The value of the erect abdominal radiograph for the diagnosis of mechanical bowel obstruction and paralytic ileus in adults presenting with acute abdominal pain

By W Z M Geng, M Fuller, B Osborne & Dr. K Thoirs

Plain abdominal radiography (PAR) is often the initial diagnostic imaging tool for patients presenting with acute abdominal pain [1]. In the acute setting PAR may consist of supine and erect abdominal radiographs and an erect chest radiograph [2]. There is discord on the value of the erect abdominal radiograph (EAR) for diagnosing acute abdominal pathologies. The EAR procedure can be uncomfortable for patients in pain and it also increases the radiation dose to which they are exposed. This article summarises the results of a recent study on whether the EAR improved diagnostic accuracy for identifying mechanical bowel obstruction and/or paralytic ileus in adults presenting with acute abdominal pain.

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INTRODUCTION

Bowel obstruction is one of the most common diagnoses in patients presenting with acute abdominal pain, accounting for 12.6–21.8% of emergency admissions [2,3,4]. Immediate life-saving surgical intervention is required in some cases so a rapid diagnosis is required for these bowel obstructions.

It has been postulated that a separate EAR may not actually be necessary because most of its findings can also be identified on the supine abdominal radiograph (SAR) [5,6]. However, air–fluid levels are only seen on the EAR and are a significant radiological sign for diagnosing acute small bowel obstruction (SBO) [7].

It would thus be helpful for radiographers to know the precise value of the EAR, as it can be a difficult radiography procedure to carry out for both the radiographer and the patient, especially when the patient is in pain or disabled. The procedure also adds to the radiation dose to which the patient is exposed. However there have only been limited investigations into the true diagnostic value of the EAR, with most studies having been undertaken over two decades ago and without the use of a standardised reference standard [2,3,8-13].

We undertook this study to determine if the inclusion of EAR in plain abdominal radiography improves diagnostic accuracy in identifying mechanical bowel obstruction and/or paralytic ileus in adults presenting with acute abdominal pain.

METHODS

40 patient cases were retrospectively sampled. There were several inclusion criteria, namely: patients who were 18–65 years old; had presented to the emergency department (ED) with acute abdominal pain and clinical suspicion of mechanical bowel obstruction or paralytic ileus; had undergone SAR and EAR within 24 h of presentation to the ED and had undergone an abdominal computed tomography (CT) scan within 4 h after PAR.

Cases were excluded if the patient was institutionalised, had psychiatric or neurological disorders or had an equivocal CT result.

Two plain abdominal radiography protocols were compared. Protocol 1 (PAR 1) consisted of only SAR, whereas protocol 2 (PAR 2) consisted of SAR and EAR. Two radiology consultants and two ED consultants, all of whom were experienced in interpreting PAR in the acute setting, participated in the study. Each assessor independently assessed the two PAR protocols, with a minimum 6-week interval between starting PAR 2 and completing PAR 1. Clinical information from the request form for each case was included with the images.

Cases were presented to the assessors in a randomised order and they were instructed to indicate their diagnostic assessment on a visual analogue scale (VAS). This consisted of a 0–100 continuous scale which provided an indication of how sure each participant was of their assessment. The left and right ends of the scale were labelled with 'definitely no obstruction/paralytic ileus' and 'definite obstruction/paralytic ileus' respectively.

REFERENCE STANDARD

The radiology report for the CT scan from each case was used to categorise each case as 'positive' or 'negative' and served as the reference standard. The assessors were blinded to the CT results. CT has a reported sensitivity, specificity and accuracy of 90–94%, 93–100% and 94–95%, respectively, for the detection of mechanical bowel obstruction, and has the highest accuracy for the differential diagnosis of mechanical small bowel obstruction and post-operative paralytic ileus [14,15].

"... Radiographers performing PAR in the investigation of mechanical bowel obstruction and paralytic ileus should be aware of the limited value of the erect radiograph..."

STATISTICAL ANALYSIS

Diagnostic accuracy was measured by calculating the area under the receiver operating characteristic curves (AUROC) for each participant for each testing session. Pair-wise comparisons ($P < 0.05$) were made between PAR protocols and assessors.

AGREEMENT TESTING

Ten duplicate cases for each PAR protocol were used to test for intra-rater agreement of each assessor's diagnostic interpretations. Each assessor was given different duplicate cases randomly mixed into the case series. Intra-class correlation coefficients (ICC) were calculated using a two-way mixed-effects model based on a single measure and absolute agreement.

RESULTS

The 40 cases in the study included 17 females and 23 males (mean age 49.0 ± 9.42 years). Fifteen (38%) cases had bowel obstruction or paralytic ileus diagnosed by CT.

DIAGNOSTIC ACCURACY OF CONSULTANTS' INTERPRETATIONS

Across all assessors, the AUROC ranged from 0.581 to 0.712 with an average of 0.632 for PAR 1 and from 0.565 to 0.673 with an average of 0.632 for PAR 2. There were no significant differences ($P > 0.05$) in AUROC between the two PAR protocols. Average sensitivity and specificity were 69.7% and 61.0% for PAR 1, respectively, and 80.0% and 53.4% for PAR 2 respectively. There was a wide variation in sensitivity and specificity values between assessors and between PAR protocols.

INTRA-RATER AGREEMENT

Moderate-to-excellent intra-rater agreement (ICC of 0.551–0.939) was achieved for PAR 1. Adding EAR to PAR 2 increased the intra-rater agreement of diagnostic interpretations for all assessors except one radiology consultant.

INTER-RATER AGREEMENT

Moderate-to-good agreement (ICC of 0.413–0.733) between the assessors was achieved for PAR 1, and good-to-excellent agreement was achieved for PAR 2.

DISCUSSION

Both PAR protocols demonstrated low-to-moderate diagnostic accuracy for identifying mechanical bowel obstruction and/or paralytic ileus in adults presenting with acute abdominal pain. We found no significant differences in the overall accuracy between the two protocols. This is consistent with other studies which have demonstrated limited value of the EAR [8,11,13]. We found no significant differences in overall diagnostic accuracy between the assessors.

Intra-rater and inter-rater agreement increased when the EAR radiograph was added to the protocol. This improvement was most profound for inter-rater agreement between the two ED consultants, which more than doubled when the EAR radiograph was added. Factors behind this result may include both the doctor's specialty or years of experience which was different from the radiologists. However, the wide confidence interval for some results indicates that the 10 duplicates cases used to test reliability may not have been enough to give a true indication of the parameter.

We asked the assessors to rate, on a continuous scale, the definite presence or absence of the conditions rather than to dichotomise their assessment into 'positive' or 'negative'. This reflects radiologic practice, where descriptors such as 'probable', 'unlikely' or 'apparent' are commonly used. There were wide variations in the sensitivity and specificity values between the assessors. This variation was also demonstrated in previous studies reporting wide ranges of sensitivity (19–96.2%) and specificity (57–100%) for diagnosing SBO [4,16,17].

Our results do not strongly support the inclusion of EAR

in PAR, with the likelihood that additional confirmatory imaging such as CT is still required. This study builds on the existing limited body of evidence investigating the value of the EAR when bowel obstruction or paralytic ileus is suspected.

LIMITATIONS

The retrospective design and sampling methods are limitations of our study. Confidence intervals for many of our outcome measurements were wide, raising the possibility that the sample was not large enough to detect true significant differences. Alternative radiographs to the EAR, such as decubitus abdominal or erect chest radiographs, were not considered in this study. The departmental CT reporting process also did not control for intra-reader and inter-reader variability between different radiology consultants.

CONCLUSION

Both PAR protocols demonstrated low diagnostic accuracy for the identification of mechanical bowel obstruction and paralytic ileus in adults presenting with acute abdominal pain. Radiographers performing PAR in the investigation of mechanical bowel obstruction and paralytic ileus should be aware of the limited value of the erect radiograph, especially in situations where it is technically difficult to achieve, patient tolerance is low and the radiographs are to be viewed by an experienced consultant radiologist.

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Book Review

Medical Imaging for Health Professionals: Technologies and Clinical Applications
Raymond M. Reilly (Editor)

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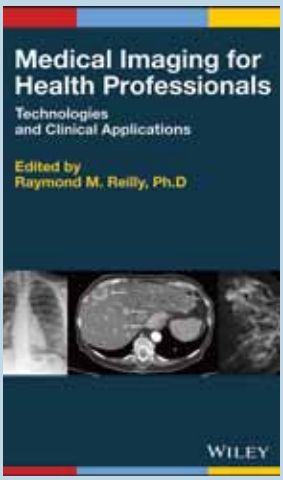

This book guides health professionals and researchers to understand and interpret medical imaging. Divided into two sections, it covers both fundamental principles and clinical applications. It describes the most common imaging technologies and their use to diagnose diseases. In addition, the authors introduce the emerging role of molecular imaging including PET in the diagnosis of cancer and to assess the effectiveness of cancer treatments. The book features many illustrations and discusses many patient case examples.

Medical Imaging for Health Professionals: Technologies and Clinical Applications offers in-depth chapters explaining the basic principles of: X-Ray, CT, and Mammography Technology; Nuclear Medicine Imaging Technology; Radionuclide Production and Radiopharmaceuticals; Magnetic Resonance Imaging (MRI) Technology; and Ultrasound Imaging Technology. It also provides chapters written by expert radiologists in well-explained terminology discussing clinical applications including: Cardiac Imaging; Lung Imaging; Breast Imaging; Endocrine Gland Imaging; Abdominal Imaging; Genitourinary Tract Imaging; Imaging of the Head, Neck, Spine and Brain; Musculoskeletal Imaging; and Molecular Imaging with Positron Emission Tomography (PET).