

The Utility of Preoperatively Marking the Most Tender Point in Appendectomy for Acute Appendicitis-A Randomized Clinical Trial (RCT)

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Abstract

Objectives: We performed a randomized controlled trial to simplify appendix identification by marking the most tender abdominal area in patients with appendicitis before surgery and examining this area during surgery.

Methods: Two hundred forty-one randomly selected cases underwent appendectomy after acute appendicitis [Subjective: 121 cases marking in the most tender area (M) and 120 controls (C)]. Comparisons between the groups included the following: (I) concordance between the most tender area and appendix tip during laparotomy in M and (II) the time required to identify the appendix, surgical duration, incision length, additional incisions, and intra/postoperative complications.

Results: For comparison I, the site marked before surgery and appendix tip direction following laparotomy matched in 75.2% cases. For comparison II, the time required for appendix identification, surgical duration, skin incision length, additional incision, and intraoperative complications were significant differences between two groups ($p < 0.05$). There was no statistically significant difference in postoperative complications (NS).

Conclusion: Marking the most tender area before appendectomy may simplify appendix identification.

Key words: Acute appendicitis, The most tender point, One finger palpation, Appendix tip direction

Introduction

In recent years, judging the degree of appendicitis and the position and morphology of the appendix before surgery has become possible because of advances in and increased use of abdominal image such as computed tomography (CT) and ultrasonography (US), etc. Therefore, physical examinations of the abdomen have been given less focus. However, physical examinations are the basis of diagnostics and should undoubtedly continue to be important. During appendectomy, all surgeons have identified the appendix to be the reason for performing the surgery. Moreover, they experienced difficulty in identifying the appendix when the findings during a

laparotomy and those from imaging do not necessarily match. Therefore, there have been rare cases in which the skin incisions are extended or cases in which the intestine and mesentery are injured. If the position and/or course of the appendix are known before surgery, intraoperative identification of the appendix would be more easy during surgery, thereby allowing the surgery to be performed more smoothly.

Therefore, in this study, we performed a randomized clinical trial (RCT) to evaluate whether identification of the appendix is made easier by marking the most tender point of the abdomen before surgery. We also evaluated whether this affects the surgical duration and/or the occurrence of intra- and/or postoperative complications in patients with acute appendicitis.

Patients and Methods

Among patients who underwent an appendectomy after a diagnosis of acute appendicitis at the Social Insurance Chikuho Hospital and related institutes from April 2001 to March 2011 (Fig. 1), patients with following characteristics were used as subjects: (1) 7 years of age or older at onset, (2) point tenderness in the right lower abdomen on physical examination, (3) findings of inflammation based on blood tests results [leukocytosis: number of leukocytes (WBC) was 10,000/mm³ or more or C-reactive protein levels (CRP) of 0.5 or more], (4) swelling of the appendix on abdominal US and/or abdominal CT, and (5) ability to obtain informed consent from the patients themselves. However, the following patients were excluded from this study: (1) patients in whom analgesics were used during physical examinations, (2) patients in whom the presence of a tumor was suspected by imaging findings, (3) patients who were pregnant, (4) patients that required intestinal resection, and (5) patients who did not provide informed consent. Using the drawing method for random sampling,

241 acute appendicitis patients were divided into two groups: the marking group (M: 121 cases), in which the most tender point of the abdomen was marked before surgery and the control group (C: 120 cases), in which the conventional surgery was performed without marking. In addition, we classified the patients according to the absence of abscess or perforation complications (M: 95 cases, C: 98 cases) or the presence of them (M: 26 cases, C: 22 cases).

Furthermore, there was no significant difference between two groups with regard to age, gender, body mass index (BMI), and the WBC count and CRP levels before surgery (Table 1).

During the procedure to mark the most tender point of abdomen, two surgeons (with 6 years or more of surgical experience) palpated the abdomen of a patient with their index finger (one finger palpation) without analgesics and divided the parts of the abdomen into three grades: (-), (+), and (++) , depending on the degree of pain. The second surgeon blinded. The (++) area was then determined to be the most tender point, and was marked with a permanent marker (Fig. 2).

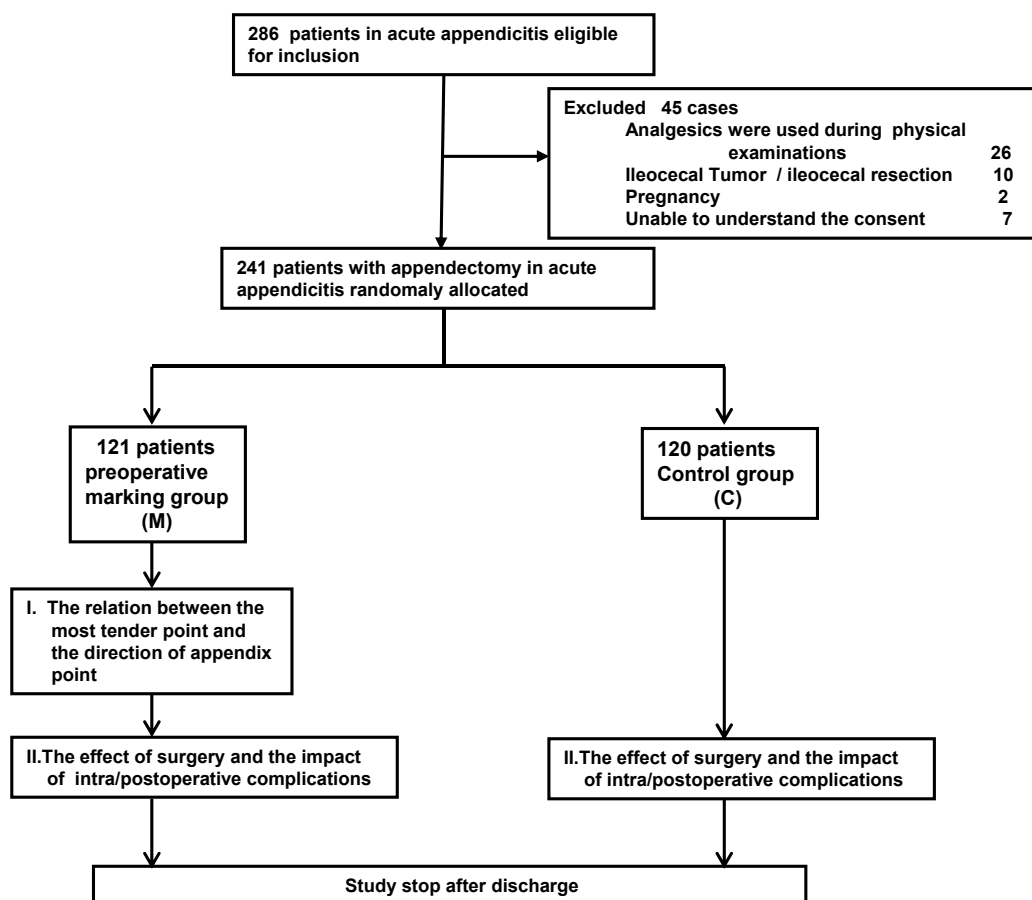


Fig. 1 Overview of the patients and the study

Table 1 Patient Back Ground (n=241)

	M (n=121)	C (n=120)	p - value
Sex (M/F)	65:56	55:65	0.1711
Age (Year)	21.8 ± 8.5	22.4 ± 9.1	0.8305
BMI	20.4 ± 2.4	20.7 ± 2.1	0.3021
WBC (/mm ³)	11,324 ± 3880	12,133 ± 3936	0.1094
CRP (mg/dl)	4.3 ± 3.0	4.8 ± 3.2	0.2863
Skin incision methods			0.7569
MacBurney	116	113	
Lennander	5	7	
Drainage	35	34	0.919
Pathological findings			0.7767
Catarrhalis	29	30	
Phlegmonosa	68	66	
Gangrenous	24	24	
Panperitonitis			
Abscess	26	22	0.5398
Perforation	9	8	0.9858

BMI: Body Mass Index; WBC: number of leukocytes (white blood cell)

CRP: C-reactive protein MacBurney: McBurney incision: cross-cutting

Lennander incision: pararectal incision



Fig. 2 The marking point in the most tender point: There is the most tender point on the head side (H) more than Mc Burney point, and we have just marked in black ink.

(I) The relationship between the most tender point and direction of appendix point.

The relationship between the direction of the most tender point before surgery and that of the tip of the appendix following laparotomy was investigated in the M group. The direction of the most tender point before surgery was one of the four directions: H for cranial (11 o'clock to 1 o'clock) ; C for caudal (5 o'clock to 7 o'clock); L for left side (abdominal median side: 2 o'clock to 4 o'clock); and R for right side (left side ventral: 8 o'clock

to 10 o'clock), in terms of the McBurney point of view [M point: 1/3 of the exterior of the line connecting the upper right anterior superior iliac spine and the umbilicus (spinoumbilical line)] (Fig.3A). The direction of the orientation of the vermiform appendix after laparotomy was one of four directions: h for cranial (11 o'clock to 1 o'clock); c for caudal (5 o'clock to 7 o'clock); l for left side (abdominal median side: 2 o'clock to 4 o'clock); and r for right side (left side ventral: 8 o'clock to 10 o'clock) in terms of the root of the appendix view (Fig. 3B).

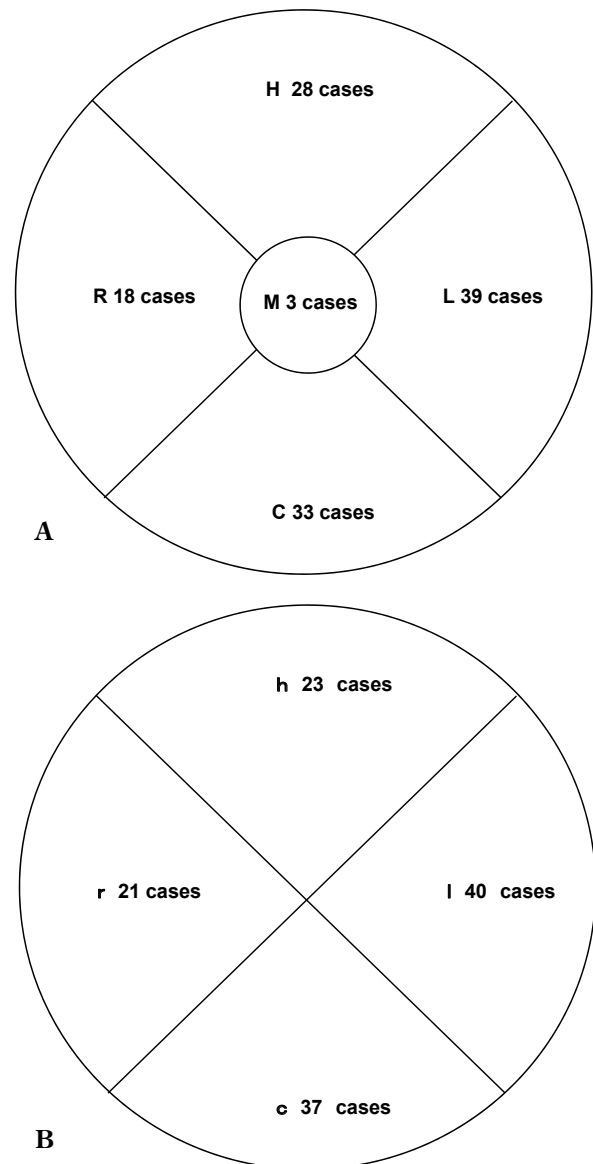


Fig. 3 A The direction of the marking point before operation as follows; H was 28 cases, L was 39 cases, C was 33 cases, R was 18 cases, M was 3 cases. B The direction of the point of vermiform appendix after operation as follows; h was 23 cases, l was 40 cases, c was 37 cases, r was 21 cases.

(II) The effects of surgery and the impact of postoperative complications

The time taken to identify the appendix [time (min) taken from commencement of surgery until the entire appendix was identified], surgical duration (time it took (min) from the commencement of surgery to the completion of operation), length of the skin incision wound (mm), presence of an extension of the skin incision, and intra- and postoperative complications were all investigated. The time was rounded to minute, and the comparison analyses between two groups were performed by χ^2 test, Fisher's exact test, two sample t-test or Mann-Whitney U-test, with a *p* value of ≤ 0.05 considered to indicate a statistically significant difference.

The study design conformed to the ethical guidelines of the Declaration of Helsinki, and obtained informed consent was obtained from each subject before their registration.

Results

(I) The relationship between the most tender point prior to surgery and the direction of the tip of the appendix upon laparotomy

The sites marked before operation in the M were: 28 cases of H, 39 cases of L, 33 cases of C, 18 cases of R, and 3 cases of M (Fig. 3A). The direction of the tip of the appendix as noted during laparotomy were: 23 cases of h, 40 cases of l, 37 cases of c, and 21 cases of r (Fig. 3B); of these 121 cases, the site marked and direction coincided in 91 cases (75.2%).

(II) The effects of surgery and impact of postoperative complications

1. Time taken to identify the appendix and the surgical duration

Table 2 shows the details regarding identification and surgical duration for both groups. The mean time taken to identify the appendix was 5.6 ± 2.0 min in the M group, and 7.0 ± 2.4 min in the C group. Furthermore, the duration was 5.5 ± 2.9 min in cases without abscess/perforation complications in the M group and 8.4 ± 8.2 min in the C group. In contrast, the duration was 8.2 ± 3.9 min in cases that had abscess/perforation complications in the M group and 13.3 ± 5.5 min in the C group. The average time taken to identify the appendix was shorter in the M group than in the C group, and this difference was statistically significant ($P < 0.05$).

The mean operation time was 40.3 ± 15.4 minutes in the M, and 49.6 ± 23.4 minutes in the C. It was 38.5 ± 14.2 minutes for cases without abscess/perforation complications in the M, and 46.6 ± 19.1 in the C. The average operation time was shorter in the M for both cases, and a statistically significant difference was observed ($P < 0.01$). On the other hand, it was 55.2 ± 17.5 minutes for cases with abscess/perforation complications in the M group and 77.4 ± 37.3 in the C, the average operation time was shorter in the M, but no statistically significance was observed ($p = 0.06525$).

2. The length of the skin incision wound and the presence of extension of the incision

The mean length of the skin incision wound 37.3 ± 8.5 mm in the M and 41.7 ± 15.1 mm in the C. It was 36.5 ± 7.2 mm for

Table 2 The Effects of Surgery

Total case	M (n=121)	C (n=120)	p-value
Distinction time (min)	5.6 ± 2.0	7.0 ± 2.4	0.00002356
Operation time (min)	40.3 ± 15.4	49.6 ± 23.4	0.0002965
Length of the skin incision (mm)	37.3 ± 8.5	41.7 ± 15.1	0.006338
Extension of the skin incision	10 (8.3%)	20 (16.7%)	0.04821
Without abscess/ perforation	M (n=95)	C (n=98)	p-value
Distinction time (min)	5.5 ± 2.9	8.4 ± 8.2	0.0005916
Operation time (min)	38.5 ± 14.2	46.6 ± 19.1	0.0004374
Length of the skin incision (mm)	36.5 ± 7.2	39.7 ± 11.6	0.01438
Extension of the skin incision	6 (6.3%)	10 (10.2%)	0.4726
With abscess/ perforation	M (n=26)	C (n=22)	p-value
Distinction time (min)	8.2 ± 3.9	13.3 ± 5.5	0.01314
Operation time (min)	55.2 ± 17.5	77.4 ± 37.3	0.06525
Length of the skin incision (mm)	44.4 ± 13.9	59.1 ± 27.9	0.1048
Extension of the skin incision	4 (15.4%)	10 (45.5%)	0.04940

Distinction time: the time taken to identify the appendix

Incision Length: the Length of Skin incision Wound

cases without abscess/ perforation complications in the M, and 39.7±11.6 mm in the C, and statistically significant differences were observed ($p<0.05$). It was 44.4±13.9 mm for cases with abscess/perforation complications in the M and 59.1±27.9 mm in the C. No statistically significant difference was observed (NS).

Extension of the skin incisions were made in 10 cases (8.3%) in the M and 20 cases (16.7%) in the C. There were more extension of the skin incisions in the C, and a statistically significant difference was observed ($P<0.05$). There were 6 cases (6.3%) for cases with no abscess/perforation complications in the M and 10 cases (10.2%) in the C. Although extension of the skin incisions tended to be observed more often in the C, no statistically significant difference was observed. There were 4 cases (15.4%) for cases with abscess/perforation complications in the M and 10 cases (45.5%) in the C, and a statistically significant difference was observed ($P<0.05$).

3. Intraoperative complications and postoperative complications (Table 3)

Intraoperative complications were observed in 4 cases (3.3%) in the M and 13 cases (10.8%) in the C, and statistically significant differences were observed ($p<0.05$). Intraoperative complications in cases without abscess/perforation complications were observed in 4 cases (4.2%) in the M and 8 cases (8.2%) in the C (NS) Regarding

cases with abscess/perforation complications, there were 0 cases in the M while there were 5 cases (22.7%) in the C, and statistically significant differences were observed ($p<0.05$).

Postoperative complications were observed in 9 cases (7.4%) in the M and 11 cases (9.2%) in the C. Postoperative complications in cases with no abscess/ perforation complications were observed in 5 cases (5.3%) in the M and 5 cases (5.1%) in the C. Postoperative complications in cases with abscess/perforation complications were observed in 4 cases (15.4%) in the M and 6 cases (27.3%) in the C. No statistically significant difference was observed in any cases (NS).

Discussion

Among acute abdomens with a main complaint of pain in the right lower abdomen, acute appendicitis is one of the diseases that are experienced most often¹. Pain in the appendix projection is believed to occur due to rising inner pressure in the small hollow organ, which is approximately 3~7cm in length and 5~6mm in diameter, generally by stricture/occlusion of the lumen and inflammation occurring distal to the site of obstruction (blind end). This area is believed to be the tender point of the McBurney point, Lanz point, etc., and these are very useful findings from physical examinations for diagnosis

Table 3 Intra-Operative and Post-Operative Complications

Total case	M (n=121)	C (n=120)	p-value
Intra-operative complications	4 (3.3%)	13 (10.8%)	0.04232 [#]
Mesocolon injury	3 (2.5%)	9 (7.5%)	
Intestine, colon injury	1 (0.8%)	4 (3.3%)	
Post-operative complications	9 (7.4%)	11 (9.2%)	0.6267 [#]
Wound infection	7 (5.8%)	9 (7.5%)	
Ileus	2 (1.7%)	2 (1.7%)	
Without abscess/perforation	M (n=95)	C (n=98)	p-value
Intra-operative complications	4 (4.2%)	8 (8.2%)	0.4016 [#]
Mesocolon injury	3 (3.2%)	6 (6.1%)	
Intestine, colon injury	1 (1.1%)	2 (2.0%)	
Post-operative complications	5 (5.3%)	5 (5.1%)	0.7838 [#]
Wound infection	3 (3.2%)	4 (4.1%)	
Ileus	2 (2.1%)	1 (1.0%)	
With abscess/perforation	M (n=26)	C (n=22)	p-value
Intra-operative complications	0	5 (22.7%)	0.01538 ^{###}
Mesocolon injury	0	3 (13.6%)	
Intestine, colon injury	0	2 (9.1%)	
Post-operative complications	4 (15.4%)	6 (27.3%)	0.5132 [#]
Wound infection	4 (15.4%)	5 (22.7%)	
Ileus	0	1 (4.5%)	

[#] Chi ^{##} Yates Chi ^{###} Fisher prob

of appendicitis^{2,3}. The therapeutic strategy is generally decided by performing a final diagnosis by integrating findings such as inflammation findings, including increased number of leukocytes, increased CRP, etc., hyperplasia of the appendiceal wall, fecalith, images of free gas, and the presence of an abscess upon imaging testing such as by abdominal US and abdominal CT⁴⁻⁷.

On the other hand, an appendectomy is a fundamental surgical procedure for surgeons. Generally, wounds are small and surgical fields are narrow, so the difficulty of the surgery differs by the degree of inflammation of appendicitis and/or thickness of the abdominal wall. In an appendectomy, laparotomy is often performed just above the root of the appendix by McBurney incision (cross-cutting) when the inflammation is localized, and Lennander incision (pararectal incision) is often selected when the inflammation ranges over a broad area or when differentiation from a tumor is difficult. Following a laparotomy, the appendicular root is identified from the taenia coli. However, even if abdominal US and/or abdominal CT are utilized, there are times in which the appendix cannot be identified because the greater omentum and/or small intestine are covering the area during laparotomy⁸. Therefore, there are cases in which the intestine, mesentery, and/or blood vessels that have become brittle from inflammation and/or surrounding organs are injured. Thus, in order to make identification of the appendix easier, there are reports that mention it is easier to make the patient assume a left-half side-lying position, keeping the subcutaneous fatty tissue and/or the small intestine away from the surgical field; or to laparoscopically look for the appendix from a distance^{9,10}. However, although advantages such as reduced postoperative pain, fewer complications, and shortened period required for social rehabilitation are reported upon laparoscopic appendectomy, unsolved issues still exist such as: lengthy surgery, increased expenses, and the fact that there are still few endoscopic surgeons, in addition to it not being a widely generalized method^{11,12}.

Therefore, we marked the most tender point prior to surgery as a method of making identification of the appendix easier. According to a report mentioning that when the most painful area was indicated by the index finger by acute appendicitis patients themselves, and that when an abdominal ultrasound was subsequently performed, the appendix was observed directly under or in the vicinity of the indicated area¹³, it is believed that with this method there is head control of the inflammation

in the vicinity of the most tender point and an enlarged appendix or its tip is present in the same area. Thus, it was believed that identification of the appendix can be performed with ease if the direction of the marked area is searched for upon laparotomy. As a result of this study, the rate of concordance regarding the direction of the most tender point before operation and the direction of appendix projection in laparotomy findings was high, at 75.2 % in the M group; and there were 30 cases (9 cases of retroperitoneal adhesions, 11 cases of muscular defense, 5 cases of perforation, and 5 cases of extreme obesity) in which the direction was completely different.

There was significant difference in the time taken to identify the appendix, operation time and they were found slightly faster in the M compared to the C. Moreover, inflamed appendixes were found with less additional incisions to the skin/abdominal wall in the M compared to the C. It was believed that the time taken for these lead to shortening of the surgical time, more in the M compared to the C. In diffuse peritonitis patients with abscess/perforation complications, in particular, it may be difficult to perform physical examinations due to pain, but by carefully performing a physical examination and finding the most tender point, identification of the appendix was performed with ease.

Concerning intraoperative complications, significant differences were observed between the two groups. However, as for the reason why more complications tended to be observed in the C, it was believed that intestinal and mesenteric injuries were caused due to frequent gripping of the ileocecum, which became brittle due to inflammatory edema. For this reason, the intestine/mesentery also needs to be gripped with more tender care. Tender and careful manipulation is required, especially when searching for inflammation appendix projections. It was believed that the reason why there were relatively fewer cases with intraoperative complications in the M group was because the position and course of the appendix was correct.

Regarding postoperative complications, no significant difference was observed between the two groups. Generally, complications following an incision are considered to occur in 7.5 to 15.5% of all cases, approximately half of which are determined to be wound infections¹⁴. Of the cases we experienced, the incidence rate of postoperative complications was approximately 7.4%, with a high rate of wound infection complications, especially in cases with abscess/perforation complications. Moreover, the onset rate of ileus was 1.7%. One of the causes for postoperative

ileus is adhesion by appendectomy¹⁵, so rapid surgical therapy in mild cases must be performed with caution. However, regarding cases observed with clearly intense inflammation, the action of administering antimicrobial agents and suppressing inflammation may deteriorate appendicitis as a result. Therefore, it is necessary to sufficiently review the surgical indications by detailed physical examinations, etc., not only from hematology tests and findings from images¹⁶.

From the above, sufficiently performing physical examination before surgery, marking the most tender point, and preferentially searching the marked site at laparotomy is believed to be useful in identification of the whole appendix. As a result, it was believed that it is possible to shorten the operation time and decrease the number of intraoperative/postoperative complications caused by unnecessary searching.

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Conflict of interest

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