Visualization of Normal Appendix in Multidetector Computed Tomography

Ansari MA, Kumar M, Subedi K.

Department of Radiology and Imaging, Tribhuvan University Teaching Hospital, Kathmandu, Nepal

Correspondence: Dr. Mukhtar Alam Ansari

Email: dr.mukhtaransari@gmail.com

Abstract

Introduction: Acute appendicitis is one of the most common causes of acute abdominal pain. Visualization of normal appendix is important to exclude the possibility of appendicitis. With the widespread use of multidetector computed tomography (MDCT) for evaluation of acute abdomen, the normal appearance and rate of visualization of appendix has to be defined.

Methods: This was a prospective cross sectional study involving 250 patients undergoing abdominal CT for various indications in Tribhuvan University Teaching Hospital between October 2012 and September 2013. One hundred twenty seven patients were female and 123 were male. Age ranged from 17 years to 73 years. CT scans of the patients were obtained with a 16 slice CT scanner with IV contrast. In all patients, there was no clinical suspicion of acute appendicitis or history of appendectomy. Appendix was searched in these patients by tracing caecum.

Results: Appendix was visualized in 215 patients, 111 females and 104 males. Appendix was not visualized in 35 patients, 16 females and 19 males. In total appendix was visualized in 86% of patients (87.4% females and 84.6% males).

Conclusion: MDCT is an accurate imaging modality for detection of appendix, whether normal or pathological. Visualization rate of normal appendix by CT scan is higher ranging up to 96% as shown in various studies. Thin collimation, use of contrast and multiplanar reconstruction may be the reason for increased rate of visualization of normal appendix.

Keywords: appendix, multidetector computed tomography

Introduction

Acute appendicitis is one of the most common causes of acute abdominal pain. Ultrasound (US) has traditionally been widely and accurately used for the diagnosis of acute appendicitis. Sonographic criteria for the diagnosis of acute appendicitis are visualization of aperistaltic, non-compressible tubular segment arising from caecum that measures more than 6.0 mm in diameter.[1-4] There are many studies in the literature for the CT diagnosis of appendicitis utilizing oral, rectal and IV contrast agents. CT criteria for the diagnosis of acute appendicitis primarily depend upon US criteria.[1-3] Most of the past studies have been conducted on helical scanners and most of these have focused on the abnormal rather than normal appendix.

Normal appendix is more commonly visualized at CT than ultrasound practically excluding the diagnosis of acute appendicitis. The question however still remains that which appendix is to be called normal? Limited studies are available in literature in which normal appendix were evaluated and much less even, on MDCT. In many text books of radiology and published articles on the topic of appendicitis, the upper limit for normal appendiceal diameter has been taken as 6.0 mm. The reported diameter of a normal appendix at CT is

based mostly on ultrasound results, using 6.0 mm short-axis thickness as the upper limit of normal.

The purpose of our study was to evaluate the frequency of visualization, normal caliber and position of the appendix in patients not having any clinical suspicion of appendicitis as a primary provisional diagnosis.

Methodology

This study was conducted in 250 patients who underwent abdominal CT for various indications in Tribhuvan University Teaching Hospital between October 2012 and September 2013. CT scans of the patients were obtained in the 16-slice Neusoft MDCT in the Department of Radiology and Imaging, with IV contrast. There was no clinical suspicion of acute appendicitis or history of appendectomy. Patients incidentally diagnosed as having inflammed or perforated appendix and other pathologies centered in the right iliac fossa were excluded from the study.

The axial and coronal reformatted images of CT images were evaluated focusing in right iliac fossa. Appendix was searched by tracing caecum. The visualization of the appendix was noted and interpreted as whether visualized or not. In those patients where appendix was visualized, tip of the appendix was localized and its position was noted whether paracolic, retrocaecal, pelvic or in midline. The contents within the lumen of the appendix were evaluated, and it was categorised whether the lumen was collapsed, contained air or fluid. The maximum transverse diameters of the appendix were noted at those segments where no luminal contents seen.

The obtained data were compiled and analyzed using standard statistical analysis. IBM SPSS 21 and Microsoft Excel were utilized for the data analysis and presentation.

Results

A total of 250 patients were included in the study. Among them, 127 patients were female and 123 were male. Patients of variable age group were included in the study, youngest patient was of 13 years of age and oldest patient was of 73 years of age (Table 1).

Table 1. Demographics of Participants

Characteristics	Number	Percentage
Sex:		
Male	123	49.2
Female	127	50.8
Age Group (Years)		
Children (<15)	2	0.8
Young Adults (15- 45)	115	48
Middle Age (45- 65)	98	39.2
Elderly (>65)	35	14

Appendix was searched in these patients by tracing caecum. It was visualized in 215 patients, 111 were female and 104 were male. Appendix was not visualized in 35 patients, 16 were female and 19 were male. In total appendix was visualized in 86% of patients. In female, appendix was visualized in 87.4%; and in male; appendix was visualized in 84.6%. (Table 2)

Table 2. Visualization Of appendix according to sex

	Frequency		Percentage
Non visualized appendix	35		14.0
	Male	19	15.4
	Female	16	12.6
Visible appendix	215		86.0
	Male	104	84.6
	Female	111	87.4
Total	250		100.0

The location of the tip of the appendix were categorised in retrocaecal, paracolic, pelvic or midline regions. Most common location of the appendix was paracolic, accounting for 52.1% of total followed by retrocaecal (28.4%), pelvic (12.1%) and midline (7.4%) in descending order. (Table 3)

	Frequency	Percentage	Valid Percentage
Paracolic	112	44.8	52.1
Retrocaecal	61	24.4	28.4
Pelvic	26	10.4	12.1
Midline	16	6.4	7.4
Total	215	86.0	100.0

The location of tip of appendix according to sex was noted. In female most common location of the tip was

paracolic, accounting for 48.0% of total visualized appendix in female, followed by retrocaecal (22.8%), pelvic (11.0%), and midline(5.5%). Similarly in male most common location of tip of appendix was paracolic (40.7%), followed by retrocaecal (26.0%), pelvic (10.6%) and midline (7.3%). (Table 4). The mean diameter of appendix was 6.5 mm with standard deviation of 1.1 mm. Lowest diameter of appendix was 4.0 mm and maximum was 10.0 mm. Mean diameter of appendix in females was 6.5 mm with a standard deviation of 1.14 mm. Similarly, mean diameter in males was 6.49 mm with a standard deviation of 1.07 mm. Mean diameter of appendix in children (<15 yrs) was 6.05 mm with a standard deviation of 1.48 mm; in young adults (15-45 yrs) mean diameter was 6.53 mm with standard deviation 1.19mm, in middle age (45-65 yrs) it was 6.43mm with standard deviation 1.05mm and in elderly (>65 yrs) mean diameter was 6.61mm with standard deviation 0.97mm (Table 4)

Table 4. Age and gender variation of appendiceal diameter

	Maximum	Minimum	Mean	SD
Diameter	10.0	4.0	6.5	1.1
Diameter according to age group				
<15 yrs	7.1	5.0	6.05	1.48
15-45	10.0	4.0	6.53	1.19
45-65	10.0	4.0	6.43	1.05
>65	9.5	4.5	6.61	0.97
Diameter according to sex				
Male	9.8	4.0	6.49	1.07
Female	10.0	4.0	6.50	1.14

Visible appendices were evaluated for their intraluminal contents. Among the visualized appendices 34 % were collapsed. The remaining 66% had the lumen distended with either air, fluid or contrast. 52% of the visualized appendiceal lumina were distended with air and 14% had intraluminal fluid. (Table 5)

Table 5. Intraluminal content of visible appendix

	Number	Percentage
Collapsed	74	34
Air in the lumen	112	52
Fluid in the lumen	29	14

Discussion

Appendicitis is a common cause of acute abdominal pain and generally has been a clinical diagnosis in which radiology had a limited role. The overall negative appendectomy rate, or rate of normal appendix at pathologic examination, was 20% prior to the use of cross sectional imaging. With the wide spread use of US and CT, there has been improvement in the preoperative diagnosis of appendicitis.

The appendix usually has a curved and tortuous course, and axial CT images alone have limitations for tracing this course, especially in the case of a retrocaecal appendix or an appendix extending into the pelvis. Therefore, the coronal reformatted images greatly assist in the tracing and demonstration of these appendices. Moreover, the coronal images easily demonstrate the entire anatomic configuration of the ileocaecal valve, the caecum and the base of appendix, which are also helpful in identifying the normal appendix.

In the current study, appendix was visualized in 215 patients, among them 104 were males and 111 were females. This accounted for visualization rate of 86% in total and 84.6% & 87.4% in male and female patients respectively. The findings of the present study were similar to the study conducted by Benjaminov et al[5], the

visualization rate of normal appendix in their study was 86% with non-enhanced CT. The findings in the current study were also similar to the findings of Tamburrini et al[6] and Huwart et al[7], who also found normal appendix in 82% of patients with contrast CT. The visualization rate of appendix in our study is higher than that of the study conducted by Bursali et al[8] and Ozturkmen et al[9], who found visualization rate of appendix 70% and 68.5% respectively. However, in both study non contrast CT images were used, in our study contrast enhanced images used; and this may be the reason of less visualization of appendix in their study. Again, the frequency of visualization of appendix in the present study was lower than that of the study done by Ya-Ting Jan et al [10], Johnson et al [11], Kim et al[12] and Joo SM et al[13], who found visualization rate appendix 93%, 94%, 98.5% and 92-96% respectively. The difference in the frequency of visualization of appendix in all these studies may be due to the difference in the CT equipment (multislice or single- slice), use of contrast (oral or intravenous), multiplanar reformation and observer variability.

In the current study the mean diameter of appendix was 6.5 mm with standard deviation of 1.1 mm. Lowest diameter of appendix was 4.0 mm and maximum diameter was 10.0 mm. The finding of our study are similar to other studies conducted by Ofer Benjaminov et al (6.6mm +/- 1.0 (SD) (range, 4.0 – 11.0 mm), L Huwart et. al (6.7 mm+/-1.2(SD) (range 5.0 – 11.0 mm) and Charoensak A et al (6.6 mm +/- 1.5(SD) (range 3.4 – 14.0 mm).[5,7,14]

The mean diameter in the current study was higher than the study conducted by H. Ozturkmen Akay et al (5mm +/- 1.34(SD) (range 2.8 – 10mm), Aykut Bursali et al (5.1mm+/-0.25), Ya – Ting Jan et al (5.6mm+/-1.3) (range 3-11mm), Victoria and Mahboubi (5.0mm +/- 1.3mm) and (5.1mm+/-1.5).[8,9,10,15]

In the current study the most common location of appendiceal tips was paracolic accounting for 52.1% of total visualized appendix, followed by retrocaecal (28.4%), pelvic (12.1%) and midline (7.4%) in descending order. In the current study the most common location of tip of the appendix were paracolic which are similar to those of the study conducted by Ofer Benjaminov et al (Paracolic – 62%, Pelvic – 19%, Retrocaecal – 10% and Midline – 9%). Paracolic location was also most common in study conducted by Aykut Bursali et al (Paracolic – 63.5%, Pelvic – 15.3%, Retrocaecal – 12.4% and midline in about 8.7%) and Ya-Ting Jan et al (Paracolic – 44%, Midline – 30%, Pelvic – 15% and retrocaecal – 11%).[5,8,10] Most common location of tip of appendix in the current study was paracolic however study done by Charoensak A et al[14] showed midline as the most common locations followed by pelvic. The percentage of other locations of appendiceal tip is different in different studies.

In the current study among the visible appendices 34 % had collapsed lumen. The remaining 66% of the visible appendices showed luminal distention with either air or fluid. 52% of the visualized appendices had intraluminal air and 14% had fluid. Our findings were similar to the study conducted by Ya –Ting Jan et al[10]. In their study 39% of visualized appendix were collapsed, 48% had distended lumen with air and about 13% containing contrast or high density. In study conducted by L Huwart et.al in 57 patients, intraluminal air was seen in 87%.[7] In the study conducted by H. Ozturkmen Akay et al, collapsed appendix was 54.2%, intraluminal air seen in 41.6%.[9] Study conducted by Charoensak, showed collapsed appendix in 16.5%, intraluminal air in 54.5% and fluid and contrast in 9%.[14]

Conclusion

MDCT is an accurate imaging modality for detection of appendix, whether normal or pathological. Visualization rate of normal appendix by CT is high ranging up to 96% as shown in various studies. Thin collimation, use of contrast and multiplanar reconstruction may be the reason for increased rate of visualization of normal appendix.

Conflict of interests: None Declared

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