



Accuracy of Surgeon's Intraoperation Diagnosis of Acute Appendicitis, Compared with the Histopathology Results

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ABSTRACT

Objective: To evaluate the accuracy of surgeons' intraoperative diagnosis in open appendectomy and compare it with the histopathology examination results afterwards.

Methods: This was a cross-sectional retrospective study accomplished in Namazee hospital affiliated with Shiraz University of Medical Sciences, in a one-year period from 2007 to 2008. Medical charts of all the patients who were admitted with impression of acute appendicitis and underwent open appendectomy in our center were included. Demographic information, intraoperative findings as in the operation note based on a method used by our surgeons, and histopathology examination of the removed appendix were recorded and reported.

Results: A total of 342 patients were studied including 229 (67%) males and 113 (33%) females, with the mean age of 16.02 ± 9.89 (range 3 to 76) years, with a large proportion from 10 to 15 years. Surgeons reported 97.4% of the patients to have acute appendicitis, 29.5%, 10.2% and 5.6% with severe, moderate and mild inflammation respectively, whereas 26.6% and 9.4% with suppurated and gangrenous appendicitis separately, 14.6% to have perforated appendicitis and only 1.5% had perforated appendicitis with peritonitis. However, 79.5% of cases showed appendicitis in the histopathology review. The accuracy of surgeons' intraoperative diagnosis is 81.6%, 85.2% for men and 72.6% for women.

Conclusion: The method used by our surgeon is not completely indicative in mild to severe inflamed appendix but it is almost always compatible with the pathology results in suppurated, gangrened, and perforated appendix. Therefore surgeons' gross observation of the inflamed appendix may not always be in concordance with the histopathology examination of the resected appendix.

Keywords: Appendicitis; Surgical findings; Histopathological findings; Intraoperative observations; Negative appendectomy.

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Introduction

Inflammation of Appendix, which is referred as Acute Appendicitis, is a common intra-abdominal condition which needs immediate surgical intervention [1-3]. Surgical appendectomy remains

the gold standard treatment of acute appendicitis, in spite of advanced modalities nowadays [4,5]. Acute appendicitis is considered to have a high lifetime risk [6], which means about 7% of the individuals undergoing appendectomy during their living,

23.1% and 12% in females and males respectively [5,7]. The excision of appendix not only decreases the risk of life-threatening complications including perforation and sepsis, but also allows for the histopathology examination which is the gold standard for confirmation the diagnosis of acute appendicitis, irrespective of the intraoperative findings [8-10]. If pathologist sees transmural inflammation of the appendix or granulocytes in the mucosa or infiltrated into the epithelium, then it is acute appendicitis [10,11]. However, open appendectomy has the disadvantage of high rate of negative appendectomy [6], which is referred to an appendectomy based on the clinical diagnosis of acute appendicitis but in which the histopathological examination of the appendix is normal [11]. In spite of the increasing role of advanced paramedical modalities such as ultrasonography and computed-tomography (CT scan) in the diagnosis of acute appendicitis, the rate of misdiagnosed cases of appendicitis has not been changed during these years (15.3%), same as the rate of perforated appendix [12-14]. Since there is interobserver variation in the assessment of appendicitis among the surgeons [15], the histopathological examination of the appendectomy specimen is highly recommended [16].

The present study was carried out with the primary goal of assessing the accuracy of the criteria used by surgeons based on their observations in the operation room (OR) for describing the inflamed appendix and compares them with the histopathological examination afterwards in one of the largest hospital of southern Iran. It also aimed at determining the rate of negative appendectomy in our center.

Materials and Methods

Study Population

This study was a retrospective cross-sectional one including all patients with the first impression of acute appendicitis admitted in the ER of surgery in Nemazee hospital, one of the largest teaching hospitals in Iran and a tertiary health care center which is affiliated with Shiraz University of Medical Sciences (SUMS), and underwent open appendectomy during a one-year period from September 2007 to September 2008. Patients whose medical files had the required information and who underwent emergency open appendectomy were included. We excluded the patients who were scheduled for elective appendectomy, patients who underwent laparoscopic appendectomy and those with incomplete profile.

Study Protocol

Medical records of the patients were reviewed and the

data was entered to a computer database. Alongside demographic information, our database included the findings reported by the surgeon in the operation note describing what the surgeon observed. In this center, acute care surgery service is responsible for open appendectomy operations; uses a classification method depending on the gross vascular appearance, consistency and the diameter of the appendix, and also any puss formation or fibrin deposition. According to this set of criteria, mild inflammation is a condition in which only the vasculature of the appendix become more prominent than in normal condition, without any change in consistency and the diameter of the organ, and no puss formation or fibrin deposition. However, increase in the size of the vasculature alongside with the hardening of the appendix classify as moderate inflammation. As the vessels becoming more prominent and proliferated, literally the appendix becomes congested, with the change in the diameter and the consistency of the organ, the surgeon defines it as severe inflammation of the appendix. Gangrenous appendix defines itself, and if there is puss or fibrin deposition, the condition is called suppurated appendicitis. When the organ is perforated, it is called perforated appendicitis, though it can either accompanied by peritonitis or not.

We did also include the histopathological examination result of the removed appendix from the pathologists' reports in our data base. Pathologists' diagnoses were classified according to their reports as acute appendicitis, normal finding, and other diagnoses.

Statistical Analysis

Then we compared the results in each group, surgeons' and pathologists' diagnoses together. The Statistical Package for Social Sciences, SPSS for Microsoft Windows, version

19.0 (SPSS Inc., Chicago, IL) was used for data analysis. Descriptive results are presented as mean \pm standard for 95% confidence interval (CI) or proportions wherever suitable.

Results

A total of 342 patients met the inclusion criteria. Among them, 67% (n=229) were males, and 33% (n=113) were females, with the mean age of 16.02 ± 9.89 (ranging from 3 to

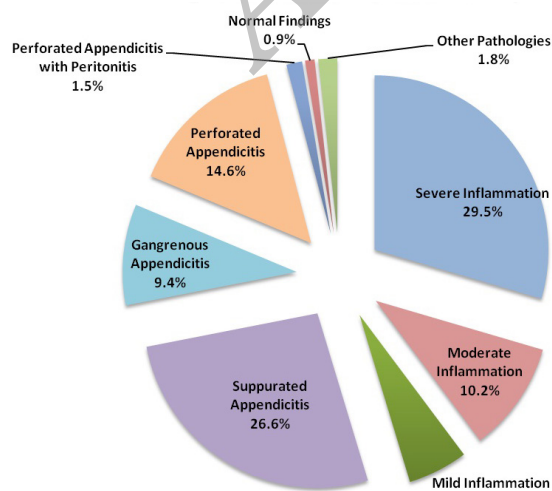
76) years. Also, 2.6% (n=9) of all patients were under 5 years, 17% (n=58) were in the group of 5-9 years, 36.3% (n=124) were 16-59 years and 0.6% (n=2) has more than 60 years. The largest group was 10-15 years with 43.6% (n=149) in which 70.5% (n=105) and 29.5% (n=44) were male and female respectively.

From the 342 patients who underwent open

Table 1. Comparison of the surgical findings with histopathology results in different genders and age groups.

Surgical Findings	Histopathology Findings			Total
	Acute Appendicitis	Normal Findings	Other Pathologies	
Acute Appendicitis(%)	271 (79.2%)	8 (2.3%)	54(15.8%)	333 (97.4%)
Male(%)	192 (56.1%)	5 (1.5%)	29(8.5%)	226 (66.1%)
Female(%)	79(23.1%)	3 (0.9%)	25(7.3%)	107 (31.3%)
< 5 years(%)	7 (2.1%)	0	2 (0.6%)	9 (2.6%)
5-9 years(%)	48(14%)	1 (0.3%)	9 (2.6%)	58(17%)
10 -15years(%)	111 (32.5%)	3 (0.9%)	29(8.5%)	143 (41.8%)
16 -59years(%)	103 (30.1%)	4 (1.2%)	14(4.1%)	121 (35.4%)
≥ 60years(%)	2 (0.6%)	0	0	2 (0.6%)
Normal Findings(%)	0	2 (0.6%)	1 (0.3%)	3 (0.9%)
Male(%)	0	2 (0.6%)	0	2 (0.6%)
Female(%)	0	0	1 (0.3%)	1 (0.3%)
< 5 years(%)	0	0	0	0
5-9 years(%)	0	0	0	0
10 -15years(%)	0	1 (0.3%)	1 (0.3%)	2 (0.6%)
16 -59years(%)	0	1 (0.3%)	0	1 (0.3%)
≥ 60years(%)	0	0	0	0
OtherPathologies(%)	1 (0.3%)	0	5 (1.5%)	6 (1.8%)
Male(%)	0	0	1 (0.3%)	1 (0.3%)
Female(%)	1 (0.3%)	0	4 (1.2%)	5 (1.5%)
< 5 years(%)	0	0	0	0
5-9 years(%)	0	0	0	0
10 -15years(%)	1 (0.3%)	0	3 (0.9%)	4 (1.2%)
16 -59years(%)	0	0	2 (0.6%)	2 (0.6%)
≥ 60years(%)	0	0	0	0
Total(%)	272 (79.5%)	10(2.9%)	60(17.5%)	342

appendectomy, 97.4% (n=333) were found to have acute appendicitis in the sight of the surgeon in the OR, and the remaining were diagnosed normal (3, 0.9%) or other pathologies (6, 1.8%). However, 79.5% (n=272) of cases showed findings in favor of acute appendicitis in their histopathological examination performed on the removed appendix after the surgery, and 20.5% (n=70) didn't meet the criteria for pathological confirmation of acute appendicitis.

**Fig. 1.** Intraoperative findings of acute appendicitis classified by the surgeons.

This means that the rate of negative appendectomy in the present study was 20.5%, 16.2% for males and 29.2% for females. Also, the negative appendectomy rates were 22.2%, 17.2%, 24.8%, and 16.9% for patients <5 years, 5-9 years, 10-15 years and 16-59 years respectively, while it was zero for patients older than 60 years, though there were only 2 patients in this group (Table 1).

According to the operation notes, and based on the classification method used by the surgeons, 29.5% (n=101) of 342 patients had severe inflammation, 26.6% (n=91) had suppurated appendicitis, 14.6% (n=50) were reported to have locally perforated appendicitis,

10.2% (n=35) were classified in moderate inflammation, 9.4% (n=32) had gangrenous appendicitis, 5.6% (n=19) were with mild inflammation and 1.5% (n=5) were reported as perforated appendicitis accompanied by peritonitis. Surgeons reported 1.8% (n=6) of patients to have pathologies other than appendicitis, and only 0.9% (n=3) found to be normal as in their operation note (Figure1).

In patients with severe inflammation, 78.9% (n=79) were confirmed to have appendicitis by the pathologists, same as 96.7% (n=88) of those

Table 2. Comparison of the surgeons' intra-operative findings with the histopathological results in different genders.

	Histopathological Findings			Total
	Acute Appendicitis	Normal Findings	Other Pathologies	
Severe Inflammation (%)	79(23.1%)	1 (0.3%)	21(6.1%)	101 (29.5%)
Male (%)	56(16.4%)	1 (0.3%)	11(3.2%)	68(19.9%)
Female (%)	23(6.7%)	0	10(2.9%)	33(9.6%)
Moderate Inflammation (%)	12(3.5%)	5 (1.5%)	18(5.3%)	35(10.2%)
Male (%)	9 (2.6%)	3 (0.9%)	10(2.9%)	22(6.4%)
Female (%)	3 (0.9%)	2 (0.6%)	8 (2.3%)	13(3.8%)
Mild Inflammation (%)	5 (1.5%)	2 (0.6%)	12(3.5%)	19(5.6%)
Male (%)	3 (0.9%)	1 (0.3%)	6 (1.8%)	10(2.9%)
Female (%)	2 (0.6%)	1 (0.3%)	6 (1.8%)	9 (2.6%)
Suppurated Appendicitis (%)	88(25.7%)	0	3 (0.9%)	91(26.6%)
Male (%)	65(19%)	0	2 (0.6%)	67(19.6%)
Female (%)	23(6.7%)	0	1 (0.3%)	24(7%)
Gangrenous Appendicitis (%)	32(9.4%)	0	0	32(9.4%)
Male (%)	21(6.1%)	0	0	21(6.1%)
Female (%)	11(3.2%)	0	0	11(3.2%)
Perforated Appendicitis (%)	50(14.6%)	0	0	50(14.6%)
Male (%)	33(9.6%)	0	0	33(9.6%)
Female (%)	17(5%)	0	0	17(5%)
Perforated Appendicitis with Peritonitis (%)	5 (1.5%)	0	0	5 (1.5%)
Male (%)	5 (1.5%)	0	0	5 (1.5%)
Female (%)	0	0	0	0
Normal Findings (%)	0	2 (0.6%)	1 (0.3%)	3 (0.9%)
Other Pathologies (%)	1 (0.3%)	0	5 (1.5%)	6 (1.8%)
Total (%)	272 (79.5%)	10(2.9%)	60(17.5%)	342

with suppurated appendicitis. All the patients with gangrenous appendicitis, locally perforated appendicitis, and perforated appendicitis accompanied by peritonitis also had acute appendicitis in their histopathology reports. However, 34.3% (n=12) and 26.3% (n=5) of the patients with moderate and mild inflammation respectively, found to have acute appendicitis in their histopathology examination. Only one of patients (16.7%) who were reported as other diagnosis by the surgeon had acute appendicitis in the view of pathologist, while none of those with normal findings in surgery reported as acute appendicitis after their specimen examined. Distribution through different genders and age groups are shown in table 2 and table 3 respectively (Table 2 and 3).

Discussion

The aim of present study was to evaluate the accuracy of intraoperation diagnosis made by

surgeons according to the method they used in the OR to classify the appendicitis based on their gross observation in Namazee hospital, southern Iran. In our study, males were almost as twice as females (67% vs. 33%), with the male to female incidence ratio of 2:1, in contrast with some studies [7,17,18] although it is variably reported in different studies, with a peak in patients aged between 10 to 16, in concordance with Memon *et al.* and Limpawattanisiri *et al.*, [9,19] The rate of negative appendectomy in our study was 20.5%, which was higher among women than men (29.2% vs. 16.2%), whereas Flum *et al.* reported lower negative appendectomy rates, 15.3% overall, 22.2% in females and 9.3% in males. Also patients aged

10-15 years have the higher rate of negative appendectomy (24.8%) in compare with others, while the rate was zero in patients older than 60 years, in contrast with other studies [12,13], however, we had only two patients older than 60 years, hence we cannot rely on this one completely. The higher rate

Table 3. Comparison of the surgeons' classification method findings with histopathological results in different age groups.

	Histopathological Findings			Total
	Acute Appendicitis	Normal Findings	Other Pathologies	
Severe Inflammation (%)	79(23.1%)	1(0.3%)	21(6.1%)	101(29.5%)
< 5years (%)	1(0.3%)	0	1(0.3%)	2(0.6%)
5-9years (%)	13(3.8%)	0	2(0.6%)	15(4.9%)
10-15years (%)	30(8.7%)	0	10(2.9%)	40(11.7%)
16-59years (%)	35(10.2%)	1(0.3%)	8(2.3%)	44(12.9%)
≥ 60years (%)	0	0	0	0
Moderate Inflammation (%)	12(3.5%)	5(1.5%)	18(5.3%)	35(10.2%)
< 5years (%)	0	0	1(0.3%)	1(0.3%)
5-9years (%)	2(0.6%)	1(0.3%)	4(1.2%)	7(2%)
10-15years (%)	6(1.8%)	3(0.9%)	11(3.2%)	20(5.9%)
16-59years (%)	4(1.2%)	1(0.3%)	2(0.6%)	7(2%)
≥ 60years (%)	0	0	0	0
Mild Inflammation (%)	5(1.5%)	2(0.6%)	12(3.5%)	19(5.6%)
< 5years (%)	0	0	0	0
5-9years (%)	1(0.3%)	0	3(0.9%)	4(1.2%)
10-15years (%)	1(0.3%)	0	7(2%)	8(2.3%)
16-59years (%)	3(0.9%)	2(0.6%)	2(0.6%)	7(2%)
≥ 60years (%)	0	0	0	0
Suppurated Appendicitis (%)	88(25.7%)	0	3(0.9%)	91(26.6%)
< 5years (%)	2(0.6%)	0	0	2(0.6%)
5-9years (%)	11(3.2%)	0	0	11(3.2%)
10-15years (%)	41(11.9%)	0	1(0.3%)	42(12.3%)
16-59years (%)	33(9.7%)	0	2(0.6%)	35(10.2%)
≥ 60years (%)	1(0.3%)	0	0	1(0.3%)
Gangrenous Appendicitis (%)	32(9.4%)	0	0	32(9.4%)
< 5years (%)	2(0.6%)	0	0	2(0.6%)
5-9years (%)	3(0.9%)	0	0	3(0.9%)
10-15years (%)	13(3.8%)	0	0	13(3.8%)
16-59years (%)	14(4.1%)	0	0	14(4.1%)
≥ 60years (%)	0	0	0	0
Perforated Appendicitis (%)	50(14.6%)	0	0	50(14.6%)
< 5years (%)	1(0.3%)	0	0	1(0.3%)
5-9years (%)	17(4.9%)	0	0	17(4.9%)
10-15years (%)	18(5.3%)	0	0	18(5.3%)
16-59years (%)	13(3.8%)	0	0	13(3.8%)
≥ 60years (%)	1(0.3%)	0	0	1(0.3%)
Perforated Appendicitis with Peritonitis (%)	5(1.5%)	0	0	5(1.5%)
< 5years (%)	1(0.3%)	0	0	1(0.3%)
5-9years (%)	1(0.3%)	0	0	1(0.3%)
10-15years (%)	2(0.6%)	0	0	2(0.6%)
16-59years (%)	1(0.3%)	0	0	1(0.3%)
≥ 60years (%)	0	0	0	0
Normal Findings (%)	0	2(0.6%)	1(0.3%)	3(0.9%)
Other Pathologies (%)	1(0.3%)	0	5(1.5%)	6(1.8%)
Total (%)	272(79.5%)	10(2.9%)	60(17.5%)	342

of negative appendectomy in our center in compare with other studies may be due to lack of diagnostic modalities such as CT scanners, which are not routinely used for diagnosing acute appendicitis in

our center, surgeons' skill, and high amount of work in the emergency department of Nemazee hospital.

According to the Table 1, the accuracy of surgeons' intraoperative diagnosis whether it was an acute

appendicitis or not is 81.6%, 85.2% in males and 72.6% in females, telling us the method used by our surgeons is more efficient in men than women. On the other hand, the accuracy in different age groups was 77.8%, 82.8%, 77.9% and 85.5% for patients under 5 years, 5-9 years, 10-15 years and 16-59 years respectively. Since we had only 2 cases above 60 years, the 100% accuracy rate may not be thoroughly reliable.

According to the Table 2, in patients with severe inflammation in their operation notes, about 20% of them had pathologies other than acute appendicitis. This rate increases in moderate inflammation and mild inflammation too, with approximately 50% and 63% respectively. When we looked back in the patients' medical files and their pathology reports, we found that follicular hyperplasia of mesenteric lymph nodes was diagnosed for almost all of them, all of those with severe inflammation, 83% of those with moderate inflammation and

92% of patients with mild inflammation. This meanwhile surgeons classified the appendix as an inflamed organ, histopathology examination revealed other disease, mesenteric lymphadenopathy, in 14.1% of the cases. Mesenteric lymphadenopathy is one of the important differential diagnoses of acute appendicitis in children, and alongside with acute pelvic inflammatory disease, twisted ovarian cyst or ruptured graafian follicle, and acute gastroenteritis contribute more than 75% of the cases with the mesenteric lymphadenopathy at the top. [5,20-22] This condition was seen slightly more in men than women in our study, (27 vs. 26 patients) with peak in patients 10-15 years (29 cases).

All the patients whom surgeons observed gangrenous appendicitis, perforated appendicitis, and perforated appendicitis with peritonitis during their operation, and 96.7% of those with suppurated appendicitis, were confirmed to have acute appendicitis by pathologists, which tells us that the method our

surgeons used was more effective in these specific conditions. Nevertheless, the classification of severe, moderate and mild inflammation by surgeons has lower efficiency, as the positive predictive value rates were

78.2%, 34.3% and 26.3% respectively. This is especially true in patients 10 to 15 years. In Monajemzadeh *et al.* study, the rate of confirmed appendicitis by pathologic examination among those who had inflammation in their surgical finding was higher, approximately

100% although they studied children under 15 years [16]. Although in their study, 25.5% of appendices which seemed grossly normal during the operation, found to be abnormal in pathologic examination [16], in our study, only 3 cases (0.9%) were reported normal in their operation notes, while none of them had histopathological evidence of appendicitis. And finally, from those who seemed to have pathologies other than appendicitis (1.8%), only one patient had acute appendicitis according to the pathology report.

We conclude that although surgeons' observation during the operation may be close to what the pathologists see during histopathological examination of the specimens, it may also be very different in some cases. Hence, routine histopathology examination remains the gold standard method for confirming the primary diagnosis of acute appendicitis. Secondly, we came to conclusion that the negative appendectomy rate is considerably affected by age and gender, and despite the advancements in medical diagnosis, it still plays a significant role in the outcome of the patients undergoing open appendectomy.

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Conflicts of Interest: None declared.

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