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Anatomical Variation of the Appendix in Relation with Appendectomy Decision

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Abstract

Background The signs and symptoms of acute appendicitis vary according to the site of the appendix; and absence of tenderness in the right iliac fossa dose not exclude appendicitis like in postileal, subhepatic and pelvic appendix. Even Alvarado scale zero is not excluding the diagnosis of acute appendicitis.

Objective To study the incidence of delayed appendectomy and its relation to the anatomical variation of the appendix and its morbidity.

Methods A prospective study for patients whom underwent appendectomy for acute appendicitis during the period from-June 2009 to June-2010. The appendix of all the patients was submitted to histopathological examination and was proved to be acutely inflamed. The patients were divided into two groups according to the time interval from the onset of the first symptom to the time of appendectomy. In group A, this interval was more than 72 hours; while in group B it was less than 72 hours.

Results Group A includes 35 patients; while group B include 201 patients. The anatomical site of the appendix in group A was very significant in delayed decision of appendectomy in postileal appendix (P=0.0001), subhepatic appendix (P=0.0004), and significant in retrocecal appendix (P=0.017); but it is not significant in pelvic appendix (P=0.88), paracecal appendix (P=0.83) and preileal appendix (P=0.95). Patients in group A had longer hospital stay due to complications 35 (100%) generalized peritonitis and 3 (8.57%) patients were died due to septic shock which is significant (P=<o.o1).

Conclusion The classical visceral-somatic sequence of pain is not mandatory for diagnosis of appendicitis. In postileal and subhepatic appendicitis there is neither pain nor tenderness in the right iliac fossa (due to its anatomical position); and when the decision of appendectomy is delayed, there were generalized peritonitis and patients died due to septic shock.

Key words Appendectomy decision, Anatomical variation, Appendix

Introduction

The appendix first becomes visible in the 8th week of embryologic development as a protuberance off the terminal portion of the caecum. During both antenatal and postnatal development, the growth rate of the caecum exceeds that of the appendix, displacing the appendix medially towards the ileocaecal valve. The relationship of the base of the appendix to the caecum remains constant, whereas the tip can be found in a retrocaecal, pelvic, subcaecal, preileal, or right pericolic position (Figure 1). These anatomic considerations have significant clinical importance in the context of acute appendicitis [(1)].

During childhood, continued growth of the caecum commonly rotates the appendix into a retrocaecal position (figure 1). In approximately 25%, rotation of the appendix does not occur; resulting in a pelvic, subcaecal or paracaecal position. Occasionally the tip of the appendix becomes extraperitoneal, lying

behind the caecum or ascending colon. Rarely the caecum does not migrate during development to its normal position in the right lower quadrant of the abdomen. In these circumstances, the appendix can be found near the gall bladder or, in the case of intestinal malrotation, in the left iliac fossa, causing diagnostic difficulty if appendicitis develops. Acute appendicitis is the most common cause of acute abdomen and appendicitis is the most frequently performed urgent abdominal operation [2].

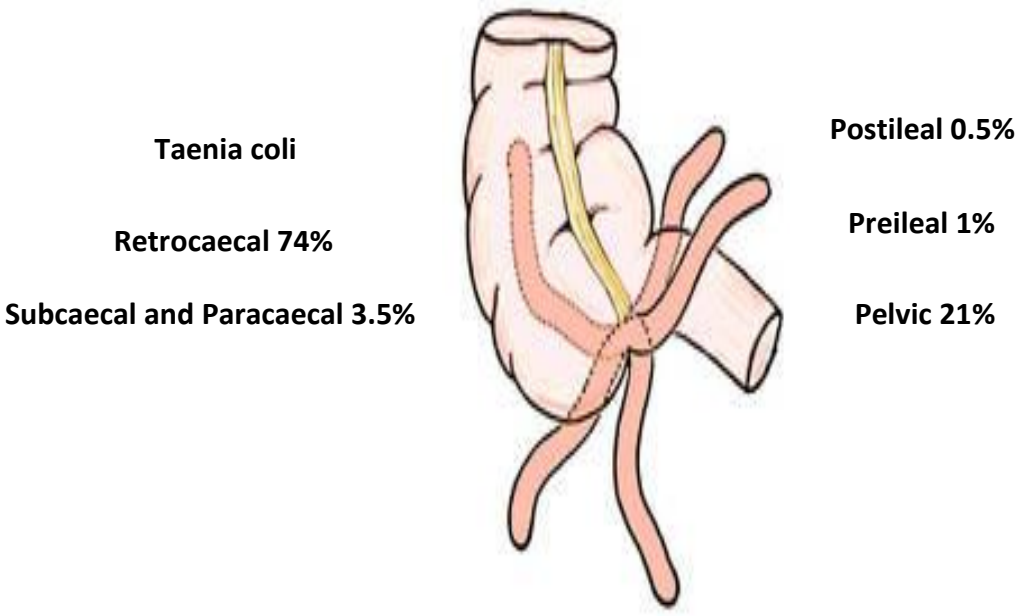

Figure 1. The various anatomical positions of the appendix .[2]

The credit for performance of the first appendectomy goes to Claudius Amyand, a surgeon at St. George's Hospital in London in 1736; he operated on an 11-year-old boy with a scrotal hernia and a fecal fistula. He successfully removed the appendix and repairs the hernia [3]. The Shattuck Professor of Pathological Anatomy from Harvard University, Boston, who presented a paper in 1886 describing the natural history and progression of the disease. He also recognized the vital importance of early diagnosis and immediate surgical intervention. The adoption of his conclusions by surgeons in North America in the following 15 years led to a decrease in the mortality of acute appendicitis from 50% to 15 % [4].

Notwithstanding advances in modern radiographic imaging and diagnostic laboratory investigations, the diagnosis of appendicitis remains essentially clinical, requiring a mixture of observation, clinical acumen and surgical science.

Peritonitis occurs as a result of free migration of bacteria through an ischemic appendicular wall, the frank perforation of a gangrenous appendix or the delayed perforation of an appendix abscess [2].

The differential diagnosis of acute appendicitis depends upon 4 major factors: the anatomic location of the inflamed appendix; the stage of the process (i.e., simple or ruptured); the patient's age; and the patient's sex. [5]

The classical features of acute appendicitis begin with poorly localized colicky abdominal pain due to mid-gut visceral discomfort in response to appendicular inflammation and obstruction. The pain is first noticed in the peri-umbilical region. With progressive inflammation of the appendix, the parietal peritoneum in the right iliac fossa becomes irritated, producing more intense, constant and

localized somatic pain that begins to predominant (pain that has shifted and changed in character).The classical visceral-somatic sequence of pain is present in only about half of those patients subsequently proven to have acute appendicitis. Atypical presentations include pain that is predominantly somatic or visceral and poorly localized according to the anatomical site of the appendix.

An inflamed appendix in the pelvis may never produce somatic pain involving the anterior abdominal wall (due to its anatomical position), but may instead cause suprapubic discomfort and tenesmus, and the tenderness may be elicited only on rectal examination which is the basis for the recommendation that a rectal examination should be performed on every patient who presents with acute lower abdominal pain [(2)]. Occasionally early diarrhea results from an inflamed appendix being in contact with the rectum. When the appendix lies entirely within the pelvis, there is usually complete absence of abdominal rigidity. And often tenderness over McBurney's point is also lacing. An inflamed appendix in contact with the bladder may cause frequency of micturition. Presence of pus cells in the general urine examination, urinary tract infection; and diarrhea not exclude diagnosis of appendicitis because of irritation to the urinary bladder and to the rectum by the inflamed appendix (according to its anatomical site) can produce these misleading symptoms [(2)].

In postileal appendicitis; the inflamed appendix lies behind the terminal ileum. It presents the greatest difficulty in diagnosis because the pain may not shift, diarrhea is a feature and marked retching may occure. Tenderness, if any, is ill defined, although it may be present immediately to the right of the umbilicus [(2)].

In subhepatic appendicitis the patient may present with abdominal pain and malaise without tenderness in the right iliac fossa but the white blood cell (WBC) count may be elevated and this is a useful and simple investigation for diagnosis of acute inflammatory disease [(2)].

The different anatomical locations of the inflamed appendix lead to vague signs and symptoms and wide differential diagnosis of acute appendicitis according to its anatomical site which may cause confusion and delayed decision of appendectomy; so acute appendicitis should always be kept in mind to avoid serious complications and mortality by early decision of appendectomy [(2)].

Methods

A prospective study of the patients whom underwent appendectomy for acute appendicitis in Al-Kadhimyia teaching hospital for one year during the period from June-2009 to June-2010 was included in this study. The appendix of all the patients was submitted to histopathological examination and was proved to be acutely inflamed, while all the non inflamed appendices were ignored from this study and not included. The patients were of the first symptom to the time of appendectomy. In group A, this interval was more than 72 hours; while in group B it was less than 72 hours.

Group A, include 35 patients; 14 male and 21 female (male to female ratio was 2:3) their age range from 4-65 years with mean age (28±87 years). While group B include 201 patients; 102 male and 99 female (male to female ratio nearly 1:1) their age ranges from 3-65 years with mean age (29 ±13 year). Table 1 show the age and sex distribution of patients in both groups.

The factors underlying diagnostic delay, and possible relations between diagnostic delay and the wide differential diagnosis due to different anatomical sites of the appendix and the course of the disease was also investigated.

Data were analyzed using SPSS 16 (Statistical Package for Social Sciences) and Microsoft office Excel 2007. Numerical variables were presented as mean ± SE, while discrete variables were presented as number and percentage. Chi-square test was used to

compare discrete variables. P-value less than 0.05 were considered significant.

Table 1. Age and sex distribution of the patients in group A and group B and its significance

Age group	Group A (total 35)		Group B (total=201)		P value
	male	female	male	female	
3-9 years	3	4	12	13	0.6
10-19 years	2	5	33	16	0.1
20-29 years	3	2	21	16	0.4
30-39 years	3	2	13	14	0.1
40-49 years	0	4	15	14	0.1
50-59 years	2	3	7	6	0.39
60-69 years	1	1	1	3	0.37
Total	14	21	102	99	

Results

The total number of the patients was 236 patients with mean age (25±48years). In group A, there were 35 patients and include 14 male and 21 female patients(male to female ratio 2:3); while in the group B there were 201 patients; and include 102 male and 99 female patients (male to female ratio nearly 1:1). Table 1 shows the age and sex distribution of patients in group A and group B.

The anatomical site of the appendix in both groups was as follows:

Postileal appendix: in group A there were 2 male and 4 female patients; while in group B there was only one male patient which is very significant (P= 0.0001).

Subhepatic appendix: in group A there were 2 male and 2 female patients; while in group B there was only one male patient which was also very significant (P=0.0004).

Retrocacal appendix: in group A there were 6 male and 11 female patients; while in group B there were 76 male and 74 female patients which is significant (P=0.017).

Pelvic appendix: in group A there were 4 male and 4 female patients; while in group B there were 21 male and 23 female patients which is not significant (P=0.88).

Paracecal appendix: in group A there were no patient; while in group B there were 2 male and 1 female patient which is not significant (P=0.083).

Preileal appendix: in group A there were no patient; while in group B there were 1 male and 1 female patient which is not significant (P=0.95).

Unfortunately 3 patients were died in the group A in the first postoperative day due to uncontrolled septic shock which is significant (P = < 0.01). Table 2 shows the site of the appendix at the time of appendectomy in group A and B.

The patients in group A had longer hospital stay (more than two days postoperatively) due to complications (generalized peritonitis and risk of septic shock) as compared with the patients in group B whom had no serious complications and were discharged from the hospital in the 2nd postoperative day, which is significant (P = < 0.01).

Late complications after discharge from the hospital in group A was 5 (8.57%) patients, three male and two female patients had recurrent admission to the hospital due to complications (adhesions and subacute intestinal obstruction); and they were improved on conservative management which is significant (P = < 0.01). Table (3) shows the incidence of complications and mortality in both groups.

Table 2. Site of the appendix at appendectomy in group A & B patients

Site of the appendix	Group A (total 35)		Group B (total=201)		P value
	male	female	male	female	
Retrocecal	6	11	76	74	0.017
Pelvic	4	4	21	23	0.88
Postileal	2	4	1	0	0.0001
Subhepatic	2	2	1	0	0.0004
Paracecal	0	0	2	1	0.83
Preileal	0	0	1	1	0.95
Total	14	21	102	99	

Table 3. Postoperative major complications and mortality in group A &B patients

Complications	Group A=35		Group B =201	
	Male	female	Male	female
Long hospital stay (> 2 days) due to complications	14 (100%)	18(85.7%)	0	0
Generalized peritonitis	14(100%)	21(100%)	0	0
Recurrent admissions for SIO due to adhesions	3(8.57%)	2(5.71%)	0	0
Mortality (in the 1st postoperative day)	0	3(8.57%)	0	0

SIO = sub acute intestinal obstruction

All the patients 35 (100%) in group A had increased white blood cell count (more than 10,000⁄mm^3); and in many patients especially those with subhepatic appendicitis the diagnosis of appendicitis and the decision for exploration and appendectomy were based mainly on the increased white blood cells (WBC) count, because those patients were presented with acute poorly localized abdominal pain for few days without tenderness in the right iliac fossa and with absence of classical visceral-somatic sequence of pain but there was high index of suspicion of acute appendicitis (nausea, anorexia, vomiting); and their history was long enough to increase their white blood cells as in any acute inflammatory disease, so the decision of exploration and appendectomy was taken. While in group B, only 46 (23%) of the patients had increased WBC count (more than 10,000⁄mm^3); and the rest of the patients was normal WBC count because the diagnosis of acute appendicitis was early and straight forward due to the presence of the classical visceral-somatic sequence of pain and tenderness in the right iliac fossa so their WBC count range between 4000-10,000⁄mm^3 and there is no enough time for the inflammatory process to increase WBC.

Discussion

Appendectomy for acute appendicitis is the most common non elective procedure performed by general surgeons [6]. It has generally been accepted that an appendectomy should be performed within a few hours of diagnosis and that a delay in the operation may lead to an increase in incidence of the morbidity and mortality [7].

A number of clinical and laboratory-based scoring systems have been devised to assist diagnosis of acute appendicitis. The most widely used is Alvarado scale. This scoring system was designed to improve the diagnosis of appendicitis and was devised by giving relative weight to specific clinical manifestation. Patients with scores of 9 to 10 are almost certain to have appendicitis; there is

little advantage in further workup, and they should go to the operating room. Patients with scores of 7 to 8 have a high likelihood of appendicitis, while scores of 5 to 6 are compatible with but not diagnostic of appendicitis [8]. Contrast-enhanced CT scanning is most useful but it is cost effective [2]. On the other hand, it is difficult to justify the expense, radiation exposure time, and possible complications of CT scanning in those patients whose scores of 0 to 4 make it extremely unlikely "but not impossible" that they have appendicitis.[1]and it is important to remember that if the patient has Alvarado score 0 and no signs and symptoms of the classical appendicitis it is not impossible that the patient may complained of acute appendicitis due to hidden appendix and variable anatomical site of the appendix which produce non typical signs and symptoms.

Acute appendicitis is relatively rare in infants, and becomes increasingly common in childhood and early adult life, reaching a peak incidence in the teens and early 20s. After middle age; the risk of developing appendicitis is quite small. The incidence of appendicitis is equal among males and females before puberty. In teenager and young adults, the male-female ratio increases to 3:2 at age 25years; thereafter, the greater incidence in males declines [2].

In this study, the age incidence in both groups is comparable and relatively equal and no significant difference between both groups (P> 0.05). Delayed decision of appendectomy in group A is more common in female 21(60%) patients than male 14(40%) patients. In group B, the sex incidence is nearly equal (102 male and 99 female). Table 1 shows the age incidence in both groups and its significance.

In group A, the patients had acute appendicitis for more than 72 hours because they were miss diagnosed (due to absence of tenderness in the right iliac fossa and according to the anatomical variation of the appendix); and then after the 72 hours, laparotomy for acute abdomen was performed. In group A, 35(100%) had generalized peritonitis, and 3 (8.57%) patients were died in the first postoperative day due to septic shock which is significant (P=<o.o1), and 5(14.29%) patients had recurrent admission to the hospital due to complications and intestinal obstruction. While in group B, were all the patients underwent appendectomy before 72 hours of the onset of first symptom of appendicitis, all the patients 201(100%) had no serious complications and no mortality and they were discharged well in the 2nd postoperative day. Table 3 shows the incidence of major complication and mortality in both groups.

The differential diagnosis of acute appendicitis depends upon four major factors: the anatomic location of the inflamed appendix; the stage of the process (i.e., simple or ruptured), the patient's age; and the patient's sex [5].

In group A the delay in the time of appendectomy were attributed to miss diagnosis of the patient's condition due to unusual presentation and non typical signs and symptoms of appendicitis (due to absence of tenderness in the right iliac fossa according to the anatomical variation of the appendix); until the patient's condition were deteriorated and (laparotomy for acute abdomen was performed which was proved to be generalized peritonitis due to perforated appendix). Table 2 shows the anatomical sites of the appendix in this group.

The signs and symptoms of patients in group A were attributed to other diseases like gastroenteritis (in postileal appendix), ureteric colic and urinary tract infection and other causes of the wide differential diagnosis of acute appendicitis. Table 2 shows the site of the appendix at the time of appendectomy in both groups and its significance in the delayed diagnosis of acute appendicitis.

In postileal appendix; the inflamed appendix lies behind the terminal ileum away of the right iliac fossa and not in contact with the parietal peritoneum of the anterior abdominal wall of the right lower abdomen [in classical appendicitis, once the inflamed appendix been

in contact with the parietal peritoneum of the anterior wall of the abdomen in the right iliac fossa, the visceral abdominal pain will shift to the right iliac fossa because the parietal pain is more sever and more precise] [(2)]. So postileal appendicitis presents the greatest difficulty in diagnosis because the pain may not shift, diarrhea is a feature and marked retching may occur. Tenderness, if any, is ill defined, although it may be present immediately to the right of the umbilicus (ill defined deep tenderness due to pressure on the inflamed appendix behind the ileum [(2)]. So it is very significant cause of delayed diagnosis of acute appendicitis in the study group and delayed decision of appendectomy (P=0.0001).

In group A; four patients had subhepatic appendicitis presented with abdominal pain and malaise without any tenderness in the right iliac fossa but their WBC count was highly increased, and in one patient there was air under the diaphragm shown by plain X-ray of the abdomen due to perforated appendix.

An inflamed appendix in the pelvis may never produce somatic pain involving the anterior abdominal wall (because the inflamed appendix not in contact with the parietal peritoneum of the anterior abdominal wall of the right lower abdomen), but may instead cause suprapubic discomfort and tenesmus. In this circumstances, tenderness may be elicited only on rectal examination and is the basis for the recommendation that a rectal examination should be performed on every patient who presents with acute lower abdominal pain [(2)].

Occasionally early diarrhea results from an inflamed appendix being in contact with the rectum. When the appendix lies entirely within the pelvis, there is usually complete absence of abdominal rigidity. And often tenderness over McBurney's point is also lacing [(2)].

An inflamed appendix in contact with the urinary bladder may cause frequency of micturition. This is more common in children (because children have shallow pelvis and the inflamed appendix been in contact with the urinary bladder causing irritation of it and frequency of micturition [(2)]. Presence of pus cells in the general urine examination, urinary tract infection; and diarrhea not exclude diagnosis of appendicitis because of irritation to the urinary bladder and to the rectum by the inflamed appendix according to its anatomical site can produce these misleading symptoms; so acute appendicitis should always be kept in mind.

The principal factors in mortality are whether rupture occurs before surgical treatment and the age of patient. Death is usually attributed to uncontrolled sepsis-peritonitis, intra-abdominal abscesses, or gram-negative septicemia [(1)].

Unfortunately 3 patients were died in group A in the first postoperative day due to uncontrolled septic shock which is significant (P = < 0.01). The first patient was 28 year old female patient presented to the emergency department with cyanosis, cold stage of septic shock, abdominal pain in the left iliac fossa and dark color urine for more than 3 days which was miss diagnosed as urinary tract infection and ureteric colic, but proved to be generalized peritonitis due to perforated postileal appendix.

The 2nd patient was nine years old female child presented to the emergency department with acute abdomen and she was treated as (typhoid fever and abdominal pain) for more than three days but proved to be generalized peritonitis due to perforated retrocecal appendix.

The 3rd patient was seven years old female child presented with abdominal pain for more than three days and was treated with antibiotics but proved to be generalized peritonitis due to perforated postileal appendix.

In group B, tenderness in the right iliac fossa and increased white blood cell (WBC) count save life of many patients; two adult females patients were underwent cesarean section one week before they develop acute appendicitis and they improve and survive after appendectomy because of high suspicion of

appendicitis and increased white blood cells (WBC) count with tenderness in the right iliac fossa (retrocecal appendix). Other two children had viral hepatitis A and jaundice presented with acutely inflamed appendix, but they improve after appendectomy because of high suspicion of appendicitis due to tenderness in the right iliac fossa (retrocecal appendix). While in patients with postileal and subhepatic appendix there was no tenderness in the right iliac fossa (because the inflamed appendix not in contact with the parietal peritoneum of the anterior abdominal wall of the right lower abdomen).

Tenderness in the right iliac fossa is helpful in decision for appendectomy in patients with viral hepatitis in spite of jaundice and saves the patient's life; but in patients with postileal and subhepatic appendix there were no tenderness in the right iliac fossa and the patient's condition progress to perforation of the appendix and generalized peritonitis.

All the patients in group A and 46 (23%) of patients in group B had increased WBC count. In some cases the decision for appendectomy depends totally on increased WBC count like in subhepatic appendicitis of 33 years old male patient in group B (he was a surgeon).

Supine abdominal radiograph may be of benefit. Plain X-ray of the abdomen in erect position and X-ray of the diaphragm can be helpful in decision for appendectomy when there were air under the diaphragm which indicates perforated viscous.

In comparison with other studies in this field; Horwitz et al find that diarrhea is important confusing symptom in making the diagnosis of acute appendicitis in very young children [9]. Gamal *et al* showing that diarrhea is very often a concomitant symptom in appendicitis [10].

The squeal of delayed diagnosis may result from late presentation by the patient but are sometimes due to the initial failure of the clinician to make the correct diagnosis [11].

Diagnostic uncertainty due to non-classical evolution of acute appendicitis may occur when the appendix is anatomically mal-located. At any age, variation in location of the appendix due to adhesions or developmental anomalies such as fetal intestinal mal-rotation leads to non-typical presentation, delays in diagnosis and increased adverse outcomes [12]. Subhepatic appendicitis was first described in 1955 by King [13], but has rarely been reported since, and includes a case of delayed diagnosis leading to perforation [14].

Despite an increased use of ultrasonography, computed tomography (CT) scanning, and laparoscopy, the rate of misdiagnosis of appendicitis has remained constant (15.3%), as has the rate of appendiceal rupture [1].

The use of a diagnostic protocol incorporating both the Alvarado score and graded compression ultrasonography failed to produce better outcomes than unaided clinical diagnosis [15].

On the other hand; Surana et al [16] studied the effects of delaying an appendectomy for acute appendicitis. They found no statistical difference in the rate of complications between children who underwent appendectomies within 6 hours of diagnosis and those who underwent appendectomies between 6 and 18 hours of diagnosis (2.3% to 4.2%, respectively; P = 0.28). A similar study by Yardeni et al [7] on the effects of delaying appendectomies by 6 to 24 hours in children showed no significant increase in the rate of perforation, operative time, or complications when compared with children who underwent the appendectomies within 6 hours. Furthermore, some studies suggest that the rate of perforation is due to a delay in patient presentation rather than to a delay in treatment [17-18].

Conclusion

The signs and symptoms of acute appendicitis vary according to the site of the appendix; and absence of tenderness in the right iliac fossa dose not exclude appendicitis like in postileal, subhepatic and pelvic appendix. The postileal and subhepatic site of the inflamed appendix are very significant causes of the delayed decision of appendectomy. In the study group,

the incidence of major complications (generalized peritonitis and septicemia) was 100% and the incidence of mortality was 8.57% due to uncontrolled septic shock.

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