ABSTRACT Context: There has been a significant debate over the use of AXR as an adjunct to the diagnosis of the acute abdomen. There are only a few numbers of clinical indications for this modality of imaging, and there has been a concerted effort from the Royal College of Radiologist (RCR) to ensure that there is a reduction in the number of AXR being performed. Evidence Acquisition: To study the most frequent presentation of abdominal pain to accident and emergency requiring abdominal X-ray imaging. To understand the correlation between the clinical indication for the imaging and the subsequent findings as reported by the Radiologist. To assess whether further imaging was done and if these yielded any benefit. To evaluate for change once interventions were instituted. Method: Phase 1-100 patients were selected at random from the patients presenting with abdominal pain to Ayr Accident and Emergency during July 2014. As previously stated, the indication for the AXR was explored with any follow-up imaging that was performed. Phase 2: was carried out for the patients presenting with abdominal pain in months of December 2019-January 2020. The same methodology was used with 100 patients to investigate the indications for AXR imaging as per Phase 1, any significant findings in relation to the clinical query and the further use of other imaging modalities. The clinical indications for the imaging were also studied and audited against the IRMER and the RCR guidelines, taking into consideration any changes in the guidelines from the time of Phase 1. Results/Measures: Phase 1: - It was seen than in 56 cases out of the 100 cases AXR was the only imaging done with no follow-up imaging. In 44 cases there was follow up imaging with other modalities. It was also noted that only in 20 cases, the indication matched with the radiological findings. In contrast, in the vast 80% of cases, there was no correlation between the indication and imaging findings. Phase 2: - As can be seen, there was an improvement in the indication put in the request with a significant reduction of 7% in the? Perforation? Obstruction as an indication. There was also a significant reduction in the number of AXR done for renal calculi related cases (11% vs 4%). There was, however, increases in both surgery similar and acute onset abdominal pain-related cases. One of the main limitations of this form of comparison is that this only represents a cohort of patients and may not be representative of the actual trend in requesting AXR. Discussion: The practice of medicine is ever-changing, and the realities of medico-legal consequences are becoming part of the way we are practising today. The tendency to over investigate and practice defensively is increasing, and this is shown clearly through this audit study. Conclusion: There can be more that can be done to reduce the number of AXR that are done for abdominal pain. It should be noted that there is no role for AXR in the diagnosis of undifferentiated abdominal pain. All clinicians requesting AXR should review the need for the same prior to proceeding due to the unnecessary exposure in the vast majority of cases.

KEYWORDS Abdomen, Imaging, X-ray, Pain management

Main learning points

- More can be done to reduce the number of AXR that are done for abdominal pain
- There is no role for AXR in the diagnosis of the undifferentiated abdominal pain
- The use of LDCT should supersede the use of AXR in diagnosis
- The vast majority of the findings on AXR are not significant
and have no additional diagnostic value
• The importance in the use of the RCR guidelines to improve patient safety and to improve patient outcomes.

Study Process

Phase 1

One hundred patients were selected at random from the patients presenting with abdominal pain to Ayr Accident and Emergency during July 2014. As previously stated, the indication for the AXR was explored with any follow-up imaging that was performed.

Main presenting complaints

• Perforation? Obstruction – 24 cases
• Renal colic/calculi related- 11 cases
• Related to altered bowel habit- 19 cases
• Surgery related- 6 cases
• Related to hepatobiliary disease- 12 cases
• Acute onset pain (confirmed as colitis/appendicitis/ cholecystitis/ischaemic with further imaging)- 7 cases

It was seen than in 56 cases out of the 100 cases AXR was the only imaging done with no follow-up imaging. In 44 cases there was follow up imaging with other modalities. It was also noted that only in 20 cases the indication matched with the radiological findings while in the vast 80% of cases there was no correlation between the indication and imaging findings (See Figure 1.)

The 2000 IRMER (ionising radiology Medical exposure regulations) were looked at. It started as per the Department of Health guidelines that exposure to any ionising radiation should prove to be diagnostically beneficial compared to its potentially harmful effects.

There was also another interesting guideline whereby it stated that the primary responsibility of the practitioner would be to justify each individual exposure to radiation.

The 6th Edition of the Royal College of Radiologist guidelines for abdominal imaging was looked at, and it was seen to be however vague on a couple of the indications. Its pieces of advice that abdominal film would be appropriate in any patient presenting with acute abdominal pain warranting a hospital admission and surgical consideration. If this were to be taken word to word, then every patient with abdominal pain presenting to A+E would undergo an AXR. A proposed algorithm for consideration of abdominal imaging was charted and was presented to the Emergency Department and the Department of Surgery at University Hospital Ayr (See Appendix 1).

Interventions carried out prior to Phase 2:

• Post Phase 1 - A proposed algorithm for Abdominal imaging was made and presented to the Emergency Department and the Directorate of Surgery in departmental meetings (See Appendix 1)
• Prior to Phase 2 - Posters highlighting the importance of validating the need for AXR imaging and clinicians to evaluate prior to requesting AXR in the Emergency Department were set up in a strategic location in the Department. (See Appendix 2)

Phase 2

Phase 2 was carried out for the patients presenting with abdominal pain in months of December 2019- January 2020. The same

![Figure 1: Percentages of findings in AXR.](image1)

![Figure 2: Diagnostic findings on AXR.](image2)

![Figure 3: Baseline line and follow up imaging.](image3)

![Figure 4: Comparisons of clinical indications in Phase 1 and Phase 4.](image4)
methodology was used to investigate the indications for AXR imaging as per Phase 1, any significant findings concerning the clinical query and the further use of other imaging modalities. The clinical indications for the imaging were also studied and audited against the IRMER and the RCR guidelines, taking into consideration any changes in the guidelines from the time of Phase 1 of the project.

Analysis of the indications for imaging in Phase 2

Total Number- 100 patients Further imaging in 49 patients- 49% AXR as only imaging in 51 patients- 51% (See Figure 3.) Significant diagnostic findings – 19% Insignificant diagnostic findings-81% (See Figure 2.) Significant diagnostic findings include dilated bowel loops suggestive of bowel obstruction, but patient underwent further CT imaging to confirm the diagnosis. The use of AXR in the post-operative period in the diagnosis of bowel obstruction is limited in value and a contrast CT imaging to assess if there are a leaking anastomosis and the level of obstruction. Localised abdominal pain suggesting intra-abdominal cause undergoing AXR-14 localised pain – 14%, there were no diagnostic findings in these cases and if specific abdominal pathology, e.g. diverticular perforation, acute diverticulitis, acute appendicitis and cholecyctitis is being queried AXR is not likely to provide useful information.

AXR for the location of ingested foreign body and to assess the position in follow up imaging can merit an AXR as was in 4 cases in our study. In one of the 4 cases, was a follow-up AXR for passage of a coin, this showed that there was no FB present. In all the other 3 cases, FB were seen on AXR. Indication as constipation and faecal loading for AXR to exclude obstruction-8% Indication to exclude toxic megacolon in IBD- 5%

Comparison of clinical indication between Phase 1 and 2

As can be seen (see Figure 4) there was an improvement in the indication put in the request with a significant reduction in the? Perforation? Obstruction as an indication. There was also a significant reduction in the number of AXR done for renal calculi related cases. There was, however, increases in both surgery-related and acute onset abdominal pain-related cases. One of the main limitations of this form of comparison is that this only represents a cohort of patients and may not be representative of the actual trend in requesting AXR.

Analysis and discussion of findings on review in Phase 2

The practice of medicine is ever-changing, and the realities of medico-legal consequences are becoming part of the way we are practising today. The tendency to over investigate and practice defensively is increasing, and this is shown clearly through this study. Education on the issue is key in preventing unnecessary exposure to radiation and ensuring patient safety.

The findings from our study are not particularly surprising with similar reproducible results in already published large scale studies. AXR is known to yield limited clinical outcomes, in a retrospective study done by Kellow et al. [1], 81% had normal or non-specific abdominal radiograph results this figure reflects the finding from our research.

There were still cases wherein the request it was stated ‘? Obstruction? Perforation’. It was noted that in a few of these cases, appendicitis was the working diagnosis. On some of the requests, it was stated that the surgical team requested the AXR. This is the culture in the vast majority of acute receiving units where the surgical team specifically request AXR prior to patient review. This is a cultural perception that will take time to change in practice. This can represent a two-fold problem, firstly the patient is undergoing unnecessary radiation which can be avoided, secondly this can represent a delay in diagnosis, and an alternative imaging modality can be better suited for diagnostic accuracy. There is another factor that may be seen to be significant, the widespread availability of AXR imaging compared to other imaging modalities. In our ED, unless a portable CXR is being requested in the resuscitation area, patients would be taken to the Radiology department. They would undergo CXR and at the same time, undergo AXR imaging.

There was a case where the patient underwent AXR for diagnosis of renal calculi without previous similar history. It has been well established that the gold-standard imaging modality for primary diagnosis of renal calculus is CT KUB. Urologists sometimes request serial X-ray KUB to assess for change in position of calculi and stent position evaluation. X-ray KUB can be useful after the patient has undergone a stone extraction procedure [2]. If the patient has had calculus visible on previous AXR, then a follow-up X-ray may be indicated.

There was a case where a patient had undergone AXR with ascites to exclude bowel obstruction; on the abdominal balance, the examination can be limited if there is extensive ascites is present.

In terms of concerns about obstruction in the post-operative phase, there were three requests for AXR to exclude postoperative obstruction, and it can be postulated that in these patients a CT A+P would be more diagnostic imaging than AXR. In the post-operative phase, only CT imaging would ensure that there were no postoperative complications, including anastomotic leak.

While there has been a marked improvement in reduction in the AXR performed, a broader understanding of the indications of AXR imaging is needed from other specialities taking over patient care from the ED.

There were a few cases where the indication for AXR was faecal loading, constipation, and it is worth noting that performing an AXR for the above indication is not justifiable. As highlighted below, only in some instances can AXR be justified for constipation. Both are based on clinical examination findings, and meticulous history taking and an AXR does not add further information to the above diagnosis.

Further Discussion

Radiation dose - AXR vs CT Abdomen and Pelvis

One of the main reasons for clinicians not requesting a CT imaging of the Abdomen and Pelvis is the amount of radiation dose in CT imaging compared with AXR imaging. The other reason is the risk of contrast-induced nephropathy in patients with acute kidney injury and those with chronic kidney disease. One of the main reasons still remains the lack of widespread accessibility of CT imaging. This is particularly the scenario in a district general hospital where the CT radiographer has to come in to perform the imaging.

In the case of Low-Dose Computed Tomography (LDCT), [3] the dose of radiation as 1.2mSv compared to AXR, which was noted to be 1.0 mSv, the values are comparable. In the obese
Table 1 Comparing the RCR 2007 Guidelines [7] for AXR imaging with the 2017 RCR Guidelines. [8]

<table>
<thead>
<tr>
<th>RCR 2007 Guidelines</th>
<th>RCR 2017 Guidelines</th>
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<tbody>
<tr>
<td>Acute abdominal pain warranting hospital admission and surgical consideration</td>
<td>Acute exacerbation of inflammatory bowel disease</td>
</tr>
<tr>
<td>Acute abdominal pain: if perforation or obstruction suspected</td>
<td>Palpable mass (specific circumstances)</td>
</tr>
<tr>
<td>Acute small or large bowel obstruction</td>
<td>Clinical suspicion of obstruction</td>
</tr>
<tr>
<td>Inflammatory bowel disease of the colon: acute exacerbation</td>
<td>Constipation (specific circumstances)</td>
</tr>
<tr>
<td>Palpable mass (indicated in specific circumstances)</td>
<td>Acute and chronic pancreatitis (specific circumstances)</td>
</tr>
<tr>
<td>Constipation (indicated in specific circumstances)</td>
<td>Sharp/poisonous pancreatitis</td>
</tr>
<tr>
<td>Acute and chronic pancreatitis</td>
<td>Smooth and small foreign body, e.g., coin, battery (specific circumstances)</td>
</tr>
<tr>
<td>Suspected ureteric colic/stones (indicated in specific circumstances)</td>
<td>Blunt or stab abdominal injury (specific circumstances)</td>
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<tr>
<td>Renal failure</td>
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<tr>
<td>Haematuria</td>
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<td>Foreign body in pharynx/upper oesophagus (indicated in specific circumstances)</td>
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<tr>
<td>Smooth and small foreign body, e.g., coin (indicated in specific circumstances)</td>
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<tr>
<td>Blunt or stab abdominal injury</td>
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<tr>
<td>Sharp/poisonous foreign body</td>
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patient, a higher dose of radiation may be required. It’s worth noting that in certain clinical cases, patients would undergo an AXR firstly then would subsequently under CT imaging that adds to exposure to unnecessary radiation. The use of LDCT is further validated in use for the diagnosis of the undifferentiated abdominal pain [4] where the diagnostic utility of AXR is most diminished. There is a move from the standard dose CT to the LDCT modality. However, this transformation will take time.

Besides a delay in appropriate imaging and exposure to unnecessary radiation, this could also lead to a delay in diagnosis and eventual delay in definitive management for a potentially unwell patient. It can be agreed that a patient would not be transferred to theatre for definitive management on the sole basis of AXR findings. This further highlights the issue that AXR imaging findings do not change management and do not alter the diagnosis all due to the limited diagnostic yield. In a cohort study [5] of 1021 patients, a change to the correct diagnosis was found in only 4% of patients.

Definitive imaging may be indicated while ongoing attempts at resuscitation are being undertaken. In the more stable patient while medical management is undergoing, then CT imaging can be conducted.

It is well established that an erect CXR would be indicated in the acute surgical abdomen if there are concerns of visceral perforation. However, in 15% of patients [6], the visceral perforation would be not seen as pneumoperitoneum due to the anatomy of the site of the perforation. There is a role for left decubitus AXR [6] for the diagnosis of pneumoperitoneum with higher sensitivity compared to plain AXR. However, this modality of imaging has become obsolete in the United Kingdom with such cases being superseded with CT imaging in these cases.

In patients with the main complaint being ingestion of foreign bodies, the majority of patients who present with FB are known to be recurrent attendees with the same complaint, exposing these patients to the radiation of a CT scan would be seen to be necessary. However, if there were concerns of an underlying obstruction, a CT scan would be warranted to identify the exact site prior to any intervention.

With regards to the RCR guidance on AXR imaging with acute abdominal pain, the 6th edition of the RCR guidance had advised that all patients needing hospital admission with a severe abdominal pain would need AXR. This has changed to the include only the above as the clinical indications for AXR further highlighting the limited utility of AXR as a diagnostic modality. This also reflects the stance that RCR has taken concerning AXR imaging. The use of AXR for blunt or stab abdominal injury is limited in clinical practice as this has been superseded by the use of Focused Abdominal Ultrasound scan in Trauma (FAST).

Conclusions

Through our study cycles, we have highlighted the importance of careful consideration prior to exposing our patients to unnecessary radiation. The phases investigated the clinical indications for AXR and whether these AXR led to any significant findings. The changes in clinical practice have also been highlighted with the move away from AXR to more definitive modalities of imaging. There has been a wider understanding of absolute indications for AXR and referring to the RCR guidelines if there are any doubts.

Acknowledgements

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Algorithm for Imaging for patients presenting with abdominal pain in A+E

Abdominal Pain

- Symptoms of bowel obstruction? (IBS?)
- Previous bowel surgery

- Yes
  - Abnormal bowel habit or BMI
  - Consider X-ray abdominal
  - Consider ultrasound abdomen

- No

- Ultrasound abdomen

- Intermittent pain
  - Evidence of perforation
  - No evidence of perforation

- CT Abdominal/Pelvis
  - Evidence of perforation
  - No evidence of perforation
  - Consider USS abdomen

- Ultrasound abdomen

- Evidence of perforation

- No evidence of perforation

- Consider USS abdomen

- IV Abdominal Imaging

Key

1. Abdominal Distension (AD) - Normal Bowel/Abdominal distension
2. Intermittent Bowel Distention
3. Change in bowel habit

This algorithm is by no means exhaustive. It only highlights the main presentations of Abdominal pain to Accident and Emergency.

N.B. - Case by case analysis of patients by the responsible clinician is required at all times. Senior Support to be sought as needed.
Why are you requesting this AXR?

Did you know that one AXR exposes your patient to 4 months of background radiation?

The 2017 RCR iRefer guidelines for plain abdominal radiology are:

- Clinical suspicion of obstruction
- Acute exacerbation of inflammatory bowel disease
- Palpable mass (specific circumstances)
- Constipation (specific circumstances)
- Acute and chronic and chronic pancreatitis (specific circumstances)
- Sharp/poisonous foreign body
- Smooth and small foreign body, e.g., coin, battery (specific circumstances)
- Blunt or stab abdominal injury (specific circumstances)

If there is any doubt about the appropriateness of the AXR please seek senior support or contact one of the radiographers who will be happy to help.

Things to think about:

- Abdominal USS, CT abdomen, CT KUB are investigations which might follow during your patient’s admission. They are all more sensitive in pin pointing a cause for acute abdominal pain.
- The clinical impression written in your notes should match your request through Symphony.
- Doctors from different specialties should be requesting their own investigations.
**Ethical statement**
There were no ethical concerns in the undertaking of this study.

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**Conflict of interest**
There are no conflicts of interest to declare by any of the authors of this study.

**References**


