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Dynamic Position Change of the Vermiform Appendix in Patients with Acute Appendicitis

Naoko Iwahashi Kondo*, Dai Kitagawa, Toshihiko Nakamura, Genkichi Saito, Eisuke Adachi, Yoichi Ikeda

Kyushu Central Hospital, Fukuoka, Japan

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***Corresponding author:** *Naoko Iwahashi Kondo, Kyushu Central Hospital, Shiobaru, Minami-ku, Fukuoka, Japan, 8158588, Tel.: +81-92-541-4936; E-mail: kondo-n@surg2.med.kyushu-u.ac.jp*

Abstract

Purpose: To determine whether the position of the appendix changes during the development of inflammation and whether the final position is related to the pathological inflammatory grade.

Methods: A total of 205 patients whose appendiceal position could be interpreted using CT imaging and who underwent an appendectomy within 24 h of initial diagnosis were enrolled in this study. The position was categorized, as being in the following regions: preileal, postileal, pelvic, subcecal, postcecal, and prececal. Patients were classified into two groups depending on the time between the onset of symptoms and the CT scan. We also divided patients into two groups depending on their pathological inflammatory grade. The relationship between the position and the time since symptom onset or the pathological inflammatory grade was investigated.

Results: The position distributions varied significantly depending on the time since symptom onset ($p=0.03$). Although the position distribution was not significantly affected by the inflammatory grade, there were more postcecal appendices than expected in the group that included non-gangrenous appendicitis ($p<0.05$).

Conclusion: The position of the appendix has been suggested to change dynamically during the development of inflammation. Patients whose appendix stays in a postcecal position may be unlikely to have advanced appendicitis.

Keywords: Vermiform appendix; Appendicitis; Position

Introduction

As for one of the causes of appendicitis, obstruction of the vermiform appendix has been advocated. Appendiceal obstruction follows by increased intraluminal pressure, ischemic, mucosal injury, and necrosis of the appendiceal wall [1-3]. This pathogenetic hypothesis is thought to be originated from the description by Volz in 1846 that appendicolith caused luminal obstruction and resulted in a perforated appendicitis with peritonitis [4]. Although many experimental studies have supported this hypothesis [5, 6], pathogenetic mechanism or development process of appendicitis has not been elucidated. Anatomically, the tip of the appendix moves freely in the area around the cecum. There were few studies about the position of the appendix in patients with acute appendicitis [7, 8]. The factors that induce the movement of the appendix have been unknown except for pregnancy [9, 10].

We hypothesized that the position change of the vermiform appendix relates the development process of appendicitis. In this study, we investigated to determine whether the position of the appendix changes during the development of inflammation and whether the final position of the appendix at diagnosis is related to the pathological inflammatory grade.

Methods

We reviewed the medical records of 396 consecutive Japanese patients who received an appendectomy at our facility from 2009 to 2013. Among this group, 221 patients presented with acute abdominal pain, underwent an intravenous contrast-enhanced CT scan upon initial presentation, underwent an appendectomy within 24 h of the initial diagnosis, and were pathologically diagnosed with acute appendicitis. In 16 patients, we were able to detect that part of the appendix was inflamed but were unable to interpret the position of the appendix; these patients were excluded from the study. A total of 205 patients met the study criteria.

The position of the appendix for each case was classified into the following 6 groups: preileal, postileal, pelvic, subcecal, postcecal, and prececal. The retrocolic position was included in the postcecal group, and the precolic position was included in the prececal group. The age and gender of the patients were also recorded. The cases were divided into two groups depending on the time from the onset of symptoms to the CT scan as follows: group S underwent a CT scan within 10 h of the onset of symptoms, and group L was scanned after a symptom duration of more than 10 h. The distributions of appendix positions in groups S and L were compared. We also divided the cases into two groups according to the pathological inflammatory grade, namely, non-gangrenous appendicitis (group non-G) and gangrenous appendicitis (group G). To determine whether the final position of the appendix at diagnosis is related to the pathological inflammatory grade, the distributions of appendix positions in group's non-G and G were also compared.

For statistical analyses of distributions of appendix positions,

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we used the chi-square test and residual analysis to compare between groups S and L and between groups G and non-G. We used the Mann-Whitney's U test to compare the distributions of appendix positions in groups of patients who were less than 18 years old and of patients who were older than 18 years. P values that were less than 0.05 were considered significant. The chi-square test and the Mann-Whitney's U test were performed using Statcel 3 (OMS, Tokorozawa, Japan), and the residual analysis was performed using js-STAR 2012 (free online in Japanese, www.kisnet.or.jp/nappa/software/star/).

Results

Patients' age was ranged from 15 to 89 years old. Nineteen patients who were less than 18 years old and 186 patients who were older than 18 years were included. The position distribution was not significantly different between the groups of patients who were less than 18 years old and of patients who were older than 18 years (p=0.09).

The patient demographics are shown in Table 1. The patients in groups L and G were significantly older than those in groups S and non-G, respectively. Among the patients with acute appendicitis, the most common position was pelvic, occurring in 93 cases (45.4%). Other positions included postcecal in 44 (21.5%), subcecal in 32 (15.6%), postileal in 22 (10.7%), preileal in 9 (4.4%), and prececal in 5 (2.4%) patients (Table 2). In both group S and group L, the most common position was pelvic (22 and 71 cases in groups S and L, respectively), followed by postcecal (17 and 27 cases in groups S and L, respectively). Distributions of the positions varied significantly between the two groups depending on the time since symptom onset (p=0.03). The residual analysis revealed that there were more pelvic appendices (p<0.05) and fewer prececal appendices (p<0.05) than expected in group L (Table 2). Although distributions of the appendix positions did not vary significantly between groups G and non-G, more appendices were observed in the postcecal position than expected in group non-G (p<0.05) (Table 3).

Discussion

Although previous studies examined the position of the vermiform appendix, the factors that determine its position remain unknown. Some authors have noted discrepancies between autopsy data and surgery data [7, 8]. Wakeley (Wakeley, 1933) dissected to analyze 10,000 cases and classified the position of the vermiform appendix into 6 types: (1) anterior or preileal; (2) "splenic" or postileal; (3) pelvic; (4) subcecal; (5) postcecal and retrocolic; and (6) ectopic [11]. He reported these appendix positions in 1.0%, 0.4%, 31.0%, 2.3%, 65.3%, and 0.1% of his cases, respectively. Hypothesizing that most of his data were based on normal appendices and comparing his data with the data from the present study, significantly fewer appendices in the postcecal position and significantly more appendices in every other position were observed in the present study (p<0.01). This result suggests that the position of the appendix varies between normal and inflamed appendices. However, the appropriateness of comparing these data with data from another study from another country seems to be limited because the distribution of appendix positions has been shown to vary between countries [8, 12, 13].

Varshney et al. (Varshney, 1996) hypothesized that gravity-aided drainage of the appendicular lumen may reduce episodes of luminal obstruction and that the postcecal position offers a benefit in terms of making the appendix- less prone to infection [7]. If this hypothesis were true, the distributions of appendix positions in patients with acute appendicitis would be similar between groups S and L in this study. The finding that the distributions of appendix positions varied between groups S and L was inconsistent with this hypothesis, suggesting that the appendix position can change dynamically during the development of inflammation. We divided the 205 cases into two groups based on the time since symptom onset, with a threshold of 10 h. Kondo et al. (Kondo, 2009) hypothesized that a few hours are needed for an inflammatory response to develop and become gangrenous and they set 10h as the threshold [14], although the threshold time needs to be validated. Moreover, to confirm that the position of the appendix changes dynamically based on the inflammatory response, additional time intervals from the time of symptom onset should be considered in future analyses. Most patients, however, were unable to report the exact time of the

Table 1: Demographics of 205 patients in each group.

	Gender		P value	Age (years)[a]	P value
	Male	Female			
Total (n=205)	109	96		41.0±20.4	
Time since symptom onset					
Group S (n=63)	36	27	n.s	35.5±16.7	P=0.01
Group L (n=142)	73	69		42.9±21.5	
Inflamatory Grade					
Group non-G (n=137)	7 74	63	n.s	37.6±18.6	P<0.01
Group G (n=68)	35	33		47.9±22.2	

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Table 2: Distributions of the appendix positions depending on the time since symptom onset.

Appendix position	Total (n=205)	(%)	Group S N=63	Group L (n=142)	P Value	
					Chi-square test	Residual analysis
Preileal	9	4.4	2	7	P=0.03	n.s
Postileal	22	10.7	10	12		n.s
Pelvic	93	45.4	22	71		P<0.05
Subcecal	32	15.6	8	24		n.s
Postcecal	44	21.5	17	27		n.s
Prececal	5	2.4	4	1		P<0.05

Table 3: Relationship between appendix position and the pathological inflammatory grade.

Appendix position	Group non-G (n=137)	Group G (n=68)	P Value	
			Chi-square test	Residual analysis
Preileal	5	4	n.s	n.s
Postileal	17	5		n.s
Pelvic	58	35		n.s
Subcecal	19	13		n.s
Postcecal	36	8		P<0.05
Prececal	2	3		n.s

onset of symptoms when this duration was more than half a day.

Studies have suggested that appendices in the postcecal position are less prone to infection [7, 8]. The finding of this study that more postcecal appendices were observed than expected in group non-G could support this conclusion of previous studies although the statistical significance of the difference was not robust.

Adhesion of the appendix to the retroperitoneum, the cecum, or other organs may prevent the appendix from moving freely. The capabilities of individual immune systems vary and may influence the progression of acute appendicitis. It appears that many factors help determine the position of the vermiform appendix. Further pathogenetic studies of acute appendicitis may be able to clarify the existence of a relationship between the development of inflammation and the position of the appendix, facilitating the proper management of acute appendicitis.

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