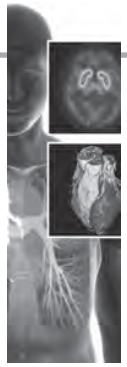

Should plain radiographs persist or be replaced by alternative scans for imaging of acute painful non-traumatic abdominal pain?

Purpose: Acute non-traumatic abdominal pain (ANTAP) is a frequent presentation at the emergency department (ED). Plain abdominal radiographs (PAR's) were historically the principal imaging tool.

The objective of this study was to determine whether PAR's are still in use for ANTAP diagnosis. The other objective was to determine whether PAR's stood-alone or were they a redundant step delaying the definitive imaging test. When CT scans were added to PAR's the sensitivity and specificity of the two modalities were compared.

Methods: A report of a retrospective study conducted at an 800-bed hospital ED between 01.06.2014 and 30.06.2014. All patients aged 15 and above who presented with ANTAP and referred first for PAR's were included. Traumatic, obstetric, gynaecologic cases were excluded. The discharge diagnosis was considered the gold standard.

Main findings: The study included 756 patients. 375 (49.6%) were males, 381 (50.4%) were females. The age range was 15 to 92 yrs. Mean age was 46 yrs. The most common presentation was an unclassified abdominal pain in 516 (68%). PAR's were requested alone for 594 (78.5%) and followed afterwards by Conventional CT in 103 (13.6%). Low dose CT was added for 33 (4.3%). The sensitivity of PAR's and CT for urinary stones was 32.8% and 91.3% respectively. The sensitivity of PAR's and CT for intestinal obstruction was 50% and 83.3% respectively.

Conclusion: PAR's are still in use as a one-stop shop for imaging the majority of patients presenting with ANTAP. In patients who had both CT and PAR's, there was a low PAR's sensitivity leading to poor congruence in diagnosing abnormal cases. However, CT delivered a higher radiation dose. There is a need to replace the conventional CT and PAR's for ANTAP imaging.

KEYWORDS: plain abdominal radiographs ▪ acute non-traumatic abdominal pain

Abbreviations: ANTAP: acute non-traumatic abdominal pain; CT: computed tomography; ED: emergency department; LDCT: low dose CT; MRI: magnetic resonance imaging; mSv: milli sievert; PAR's: plain abdominal radiographs; ultra-LDCT: ultra-low dose CT; US: ultrasound

Introduction

Emergency department (ED) physicians are facing the challenge of handling acute non-traumatic abdominal pain (ANTAP) on daily bases [1-3]. Plain abdominal radiographs (PAR's) were historically the only imaging test for abdominal emergencies [1]. Even after the discovery of CT and MRI, Field declared that PAR's are expected to maintain their superiority in demonstrating the bowel gas pattern for many subsequent years [4].

In the last century, most patients with ANTAP would undergo PAR's [2]. This rate has recently decreased to less than a quarter of imaged cases. CT and US followed a reverse rising utilization pattern [2]. According to Smith and Hall's literature review of PAR's use, 25% of the radiographs showed some abnormality but the majority of those findings were unrelated to the final diagnosis. Many workers have decided that PAR's have little value in the ED [5-7].

The introduction of CT scanning had a remarkable impact on diagnostic imaging. Abdominal CT scans usually require the administration of contrast media via the oral, rectal or intravenous route which is a cost burden. CT exposes the patient to a higher dose of ionizing radiation which can increase the risk of cancer development [8]. An Australian study, reported a higher cancer incidence in those exposed to CT [9]. The recently used low dose CT (LDCT) delivers much less mSv compared to conventional enhanced CT [10]. Non-contrast LDCT has gained an increasing popularity for imaging renal colic [10]. Haller et al compared the results of PAR's versus LDCT.

M Abd El Bagi[1]*, Badr Mutairi[1], Sami Alsolamy[2], Mohamed Alaizari[1] , Sumaya Alrashid[1], Ibrahim Alrashidi[1], Naila Shaheen[3] & Mercia Reutener[1]

[1]Diagnostic Imaging Department, King Abdulaziz Medical City, Riyadh, Kingdom of Saudi Arabia

[2]Emergency Medicine Department, King Abdulaziz Medical City, Riyadh, Kingdom of Saudi Arabia

[3]Department of Biostatistics and Bioinformatics, King Abdullah International Medical Research Centre, King Saud Bin Abdulaziz University for Health Sciences, Kingdom of Saudi Arabia

**Author for correspondence:*

drm_bagi@hotmail.com

He concluded that "Patients who underwent PAR's needed more imaging in 38% of cases, while those who had low dose CT needed additional extra imaging in 4% of cases" [11].

Fortunately, as the use of CT rapidly increases, there is a parallel effort to manufacture lower dose scanners and develop lower dose protocols [11]. The industry has recently produced ultra-LDCT but not without limitations [12,13]. Expectedly, these shortcomings will soon be overcome.

The guidelines for imaging of ANTAP are widely debated by many authors [14-18] and are regularly revised by the relevant authorities and groups [19,20]. However, the technologic advances may supersede such guidelines revisions. Excessive requisition of radiographs and scans is not uncommon in some Middle East countries where there are expatriate practitioners who may tend to have a protective tendency [21]. MRI has recently been used by some workers for imaging ANTAP particularly in pregnant women [22].

It is unknown whether PAR's are still used or have been abandoned since the recent application of the 4 hours ED clearance restriction. The objective of this study was to determine whether PAR's are still in use for ANTAP diagnosis presenting to the ED. The other objective was to find out when PAR's were used, did they stand-alone or were they a redundant step delaying the definitive imaging test. When CT scans were added to PAR's, the sensitivity and specificity of the two modalities were compared to see the congruence of PAR's with CT results, and whether there is a need to call for alternatives for either modality. Unlike other studies, this work focusses only on those sent initially for PAR's alone. Our results have answered the relevant questions raised.

Methods

■ Setting

The setting for this retrospective study was an (ED) with 115 beds receiving more than 150,000 annual visits in an 800-bed tertiary care centre. Institutional Review Board (IBR) approval was obtained. Using our institution database, all patients with the age of 15 or more who have attended the ED with ANTAP and referred first or only for PAR's during the period from 01.06.2014 to 30.06.2014 were included. The month was chosen to avoid the fasting periods and the feast season which may affect the clinical presentation pattern and frequencies of abdominal pain.

■ Inclusion criteria

All patients complaining of ANTAP of any abdominal quadrant or internal organ as filtered by the triage process were included if referred for ANTAP alone at first. Those who had subsequent imaging afterwards were included.

■ Exclusion criteria

Traumatic, gynaecologic, obstetric and paediatric cases were excluded. Patients who had hospital admission, surgery or any imaging in the previous two weeks were excluded to maintain the originality of the presentations. Patients who had simultaneous requests for other scans were also excluded.

■ Study design

Only the written reports, and the discharge notes, were reviewed. There was no attempt to re-assess the images retrospectively. The triage notes and the discharge summaries were reviewed by the ED team members (SS and AZ) while the radiology reports were reviewed by the radiologists (MA, BM, SA and IA).

■ Outcome measures

The outcome measure for this study was to find the indications for PAR's and how frequently they were alone sufficient or otherwise. PAR's and CT sensitivity in this series were compared to the literature using the commonly presenting conditions namely intestinal obstruction and urinary calculi. Results included patient demographics, summarized proportions, percentages, age mean and standard deviation. The final discharge diagnosis from the ward or ED was taken as the gold standard. Results were tabulated using counts with the corresponding 95% CI. We assessed the predictive power of PAR's and CT by the sensitivity and specificity and their congruence of agreements by Kappa statistics at 95% CI.

Results

15140 patients visited our ED department during June 2014 with a variety of presentations. PAR's were the first requested imaging test for 756 (4.9%) of them due to ANTAP. 375 (49.6%) of those 756 patients were males, and

381 (50.4%) were females. The age range was 15 to 92 yrs. Mean age was 46 yrs. The most frequent age group encountered was 20-39 years in 277 (36.6%), and the rarest was the 15-19 groups of 44 (5.8%) (TABLE 1). The most encountered indication for PAR's was a non-specific abdominal pain in 516 (68%) (TABLE 2). The second frequent presentation was the organ-specific pain in 77 (10.1%). Abdominal distension was the third request for 69 (9.1%). There was no request for biliary colic, appendicitis, pancreatitis, inflammatory bowel disease, abscess, gynaecologic conditions or peptic ulcers. The rarest order was for bowel ischemia, gastrointestinal haemorrhage and constipation in one (0.1%) for each. The non-specific abdominal pain topped the list in the youngest age group of 15-19 occurring in 42 out of 44 (95.5%) while abdominal distension was mostly seen in 10 (40%) out of the 25 over 80 patients. Haematuria affected 8 (2.9%) of the 277 patients aged 20-39. Abdominal pain was the commoner presentation in 335 (93.2%) of females compared to 324 (86.4%) in males. PAR's were the only imaging test for the vast majority of cases 594 (78.57%). In 103 (13.6%) conventional contrasted CT was requested. In 33 (4.3%) LDCT was added. None had U-LDCT as it was not available. US was used in 52 (6.8%) and MRI for only one patient (0.1%). TABLE 3 demonstrates the average of 1.25 scans added per patient. The sensitivity and specificity of PARS and CT are reported in (TABLES 4 and 5) with the discharge diagnosis as the gold standard. When both PARS and CT were used, there was a congruence of only 35.5% for diseased cases (Kappa SE 0.044) (5% confidence interval -0.152-0.239).

The final diagnosis was considered the gold standard and taken from the ED or the in-patient discharge summary. Renal stones were commoner in males than females, while UTI inflammatory bowel disease and cholelithiasis were commoners in women (TABLE 6). Urolithiasis was commoner in the 50-59 and the 20-39 age groups but not detected in the young 15-19 group. There was no case of diverticulitis or foreign body in this series. Intestinal obstruction and severe constipation were both

Table 1. Patients age groups prevalence n=756.

Age group	Prevalence of age groups
15-19	44 (5.8%)
20-39	277 (36.6%)
40-59	216 (28.6%)
60-79	194 (25.7%)
80-100	25 (3.3%)

Table 2. Indications for plain abdominal radiographs (PARS) request n=756.

Non-Specific Abdominal pain	516 (68.2%)
Organ specific abdominal pain	77 (10.1%)
Abdominal distension	69 (9.1%)
Vomiting	29 (3.8%)
Urinary tract symptoms	23 (3.0%)
Intestinal obstruction	22 (2.9%)
Perforation	4 (0.5%)
Mass	2 (2.6%)
FB	2 (2.6%)
Constipation	1 (0.1%)
Ischaemia	1 (0.1%)
GI bleed	1 (0.1%)
Incomplete records	9 (1.2%)

Table 3. Number of performed radiologic tests for those who had PAR's n=756.

Number of performed tests		Number of patients
PAR's alone	1 test	594 (78.57%)
PAR's plus one tests	2 tests	140 (18.51%)
PAR's plus 2 tests	3 tests	17 (2.35%)
PAR's plus 3 tests	4 tests	2 (0.53%)
Incomplete records	-------	3 (0.39%)

Table 4. Comparison of our PAR's Sensitivity and Specificity for intestinal obstruction and urinary stones.

Diagnosis	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
Intestinal obstruction	50	99.06	41.6	99.33
Urinary stones	32.8	99.56	88	93.84

Table 5. Sensitivity and specificity of CT for intestinal obstruction and urinary stones.

	Sensitivity(95%CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
Intestinal obstruction	83.33	96.91	62.50	98.95
Renal stones	91.3	97.50	91.30	97.50

Table 6. Comparison of the commonest final diagnosis across gender n=756.

Diagnosis	Females n=381	Males n=375
Renal stones	25 (6.6%)	42 (11.2%)
Cholelithiasis	21 (5.5%)	9 (2.4%)
Intestinal obstruction	3 (0.8%)	7 (1.9%)
Inflammatory bowel disease	8 (2.1%)	3 (0.85)
Appendicitis	2 (0.5%0	9 (2.4%)
UTI	75 (19.7%)	43 (11.5%)
Pancreatitis	2 (0.5%)	5 (1.3%)

Table 7. Common final diagnosis distribution across age categories n=756.

Diagnosis	15-19 years	20-39 years	40-59 years	60-79 years	80-100 years
Renal stones	--	30 (10.9%)	25 (11.6%)	11 (5.7%)	1 (4%)
Appendicitis	1 (2.3%)	6 (2.2%)	3 (1.4%)	1 (0.5%)	--
Pancreatitis	--	1 (0.4%)	2 (0.9%)	5 (2.6%)	--
Intestinal Obstruction	--	2 (0.7%)	1 (0.5%)	6 (3.1%)	1 (4%)
Cholelithiasis	--	6 (2.2%)	11 (5.1%)	12 (6.2%)	1 (4%)
UTI	7 (15.9%)	47 (17%)	28 (13%)	35 (18%)	1 (4%)
Gastroenteritis	8 (18.2%)	24 (8.7%)	18 (8.3%)	8 (4.1%)	--

commoners in the 60-79 age group while gastroenteritis was commoner in the young age group of 15-19.UTI was least frequent in the 80-100 years group (TABLE 7).

The most frequent finding on CT was renal stones in 23 (22.33%) of the 103 patients scanned. Appendicitis was detected in 5 (4.85) Intestinal obstruction in 8 (7.77%) and pancreatitis

3 (2.91%) of those who had CT. None of the severely constipated patients underwent a CT scan. CT was normal in 10 (9.71%) of the 103 referred for scanning after PAR's.

Discussion

The results of this study show that PAR's were surprisingly commonly used alone for the majority of cases. This finding contradicts the previous beliefs that the expatriate staffs in this affluent country are overusing other imaging modalities as a self-protective attitude [22].

PAR's alone, were requested for the majority of cases 594 (78.57%) unlike the previous report of 21% [2]. In that paper, CT or US were used for 42% of cases compared to 24.7% in this series. This finding was not explained in this study and possibly due to strict compliance with departmental policies. Another possibility is the increased demand for CT at this tertiary trauma referral centre, and the staff tendency to reserve CT for the needier and polytrauma patients.

The non-specific abdominal pain was the most frequent clinical presentation similar to a previous report of 22 different studies involving 3340 patients [19]. However, the second commonest in this series were renal problems in 185 (24.4%) whereas it was appendicitis in other series of 3340 patients [19]. This difference indicates a geographic variation of disease patterns as suggested previously [8]. Gastroenteritis was prominent in this study 58 (8%), affecting 8 (18.2%) of the youngest age group of (15-19 years). This is perhaps due to the current trend in young people to consume fast food from food trucks. The sensitivity and specificity of PAR's for intestinal obstruction was 50% and 99.6% (TABLE 4). This result matched with a published literature of 49 % and 98%, respectively [18]. The 32.8% sensitivity and 99.65% specificity of PAR's for urinary stones were higher than previous reports of 9% and 99% respectively. The 91.35%sensitivity and 97.5% specificity of CT for renal calculi were higher in this series compared to earlier reports of 68% sensitivity and 91% specificity [18]. The higher prevalence and higher sensitivity of urolithiasis in this series are due to the dry climate effect of dehydration and the stone's chemistry. CT sensitivity of 83.3% for intestinal obstruction was higher than the previous report of 75%, but the 96.91% specificity was lower than the 99% specificity of the previous report (TABLE 5). PAR's low sensitivity for intestinal obstruction of 50% in this series matched

previous reports 0f 49% [18]. Specificity of PAR's and CT for intestinal obstruction was high at 99 and 98%, respectively [18].

Surprisingly US were, however, less utilized than CT in this series. The recent ED 4 h clearance target restriction has limited the time for US referral to the radiology department which is at a distance from ED while PAR's are available within the ED. MRI was only used once despite recent reports of usefulness [22].

PAR's have the advantage of delivering less than one-fifth of the standard contrasted CT dose which has favoured its use as a first line test. It was however of much lower sensitivity compared to CT in this series and by other researchers in (TABLES 4 and 5) [18]. When both PAR's and conventional CT were used, there was an unsatisfactory congruence of PAR's with CT in 35.7% for the significantly abnormal cases. This observation should favour the use of CT as the first test albeit higher radiation dose. There was however little utilization of LDCT in 33 (4.3%) of cases. The radiation dose of LDCT stone protocol for 40 consecutive patients in 4 different CT scanners was reviewed. The average dose was 4.898- 5.257 mSv, less than half the conventional CT dose but still higher than the dose deliverable by PAR's.

■ Study limitations

The limitation of this study is the retrospective nature. The severity of pain was not scored. Patients were not followed up beyond the discharge time. The age groups were not stratified for disease prevalence. The appropriateness of those who underwent PAR's was not reviewed. LDCT sensitivity was not assessed separately from conventional CT. Numbers of either scan were small for accurate judgment. Patients who presented with ANTAP and sent directly to US or CT initially were not included even if they subsequently underwent PAR's. This exclusion could explain the rarity of known common conditions like appendicitis in this report which would have been directly sent for either a CT or US scan.

Conclusion

The results of this study indicate that PAR's are still a one-stop shop imaging test when requested by the ED for ANTAP despite the availability of CT, US and MRI. The 4 h target at the ED limits the number of imaging tests that can be performed. PAR's accuracy finding in this series matched other workers except for higher sensitivity for urolithiasis. In patients who had both CT and PAR's, there was an unsatisfactory congruence of findings due to the lower sensitivity of PAR's. There is a need to replace the insensitive PAR's and avoid the higher radiation dose of conventional CT by alternative tests.

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