

Acute Appendicitis in the Elderly in the Twenty-First Century

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Abstract

Background The incidence of appendicitis in the elderly has risen. Older age is an independent predictor of poor surgical outcome. Herein, we present the most comprehensive single institution study to describe the natural history and outcome of appendicitis in elderly patients.

Methods A review of 1898 consecutive patients who underwent appendectomy between 2004 and 2007 was performed. The elderly patients were defined as older than 68 years.

Results The median age of the entire cohort was 25 years, and 55 % were males. The elderly group included 68 patients (3.6 %). On comparison by age, the elderly group had a significantly longer delay from symptom onset to admission (50 vs 31 h, $P=0.01$) and from admission to surgery, a longer operative time and hospital stay, and higher rates of postoperative complications and complicated appendicitis.

Conclusion The current study demonstrated several unique characteristics of the elderly population with acute appendicitis, which include poor outcome and longer time intervals to diagnosis and treatment. In order to improve the poor outcome of the elderly population with appendicitis, prospective trials are necessary.

Keywords Appendicitis · Appendectomy · Elderly · Octogenarians · Outcome

Introduction

During the past few decades, the combination of sustained decreases in fertility and dramatic increases in life expectancy has led to an increasingly aging population.¹ A study conducted in 2010 in the USA estimated that the over 65-year age

group would double from 40 million to 80 million by 2040.² The proportion of the elderly population undergoing surgery has increased even faster than the rate of population aging,³ and elderly patients currently account for a large part of surgical practices.⁴ In the 1950s, advanced age (>55 years) was considered a contraindication for surgery and anesthesia.⁵ Today, however, operations are performed on octogenarians and even centenarians. Nevertheless, age remains an independent predictor of poor surgical outcome.^{6,7} Therefore, researchers are seeking to develop management strategies tailored specifically to the elderly population.

The lifetime risk of appendicitis is approximately 7 %. Perforated appendicitis accounts for approximately 20 % of all cases of appendicitis and significantly increases the rate of postoperative complications.⁸ The incidence of appendicitis in the elderly has risen concomitant with the increase in longevity,^{9–13} with reported rates of perforation as high as 70 %¹⁴ and of morbidity as high as 48 %.¹⁵ A recent randomized trial showed that antibiotics may serve as a safe first-line therapy in unselected patients with appendicitis.¹⁶ These findings were supported by others.^{17,18} However, the optimal management strategy of acute appendicitis in the elderly is

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still unclear, and only a limited number of series have addressed this issue.

Herein, we present the most comprehensive single institution study, which compares elderly and non-elderly patients with acute appendicitis. The aim of the present study was to describe the unique natural history and postoperative outcome of acute appendicitis in a large cohort of elderly patients.

Methods

Study Design

The study was approved by the institutional review board. A search of the administrative database of a tertiary university-affiliated medical center using appendectomy procedural codes yielded 1898 consecutive patients who underwent appendectomy in 2004–2007. The following data were abstracted for each patient from the medical records of the relevant hospital departments (emergency room, surgery, anesthesiology) and outpatient clinics: patient age and sex, body temperature on admission, white blood cell count, findings on imaging studies, time from symptom onset to emergency room admission (“patient interval”), and time from emergency room admission to the operating room (“hospital interval”). The patient interval was determined by the self-reported history taken in the emergency room; the hospital interval was derived from the computerized documentation. In addition, the pathology reports were reviewed, and the results were categorized as follows: non-inflamed appendix, simple acute appendicitis, and complicated appendicitis (gangrenous, perforated, or periappendicular abscess). Operative time was recorded, as well as postoperative length of stay and postoperative complications.

Data Analysis

The study variables were analyzed twice. First, the patients were divided into two groups by age of 68 years or more (“elderly group”) or younger than 68 years (“non-elderly group”). This cutoff was chosen on the basis of the recent prospective analysis by Kurian et al.¹⁹ wherein age 68 years was found to be the objective optimum definition of “old” for patients undergoing gastrointestinal surgical procedures. For the second analysis, patients were divided by age 79 years or more (“octogenarian group”) or younger than 79 years (“non-octogenarian group”).

Descriptive and comparative statistical analyses were performed using Statistical Software for the Social Sciences (SPSS) version 21. Continuous variables were

compared between groups with Student’s *t* test or Mann–Whitney test, as appropriate by type of distribution. Categorical variables were compared with χ^2 or Fisher exact test, depending on the number of observations. A *P* value of <0.05 was considered significant.

Results

Demographics

Median age of the 1898 patients who met the inclusion criteria was 25 years (range 2–94); 55.4 % were males. Stratification by age yielded 68 elderly patients (3.6 %) and 28 octogenarians (1.5 %); both these groups had a significant female predominance (68.7 and 82.1 %, respectively; *P*<0.001 for both) (Table 1).

Preoperative Factors

The patient interval was 50 h in the elderly group and 31 h in the non-elderly group (*P*=0.01). Similar values were recorded on comparison of the octogenarian and non-octogenarian groups (51 vs 32 h, *P*=0.01). Additionally, the hospital interval was longer than 12 h in 67.2 % of the elderly patients and 71.4 % of the octogenarian patients compared to 34.4 % in the non-elderly group and 35 % in the non-octogenarian group (*P*<0.001 for both). There were no significant between-group differences in white blood cell count (WBC) or body temperature at presentation. Younger patients were more likely to undergo preoperative sonograms (NS). Older patients were significantly more likely to undergo preoperative computerized tomography (CT), with rates of 74.6 % in the elderly group and 78.6 % in the octogenarian group compared to 17.6 and 19.8 % in the non-elderly and non-octogenarian groups, respectively (*P*<0.001 for both).

Operative Factors

The average operative time was 88 min in the elderly group and 92.7 min in the octogenarian group. Both these values were significantly higher than those in the corresponding younger groups (66.9 min in the non-elderly group, 67.3 min in the non-octogenarian group, *P*<0.001 for both; Table 2). Similar rates for the use of a laparoscopic approach were recorded in all groups, with 55 % of the cohort undergoing laparoscopic appendectomy, and 45 %, an open procedure. However, between-group conversion rates differed significantly: laparoscopy was converted to open appendectomy in 6 % of the elderly group compared to 1.2 % of the non-elderly group (*P*=0.01) and

Table 1 Demographic and preoperative data in 1898 patients with appendicitis, by age groups

Characteristic	All patients (n=1898)	Elderly (n=68)	Non-elderly (n=1830)	P value	Octogenarian (n=28)	Non-octogenarian (n=1870)	P value
Average age (years)	28±17	78±7	23±15	NA	85±4	24±16	NA
Gender				<0.001			<0.001
Male	1052 (55.4 %)	21 (31.3 %)	1031 (56.3 %)		5 (17.9 %)	1047 (56 %)	
Female	846 (44.6 %)	46 (68.7 %)	799 (43.7 %)		23 (82.1 %)	833 (44 %)	
Patient interval ≥3 days				0.06			0.08
No	1439 (86.2 %)	47 (78.3 %)	1392 (86.6 %)		17 (73.9 %)	1422 (86.4 %)	
Yes	230 (13.8 %)	13 (21.7 %)	216 (13.4 %)		6 (26.1 %)	224 (13.6 %)	
Patient interval (h)	32±36	50±70	31±33	0.01	51±70	32±26	0.01
Hospital interval >12 h				<0.001			<0.001
No	1223 (64.4 %)	22 (32.8 %)	1201 (65.6 %)		8 (28.6 %)	1215 (65 %)	
Yes	675 (35.6 %)	45 (67.2 %)	629 (34.4 %)		20 (71.4 %)	665 (35 %)	
Hospital interval (h)	12.2±11	15.3±7.4	12.1±11	0.01	15.5±7	12.2±11	0.02
WBC (×10 ³ /mm ³)	14.4±4	14.1±4	14.5±4.5	0.4	14.3±5.9	14.4±4.5	0.8
Abnormal WBC ^a				0.8			0.9
No	433 (23 %)	16 (24.2 %)	417 (23 %)		6 (22.2 %)	427 (23 %)	
Yes	1447 (77 %)	50 (75.8 %)	1396 (77 %)		21 (77.8 %)	1426 (77 %)	
Neutrophilia ^b				0.4			0.8
No	338 (18.4 %)	6 (9 %)	332 (18.8 %)		4 (14.3 %)	334 (18.5 %)	
Yes	1499 (81.6 %)	61 (91 %)	1437 (81.2 %)		24 (85.7 %)	1475 (81.5 %)	
Temperature (°C)	37.19±0.84	37.28±0.936	37.2±0.842	0.5	37.12±0.75	37.2±0.84	0.6
Fever ^c				0.7			0.8
No	1065 (69.9 %)	36 (67.9 %)	1028 (70 %)		13 (72.2 %)	1052 (69.9 %)	
Yes	458 (30.1 %)	17 (32.1 %)	441 (30 %)		5 (27.8 %)	453 (30.1 %)	
Preoperative CT				<0.001			<0.001
No	1525 (80.3 %)	17 (25.4 %)	1508 (82.4 %)		6 (21.4 %)	1519 (80.2 %)	
Yes	373 (19.7 %)	50 (74.6 %)	322 (17.6 %)		22 (78.6 %)	351 (19.8 %)	
Preoperative US				0.2			0.8
No	1564 (82.4 %)	59 (88.1 %)	1504 (82.2 %)		24 (85.7 %)	1540 (82.4 %)	
Yes	334 (17.6 %)	8 (11.9 %)	326 (17.8 %)		4 (14.3 %)	330 (17.6 %)	

Continuous variables are expressed as mean±SD; categorical variables are expressed as n (%)

NA not applicable, CT computerized tomography, US

^a Abnormal WBC defined as less than $3.5 \times 10^3/\text{mm}^3$ or more than $11 \times 10^3/\text{mm}^3$ white blood cells

^b Neutrophilia defined as more than 79 % neutrophils

^c Fever was defined as temperature higher than 37.8 °C

in 10.7 % of the octogenarian group compared to 1.2 % of the non-octogenarian group ($P=0.006$, Table 2).

Postoperative Factors

The elderly and octogenarian groups had a longer average hospital stay (5.7 and 5.8 days, respectively) than the corresponding younger groups (3.2 days each, $P<0.001$ for both) (Table 3). The older groups also had a significantly higher rate of postoperative complications (34.4 and 39.3 %, respectively) than the younger groups (13.1 and 13.5 %, respectively,

$P<0.001$ for both). Analysis of the specific complications revealed a significantly higher rate of wound infections in the elderly than the non-elderly group (9 vs 3.7 %, $P=0.03$) (Table 3). Only one patient (aged 82 years) died in the early postoperative period.

Pathology

Rates of complicated appendicitis were significantly higher in the elderly group (40.3 %) and the octogenarian group (35.7 %) than in the younger groups (16.0 and

Table 2 Operative characteristics in 1898 patients with appendicitis, by age groups

Characteristic	All patients (n=1898)	Elderly (n=68)	Non-elderly (n=1830)	P value	Octogenarian (n=28)	Non-octogenarian (n=1870)	P value
Operative time (min)	67.7±25.6	88±34.7	66.9±24.9	<0.001	92.7±43.3	67.3±25.03	<0.001
Operative time longer than 1 h				<0.001			0.02
No	957 (50.4 %)	17 (25.4 %)	940 (51.4 %)		8 (28.6 %)	949 (50.7 %)	
Yes	941 (49.6 %)	50 (74.6 %)	890 (48.6 %)		20 (71.4 %)	921 (49.3 %)	
Surgical approach				0.5			0.5
Laparoscopy	1043 (55 %)	39 (58 %)	1004 (55 %)		14 (50 %)	1029 (55 %)	
Open	845 (45 %)	28 (42 %)	826 (45 %)		14 (50 %)	841 (45 %)	
Conversion (laparoscopic to open)				0.01			0.006
No	1872 (98.6 %)	63 (94 %)	1808 (98.8 %)		25 (89.3 %)	1847 (98.8 %)	
Yes	26 (1.4 %)	4 (6 %)	22 (1.2 %)		3 (10.7 %)	23 (1.2 %)	

Continuous variables are expressed as mean±SD; categorical variables are expressed as n (%)

16.6 %, respectively, $P<0.01$ for both) (Table 4). Rates of negative appendectomy were 9 % in the elderly group and 10.7 % in the octogenarian group compared to 15.7 and 15.6 % in the corresponding younger groups (NS) (Table 4). Figure 1 illustrates the patient outcome characteristics by age groups.

Discussion

The aim of the present study was to evaluate the characteristics and outcome of acute appendicitis in elderly patients. This issue is relevant to the rising burden of health care posed by the increasing life expectancy of the population and the

consequent increase in the number of elderly undergoing surgery. Recently, several level 1 studies have shown that non-operative management of acute appendicitis is effective and safe.^{16–18,20} Moreover, the safety of non-operative treatment was reported in patients older than 80 years.²¹ It can be speculated that the non-operative management strategy may have potential benefits for the elderly patients by avoiding the morbidity associated with surgery.

The present study shows that the outcome of acute appendicitis is poorer in elderly than in younger patients. A major finding was the almost double interval from symptom onset to admission for the elderly and octogenarian patients (50 and 51 h) compared to their younger counterparts (30 and 32 h). A long delay in seeking medical help among elderly patients has

Table 3 Postoperative factors in 1898 patients with appendicitis, by age groups

Characteristic	All patients (n=1898)	Elderly (n=68)	Non-elderly (n=1830)	P value	Octogenarian (n=28)	Non-octogenarian (n=1870)	P value
LOS (days)	3.3±2.9	5.7±4.6	3.2±2.8	<0.001	5.8±4.9	3.2±2.8	<0.001
LOS ≥3 days				<0.001			<0.001
No	908 (48.4 %)	10 (15.2 %)	897 (49.6 %)		4 (14.8 %)	904 (48.9 %)	
Yes	990 (51.6 %)	56 (84.8 %)	912 (50.4 %)		23 (85.2 %)	945 (51.1 %)	
Any complication				<0.001			<0.001
No	1634 (86.1 %)	44 (65.7 %)	1589 (86.9 %)		17 (60.7 %)	1617 (86.5 %)	
Yes	263 (13.9 %)	23 (34.3 %)	240 (13.1 %)		11 (39.3 %)	252 (13.5 %)	
Wound infection				0.03			0.2
No	1824 (96.1 %)	61 (91 %)	1762 (96.3 %)		26 (92.9 %)	1798 (96.1 %)	
Yes	74 (3.9 %)	6 (9 %)	68 (3.7 %)		2 (7.1 %)	72 (3.9 %)	
Intra-abdominal abscess				0.7			0.5
No	1840 (96.9 %)	66 (98.5 %)	1773 (96.9 %)		27 (96.4 %)	1813 (97 %)	
Yes	58 (3.1 %)	1 (1.5 %)	57 (3.1 %)		1 (3.6 %)	57 (3 %)	

Continuous variables are expressed as mean±SD; categorical variables are expressed as n (%)

LOS length of hospital stay

Table 4 Pathology data in 1898 patients with appendicitis, by age groups

Characteristic	All patients (n=1898)	Elderly (n=68)	Non-elderly (n=1830)	P value	Octogenarian (n=28)	Non-octogenarian (n=1870)	P value
Complicated appendicitis				<0.001			0.007
No	1578 (83.1 %)	40 (59.7 %)	1537 (84 %)		18 (64.3 %)	1560 (83.4 %)	
Yes	320 (16.9 %)	27 (40.3 %)	293 (16 %)		10 (35.7 %)	310 (16.6 %)	
Non-inflamed appendix				0.13			0.6
No	1604 (84.5 %)	61 (91 %)	1543 (84.3 %)		25 (89.3 %)	1579 (84.4 %)	
Yes	294 (15.5 %)	6 (9 %)	287 (15.7 %)		3 (10.7 %)	291 (15.6 %)	

Continuous variables are expressed as mean±SD; categorical variables are expressed as n (%)

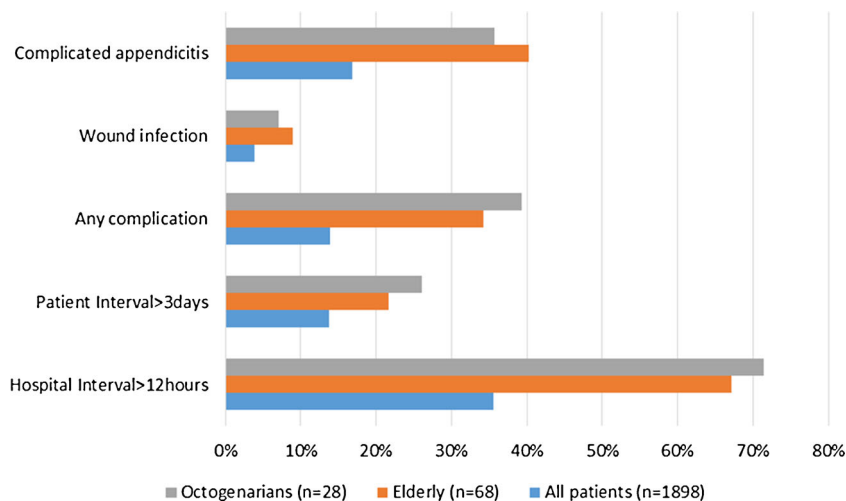
been reported by others as well,^{22–27} and in a previous study, our group found that a prolonged patient interval was associated with higher rate of postoperative complications.²⁸ In addition, in the present study, the interval from hospital admission to surgery was also longer in the elderly and octogenarian groups. The long hospital interval might be explained in part by the often atypical presentation of acute appendicitis in older patients, leading to the need for a more comprehensive workup, including cross-sectional imaging.²² This assumption is supported by the higher rates of preoperative CT in our elderly and octogenarian groups (74.6 and 78.6 %, respectively) compared to the non-elderly and non-octogenarian groups (17.6 and 19.6 %, respectively). The increased utilization of CT in the elderly may also reflect the higher proportion of advanced pathology in this group (with more than one third presenting with complicated appendicitis). On the basis of this level of evidence, we recommend early utilization of cross-sectional imaging for the evaluation of elderly patients with suspected acute appendicitis to identify the substantial portion of patients with complicated appendicitis.

Longer operative times were noted for the elderly and octogenarian patients in our study, which may have been attributable to the higher rates of complicated appendicitis in these groups. Accordingly, the advanced pathology in the older patients

probably accounts for their higher conversion rate, higher rate of postoperative complications, and longer hospital stay.

Taken together, the findings of this study demonstrated that elderly patients with appendicitis constitute a high-risk group with unique risk-related characteristics throughout the disease course, in the preoperative, intra-operative, and postoperative periods. Nevertheless, surgery remains the standard of care in all age groups. Studies have suggested that surgeons treating elderly patients should also weigh such factors as frailty, comorbidities, risk of relapse, performance, and cognitive status, all of which have important predictive value for outcome.^{29,30} The frailty index, a new instrument introduced for this purpose, incorporates 50 variables on patient demographics (age, comorbidities, and medication history), social activity, activities of daily living, nutritional status, and general mood.³¹ Joseph et al.³² found that the frailty index may serve as an independent predictor of in-hospital complications and adverse discharge disposition in geriatric trauma patients. Incorporating this and other new metrics into future studies on the outcome of elderly patients with appendicitis may help clinicians develop better individually tailored management strategies.

The present study is limited by its retrospective design, in which biases cannot be excluded. For example, antibiotic treatment was initiated without an exact timing protocol and

Fig. 1 Characteristics of 1898 patients with appendicitis, stratified by age groups

might have halted pathologic progression. Our use of a cohort from a single institution also harbored an inherent selection bias which narrows the generalizability of the findings. An additional bias might have resulted from the fact that patients who presented to the ER with advanced pathology have been worked up more extensively (e.g., ultrasound and CT) which resulted in longer time intervals. Nonetheless, to our knowledge, this study is the most comprehensive single-institution series comparing elderly and non-elderly patients with acute appendicitis. We have assessed, in greater detail than prior analyses, the prehospital and intra-hospital time variables associated with delays to care. In addition, besides the patient interval, all data were collected from objective sources.

In conclusion, this study demonstrates several unique characteristics of the elderly patients with acute appendicitis, which include poor outcome and longer time intervals to diagnosis and treatment. These data will be useful for informing future prospective trials, which are necessary in order to improve the poor outcome and to determine the optimal management strategy.

Conflict of Interest All authors declare that they have no conflict of interests regarding this study.

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