

Imaging of acute appendicitis in children: EU versus U.S. ... or US versus CT? A European perspective

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Abstract There is substantial evidence that imaging may reduce the negative appendectomy rate, also in children. However, controversy exists about the preferred method: US or CT, and the choice appears to be determined by the side of the Atlantic Ocean. This review brings forth several arguments in favour of US.

Keywords Appendix · Appendicitis · CT · Ultrasound · Children

Introduction

In making the diagnosis acute appendicitis, the clinician tries to avoid the Scylla of missing a perforation as well as the Charybdis of negative (read: unnecessary) appendectomy. The consequence of this ‘safe navigation’ has been that 15–25% of the appendices removed for the presumed diagnosis of acute appendicitis are normal [1]. Annually, this means that in The Netherlands with 16 million inhabitants, around 2,000 unnecessary operations are performed for suspected acute appendicitis. The diagnosis is more difficult in young children and adolescent girls and the rate of negative appendectomy is therefore higher in these categories [2].

Traditional teaching said that “when in doubt, take it out”, but this attitude is more and more questioned, as it has been shown that the complication rate of negative appendectomy is similar to that of operation for simple appendicitis, namely around 11% [3]. This figure includes only the short-term complications, such as wound abscess, prolonged ileus and respiratory tract infections. Long-term complications, such as adhesive small bowel obstruction have been reported to occur in up to 5% of patients after negative appendectomy. Add to these complications, the pain, emotional upset and social disruption, and the financial cost of negative appendectomy, and it will be clear that such a procedure should be avoided. Therefore, we propose that a negative appendectomy is no longer considered as an inevitable side effect of surgical decision making, but as a complication itself [4, 5].

How to avoid negative appendectomy?

As outlined above, making the diagnosis of acute appendicitis solely on clinical grounds leads to a high rate of negative appendectomy. With modern imaging methods, when applied timely and if viewed critically, as an adjunct to clinical decision making, the accuracy can be improved up to 95% [6–8]. Although not all publications have been able to confirm improved accuracy, this might be due to methodological flaws, lack of experience of the imaging specialists, or poor patient selection. The diagnostic value of a test is related to the a priori chance or prevalence of the disease in the study population. Wide application of a diagnostic test such as imaging to an unselected group of patients with abdominal pain will result in a lower accuracy than when used in a group of patients selected by clinicians on the basis of history, physical findings and basic

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laboratory data [9]. Wholesale use of either CT or US without thorough examination by an experienced surgeon will not lead to improved diagnostics and reduction of the negative appendectomy rate [10, 11].

US or CT in children with suspected appendicitis?

Prospective studies comparing US and CT in children with suspected appendicitis are difficult to perform because of methodological and ethical arguments. Comparisons between published data are hampered by certain cultural backgrounds; in Europe, US is often performed by radiologists, whereas in the USA this is done by ultrasonographers. This may help to explain the different values ascribed to these methods. Furthermore, body-mass-index of children in the USA is significantly higher than in Europe [12, 13].

Although the diagnostic accuracy of CT is reported to be higher than that of US, particularly in adults, it is debatable whether CT is able to reduce the negative appendectomy rate in children [14, 15].

What are the arguments in favour of US? There is the concern about the long-term effects of radiation from CT in children. Literature reports about the increased risk of cancer induction suggest that the dangers of CT are severely underestimated in this respect [16]. *Primum nil nocere* (first do no harm) dictates us to refrain from potentially harmful procedures if other tests are available. Besides the radiation risk, CT is also less desirable in children because of their lack of abdominal fat. Fat stranding is difficult to recognize and the appendix may be difficult to distinguish from surrounding bowel due to the absence of body fat [17]. Furthermore, CT, in contrast to US, is more expensive, more invasive with the use of oral, intravenous, or rectal contrast medium, requires sedation in some children and brings additional risks with contrast agents [18]. CT reports are operator dependent, just like US. Publication bias may obscure this, as the studies by experienced and dedicated CT specialists are more likely to be published [19].

US, if performed by experienced and dedicated radiologists, may achieve a diagnostic accuracy that is as good as CT. The advantages of US in children are well recognized: the relatively thin abdominal wall and the absence of fat make these patients more suited for US than for CT, which requires fat tissue to distinguish the intra-abdominal organs [20–22].

The normal appendix can be seen in 82% of asymptomatic children [23]. If the normal appendix can be visualised with US, appendicitis can be safely ruled out. US signs of appendicitis are a non-compressible appendix with a diameter of 6 mm or more, with or without the presence of an appendicolith. Care should be taken in patients with

cystic fibrosis as in these patients the appendix is often enlarged (>8 mm in diameter) due to mucoid impaction, without appendicitis [24].

Secondary signs such as increased echogenicity of the surrounding area of the appendix suggesting inflammation of mesenteric fat, local fluid collections suggesting an appendicular abscess, or local dilatation of the thin bowel without peristalsis indicating focal peritonitis, might be present. In these cases the diagnosis of appendicitis can be safely made [25].

What about the cases in which the appendix cannot be seen with US – the equivocal cases? If secondary signs of appendicitis are present, without visualisation of the appendix, the diagnosis of appendicitis is very likely. A pitfall might be primary bacterial peritonitis, in which secondary signs may be seen without appendicitis. If no secondary signs are seen, i.e. the US examination is normal or an alternative diagnosis is seen, appendicitis is very unlikely.

In equivocal cases a short period of observation with repeated examination by the same clinician has not been shown to increase the risk of perforation in patients without generalised peritonitis. If, on the other hand, the abdominal signs and symptoms are severe, surgical intervention will be indicated. In those circumstances, diagnostic laparoscopy may be the best option, although this requires general anaesthesia. If the clinical judgement is that a condition may be present that does not require acute surgical intervention, e.g. pancreatitis or Crohn disease, CT should be considered [26].

Conclusion

Appendectomy should not be undertaken without imaging to confirm the clinical suspicion. The choice between US and CT will have to be made on the basis of available expertise in combination with common sense. The radiation risk of CT in children is an obstacle of sufficient size to make us prefer US as the imaging study of first choice, particularly as the diagnostic yield of US is comparable to CT.

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