



The Impact of Smoking on the Complications of Acute Appendicitis

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Abstract

Introduction The pathophysiology of appendicitis likely stems from obstruction of the appendiceal orifice leading to an increase in intraluminal and intramural pressure, resulting in small vessel occlusion and lymphatic stasis. Organ supplied by an end artery, such as the appendix, are more prone to the deleterious effects of arterial occlusion. The continuous cigarette smoking might be associated with a greater risk for developing atherosclerosis.

Objectives The aim is to evaluate the effect of cigarette smoking on the incidence of complications of acute appendicitis.

Methods Patients suffered from symptoms and signs suggesting acute appendicitis were examined and investigated. a multiple items collecting data questionnaire including smoking status and exclusion of confounders were constructed. The complicated and non-complicated appendicitis were compared concerning their smoking status.

Results Seventy-two Patients were included in this study; the mean age of studied patients was 24.13 ± 9.1 years. The age of 57% of patients were below the mean age and considered as younger age group, while the remaining 43% of patients were equal or above the mean age which considered as older age group. Thirty-three percentage of patients had ≥ 36 hours prehospital delay and considered as delay group, while the remaining 67% of patients had < 36 hours prehospital delay which considered no delay group, males constitute 54% of studied patients. smokers constitute 29% while the remaining 71% of studied patients were nonsmokers, 61.9% of the smokers developed complications of appendicitis.

Conclusion Perforated acute appendicitis is higher among current tobacco smokers.

Keywords

- ▶ Appendicitis
- ▶ complicated
- ▶ smoking

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Introduction

Appendix is a narrow worm like structure present in the right iliac fossa, arising from the posteromedial wall of the caecum about 2 cm below the ileocecal junction and has no constant anatomical position. The length of appendix varies from 2 to 20 cm with an average of 9 cm, microscopically the vermiform appendix is a muscular tube containing a large amount of lymphoid tissue.¹ The appendix is suspended by a peritoneal fold called mesoappendix covering its variable length and carrying the blood supply to the organ, by appendicular artery, a branch derived from ileocolic artery. The appendicular artery is an end artery; hence the inflammation of the appendix the vascular thrombosis may produce gangrene of its tip.¹

Acute appendicitis is one of the most common causes of abdominal pain in emergency departments. Acute uncomplicated and complicated appendicitis are epidemiologically and clinically different disease entities.² Also supporting the idea of a different pathophysiology and disease course. The majority (70–80%) of cases are uncomplicated. The incidence of uncomplicated acute appendicitis has been declining, whereas the incidence of complicated acute appendicitis has been quite steady over time.³

Acute appendicitis shows a lifetime risk of 7%. Its overall incidence is approximately 11 cases per 10,000 individuals per year, and may occur at any age, although it is relatively rare at the extremes of age. Between 15 and 30 years of age there is an increase of 23 cases per 10,000 populations/year and then a decline of cases with aging.⁴ Male patients had a higher risk of having perforated appendicitis than female patients at all ages, with an overall male-to-female ratio of 1.39:1.⁵

The vermiform appendix is not a rudimentary organ, but rather an important part of the immune system with a distinct function within the gastrointestinal lymphoid tissue (GALT) different from lymphoid tissue in other parts of the intestine.⁶

The pathology underneath acute appendicitis is mostly from appendicular lumen obstruction, which ends in inflammation, ischemia and perforation that can be rapid onset with peritonitis or slower and localized abscess formation. The obstruction can be due to lymphoid hyperplasia, parasitic infestation, fecoliths, or tumors whether benign or malignant. The obstruction leads to mucus accumulation in the lumen, distension an elevation of intraluminal and intramural pressure, causing occlusion in small vessel and lymphatic stasis ending in ischemia and necrosis, followed by aerobic bacterial overgrowth followed later by mixed aerobes and anaerobes including *Escherichia coli*, *Peptostreptococcus*, *Bacteroides*, and *Pseudomonas*.⁷

If untreated, the inflamed appendix eventually perforates. Free perforation will lead to soiling of the intraperitoneal cavity with pus or feces. A perforation can also be enclosed by the surrounding soft tissues (omentum, mesentery, or bowel), thus leading to the development of an inflammatory mass. This inflammatory mass may contain pus (abscess), or it may not (phlegmon). There is some debate as to whether

perforated appendicitis is a disease process distinct from uncomplicated appendicitis.⁸ Diversion, as well as the deleterious effects of arterial occlusion, can be minimized if adequate collateral circulation is established soon enough to prevent damage to the ischemic tissue.⁹ Organ supplied by an end artery, such as retina, are more prone to the deleterious effects of arterial occlusion.⁹ Although smoking is vastly spread between 1,3 billion people worldwide is a major health problem mainly in developing countries, on the other hand its prevalence declined in others through education towards the risks and tobacco control strategies. Lebanon has younger age group smokers of 53%, 43% in Yemen, 31% in Syria, Saudia arabia and Jordan 25% each, 23% in Iraq, 18% in Kuwait and in Oman 7%.¹⁰ In Iraq, 44% mortalities in the country takes place as a result of non-communicable diseases. The most include diabetes, respiratory diseases, stroke, heart disease and cancer.¹¹ A 2006 survey showed adult risk factors 41.4% had hypertension, 10.8% hyperglycaemia, 37.7% hyperlipidaemia, 66% overweight, 33% obese, 90.5% had low vegetable and fruit consumption and 56.7 had low physical activities. On the other hand, has 21.9% adult smoking prevalence.¹²

Tobacco use, in any form, can be described as a behavioral process which elicits psychological and physiologic addictive mood among users. Nicotine, the active ingredient in tobacco, is highly addictive, resulting in sustained tobacco use. Tobacco use is divided into combustible and noncombustible tobacco products. Combustible tobacco products include cigarettes, cigars, cigarillos, small cigars, water pipes (hookah), and pipes. Noncombustible tobacco products include electronic cigarettes and tobacco formulations developed for chewing, dipping, or snuffing. According to the 2013–2014 National Adult Tobacco Survey (NATS), the United States' national prevalence for current tobacco product use was 21.3% in adults aged ≥ 18 years. Distribution of tobacco product use include: 17% for cigarettes, 1.8% for cigars/cigarillos/filtered little cigars, 0.3% for pipes, 0.6% for water pipes/hookah, 3.3% for electronic cigarettes, and 2.5% for smokeless tobacco.¹³ Cardiovascular diseases including atherosclerosis, stroke, ischaemic heart disease, and peripheral vascular disease are linked to smoking.¹⁴ More than 4000 chemical materials in tobacco smoke adversely affect human health among which exert most pharmacological effects; carbon monoxide, free radicles and nicotine which induces clot formation in the coronary arteries, increases endothelium dysfunction, and weakens vascular activity. Elevated carboxy-haemoglobin can lead to hypoxia, sub-endothelial edema as it affects vascular permeability and cause lipid deposition while Free radicals and peroxides involved with prostaglandins and thromboxane synthesis, and in pathogenesis of different diseases as atherosclerosis, carcinoma, and inflammatory processes.¹⁴

Haematologically continuous cigarette smoking raises RBC count, hemoglobin concentration, packed cell volume, white blood cell count, mean corpuscular volume and mean corpuscular haemoglobin concentration, all of which may increase atherosclerosis risk.¹⁴ Furthermore, leukocyte recruitment mediated by endothelial adhesion molecules

as an essential element in the initiation of atherosclerosis is increased by smoking. For example, the smoking increases the plasma concentration of soluble vascular cell adhesion molecule-1 in patients with coronary artery disease.¹⁵ The aim of this study is to evaluate the effect of cigarette smoking on the incidence of complications of acute appendicitis (perforation, gangrene or mass) because all the beforehand complications are the sequelae of ischemia and the smoking is a leading cause of atherosclerosis which affects arteries and as the appendicular artery is an end artery then its involvement by atherosclerosis supposed to lead to more incidence of ischemia and complications of appendicitis.

Methods

This is a hospital-based case-control study conducted in Al-Kindy teaching hospital in Baghdad, data were collected from April the 1st 2019 till January the 3rd 2020 using convenience sampling method, in which patients suffered from symptoms and signs suggesting acute appendicitis were examined and investigated. The prehospital time delay (in hours) was categorized later into delay group who had ≥ 36 hours pre hospital delay time and those who had < 36 hours pre hospital delay considered not delayed group.¹⁶ The mean age was calculated and the groups were categorized into younger age group of patients less than the mean and older age group of patients equal and more than the mean. The complicated appendicitis (perforated and gangrenous) had been witnessed intra operatively, but all complicated and non-complicated cases sent for histopathology examination.

Inclusion Criteria

All patients admitted to the emergency department during the study period who were suspected of having acute appendicitis.

Exclusion Criteria

patients who smoke hookah because were small in number, hookah and cigarette together, patients had chronic comorbidities, patients with chronic use of drugs and patients with previous history of abdominal surgery, a patient with abnormal body mass index (BMI) and as all can be considered as confounders. Also, all normal appendix specimen by paraffin section histopathological examination.

Ethical Approval and Permission

Ethical permission was approved by the scientific committee in Alkindy college of medicine.

Statistical Analysis

Collected data were plotted into Microsoft excel sheet 2016 and loaded into SPSS V26 statistical program which was used in statistical analysis.

Descriptive statistics were presented using tables and graphs while 2 sample T test was used to find out significance of difference between means of numerical variables, Chi-square test was used to find out significant association between related categorical variables, Odd ratio (OR) and 95% confidence interval (CI) was used to find out significance of odds relationship between risk factors and occurrence of complications, p value less than 0.05 was considered a significant cutoff point.

Results

One hundred two patients enrolled in this study, 100 patients underwent open appendectomy, while 2 patients who had appendicular mass diagnosed by clinical assessment and radiological imaging (abdominal U/S and CT scan).

Six patients were hookah smokers, another six patients were combined cigarette and hookah smokers, one patient had abnormal BMI, six patients had co-morbidities all of them were excluded, after that; when histopathology results had been obtained, ten patients who showed follicular hyperplasia and one patient who showed carcinoid tumor without inflammation of the appendix were excluded, The remaining Seventy-Two Patients were included in this study, 24(33.3%) patients developed complications, while 48 (66.6%) patients did not develop complications. All the smoker patients included in this study were current smokers (► **Table 1**).

The age of the patients included in this study range from 15 to 62-year-old, the mean age of studied patients was 24.13 ± 9.1 years. The age of 57% of patients were below the mean age and considered as younger age group, while the remaining 43% of patients were equal or above the mean age which considered as older age group (► **Tables 2 and 3**).

Thirty-three percentage of patients had ≥ 36 hours' pre-hospital delay and considered as delay group, while the remaining 67% of patients had < 36 hours' prehospital delay which considered no delayed group (► **Table 4**).

Discussion

The rate of smoking in this study was 29% and this comes in agreement with the rate of smoking found by prabhat et al study.¹⁷

This study shows that significant association was noticed between smoking status and complicated appendicitis

Table 1 Significance of studied patients' complication according to smoking status

Smoking status	Complicated N (%)	Not complicated N (%)	Odds ratio	95%CI	P value
Smoker	13(61.9%)	8(38.1%)	5.91	1.957–17.840	0.001
Non smoker	11(21.6%)	40(78.4%)			

Table 2 Significance of studied patients' complication according to age grouping and smoking status

Age groups	Complicated N (%)	Not complicated N (%)	Odds ratio	95%CI	P value	Smoking status	Complicated N (%)	Not complicated N (%)	Odds ratio	95%CI	P value
Younger age group	10(24.4%)	31(75.6%)	0.392	0.143–1.069	0.064	Smoker	4 (40.9%)	6(60%)	2.778	0.591–13.054	0.183
						Non smoker	6(19.4%)	25(80%)			
Older age group	14(45.2%)	17(54.8%)				Smoker	9(81.8%)	2(18.2%)	13.5	12.152–84.688	0.003
						Non smoker	5(25%)	15(75%)			

Table 3 Significance of studied patients' complication according to sex and smoking status

Sex	Complicated N (%)	Not complicated N (%)	Odds ratio	95%CI	P value	Smoking status	Complicated N (%)	Not complicated N (%)	Odds ratio	95%CI	P value
Male	17(43.6%)	22(56.4)	2.87	1.007–8.181	0.045	Smoker	13(65%)	7(35%)	6.964	1.657-29-263	0.006
						Non smoker	4(21.1%)	15(78.9%)			
Female	7(21.2%)	26(78.8%)				Smoker	0(0%)	1(100%)	Not applicable	Not applicable	0.788
						Non smoker	7(21.9%)	25(78.1%)			

Table 4 Significance of studied patients according to preoperative delay and smoking status

Delay status	Complication N (%)	No complication N (%)	Odds ratio	95%CI	P value	Smoking status	Complication N (%)	No complication N (%)	Odds ratio	95%CI	P value
Delay	12(50%)	12(50%)	3	1.068–8.428	0.034	Smoker	5(71.4%)	2(28.6%)	3.571	0.532–23.953	0.185
						Non smoker	7(41.2%)	10(58.8%)			
No delay	12(25%)	36(75%)				Smoker	8(57.1%)	6(42.9%)	10	2.262–44.203	0.002
						Non smoker	4(11.8%)	30(88.2%)			

where OR was 5.91, 95% CI = 1.957- 17.84 and this goes in concordance with Sadr Azodi *et al* study which showed increased risk and rapid progress of acute appendicitis to perforation in currently tobacco smokers.¹⁸

In this study there was no significant association between age groups and complications, p value 0.064. There was no significant association between smoking and developing complications among younger age group patients, P value 0.183 while significant association was noticed between smoking and developing complications among older age patients P value 0.003, OR = 13.5, 95% CI = 12.152–84.688 and this agrees with what had been found by Sadr Azodi *et al*¹⁸; that older age is more prone to complications can be due to the effect of aging specially if the patient is smoker which may reflect longer duration of smoking effect. Fifty-four percentage of patients in this study were males, significant association was noticed between sex and complications development, which is more among male patients, P value 0.045, OR = 2.87, 95% CI = 1.007–8.181 and this may be the effect of smoking which was more prevalent among male than among female patients and this result goes with the study done by Balogun *et al*.¹⁹

There was significant association shown between delay and complications, P value 0.034, OR = 3, 95% CI = 1.068–8.428 and this goes with study done by Bickell *et al*.¹⁶

There was no significant association between smoking status and development of complications among delayed patients' P value 0.185 while no delay smokers had more complications than no delay nonsmokers, P value 0.002, OR = 10, 95% CI = 2.262–44.203, and this suggests that smoking may play an important role in occurrence of complications even if there was no prehospital delay.

In Conclusion

Perforated acute appendicitis is higher among current tobacco smokers. Older age group smokers had more complications than younger age group smokers. Males had more complications than females.

Smokers who were not delayed had more complications than non-delayed nonsmokers.

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Conflicts of Interest

There is no conflict of interest.

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