The Relationship of Delayed Appendectomy to the Incidence of Surgical Site Infection (SSI) in Acute Appendicitis Patients: a Narrative Review

Hubungan Penundaan Apendektomi dengan Kejadian Surgical Site Infection (SSI) pada Pasien Apendisitis Akut: Tinjauan Naratif

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Abstract

Acute appendicitis is one of the most common causes of surgery worldwide. Appendectomy is a skeptical surgical intervention associated with the risk of Surgical Site Infection (SSI). The purpose of this analysis was to describe the relationship between delayed appendectomy in acute appendicitis and the incidence of SSI. Reviewers selected articles containing data on the incidence of SSI due to appendectomy delays for 3 to 48 hours from seven databases, namely Pubmed, Nature, SpringerLink, Science Direct, ProQuest, Oxford Open Access Journal, and Cochrane Library. The data source was secondary data from international articles published in 2011 to 2020 based on the PICO criteria. The data obtained were then grouped and synthesized without meta-analysis/Synthesis Without Meta-analysis (SWiM) descriptively. A total of 2,778 articles were collected, of which 24 studies met the inclusion criteria. A total of 4 articles showed an association between appendectomy delay and SSI while the other 20 articles did not show a relationship between the two. There was no relationship between appendectomy delays for less than 48 hours since hospital admission to surgery with the incidence of SSI, however a delayed for more than 48 hours showed a significant value. The results showed there was no relationship between delayed appendectomy for less than 48 hours since the time the patient was admitted to the hospital until the surgery took place, but a delayed appendectomy delay for more than 48 hours showed a significant relationship with the incidence of SSI. This narrative review supports early surgical intervention of acute appendicitis cases by considering the severity of the patient to avoid other surgical complications.

Keywords: appendectomy; delay; surgical site infection

Abstrak

Apendisitis akut menjadi salah satu penyebab pembedahan yang paling sering ditemukan di seluruh dunia. Apendektomi merupakan intervensi bedah skeptis yang berhubungan dengan risiko terjadinya

Surgical Site Infection (SSI). Tujuan analisis ini untuk mendapatkan gambaran hubungan antara penundaan apendektomi pada apendisitis akut dengan kejadian SSI. Reviewer memilih artikel yang memuat data kejadian SSI akibat penundaan apendektomi selama 3 sampai 48 jam dari tujuh basis data yaitu Pubmed, Nature, SpringerLink, Science Direct, ProQuest, Oxford Open Access Journal, dan Cochrane Library. Sumber data berupa data sekunder dari artikel internasional yang diterbitkan pada tahun 2011 hingga 2020 berdasarkan kriteria PICO. Data yang didapatkan kemudian dikelompokkan dan disintesis tanpa meta-analisis/Synthesis Without Meta-analysis (SWiM) secara deskriptif. Total artikel yang dikumpulkan adalah 2.778 artikel, sebanyak 24 studi memenuhi kriteria inklusi. Sebanyak 4 artikel menunjukkan hubungan antara keterlambatan apendektomi dengan SSI sedangkan 20 artikel lainnya tidak menunjukkan hubungan keduanya.Tidak ada hubungan penundaan apendektomi kurang dari 48 jam sejak masuk rumah sakit hingga operasi dengan insidensi SSI namun penundaan lebih dari 48 jam menunjukkan nilai yang signifikan. Berdasarkan hasil analisis, disimpulkan bahwa tidak terdapat hubungan penundaan apendektomi selama kurang dari 48 jam sejak pasien masuk rumah sakit hingga proses pembedahan berlangsung tetapi penundaan apendektomi lebih dari 48 jam menunjukkan adanya hubungan signifikan terhadap kejadian SSI. Tinjauan naratif ini mendukung intervensi bedah yang cepat pada kasus apendisitis akut dengan mempertimbangkan tingkat keparahan pasien dan untuk menghindari komplikasi pembedahan lain.

Kata kunci : apendektomi; penundaan; surgical site infection

INTRODUCTION

Appendicitis is an inflammation in the verimiformis appendix, a narrow and dead-end with a length of 5-9 cm before the caecum.[1] Acute appendicitis is one of the causes of surgery throughout the world attacking 160/100,000 people in the Middle East till 206/100,000 people in Asia.[2] The highest incidence of appendicitis occurs in children and young adults, but theoretically, acute appendicitis can occur at any age with a ratio of men and women by 1.4:1.[3]

Appendectomy is the best management of handling appendicitis. Since the first appendectomy was carried out by McBurney in 1864, the appendix appointment operation was considered a standard of treatment for acute appendicitis. There are two types of appendectomy, namely open and laparoscopic appendectomy. At present, laparoscopic appendectomy is the standard of new care in Western countries.[4] Apart from the surgery technique carried out, the appendectomy remains a skeptical surgical intervention relating to the risk of the occurrence of the Surgical Site Infection (SSI). Surgical Site Infection is a postoperative nosocomial infection in the incision area, inner tissue, and organs within 30 days after the surgical procedure. In appendicitis cases, SSI is a serious medical problem that increases the financial burden, health care systems, and patient's individual condition. This infection also affects patients' quality of life.[5]

Teixeira et al. in 2012 has reported that the delay of the appendectomy for more than 6 hours increases the risk of SSI, while Gurien has not found their correlation.[6,7] This heterogenity may reflect the limitations of the method and quality of existing research data, aswell as the definition variations used to determine the research group. Although extensive research has been conducted, the relationship between delayed appendectomy and the risk of complications of appendicitis, especially SSI is still not convincing. Hence the purpose of this narrative was to describe the relationship between delayed appendectomy and the incidence of SSI in acute appendicitis based on literature with heterogeneous data.

METHODS

Potential relevant articles were comprehensively searched using Cochrane Library, PubMed, Nature, ProQuest, Springer, Science Direct, and Oxford Free Access Journal that studied the Surgical Site Infection among appendectomy patients in ten years (2011 to 2020). A literature research was conducted from December 2020 to January 2021. Article search was done by using Advanced Search, Boolean Operators, and Bibliographic Searching according to keywords combined with MeSH synonyms.

The keywords and its synonym according to MeSH were appendectomy, appendicitis, appendicectomy, early, time, timing, surgical site infection, surgical wound infection, and postoperative wound infection. These keywords were combined using a Boolean operator AND and OR. A flow diagram describing the study selection process is shown in Figure 1.

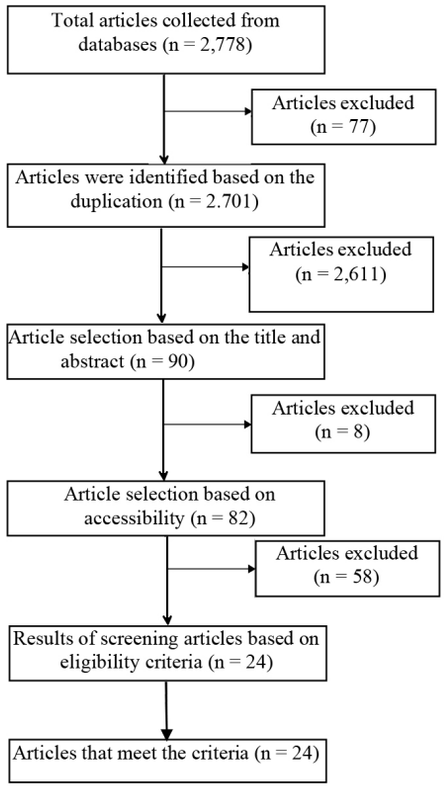

Figure 1. Flow Chart of The Data Selection

This narrative review considered all studies conducted in all countries that reported SSI after delayed appendectomy. Appendectomy delay in this study was defined as the time lag since the patient was admitted to the hospital by appendectomy (intra-hospital delay) within 3-48 hours. The sample in this study was obtained after the entire population was collected through the selection stage. The selection started with the exclusion of the duplicated article, the suitability of the title, abstract, accessibility, and the feasibility criteria that have been determined. Based on the feasibility criteria, we read their titles and abstracts. If studies were relevant for our review,we examined the full texts. Studies of other SSI risk factors and studies on surgical risk factors besides appendectomy were excluded. We reviewed all study types with original data published in the English language. Our literature eligibility criteria were using PICOS (population, intervention, comparison, outcome, and studies).

One reviewer (W.A) independently screened literature titles and abstracts and excluded irrelevant studies. Data from eligible studies were extracted and crosschecked to review the accuracy by the second and the third author (E.S and E.E). We collected literature characteristic data, including research study design, research location, large sample, data retrieval period, and its inclusion criteria. Patient's characteristic data, including age and gender were extracted. Duration of follow-up, time delays (3 to 48 hours) in appendectomy, the incidence of SSI, and the relationship of delaying appendectomy to the incidence of SSI were also extracted. Data synthesis was done without meta-analysis. Data synthesis was done without meta-analysis/Syntnesis Without Meta-analysis (SWiM). Data were analyzed and described descriptively. Researchers draw conclusions based on results obtained from the synthesis and analysis process.

RESULTS

After conducting the research process according to the specified keyword. There were 2,778 articles collected from seven databases. We identified 24 studies that met our inclusion criteria. There were two types of study design, namely 23 articles were cohort-retrospective research and 1 article was cohort-prospective research. The studies in the articles were carried out in 5 different countries. Fourteen (14) studies were conducted in the United States, 6 were held in the Republic of Korea, 2 studies were in Switzerland, 1 was done in Sweden, and 1 was performed in Estonia.

The sample size of each article was different depending on the number of patients of each research location, and the inclusion criteria were specified by each researcher. The characteristic of the studies included is shown in Table 1.

The research conducted in the selected article showed the age and percentage of different sexes. Of the 24 articles, 7 of them were specializing in the children's population, 9 articles had adult patients, 7 articles did not specialize in certain age groups, and 1 article that did not include age demographic data. Based on the percentage of sex, the majority of articles showed that the case of acute appendicitis and more appendectomy occur in male than female patients. There were 23 of 24 articles that had a percentage of male patients more than female patients while article by Fair et al. showed more female patients' percentages than male. Patients' groupings and relationship of appendectomy to SSI incidence are presented in Table 2.

DISCUSSION

There are various risk factors associated with the occurrence of SSI. It depends on factors related to patients (eg. age, comorbid disease) and procedural factors (for example the duration of the operation, type of wound, and use of prophylactic antibiotics). In appendicitis, other factors have been reported, namely diabetes mellitus, obesity, and nutritional factors. Complex appendicitis, especially the type of gangrene and perforation, is related to the greater risk of SSI.[8]

Based on the selection of articles, 24 articles discussed the relationship between delayed appendectomy since the patient hospital admission with the incidence of Surgical Site Infection (SSI). The durations of the postpontment ranged from 3 hours to more than 48 hours, depending on the grouping performed by the previous researchers. A total of 4 articles showed a relationship between delayed appendectomy and the incidence of SSI while 20 other articles did not show any association. The length of follow-up time was mostly 30 days.

Alore et al. (2018), Fair et al. (2015), Teixiera et al. (2012), and Udgiri et al. (2011) have shown the relations of delayed appendectomy with the incidence of SSI while the other 20 articles show no significant relationship. There are several reasons for the delay before the surgical procedure. A study in South Korea states that delays can occur due to various factors, such as patients' treatment time, evaluation time, surgical consultation, pre-existing surgical schedules, and the patient's nil per os (fasting) time.[10] McIsaac et al. cited the reason for the delay, namely the increase in cases that were not accompanied by the number of staff, especially on night shifts and the availability of operating rooms.[11] Besides, a delay is also needed to maintain adequate patient resuscitation and reduce surgeon fatigue due to overnight surgery.[12]

Alore et al. (2018) mentioned appendectomy performed at a delay of 3 days had a worse outcome as indicated by an increase in mortality at 30 days, and all postoperative complications than a delay of 1 day and/or two days. After adjustment for confounding variables, it was found that appendectomy delay was not

Table 1. Characteristic of The Selected Articles

Author	Year	Study Design	Location	Sample Size	Data Collection	Inclusion Criteria
Abbas et al.[14]	2016	Cohort Retrospective	USA (Texas)	1.211	1 January 2013 – 31 May 2014	- ≤18 years old - Excludes incidental appendicitis, interval appendicitis, or negative appendicitis
Aiken et al.[15]	2020	Cohort Retrospective	USA (Wisconsin)	1.372	January 2014 – December 2018	- ≥18 years old - Appendectomy performed before 24 hours after admission
Almstrom et al.[16]	2017	Cohort Retrospective	Sweden	2.756	2006 – 2013	- 0 – 15 years old - Appendectomy in suspect appendicitis
Alore et al.[13]	2018	Cohort Retrospective	USA (Texas)	112.122	2012 – 2015	- Delay ≤4 days - Excludes incidental appendicitis, interval appendicitis, or negative appendicitis
Boomer et al.[17]	2014	Cohort Retrospective	USA (Ohio)	1.388	1 January 2010 – 31 December 2012	- ≤18 years old - Diagnosed appendicitis - Excludes incidental appendicitis, interval appendicitis, or negative appendicitis
Boomer et al.[18]	2016	Cohort Retrospective	USA (Ohio)	1.338	1 January 2010 – 30 June 2012	- ≤18 years old - Diagnosed appendicitis - Excludes incidental appendicitis, interval appendicitis, or negative appendicitis - Listed in The National Surgical Quality Improvement Program for Pediatrics (NSQIP-Pediatrics)
Busch et al.[19]	2011	Cohort Retrospective	Switzerland	1.675	January 2003 – January 2006	- >16 years old - Suspect appendicitis in 6 hospitals
Eko et al.[20]	2013	Cohort Retrospective	USA (Massechussets)	396	1 January 2005 – 31 December 2007	- All patients underwent appendectomy - Excludes incidental appendicitis, interval appendicitis, or negative appendicitis
Fair et al.[21]	2015	Cohort Retrospective	USA (Illinois)	69.926	2007 – 2012	- Nonperforated appendicitis - Listed in The American College of Surgeons NSQIP (ACS-NSQIP)
Gurien et al.[8]	2016	Cohort Retrospective	USA (Arkansas)	484	January 2009 – December 2012	- Pediatric surgery patients - Suspect appendicitis and confirmed - Nonperforated appendicitis
Jeon et al.[22]	2016	Cohort retrospective	Republic of Korea	4.148	January 2008 – December 2013	- Suspect appendicitis - Excludes incidental appendicitis, interval appendicitis, or negative appendicitis
Jeon et al.[23]	2018	Cohort Retrospective	Republic of Korea	5.956	January 2008 – December 2016	- Excludes incidental appendicitis, interval appendicitis, or negative appendicitis
Kim H. K. et al.[10]	2016	Cohort Retrospective	Republic of Korea	4.065	January 2010 – December 2014	- Suspect appendicitis - Laparoscopic appendectomy - Excludes incidental appendicitis, interval appendicitis, or negative appendicitis
Kim M. et al.[24]	2015	Cohort Retrospective	Republic of Korea	397	October 2013 – August 2014	- Thickened appendix >6 mm in diameter, thickened walls, or peri appendix fat infiltration. Noncomplicated appendicitis
Kim S.H. et al.[25]	2015	Cohort Retrospective	Republic of Korea	1.805	January 2007 – February 2012	- Nonperforated appendicitis - Excludes incidental appendicitis, interval appendicitis, or negative appendicitis
Nagpal et al.[26]	2012	Cohort retrospective	USA	353	January 2009 – December 2010	- Patients operated in 24 hours after diagnosis - The patient remains at the same health care provider after diagnosis
Saar et al.[27]	2016	Cohort prospective	Estonia	266	1 November 2013 – 1 December 2014	- >18 years old - Agree on *informed consent* - Did not accept previous nonoperating management for the same complain

Author	Year	Study Design	Location	Sample Size	Data Collection	Inclusion Criteria
Saluja et al.[28]	2018	Cohort Retrospective	USA (New York)	8.840	2000 – 2013	- ≤18 years old - No noncomplicated appendicitis history - Diagnosed with acute appendicitis and generalized peritonitis or with a peritoneal abscess
Sauvain et al.[29]	2016	Cohort retrospective	Switzerland	2.559	12 February 2007 – 28 March 2011	- Suspect appendicitis in 6 hospitals in Zurich region - >16 years old
Serres et al.[9]	2017	Cohort Retrospective	USA (Massechusset)	2.429	1 January 2013 – 31 December 2014	- ≤18 years old - Appendectomy in 24 hours after admission - Listed in NSQIP-*Pediatric*
Seudeal et al.[30]	2018	Cohort retrospective	USA	116	March 2015 – March 2016	- 18 – 90 years old - Diagnosed with appendicitis - Non pregnant - Initial examination and appendectomy were performed at the same hospital
Shin et al. [31]	2014	Cohort retrospective	Republic of Korea	333	1 January 2011 – 31 December 2011	- 16 – 65 years old - Not in a state of pregnancy or in intensive care - Diagnosis of appendicitis
Taixiera et al.[7]	2012	Cohort Retrospective	USA (California)	4.108	June 2003 – June 2011	- All patients underwent an appendectomy
Udgiri et al.[32]	2011	Cohort retrospective	USA	201	2009	- Excludes incidental appendicitis, interval appendicitis, or negative appendicitis

Table 2. Articles Review of the Appendectomy and SSI Relationship

Author, Year	Patient Groupings	Appendectomy-SSI	
		Related	Not Related
Abbas et al., 2016	Patients were divided into two groups, namely patients with postoperative complications and patients without complications.		√
Aiken et al., 2020	Patients were divided into two groups, namely the group that was operated on in 12 hours and >12 hours.		√
Almstrom et al., 2017	Patients were divided into 4 groups, namely groups with interval from admission to appendectomy for 0-12 hours, 12-24 hours, 24-36 hours, and> 36 hours.		√
Alore et al., 2018	Patients were divided into 3 groups, namely the group with interval of admission to surgery in 1 day (HD1), 2 days (HD 2), 3 days (HD3).	√	
Boomer et al., 2014	Patients were divided into 5 groups between admission and appendectomy, namely <3 hours, 3-6 hours, 6-9 hours, 9-12 hours, and >12 hours group.		√
Boomer et al., 2016	Patients were divided into 5 groups between admission and different appendectomy, namely <3 hours, 3-6 hours, 6-9 hours, 9-12 hours, and >12 hours groups.		√
Busch et al., 2011	Patients were divided into two groups, the time between admission and appendectomy was different, namely the group ≤12 hours and >12 hours.		√
Eko et al., 2013	Patients were grouped into 4 groups of operative time, namely ≤6 hours, 6-12 hours, 12-18 hours, and >18 hours.		√
Fair et al., 2015	Patients were divided into 3 groups, namely Group 1 with a delay of <24 hours, Group 2 24-48 hours, and Group 3 >48 hours.	√	
Gurien et al., 2016	Patients were grouped into 2 groups of time from admission to the patient entering the operating room, namely the group <6 hours and >6 hours.		√
Jeon et al., 2016	Delays were grouped into 4 groups, namely the group ≤6 hours, 6-12 hours, 12-18 hours, and >18 hours.		√
Jeon et al., 2018	Delays were grouped into 2 groups, namely groups ≤12 hours and >12 hours.		√
Kim H.K. et al., 2016	Kim S.H. et al.,2015		
Patients were divided	into 4 groups, namely Group A with a delay of 0-6 hours, Group B 6-12 hours, Group C 12-18 hours, and Group D >18 hours.		√
	Patients were divided into two groups of time lag from admission to hospital and appendectomy, namely the Immediate group at 12 hours and the delay of 12-24 hours.		√
Kim M. et al., 2016	Patients were grouped into 2 groups of delay, namely <6 hours and 6-24 hours.		√

Author, Year	Patient Groupings	Appendectomy-SSI	
		Related	Not Related
Nagpal et al., 2012	The time lag between the surgical decision and incision was ≤6 hours (Early) and> 6 hours (Late).		√
Saar et al., 2016	Patients were stratified according to surgical relief of abdominal pain. There are 4 groups, namely 0-12 hours, 13-24 hours, 25-36 hours, 37-48 hours, and >48 hours.		√
Saluja et al., 2018	Patients were grouped into 2 groups, namely the group with a gap in admission time with surgery of 2 days (Early) and more than 2 days (Late).		√
Sauvain et al., 2016	Patients were divided into 2 groups, namely surgical interval <360 minutes and ≥360 minutes.		√
Serres et al., 2017	Patients were grouped into 2 groups, namely Early and Late based on the time lag from admission to the ER with appendectomy based on the median time delay.		√
Seudeal et al., 2018	Patients were divided into 2 groups, namely the time lag to intervention within 8 hours (Group 1) and after 8 hours (Group 2).		√
Shin et al., 2014	Patients were grouped into 2 groups, namely Group A with a time lag of ≤8 hours from arrival at the hospital by incision and Group B >8 hours.		√
Taixiera et al. 2012	Patients were divided into 2 groups, namely <6 hours and> 6 hours.	√	
Udgiri et al.,2011	The time lag between incision and arrival at the ER was less than 10 hours (Group A) and more than 10 hours (Group B) after arriving at the ER.	√	

a significant predictor of major complications, but rather the type of procedure and ASA-PS grade.[13] Fair et al. (2015) showed there is a significant relations between the delay of 24, 48, and >48 hours with wound infection. After adjusting for confounding variables, the risk was attenuated, but it still increased for the group that experienced a delay of> 48 hours, whereas there was still no increased risk for a delay of 2 days compared to 1 day.[21] Udgiri et al. (2011) demonstrated that patient delay >10 hours had a significant association with an increase in SSI but not significant for superficial SSI. Besides that, the delay also shows a significant relationship with the length of stay.[26]

Aiken et al. (2020) showed no significant difference between delayed cases of >12 hours and non delayed cases for surgery time (within 12 hours), intraoperative findings, rates of perforation, or postoperative complications including SSI. However, despite being declared safe, delayed appendectomy was associated with increased length of stay and increased total hospital costs compared to appendectomy within 12 hours of reaching the emergency room.[15]

Likewise, the results are shown by Almstorm et al. (2017) and Boomer et al. (2016, 2018). Six studies conducted in the Republic of Korea showed no association with delayed appendectomy with SSI.[10,22–26] But the delay has an impact on the length of stay and other postoperative complications such as ileus. The six studies show that a delay of 24 hours is still relatively safe. These results are consistent with Gurien et al. (2016) that there was no statistical significance indicating SSI or perforation was associated with delayed appendectomy, but white blood count at admission was significant with perforation.[7]

Based on a review conducted by reviewers from 24 articles discussing the relationship between delayed appendectomy and SSI, it is known that the delayed in appendectomy since the patient was admitted to the hospital until the surgical process took place was not associated with an increased risk of SSI if the delay was less than 48 hours. Nonetheless, this narrative review supports prompt surgical intervention of acute appendicitis cases considering the severity of the patient.

CONCLUSION

A delayed appendectomy since the surgery admission time does not show any significant correlations to the incidence of SSI. Appendectomy should be done immediately to reduce other postoperative complications by considering the severity of acute appendicitis.

SUGGESTIONS

The decision of surgery schedule and postponement of the appendectomy should be under the consideration of the severity of the patient condition through a review of the clinical condition and the results of investigations.

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REFERENCES

1. Sellars H, Boorman P. Acute appendicitis. Surg [Internet]. 2017;35(8):432–8.
2. Martínez-Pérez A, Payá-Llorente C , Santarrufina-Martínez S, Sebastián-Tomás JC, Martínez-López E, de'Angelis N. Predictors for prolonged length of stay after laparoscopic appendectomy for complicated acute appendicitis in adults. Surg Endosc [Internet]. 2020;(0123456789). Available from: https://doi.org/10.1007/s00464-020-07841-9
3. Dixon F, Singh A. Acute appendicitis. Surg[Internet]. 2020;38(6):310–7. Available from: http://www.sciencedirect.com/science/article/pii/S0 26 3931920300715
4. Becker P, Fichtner-Feigl S, Schilling D. Clinical management of appendicitis. Visc Med. 2018;34(6):453–8.
5. Badia JM, Casey AL, Petrosillo N, Hudson PM, Mitchell SA, Crosby C. Impact of surgical site infection on healthcare costs and patient outcomes: a systematic review in six European countries. J Hosp Infect [Internet]. 2017;96(1):1–15. Available from: http://dx.doi.org/10.1016/j.jhin.2017.03.004
6. Teixeira PG, Sivrikoz E, Inaba K, Talving P, Lam L, Demetriades D. Appendectomy timing: waiting until the next morning increases the risk of surgical site infections. Ann Surg. 2012 Sep;256(3):538–43.
7. Gurien LA, Wyrick DL, Smith SD, Dassinger MS. Optimal timing of appendectomy in the pediatric population. J Surg Res [Internet]. 2016;202(1):126–31. Available from: http://www.sciencedirect.com/science/article/pii/S0 02 2480415012044.
8. Garcell HG, Arias AV, Sandoval CP, Valle Gamboa ME, Sado AB, Alfonso Serrano RN. Impact of a focused antimicrobial stewardship program in adherence to antibiotic prophylaxis and antimicrobial consumption in appendectomies. J Infect Public Health.2017;10(4):415–20.
9. Serres SK, Cameron DB, Glass CC, Graham DA, Zurakowski D, Karki M, et al. Time to Appendectomy and Risk of Complicated Appendicitis and Adverse Outcomes in Children. JAMA Pediatr. 2017 Aug;171(8):740–6.
10. Kim HK, Kim YS, Lee SH, Lee HH. Impact ofa Delayed Laparoscopic Appendectomy on the Risk of Complications in Acute Appendicitis: A Retrospective Study of 4,065 Patients. Dig Surg. 2016;34(1):25–9.
11. McIsaac DI, Abdulla K, Yang H, Sundaresan S, Doering P, Vaswani SG, et al. Association of delay of urgent or emergency surgery with mortality and use of health care resources: A propensity score-matched observational cohort study. Cmaj.2017;189(27):E905–12.
12. Burjonrappa S, Rachel D. Pediatric appendectomy: Optimal surgical timing and risk assessment. Am Surg. 2014;80(5):496–9.
13. Alore EA, Ward JL, Todd SR, Wilson CT, Gordy SD, Hoffman MK, et al. Population-level outcomes of early versus delayed appendectomy for acute appendicitis using the American College of Surgeons National Surgical Quality Improvement Program. J Surg Res [Internet].2018;229:234–42. Available from: http://www.sciencedirect.com/science/article/pii/S0 02 2480418302506

14. Abbas PI, Peterson M, Stephens LJ, Rodriguez JR, Lee TC, Brandt ML, et al. Evaluating the effect of time process measures on appendectomy clinical outcomes. J Pediatr Surg [Internet]. 2016;51(5):810–4. Available from:http://www.sciencedirect.com/science/article/pii/S0022346816000907

15. Aiken T, Barrett J, Stahl CC, Schwartz PB, Udani S, Acher AW, et al. Operative Delay in Adults with Appendicitis: Time is Money. J SurgRes [Internet]. 2020;253:232–7. Available: http://www.sciencedirect.com/science/article/pii/S0 02 2480420301700

16. Almström M, Svensson JF, Svenningsson A, Hagel E, Wester T. Population-based cohort study on the epidemiology of acute appendicitis in children in Sweden in 1987-2013. BJS Open. 2018;2(3):142–50.

17. Boomer LA, Cooper JN, Deans KJ, Minneci PC, Leonhart K, Diefenbach KA, et al. Does delay in appendectomy affect surgical site infection in children with appendicitis? J Pediatr Surg [Internet]. 2014;49(6):1026–9. Available from: http://www.sciencedirect.com/science/article/pii/S0 02 2346814000530

18. Boomer LA, Cooper JN, Anandalwar S, FallonSC, Ostlie D, Leys CM, et al. DelayingAppendectomy Does Not Lead to Higher Rates of Surgical Site Infections: A Multi-institutional Analysis of Children With Appendicitis. Ann Surg. 2016 Jul;264(1):164–8.

19. Busch M, Gutzwiller FS, Aellig S, Kuettel R, Metzger U, Zingg U. In-hospital delay increases the risk of perforation in adults with appendicitis. World J Surg. 2011;35(7):1626–33.

20. Eko FN, Ryb GE, Drager L, Goldwater E, Wu JJ, Counihan TC. Ideal timing of surgery for acute uncomplicated appendicitis. N Am J Med Sci. 2013;5(1):22–7.

21. Fair BA, Kubasiak JC, Janssen I, Myers JA, Millikan KW, Deziel DJ, et al. The impact of operative timing on outcomes of appendicitis: a National Surgical Quality Improvement Project analysis. Am J Surg [Internet]. 2015;209(3):498–502. Available from:http://www.sciencedirect.com/science/article/pii/S000 2961014006072

22. Jeon BG, Kim HJ, Jung KH, Lim HI, Kim SW, Park JS, et al. Appendectomy: Should it be performed so quickly? Am Surg. 2016;82(1):65–74.

23. Jeon BG, Kim HJ, Heo SC. CT Scan Findings Can Predict the Safety of Delayed Appendectomy for Acute Appendicitis. J Gastrointest Surg. 2018;1856– 66.

24. Kim M, Oh ST. Effect of time delays for appendectomy as observed on computed tomography in patients with noncomplicated appendicitis. Am J Emerg Med [Internet]. 2016;34(2):167–9. Available from: http://dx.doi.org/10.1016/j.ajem.2015.10.009

25. Kim SH, Park SJ, Park YY, Choi S Il. Delayed appendectomy is safe in patients with acute nonperforated appendicitis. Int Surg. 2015;100(6):1004–10.

26. Nagpal K, Udgiri N, Sharma N, Curras E, Cosgrove JM, Farkas DT. Delaying an appendectomy: Is it safe? Am Surg. 2012;78(8):897–900.

27. Saar S, Talving P, Laos J, Põdramägi T, Sokirjanski M, Lustenberger T, et al. Delay Between Onset of Symptoms and Surgery in Acute Appendicitis Increases Perioperative Morbidity: A Prospective Study. World J Surg. 2016 Jun;40(6):1308–14.

28. Saluja S, Sun T, Mao J, Steigman SA, Oh PS, Yeo HL, et al. Early versus late surgical management of complicated appendicitis in children: A statewide database analysis with one- year follow-up. J Pediatr Surg. 2018 Jul;53(7):1339–44.

29. Sauvain M-O, Slankamenac K, Muller MK, Wildi S, Metzger U, Schmid W, et al. Delaying surgery to perform CT scans for suspected appendicitis decreases the rate of negative appendectomies without increasing the rate of perforation nor postoperative complications. Langenbeck's Arch Surg. 2016 Aug;401(5):643– 9.

30. Seudeal K, Abidi H, Shebrain S. Early versusdelayed appendectomy: A comparison ofoutcomes. Am J Surg [Internet]. 2018;215(3):483–6. Available from: http://www.sciencedirect.com/science/article/pii/S0 00 2961017310784

31. Shin CS, Roh YN, Kim JI. Delayed appendectomy versus early appendectomy in the treatment of acute appendicitis: A retrospective study. World J Emerg Surg. 2014;9(1):1–6.

32. Udgiri, N., E. Curras, V. K. Kella, K. Nagpal,dan J. Cosgrove. Appendicitis? Is it an Emergency? The American Surgeon.2011;77(7):898-900.

33. Danwang, C., T. N. Mazou, J. N. Tochie, R. N. Nzalie, dan J. J. Bigna. Global prevalence and incidence of surgical site infections after appendectomy: A systematic review and meta-analysis protocol. BMJ Open. 2018;8(8): 1–4.

34. Chen, C.C., C. T. Ting, M. J. Tsai, W. C. Hsu, P. C. Chen, M. D. Lee, M. H. Liu, dan H. C. Shih. Appendectomy timing: Will delayed surgery increase the complications? Journal of the Chinese Medical Association. 2015;78(7): 395–399