Overview of Types of Wound Closure Regarding Post Appendectomy Wound Infection (Subcuticular Vs Interrupted)

Sattar Jabbar Khadhum[1] FICMS , MRCS
Mustafa Adnan Khaleel[1] M.B.Ch. B
Ayman Nadeem Kadum[1] M.B.Ch.B, F.I.C.M.S

[1] Department of Surgery, Al-Yarmouk Teaching Hospital Baghdad-Iraq

Abstract

Background; wounds represent an essential part of surgical operations, wound infection after appendicectomy remains a significant problem around the world. The incidence varied from 6.2 in high-income countries to 11.1 per 100 appendectomies in low-income countries.

Objectives; this study aims to compare the type of wound closure (subcuticular vs interrupted) in terms of wound infection post appendectomy.

Patients and Methods; this is a prospective cross-sectional study following a cohort of patients with appendectomy conducted at Al Yarmook Teaching Hospital for 1 year, from the first of April 2021 up to the end of March 2022. A sample size of 100 patients was reached. Patients were enrolled in the study after assessment of eligibility and the allocation to subcuticular suture or vertical interrupted mattress groups was determined randomly. Follow-up was achieved on 1, 2, 5, 10 and 30 days. All data were analyzed by using Statistical Package for Social Sciences (SPSS). Independent t-test and Chi-square test were calculated to explore the difference and association between variables. Binary logistic regression analysis was performed to predict the odds of having a wound infection. In all statistical analyses, a P-value equal to or less than 0.05 was indicative of a statistically significant difference

Results; the average age for the subcuticular and interrupted mattress group was 25.56±9.76 and 27.84±8.65 respectively. Wound infection occurred among 13/100 of the sample. No significant difference between the two types of suturing techniques (subcuticular vs interrupted) along with the follow-up period. The odds of developing wound infection were significantly higher among the males, smokers, and those with a positive family history of appendectomy and complicated by wound infection

Conclusion; this study shows that the odds of developing wound infection were significantly higher among the males، smokers, and those with a positive family history of appendectomy and complicated by wound infection

Keywords; wound closure, types of closure, suture, appendectomy.

Introduction

Wounds represent an essential part in surgery. Appendiceal wounds are by far the commonest in surgical practice as the most common causes of acute abdominal pain in adults and children is acute appendicitis. Males have a slightly higher predisposition of developing acute appendicitis compared to females [1]. Wound infection after appendicectomy remains a significant problem around the world. The incidence varied from 5.8 in Europe to 12.6 per 100 appendectomies in Africa, and it seemed to increase when the level of income decreased, from around 6.2 in developed countries to 11.1 per 100 appendectomies in developing countries. Open appendectomy (11.0 per 100 surgical procedures) was found to have a higher incidence of surgical site infection (SSI) compared with laparoscopy (4.6 per 100 appendectomies).

As such, wounds with infection frequently require reoperation and exploration, thus leading to poor cosmetic outcomes. [2, 3]

Even though bacteria are a common part of the intact skin microbiota and wounds including both, aerobic and anaerobic, Gram-negative and Gram-positive bacteria have been reported to be implicated in appendicitis such as Bacteroides fragilis, Beta-hemolytic streptococci, Yersinia enterocolitica, E. coli, and Klebsiella spp. As a result, and irrespective to the current progress in wound management techniques, bacterial and fungal infections are still considered as one of the most shared and painful states which lead to significant mortality and morbidity. [4,5] Wound infection can be defined as the invasion of organisms into tissues following a breakdown of local and systemic host defenses, leading to either cellulitis, lymphangitis, abscess formation or bacteremia [6].

The majority of surgical wounds infection is denoted as superficial SSI. The remaining would include deep SSI, like an infection in the deeper musculofascial layers or organ space infection such as an abdominal abscess after an anastomotic leak.[6] Surgical site infection can be defined as one that

occurs within 30 days of surgery (without implants) and within one year of surgery if there is an implant in place. [7] Any infection that follows surgery may be termed endogenous or exogenous, depending on the source of the bacterial contamination. Endogenous organisms are present on or in the patient at the time of surgery, whereas exogenous organisms come from outside the patient. In modern hospital practice, endogenous organisms colonizing the patient are by far the most common source of infection. [6] This study aims to compare the type of wound closure (subcuticular vs interrupted) in terms of wound infection post appendectomy.

Patients and Methods

Study design and settings:

This is a prospective cross-sectional study following a cohort of patients with appendectomy, conducted at the surgical department of Al Yarmook Teaching Hospital in Al Karkh- Baghdad, Iraq for a period of 1 year from 1st of April 2021 up to the end of March 2022. A total of 100 patients with acute appendicitis were chosen. Prophylactic antibiotic dose of ceftriaxone 1g IV or Gentamycin 5 mg/kg IV as single dose one hour prior to surgical incision in case of penicillin allergy, with metronidazole 15 mg/kg IV were used prior to operation before one hour. We used 0-3 vicryl suture for subcutaneous layers and 0-2 nylon for skin closure for all the patients.

Action plan:

A total of 116 patients were approached for this study. All interviews were carried within the hospital premises. Figure (1) demonstrates the action plan and allocation of study subjects. The plan involved the following stages:

Enrollment: for all approached patients a verbal consent was obtained and explaining the aim of the study was done. Consented patients' phone numbers were recorded for sake of follow up appointments.

Patients were enrolled in the current study after assessment of eligibility based of the following criteria:

Inclusion Criteria:

All patients scheduled for appendectomy in Al Yarmook teaching hospital within the study period.

Exclusion Criteria:

Included the following: Patient age ≥60 years old; Patients with diabetes mellitus; Immunocompromised patients, on chemotherapy, and / or steroid therapy; Obesity (BMI >35); Perforated appendix

Allocation:

The next step was the allocation of patients into the two designated groups; for group 1: subcuticular wound closure was applied and for group 2: vertical interrupted mattress was used. The starting point of patients' allocation was determined through the use of simple random technique (lottery method) after which patients were allocated alternatively between the two groups.

Wound Closure:

After the allocation was determined and patients concordantly admitted to surgery. The wounds closure was done exclusively by the researcher, in addition to all data recording in order to eliminate bias. All inpatients received a single dose of ceftriaxone 1gm IV and Metronidazole 500mg x1 IV

Follow up:

During which the researcher traced the signs and symptoms of wound infection through the following follow-up points:

Post op day 2:

This point was assessed after 2 days from the operation upon patients' hospital-discharge. Notes were taken and recorded accordingly All patients were provided with follow-up cards that shows the date of the next visit appointment. All patients received oral Augmentin tab 1g x2 and metronidazole 500mg x 3 orally

Post op day 5:

It was achieved on patients' visits.

Post op day 10:

Assessment was done during surgical suture removal session.

Post op day 30:

Final assessment was done through phone call.

Analysis:

Patients who were lost to follow up on any point, were removed from final analysis.

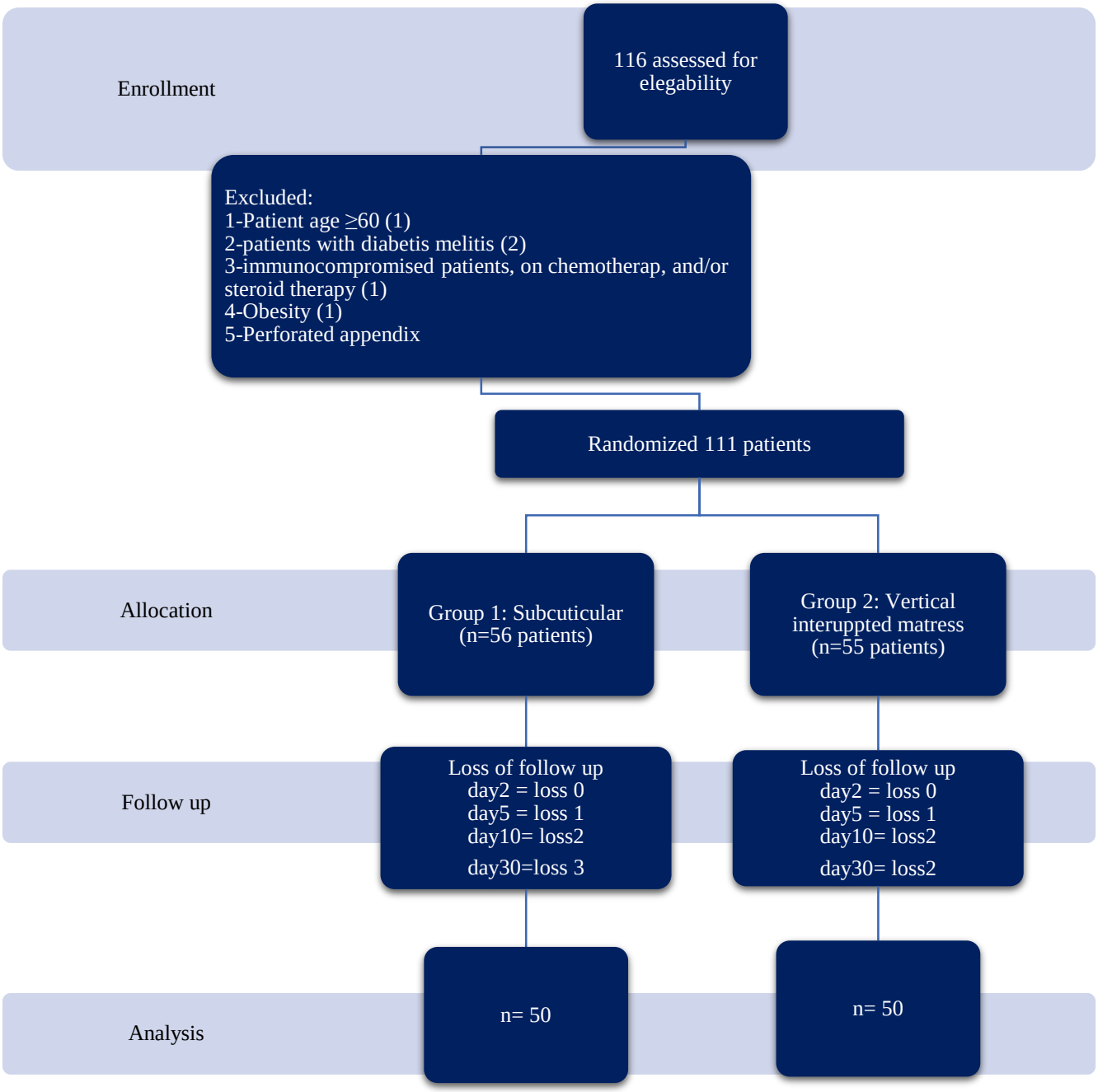

Figure (1) Action plan

Tools of the study:

The current study used a structured questionnaire to collect data from all eligible participants regarding: age (in years), gender (male/ female), type of appendiceal inflammation (catarrhal or obstructive), previous history of surgical operations (No/Yes), Smoking (No/Yes), family history of appendectomy complicated by wound infection (No/Yes). Then all patients enrolled were alternatively divided into the two designated groups:

Group 1:

Subcuticular suture was used to close the wound and,

Group 2:

Vertical interrupted mattress was applied.

All information were collected and documented by the researcher. Patients were re-checked post operatively on designated follow up points and the data that were collected on each follow-up point included the following: wound infection (No/Yes), type of wound infection (Erythema, cellulitis, pus discharge, wound disruption)

Ethical considerations:

The study was approved by the Scientific Council of General Surgery of the Arab Board for Medical Specializations and permission was obtained from the Al-Karkh Health Directorate and Al Yarmouk Teaching Hospital.

Verbal consents were obtained, all patients' records were reviewed personally and exclusively, no divulge of information occurred, all record were coded in a serial number and kept anonymous.

Statistical analysis:

All data were coded, summarized and analyzed by using Statistical Package for Social Sciences (SPSS). Continuous data were presented in means and standard deviations (M±SD), while for categorical data, frequencies and percentages n (%) were applied to ensure a better presentation and summarization.

Binary logistic regression analysis was performed to predict the odds of having wound infection (dependent variable) by independent variables (age, smoking, degree of inflammation, type of wound closure, wound extension, history of previous abdominal surgeries, and family history of appendectomy complicated by wound infection).

In all statistical analysis, P-value equal or less than 0.05 was indicative of statistically significant difference.

Results

The current study included 100 participants divided into two groups. Figure (2) shows the age distribution of participants according to the type of suture technique used. Majority of patients were in 20-29 age group. No significant difference was attained between the two groups (p-value >0.05).

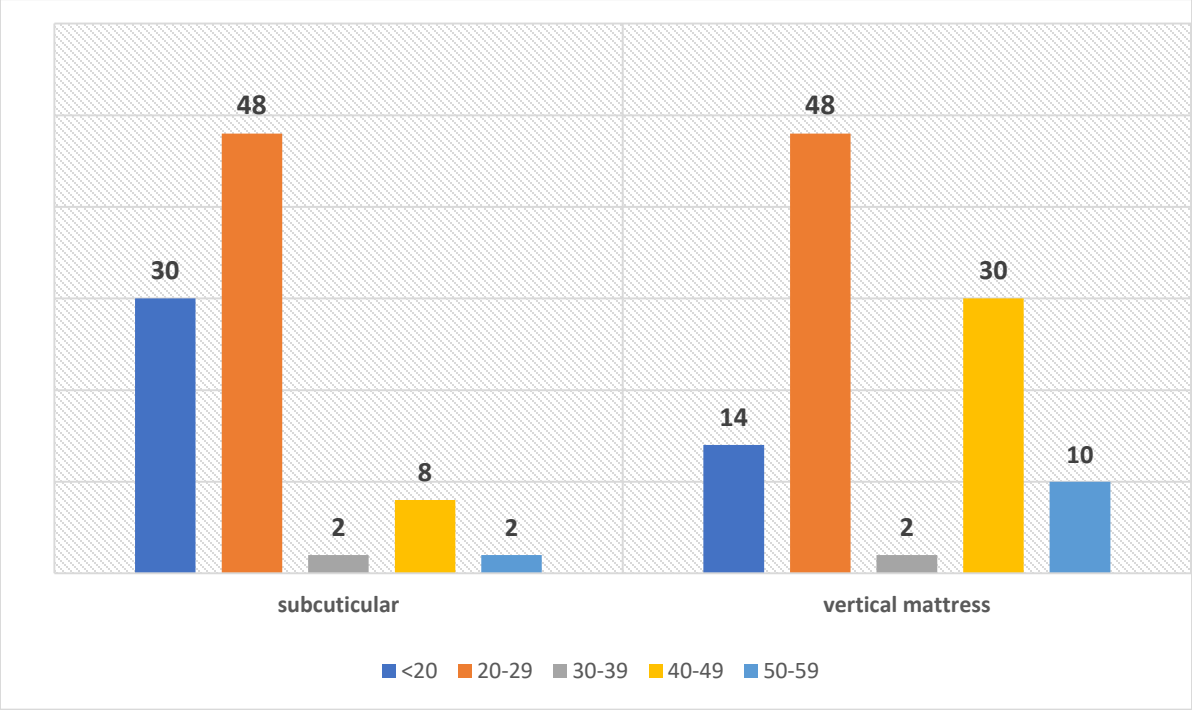

Figure (2) Age distribution of participants according to the type of suture technique used

Almost two thirds of the sample were females 71 (71%) and the remaining 29 (29%) were males. 60 (60%) of patients had catarrhal appendicitis while the remaining 40 (40%) had obstructive. There was no significant association between type of suturing and gender nor type of appendicitis. Table (1) shows the distribution of the sample by wound closure type.

Table (1) Distribution of the study sample according to the type of wound closure technique

VARIABLES		Wound closure		TOTAL	P VALUE
		Subcuticular	Vertical mattress		
Gender	Male	15(51.7%)	14(48.3%)	29(100%)	1.000
	Female	35(49.3%)	36(50.7%)	71(100%)	
Inflammation	catarrhal	33(55%)	27(45%)	60(100%)	0.221
	obstructive	17(42.5%)	23(57.5%)	40(100%)	

Thirty patients had past surgical history, 11(22%) among the subcuticular group and 19(38%) among the interrupted group. Table (2) shows no significant association was seen between the two groups (p value= 0.126)

Table (2) the distribution of patients by past surgical history according to the type of closure used

Variable		Wound closure		P value
		Subcuticular	Interrupted mattress	
Past surgical history	No	39(78%)	31(62%)	0.126
	Yes	11(22%)	19(38%)	

Smoking showed no significant association with the type of closure used (p-value= 0.317), table (3) shows the distribution of patients by smoking according to the type of suture used.

Table (3) The distribution of patients by smoking according to the type of closure used

Variable		Wound closure		P-value
		Subcuticular	Interrupted mattress	
Smoking	No	42(84%)	38(76%)	0.317
	Yes	8(16%)	12(24%)	

Eight patients stated having a positive family history of appendectomy complicated by a wound infection. No significant difference was noted between the type of wound closure and family history (p value=1.000). Table (4) shows the distribution of patients by family history according to the type of suture

Table (4) Distribution of patients by family history according to the type of closure

Variable		Wound closure		P value
		Subcuticular	Interrupted mattress	
Family history of appendectomy complicated by wound infection	No	46(92%)	46(92%)	1.000
	Yes	4(8%)	4(8%)	

Wound infection prevalence was 13/100 (13%). wound infection among 7/50 (14%) of the subcuticular suture group and 6/50 (12%) among the interrupted suture group postoperatively. Figure (3) demonstrate the percentage of wound infection according to suture type.

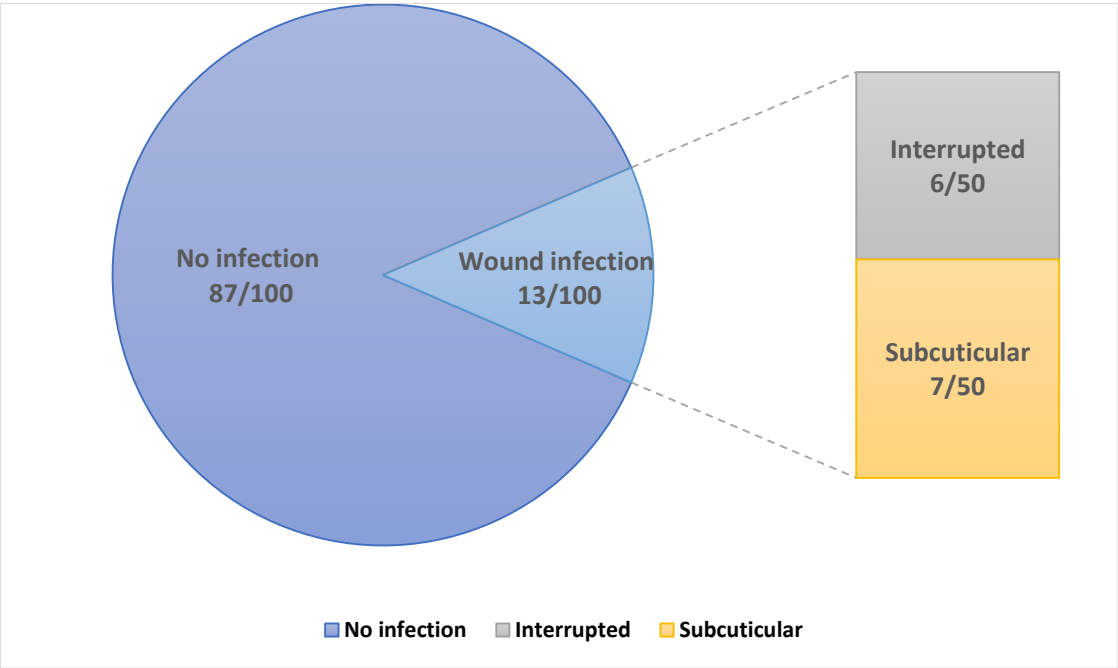

Figure (3) Percentage of wound infection according to suture type

No significant difference in developing wound infection was demonstrated between the two types of wound closure. (p-value = 0.766). Table (5) demonstrates the type of wound infection noticed in the studied group according to the type of suture used. Among the subcuticular group, 4(8%) had cellulitis and 3(6%) had pus discharge, and among the interrupted group 2 (4%) had cellulitis and 4(8%) had pus discharge, no significant association was seen (p value=0.664) between the type of infection and type of suture used.

Table (5) Types of wound infection noticed in the studied group according to the type of closure used.

Variables		subcuticular	interrupted	P-value
Type of wound infection	No infection	43(86%)	44(88%)	0.664
	Cellulitis	4(8%)	2 (4%)	
	Pus discharge	3(6%)	4(8%)	
Total		50(100%)	50(100%)	

Among the subcuticular group, only 2(28.6%) patients below the age of 20 years old had wound infection, 3(42.9%) in the 20-29 age group, and 2 (28.6%) at 30-39 years of age had wound infection. As seen in Figure (4). No significant association between age and wound infection in the subcuticular group was observed (p value=0.240). as for the interrupted vertical mattress group, wound infection was noted in 2(33.3%), 2(33.3%), 1(16.7%), and 1 (16.7%) at ages less than 20, 20-29, 30-39 and 40-49 years respectively. No significant association between age and wound infection in the interrupted group was detected (P- value=0.126).

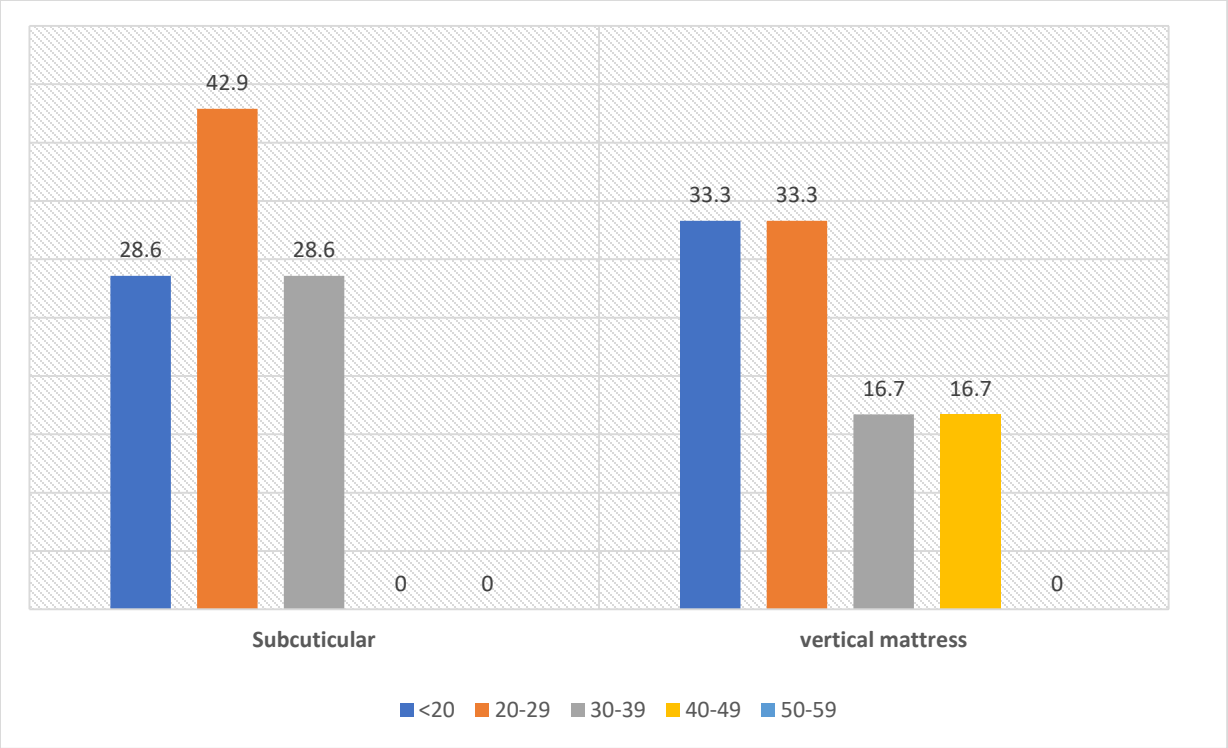

Figure (4) wound infection distribution by age categories according to type closure of

The study showed a significant association between having wound infection and the gender of the patients; table (6) shows the distribution of patients by gender according to wound infection. The majority 91.5% of women had no wound infection compared to 75.9% of men. (P-value=0.041)

Table (6) Gender distribution of the study sample according to wound infection

variables		Wound Infection		total	p-value
		NO	YES		
Gender	Male	22(75.9%)	7(24.1%)	29(100%)	**0.041**
	Female	56(91.5%)	5(8.5%)	61(100%)	

The current study illustrated no difference between the two types of wound closure and having wound infection within the follow-up period that lasted 30 days. As seen in the table (7) and figure (5) which showed no significant difference between the two types of suturing techniques (subcuticular vs interrupted) along the follow-up period. (P-value = 1.000).

Table (7) Distribution of the studied sample by type of wound closure according to the follow-up period

Follow up period	Type of wound closure				P-value
	Subcuticular		Interrupted		
	No infection	Wound infection	No infection	Wound infection	
Day 2	49(98%)	1(2%)	49(98%)	1(2%)	1.000
Day 5	47(94%)	3(8%)	47(94%)	3(6%)	1.000
Day 10	48(96%)	2(4%)	48(96%)	2(4%)	1.000
Day 30	50(100%)	0	50(100%)	0	1.000

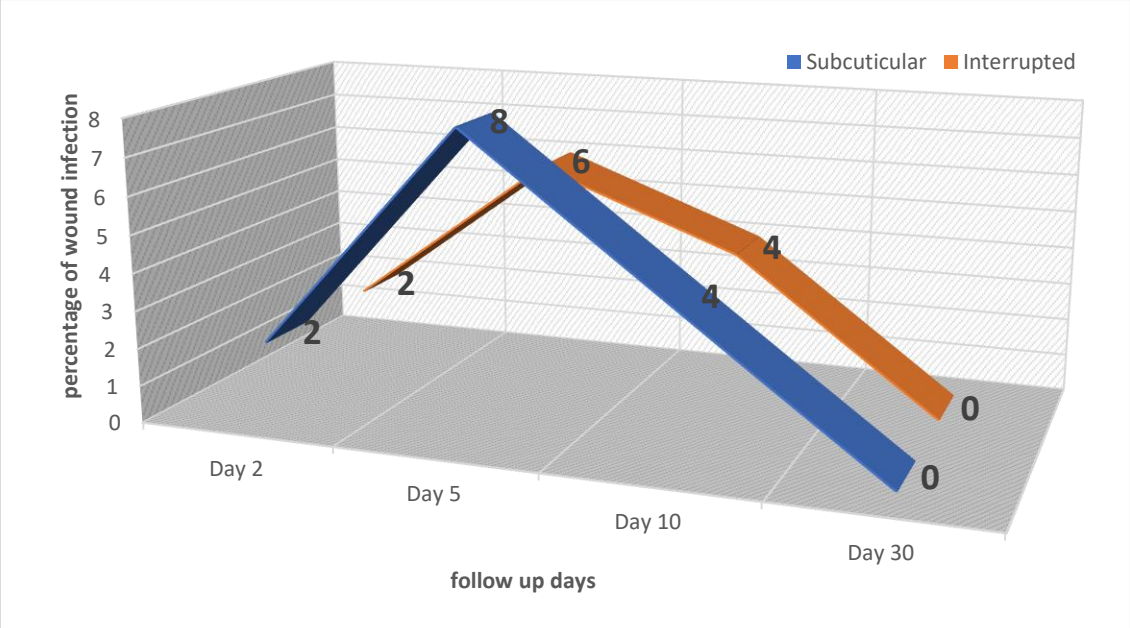

Figure (5) shows the wound infection rate per day of follow-up by type of closure.

Risk factors for wound infection in appendectomy.

Binary logistic regression was applied to predict factors that affect the occurrence of wound infection post-operatively. Table (8) shows that the odds of developing wound infection among the males is 3.44 more than the odds of developing wound infection among females. (P-value= 0.042)

Smoking showed a significant relation to wound infection, the odds of having wound infection was 4.46 among smokers than non-smokers (P-value =0.027) interestingly the odds of wound infection among patients who reported a positive family history of appendectomy and complicated by wound infection was 5.096 higher than patients with no such history (P value= 0.046)

Table (8) Binary logistic analysis

Variables	B	P value	OR	95% C.I. for OR	
				Lower	Upper
Age in years	-0.021	0.560	0.980	0.914	1.050
Male	1.237	0.042	3.447	1.046	11.362
Smoking	1.497	0.017	4.469	1.305	15.310
Subcuticular	0.390	0.546	1.477	0.416	5.238
Catarrhal appendicitis	-0.290	0.628	0.748	0.232	2.417
History of previous surgery	0.165	0.805	1.179	0.319	4.356
Family history of appendectomy complicated by wound infection	1.628	0.046	5.096	1.026	25.309

Discussion

Wound infection is one of the most researched subjects and one of the major public health issues globally and specifically among the developing countries, as the burden of wound infection would reach around 11.8% despite the variability of results reported which ranges from around 1.2 up to 23.6 per 100 surgical procedures. [8] The current study showed that wound infection occurred in 13 cases out of 100 participants (prevalence 13%), the current result is higher than that issued in a meta-analysis study published by Curcio D et al where the SSI prevalence in Africa and the Middle East was 10% [9] While our result is comparable to a study by Kehagias I et al, where the reported prevalence of wound infection was 12.8% [10] And also comparable to a study by Aranda-Narváez JM et al, where the overall wound infection rate was 13.4% [11] and to a clinical trial post appendectomy by Lee P et al [12], where the prevalence of wound infection was 14.6% while in a study by Allegranzi B et al, the pooled prevalence of infection in developing countries was 15.5% [13] The difference in results might be due to the type of study, sample size, and the fact that the data were all pooled from one center (Al Yarmook Teaching Hospital). Our result is higher than that reported in Thailand by Noorit P et al wound infection was reported at 8.7% post appendectomies [14] and higher than the results of a study from Saudi Arabia by Koumu MI et al who reported wound infection of 7.15% post appendectomies. [15] Our study results were also higher than that reported by Giesen L et al from the Netherlands, where SSI post appendectomy prevalence was 6.6% [16], and in Turkey 6.9% [17] also lower than results reported in a study by junker T et al from Switzerland where the overall SSI rate was 4.7% [18] Latin America, Asia, and China where the overall prevalence of SSI was 7%, 4%, and 4% respectively. [9] This discrepancy might indicate the socioeconomic status of research sites and the preparedness of the health systems against nosocomial infections.

The study reported wound infection among 7/50 the subcuticular suture group and 6/50 among the interrupted suture group postoperatively. No significant difference in wound infection rates was demonstrated between the two types of wound closure (subcuticular vs interrupted) throughout the follow-up period, and this is agreeing with a study by Safar A in Basra [19]

Where no significant difference in regard to wound infection was noted between skin closure approaches. Our result is also in alignment with the outcomes of a published study by Cochetti G et al 2020, where the authors found no difference in wound infection rates between wound closure techniques [20] and also with a recent meta- analysis by Sharma A et al 2021. [2] There was no significant difference in the risk of wound infection. A study by Goto S et al 2020 stated no clear difference in wound infection rates for subcuticular sutures in comparison with any other skin closure methods. [21_23]

Cellulitis and pus discharge were the main types of wound infection reported in the current study. Patients who encountered cellulitis were treated conservatively by broad spectrum antibiotic (ceftriaxone 1-gram x2 IM and metronidazole 500mg x3 orally for 5 days and re-evaluation was made). As for the patients with pus discharge, in case of subcuticular suturing a stitch removed and wick inserted with broad spectrum antibiotic (ceftriaxone 1-gram x2 IM and metronidazole 500mg x3 orally) as for interrupted suturing also a stitch removed and wick inserted with broad spectrum antibiotic (ceftriaxone 1-gram x2 IM and metronidazole 500mg x3 orally with a daily irrigation and dressing was done, and secondary closure after 7 to 10 days). Wound infections are not to be taken lightly; they account for nearly one-quarter of nosocomial infections which places them as the second most common type of hospital-based infections. [24]

The effect of wound infections lies in causing surgical procedure failure, increased morbidity, mortality, and higher health care costs as they prolong hospitalization and above all a rise in the antimicrobial-resistant bacteria emergence. The study showed that being a male, a smoker and with a positive family history of wound-infection complicated appendectomy increased the risk of having wound infection.

The odds of developing wound infection among males was 3.4 more than in females. This finding is in alignment with the result of a study by Bevin C et al [25] and by Aghdassi S et al [26], and Langelotz C et al study declared that gender differences in wound infection susceptibility exist and they are specific to the surgical procedure done. [27]

It had been confirmed that the male gender is an independent hazard factor for major infections (P=0.04) and that males had a 58% greater risk of developing a major infection [28] An overabundance of information that exists nowadays indicates estrogens can be a regulator of healing and applying systemic or topical estradiol treatment might promote healing. However, it is still not understood what effects estrogen treatment has on microbial profiles within a wound and how this differs between males and females.[29]

Further studies are needed to tackle the differences. However other studies reported no

difference in wound infection between genders [15,19,30] which might be related to differences in sampling and sample size.

Smoking showed a significant relation to wound infection, the odds of having wound infection was 4.4 among smokers than non-smokers. Nicotine and carbon monoxide decrease oxygen transport and distort the patient's immune system and so jeopardizing for higher risk of infections. It had been stated that smoking just one cigarette decreases the body's ability to deliver necessary nutrients for healing after surgery. [31] And thus it can delay wound healing. Our result is in agreement with that issued in a study by AbdulQader H and Saadi A in Iraq-Kurdistan-Erbil where the authors confirmed a significant association of smoking with SSI. [32] Several studies are in alignment with our results [33,34] Although a study by Safar A found no significant association between smoking and wound infection [19] This difference might be related to the sample size used. According to WHO records smokers who quit approximately 4 weeks or more before having surgery, usually will have a lower risk of complications and even better results 6 months afterward. [31]

The odds of wound infection among patients who reported a positive family history of appendectomy and complicated by wound infection was 5.09 more than patients with no such history. This can be related to the fact that having a family history of appendectomy does increase the risk of having appendicitis which agrees with a study by Yaseen T et al [35], and Drescher M et al [36] A possibility might indicate a genetic predisposition to developing appendicitis, or it is linked to associated inherent immune system diseases like Crohn's disease [37] or others that eventually will cause a disturbance in the immune system and leads to a higher risk of wound infection. Yet a study by Safar A found no significant association between previous family history and wound infection [19].

Conclusions

Wound infection post appendectomy was 13% for the whole sample. No significant difference between the two types of suturing techniques (subcuticular vs interrupted) in regard to wound infection risk along all the follow up period. Factors that affect the occurrence of wound infection post operatively were male gender, smoking and having positive family history of complicated appendectomy. Wound infection is a serious burden that needs to be addressed early, regardless of wound closure techniques rising awareness regarding the issue remain one an optimum method especially if risk factors like male gender, smoking and having a previous family history were considered.

References

1. Jones M, Lopez R,Deppen J. Appendicitis. In: StatPearls. Treasure Island (FL): StatPearls Publishing LLC; 2022. Available from: https://www.ncbi.nlm.nih.gov/books/NBK493193/
2. Sharma A, Rajalingam V, Nageswaran H, Best L. A meta-analysis on continuous *versus* interrupted skin closure following appendicectomy, *British Journal of Surgery*. 2021;108(8): 898–907
3. Danwang C, Bigna JJ, Tochie J, Mbonda A, Mbanga C, Nzalie R, et al. Global incidence of surgical site infection after appendectomy: a systematic review and meta-analysis. BMJ open. 2020; 10(2), e034266. https://doi.org/10.1136/bmjopen-2019-034266
4. Negut I, Grumezescu V, Grumezescu AM. Treatment Strategies for Infected Wounds. Molecules. 2018;23(9):2392.
5. Al-Janabi MS, Al-Janabi SA, Al-Mahdawi AM. Bacterial infections in patients with appendicitis in Hilla City, Iraq. Med J Babylon 2019;16:55-7
6. Bailey H, Love R, Mann C, Russell R. Bailey & Love's Short Practice of Surgery. 27th ed. London: Chapman & Hall Medical; 2018.
7. Wong J, Ho C, Scott G, Machin JT, Briggs T. Getting It Right First Time: the national survey of surgical site infection rates in NHS trusts in England. *Ann R Coll Surg Engl*. 2019;101(7):463-471.
8. WHO. report on the burden of endemic healthcare-associated infection worldwide - a systematic review of the literature. World Health Organization; 2011. Available at https://apps.who.int/iris/bitstream/handle/10665/80135/9789241501507_eng.pdf;jsessionid (accessed 12th Jun 2022)
9. Curcio D, Cane A, Fernández F, Correa J. Surgical site infection in elective clean and clean-contaminated surgeries in developing countries. Int J Infect Dis. 2019;80:34-45.
10. Kehagias I, Karamanakos SN, Panagiotopoulos S, Panagopoulos K, Kalfarentzos F. Laparoscopic versus open appendectomy: which way to go?. *World J Gastroenterol*. 2008;14(31):4909-4914.
11. Aranda-Narváez JM, Prieto-Puga Arjona T, García-Albiach B, Montiel-Casado MC, González-Sánchez AJ, Sánchez-Pérez B, Titos-García A, Santoyo-Santoyo J. Infección de sitio quirúrgico tras apendicectomía urgente: tasa global y tipo según la vía de abordaje (abierta/laparoscópica) [Post-appendectomy surgical site infection: overall rate and type according to open/laparoscopic approach].

Enferm Infecc Microbiol Clin. 2014;32(2):76-81. Spanish.
12. Lee P, Waxman K, Taylor B, Yim S. Use of Wound-Protection System and Postoperative Wound-Infection Rates in Open Appendectomy: A Randomized Prospective Trial. Arch Surg. 2009;144(9):872–875. doi:10.1001/archsurg.2009.151
13. Allegranzi B, Bagheri Nejad S, Combescure C, Graafmans W, Attar H, Donaldson L, Pittet D. Burden of endemic health-care-associated infection in developing countries: systematic review and meta-analysis. Lancet. 2011;377(9761):228-41.
14. Noorit P, Siribumrungwong B, Thakkinstian A. Clinical prediction score for superficial surgical site infection after appendectomy in adults with complicated appendicitis. *World J Emerg Surg* **13,** 23 (2018). https://doi.org/10.1186/s13017-018-0186-1
15. 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 5;13(7):e16187.
16. Giesen L, Boom A, Rossem C, Hoed P, Bas P.L. Wijnhoven B. Retrospective Multicenter Study on Risk Factors for Surgical Site Infections after Appendectomy for Acute Appendicitis Dig Surg 2017;34:103–107
17. Güler Y, Karabulut Z, Çaliş H,Serkan Şengül S. Comparison of laparoscopic and open appendectomy on wound infection and healing in complicated appendicitis. International wound journal.2020;17(4): 957-965
18. Junker T, Mujagic E, Hoffmann H, Rosenthal R, Misteli H, Zwahlen M, et al. Prevention and control of surgical site infections: review of the Basel Cohort Study. Swiss Med Wkly. 2012;142:w13616
19. Safar A. Comparative study between interrupted mattress and continuous subcuticular skin closure in regarding post appendectomy wound infection. *Basrah Journal of Surgery*, 22, 1, 2016, 17-24.
20. Cochetti G, Abraha I, Randolph J, Montedori A, Boni A, Arezzo A, Mazza E, Rossi De Vermandois JA, Cirocchi R, Mearini E. Surgical wound closure by staples or sutures?: Systematic review. Medicine (Baltimore). 2020;99(25):e20573.
21. Goto S, Sakamoto T, Ganeko R, Hida K, Furukawa TA, Sakai Y. Subcuticular sutures for skin closure in non-obstetric surgery. Cochrane Database Syst Rev. 2020 Apr 9;4(4):CD012124.
22. Smith TO, Sexton D, Mann C, Donell S. Sutures versus staples for skin closure in orthopaedic surgery: meta-analysis. BMJ. 2010 Mar 16;340:c1199.
23. Iavazzo C, Gkegkes ID, Vouloumanou EK, et al. Sutures versus staples for the management of surgical wounds: a meta-analysis of randomized controlled trials. 2011. In: Database of Abstracts of Reviews of Effects (DARE): Quality-assessed Reviews [Internet]. York (UK): Centre for Reviews and Dissemination (UK); 1995- . Available from: https://www.ncbi.nlm.nih.gov/books/NBK81152/
24. Ali K, Al-Jaff B. Source and antibiotic susceptibility of gram-negative bacteria causing superficial incisional surgical site infections. International Journal of Surgery Open. 2021;30,100318
25. Bevin C, Yoon JC, Sandra HR, Yoko F, Matthew N, Elaine L. Gender Differences in Risk of Bloodstream and Surgical Site Infection. J Gen Intern Med.2013; 28(10):1318
26. Aghdassi S, Schröder C, Gastmeier P. Gender-related risk factors for surgical site infections. Results from 10 years of surveillance in Germany. Antimicrobial Resistance & Infection Control. 2019;8. 10.1186/s13756-019-0547-x.
27. Langelotz C, Mueller-Rau C, Terziyski S, Rau B, Krannich A, Gastmeier P, Geffers C. Gender-Specific Differences in Surgical Site Infections: An Analysis of 438,050 Surgical Procedures from the German National Nosocomial Infections Surveillance System. Viszeralmedizin. 2014 Apr;30(2):114-7.
28. Offner PJ, Moore EE, Biffl WL. Male gender is a risk factor for major infections after surgery. Arch Surg. 1999 Sep;134(9):935-8; discussion 938-40. doi: 10.1001/archsurg.134.9.935. PMID: 10487586.
29. Klein S, Roberts C. Sex and Gender Differences in Infection and Treatments for Infectious Diseases. Switzerland: . Springer International Publishing; 2015 available at https://link.springer.com/content/pdf/bfm%3A978-3-319-16438-0%2F1 (accessed 12th June 2022)
30. Mehmood Y , Shafiq P, Ashraf N. Wound Infection Rate in Primary and Delayed Primary Wound Closure. P J M H S. 2020;14(3): 1555-1558
31. WHO. Smoking greatly increases risk of complications after surgery. World health organization; 2020. Available at https://www.who.int/news/item/20-01-2020-smoking-greatly-increases-risk-of-complications-after-surgery (accessed 13th june 2022)

32. AbdulQader H, Saadi A. The distribution of pathogens, risk factors and their antimicrobial susceptibility patterns among post-surgical site infection in Rizgari teaching hospital in Erbil/Kurdistan Region/ Iraq. Journal of University of Duhok;2019(22)1: 1-10
33. Sørensen LT. Wound Healing and Infection in Surgery: The Clinical Impact of Smoking and Smoking Cessation: A Systematic Review and Meta-analysis. *Arch Surg.* 2012;147(4):373–383. doi:10.1001/archsurg.2012.5
34. Ahmed HJ, Nabeel A, Tharwat IS. The Effect of Perioperative use of Prophylactic Antibiotic on Surgical Wound Infection. Iraqi Postgraduate Medi Jour. 2013: 12; 2
35. Yaseen T, Qais Z Abass Z. Impact of Family History on Acute Appendicitis – An Iraqi Study at Baghdad Teaching Hospital. *International Journal of Medical Students*.2018; *6*(2), 47–51. https://doi.org/10.5195/ijms.2018.6
36. Drescher M, Marcotte S, Grant R, Staff L. Family History Is a Predictor for Appendicitis in Adults in the Emergency Department. The western journal of emergency medicine.2012; 13. 468-71. 10.5811/westjem.2011.6.6679.
37. Stringer M. Acute appendicitis. Journal of Paediatrics and Child Health.2017; 53: 1071-1076. doi:10.1111/jpc.13737