



The risk factors for infected and perforated appendicitis

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ABSTRACT

It is believed that the appendix will be perforated if the surgery of an acute appendicitis is delayed. However, some of the recent studies, contested this hypothesis and shown that only a delay in the treatment cannot fully explain perforated appendicitis. This study aimed to examine the prevalence and risk factors for perforated appendicitis in patients with acute appendicitis. A cross-sectional study was conducted in Shahid Beheshti Medical center. Data from 526 patients diagnosed with acute appendicitis were extracted from file related to the patients who undergone appendectomy since 2011 till the end of 2015. Performing an appendectomy after more than 48 hours from the onset of symptoms was defined as a delayed appendectomy. Data related to the patients' age, gender, type of appendicitis, and the delay in appendectomy were gathered using a checklist. Descriptive statistics (frequency, percentage) were used to describe the data. Chi-square and Fisher's exact tests were used to analyze the data. Among the 526 patients with a diagnosis of acute appendicitis, 24.3% were perforated while 75.7% were non-perforated appendicitis. Of the total patients, 72.2% were referred to the hospital and were operated in less than 48 hours while 27.8% were referred and operated with a delay more than 48 hours. The rate of septic appendicitis was 55.5% and 72.6% in patients without and with delayed appendectomy, respectively but the rate of perforated appendicitis was 28.9% and 12.3% in patients without and with delayed appendectomy, respectively (P value < 0.05). The majority of cases of perforated appendicitis were occurred males (73.4%) and in the age range of 15 to 34 years (33.8%). Physiopathology of perforated appendicitis is very complex and a delay in appendectomy cannot fully justify the physiopathology of perforated appendicitis. The fact that perforation cannot fully explained be a delay in appendectomy may prevent many cases of unnecessary surgeries in patients with acute appendicitis. Further studies are recommended to confirm the findings of the present study.

Keywords: Acute appendicitis, perforated appendicitis, infected appendix.

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INTRODUCTION

Acute appendicitis is the most common cause of acute surgical abdomen. In developed countries, almost one out of every 1,000 people gets acute appendicitis each year [1]. Despite the numerous studies on patients with acute appendicitis, it is still a clinical challenge facing general surgeons and its etiology is not completely understood. Obstruction of the lumen due to fecaliths, hyperplasia of the lymphoid tissue or foreign bodies are proposed as the most common causes of acute appendicitis. When the lumen of appendix is obstructed, the intraluminal pressure will increase due to bacterial growth and mucus accumulation. Then, the appendix becomes inflamed and edematous and its wall becomes ischemic and necrotic. Finally, the gangrenous appendix is perforated and its contents are spread in the abdominal cavity, causing peritonitis [2].

Approximately 300,000 appendectomies are performed in the United States of America annually. Most of these surgeries are performed on an emergency basis to avoid the mortality due to complications such as perforation and peritonitis [3]. Studies

have shown that the mortality of appendicitis will increases up to 3.5- to 10-fold if the appendix is perforated [4]. It is believed

that the appendix will be perforated if the surgery of an uncomplicated acute appendicitis is delayed. However, some of the recent studies, contested this hypothesis and shown that only a delay in the treatment cannot fully explain the perforation of appendix. Biological evidences suggest that appendicitis is the result of a severe immune response and immune response in non-perforated appendicitis is quite different from the perforated one. In other words, perforation does not occur due to an exacerbated immune response [5]. On the other hand, recent studies have shown that a high percentage of patients with appendicitis have improved only through antibiotic therapy. Such findings are in contrast with the assumption that all cases of appendicitis need surgery [6].

It is still unknown that why appendix becomes perforated in some patients. Complications of a perforated appendicitis are so dangerous that physicians usually prefer to remove the appendix surgically. The fear of a perforated appendicitis has led the surgeons to accept the possibility of removal of an unaffected appendix so that even up to 30% negative appendectomy is acceptable [7].

Physiopathology of perforated appendicitis is very complex and the delay in treatment cannot fully justify this physiopathology. Evidence suggests that in many patients the

appendix became perforated before the patients come to the doctors for their abdominal pain. Such evidence confirms the claim that perforation might be the result of a number of factors such as infection, genetic factors and the structure of the appendiceal wall. These hypotheses if confirmed show that physicians usually have enough time to implement nonsurgical treatments such as the antibiotic therapy without fear of perforation and its complications such as surgical site infection, bowel obstruction caused by adhesions, pneumonia and women's infertility [1, 2].

OBJECTIVES

In this study, we examined the risk factors for perforated appendicitis in patients with acute appendicitis. We also examined the rate of appendix perforation due to delayed appendectomy.

MATERIALS AND METHODS

This cross-sectional study was conducted in Shahid Beheshti Medical center. This hospital is located in centre of Iran. Data from 526 patients diagnosed with acute appendicitis were extracted from file related to the patients who undergone appendectomy since 2011 till the end of 2015.

Firstly the files of all patients who were admitted with the diagnosis of appendicitis were evaluated and the files of patients with a confirmed medical diagnosis of acute appendicitis and without any other medical or surgical comorbidity were enrolled. Performing an appendectomy after more than 48 hours from the onset of symptoms was considered as a delayed appendectomy [8, 9]. Data related to the patients' age, gender, type of appendicitis (according to the pathology report), and the delay in appendectomy (yes/no) were gathered using a checklist.

Ethical Considerations

This study was approved by the Research Ethics Committee and permission was obtained from the hospital authorities.

Personal information of patients and surgeons were kept confidential.

Data Analysis

The data was analyzed using SPSS software Version 13 (SPSS, Chicago, IL, USA). Descriptive statistics (frequency, percentage) were used to describe the data. Chi-square and Fisher's exact tests were used to analyze the data. P values less than 0.05 were considered significant for all tests.

RESULTS

Among the 526 patients who were hospitalized with a diagnosis of acute appendicitis, the majority (60.2%) were septic appendicitis. Of the total cases, 24.3% were perforated while 75.7% were non-perforated appendicitis. Of the total patients, 72.2% were referred to the hospital and were operated in less than 48 hours while 27.8% were referred and operated with a delay more than 48 hours. The rate of perforated appendicitis was 28.9% and 12.3% in patients without and with delayed appendectomy, respectively (P value < 0.05) (Table 1). The majority of patients were male (61.9%) while 38.1% were female. Table 2 presents the frequencies of perforated and non-perforated appendicitis among males and females (P value = 0.017).

The majority of cases of perforated appendicitis were occurred in the age range of 15 to 34 years (33.8%) while only 8% of perforations have been occurred in people over 65 years old (P value = 0.001) (Table 3).

Of 128 patients with perforated appendicitis, 31 ones (24.2%) have used analgesics and/or antibiotics before hospital admission. However, this rate was 25.9% among patients with a non-perforated appendicitis (P value <0.05). Irrespective of the type of appendicitis, all patients experience pain and tenderness in the right lower quadrant of the abdomen. Moreover, 91% and 94% of patients without and with a perforated appendicitis has leukocytosis (WBC > 10000) with a shift to the left.

Table 1:- The distribution of different types of appendicitis in patients without and with delayed appendectomy

Delay	Type						Total
	Catarrhal	Abscess	Phlegmon	Perforated	Gangrenous	Septic	
Without delay	10 (2.6)	10 (2.6)	9 (2.4)	110 (28.9)	30 (7.9)	211 (55.5)	380 (100)
Delayed	11 (7.5)	3 (2)	0	18 (12.3)	8 (5.4)	106 (72.6)	146 (100)
Total	21 (3.9)	13 (2.4)	9 (1.7)	128 (24.3)	38 (7.2)	317 (60.2)	526 (100)

Table 2:- The distribution of perforated and non-perforated appendicitis among males and females

Gender	Type of appendicitis	
	Perforated	Non-perforated
Male	94 (73.4)	232 (58.2)
Female	34 (26.6)	166 (41.8)
Total	128 (100)	398 (100)

Table 3: - The distribution of perforated and non-perforated appendicitis in different age groups

Type of appendicitis	Age group			
	< 14	15-34	35-64	> 65
Perforated	8 (11.6)	23 (7)	13 (13.8)	12 (34.2)
Non-perforated	61 (88.4)	305 (93)	81 (76.2)	23 (65.8)
Total	69	328	94	35

DISCUSSION

Among the total cases of acute appendicitis examined in this study 24.3% were perforated appendicitis that was mostly occurred in the age range of 15 to 34 years old. The higher proportion of perforation was in people over 65 years old while the children younger than 14 years were in the second rank. This findings are consistent with the scientific literature [10, 11]. Although no clear justification was presented for the high incidence of perforation in older adults and children, however, absence of clinical symptoms, existence of multiple differential diagnosis, lower levels of sensitivity to pain and presence of co-morbidities in older people, and inability to locate pain and shortness of the omentum in children are among the reasons for the delays in diagnosis and treatment of appendicitis in these age groups [10,11].

In this study, the overall incidence of perforated appendicitis was 24.3%. However, this rate was 28.9% and 14.1% in patients without and with delayed appendectomy, respectively. In some of the previous studies the delay in referral was cited as the main cause of perforation. However, this claim is controversial and has never been proved.

In the present study, the rate of perforated appendicitis was higher in males than in females. This finding is in contrast with the hypothesis that several differential diagnoses in females might result in a delay in appendectomy in women. In a study on 196 patients with acute appendicitis, Guss *et al.* have also reported that the mean delay was 477 and 709 min in males and females respectively. However, the rate of perforated appendicitis was significantly higher among males than females [12].

In the present study, the rate of perforated appendicitis was higher in patients without a delay in appendectomy. This finding was consistent with a previous study on 5755 cases of appendectomy in which despite the fact that all patients were operated within the first 24 hours of the onset of pain, a third of them had perforated appendicitis [8]. This study also supports the hypothesis that a delayed appendectomy cannot justify the occurrence of perforated appendicitis. However, there are studies with conflicting results. In a study of 129 cases of acute appendicitis in children under 14 years, the rate of perforation was significantly higher among those who were diagnosed and operated after the first 48 hours [9]. The rate of appendectomy and diagnosis of appendicitis have considerably increased in recent decades due to using new diagnostic technologies such as CT scan. However, the rate of perforated appendicitis did not decrease. This finding confirms the fact that perforated and non-perforated appendicitis have different Pathophysiologic processes [13-17].

CONCLUSION

Age, gender, analgesics and antibiotic drugs are among the risk factors of perforated appendicitis. However, a delayed appendectomy cannot be assumed as a risk factor for perforated appendicitis, by itself. Physiopathology of perforated appendicitis is actually very complex and a delay in appendectomy cannot fully justify the physiopathology of perforation. The fact that perforation cannot fully explained be a delay in appendectomy may prevent many cases of unnecessary surgeries in patients with acute appendicitis. Further studies are recommended to confirm the findings of the present study. Such studies would be valuable in making decisions about the treatment of patients with acute appendicitis.

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Conflict of Interest

The authors have no conflict of interest to disclose.

Authors' Contribution

Saeed Nouri developed the study concept and design and the acquisition of data, interpretations of data, and drafting of the manuscript. Davood Kheirkhah and Zahra Soleimani developed the protocol, analysis of data and drafting of the manuscript.

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