

Sonographic Appearance of Normal Appendix in Children

Abdus Sami Qazi

Department of Radiology, Lahore General Hospital, Lahore.

Abstract

Objective: To prospectively evaluate sonographic features of a normal appendix and to determine frequency with which normal appendix can be visualized in an Emergency Department in the paediatric age group using commercially available 3.75 MHz probe with a view to confidently differentiate normal from inflamed appendix, a decision of great importance whereby an unnecessary appendectomy can be avoided in a good number of cases. **Material and Methods:** A total of 300 consecutive children (140 males and 160 females, median age 10.2 years, range 8-14 years) without clinical signs of acute appendicitis were examined in the Emergency Department of Lahore General Hospital, Lahore by trans-abdominal sonography using commercially available 3.75 MHz curved array probe. The detection rate, outer appendiceal diameter, appendiceal intraluminal contents and peri-appendiceal tissues were evaluated. **Results:** Normal appendix could be visualized in 58 out of 300 (19.3%) patients. In the remaining 242 it could not be visualized in the set time of 5 minutes. Mean outer appendiceal diameter was noted to be 4.27 mm (range 3.0 mm to 6.3 mm). In 53 of 58 (91%) patients with depicted appendices, the appendix was found to be in classical location whereas it was retrocecal in location in the remaining 5 (9%) patients. In all the cases the appendix was noted to be easily compressible and in 43 out of 58 (74%) normal appendices, the lumen was noted to be filled with fluid. It was noted to be empty in 18 out of 58 (32%) patients whereas air could be detected in 2 (4%) patients. No change was noted in the sonographic appearance of periappendiceal soft tissues. Mildly enlarged mesenteric lymph nodes in the right iliac fossa were seen in just 3 (5%) patients. None of the evaluated normal children showed localized fluid collection. **Conclusion:** Normal appendix was visualized in 19.3% of the normal children using commercially available 3.75 MHz probe which is usually a standard probe supplied with all commonly available ultrasound machines. The detection rate is towards the lower side of the results claimed in recent studies using high frequency linear probes and utilizing Tissue Harmonic Imaging (THI) technique.

Key words: Normal appendix, children, ultrasonography, Tissue Harmonic Imaging.

INTRODUCTION

Acute appendicitis may occur at any age, although it is relatively rare at the extremes of age. The maximum incidence of the disease occurs in the 2nd decade; thereafter, disease incidence declines with age^{1,2}. Ultrasonography is a widely available and inexpensive modality with the potential for highly accurate imaging in the patient suspected to have acute appendicitis. Although operator skill is an important factor in all ultrasonography examinations, it has particular

importance in the examination of the patient with right-lower-quadrant pain.

Transabdominal sonography has been performed as an imaging modality in patients with suspected appendicitis as this modality can rapidly help distinguish patients with appendicitis from those with normal appendix³. After the introduction of sonography in medical practice, Puylaert was the first to use sonography in 1986 for detection of inflamed appendix by developing and promoting a special technique called graded compression technique. At that time, in the presence of

supporting clinical findings, a diagnosis of acute appendicitis was offered if appendiceal outer diameter exceeded 6 mm. This remained the only sonographic criterion of acute appendicitis for a short time, however, with the improvement in ultrasound technology and development of new techniques of imaging especially Tissue Harmonic Imaging (THI)^{4,5}, it became possible to visualize even normal appendix. Rapid expansion of knowledge and experience to detect the normal appendix has helped the radiologists to differentiate normal from abnormal appendix.

In Pakistan, paediatric population constitutes nearly 40% of the total population. Most of the criteria of normal appendix have been investigated in adult population only but there has been little information available on the sonographic visualization of the normal paediatric appendix in large series of asymptomatic subjects. The purpose of this study was to evaluate the frequency of depiction of normal appendix in asymptomatic children and to evaluate the ultrasound appearance of normal appendix.

The reason for this comparative study was the appreciation by the author that every radiologist should be well versant with normal sonographic appearance of the appendix so that he can confidently differentiate normal from inflamed appendix, a decision of great importance in any emergency department whereby an unnecessary appendectomy can be avoided in a good number of cases.

MATERIALS AND METHODS

During a period of 15 months from May 2007 to August 2008, all asymptomatic children aged 4–15 years referred to the Emergency Radiology Department of the Lahore General Hospital were specifically examined with a view to localize the normal appendix by the author having more than 13 years post fellowship experience in Radiology. Children with abdominal pain, pain in right iliac fossa and those with appendectomy were excluded from the study.

As in Emergency Radiology Department, we have Toshiba ultrasound equipment (Famio 5, Toshiba Medical Systems, Japan) with standard

3.75MHz probe, a study was planned to compare the detection rate of normal appendix with the previously studied appendiceal detection rates using high frequency linear probes as well as THI.

300 consecutive children (140 males, 160 females, median age 10.3 years, aged between 8 to 14 years) without clinical suspicion of acute appendicitis were evaluated. The patients were examined when their bladders were adequately distended. Localization of appendix started with a transverse axial scan showing right major psoas major muscle and iliac vessels and using this image as a guide, appendices were traced at the location of ileocecal valve and distal border of the ileum. Normal appendix is usually localized between these structures and abdominal wall⁶. (Fig. 1)

Transverse and longitudinal images of appendix were obtained and the study was found to be negative if the appendix could not be visualized in the set time of 5 minutes. An attempt was made to define the position of the appendix whether classical or retrocecal. The normal classical appendix was the one noted in front of the iliac vessels and pointing towards the pelvis or lying above the colon in the paracolic gutter. Outer appendiceal diameter was measured in the transverse plane of the appendix at the point of maximum diameter. Intraluminal contents were specifically evaluated with a view to assess whether the lumen was empty or filled with gas or fecal material. Periappendiceal soft tissues were considered inflamed when they presented as hyperechoic, diffused, smudgy, ill defined mass surrounding an enlarged appendix. Attention was also directed towards careful detection of localized fluid collection in right iliac fossa.

The normal appendix appears as a blind ending loop with the wall showing varying echogenicity concentric circles of intima, media and tunica without demonstrable peristaltic activity. Its outer diameter is less than or equal to 5 mm in children and a normal appendix is easily compressible under the probe.

Technique

An excellent routine for the actual ultrasonographic examination of the right lower quadrant is to scan in the transverse plane by starting from the tip of the liver and proceeding to

the pelvic brim. Several sweeps from the lateral aspect to the medial aspect may be necessary. The ascending colon usually is appreciated by its gas content and haustral pattern. In the location of the cecum, careful attention should be paid to inflammatory changes in the perienteric fat and the appendix itself. Sagittal and oblique images should then be obtained until the entire region of interest has been scanned. Detailed images are obtained of the appendix, if it is seen. The course of the appendix is variable and includes both retrocecal and pelvic locations. The appendix in the former location often is best appreciated on scans obtained with the transducer positioned adjacent to the cecum or to the ascending colon, with an oblique plane of insonation. The pelvic appendix, in comparison, often is best seen in women with endovaginal scanning. Different degrees of bladder filling also will influence the ability to see a pelvic appendix.

RESULTS

Normal appendix could be visualized in 58 out of 300 (19.3%) normal children, a detection rate on the lower side of the data being claimed in the current literature. A great variation in the outer appendiceal diameter was noted ranging from 3.0 mm to 6.3 mm with the mean diameter of 4.27 mm. All normal appendices appeared as a blind ending loop having lamellated appearance with relatively sharply defined borders and having uniform diameter throughout their lengths. None of the normal appendices appeared ballooned up or ovoid in configuration. Essentially a normal appendix was noted to be easily compressible and showed significant reduction in anteroposterior dimension when compressed by overlying ultrasound probe. None of these 58 normal children showed an appendicolith, localized right iliac fossa fluid collection or hyperechoic inflamed periappendiceal fat. Contents of the appendiceal lumen were noted to be fluid in 43 out of 58 (74%) of the cases, air bubbles were detected within the lumen in 2 (4%) patients whereas lumen was noted to be empty in the remaining 13 of 58 (22%) patients. While evaluating surrounding soft tissues, mildly enlarged mesenteric lymph nodes ranging in size from 5 to 8 mm were detected in only 3 (5%) patients.

DISCUSSION

The adult appendix is a long diverticulum averaging 10 cm in length that arises from the posteromedial wall of the cecum, approximately 3 cm below the ileocecal valve⁷. Although the relationship of the base of the appendix to the cecum essentially is constant, the remainder of the appendix is free, which accounts for its variable location in the abdominal cavity. The appendix may lie in a retrocecal, subcecal, retroileal, preileal, or pelvic site. This variability in location may greatly influence the clinical presentation in patients with appendicitis^{8,9}.

The normal appendix is seen infrequently at US, although it may be seen, particularly in thin patients, with excellent-quality examinations. The normal appendix appears as a blind ending loop with the wall showing varying echogenicity concentric circles of intima, media and tunica without demonstrable peristaltic activity. Its outer diameter is less than or equal to 5 mm in children and a normal appendix is easily compressible under the probe. Rioux¹⁰ described the visualization of the normal appendix in an amazing 82% of scanned normal adults without acute appendicitis. In the experience of Birnbaum, Wilson and Puylaert^{11,12}, this number usually is substantially lower, 0%–4%, in the adult population, regardless of technique.

Although appendicitis may be ruled out if the appearance of the appendix is normal on ultrasonography, a normal appendix is seen in less than 5 percent of patients^{12,13}. Most physicians hesitate to make clinical decisions about appendicitis when the appendix itself is not seen on imaging studies. Therefore, the failure to see the appendix, whether it is diseased or normal, fundamentally limits the usefulness of ultrasonography for the diagnosis of appendix.

Simonovsky¹⁴ claimed a detection rate of normal appendix in 49% of the examined asymptomatic patients but the patients had very wide age variation from 1 to 84 years. However he focused mainly on the appendiceal mural thickness variation, a criterion not included in the present study because such measurements generally require high frequency probes. Similarly, other studies have used colour Doppler sonography to differentiate

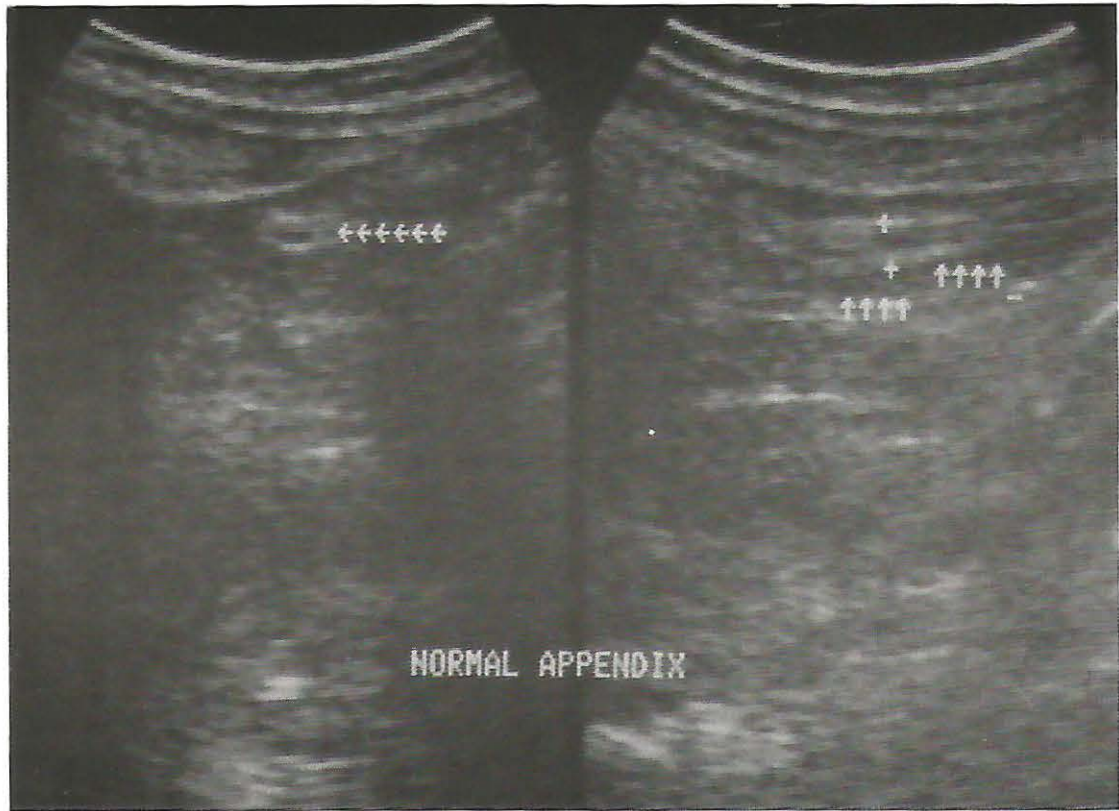


Fig. 1: Normal Appendix (marked by arrows) in an 8 year old child, appearing as a blind ending loop with an antero-posterior diameter of 4 mm.

normal from abnormal appendix by evaluating the changes in the colour flow. Of course non availability of such equipment in Emergency Radiology Department forbade the author from using this criterion. In many of the studies, Body Mass Index (BMI) has also been included in the statistical analysis of detection rate of normal appendix by sonography because people of all age groups were included varying in physique from thin lean to obese ones. However the present study was focused solely on children and in Pakistan childhood obesity is rarely observed therefore inclusion of BMI was found unnecessary. Rettenbacher¹⁵ reported a detection rate of 68% in asymptomatic patients. Wiersma et al¹⁶ found that in paediatric subjects, normal appendix was depicted more frequently than adults possibly because of less attenuation of ultrasonic beam by subcutaneous fat and muscle which are thinner in paediatric subjects. The author chose to measure outer appendiceal diameter rather than appendiceal wall thickness as

most of the studies have used the same criterion and hence a more effective comparison could be made¹⁷. Gas in the appendiceal lumen was revealed in 75% of the cases and in upto 86% for a controlled group in another study¹⁸ however the author found significant difference in this finding by demonstrating air in just 2 out of 58 (4%) of the children.

Though resolution of the body surface is superior to that of the conventional sonography in THI, it has been reported that a low frequency convex transducer is preferable when searching for a normal appendix in a deep location or in obese patients¹⁹.

The author believes that there were some obvious limitations in the study design i.e. pathological evidence of a normal appendix was never obtained for obvious reasons and secondly absence of CT examination or surgery in all these cases did not confirm the actual location of the appendix as suspected on sonography. Another

reason of failure to detect normal appendix in children seems to be its retrocecal location which, according to Ceres et al²⁰, is found in 28% of the examined children. In the present study only 5 of 58 (9%) children had a retrocecal appendix. As against visualization of mesenteric lymph nodes in almost 53% of the children in a study conducted by Wiersema¹⁶, presence of such lymph nodes was noted in just 3 (5%) children. In the present study, this significant difference needs to be explored in more elaborate and extensive study designs. May be racial or genetic factors are the underlying cause of low percentage of visualization of enlarged mesenteric lymph nodes though presence of mesenteric lymph nodes smaller than 10mm in an asymptomatic child is a non specific finding.

CONCLUSIONS

The sonographic detection rate of 19.3% achieved in this study falls within a highly variable detection rate of 4% to 95% quoted in current literature. The author believes that a lower detection rate is primarily due to the use of low frequency convex probe as against high frequency linear probes employed in those studies showing detection rate of more than 80% in normal children. A set time of 5 minutes, if extended up to 15 minutes as exercised in other studies, could possibly have improved the detection rate. Conduction of this study in an Emergency Department, where patient load is too much, could have also contributed to the lower percentage of visualization of appendix. The author believes that overcoming the above mentioned difficulties and adverse conditions may lead to increased frequency with which the normal appendix can be visualized. It is also desired that every radiologist should keep practicing to look for appendix so that he is able to differentiate a normal appendix from an early inflamed appendix, a decision of great significance in emergency situation, particularly in patients with pain in right iliac fossa.

REFERENCES

1. Addiss DG, Shaffer N, Fowler BS, Tauxe RV. The epidemiology of appendicitis and

- appendectomy in the United States. *Am J Epidemiol* 1990; 132: 910-25.
2. Primatesta P, Goldacre MJ. Appendicectomy for acute appendicitis and for other conditions: an epidemiological study. *Int J Epidemiol* 1994; 23: 155-60.
3. Chan I, Bicknell SG, Graham M. Utility and diagnostic accuracy of sonography in detecting appendicitis in a community hospital. *AJR Am J Roentgenol* 2005; 184: 1809-12.
4. Yucel C, Ozdemir H, Asik E, Oner Y, Isik S. Benefits of tissue harmonic imaging in the evaluation of abdominal and pelvic lesions. *Abdom Imaging* 2003; 28: 103-9.
5. Shapiro RS, Wagreich J, Parsons RB, Stancato-Pasik A, Yeh HC, Lao R. Tissue harmonic imaging sonography: evaluation of image quality compared with conventional sonography. *AJR Am J Roentgenol* 1998; 171: 1203-6.
6. Ceres L, Alonso I, Lopez P, Parra G, Echeverry J. Ultrasound study of acute appendicitis in children with emphasis upon the diagnosis of retrocecal appendicitis. *Pediatr Radiol* 1990; 20: 258-61.
7. Buschard K, Kjaeldgaard A. Investigation and analysis of the position, fixation, length and embryology of the vermiform appendix. *Acta Chir Scand* 1973; 139: 293-98.
8. Guidry SP, Poole GV. The anatomy of appendicitis. *Am Surg* 1994; 60: 68-71.
9. Wagner JM, McKinney P, Carpenter JL. Does this patient have appendicitis? *JAMA* 1996; 276: 1589-94.
10. Rioux M. Sonographic detection of the normal and abnormal appendix. *AJR Am J Roentgenol* 1992; 158: 773-78.
11. Birnbaum BA, Wilson SR. Appendicitis at the millennium. *Radiology* 2000; 215: 337-48.
12. Puylaert JBCM, Rutgers PH, Lalisang RI, et al. A prospective study of ultrasonography in the diagnosis of appendicitis. *N Engl J Med* 1987; 317: 666-69.
13. Jeffrey RB Jr, Laing FC, Townsend RR. Acute appendicitis: sonographic criteria based on 250 cases. *Radiology* 1988; 167:

- 327-29.
14. Simonovsky V. Sonographic detection of normal and abnormal appendix. *Clin Radiol* 1999; 54: 533-39.
 15. Rettenbacher T, Hollerweger A, Macheiner P. Ovoid shape of the vermiform appendix: a criterion to exclude acute appendicitis—evaluation with US. *Radiology* 2003; 226: 95-100.
 16. Wiersma F, Sramek A, Holscher HC. US features of the normal appendix and surrounding area in children. *Radiology* 2005; 235: 1018-22.
 17. Rettenbacher L, Tomaselli F, Schneider B, Gritzmann N. Outer diameter of the vermiform appendix as a sign of acute appendicitis: evaluation at US. *Radiology* 2001; 218: 757-62.
 18. Rettenbacher T, Hollerweger A, Macheiner P, et al. Presence or absence of gas in the appendix: additional criteria to rule out or confirm acute appendicitis—evaluation with US. *Radiology* 2000; 214: 183-87.
 19. Lee JH, Jeong YK, Park KB, Park JK, Jeong AK, Hwang JC. Operator-dependent techniques for graded compression sonography to detect the appendix and diagnose acute appendicitis. *AJR Am J Roentgenol* 2005; 184: 91-7.
 20. Ceres L, Alonso I, Lopez P, Parra G, Echeverry J. Ultrasound study of acute appendicitis in children with emphasis upon the diagnosis of retrocecal appendicitis. *Pediatr Radiol* 1990; 20: 258-61.

Address for Correspondence

Abdus Sami Qazi
Assistant Professor
Department of Radiology
PGMI/Lahore General Hospital, Lahore
E-mail: sami_qazi2001@hotmail.com
Mobile: 00923009443817