

Unnecessary Use of Plain Abdominal Radiographs in Patients of Acute Abdomen

Delvene Soares^{1*} and Khwaja Muhammad Inam Pal²

¹Department of Surgery, Royal London Hospital, Whitechapel E1 1FR, United Kingdom

²Department of Surgery, Aga Khan University Hospital, United Kingdom

*Corresponding author:

Delvene Soares,
Department of Surgery, Royal London Hospital,
Whitechapel E1 1FR, United Kingdom,
Tel: +447498716231,
E-mail: delvene.soares@gmail.com

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1. Abstract

1.1. Introduction: Acute abdomen accounts for 5-10% of visits to the emergency room (ER). An early and accurate diagnosis is essential in the management of these patients. Usually the first radiological investigation performed is an abdominal X-ray (AXR). However in most cases an AXR is unable to reach a diagnosis and the patient then has to undergo further investigations. In our study, we wish to establish in how many patients presenting to the emergency department with acute abdominal pain was an unnecessary AXR done, and did not lead to a final diagnosis.

1.2. Material and Methods: This was a prospective cohort study conducted at the Department of Surgery at Aga Khan University Hospital over a 6 month period from April to October 2016. Patients aged 16 and above, who presented to the ER with non-traumatic abdominal pain, lasting more than 2 hours and less than 5 days in duration, and which measured more than 5 on the visual analog scale (VAS) were included in the study. Those who presented with acute abdomen and undergoing an AXR were followed. The principal investigator then reviewed how helpful the X-ray was in the diagnosis, and calculated the proportion of X-rays that were done unnecessarily. Data was analyzed using SPSS version 19.

1.3. Results: There was an unnecessary use of abdominal x-ray in 69% of the patients presenting with acute abdomen.

1.4. Conclusion: The abdominal X-ray for acute abdomen was done unnecessarily in a large proportion of patients and was only found to be helpful in few situations.

2. Introduction

Acute abdomen accounts for 5-10% of visits to the ER [1]. Most of these patients require immediate treatment of not just the signs and symptoms but also of the underlying cause. The wide variety in presentation of symptoms and the broad spectrum of associated diseases complicate the identification of the cause of the pain, which may vary from life-threatening diseases requiring emergency surgery to mild self-limiting etiologies [2]. An early and accurate diagnosis is essential in decision making, and insufficient workup results in unnecessary interventions or delayed treatment. 1 Studies have shown that imaging increases the accuracy of the clinical diagnosis [3, 4] and can lead to changes in treatment and management of the patients [5, 6]. Imaging also increases the level of diagnostic certainty in patients with an acute abdomen [7, 8]. Initially and even today, usually the first radiological investigation performed in these patients is an AXR. As stated by Field in 1984, 'Plain films are likely to remain the best method of imaging gas shadows for many years to come and computed tomography scanning, isotope studies and nuclear magnetic resonance are unlikely to play any major role in the initial investigation of the acute abdomen' [9]. However, 30 years later the situation has changed completely: in most cases an AXR is unable to reach a diagnosis and the patient then has to undergo further investigations. This in turn leads to an increase in the cost of management, exposure to unnecessary radiation – all of which then leads to a delay in the treatment.

Guidelines published by the Royal College of Radiologists (RCR)

[10]. state that there are only certain indications for an AXR in the acute abdomen: intestinal obstruction, bowel perforation, renal/ureteric colic, constipation in geriatric/psychiatric patients and acute abdominal pain warranting admission for consideration of surgery. In a study conducted by Morris-Stiff et al, 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 [11].

The objective of our study was to estimate the proportion of unnecessary abdominal X-rays done in patients presenting with acute abdomen. One study showed a 76% unnecessary use of the modality [12]. Furthermore in another study, AXR was found to give the correct diagnosis in only 20% of the patients [13 -15]. So if the AXR is not diagnostic in such a large proportion of patients, should we even be performing it? This additional investigation not only adds to the cost of the patient but also to the radiation exposure. AXR exposes the patient to 0.7 mSv of radiation which is equivalent to a 6 month period of background radiation [2]. As per the guidelines of the RCR, only when we are suspecting certain diagnoses should an AXR be performed instead of unnecessarily subjecting all patients with an acute abdomen to this investigation.

3. Materials and Methods

This was a prospective single-arm cohort study conducted at the Department of Surgery at the Aga Khan University Hospital in Karachi, Pakistan for a duration of 6 months, from April to October 2016. Keeping the confidence level at 95% with an anticipated population proportion of 76% and a precision of 8%, the sample size was calculated to be 110 patients, and non-probability consecutive sampling was used.

We included all patients aged 16 years and above, of any gender, who presented to the ER with non-traumatic abdominal pain, lasting more than 2 hours and less than 5 days in duration, and measuring more than 5 on the VAS. We only considered those patients who underwent a plain supine AXR, and excluded those who underwent erect abdominal and chest x-rays. We also excluded those with incomplete records, those who left against medical advice and pregnant patients.

For the purpose of this study, we defined unnecessary AXRs as those which were reported as non-specific, those reported as normal in spite of positive findings on examination, and those AXRs requiring further investigations. Ethical approval was sought and obtained from the Ethical Review Committee of our University - no consent was required, since the principal investigator was not in direct contact with the patients and no personal details of the patients were revealed. All patients presenting to the ER with an acute abdomen and undergoing a supine AXR were followed. The initial diagnosis after history and physical examination was noted

down. The final report of the X-ray (as reported by the radiology attending) was then reviewed to see if there were any significant findings if it changed or aided our provisional diagnosis, or if it lead to a final diagnosis. The principal investigator then reviewed how helpful the X-ray was in the diagnosis, and if it was necessary to have been done. The proportion of X-rays that were done unnecessarily were then calculated. Data was collected on a specifically designed proforma. Data was analyzed using SPSS version 19. Qualitative variables such as gender, location of pain, initial diagnosis, AXR findings, final diagnosis and 'the unnecessary use of AXR', were reported in frequencies and proportions. Quantitative variables such as age, duration of complaints and VAS were reported as mean +/- standard deviation. Proportions were compared using Chi Square test. P value of less than or equal to 0.05 was considered as significant.

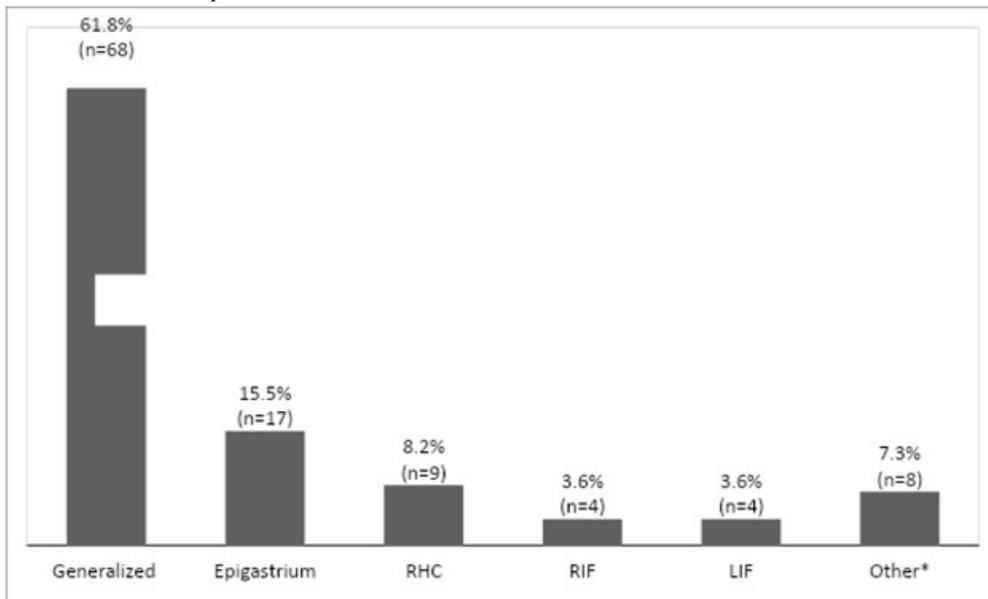
4. Results

A total of 110 patients were included in the study. 57 patients (51.8%) were males and 53 (48.2%) were females. The mean age of the patients was 47.54 +/- 13.6 years. The mean duration of pain was 72.1 +/- 36.6 hours, with a median of 72 hours and an inter-quartile range from 48 - 96 hours. The mean pain score according to the VAS was 6.92 +/- 1.05 (Table 1). 61.8% (68 patients) of the patients presented with generalized abdominal pain, 15.5% (17 patients) with epigastric pain, 8.2% (9 patients) with pain in the right hypochondrium (RHC), 3.6% (4 patients) with pain in the right iliac fossa (RIF) and left iliac fossa (LIF) respectively, and 7.3% (8 patients) with pain in other regions or pain in more than 1 region (Table 2). The initial diagnosis, based on history and physical examination, was intestinal obstruction in 47.3% (52 patients) of the cases, followed by acute pancreatitis in 15.5% (17 patients), peritonitis (most likely secondary to a hollow viscus perforation) in 9.1% (10 patients), constipation (without any signs and symptoms of obstruction) in 8.2% (9 patients), acute cholecystitis in 5.5% (6 patients) and acute appendicitis in 4.5% (5 patients). Other initial diagnoses included conditions such as generalized abdominal pain, choledocholithiasis, colitis, gossipyboma, hepatitis, liver failure, liver abscess, mesenteric ischemia and upper GI bleed (Table 3).

Table 1: Patient demographics

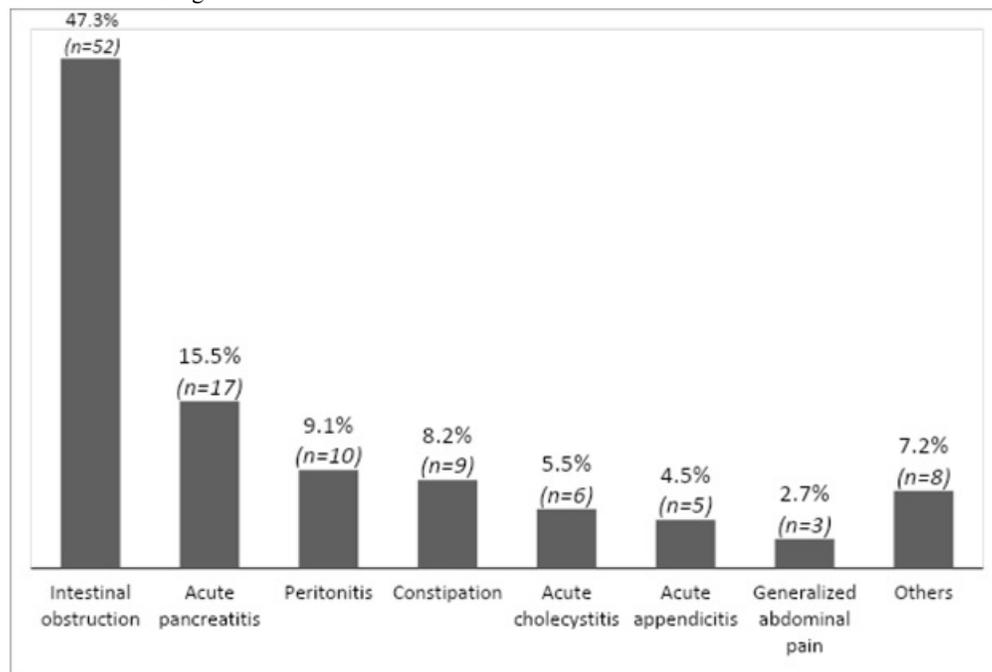
Age	47.54 +/- 13.6 years
Sex: Male Female	51.8% (n=57) 48.2% (n=53)
Duration of pain	72.1 +/- 36.6 hours
VAS	6.92 +/- 1.05

Table 2. Location of pain.



*Periumbilical, LHC, lumbar region, hypogastrium, pain in > 1 region.

Table 3. Initial Diagnosis.



We only considered the most significant findings in the AXR report. The findings included a non-specific bowel gas pattern in 50% (n= 55) of the patients, dilated small bowel loops in 23.6% (n=26) and fecal loading in 19.1% (n=21); air fluid levels, calcific opacity in the right lumbar region, dilated large bowel loops in 1.8% respectively; and diffuse haziness in the abdomen and a foreign body in 1 patient respectively (Table 4).

The final diagnosis yielded a wide spectrum of results with intestinal obstruction (27.3%), acute pancreatitis (14.5%) and constipation (10%) being the most common conditions. Other final diagnoses included GI causes (acute appendicitis, acute cholecystitis, gastritis, ileitis/colitis, perforation, non-obstructed hernia, clinicsofsurgery.com

perforated appendix, perforated gall bladder, paralytic ileus) and non-GI causes (myocardial infarction, ureteric stone, gossipyoma, dengue). (Table 5).

So to answer the main question of our study, the proportion of unnecessary AXRs was found to be 69.1% (n=76) with only 30.9% (n=34) actually leading to a final diagnosis. We also looked at different variables with regards to unnecessary x-rays – the location, initial diagnosis and the final diagnosis.

The location of pain was first stratified into generalized and localized pain. This was done because it was observed that when the 9 regions were looked at individually, the number of necessary AXRs was too small for analysis. Table 6 shows the decreased

likelihood of an AXR being unnecessary if done for generalized abdominal pain (58.8%) compared to when it is done for localized pain (85.7%) and this was found to be significant ($p = 0.003$). However, even when done for generalized pain, it is more likely to be an unnecessary one. 51.9% of the patients with an initial diagnosis of obstruction had findings that were picked up on an AXR (Table 7). In conditions such as pancreatitis, perforation and cholecystitis, a 100% unnecessary use of the modality was noted, and an 80% unnecessary use was observed in appendicitis. A sim-

ilar pattern was seen with the final diagnosis (Table 8). A 100% unnecessary use was seen in acute pancreatitis, acute cholecystitis and perforation. Interestingly, intestinal obstruction was observed to be the final diagnosis in which the AXR was found to be useful – an unnecessary use was observed in only 36.7% of patients. However, the low number of necessary X-rays for both these variables did not satisfy the assumptions of the Chi squared test, so we were unable to run any analysis on these figures.

Table 4. AXR findings.

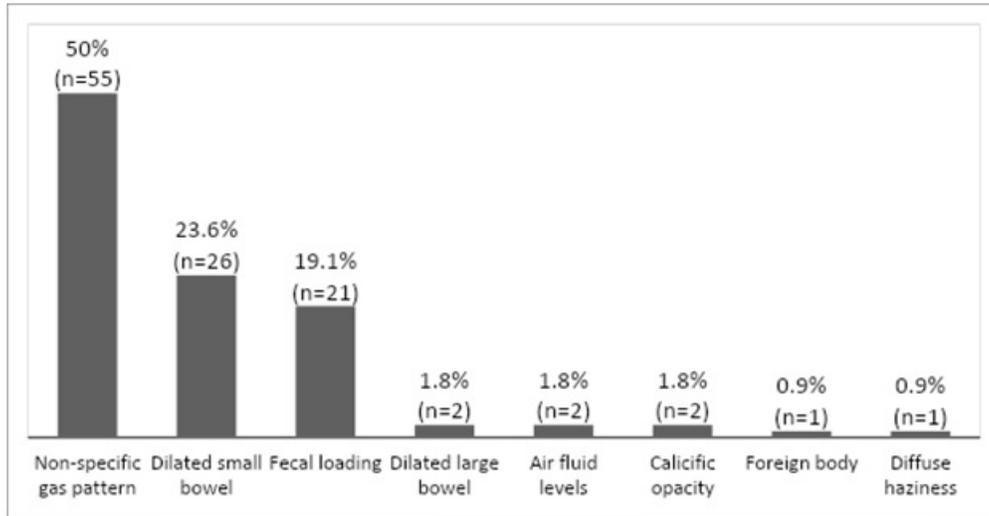


Table 5. Final Diagnosis.

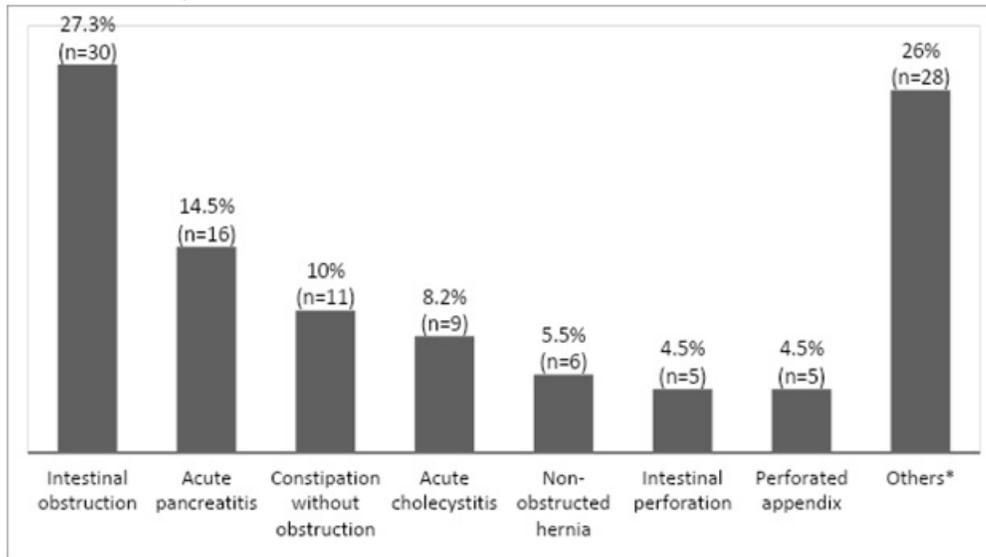


Table 6. Association between location of pain and unnecessary AXR.

		Generalized	Localized	
Unnecessary AXR	Yes	40	36	p = 0.003
	No	28	6	
% unnecessary AXR		58.8%	85.7%	

Table 7. Association between initial diagnosis and unnecessary AXR.

Unnecessary AXR	Yes	No	Total	% unnecessary AXRs
Intestinal obstruction	27	25	52	51.9
Acute pancreatitis	17	0	17	100
Perforation	10	0	10	100
Acute cholecystitis	6	0	6	100
Acute appendicitis	4	1	5	80
Others	12	8	20	60

Table 8. Association between final diagnosis and unnecessary AXR.

Unnecessary AXR	Yes	No	Total	% unnecessary AXRs
Acute pancreatitis	16	0	16	100
Intestinal obstruction	11	19	30	36.7
Acute cholecystitis	9	0	9	100
Perforation	10	0	10	100
Others	30	15	45	66.7

We also looked at the usefulness of erect chest x-rays and other views of abdominal x-rays (erect and lateral decubitus). An erect CXR was done in 78.2% (n = 86) of the patients and other abdominal views were obtained in 10.9% (n = 12). The chest x-ray was only found to be necessary in 1.8% (n = 2) patients and both of these were patients with pneumoperitoneum (air under the diaphragm). However, when we looked at all patients with the final diagnosis of intestinal perforation, only 2 out of 5 perforations were detected on an erect chest x-ray.

Only 8.2% (n = 12) of other abdominal views were found to be necessary – out of these, 11 had the same findings as the corresponding supine abdominal x-ray. 1 lateral decubitus abdominal x-ray correctly diagnosed pneumoperitoneum, but this was also detected on the chest x-ray. So it can be concluded that while chest x-ray may have some usefulness in diagnosing perforations, other views of the abdominal x-ray conferred no additional information to the final diagnosis.

5. Discussion

The primary aim of our study was to identify the proportion of plain abdominal x-rays that were done unnecessarily in patients presenting with acute abdominal pain to the ER. We found that an overwhelming percentage of 69% of abdominal x-rays were done unnecessarily, i.e. 69% of patients required further tests and investigations which in turn led to an increased cost of treatment, unnecessary exposure to the radiation from the x-ray and most im-

portantly, a delay in treatment all of which could have been avoided had the AXR not been performed.

On further analysis, the AXR was found to be unnecessary depending on the location of pain, the initial diagnosis and the final diagnosis. But as mentioned before, the numbers were too small to run an analysis on them. The two areas where the abdominal x-ray was particularly helpful was in identifying renal/ureteric stones (2/2 patients) and in detecting foreign bodies (n=1). However, the numbers of these cases are too small to come to a definitive conclusion.

The cases in which the AXR was particularly unhelpful, was in the diagnosis of acute pancreatitis, acute cholecystitis, perforation and conditions of inflammation of any of the structures of the GI tract. It can be stipulated that the AXR is useful in such conditions to rule out other diagnoses, rather than to confirm the above mentioned diagnoses. It should be mentioned that as far as hollow viscus perforations were concerned, these were better detected on an erect chest x-ray but the numbers were too small to comment on. Our study showed that 69% of the plain abdominal x-rays were done unnecessarily – i.e. only 31% were able to correctly identify the final diagnosis. This is comparable to the study conducted by Haller et al which showed that the plain abdominal x-ray was able to detect the final diagnosis in 20% of the cases.¹³ Other studies showed that the AXR had a similar yield in detecting abnormalities compared to our study: in a study done by Anyanwu and Moaly-

pour in 1998, they found that 62% of the AXRs were unnecessary,²⁰ and in another study conducted by Ahn et al in 2002, they found that 68% of AXRs were unnecessary.²³ In a more recent study by Sreedhan et al in 2014¹², they found that 76% of AXRs were non-specific. We can further extrapolate that with the passage of time, the proportion of unnecessary AXRs seems to be increasing. As per the guidelines of the Royal College of Radiologists,¹⁰ the few conditions in which the plain abdominal x-ray is still of diagnostic value include intestinal obstruction, bowel perforation (this is mostly diagnosed with an erect rather than a supine x-ray), renal/ureteric colic, constipation in geriatric/psychiatric patients, acute abdominal pain warranting admission for consideration of surgery, and foreign body. These above mentioned conditions were similar to the final diagnoses that we were able to identify in our study - Using the AXR alone we were able to correctly diagnose intestinal obstruction in 63.3% of patients, ureteric stones in 2 out of 2 patients and a foreign body in 1 patient. This shows that if one orders an abdominal x-ray after consideration of the RCR indications, its diagnostic value increases. One of the strengths of our study is that this is one of the few studies on the use of AXRs from our region. This is of particular importance as an AXR may be the only available investigation for acute abdomen in several parts of our country, due to constraints of cost and infrastructure. Secondly, this was a prospective study so we were able to follow the patients from the time they presented to the ER to their final diagnosis. Also, we only considered AXRs that were reported by the radiology attending, which standardized the level of reporting on these x-rays. Apart from the limitations of a cohort study itself, other limitations include the fact that we had small numbers of necessary AXRs, so we were unable to run statistical tests on the data. Furthermore, this study only includes data from our institution; data from other institutions would also be needed in order to apply these results for the formation of guidelines. In today's age, with the easy availability and better diagnostic accuracy of other imaging techniques such as ultrasound and CT scan of the abdomen, the plain abdominal radiograph has a very limited role – to some point, it only helps in ruling out and excluding certain diagnoses, rather than being used to come to a final diagnosis.

6. Conclusion

As seen in our study and previous other studies, the plain abdominal radiograph is no longer the initial investigation of choice for the evaluation of the acute abdomen.² With newer diagnostic modalities that are now available, it seems to have become only an investigation of exclusion. However, if one keeps in mind the guidelines of the Royal College of Radiologists¹⁰ when ordering an abdominal x-ray, its value as a diagnostic tool increases and this may save the patient from extensive and expensive further investigations. We recommend that physicians should be made aware of the principles and the context of the RCR guidelines which will

aid in their decision making when dealing with an acute abdomen in the ER.

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