

ORIGINAL ARTICLE

COMPARISON OF PRIMARY WOUND CLOSURE WITH DELAYED
PRIMARY CLOSURE IN PERFORATED APPENDICITIS

Mukhtar Ahmad, Kishwar Ali, Humera Latif, Saman Naz, Khalid Said*

Department of General Surgery, *Department of Gastroenterology, Ayub Teaching Hospital, Abbottabad, Pakistan

Background: Delayed primary closure in cases of acute appendicitis is debated among the surgeons as to whether it decreases the rate of wound infection in comparison to primary closure. The aim of this study was to find out the optimal method of wound closure in cases of perforated appendicitis. **Methods:** This randomized control trial was conducted at the surgical units of Ayub Teaching Hospital Abbottabad from May to November 2012. A total of 158 patients having perforated appendicitis were included in the study. They were randomly divided into two groups. The wounds were primarily closed in one group and left open with daily saline soaked dressing, to be closed on postoperative day 4 in case of the other group. The main outcome measure was wound infection. A wound was considered infected if it was discharging pus, was red and swollen on postoperative day 8th. The method of wound closure was considered efficacious if there was no wound infection till 8th postoperative day. **Results:** A total of 158 patients, 56 (35.4%) male and 102 (64.6%) female were included in the study. Primary closure group had a total number of 79 patients with 26 (32.9%) male and 53 (67.1%) female. Delayed primary group had also a total number of 79 patients with 30 (38%) male and 49 (62%) female. The mean age of patients in the primary closure group was 26.67±7.32 years while in the delayed primary group was 28.15±6.88 years. In the entire series, 36 (22.8%) patients developed wound infection. There was a significant association between wound infection and type of skin closure (Delayed Primary Closure 6.3% vs. Primary Closure 39.2%, $p<0.000$). **Conclusion:** Delayed Primary closure is the optimal management strategy in case of perforated appendicitis as it decreases the incidence of wound infection.

Keywords: Delayed primary closure, primary closure, perforated appendicitis, wound, infection

J Ayub Med Coll Abbottabad 2014;26(2):153-7

INTRODUCTION

The most common cause of acute abdomen in young adults is acute appendicitis. It is rare in infants and middle age but common in early adult life. Before puberty the male to female ratio is equal which increases to 3:2 at the age of 25.¹

The treatment of acute appendicitis is appendectomy.¹ Infection of the operative incision can increase post-operative morbidity.^{2,3} It can increase post-operative pain, cost burden, hospital stay, sepsis and overall patient dissatisfaction.⁴ Incidence of wound infection in non-perforated appendicitis is reported to be less than 10% and in perforated ones is 15–20%.² Infection is highest in diffuse peritonitis (35%).²

After uncomplicated appendectomy the skin wound can be closed primarily.² In case of gross wound contamination the wound is left open for secondary healing or delayed primary closure.^{2,5} Primary closure is through subcuticular or interrupted suture.^{6,7}

Perforated appendicitis wounds have been traditionally managed by delayed primary closure with the concept that it has less chances of infection.² Open wound management has been previously considered as the treatment of choice for perforated

appendicitis due to the high rate of infection in such cases.² In this method the wound is left open with saline soaked gauze dressings daily. The wound is closed after a few days when the condition of the incision permits (delayed primary closure). This method, by lowering the incidence of surgical wound infection, also decreases the chances of wound dehiscence, thus lowering the hospital stay and overall morbidity. The cosmetic results however are poor for open wound management.⁸

Recent research shows that even perforated appendicitis wound can be closed primarily especially with the current antimicrobial regimes.² Primary wound closure is better than delayed primary closure in terms of cosmetic outcome and patient tolerability.⁸

The most important reason for controversy between primary versus delayed primary closure after perforated appendicitis is post-operative wound infection.² Studies show that infection rates in the primary closure group and delayed primary closure are (8%¹⁰ versus 2.7%⁸ respectively) and (19%¹¹ versus 4.2%⁹ respectively).

The objective of this study was to compare the efficacy of primary wound closure with delayed primary wound closure in terms of wound infection

after surgery for perforated appendix and get local evidence of the effectiveness of either procedure.

MATERIAL AND METHODS

This randomized controlled trial was carried out in the department of general surgery, Ayub Teaching Hospital Abbottabad from May 2012 to November 2012. Sample size was 79 in each group using 19%¹¹ proportion of wound infection in primary closure group and 4.2%⁹ proportion of wound infection in delayed primary closure group after surgery for perforated appendix, 95% confidence interval and 90% power of the test under WHO sample size calculations. Consecutive (Non-probability sampling) technique was used.

All patients with perforated appendicitis of either gender between 18–65 years of age were included in the study. Patients having diabetes mellitus, appendicular abscess, previous history of surgery, history of intake of steroids and having HIV/AIDS were excluded from the study.

Approval of the study was obtained from the hospital ethical committee. All patients presenting with pain in right lower quadrant of abdomen were admitted in surgical unit through OPD or emergency department. Diagnosis of acute appendicitis was performed by history (pain in right iliac fossa, vomiting) physical examination (tenderness in right iliac fossa) and investigation (white cell count $\geq 11000 \text{ cm}^3/\text{dl}$) and diagnosed per operatively as having perforated appendix. The procedure of the study was explained to the patients and a written informed consent was obtained.

The patients were randomly allocated in to two groups A and B using lottery method. Patient in group-A underwent primary closure of the skin i.e., immediately after surgery while patients in group-B were subjected to delayed primary closure of the skin i.e., 3 days after surgery for perforated appendix. All the patients were operated using standard Grid-iron incision. Wounds were closed in either technique with prolene 2/0 as suture material. Antibiotics were used during the course of the operation, either pre-operatively or at induction of anaesthesia and post operatively.

The exclusion criteria were strictly followed to control confounding variables and exclude bias in the study results. The entire patient's surgical sites were followed up till 8th post closure days to detect effectiveness in terms of wound infection and skin stitches were removed on 10th post closure day. The demographic and clinical data of all patients i.e., name, age, gender, technique of skin closure and wound infection were recorded on a pre-designed *pro forma*.

The data was analysed using SPSS-15. Frequency and percentage were computed for categorical data including gender and effectiveness. Continuous data like age was presented with mean \pm SD. Chi square test was used to compare the effectiveness in both the groups while keeping *p*-value of ≤ 0.05 as significant. Effectiveness in both groups was stratified among age and gender to see the effect modifications. All results were presented in the form of tables and charts.

RESULTS

A total of 158 patients, 56 (35.4%) male and 102 (64.6%) female were included in the study. The mean age of the patients was 27.41 ± 7.12 years with a range of 18–45 years. There were 75 (47.5%) patients in the range of 15–25 years, 55 (34.8%) patients in the range of 26–35 years and 28 (17.7%) patients in the range of 36–45 years. No patient was withdrawn from the study, and there was no peri-operative mortality or major complication such as organ failure, appendiceal stump leakage or intra-abdominal abscess.

The patients were divided into two equal groups. Primary closure group had a total number of 79 patients with 26 (32.9%) male and 53 (67.1%) female. Delayed primary group had also a total number of 79 patients with 30 (38%) male and 49 (62%) female (Table-1). The mean age of patients in the primary closure group was 26.67 ± 7.32 years while in the delayed primary group was 28.15 ± 6.88 years.

In the entire series, 36 (22.8%) patients developed wound infection. In the primary closure group, wound infection was observed in 31 out of 79 patients (39.2%) on post-operative day eight (Table-1). The wounds of these patients were opened by removing the skin stitches only and managed by the open technique with daily saline soaked packing. 25 of them were delayed primarily closed while 6 were left open for healing by secondary intention.

In the delayed primary closure group, wound infection was observed in 5 out of 79 patients (6.3%) on 8th postoperative day of wound closure while all the remaining wounds (74 in number) healed after delayed primary closure without any infection (Table-3). The infected wounds in this group were opened by removing the skin stitches and subjected to healing by secondary intention. There was a significant association between wound infection and type of skin closure (Delayed Primary Closure 6.3% vs. Primary Closure 39.2%, $p < 0.000$).

Effectiveness in both groups was stratified among age and gender to see the effect modifications. It was observed that effectiveness of delayed primary closure over primary closure was statistically significant even among different age groups and both sexes.

There was no significant effect of age and gender on wound infection in both the groups.

Table-1: Wound infection rate in different groups

Wound infection	Primary closure group	Delayed primary closure group	Total
Yes	31 (39.2%)	5 (6.3%)	36 (22.8%)
No	48 (60.8%)	74 (93.7%)	122 (77.2%)
Total	79 (100%)	79 (100%)	158 (100%)

p-value less than 0.000

Table-2: Effectiveness in different age groups

Age groups	Effectiveness	Primary closure group	Delayed primary closure group	Total
15–25 years ^a	No	20(83.3%)	4 (16.7%)	24 (100%)
	Yes	24 (47.1%)	27 (52.9%)	51 (100%)
	Total	44 (58.7%)	31 (41.3%)	75 (100%)
26–35 years ^b	No	9 (90%)	1 (10%)	10 (100%)
	Yes	14 (31.1%)	31 (68.9%)	45 (100%)
	Total	23 (41.8%)	32 (58.2%)	55 (100%)
36–45 years ^c	No	2 (100%)	0 (0%)	2 (100%)
	Yes	10 (38.5%)	16 (61.5%)	26 (100%)
	Total	12 (42.9%)	16 (57.1%)	28 (100%)

a: p-value less than .003, b: p-value less than .001, c: p-value less than .009

Table-3: Effectiveness in different gender groups

Gender	Effectiveness	Primary closure group	Delayed primary closure group	Total
Male ^a	No	11 (84.6%)	2 (15.4%)	13 (100%)
	Yes	15 (34.9%)	28 (65.1%)	43 (100%)
	Total	26 (46.4%)	30 (53.6%)	56 (100%)
Female ^b	No	20 (87%)	3 (13%)	23 (100%)
	Yes	33 (41.8%)	46 (58.2%)	79 (100%)
	Total	53 (52%)	49 (48%)	102 (100%)

a: p-value less than .002 ,b: p-value less than .000

DISCUSSION

The financial impact and complications of wound infection and its sequelae are significant. Davey and Nathwani¹² found excess in hospital costs per wound infection of \$600 for an inguinal hernia repair and \$2,152 for colorectal surgery. Other authors have reported increased costs associated with the hospital stay.^{13,14} Riou *et al*¹⁵ reported a wound infection rate of 45% in patients undergoing major abdominal surgery. Bucknall *et al*¹⁶ found a 1.7% incidence of burst abdomen and a 7.4% incidence of incisional hernia among 1,129 major laparotomies where wound infection was a significant contributing factor. Irvin *et al*¹⁷, Haddad and Macon¹⁸ found that dehiscence and herniation occurred more in infected wounds. Necrotizing fasciitis remains a rare but potentially lethal complication of surgical wound infections. The increased incidence of significant complications associated with wound infection supports the notion that it is prudent to avoid wound infection whenever possible.¹⁹

In the modern era, Delayed Primary Closure of contaminated and dirty wounds was popularized in

World War I as described by Hepburn in 1919.²⁰ Its use in peacetime was described by Wilke²¹ in 1931 and by Collier and Valk²² in 1940. This technique became the standard of care in World War II.²³ Grosfeld and Solit²⁴ in 1968 reviewed perforated appendiceal wounds and found a wound infection rate of 2.3% for delayed closure compared to 14.6% with Primary closure. These studies were performed, however, before current antimicrobial regimens were available. More recently, Lemieur *et al*²⁵ found a wound infection rate in perforated appendicitis of 24% when the incision was closed primarily, and Yellin *et al*²⁶ found a wound infection rate of approximately 4% after Delayed Primary Closure of all their advanced appendicitis wounds.

Tsang *et al*²⁷ studied 63 children with gangrenous or perforated appendicitis and found no difference in the rate of wound infection between the two groups. Pettigrew²⁸ and Andersen *et al*²⁹ both randomized more than 100 patients each with gangrenous or perforated appendicitis to Delayed primary closure group versus Primary closure group. These authors used topical antibiotics in one or more randomized arms, and even though they found benefit in the use of these antibiotics, this may have constituted a significant confounding variable. Table-7 summarizes the results of these previous prospective randomized trials comparing Delayed primary closure with Primary closure. Further, these studies were at least 20 years old, highlighting the need to address this issue with a more recent trial.

Our study compared the wound infection rate between primary and delayed primary closure techniques after perforated appendicitis. Being categorized as contaminated surgery the chances of wound infection are high after appendiceal perforation and delayed primary closure has been considered as a better option for its management.¹⁹ However the cosmetic results and patient tolerability of delayed primary closure are not good as compared to primary closure. Literature has shown that primary closure is well tolerated after perforated appendicitis when the wound is thoroughly washed with normal saline and preoperative antibiotics are given.³⁰⁻³² Our hypothesis was that primary closure is more suitable in such cases.

A total of 158 patients, 56 (35.4%) male and 102 (64.6%) female were included in the study. The mean ages of the patients were 27.4±7.12 years. The patients were randomized into two equal groups. Primary closure group had 26 (32.9%) male and 53 (67.1%) female. Delayed primary group had 30 (38%) male and 49 (62%) female. The mean age of patients in the primary closure group were 26.67±7.32 years while in the delayed primary group were 28.15±6.88 years. Male-to-female ratio as well

as age group of appendicitis in the study was comparable with other studies.³³

In the primary closure group, wound infection rate was 39.2% while it was 6.3% in the delayed primary closure group. There was significant difference between the two methods regarding wound infection (p value less than 0.000). Our study showed that delayed primary closure is more suitable for wound management after perforated appendicitis. This was against our proposed hypothesis.

The infection rates in our study were comparable to other studies. Chiang RA found that primary closure had a higher incidence of wound infection as compared to delayed primary closure in post perforated appendectomy wounds (38.9% vs. 2.9%).³⁴ Similarly Cohn SM found a higher infection rate for primary closure (48% vs. 12%) in all dirty wounds while (50% vs. 0%) in perforated appendectomy wounds,¹⁹ Duttaroy DD found that Infections were significantly more common in the primary closure group (42.5% vs. 2.7% for Delayed primary group).⁸

We found that delayed primary closure was more effective in the management of perforated appendicitis wounds as compared to primary closure (93.7% vs. 60.8%). The wound becomes contaminated during surgery for perforated appendicitis by manipulation and seepage of purulent exudate into the wound. Primary closure of such a wound creates a potential closed space infection. The high incidence of superficial wound infection (39.2%) occurring when such a wound is closed primarily bears out this observation. Therefore it is better to manage such a wound with delayed primary closure.

CONCLUSION

Our study found that in patients undergoing operation for perforated appendicitis, delayed primary closure was more efficacious in wound management as compared to primary closure. Delayed primary closure decreases the incidence of surgical wound infection in these patients. In conclusion, a strategy of delayed primary closure should be considered in cases of perforated appendicitis to prevent patients from complications of wound infection.

REFERENCES

- O'Connell PR. The vermiform appendix. In: Williams NS, Bulstrode CJK, O'Connell PR, editors. Bailey and Love's short practice of surgery. 25th ed. UK: Edward Arnold Ltd; 2008.p. 1204–11.
- Mehrabi Bahar M, Jangjoo A, Amouzesi A, Kavianifar K. Wound infection incidence in patients with simple and gangrenous or perforated appendicitis. Arch Iran Med 2010;13:13–6.
- Chamisa I. A clinicopathological review of 324 appendices removed for acute appendicitis in Durban, South Africa: a retrospective analysis. Ann R Coll Surg Engl 2009;91:688–92.
- Bickel A, Gurevits M, Vamos R, Ivry S, Eitan A. Perioperative hyperoxygenation and wound site infection following surgery for acute appendicitis: a randomized, prospective, controlled trial. Arch Surg. 2011;146:464–70.
- Misteli H, Kalbermatten D, Settelen C. Simple and complicated surgical wounds. Ther Umsch. 2012;69:23–7.
- Sookpotarom P, Khampiwmar W, Termwattanaphakdee T. Vigorous wound irrigation followed by subcuticular skin closure in children with perforated appendicitis. J Med Assoc Thai 2010;93:318–23.
- Pauniah SL, Lahdes-Vasama T, Helminen MT, Iber T, Mäkelä E, Pajulo O. Non-absorbable interrupted versus absorbable continuous skin closure in pediatric appendectomies. Scand J Surg 2010;99:142–6.
- Duttaroy DD, Jitendra J, Duttaroy B, Bansal U, Dhameja P, Patel G, *et al.* Management Strategy for Dirty Abdominal Incisions: Primary or Delayed Primary Closure? A Randomized Trial. Surg Infect (Larchmt) 2009;10:129–36.
- Chiang RA, Chen SL, Tsai YC, Bair MJ. Comparison of primary wound closure versus open wound management in perforated appendicitis. J Formos Med Assoc. 2006;105:791–5.
- Roger AD, Hampton MI, Bunting M, Atherstone AK. Audit of Appendectomies at Frere hospital, Eastern Cape. S Afr J Surg 2008;46(3):74–7.
- Towfigh S, Clarke T, Yacoub W, Pooli AH, Mason RJ, Katkhouda N, *et al.* Significant reduction of wound infections with daily probing of contaminated wounds: a prospective randomized clinical trial. Arch Surg 2011;146:448–52.
- Davey PG, Nathwani D. What is the value of preventing postoperative infections? New Horiz 1998;6(2 Suppl):S64–71.
- Shulkin DJ, Kinoshian B, Glick H, Glen-Puschett C, Daly J, Eisenberg JM. The economic impact of infections. An analysis of hospital costs and charges in surgical patients with cancer. Arch Surg 1993;128:449–52.
- Poulsen KB, Bremmelgaard A, Sorensen AI, Raahave D, Petersen JV. Estimated costs of postoperative wound infections. A case-control study of marginal hospital and social security costs. Epidemiol Infect. 1994;113:283–95.
- Riou JP, Cohen JR, Johnson H Jr. Factors influencing wound dehiscence. Am J Surg 1992;163:324–30.
- Bucknall TE, Cox PJ, Ellis H. Burst abdomen and incisional hernia: a prospective study of 1129 major laparotomies. Br Med J (Clin Res Ed) 1982;284(6320):931–3.
- Irvin TT, Stoddard CJ, Greaney MG, Duthie HL. Abdominal wound healing: a prospective clinical study. Br Med J 1977;2(6083):351–2.
- Haddad V, Macon WL 4th. Abdominal wound dehiscence and evisceration: contributing factors and improved mortality. Am Surg. 1980;46:508–13.
- Cohn SM, Giannotti G, Ong AW, Varela JE, Shatz DV, McKenney MG, *et al.* Prospective randomized trial of two wound management strategies for dirty abdominal wounds. Ann Surg. 2001;233:409–13.
- Hepburn HH. Delayed primary suture of wounds. Br Med J. 1919;1(3033): 181–3.
- Wilke DP. Observations on mortality in acute appendicular disease. Br Med J 1931;1(3658): 253–5.
- Coller FA, Valk WL. The delayed closure of contaminated wounds. A preliminary report. Ann Surg 1940;112:256–70.
- Wilson H. Secondary Suture of War Wounds: A Clinical Study of 305 Secondary Closures. Ann Surg 1945;121:152–6.
- Grosfeld JL, Solit RW. Prevention of wound infection in perforated appendicitis: experience with delayed primary wound closure. Ann Surg 1968;168:891–5.
- Lemieur TP, Rodriguez JL, Jacobs DM, Bennett ME, West MA. Wound management in perforated appendicitis. Am Surg 1999;65:439–43.

26. Yellin AE, Berne TV, Heseltine PN, Appleman MD, Gill M, Chin A, *et al.* Prospective randomized study of two different doses of clindamycin admixed with gentamicin in the management of perforated appendicitis. *Am Surg* 1993;4:248–55.
 27. Tsang TM, Tam PKH, Saing H. Delayed primary wound closure using skin tapes for advanced appendicitis in children. *Arch Surg* 1992;127:451–53.
 28. Pettigrew RA. Delayed primary wound closure in gangrenous and perforated appendicitis. *Br J Surg* 1981;68:635–8.
 29. Andersen B, Bendtsen A, Holbraad L, Schantz A. Wound infections after appendectomy. I. A controlled trial on the prophylactic efficacy of topical ampicillin in non-perforated appendicitis. II. A controlled trial on the prophylactic efficacy of delayed primary suture and topical ampicillin in perforated appendicitis. *Acta Chir Scand* 1972;138:531–6.
 30. Henry MC, Moss RL. Primary versus delayed wound closure in complicated appendicitis: an international systematic review and meta-analysis. *Pediatr Surg Int* 2005 Aug;21(8):625–30.
 31. Rucinski J, Fabian T, Panagopoulos G, Schein M, Wise L. Gangrenous and perforated appendicitis: A meta-analytic study of 2532 patients indicates that the incision should be closed primarily. *Surgery*.2002;127:136–41.
 32. Khan KI, Mahmood S, Akmal M, Waqas A. Comparison of rate of surgical wound infection, length of hospital stay and patient convenience in complicated appendicitis between primary closure and delayed primary closure. *J Pak Med Assoc* 2012;62:596–8.
 33. Statistics by Country for Acute Appendicitis. US Census Bureau, International Data Base, 2004.
 34. Chiang RA, Chen SL, Tsai YC. Delayed primary closure versus primary closure for wound management in perforated appendicitis: a prospective randomized controlled trial. *J Chin Med Assoc* 2012;75:156–9.
-

Address for Correspondence:

Dr Kishwar Ali, Room No. DR 22, Family Doctor Hostel, Ayub Teaching Hospital, Abbottabad, Pakistan

Cell: +92-333-9474480.

Email: drkaish1@gmail.com