) patients with NNIS score 3 and 2 (66.67%) cases of SSI.

di leo A et al quoted, the NNIS method can be useful for SSI surveillance and monitoring in single surgical wards.<sup>22</sup> Longer operations, diabetes mellitus, and obesity increase the risk of SSI, as does performance of surgery in an emergency situation. Seventy-six patients were affected by incision site infection, and the SSI rate was 5.9%. Thirty-four (2.6% of the series) were superficial incisional, 32 (2.5%) deep incisional, and 10 (0.8%) organ/space SSIs.

In a study by Petrosilo N et al in the year, out of 221 cases of appendectomy the incidence of SSI increased with increasing NNIS Score.<sup>23</sup> There was 17.1% SSI in patients with nines index score 1 and 16.6% SSI in patients with nines index score 2 or more. In a study by Patel SM, quoted that rate of SSI increases with increase in NNIS index score from 0 to 3.<sup>24</sup> Out of 12 patients operated for appendectomy with NNIS index score 0 the infection rate was 0%,6 patients were operated with NNIS score 2 and had infection rate of 16.7% whereas 3

patients with NNIS score 3 were operated and had an infection rate of 50%.

**Distribution of patients in two groups according to SSI**

In the laparoscopic appendectomies done, there was only 1 case of superficial surgical site infection and no cases of deep or organ space SSI whereas in open appendectomy there were 7 (63.63%) cases of superficial SSI, 3 (27.27%) cases of deep SSI and 1 (9.09%) case of organ space SSI.

Hemmila MR et al studied that in her study there were 266 (4.4%) of superficial SSI, 69 (1.1%) cases of deep incisional SSI and 113 (1.9%) cases of organ space SSI in the open group whereas in the laparoscopic group there were 207 (1.3%) of superficial incisional SSI, 40 (0.3%) of deep incisional SSI and 292 (1.9%) of organ space SSI.<sup>25,26</sup>

Xiao Y stated that in his study out of 16,263 patients overall SSI was 1,010 (6.2%). In the laparoscopic group there were 64 (1.9%) cases of incisional SSI and 539 (4.2%) cases of SSI in the open group.<sup>15</sup>

The laparoscopic group had 104(3.0%) cases of organ space SSI and open group had 390 (3.0%) cases of organ space SSI. He concluded that Laparoscopic appendectomy was independently associated with lower incidences of overall and incisional SSI compared with open appendectomy.

Suh YJ studied that out of 318 cases of laparoscopic appendectomy there were 2 (0.6%) cases of superficial incisional SSI, 3 (0.9%) cases of deep incisional and 4 (1.3%) cases of organ space surgical site infection. Whereas in the open group out of 431 cases there were 14 (3.2%) cases of superficial incisional SSI, 4 (0.9%) of deep incisional and 2 (0.5%) of organ space. He concluded that laparoscopic appendectomy demonstrated a reduced risk of superficial incisional SSI compared to open appendectomy.

**Table 1: Independent risk factors associated with surgical site infection after appendectomy.**

	Unstandardized Coefficients		Standardized coefficients	T	p-value
	B	Std. Error	Beta		
Surgical Site	2.327	0.387			
<b>Overall SSI</b>					
Surgical procedure	-0.021	0.049	-0.030	0.416	0.678, NS
Hypertension	-0.220	0.130	-0.146	1.690	0.094, NS
Diabetes mellitus	-0.103	0.141	-0.080	0.731	0.466, NS
Wound class II Vs III	0.322	0.114	0.524	2.824	0.006, S
Intraoperative findings	0.020	0.045	0.034	0.453	0.651, NS
NNIS index	-0.385	0.078	-1.087	4.914	0.0001, S

Ingraham AM stated that out of 32,683 patients of appendectomy there were a total of 1327 (4.06%) cases of surgical site infections.<sup>18</sup> In the laparoscopic group there were 314 (1.26%) of superficial SSI, 60 (0.24%) cases of deep incisional SSI and 448 (1.79%) cases of organ space SSI while in the open group there were 300 (3.89%) cases of superficial SSI, 76 (0.99%) cases of deep incisional SSI and 133 (1.72%) cases of organ space SSI. In a study by di leo A et al, seventy-six patients were affected by incision site infection, and the SSI rate was 5.9%.<sup>22</sup> Thirty-four (2.6% of the series) were superficial incisional, 32 (2.5%) deep incisional, and 10 (0.8%) organ/space SSIs.

The studies concluded that the higher the NNIS index higher will be the risk for surgical site infection.

In multivariate logistic regression analysis of independent risk factors associated with surgical site infection after appendectomy, the analysis involved 6 variables in our study-surgical procedure, hypertension, diabetes mellitus, wound class II versus III, Intraoperative findings and NNIS index. Out of these variables wound class II vs III with p value 0.006 and NNIS index with p-value 0.0001 were found to be significant. In studies by Sivrikoz E, Ming et al, Tsai et al, SSI was encountered more frequently in the diabetic group as compared with the nondiabetic group.<sup>27,28,19</sup>

Hemmila MR et al, Isik O et al, Dinda VO in the year Xiao Y et al, studied that the risk of surgical site infection increases with increasing wound class score.<sup>25,29,30,15</sup> Minutolo et al, Suh YJ et al, Baek HN et studied that the intraoperative findings were directly proportional to the surgical site infection.<sup>14,18,16</sup> Abscess formation, perforated appendicitis, gangrenous appendix, hyperaemic cases, Complicated cases may result in increased SSI.

Petrosilo N et al, di leo A et al, Gaynes RP et al stated that the higher the NNIS index score the higher is the occurrence of SSI.<sup>23,22,31</sup>

## CONCLUSION

There were more cases of surgical site infection in the patients operated by open approach than laparoscopic approach and wound class II vs III and NNIS index were found to be significantly associated with surgical site infection.

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