‘To have ... or not to have’. Should computed tomography and ultrasonography be implemented as a routine work-up for patients with suspected acute appendicitis in a regional hospital?

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ABSTRACT

INTRODUCTION Appendicitis is a common diagnosis, but is by no means a simple one to establish. This retrospective study investigated the value of medical imaging (ultrasonography and/or computed tomography [CT]) for patients with suspected appendicitis. Negative appendectomy rate and appendiceal perforation with or without medical imaging were used as end points for this investigation.

PATIENTS AND METHODS This study retrospectively reviewed all patients admitted in one district general hospital with suspected acute appendicitis. The patient cohort was identified from the Unit Registry and an International Classification of Diseases-based Review of medical records. The medical records were analysed, and the outcome of patients were followed up.

RESULTS Between 12 January 2004 to 27 May 2005, 168 patients' medical records were audited. The negative appendicitis rate was 6.7% and appendiceal perforation rate was 3.2%. Among them, only 20 in-patients (12%) had medical imaging (ultrasonography and/or CT scan) after clinical assessment for suspected acute appendicitis. Medical imaging had a 70% prediction rate for acute appendicitis, 20% false-negative rate, and 10% false-positive rate. Overall, the prediction rate for appendicitis by clinical assessment supplemented by laboratory tests and medical imaging at clinician's discretion was 93.2%.

CONCLUSIONS Despite studies advocating routine use of medical imaging for patients with suspected acute appendicitis, this study showed that the clinical evaluation is still paramount to the management of patients with suspected acute appendicitis before considering medical imaging.

KEYWORDS

Acute appendicitis – RIF – RLQ – District general hospital – Clinical assessment – CT scan – Ultrasonography

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Surgery for pain in the right lower quadrant of the abdomen remains a clinical dilemma. Acute appendicitis is traditionally a clinical diagnosis; however, not all patients present with the ‘classical’ symptoms and signs of acute appendicitis. Although patients with atypical symptoms and signs can be admitted to hospital for a period of observation, laboratory tests and medical imaging that may culminate in a diagnostic laparoscopy, this approach can be associated with its own morbidity and financial costs. Recent studies advocated medical imaging, mainly helical computed tomography (CT) and ultrasonography scans, for management of this condition.^{1–6}

The dilemma in the clinical diagnosis of acute appendicitis is to balance diagnostic accuracy with appendiceal perforation. Centres with the most accurate diagnosis

(89%) have a higher rate of appendiceal perforation (29%), and vice versa, presumably due to earlier operation.^{7,8}

This retrospective study was designed to audit the experience of managing patients with suspected acute appendicitis by the conventional approach at a district general hospital. If the result was not satisfactory when compared to other centres, a protocol CT and/or ultrasonography scan (as advocated by some) would be instituted and a prospective audit conducted.

Patients and Methods

This study was a retrospective audit of patients over 15 years of age who presented to the emergency department of

Latrobe Regional Hospital (LRH), Australia, between 12 January 2004 and 2 July 2005. LRH located at 150 km east of Melbourne. The hospital consisted of 250 beds and specialties including general surgical, gynaecology, urology, orthopaedic surgery, general medical, paediatric and psychiatry. The clinical diagnosis was established by a senior general surgeon in all patients. Management, including discharge home, laboratory tests, medical imaging, admission for observation, and operation (laparotomy or laparoscopy) was based on the senior surgeon's clinical assessment and discretion.

LRH is a district general hospital that receives patients from both urban and rural communities, with a catchment of approximately 30,000 people. The clinical presentation was right iliac fossa (RIF) or right lower quadrant (RLQ) pain, where a diagnosis of acute appendicitis was considered. Occasionally, referrals from other units for suspected appendicitis, especially gynaecology and paediatric departments, are included. Patients were initially assessed by the emergency department staff and referred to the general surgical units if acute appendicitis was suspected. Pre-operative evaluation included documenting the medical history, physical examination and laboratory tests (including pregnancy tests if appropriate) all at the discretion of a surgeon at the on-call general surgical unit. Exclusion criteria were signs of acute bowel obstruction, contra-indication to surgery, and contra-indication to general anaesthesia. Signs of acute pancreatitis or acute aneurysm of the abdominal aorta or iliac arteries on laboratory tests and/or medical imaging were considered to be stopping points. The patients having laboratory tests, medical imaging, referral to other units, an operation, admission for observation, or discharge home depended on the clinical assessment of the senior surgeons.

Patients with 'classical' clinical symptoms and signs of acute appendicitis might undergo appendicectomy without pre-operative laboratory tests or medical imaging. Patients with equivocal clinical findings and laboratory tests might subsequently undergo a helical CT and/or an ultrasonography scan for further assessment at the surgeon's discretion. The choice of imaging modality was made by the surgeon at the time of assessment. These images were reviewed by the attending radiologist.

Detailed information on each patient, including clinical findings, results of laboratory tests, preoperative ultrasonography and/or CT scan, operative finding, and the histopathology report was recorded and analysed. The end points of the study included negative appendicectomy and appendiceal perforation.

All CT scans were performed with a helical CT scanner (10 multi-slide Phillip® MX8000), and no oral or rectal contrast was used. The primary criteria used to establish the diagnosis of appendicitis included an abnormal appendix,

presence of an appendicolith, peri-appendiceal phlegmon or abscess and peri-appendiceal inflammatory changes, such as fat stranding of the meso-appendix or adjacent retroperitoneal fat. An abnormal appendix was defined as a distended fluid-filled, blind-ending tubular structure ('double halo' or 'target sign') with a thickened wall greater than 6 mm in diameter. Pericaecal inflammatory change were defined as fat clouding or stranding, local fascial thickening, local fluid collections or phlegmon, or abscess formation.^{2,7-10}

Ultrasonography (Toshiba, Tochigi, Japan) was performed with high-frequency, Linear C5-2 or Linear array 12-5 MHz transducers depending on individual circumstances. Scanning was performed with the patient having a full bladder, to optimise imaging of the pelvic organs. The point of maximum tenderness in the right lower quadrant was identified, and gentle graded compression of the caecal pole was performed to displace bowel gas. The study was completed by examination of the pelvic organs. Ultrasonographic diagnosis of appendicitis was based on visualisation of a non-compressible, tubular, non-peristaltic, blind-ending structure, 6 mm or greater in diameter, or the presence of an appendicolith with a normal-sized appendix. The appendix had to be constant in position and shape on imaging. Other sonographic findings were considered to be non-diagnostic if seen in isolation. These included a disruption of the echogenic line of submucosa (indicating necrosis of the appendiceal wall), a peri-appendiceal mass, and localised or general free peritoneal fluid.¹⁰⁻¹⁵

Follow-up of both operated on and non-operated on patients included completion of postoperative and post-discharge records 1 day, 2 days, 1 week and 6 weeks after discharge. Other data collected included operation note, hospital stay, pathological diagnosis, complications and change of diagnosis and treatment after discharge. The definitive diagnosis was made with operative findings and the histology report.

A general surgical trainee, an intern and general practitioner who were not directly working for the surgeons or the radiology department of LRH were involved in this project to limit bias and confounding factors while collecting the data.

Results

A total of 168 consecutive patients who presented to LRH were included in this study; age range 6-81 years (mean age, 20.4 years), 98 males and 70 females.

Of these, 132 patients had an 'immediate' appendicectomy, of which were 46 open and 86 laparoscopic surgery. There were 10 negative appendicectomies (6.7%). All were diagnosed with 'appendicitis' on clinical grounds supplemented by laboratory tests if required, but they did not have any medical imaging before operation. Although five patients had normal appendices, they had other major

abdominal or pelvic complications that required surgery. One patient had torsion of a fallopian tube with very extensive haemorrhage, one had rupture of a large ovarian cyst with extensive haemorrhage, one had a ruptured Meckel's diverticulum and there was one adenocarcinoma of the caecum. They all received appropriate operation and no major complications had been recorded after 6 months of follow-up. Five patients had a normal appendix and no major abdominal or pelvic pathology was encountered. Therefore, the true negative appendectomy rate was 3.2%.

Twenty patients with equivocal presentations had in-patient ultrasonography and/or CT scans. Sixteen scans accurately diagnosed acute appendicitis or revealed normal appendix (consistent with clinical assessment). Hence, the sensitivity of medical imaging was 70%. However, there were four false-negatives (three ultrasonography scans and one CT scan; 20%). These patients were admitted for observation (based on clinical assessment) and were all eventually operated on to remove the appendix (two open and two laparoscopic). All four had appendicitis according to their histopathology report. There were two false-positives (one on ultrasonography and one on CT scan; 10%). One patient had an ultrasonography scan showing signs suggestive of possible appendicitis. He was unwell and had laparoscopic appendectomy for a normal appendix on histopathology report; he improved after operation. The other patient had ultrasonography scan and showed signs suggestive of a possible appendicitis. She was admitted for observation on the ward and improved clinically without surgery. She was discharged home, and followed up at out-patient clinic. There has been no documented complication to date.

Regarding appendiceal perforation, seven patients (3.2%) had appendiceal perforation, five of whom had an appendectomy immediately after review (no laboratory and/or medical imaging) and two had appendiceal perforations occurring during the operation. There was no appendiceal perforation due to delay for observation.

Thirty-six patients were admitted to hospital for observation. Six eventually had an appendectomy; four had appendicitis with no perforation, while two had normal appendices (discussed above). Seven patients were admitted for observation, and had further laboratory tests and medical imaging. The tests and medical imaging were all normal, and they improved clinically and were discharged without operation. Eighteen were admitted for observation on the ward. They clinically improved and were discharged home without the need for operation or medical imaging.

The study was terminated at this point. The preliminary result of this study has demonstrated that management of patients with suspected acute appendicitis by clinical assessment and performing laboratory tests and medical imaging, as appropriate, was satisfactory. With known cost, limitations and side effects of CT and ultrasonography

scans, the ethical committee of the hospital had decided not to proceed with the implementation of medical imaging (CT scan) for suspected appendicitis as routine work-up.

Discussion

In the Western world, the life-time risk of acute appendicitis is 6.7% for females and 8.6% for males. However, the life-time chance of appendectomy is higher with reports that the average negative appendectomy rate can be as high as 20%.^{14,15} Recent studies advocating CT scan, with or without rectal contrast, and ultrasonography for diagnosis of appendicitis have appeared in the medical, paediatric, radiological, emergency and surgical literature. These reports have had an large influence on practice and with claims of reducing negative appendectomy and costs of admitting patients for observation without additional comorbidity to the patients.^{1,5,5,16} In many centres, medical imaging has been included in the routine work-up for patients with suspected appendicitis.

However, studies advocating the use of medical imaging to diagnose appendicitis were mostly conducted at tertiary or specialist centres where professional and technical expertise can be difficult to replicate in other situations.^{2,17} In addition, protocols for imaging patients with suspected acute appendicitis have not yet been standardised, so variable interpretation of the imaging and patients' outcome may be expected as also shown in this study.^{5,10}

The quality of care in this study, using as indicators the rates of appendiceal perforation (7; 3.2%) and the rates of true negative appendectomy (5; 3.2%), was satisfactory when compared with other studies (including those that had medical imaging as their routine work-up).^{1,5,16,18,19} Five of 10 negative appendectomies were found to have other major pathology, which would still need surgery. Two of seven appendiceal perforations occurred during surgery. Hence, there were only five appendiceal perforations making the true perforation rate 2.2%. It should also be noted that there was no delayed appendectomy because of undue observation. A diagnostic strategy based on the clinical acumen of a general surgeon supplemented with laboratory tests at clinician discretion has shown to be satisfactory. This strategy may be more generalisable to a regional centre than at a tertiary referral centre where the protocols, technology, and technical expertise of radiologists and technicians might be unique.

In this study, only 20 equivocal cases had helical CT and/or ultrasonography as an in-patient. The sensitivity and specificity of the medical imaging were not as convincing as suggested by some. The result was obviously due to only 12% of cases having medical imaging in this series which was not statistically significant. Nevertheless, the medical imaging may only be needed for clinically equivocal presenta-

tions. For patients with 'classical' symptoms and signs of acute appendicitis or 'acute abdomen' requiring operation, the additional benefit from medical imaging is debatable.²⁰

Despite studies advocating CT and/or ultrasonography scan for diagnosing appendicitis, these studies also had false-negative results.^{5,21} These might lead to serious consequences if a clinician solely relied on medical imaging to diagnose appendicitis and made the clinical decision to operate or discharge a patient, especially in a rural area. In the situation of a patient with negative medical imaging, the clinician should always consider individual circumstances before discharging the patient. In this study, there were four equivocal cases where medical imaging did not show signs of appendicitis but who, eventually, received a laparoscopy and appendicectomy. They all had histopathologically proven appendicitis.

Because appendicitis is an evolving pathological process, and early appendicitis can be impossible to differentiate from other causes of abdominal pain, clinical re-evaluation after a period of observation and supportive care could be appropriate.²² However, cost analysis may be biased towards rapid testing and medical imaging to make the diagnosis. If appendicitis can be ruled out (by testing and/or medical imaging), the patient should be sent home from the emergency department or diverted to another specialty.²³ In an urban setting, this strategy may be successful, especially where patients do not live far from the hospital. However, in a rural hospital, discharging a patient with a clinical suspicion of appendicitis and normal medical imaging might not be a safe option.

Benedeck *et al.*⁴ reported that helical CT without oral or rectal contrast could achieve an acceptable accuracy rate of diagnosing appendicitis, which eliminates the discomfort and extra work of contrast administration, especially in children. However, the radiation from CT scans can still cause a increased life-time risk of malignancy,²⁴ which is particularly serious in paediatric patients and is harmful to pregnant patients. The benefits of imaging include eliminating in-patient observation and unnecessary surgery, as advocated by others,^{1,16,25} must be weighed against the malignancy risk from radiation, as well as financial cost.

Although an ultrasonography scan is safe with pregnant women and free of radiation-induced malignancy, it has several limitations. These include the inability to visualise the appendix in individuals where bowel gas or an empty urinary bladder limit views in obese patients, the inability to compress the underlying bowel in cases with severe pain, and a decreased specificity associated with perforation. Ultimately, the sensitivity and reliability of scan is largely dependent on the experience of the technicians.^{5,13,16,26}

In this study, only six in-patient scans were conducted after-hours, which certainly saved on the cost of re-call staff to perform scans and radiologists to interpret the imaging.

Therefore, the cost of staff and running the machinery need to be taken into consideration when conducting cost-effective analysis and comparisons.

Improved technology does not always translate into improved diagnosis and patient outcome. Weyant *et al.*^{27,28} reported their experience of 625 patients with appendicitis but found no correlation between CT findings and pathologically proven appendiceal disease. A previous population-based study on this subject was conducted during the 12-year period from 1987 to 1998 when the techniques of CT, ultrasonography, and laparoscopy were improving. Contrary to expectation, the incidence of negative appendicectomies and perforation did not change with the availability of advanced diagnostic testing.²⁹

Although these medical imaging modalities might not be considered as a diagnostic routine for patients with suspected appendicitis, they still have roles in patients with right iliac fossa pain where other pathology is suspected. Ultrasonography scans can be useful to identify gynaecological pathology, such as ovarian cysts, which is helpful in explaining the cause of symptoms. Also, a CT scan can be useful when other causes of right iliac fossa are suspected, such as inflammatory bowel disease and ureteric calculi. In addition, both medical imaging modalities were found useful in demonstrating peritoneal fluid which might explain a patient's symptoms and signs.^{1,8,16,18,19,26} Subsequently, the finding might lead to diagnostic laparoscopy with clinical correlation. In addition, medical imaging has prevented 'missed appendicitis' in two equivocal presentations in this series. We believe that there is definitely a role for medical imaging, as long as its result is correlated with clinical assessment.

Conclusions

Clinical assessment supplemented with laboratory tests and medical imaging if appropriate for patients with suspected acute appendicitis was satisfactory. In this study, ultrasonography and CT scans were only used in equivocal cases. We found that the scans must be interpreted within the clinical context. Protocols on the routine use of medical imaging may need to be investigated and standardised further before implementation as a part of work-up for patients with suspected acute appendicitis.

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