



Comparing the complications of purse-string and simple ligation of appendix stump in appendectomy: A randomized clinical trial

Mehrdad Sayyadinia¹, Hosein Hamadiyan³, Suroor Mokaripoor^{2*} and Mohsen azaad⁴

¹Assistant Professor of General Surgery, Bandar Abbas Shahid Mohammadi Hospital, Payambare A'zam Medical-Educational Center, Hormozgan University of Medical Science, Iran

²Resident of General Surgery, Payambare A'zam Medical-Educational Center, Hormozgan University of Medical Science, Iran

³Student Research Committee, Hormozgan University of Medical Sciences, Bandar Abbas, Iran

⁴Statistics and Epidemiology Mentor, Hormozgan University of Medical Science, Iran

*Corresponding Email: suroormokaripoor@gmail.com

ABSTRACT

Appendectomy is one of the most prevalent emergency surgeries in the world. In the present research, the consequences of closing off stump appendicitis via simple ligation versus purse-string were compared and contrasted. In the present randomized clinical trial, 140 patients had an appendectomy surgery in Shahid Mohammadi Hospital of Bandar Abbas between 2014 and 2015. Subjects were selected based on the convenient sampling method. In accordance with the inclusion and exclusion criteria as well as the tabular output of Random Allocation software, the subjects were randomly divided into two groups. In one group, 70 subjects underwent the purse-string technique (Group 1) and in the other group, 70 patients experienced the simple ligation technique (Group 2). The following information was recorded over a two-month and a one-year follow-up: surgical site infection (SSI), abdominal abscess, non-healing surgical wounds, fecal fistula, bowel obstruction, ileus, duration of operation, and duration of hospitalization. The data entered SPSS (version 19) and were analyzed through t-test, Man-Whitney U-test, Chi-squared test and Fisher's exact test. Level of significance was set at $p \leq 0.05$. The mean age of subjects in groups 1 and 2 were 26.21 ± 8.13 and 27.14 ± 10 years, respectively. In the intervention group, there was 4.3% of SSI, while in the control group this rate was 2.9%. 8.6% of patients in group 1 got afflicted with post-surgery ileus. In group 2, 1.4% of patients suffered from this problem. The mean duration of hospitalization was 1.40 ± 0.79 and 1.41 ± 0.71 days for group 1 and group 2, respectively. This difference between the two groups was not statistically significant ($P=0.596$). No instance of abdominal abscess, bowel obstruction and fecal fistula was observed in the two groups. No statistically significant difference was found between the two groups in terms of the type of surgery. Due to the fact that simple ligation takes shorter time to proceed, as compared to the purse-string technique, it can be considered as the preferred technique.

Key terms: acute appendicitis, simple ligation, surgical site infection (SSI), purse-string

INTRODUCTION

Appendix is a blind-ended tube, a finger-like pouch which is connected to the colon. Its length varies between 2-20 cm, and its diameter ranges from 6 to 8 mm. Infection and inflammation in appendix leads to appendicitis [1]. The mortality rate associated with non-perforated appendicitis is 0.1%, while the same rate caused by perforated appendicitis is about 3%, which can reach as high as 15% in the elderly population [2]. Acute appendicitis accounts for the majority of emergency abdominal surgeries. In fact, 7% of all people might need to have their appendix

removed within their life due to the acute appendicitis [3]. It is associated with the highest rate of disease occurrence in one's second or third decade of life, and is more prevalent among men than women [4].

Acute appendicitis is diagnosed through a combination of patient's history, physical examinations, lab tests and radiological studies [5]. Ultrasonography was used as the first choice which helps to assure that one is afflicted with appendicitis [4]. Pathology is the final key to a definitive diagnosis of appendicitis [6]. The two treatments of acute appendicitis are open appendectomy and laparoscopic appendectomy. The main privilege of the latter is less postoperative pain accompanied by a quicker return to normal activities [7]. Surgeons use different techniques in dealing with appendectomy, such as abdominal incision, ligation, burial of appendix stump and so on. Simple ligation with non-burial of appendix stump was introduced in 1884 by Keronlein. Stump inversion is done through stump purse-string or z stitch which lengthens the length of operation. Postoperative disruption in bowel motility is the most prevalent cause of delayed discharge from hospital. Disrupted bowel motility is usually temporary and reversible only if its stimulant is corrected [8]. One complication of appendectomy is surgical site infection which occurs the most prevalently one week after the surgery [9].

The increasing number of patients suffering from appendicitis necessitates a better recognition of treatments, choice of simpler and more effective techniques with the fewest complications. Since some surgeons prefer simple ligation and others prefer the purse-string of appendix stump, the complications of the two techniques were compared in the present research. The results can, to some extent, reveal the necessity of either of these techniques to surgeons.

MATERIALS AND METHODS

Subjects

The present research was a single-blinded randomized clinical trial. It was conducted in the department of surgery of Shahid Mohammadi Hospital in Bandar Abbas in 2014-15. The target population was comprised of all patients who were diagnosed with acute appendicitis through their history and clinical examination. Patients who were definitively diagnosed with acute appendicitis in the supportive phase of the surgery entered the study. The exclusion criteria included: less than 14 or above 50 years of age, normal appendix or advanced and perforated appendicitis, diabetes, consumption of chemotherapy drugs, cortisone or Immunosuppressive drugs, affliction with HIV, having radiotherapy.

Sample size

140 patients were selected through convenient sampling method. According to the inclusion and exclusion criteria as well as the table obtained from Random Allocation software were randomly divided into two groups of 70. No subject knew which surgery technique would be used on him/her.

Research protocol

After general anesthesia, the surgical site was prepared using betadine solution (10%). McBurney' incision was made; fascia was opened and the muscle was split; peritoneum was opened and separated from abdominal wall; in the ligation group, after releasing the appendix and mesoappendix by surgical silk 2/0, initially the ligator was inserted in the appendix base by surgical silk 0; afterwards, the appendix was placed 3-4 millimeters from the ligator under resection. No stretching of the mesoappendix was done in any cases to strengthen the stump. All operation phases up until the ligation of mesoappendiceal arteries were repeated in the second group using the purse string technique. However, after placing the primary ligator on appendix base using chromic suture 2/0 and performing the appendectomy, purse-string was performed 1 centimeter from the perimeter of the appendix base via the seromuscular technique using surgical silk 3/0. Once the stump was invigilated, appendix was sutured and stabilized within the cecum. In this technique, only one row of purse-string was made. The rest of the surgery procedures was the same for both groups and consisted of drying the operation field with gauze dressing, hemostatic gauze and then counting the gauzes and surgical devices. Subsequently, the peritoneum was closed using continuous chromic suture 2/0. Then, the muscles were sutured using chromic suture 2/0, followed by the closure of fascia via chromic suture 0. In this phase, subcutaneous tissues which were more superficial than external fascia were washed in normal saline solution. Eventually, the skin edges were closed off using nylon suture 2/0 or 3/0 following the vertical matrix technique. The bandaging was done using dry gauze dressings. No washing of abdominal cavity was performed in either group. Neither was any drain used after the surgery. The skin was closed following a similar procedure. Due to the fact that the two techniques have been included in many references and publications and have been approved by the Committee of Ethics, they pose no ethical threat.

All the patients had been given ceftriaxone (1 g) and metronidazole (500 mg) half an hour before the surgery. They were followed for 2 months as well as 1 year after the surgery through visiting the clinics or hospital emergency section or through phone calls. Assistants who were unaware of the grouping of patients analyzed the research variables. These variables included surgical site infection (redness, warmth, pus secretion within 2 weeks of surgery), abdominal abscess (based on clinical findings and ultrasonography confirmation), non-healing surgical wounds (deep opening of skin and fascia), fecal fistula (clinical symptoms, wound infection, excretion of feces from wound), bowel obstruction, ileus (obstruction due to non-mechanical cause), duration of operation (length of stay since the surgery to the day of discharge), and duration of hospitalization.

Statistical procedure

The collected data entered SPSS (version 19) and the results were reported as mean, standard deviation and percentage. Independent-sample t-test, Man-Whitney U-test, chi-squared test and Fisher's exact test were used to analyze the data. Level of significance was set at $p \leq 0.05$.

RESULTS

From among the 168 patients who underwent appendectomy, some were excluded due to a number of reasons: 5 were younger than 14; 2 had a normal appendicitis; 8 had perforated appendicitis; 13 were inaccessible and did not fulfil the one-year follow-up. Consequently, the study was conducted on 140 patients suffering from acute appendicitis. Their mean Alvarado score was 72.8 ± 8.5 (Min=6, Max=9). 52 subjects were female (37.1%) while 88 were male (62.9%). The average age of the participants was 26.67 ± 9.08 years. 9 patients (6.4%) had a background of a prior disease (e.g. diabetes, hypertension, etc.), while 131 (93.6%) had none. Medical history of 9 patients (6.4%) was positive. The mean duration of surgeries was about 30 ± 10.75 minutes (10-60 minutes). The mean duration of hospital stay after surgery was estimated to be 1.5 day. The overall number of infection cases observed was 5 (3.6% of all surgeries). From among the 140 patients who had appendectomy in this research, 7 patients (5%) got afflicted with postoperative ileus. No sign of abdominal abscess, bowel obstruction or fistula was observed in either group after the surgery. Patients had been randomly assigned to either of the two groups which differed in terms of the type of surgery. Group 1 was supposed to experience simple ligation technique while group 2 would undergo the purse-string type of appendectomy. Both groups had the same number of subjects (70). Sex distribution was approximately similar in the two groups, and had no statistically significant divergence (0.484) (table 1).

There was no statistically significant difference in the mean age of the two groups (0.548) (table 2).

No instances of abdominal abscess, non-healing wound, fecal fistula or mechanical obstruction were reported in the two research groups. A comparison of the two groups in terms of surgical site infection revealed no statistically significant difference (1.000). Neither was any significant difference found between the groups in terms of postoperative ileus (0.116) (table 3).

The divergence of the two groups was not statistically significant concerning the duration of hospitalization (0.596). However, the mean length of the surgery was found to be significantly different between the two groups (table 4).

Table 1. Comparison of groups 1 and 2 in terms of sex distribution

Surgery technique	sex		total	Chi-squared test	Degree of freedom	p-value
	male	female				
Purse-string	42(60%)	28(40%)	70(100%)	0.490	1	0.484
Simple ligation	46(65.7%)	24(34.3%)	70(100%)			
total	88(62.85%)	52(37.15%)	140(100%)			

Table 2. Comparison of groups 1 and 2 in terms of age distribution

Surgery technique	age			Independent-sample t-test	Degree of freedom	p-value
	Min.	Max.	Mean \pm SD			
Purse-string	15	45	26.21 \pm 8.13	0.603	138	0.548
Simple ligation	14	53	27.14 \pm 10			

Table 3. Comparison of groups 1 and 2 in terms of SSI and ileus

variable	Surgery technique		total	Fisher's exact test	
	Purse-string	Simple ligation			
SSI	Yes	3(4.29%)	2(2.86%)	5(3.57%)	1.000
	no	67(95.71%)	68(97.14%)	135(96.43%)	
	total	70(100%)	70(100%)	140(100%)	
ileus	Yes	6(8.57%)	1(1.43%)	7(5%)	0.116
	No	64(91.43%)	69(98.57%)	133(95%)	
	total	70(100%)	70(100%)	140(100%)	

Table 4. Comparison of groups 1 and 2 in terms of the mean duration of surgery and hospitalization

variable	Surgery technique		Man-Whitney U-test	P-value	
	Purse-string	Simple ligation			
Hospitalization (days)	mean	1.4±0.79	1.41±0.71	0.531	0.596
	Min.	1	1		
	Max.	1	3		
Surgery (minutes)	mean	35.74±9.53	24.34±8.73	6.629	0.001
	Min.	20	10		
	Max.	60	45		

DISCUSSION

There was no statistically significant difference between the two research groups in terms of the duration of hospital stay, SSI and ileus. However, the length of surgery showed a significant divergence between the groups.

In appendectomy, many surgeons perform simple ligation of stump while others still prefer the purse string or z-suturing of the stump. One advantage of purse-string is providing safe sutures not threatening to rupture the stump. The other advantages are lowering the chance of infection due to the secretion of pathogens from the stump, lowering the chance of surgical site infection and a better repair of the bowel through the formation of granulation tissue and collagen in the serosa. Simple ligation has its own proponents due to its quick application and the simple anatomy of cecum [10, 11].

In a myriad of other clinical trials, a shorter duration of surgery using simple ligation has been reported which is consistent with the finding of the present research [12-18]. In the present study, the time difference of the two surgeries was 10 minutes. One reason why the purse-string technique takes longer is the suturing of the peritoneum, which is not performed in the simple ligation technique (creating a tobacco cavity to bury the appendix stump). On the other hand, the shorter length of the surgery in some studies can be attributed to the surgeon's skills [18]. Overall, the majority of studies recommend simple ligation due to the ease and shorter time of performance [14-16]. The duration of hospitalization after appendectomy in the simple ligation group and stump burial was 1.41 and 1.40 day, respectively. There was no statistically significant difference between the two research groups in terms of the length of hospital stay. In a limited number of studies, the length hospital stay was longer in the simple ligation group [19]. However, in a myriad of studies including the present research no significant difference was found between the groups in terms of this variable [13, 15-17, 19].

The findings of the present research revealed that the prevalence of surgical site infection after appendectomy is not a function of the technique of surgery. This finding is consistent with that of a great many studies [12, 13, 15-18, 20].

In 1992, Jacobs maintained that the surgical site infection was significantly higher in patients who underwent the burial of appendix stump [14]. Less infection in simple ligation can be due to the shorter time it takes, the ease of the procedure and no manipulation of the anatomy of cecum wall. On the other hand, Ellis pointed out the following as some reasons for the priority of the purse-string technique: the higher safety of appendix stump, less threat of rupture, elusiveness of appendix stump, less chance of peritonitis due to the secretion of pathogens from the stump residual, less SSI, better repair of the bowel through granulation tissue and collagen of cecum serosa [21]. Although the retrospective body of research reported more infections in the application of simple ligation, later prospective studies reported the same rate in the two techniques. The belief is that this alteration has been a function of incorporating antibiotic treatment and prophylaxis of infection before the surgery [19].

The present research found no statistically significant difference between the groups in terms of the prevalence of ileus. This finding was similar to the results of many other studies. The only research which reports a contrary result was Ellis' research [21].

Abdominal abscess is a rare complication of appendectomy. The occurrence of abdominal abscess is higher among those favoring the technique of appendix stump burial. Proponents of this technique assume that in simple ligation, appendix stump is in contact with the defense mechanisms of the peritoneum that can prevent peritoneal abscesses. According to this theory, abscess is more prevalent in patients whose appendix stump has been buried in cecum wall and have no peritoneal defense mechanism [22-24]. No instance of abscess was found in the present research.

Intracutaneous fistula is another complication of appendectomy that might occur as a result of the inadequate closure of bowel wall. Although it is not prevalent, intracutaneous fistula can be very dangerous. The main reason for favoring simple ligation is the concern about the inadequate closure of appendix stump. In this technique, due to the creation of a tobacco cavity, the safety is twice as high [25]. However, the evidence shows the opposite case i.e. the occurrence of fistula is lower in simple ligation [24-26]. No instance of fistula was observed in the present research. Bowel obstruction is considered as another rare complication of appendectomy. It can occur within a few days or few years of the surgery. One theory is that appendix stump might soon suffer adhesions in abdominal cavity [25]. This theory has not been proved yet. Retrospective studies which traced back patients' 5 years proved otherwise. In other words, the prevalence of bowel obstruction is higher in patients whose appendix stump has been buried [27, 28]. Nevertheless, in Engstrom's study, bowel obstruction an adhesion was reported more in the application of stump burial [22]. No instance of obstruction was observed in the present research.

A serious limitation of this study is the small research sample size and the limited time span of research. More extensive research and lengthier follow-up is suggested in this domain.

CONCLUSION

According to the findings of the present research, simple ligation and stump burial were the same in terms of complications and the length of hospital stay. Creating a tobacco cavity is an extra procedure which changes the anatomy of cecum and, therefore, increases the risk of pathogenic damages. Simple ligation is suggested as the preferable technique in appendectomy due to the ease of performance, no alteration of cecum anatomy and shorter time of surgery.

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