The use of plain abdominal x rays in the emergency department

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ABSTRACT

Abdominal x rays expose patients to significant doses of radiation and have limited use in emergency medicine. This review explores the evidence supporting the use of abdominal x rays in the emergency department, with particular reference to recent guidelines published by the Royal College of Radiologists. The authors’ recommendations for the use of abdominal x rays in the emergency department are given.

Investigations are useful when the results affect clinical management by confirming or excluding a diagnosis, or when they aid risk stratification of a potentially serious condition. The plain abdominal x ray (AXR) is a commonly requested investigation in the emergency department (ED). The average AXR exposes the patient to 35 times the radiation dose of a chest x ray (0.7 mSv).1 Anecdotally, the AXR is overused and unhelpful in the majority of conditions presenting to the ED. In the past, surgeons have requested an AXR as part of the routine work-up of patients with undifferentiated abdominal pain. There are also more specific reasons for requesting this investigation, for example in the case of an ingested foreign body, intestinal obstruction, renal colic, pancreatitis and suspected appendicitis. The Royal College of Radiologists (RCR) have recently updated guidelines for the use of plain abdominal radiography in the hospital setting (see box 1), although they do not specify whether this is applicable to ED patients in most cases and many of the recommendations are made on the basis of poor quality evidence or expert opinion.2

This review aims to evidence supporting the use of the plain AXR as a diagnostic test in the ED by performing a structured literature review.

METHODS

A comprehensive search of the literature was carried out, using Medline and Pre-Medline (OVID platform) 1966 to June 2007, Embase, evidence-based medicine reviews and the BestBETS database. Search terms included “plain abdominal radiograph”, “abdominal x rays”, “abdominal films”, “abdominal roentgenogram”, “abdominal imaging” and “abdominal pain”. The MeSH heading searched was “radiography, abdominal”.

The bibliographies of relevant papers were examined and cross-referenced. Papers were critically appraised for the quality of evidence presented. Studies were preferred in accordance with the usual hierarchy of evidence, namely controlled clinical trials, prospective studies (including case-control studies) and case reports. Review articles were examined for their reference lists.

RESULTS

A total of 38 original papers was found that were relevant to the research question and these have been examined in detail (see table 1 available online only). A recurring problem throughout the studies was the lack of a consistent gold standard with which to compare the plain AXR as a diagnostic test. Some recent studies have used computed tomography (CT) as the gold standard. Many of the retrospective chart reviews had no methodological control and were simply the authors’ subjective interpretation of the results. No evidence was found to support the use of plain AXR in patients with pancreatitis, inflammatory bowel disease, renal failure or haematuria.

DISCUSSION

Undifferentiated abdominal pain

Most papers focus on the use of AXR in undifferentiated abdominal pain. As early as the 1960s, it was appreciated that the diagnostic yield in this group of patients is low, with Rosenbaum et al3 finding that 7% of AXR were diagnostic, with 10.4% showing sufficient evidence of pathology to require additional investigation. A later study included 1000 patients presenting with abdominal pain, in whom 38% had an AXR, of which 8 out of 427 were abnormal, but in no case was the clinical diagnosis changed by the AXR.4

A larger study looked prospectively at 1780 referrals for AXR in patients with abdominal pain,5 and found that 10% of studies showed an abnormality. The authors suggest that the adoption of defined referral criteria would result in a minimal loss of clinically useful information, large financial savings and a reduction in radiation exposure, to the effect of 53.7% fewer AXR being performed.

Another large series had 5080 patients presenting with abdominal pain over a 4-year period, of whom 45% had a plain AXR performed.6 From 1566 patients with an initial diagnosis of non-specific abdominal pain, 508 underwent AXR, of which 75% were normal and 25% showed some abnormality, but over half of these abnormalities were felt to be unrelated to the final diagnosis. This chart review had the potential for considerable bias, as one of the authors was essentially responsible for making the final clinical diagnosis. Rorthrock et al7 undertook a prospective observational study looking at children who had an AXR during a period of one year, in an attempt to define
Box 1 RCR guidelines for the use of plain abdominal radiography

- Acute abdominal pain warranting hospital admission and surgical consideration
- Acute abdominal pain: if perforation or obstruction suspected
- Acute small or large bowel obstruction
- Inflammatory bowel disease of the colon: acute exacerbation
- Palpable mass (indicated in specific circumstances)
- Constipation (indicated in specific circumstances)
- Acute and chronic pancreatitis
- Suspected ureteric colic/stones (indicated in specific circumstances)
- Renal failure
- Haematuria
- Foreign body in pharynx/upper oesophagus (indicated in specific circumstances)
- Smooth and small foreign body, eg, coin (indicated in specific circumstances)
- Sharp/poisonous foreign body
- Blunt or stab abdominal injury

a clinical decision rule for ordering AXR. They concluded that
limiting radiographs to children with a history of abdominal
surgery, suspicion of foreign body ingestion, abnormal bowel
sounds, abdominal distension, or peritoneal signs would have
detected 95% of diagnostic radiographs in patients with major
disease while eliminating 58% of films.

Anyanwu and Moalypour looked further into diagnostic
yield in 224 patients presenting with abdominal pain: 10.4%
were diagnostic, showing obstruction, perforation or renal
calculi. The authors suggested that some radiographs are
requested to avoid criticism from senior members of staff or
simply for completeness of assessment. Feyler et al conducted
a prospective observational study of AXR in acute medical
emergencies. Of 1309 admissions, 131 had an AXR, of which
only 12% were deemed appropriate according to the RCR
guidelines and 7% influenced the management.

Gerhardt et al undertook a complex prospective study in
order to identify a clinical guideline for the evaluation of non-
specific abdominal pain using several clinical and radiological
variables. Combined with clinical examination and laboratory
analysis, AXR was found to have a sensitivity of 56% and
specificity of 81% at predicting the need for urgent intervention
in the first 24 h. Of note, the addition of CT to this diagnostic
model increased the sensitivity to 92% and specificity to 90%.

Another recent paper looked at whether AXR requesting is
influenced by the time of year, thus comparing the requesting
habits of doctors at the beginning and end of their time in the
ED.11 The RCR guidelines were followed in 32% of the total
requests and when guidelines were followed positive findings
were found in 76.7%, as opposed to 8.9% when guidelines were
not followed. This is comparable to two other studies auditing
AXR use against RCR guidelines, one of which found that AXR
were performed in 18.5% of patients presenting to the ED
with abdominal pain, but 71% did not comply with the RCR
guidelines.12 The other found that 70% of requests did not
comply with the RCR guidelines.13

From the available evidence, it would appear that plain AXR
should not be used as a routine investigation in patients with
undiagnosed abdominal pain, unless there is clinical suspi-
cion of bowel obstruction (see next paragraph).

Bowel obstruction
A prospective study to determine the value of AXR in
comparison with history and examination in acute abdominal
pain (bowel obstruction in particular) found that from a study
population of 1254 patients, 56.1% had AXR performed.14 A
total of 15.8% showed findings leading to diagnosis or
immediate treatment and 64.7% were negative. The sensitivity
of AXR for detecting obstruction was 90.8% and the positive
predictive value was 80.2%. The authors found several variables
from the history and examination that related to the likelihood
of having bowel obstruction. The six variables with highest
sensitivity were a distended abdomen, increased bowel sounds,
history of constipation, previous abdominal surgery, age over
50 years and vomiting. If only patients with any two of these
symptoms had had radiographs taken, 42.6% could have been
avoided without loss of diagnostic accuracy. These results
enabled them to propose a simple clinical algorithm that would
support decision making in patients with acute abdominal pain
and help to avoid unnecessary AXR.

Suri et al conducted a (small) prospective study comparing
AXR with ultrasound and CT in their ability to diagnose
obstruction, including the level and cause of the obstruction.
The authors found that AXR had a sensitivity of 77% and
specificity of 80%. They were able to diagnose the level of
obstruction in 60% but the aetiology in only 7%. Their results
highlight CT as the most sensitive (93%) and specific (100%)
investigation in the diagnosis of obstruction.

Maglinte et al looked at the respective values of CT and AXR
in suspected small bowel obstruction. They found AXR had
69% sensitivity and 57% specificity. The main advantage of CT
is its ability to diagnose the cause of the obstruction, which it
did in 95% of true positives.

It is suggested from this evidence that plain AXR should
remain the initial method of radiological evaluation in the work-
up of patients with suspected small bowel obstruction, with the
addition of CT in patients with a high clinical suspicion of
obstruction.17 18

Hollow viscus perforation
No evidence was found to support AXR in the investigation of
suspected intra-abdominal hollow viscus perforation, which
would be supported by current ED practice of performing an
erect chest film as the first-line radiological investigation. One
study did compare the values of plain x ray (erect chest film)
and ultrasound in the detection of pneumoperitoneum in
patients with suspected perforation.19 Ultrasound had a
sensitivity of 92% (versus 78%), a negative predictive value of
59% (versus 20%) and specificity of 53% (versus 55%). The
authors concluded that ultrasound is more sensitive than plain
radiography in the diagnosis of pneumoperitoneum, and this
may play a larger role in the future as more emergency
physicians use ultrasound as a bedside diagnostic tool.

Appendicitis
Most emergency physicians would agree that appendicitis is a
clinical diagnosis in which plain AXR plays no role. This is
supported by the available evidence. In a retrospective chart
review of 821 consecutive patients with suspected appendicitis,
Rao et al found that 78% underwent AXR, but no individual
radiographic finding was statistically more likely to occur in
patients with appendicitis. In another large study of 5080
patients, 19% of appendicitis patients were imaged, with 79%-
being normal, and of the remaining 21%, 21 out of the 28 AXR

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findings were inconsistent or incidental. In a prospective series of 104 patients presenting with right lower quadrant pain, the treatment plan was altered by an AXR in 6% of cases, including renal calculus in two cases (with blood on urinalysis) and ileus in three cases.

Another recent study from Turkey looked at patients who had undergone appendicectomy, and found that AXR was “helpful” in diagnosis in less than 10% of cases and these were when the appendix had perforated. The authors make the point that these patients would all have gone to surgery on clinical grounds alone. Another Turkish group performed a point that these patients would all have gone to surgery on clinical grounds alone. Another Turkish group performed a retrospective analysis looking at the value of 13 signs on AXR in the diagnosis of appendicitis in children. They quote a sensitivity of 84% of AXR in diagnosing appendicitis, although the presence of lumbar scoliosis made up half of the detected abnormalities and the usefulness of the investigation is betrayed by a low specificity (44%) and negative predictive value.

From the available evidence, plain AXR should not be used as a routine investigation in patients with clinically suspected appendicitis.

Renal or ureteric colic
In most UK ED, the first-line radiological investigation of a patient with suspected renal colic would be an intravenous urogram or a CT kidney, ureter, bladder examination. The addition of a plain AXR prior to this would seem to add no benefit. A retrospective case review looked at the role of CT and AXR in diagnosing ureteric calculi. Using CT as the gold standard in a population of 855 patients with suspected renal colic, plain AXR had a sensitivity of 45% and a specificity of 77% of picking up ureteric calculi. This supports the use of CT as the initial investigation without the need to perform an AXR beforehand. Monitoring and follow-up of patients with renal calculi may involve plain AXR but this is outwith the scope of ED practice.

Acute and chronic pancreatitis
Recognised abnormalities on plain AXR in acute pancreatitis are the presence of a sentinel loop and the colon cut-off sign. However, the recommendations of the RCR seem at odds with current practice in ED in the UK, and no evidence could be found to support the use of plain AXR in the diagnosis of pancreatitis.

Ingested foreign body
Ingested foreign bodies are a common presentation to the ED, particularly in children, when the main concern (in the case of non-hazardous foreign body) is impaction in the oesophagus. Normally, the first-line investigation is either chest x ray or the use of a hand-held metal detector. A discussion of the merits of hand-held metal detectors over plain x rays, and algorithms for management, can be found in two recent papers in this journal. In cases of potentially hazardous foreign bodies, such as sharp objects, button batteries or large non-metallic foreign bodies (such as large glass beads), plain x ray is recommended to identify position but again this would normally start with a chest film. Plain AXR should be reserved for those patients who have a negative chest film but who have a foreign body detected by metal detector and in those who have a potentially harmful foreign body as above.

The use of plain AXR in the detection of packages in suspected body packers has been the subject of a short cut review. Although diagnostic if positive, the plain AXR is not sufficiently sensitive to exclude a foreign body in this group of patients.

Trauma—blunt trauma and stab wounds
The use of plain AXR in trauma is certainly not commonplace in the UK, but there is some literature suggesting it may play a role in certain circumstances, particularly in environments where there is no capacity to perform CT. In a prospective study from India, where CT was not available, plain AXR was used in conjunction with ultrasound and paracentesis (diagnostic peritoneal lavage) to investigate 72 patients with abdominal trauma and was diagnostic in three cases of intestinal injury, although the authors do not use a gold standard, and indeed do not mention whether the bowel injury could have been diagnosed from the diagnostic peritoneal lavage result. It would appear that if CT is to be performed, the addition of plain AXR beforehand will add no benefit.

In penetrating trauma, some centres have advocated the use of plain AXR to look for evidence of extraluminal air in the peritoneal cavity, although there seems to be reasonable evidence that this is neither useful nor cost-effective. Many centres now follow an approach that involves either emergency surgery (if haemodynamically unstable), or local wound exploration progressing to laparoscopy and laparotomy depending on the findings.

GENERAL COMMENTS
This review has found limited evidence to support the use of AXR in patients presenting to the ED. The indiscriminate use of the AXR as a routine investigation in the general work-up of patients presenting with undifferentiated abdominal pain is costly, exposes the patient to unnecessary radiation and is not indicated in the majority of cases.

If for a moment we turn history on its head and suppose that a new investigation, the AXR, has been suggested as a diagnostic test in the investigation of patients with various abdominal pathologies, we would subject it to rigorous investigation and control before suggesting it should be used in everyday practice. From the available evidence it would be dismissed as a poor test and not recommended for use in the ED.

Several studies have compared the use of CT and plain AXR in patients with abdominal pain and universally support the early use of CT in patients presenting with abdominal pain requiring admission. The role of ultrasound in ED management of patients with abdominal pain may well increase as it becomes more commonplace and ultrasound expertise in the specialty grows, but further work is needed in this area before recommendations regarding its use can be made.

During this search several papers were found that explored related aspects of the use of AXR in the ED worth mention, such as the different types of AXR, image interpretation, requesting habits of staff and the influence of the AXR on patient management plans.

The three-film abdominal series has been compared with standard views and found to be superfluous to requirements. Both studies concluded that the upright abdominal radiograph can be eliminated from the standard series without loss of diagnostic information. Numerous articles comment on the problems with the accurate interpretation of AXR, and several authors have challenged the request process for AXR. Consistently, studies have shown that the AXR rarely changes management plans and is often used as a defensive screening investigation. Despite the available evidence, there has been a continuing failure to act to alter practice and reduce the burden of abdominal radiographs being performed in the ED.
It would seem that the RCR guidelines for the use of plain AXR are not supported by either current evidence or established practice and should be reviewed in the context of ED use of this investigation (box 2).

### Box 2 Suggested use of plain abdominal radiography in the ED

- Acute abdominal pain: if bowel obstruction suspected
- Oesophageal foreign body suspected (depending on local protocol for metal detector)
- Sharp/poisonous foreign body suspected

**CONCLUSION**

The plain AXR has limited use in the ED for specific conditions, but should not be used indiscriminately as a routine investigation in undifferentiated patients presenting with abdominal symptoms.

**Competing interests:** None.

**REFERENCES**