



جامعة
بنغازي الحديثة



**مجلة جامعة بنغازي الحديثة للعلوم
والدراسات الإنسانية
مجلة علمية إلكترونية محكمة**

العدد العاشر

لسنة 2020

حقوق الطبع محفوظة

شروط كتابة البحث العلمي في مجلة جامعة بنغازي الحديثة للعلوم والدراسات الإنسانية

- 1- الملخص باللغة العربية وباللغة الانجليزية (150 كلمة).
- 2- المقدمة، وتشمل التالي:
 - ❖ نبذة عن موضوع الدراسة (مدخل).
 - ❖ مشكلة الدراسة.
 - ❖ أهمية الدراسة.
 - ❖ أهداف الدراسة.
 - ❖ المنهج العلمي المتبع في الدراسة.
- 3- الخاتمة. (أهم نتائج البحث - التوصيات).
- 4- قائمة المصادر والمراجع.
- 5- عدد صفحات البحث لا تزيد عن (25) صفحة متضمنة الملاحق وقائمة المصادر والمراجع.

القواعد العامة لقبول النشر

1. تقبل المجلة نشر البحوث باللغتين العربية والانجليزية؛ والتي تتوافر فيها الشروط الآتية:
 - أن يكون البحث أصيلاً، وتتوافر فيه شروط البحث العلمي المعتمد على الأصول العلمية والمنهجية المتعارف عليها من حيث الإحاطة والاستقصاء والإضافة المعرفية (النتائج) والمنهجية والتوثيق وسلامة اللغة ودقة التعبير.
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 - أن تكون الجداول والأشكال مدرجة في أماكنها الصحيحة، وأن تشمل العناوين والبيانات الإيضاحية.
 - أن يكون البحث ملتزماً بدقة التوثيق حسب دليل جمعية علم النفس الأمريكية (APA) وتثبيت هوامش البحث في نفس الصفحة والمصادر والمراجع في نهاية البحث على النحو الآتي:
 - أن تُثبت المراجع بذكر اسم المؤلف، ثم يوضع تاريخ نشره بين حاصرتين، يلي ذلك عنوان المصدر، متبوعاً باسم المحقق أو المترجم، ودار النشر، ومكان النشر، ورقم الجزء، ورقم الصفحة.
 - عند استخدام الدوريات (المجلات، المؤتمرات العلمية، الندوات) بوصفها مراجع للبحث: يُذكر اسم صاحب المقالة كاملاً، ثم تاريخ النشر بين حاصرتين، ثم عنوان المقالة، ثم ذكر اسم المجلة، ثم رقم المجلد، ثم رقم العدد، ودار النشر، ومكان النشر، ورقم الصفحة.
2. يقدم الباحث ملخص باللغتين العربية والانجليزية في حدود (150 كلمة) بحيث يتضمن مشكلة الدراسة، والهدف الرئيسي للدراسة، ومنهجية الدراسة، ونتائج الدراسة. ووضع الكلمات الرئيسية في نهاية الملخص (خمس كلمات).

3. تحتفظ مجلة جامعة بنغازي الحديثة بحقها في أسلوب إخراج البحث النهائي عند النشر.

إجراءات النشر

ترسل جميع المواد عبر البريد الإلكتروني الخاص بالمجلة جامعة بنغازي الحديثة وهو كالتالي:

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- ✓ في حالة قبول البحث مبدئياً يتم عرضة على مُحكمين من ذوي الاختصاص في مجال البحث، ويتم اختيارهم بسرية تامة، ولا يُعرض عليهم اسم الباحث أو بياناته، وذلك لإبداء آرائهم حول مدى أصالة البحث، وقيمتها العلمية، ومدى التزام الباحث بالمنهجية المتعارف عليها، ويطلب من المحكم تحديد مدى صلاحية البحث للنشر في المجلة من عدمها.
- ✓ يُخطر الباحث بقرار صلاحية بحثه للنشر من عدمها خلال شهرين من تاريخ الاستلام للبحث، وبموعد النشر، ورقم العدد الذي سينشر فيه البحث.
- ✓ في حالة ورود ملاحظات من المحكمين، تُرسل تلك الملاحظات إلى الباحث لإجراء التعديلات اللازمة بموجبها، على أن تعاد للمجلة خلال مدة أقصاها عشرة أيام.
- ✓ الأبحاث التي لم تتم الموافقة على نشرها لا تعاد إلى الباحثين.
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Plain abdominal radiograph in evaluation of acute abdominal pain

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Abstract.

Physicians more frequently consider abdominal radiography a routine procedure in the assessment of acute abdominal pain. Purpose of this study: investigate the value of Plain Abdominal Radiograph (PAR) in the diagnosis of patients presenting with acute abdominal pain to the surgical department of a medical institution, determine the frequency of appropriately performed PARs according to the Royal College of Radiologists (RCR) guidelines. Methods: A retrospective review of abdominal radiographs and medical records was conducted for patients admitted to the surgical unit with acute abdominal pain from January to December 2019. Only the first radiograph per patient was used for analysis. PARs were sorted as having positive or negative findings. The final diagnosis in patients' medical records was used as the standard reference for analysis. Chi-square tests was used to study the associations between PAR findings and a final diagnosis, a statistically significant finding was considered $P < 0.05$. The sensitivity, specificity, and accuracy of the radiographic diagnosis were determined. The clinical data, radiographic findings and final diagnosis were used to determine the appropriateness of PARs according to RCR guidelines. Results: 120 cases included in the study, PAR showed positive findings and influenced the clinical management in 27 patients (23%). Patients with Intestinal obstruction had the highest number of positive PAR findings (25 out of total 30 patients, 83%), PAR was non-diagnostic in a significant number of cases (88 patients, 73%) when patients with intestinal obstruction were excluded ($P < 0.0001$). The sensitivity, specificity, and accuracy of PAR for intestinal obstruction were 83% (95% CI = 65-94), 98% (95% CI = 92-100) and 94% (95% CI = 88-98) respectively. According to the RCR guidelines, PAR was appropriately indicated in only 61 (51%) patients. Conclusion: Overall, PAR had low impact on the diagnosis of patients with acute abdominal pain; PAR has its most significant value in the diagnosis of intestinal obstruction with high sensitivity, specificity and accuracy. Staff education about guidelines and local departmental protocols are recommended to reduce any out-of-hours inappropriate utilization of PAR.

Key words: Plain abdominal radiograph, acute abdominal pain, intestinal obstruction. RCR guidelines.

الملخص:

يعتبر الأطباء في كثير من الأحيان أن التصوير بالأشعة للبطن إجراء روتيني في تقييم آلام البطن الحادة دون معرفة قيمتها. الغرض من هذه الدراسة: التحقق من قيمة التصوير بالأشعة للبطن في تشخيص المرضى الذين يعانون من آلام البطن الحادة وتم إدخالهم إلى قسم الجراحة بمستشفى معين، مع تحديد وتيرة إجراء الصور بشكل مناسب وفقاً للقواعد الإرشادية للكلية الملكية لأطباء الأشعة RCR. الطريقة: تم إجراء مراجعة بأثر رجعي لصور الأشعة والسجلات الطبية للمرضى الذين تم إدخالهم إلى الوحدة الجراحية بالمستشفى والذين يعانون من آلام البطن الحادة من يناير إلى ديسمبر 2019. تم استخدام أول صورة أشعة فقط لكل مريض للتقييم. تم تصنيف صور الأشعة على أنها تحمل نتائج إيجابية أو سلبية. تم استخدام التشخيص النهائي في السجلات الطبية للمرضى كمرجع معياري للتقييم. تم استخدام اختبارات Chi-square لدراسة الارتباطات بين نتائج صور الأشعة والتشخيص النهائي، واعتبرت نتيجة $P > 0.05$ ذات دلالة إحصائية. تم تحديد حساسية ونوعية ودقة التشخيص المستخلص من صور الأشعة. تم استخدام البيانات السريرية ونتائج صور الأشعة والتشخيص النهائي لتحديد مدى ملائمتها وفقاً لإرشادات RCR. النتائج: 120 حالة تم تضمينها في الدراسة، أظهرت صور الأشعة نتائج إيجابية وأثرت على مسار العلاج في 27 مريضاً (23%). كان لدى المرضى الذين يعانون من انسداد معوي أكبر عدد من النتائج الإيجابية (25 من إجمالي 30 مريضاً، 83%) كانت صور الأشعة غير تشخيصية في عدد كبير من الحالات (88 مريضاً، 73%) عندما تم استبعاد المرضى الذين يعانون من انسداد معوي ($P > 0.0001$). كانت حساسية ونوعية ودقة صور الأشعة في تشخيص انسداد الأمعاء 83% (95% CI 65-94) 98% (95% CI 92-100) 94% (95% CI 88-98) على التوالي، كانت صور الأشعة مبرراً القيام بها في 61 (51%) مريض فقط وفقاً لإرشادات RCR. الخلاصة: بشكل عام، كان لصور أشعة البطن دور ضعيف في تشخيص المرضى الذين يعانون من آلام البطن الحادة. كانت لها الأهمية في تشخيص انسداد الأمعاء بحساسية وخصوصية ودقة عالية. يوصى بتثقيف الأطباء بقسم الجراحة حول المبادئ التوجيهية للكلية الملكية لأطباء الأشعة وأجراء بروتوكولات داخلية لتقليل أي استخدام غير مناسب للتصوير بالأشعة خارج ساعات العمل.

Introduction

Acute abdominal pain is a common complaint encountered in emergency settings with a reported incidence of approximately 7-10% of presentations to the emergency department (ED) (Cervellin et al., 2016; Hastings & Powers, 2011; Laméris et al., 2009). It is commonly defined as pain of non-traumatic origin with a maximum duration of five days (Gans et al., 2015). Conditions causing acute abdomen constantly manifest with pain, these commonly include appendicitis, intestinal obstruction, diverticulitis, cholecystitis, renal colic, acute intestinal ischemia, perforation, pancreatitis or gynecological disorders (Artigas Martín et al., 2015). The medical history, physical examination and laboratory tests are the initial steps in the diagnostic workup for patients presenting with acute abdominal pain. Imaging is then required in selected cases to help establish the correct diagnosis (Stoker et al., 2009). The plain abdominal radiograph (PAR) has been the first diagnostic radiographic examination after the physical examination (Simeone et al., 1985).

Traditionally, there has always been a tendency toward performing PAR in patients with acute abdominal pain (Lee, 1976); this has not changed even with the introduction of other modalities such as ultrasound and CT (Artigas Martín et al., 2015). On the other hand, several publications recognize the low diagnostic yield of PAR in patients with acute abdominal pain (Artigas Martín et al., 2015; Gans et al., 2012, Smith & Hall, 2009). Moreover, abdominal radiograph delivers one of the highest radiation doses (0.7 mSv as against 0.1 mSv for a chest radiography), hence guidelines have been formulated to restrict PAR indications (Bertin et al., 2019). The Royal College of Radiologists (RCR) 2007 guidelines limit PAR for patients with acute abdominal pain in hospital settings to if hospital admission and surgical consideration are warranted or if perforation or intestinal obstruction is suspected (Smith & Hall, 2009). The most recent RCR (2017) guidelines further restrict PAR indications in patients with acute abdominal pain to mainly clinical suspicion of obstruction (Duncan et al., 2018). As more frequently physicians consider abdominal radiography a routine procedure or even a defensive screening tool to assure patients' normality, there are no local published studies assessing its usefulness. The main purpose of this study was to retrospectively investigate the value of PAR in the diagnosis of patients presenting with acute abdominal pain to the surgical department of a medical institution. An additional aim was to determine the frequency of appropriate PARs according to RCR guidelines.

Methods.

This study was undertaken at Althora Teaching General Hospital of Albeida, Libya. It is the only general hospital in the area.

Patients referred for imaging from the surgical unit over the period January to December 2019 were retrospectively selected from the picture archive and communication system (PACS) of the radiology department. A total of 884 conventional abdominal radiographic examinations were performed in that period. Hard-copy radiographs were reviewed and reported by a consultant radiologist, clinical information was not available to the reader due to lack of radiology clinical database in the radiology department. PARs were classified according to whether the report noted a positive finding (small or large bowel obstruction or free intraperitoneal air), or negative finding (i.e. no abnormalities found). Patients whose radiographs

demonstrated radiopaque foreign body were excluded. Hospital records were then reviewed and information relevant to the study were obtained. Case inclusion criteria were patients who had been admitted to the surgical department with acute abdominal pain and had undergone PAR in the acute setting. Postoperative inpatients who developed acute abdominal pain were also eligible. Patients with missing clinical records or who were found to have undergone PAR for reasons other than acute abdomen were excluded from data analysis. The study sample size comprised of 120 cases. Only the first radiograph per patient was used for analysis. The data collected from hospital records for the purpose of the study were clinical history, physical and laboratory examination, the impact of PAR findings on patient's management i.e.

The decision to perform an urgent surgical procedure or medical management and had the initial diagnosis changed after PAR or was supported by PAR findings. The surgical comment on the radiograph was recorded to determine if there was agreement with the consultant radiologist's report. For Patients who had undergone surgical treatment, the type of surgery and surgical findings were also recorded. Radiograph's findings were compared with operative findings or clinical course in all patients. The final diagnosis of the patient (made before discharge or transfer to other hospital) served as the reference standard for PAR results' analysis. The sensitivity, specificity, and accuracy of the radiographic diagnoses recorded by the radiologist were determined and the 95% confidence interval (CI) was calculated for each of the proportions. The diagnosis of mechanical bowel obstruction or ileus were identified under the same category of intestinal obstruction, as it is often difficult to distinguish between an ileus and mechanical bowel obstruction on a plain film (Musson et al, 2011).

The clinical course, radiographic findings and final diagnoses were used to determine the appropriateness of PARs in relation to RCR 2017 iRefer guidelines (as cited in Dunkan et al, 2018). They include clinical suspicion of obstruction, acute exacerbation of inflammatory bowel disease, and specific circumstances of palpable mass, constipation and pancreatitis.

All statistical calculations were performed using MedCalc Statistical Software version 19.4.1 (MedCalc Software by Ostend, Belgium). The Chi-squared test was used to study the associations between PAR findings and final diagnosis. The surgical note of PAR and the radiologist's report were compared using the McNemar test (paired proportion). A *P* value of less than 0.05 was considered significant. For diagnostic assessment of PAR, a receiver operating characteristic (ROC) curve was generated using data from the radiologist's report and binomial data from the final diagnosis of patient (standard reference).

Results.

A total of 120 cases were included in the study, 61 females and 59 males. The mean age of the patients was 39 years \pm 23 SD (range 1- 90 years), all of whom were subjected to PAR on admission. 117 patients had undergone erect abdominal radiograph (EAR), four patients had supine in addition to erect studies done, whereas three patients had only supine abdominal radiographs. All cases had presented with acute abdominal pain, other symptoms and signs at time of presentation are summarized in Table 1. The final diagnoses for all cases is shown in Table 2.

Table 1. Clinical presentation of patients included in the study:

Symptoms and physical signs	No of patients (frequency %)
Abdominal pain	120 (100%)
Vomiting	90 (75%)
Constipation	32 (27%)
Abdominal distension	17 (14%)
Diarrhea	5 (4%)
Fever	9 (8%)
Focal abdominal swelling	8 (7%)
Guarding or Rigidity	23 (19%)
Rebound or diffuse Tenderness	28 (23%)
Distended abdomen on examination	22 (18%)

Table 2. Final diagnosis of the 120 patients who had abdominal radiographs

Diagnosis	No of patients	Diagnosis	No of patients
Intestinal obstruction	30	Non-specific pain	7
Acute appendicitis	22	UTI, renal colic	6
Acute gastritis/peptic ulcer disease	10	Acute pancreatitis	5
Acute Biliary disease (Acute cholecystitis, GB empyema, acute cholangitis)	10	Ischemic bowel	4
Gastroenteritis	6	Hernias	2
Constipation	7	Hirschprung's disease.	2
Inflammatory diseases of bowel (Acute diverticulitis, Crohn's disease, TB)	3	Others (Ileocecal tumour, Hepatitis, Pericarditis, Spotted fever, Colonic pseudo-obstruction, Pelvic inflammatory disease)	6

PAR showed positive findings in 27 patients (23%). Dilated bowel loops was the most frequent finding, present in 25 patients (93% of positive findings), the other finding was pneumoperitoneum noticed in two patients (7%).

Patients with Intestinal obstruction had the highest number of positive PAR findings (25 out of total 30 patients, 83%), PAR was non-diagnostic in a significant number of cases (88 patients, 73%) when patients with intestinal obstruction were excluded (Chi-squared = 89.000, DF=1, $P < 0.0001$). (Table 3).

Table 3. Association between findings on plain abdominal radiographs and diagnostic value (excluding patients with intestinal obstruction)

PAR	Diagnostic	Non-diagnostic
Positive findings	2	0
Negative findings	0	88

The prevalence of intestinal obstruction in this study was 25 % - 30 out of 120 patients. Four cases were due to ileus caused by perforated appendicitis in three cases and sigmoid rupture in one case, the final diagnosis was established at laparotomy. 22 cases had mechanical small bowel obstruction (SBO): 13 cases were confirmed in surgery where adhesions were found in 5 cases, colonic mass in two cases, ileal mass in one case, Meckel's diverticulum (one case), Bezoar in one case, incarcerated inguinal hernia in two cases and strangulated paraumbilical hernia in one case. Whereas 9 cases (5 adhesions, 2 crohn's disease, 1 hernia, 1 TB of small intestine)

were conservatively managed. Four cases had large bowel obstruction (LBO). The causes confirmed in surgery were sigmoid volvulus and rectal mass, while two cases of inspissated feces were conservatively treated.

Initial x-ray showed SBO in 15 patients, possible SBO in six patients, LBO in 4 patients, PAR was normal in five cases with final diagnosis of SBO. The sensitivity, specificity and accuracy of PAR for the diagnosis of intestinal obstruction were 83% (95% CI = 65-94), 98% (95% CI = 92-100) and 94% (95% CI = 88-98) respectively. (Table 4).

Table 4. Radiographic diagnosis of intestinal obstruction.

PAR diagnosis	Final diagnosis obstruction (n= 30)	Final diagnosis no obstruction (n= 90)
SBO	15 TP	0 FP
Possible SBO	6 TP	1 FP
LBO	4 TP	1 FP
NO obstruction	5 FN	88 TN
Total PAR	30	90

TP = true positive; FP = false positive; FN = false negative; FP = false positive. Sensitivity = $TP / (TP + FN)$; specificity = $TN / (TN + FP)$. Plain x-ray diagnosis: Sensitivity = $25/30 = 83\%$, Specificity = $88/90 = 97.7\%$. The percentage of missed cases = $5/30 = 16\%$.

The ROC curve analysis (Figure 1) confirmed a significant association between PAR findings and a final diagnosis of intestinal obstruction.

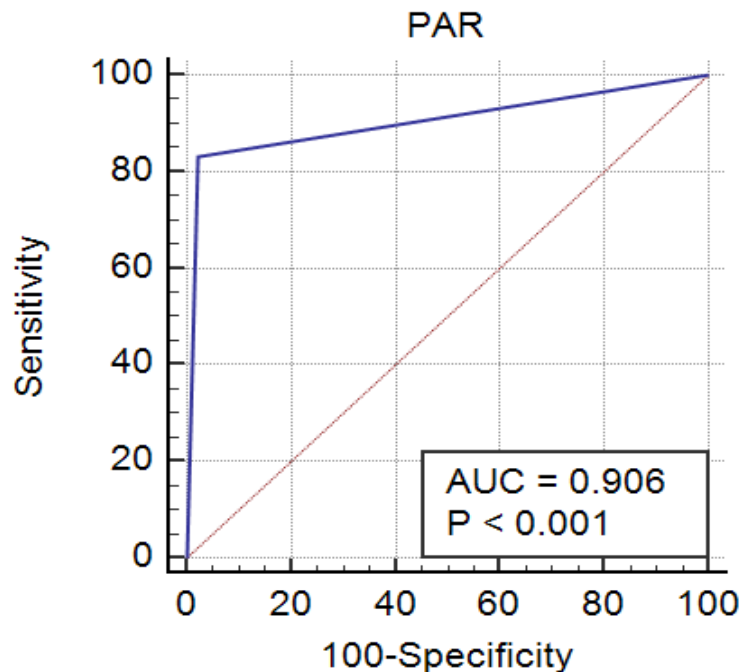


Figure 1. ROC curve of PAR diagnosis of intestinal obstruction, the true positive rate (Sensitivity) is plotted in function of the false positive rate (100-Specificity). The Area under the curve (AUC) value of 0.9 (AUC range from zero to 1) indicates a high diagnostic performance of PAR for this diagnosis.

Positive PAR findings were seen in four out of 22 cases (18%) with final diagnosis of appendicitis, none of which was specific for acute appendicitis. Three cases showed mechanical SBO or ileus on their radiographs and one case had a small amount of free air under the right diaphragm indicative of gastrointestinal perforation (Figure 2). PAR sensitivity could not be calculated for acute appendicitis due to absence of specific findings. The final diagnosis of perforated appendicitis as the underlying cause was found at exploratory laparotomy. PAR showed negative findings in all other disease categories mentioned in Table 2.

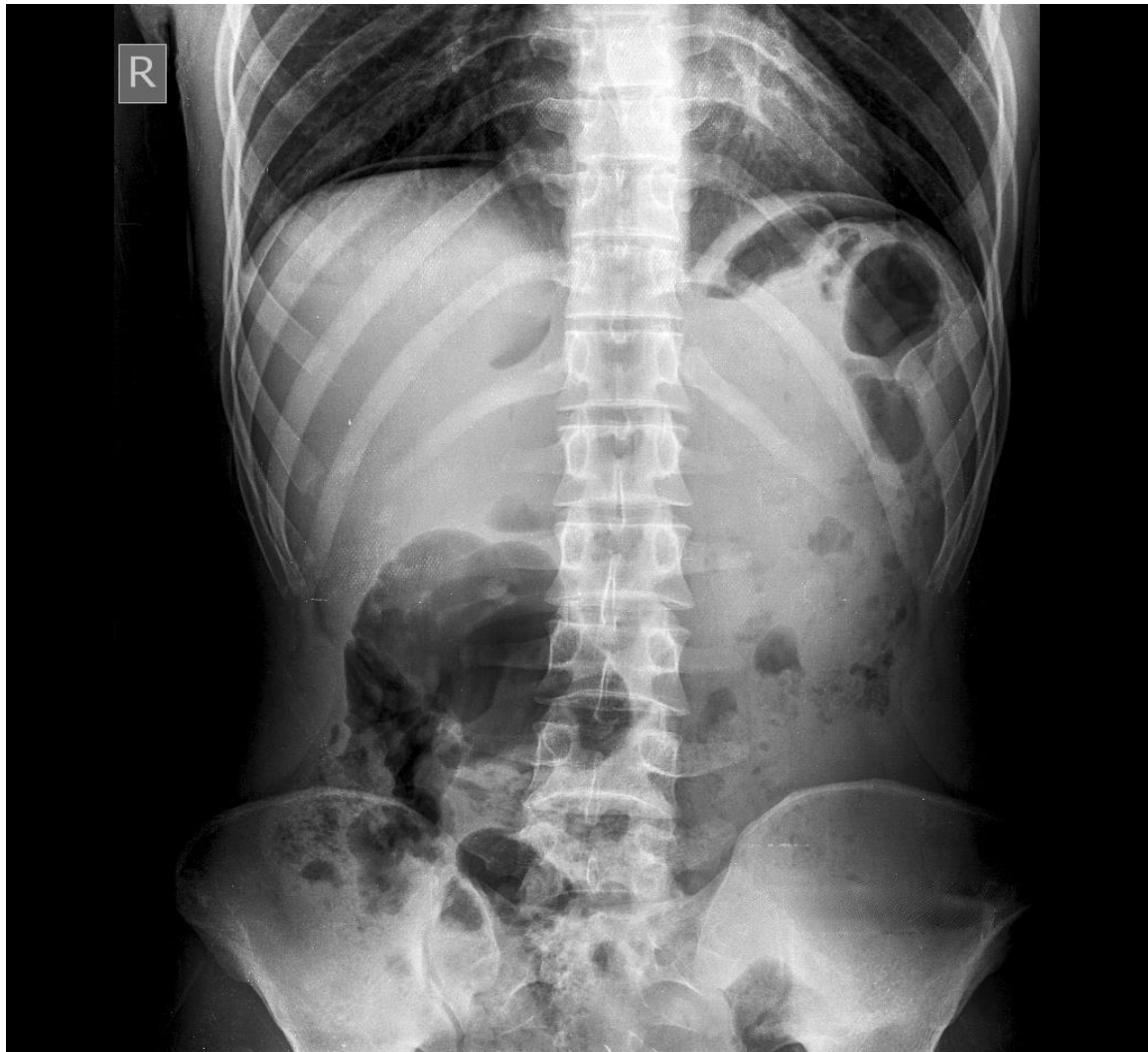


Figure 2. Twenty-one-year-old male patient presented with periumbilical pain and vomiting for one day, PAR showing thin layer of free air under right diaphragmatic dome, which resulted in urgent surgical exploration with an initial diagnosis of gastrointestinal perforation, the surgery revealed perforated appendix with diffuse intraperitoneal pus collection.

PAR was misinterpreted by admitting surgeons as positive for intestinal obstruction on erect radiograph in three cases. However, no changes in management were made based on this surgical misinterpretation of EAR. The final diagnosis was perforated appendicitis (confirmed on surgery), infective enteritis and constipation. In one case, the findings of possible SBO on EAR were missed, which resulted in a delay in admission that was done 2 days from the initial PAR, an urgent laparotomy

done revealed strangulated paraumbilical hernia. The difference between initial surgical note of PAR and the radiologist's interpretation did not reach statistical significance using McNemar test on paired proportions ($P = 0.6250$).

Nineteen patients (70% of positive finding population and 16% of total study population) with positive PAR findings (17 cases intestinal obstruction, 2 free intraperitoneal air) had laparotomy, 14 of them were urgent based on PAR and clinical findings. PAR were diagnostic and influenced the clinical management in 27 patients (23%), changing the initial diagnosis in one patient (1%) (Illustrated in Figure 3) and helping to confirm the suspected clinical diagnosis in the other 26 patients.

PAR was found appropriate in relation to clinical course and final diagnosis and according to the RCR iRefer guidelines in 61 patients out of the 120 (51%).



Figure 3. 55-year-old female patient presented with acute right hypochondrial pain started 4 days before admission, associated with nausea and vomiting. The initial clinical diagnosis was acute cholecystitis, EAR showed multiple dilated air filled small bowel loops with multiple air-fluid levels suspicious for small bowel obstruction, the cause of obstruction at laparotomy was sigmoid carcinoma with profound omental metastasis.

Discussion.

The primary finding of this study was that the vast majority of PARs performed in patients admitted on emergency surgical intakes with acute abdominal pain would be normal or non-specific in diagnoses other than intestinal obstruction ($P < 0.001$). About 77% of PAR performed in this study were deemed non-diagnostic, PAR showed highest sensitivity (83%) for intestinal obstruction and no sensitivity for any other surgical disease. Our findings were in keeping with other studies, which have also evaluated the need for PAR in patients with acute abdominal pain. In Ahn et al. (2002) study, the sensitivity of abdominal radiography was highest for intraabdominal foreign body and for bowel obstruction while abdominal radiography had 0% sensitivity for appendicitis, pyelonephritis, pancreatitis, and diverticulitis. Bhangu et al. (2010) who specifically studied the value of PAR in investigating patients with appendicitis, acute gallbladder disease or acute pancreatitis found that PAR did not aid in the diagnosis of these conditions. In Prasannan et al. (2005) study, PARs were non diagnostic in 82% of cases in surgical conditions other than intestinal obstruction, and similarly to our study showed high sensitivity in cases of intestinal obstruction.

The most important plain radiographic finding for acute appendicitis is the recognition of an appendicolith, which has a reported incidence of only 13%–22% (Baker, 1996; Petroianu, 2012). In the current study, there were two positive radiographic findings associated with complicated appendicitis in form of small bowel obstruction (two cases) and pneumoperitoneum in one patient, none of which is sensitive or specific for appendicitis but rather diagnostic for the complications. This is in keeping with the findings of Boleslawski et al. (1999) who reported that PAR is not helpful in the evaluation of patients with suspected appendicitis but it may be performed in selected patients with clinically suspected small bowel obstruction or urinary symptoms. Pneumoperitoneum on abdominal radiograph is rarely encountered in association with perforated appendicitis, with an estimated incidence in the literature of 0–7.1% of all patients presenting pneumoperitoneum (Duman, 2014). Its presence would pose a diagnostic dilemma, as a perforated peptic ulcer is the most common pathology associated with pneumoperitoneum. However, it may be considered as a favorable sign because it had resulted in the patient receiving immediate surgical exploration and cure.

The most common cause of abdominal pain warranting admission to surgical unit and undertaking PAR in our series was intestinal obstruction (25%). The sensitivity and specificity values of PAR for intestinal obstruction were 83% and 97% respectively; they are most similar to Kim et al. (2011) results who reported a sensitivity and specificity for small bowel obstruction (SBO) of 82.0% and 96.4%. Most of the other previous studies have also reported similar sensitivity values to our study. Prasannan et al. (2005) reported a sensitivity of 80% for intestinal obstruction in a prospective audit of 168 patients with acute abdominal pain examined with PAR. Thompson et al. (2007) reported a mean sensitivity of 82% and specificity of 83% among different reviewers who retrospectively examined abdominal radiography of 90 patients with suspected SBO. Maglinte et al. in 1996 reported a sensitivity of 86% for high-grade bowel obstruction. In Tie & Edwin (2016) study, the sensitivity of supine abdominal radiographs was 88.5% whilst the sensitivity of EARs was 84.6% and when examined in combination, the sensitivity increased to 96%. Geng et al. (2018) reported an average sensitivity of 80% in a series of a consecutive 40 patients with suspected mechanical bowel obstruction or ileus. Conversely, other studies have reported lower sensitivity of PAR for intestinal obstruction. In Shrake et al. (1991),

the overall sensitivity of PAR was 66% in examination of 117 patients undergoing both PAR and enteroclysis for suspected SBO, Frager et al. (1995) reported only 19% sensitivity of radiography compared to 100% sensitivity of CT in examinations of 36 patients with suspected bowel obstruction. In these studies plain radiographs were found to be an unreliable predictive for the presence of obstruction and the use of enteroclysis or CT were advocated instead. Our results of high diagnostic accuracy of PAR for intestinal obstruction are in agreement with the opinions of authors; Kim et al. (2011), Maglinte et al. (1996), Thompson et al. (2007), who concluded that abdominal radiographs are accurate in the detection of acute SBO and Plain film radiography should remain the initial method of imaging patients with suspected bowel obstruction.

The fact that 94% of PAR were only done in erect position suggests that PAR is being approached by the surgeons in the targeted medical institution as a simple decision aid to exclude intestinal obstruction. However, EAR has its limitations. Several studies had reported a small benefit of adding EAR to supine radiograph in evaluating patients with acute abdominal pain or suspected bowel obstruction and that the findings on EAR can be potentially misleading (Field et al., 1985; Hayward et al., 1984; Mirvis et al., 1986; Geng et al., 2018; Tie & Edwin, 2016). This was found in three cases in our series where the presence of air-fluid levels in bowel loops on the erect studies were misleading to the surgical resident for the presence of intestinal obstruction. The presence of multiple air-fluid levels on EAR is not pathognomic of SBO and can be observed in other conditions like gastroenteritis (Tie & Edwin, 2016). Furthermore, a recent study by Tie & Edwin (2016) showed a lower sensitivity and specificity values of EAR compared to the supine in the detection of intestinal obstruction.

In our series, Positive PAR findings were of diagnostic value and influenced the management in 23% of patients. These results, although higher than those reported in previous studies suggest low contribution of PAR in patient's management. In Stower et al. (1985) prospective audit of 97 patients with acute abdominal pain, PAR were considered diagnostic in 15.5% and altered patient's management in 4%. Anyanwu & Moalypour (1998) reported PAR to be diagnostic in only 10% in his retrospective analysis of 125 patients with acute abdominal pain. Kellow et al. (2008), who retrospectively reviewed the initial PARs of 874 patients presented to the ED with acute abdominal pain, found that PAR was possibly helpful in changing treatment without a follow-up study in 4% of patients. In Van Randen et al. (2011) prospective evaluation of the added value of plain radiographs on top of clinical assessment in 1021 patients, the clinical diagnosis was correctly changed after PAR in 4% of the cases. In Feyler et al. (2002) prospective analysis of 131 PARs performed in admitted patients, PAR influenced the clinical management in only nine cases (7%) and in only 16 cases (12%) were the abdominal radiographs indicated according to guidelines.

Recent studies identifying the indications for PAR in surgical admission units and comparing them against international guidelines showed that RCR guidelines were not being followed in a significant number of cases. Morris-Harris et al. (2006) found compliance of PAR indications to RCR guidelines in only 32% in his study while 46% compliance was reported by Bertin et al. (2019). In the present study, Adherence to RCR guidelines was found in 51% of cases. PAR was performed in cases where the clinical diagnosis was evident suggesting that junior surgical staff, who are the first to evaluate the patient, may be using PAR indiscriminately in the

assessment of acute abdominal pain. This is in keeping with the findings of previous studies, which reported that junior doctors tend to request PAR as part of a package of routine investigations for patients with acute abdominal pain (Feyler et al., 2002; Geng et al., 2018; Stower et al., 1985). Staff knowledge about guidelines would have limited almost half of PARs in the current study and positive PAR findings would have been found in 41% of cases instead of 23%. In another study of 225 patients, RCR guidelines were followed in only 32%, when guidelines were adhered to, positive findings were identified in 77% of cases whereas when guidelines were not followed, positive findings were seen in 25% of PARs (Morris-Harris et al., 2006). In Prasannan et al. (2005) study, 61% of patients were inappropriately subjected to PAR with findings that did not correlate with the clinical diagnosis (compared to 49% in our study). However, 77.7% of those patients with inappropriate films had radiographs requested in the ED rather than the surgical wards, which accounted for the higher number of appropriate PARs in the present study.

There was no statistically significant difference between the consultant radiologist's PAR interpretation and surgical note of PAR in the current study ($P=0.6$). In the majority of cases, the comment on PAR was made by a consultant surgeon on postadmission, the difference between radiologist's report and surgical note was found in cases where the admitting junior residents had documented their initial interpretation of the radiograph. Similar to our results, Geng et al. (2018) did not find a significant difference between experienced radiologist and experienced non-radiologist assessors. Field et al. (1985) who compared the interpretations made by radiologists and non-radiologists found that junior non-radiology doctors mostly missed, misinterpreted or identified irrelevant radiological features. In doubtful cases, a senior staff member or a radiologist should be consulted.

This study has several limitations mainly caused by the retrospective method of the study and sampling of data from medical records. The analysis of PAR's role in the decision-making process or diagnosis was not possible beyond the clinical notes written in patients' files, which may have not been adequately documented in all cases. The retrospective nature also limited the evaluation of surgical residents' skills in abdominal radiograph interpretation separately from those of postadmission seniors. Only a prospective audit would enable the analysis of junior and senior surgeons' PAR reading skills in details. Another limitation was a lack of hospital records for patients who may have had undertaken PAR for evaluation of acute abdominal pain but were subsequently not admitted. The criteria of including patients institutionalized in surgical unit may have created some unavoidable bias in favor of PAR use in our study with more number of appropriately indicated PARs included than inappropriate ones performed in patients where admission was deemed unnecessary.

Conclusion.

The overall diagnostic yield of PAR in patients presenting with acute abdominal pain is low. PAR has its most significant value in the diagnosis of intestinal obstruction with high sensitivity, specificity and accuracy. RCR guidelines were applicable in more than half of the abdominal radiographs requested by the surgical unit; however, staff education and local departmental protocols are recommended to reduce any out-of-hours inappropriate utilization of PAR, thus increasing the overall diagnostic performance of PAR.

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