Ultrasound of the acute right iliac fossa

Background
Acute right iliac fossa pain remains one of the commonest acute surgical presentations with appendicitis having a prevalence of approximately 14% in patients presenting with abdominal pain to emergency departments. It is well recognised that clinical diagnosis is inaccurate particularly in females, due to overlap with other conditions. This results in a negative appendicectomy rate of typically between 20-25%, but as high as 40% without imaging. It is well established that pre-operative imaging can significantly reduce this rate to well under 10%.

Although the majority of published studies refer to the efficacy of computed tomography, there is also good evidence as to the value of ultrasound, particularly in the paediatric population. However, no consensus exists for the best imaging strategy, with a variety of approaches varying from no pre-operative imaging, to all being imaged with CT or the selective use of CT, ultrasound or MRI. The use of ultrasound as the primary test is increasingly advocated, particularly in the paediatric population, and offers a number of advantages particularly its portability, speed and lack of ionising radiation.

Technique
Patients are usually examined fasting, naturally filling the bladder allows better identification of deep pelvic structures. Although better deep pelvic assessment may be obtained by oral fluid load, the presence of increased intraluminal fluid in the fasting state may be a pointer to disease, eg obstruction, and therefore giving an oral fluid load may obscure some diagnoses.

Initial abdominal survey is performed with a general abdominal probe, paying particular attention to the presence of intra abdominal or pelvic fluid and other conditions that may present with right iliac fossa (RIF) pain. A higher frequency probe is then used to specifically examine the RIF and the point of maximal pain. The use of careful graded compression brings the target structures closer to the probe and displaces bowel gas. It is essential to orientate by systematically examining the RIF structures, starting with the right colon, caecum and ileocaecal valve. From the ICV the distal ileum may be identified. Thickening of the ileum may occur in primary infective or inflammatory conditions or may be secondary to oedema in appendicitis and may therefore be a useful indicator of pathology. The position of the appendix is variable; classically it may lie under the distal ileum or adjacent to the ileac vessels. Failure to identify it necessitates surveying the paracolic and retrocaecal positions together with the subhepatic region. The normal non thickened appendix is identified variably and is usually <6mm in diameter with preservation of layer structure. The lumen is collapsed or contains variable gas or faecal material and a normal meso appendix (figures 1a and 1b).

Ultrasound findings in appendicitis
Although obstruction of the lumen is often described as the precipitant for the initial inflammatory process, it is identified pathologically in only a third of cases and may be due to a faecolith, lymphoid hyperplasia or even worm infestation. The obstruction may manifest as an initial distension of the appendicular lumen, as infection supervenes the appendix thickens with preservation and widening of the layer structure. Although the inflamed appendix is usually >6mm in diameter, caution is advised on overreliance on measurements as children particularly may have normal appendices >6mm due to lymphoid hyperplasia. As the inflammatory process progresses, loss of structure and increased echogenicity is identified in the meso appendiceal fat which is noted to creep around the appendix, becoming non-compressible (figure 2). This is the most important diagnostic finding in appendicitis. An appendicolith may be identified together with important secondary signs such as free fluid, ileus, lymphadenopathy, caecal and ileal oedema. The loss of appendiceal layers together with free fluid implies perforation.

Complications such as abscesses, appendicular masses and mucocoeles may be readily identified with ultrasound, although it is not always possible to identify the appendix within a large, complex inflammatory mass.

Differential diagnosis
In addition to gynaecological and urological conditions which are not discussed here, there are a number of other conditions readily visualised with ultrasound.

Crohn’s disease may present acutely with right iliac fossa pain. The ultrasonic features of Crohn’s disease are well described and include thickening of the distal ileum, widening of mucosal and submucosal layers ulceration, increase in Doppler vascularity, fat wrapping, lymphadenopathy, abscess and fistulation. It may involve the appendix, resulting in thickening leading to difficulty in differentiating from complex appendicitis which may in turn involve the distal ileum, though careful attention to the morphological features and serial scanning usually allows differentiation.

Infective ileitis is an important differential diagnosis that can be readily identified with ultrasound. It is usually caused by infection with Campylobacter, Salmonella or Yersinia and presents with right lower quadrant pain and...
variable diarrhoea. Ultrasound demonstrates widened sub-
mucosa of the distal ileum and variably of the caecum and
right colon12 and although the appendix may be thickened,
there is no change in the perienteric fat, allowing differen-
tiation from appendicitis or Crohn’s disease (figure 4). Lymphadenopathy may be variably present. The condition is
self limiting and usually is completely resolved at follow-up
ultrasound at three weeks.

Right colonic diverticulitis is another important and
increasingly recognised differential, accounting for 6.5% of
patients undergoing CT of the appendix. It is more common
in Asians/oriental groups and differs from left-sided diverti-
culitis as it is usually a solitary diverticulum arising from
the medial wall with no muscular hypertrophy. As it has a
wider neck it usually self limits. Ultrasound demonstrates a
thickened projecting diverticulum with a capping of inflamed
echogenic pericolonic fat16 (figure 5).

Other differential diagnoses that may be identified at
ultrasound include: Meckel’s diverticulitis, tumours, intus-
susceptions, epiploic appendagitis, abdominal wall pathol-
yogy including hernias/muscle tears and mesenteric adenits
in children. Care should be taken in diagnosing mesenteric
adenitis as RIF lymphadenopathy in children may be sec-
ondary to other conditions such as appendicitis and Crohn’s
disease.

Pitfalls

There are a number of pitfalls to be considered in the use
of ultrasound in the RIF. These include mability to identify
anatomy due to patient build, gas or tenderness. Identification of the appendix in unusual positions may
cause diagnostic difficulties, particularly when retrocaecal
or subhepatic, though the presence of secondary signs may
be helpful pointers to its visualisation. In pregnancy the
presence of a gravid uterus, particularly in the later stages,
can make identification of appendicitis very difficult.17 MRI
may be a useful adjunct in these cases.18

It is important to remember that appendicitis may affect
only a portion of the appendix and therefore it is essential to
visualise the whole of the appendix, particularly the tip for
full exclusion. The appendix may also thicken secondary to
an adjacent inflammatory process, particularly inflamma-
tory bowel disease and sigmoid diverticulitis when the apex
of the sigmoid loop extends to the right. Obstructing
muma of the right colon and caecum may result in thick-
ening of the appendix secondary to oedema, however absence of
inflammatory fat and careful assessment of the appen-
dicular orifice, caecum and right colon should allow correct
diagnosis.

Conclusion

Although CT demonstrates better test performance than
ultrasound,19,20 ultrasound has a number of advantages, not
least the lack of ionising radiation, portability and dynamic
clinical correlation. The greater use of ultrasound as the pri-
mary imaging technique in acute RIF pain – reserving CT
for those unsuitable for US or in whom US is inconclusive –
would significantly reduce the necessity for CT while
significantly reducing the negative appendicectomy rate.19,20

References

2. Andersson R E. Meta analysis of the clinical and laboratory diagnosis of
3. Velmahos G, Sutaria R. Balancing the normal appendicectomy rate with
the perforated appendicitis rate; implications for quality assurance. Am
5. Rosen M P, Ding A, Blake M A. ACR Appropriateness Criteria Right lower
6. Toorencviet B R, Wiersma F, Bukker R F. Routine ultrasound and
limited computed tomography for the diagnosis of acute appendicitis. World
7. Thirumoorthi A S, Fefferman N R, Ginsburg H B et al. Managing radia-
tion exposure in children – re-examining the role of ultrasound in the diag-
8. Puylaert J B. Ultrasound of acute GI tract conditions. Eur Radiol
2001;11(10):1567-77.
9. Kosaad N, N’jouon-Domoua A M, N’dri K J et al. The diagnostic value of
indirect ultrasound signs during acute adult appendicitis. Diag Interv
10. Wiersma F, Toorencvit B R, Bloom J L et al. US examination of the
appendix in children with suspected appendicitis; the additional value of
11. Engin O, Murrali A, Ucar A D et al. The importance of follicular in the ul-
12. Trout A T, Sanchez R, Ludino-Torres F M. Re-evaluating the sonographic
criteria for acute appendicitis in children; a review of the literature and a
13. Lee M W, Kim Y J, Jeon H J et al. Sonography of acute right lower quad-
rant pain: Importance of increased intraabdominal fat echo. Am J
imaging features with a high probability of appendicitis. Eur Radiol
15. Puylaert J B, Van der Zant P M, Moutsos J A. Infectious ileocecal causis
by Yersinia, Campylobacter, and Salmonella; clinical, radiological and
17. Lehner P E, Gross J A, Linna K P et al. Utility of ultrasound for evalu-
ating the appendix during the second and third trimester of pregnancy.
18. van Randen A, Laméris W, van Es H W et al. A comparison of the accur-
cacy of ultrasound and computed tomography in common diagnoses caus-
19. van Randen A, Bicap S, Zeevanderman A H et al. Acute appendicitis: Meta-
analysis of diagnostic performance of CT and graded compression US
related to prevalence of disease radiology 2008;249:97-106.
staged US and CT protocol for the diagnosis of pediatric appendicitis;
reducing radiation exposure in the age of ALARA. Radiology
Figure 1A
Normal (long) appendix longitudinal section (LS).

Figure 1B
Transverse section (TS) normal appendix and meso appendix (arrows).

Figure 2
TS inflamed appendicitis with mild thickening of the appendix (arrowheads) but extensive inflammation of the meso appendix (arrows).

Figure 3
Crohn’s disease with thickened terminal ileum (arrowheads) and secondary involvement of the appendix (arrows).

Figure 4
Infective ileitis. Thickened distal ileum but no change in perienteric fat.

Figure 5
Right colonic diverticulitis. TS, medially projecting diverticulum with capping of inflamed peridivertic-