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ROLE OF TRADITIONAL ABDOMINAL RADIOGRAPHY IN PATIENTS WITH NONTRAUMATIC ACUTE ABDOMINAL PAIN IN THE ERA OF COMPUTED TOMOGRAPHY

Radiodiagnosis

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ABSTRACT

Aim: To assess comparative role of traditional abdominal radiography and computed tomography in patients with non-traumatic acute abdominal pain.

Background: Acute abdomen is a clinical entity which is characterized by acute abdominal pain of sudden onset. Patients with an acute abdomen constitute the largest group of patients presenting to the emergency department. It is crucial to identify the patients requiring surgery for the timely management. Plain radiographs are still an important initial investigation in the evaluation of patients with acute abdomen. The introduction of multidetector CT (MDCT) has impacted imaging of all organs of the body, especially the abdomen.

Materials and Methods: After informed consent of patients, 167 patients are included in the study. These patients underwent an erect abdominal radiography and a MDCT CT examination. Final diagnosis was established with surgical, biochemical and clinical follow up.

Result: Among the 167 patients examined, CT yielded an overall sensitivity, specificity, and accuracy of 93.0%, 92.1%, and 93.6%, respectively. The abdominal radiography interpretations yielded an overall sensitivity, specificity, and accuracy of 34.0%, 83.8%, and 52.0%, respectively. The accuracy of CT was significantly greater than the accuracy of plain abdominal radiography.

Conclusion: Abdominal radiography is an insensitive technique in the evaluation of patients with nontraumatic acute abdominal pain but can be used in initial evaluation in patients with suspected renal calculus, obstruction and perforation. CT is a more sensitive and accurate technique in the evaluation of patients with nontraumatic acute abdominal pain and provides more information than abdominal radiography. Guidelines and protocols should be established to minimise the indiscriminate use of low diagnostic yield modalities like abdominal radiography and conserve time and cost by using the better modalities as this can have impact on management and outcome.

KEYWORDS

Acute abdomen, Computed tomography, X-Ray

Introduction:

Abdominal pain is one of the most frequent complaints of adults presenting to the emergency department. [1] As this complaint is non-specific, etiologies may range from trivial conditions, which do not require any medical intervention to life-threatening pathologies that necessitate urgent intervention. [2] It is often difficult to reach a diagnosis based on physical examination alone and imaging plays an important role in the decision-making regarding management planning and in providing a definitive diagnosis.

Early diagnosis is invaluable in these patients and may have an impact on management and outcome. Therefore, choice of imaging modality is of utmost importance. Plain abdominal radiograph is an inexpensive and rapid imaging modality compared to the some other imaging modalities, such as barium investigations, computed tomography (CT), ultrasound and magnetic resonance imaging (MRI). [3]

Despite numerous studies documenting its low sensitivity, plain abdominal imaging is still frequently ordered in the emergency department. [4] The purpose of this study is to describe the outcomes of the use of plain abdominal radiographs and compare it with computed tomography in the diagnosis of patients presenting with acute nontraumatic abdominal pain to the emergency department.

Materials and Methods

This is a prospective observational study in which the patients presenting in our institution with acute abdominal pain during a 6-month period are reviewed. Excluded are the patients with history of trauma, pregnant woman and patients who did not have results for plain radiography.

Institutional ethical committee approval was obtained for the study.

Study protocol

The initial radiograph taken was reviewed by the consultant. The interpretation was categorized as follows: (i) 'Normal'– when no pathological findings were found, (ii) 'Abnormal –when bowel obstruction (small or large) or free intraperitoneal air or a definite pathology was suspected, and (iii) 'Non-specific' – when intermediate findings were there requiring further evaluation. [5]

The results of CT examination were compared with the findings of the plain abdominal radiographs. All abdominal radiographic images and CT examinations were reviewed by trained consultants with more than 5 years experience.

Medical records of the patient were further evaluated for comparing the results of additional imaging studies and for final diagnosis, clinical management and outcome.

Methods

All patients presenting to our institution with history of non-traumatic abdominal pain of more than two hours' and less than five days' duration were included in the study. [6] Patients were identified at the emergency department and were referred by the general practitioner or surgeon. After taking consent, patients underwent abdominal radiography and CT examination.

Radiography included Upright/Supine view. Radiographs were obtained on 800 mAs X-Ray machine by using standard imaging techniques. In the abdomen, tube voltage was 65-110 kVp, and tube current was 30-50 mAs based on the built of the patient.

For CT examination, IV/Oral/Rectal contrast, if required and indicated, was given to the patient after atleast 4 hours of fasting. For Intravenous contrast, injection of 125-150 ml contrast after a 60-second delay with 3 ml/s was given. For oral contrast, we preferred to give 850–1000 ml of a 2% solution of oral diluted water-soluble contrast material at least 1 hr before scanning. Rectal contrast material was given with the patient in the left decubitus position; 400–600 ml of a 3% solution of water-soluble contrast material was administered by gravity through a soft rubber rectal catheter without using a balloon. Scan was performed in supine position on 16-Slice whole body computed tomography scanner. Scans were obtained from the diaphragm to beneath the symphysis pubis using a collimation of 3–7 mm and a pitch of 0.75-1.0. Images will be obtained with tube voltage 120 kVp and tube current 50 mAs. The axial sections were obtained and coronal and sagittal reformatting was done as and when required.

Data analysis

All scans performed were reported by a resident/consultant radiologist. Scans, if initially reported by the resident, were reviewed

by consultant radiologist. Abdominal radiograph interpretation, CT diagnosis (as reported by the consultant radiologist with the support of the clinical information provided by the clinician on the request form) and the final diagnosis (as stated on the discharge summary or confirmed on surgical/pathological/clinical follow-up) were compared. Final/Discharge diagnosis was based on clinical exam ination, laboratory data, surgical follow-up and results of all imaging studies, including CT, patient management and outcome. The diagnosis suggested on CT/Radiography was compared with the final diagnosis and assessed as: (i) correct, when the diagnosis suggested on imaging matched the final diagnosis; (ii) non-specific, when the diagnosis suggested on imaging listed the final diagnosis within the differential diagnosis; and (iii) incorrect, when the diagnosis suggested on imaging did not match the final diagnosis and was not mentioned within the differential diagnosis. [7]

Statistics

A positive result was considered if findings in any abdominal radiograph or CT examination were suggestive of acute pathology. If the imaging findings correlated with the diagnosis that was confirmed with surgical, gross pathologic, and/or clinical follow-up, the imaging diagnosis was considered true-positive (TF). Likewise, identification of findings believed to be clinically important that could not be corroborated with other imaging studies or with clinical or surgical follow-up was considered a false-positive (FP). True-negative (TN) result was considered if the abdominal radiography or CT findings were not suggestive of an acute process and nonspecific abdominal pain was diagnosed in the patient. Finally, findings were considered false-negative (FN) when abdominal radiography or CT findings did not indicate the acute process that was ultimately found in the patient. [8]

Here, the null hypothesis is that there is no difference in sensitivity, specificity &accuracy between abdominal radiography and CT abdomen. Sensitivity, specificity, positive predictive value, negative predictive value and accuracy were calculated using the following formulas:

Accuracy: The accuracy of a test is its ability to differentiate the diseased cases and healthy cases correctly. To estimate the accuracy of a test, we need to calculate the proportion of true positive and true negative in all evaluated cases. Mathematically, this can be stated as:

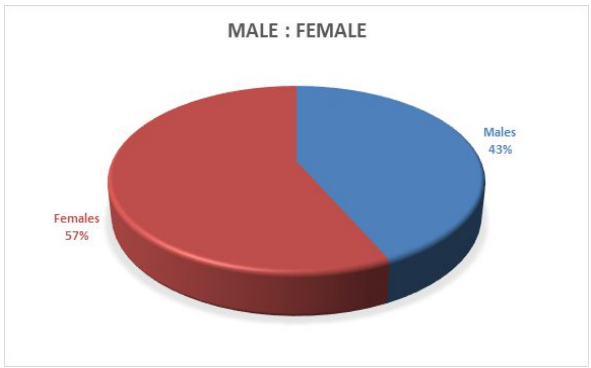
Accuracy=TP+TN / TP+TN+FP+FN

Sensitivity: The sensitivity of a test is its ability to determine the patient cases correctly. To estimate it, we should calculate the proportion of true positive in patient cases. Mathematically, this can be stated as:

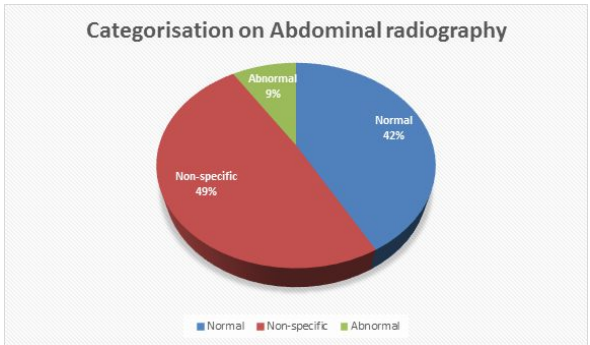
Sensitivity=TP / TP+FN

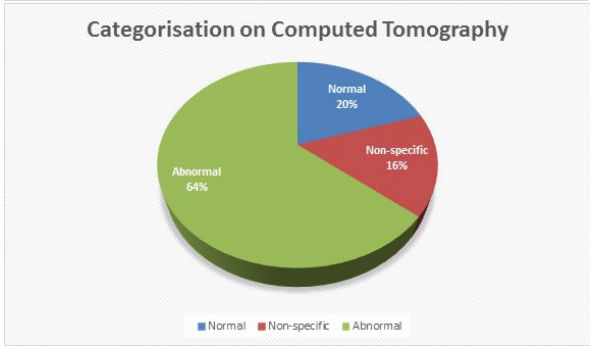
Specificity: The specificity of a test is its ability to determine the healthy cases correctly. To estimate it, we should calculate the proportion of true negative in healthy cases. Mathematically, this can be stated as:

Specificity=TN / TN+FP [9]

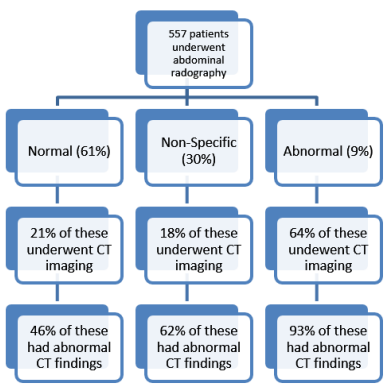


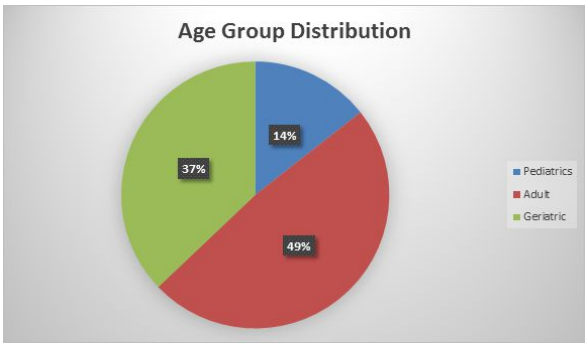
Based on the CT findings, patients were categorised as: (a) Normal – When imaging suggested no abnormality; (b) Non-specific: When imaging showed some positive findings but not pointing to a specific diagnosis and several differentials were given and further investigation advised; (c) Abnormal – When imaging suggested a specific diagnosis. [10]

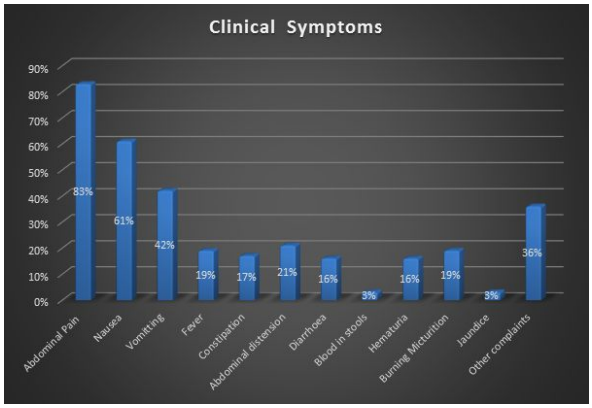




Final diagnosis	Correctly diagnosed on CT	False negative on CT	Correctly diagnosed on X-Ray	False negative on X-Ray
Acute Appendicitis (18)	17	1	0	18
Acute Pancreatitis (24)	21	2	0	24
Cholecystitis (8)	6	1	0	8
Cholelithiasis (13)	12	1	3	10
Inflammatory Bowel Disease (9)	7	0	0	9
Renal Calculi (43)	42	1	24	19
Pyelonephritis (2)	1	1	0	2
Colitis (4)	3	1	0	4
Intussusception (6)	6	0	1	5
Perforation (6)	6	0	5	1
Intestinal Obstruction (17)	15	1	9	8
Epiploic appendagitis (2)	2	0	0	2
Ileus (3)	2	1	1	2
Total Cases	140	10	25	79







Dose Consideration

Standard imaging protocols were used. CT images were obtained using tube voltage of 110 kVp and tube current of 50 mAs. The following CT scanner outputs were recorded: volume CT dose index (CTDIvol), an index of dose for a fixed volume for a specific acquisition protocol as measured in and calculated in a standard size polymetylmethacrylate phantom; and the dose-length product (DLP), where DLP = CTDIvol × (length of scanned anatomic region).These data are routinely stored on the PACS. These variables were compared in both studies.Effective dose was calculated by multiplying the DLP by the conversion coefficient, k,which depends on the anatomic region examined; for chest, abdomen, and pelvis, $k = 0.015$ mSv/(mGy · cm). This calculation is not affected by the patient sex or age. [11]

Standard: CTDIvol (mGy): 17.6 mGy;DLP (mGy/cm): 843 mGy; **Effective Dose (mSv):** 12.64mSv
The standard X-Ray dose was taken as 0.7 mSv

Results

A total of 167 patients were included in our study in a period of 8 months from 1st August, 2016 to 31stMarch, 2017. Maximum cases were in the adult age group (49%, n=81), followed by geriatric age group (37%, n=62) and least in the paediatric age group (14%, n=24). Females constituted 57% (n=95) of total cases while males constituted 43% (n=72). The most common symptom of presentation was Abdominal pain (83%), followed by nausea (61%) and vomitting (42%).Other abdominal symptoms were fever, constipation, abdominal distension, burning micturition, diarrhea, blood in stools, hematuria, jaundice etc.

The radiation dose for abdominal radiograph is approximately 0.7-1 mSv compared to 10 mSv in CT.

In 557 patients, abdominal radiography was performed and interpretation was normal in 42%, non-specific in 49%and abnormal in 9%.

34% of the normal patients underwent further imaging. In those, abdominal CT needed to be performed in 21%.In this group of patients with normal abdominal plain film, abnormal CT imagingresults were found in 46%. Abnormal results on the CT imaging were alsofound in 62% and 93% in patients whom abdominal plain film read as nonspecificand abnormal, respectively.

MDCT CT yielded an overall sensitivity, specificity, and accuracy of 93.3%, 90.9%, and 92.5%, respectively. The abdominal radiography interpretations yielded an overall sensitivity, specificity, and accuracy of 24.0%, 74.6%, and 46.10%, respectively. The accuracy of CT was significantly greater than the accuracy of plain abdominal radiography.

ABDOMINAL RADIOGRAPHY RESULTS FOR PATIENTS WHO UNDERWENT FURTHER COMPUTED TOMOGRAPHY IMAGING	
PLAIN FILM RESULTS	ABNORMALCOMPUTED TOMOGRAPHY IMAGING RESULTS
Normal (61%)	46%
Non-specific (30%)	62%
Abnormal (9%)	93%

Discussion

Abdominal radiography is conventionally the first investigation requested inthe emergency department in patients with acute abdominal pain, despite its limitations.

Normal or non-specific results are usually found (91% in our study). This may be explained by the fact further imaging (CT) can detect abnormalities which had not been seen in plain films (42% of abdominal plain films read as normal and 49% ofabdominal plain films read as non-specific or not relevant).

Any abnormality detected on abdominal radiography was also detected on CT imaging in all the cases. In addition, CT was able to detect abnormality in 46% of the patients with normal abdominal radiography indicating low sensitivity of the abdominal radiography. CT has to performed in a large proportion of patients who were normal on abdominal radiography which indicate low level of certainty of the clinician on the diagnosis of plain abdominal radiography. Abdominal radiography was non-specific in 30% of the patients, 62% of whom on computed tomography imaging were labelled as abnormal. This unnecessarily delayed the management in many of the patients.

An abnormal result neither predict the outcome nor influence the management of the patient (49% patients with abnormal results were discharged), does not avoid further imaging and may delay the start of treatment.

Although the radiation dose of X-Ray is approximately 7% of the CT dose, X-Ray does not provide any information for most of the pathologies neither it prevents further imaging, thereby exposes the patients to unnecessary radiation. While in few patients it provides accurate diagnosis and in few others its normal results preclude supplementary imaging.

Conclusion

We conclude that abdominal radiography is an insensitive technique in the evaluation of nontraumatic acute abdominal pain but can be used as an initial evaluation in patients with suspected renal calculus, obstruction and perforation. Even a normal abdominal radiography result, does not exclude pathology in several of the patients and patients need to go for further imaging. Computed Tomography is a more sensitive, specific and accurate technique in evaluation of patients with these conditions although it exposed the patient to 10 times more radiation than the X-Ray. The role of X-Ray is limited in conditions other than renal calculus, intestinal obstruction and perforation and CT should be the primary modality of choice.

Although the radiation exposure of CT is significantly higher than abdominal radiography in patients with non-traumatic acute abdomen, X-Ray does not provide any additional information neither a normal result excludes the pathology. So, the use of X-Ray should be avoided to prevent unnecessary radiation exposure to the patient presenting with acute abdomen.

With wide availability, CT has the potential to become the first line investigation in patients with acute abdomen. This could prevent the delay in management; avoid unnecessary radiation to the patient, overall healthcare cost and duration of hospital stay. Further work shall be done on these aspects to formulate guidelines for first line investigation in patients with acute abdomen.

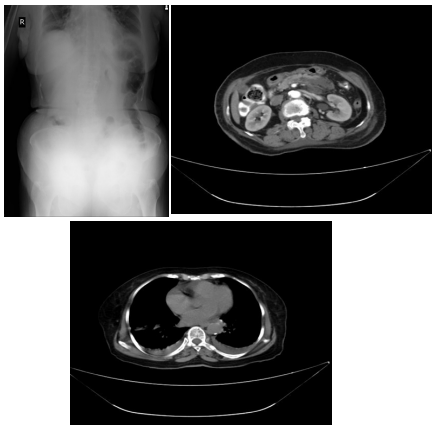


Fig 1 (A,B,C) Pancreatitis with bilateral pleural effusion (23Y/F)
Patient presented with pain abdomen and vomiting of 2 days duration. X-ray shows no obvious abnormality and was reported as normal.

There is e/o peripancreatic fluid collection and fat stranding s/o pancreatitis.

Also, Bilateral pleural effusion can be seen.

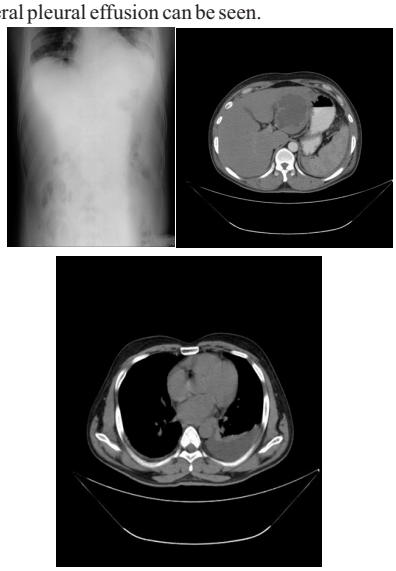


Fig 2 (A, B, C):
Normal X-Ray of 42 year old male patient who presented with fever and pain in right hypochondrium.

Axial CT image shows liver abcess showing irregular margins. The wall of the abcess demonstrated enhancement on the CECT.

Fluid collection is noted in left pleural cavity.

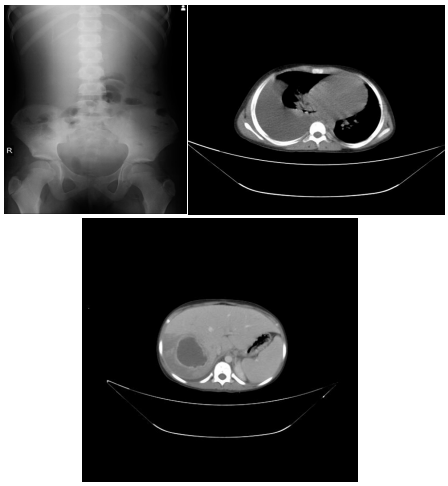


Fig 3 (A, B, C):
Normal X-Ray of 19Y/F who presented with complaint of fever, vomiting and abdominal pain.

There is ill defined hypodense lesion in segment 4 and 5 of liver. On post contrast study there is peripheral shaggy enhancement. These features are consistent with liver abcess.

Pleural effusion is noted on right side.

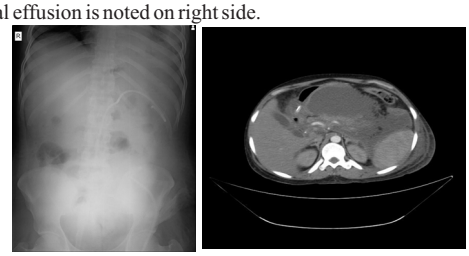


Fig 4 (A, B):
Normal X-Ray of 26Y/M who presented with complaint of fever and severe abdominal pain of 8 hours onset. Colon cut off sign which is typical of pancreatitis cannot be appreciated here.

CECT image at the level of pancreas showing heterogenous enhancement of pancreas with peripancreatic fluid and large loculated fluid collection. These findings are consistent with acute pancreatitis with pseudopancreatic cyst.

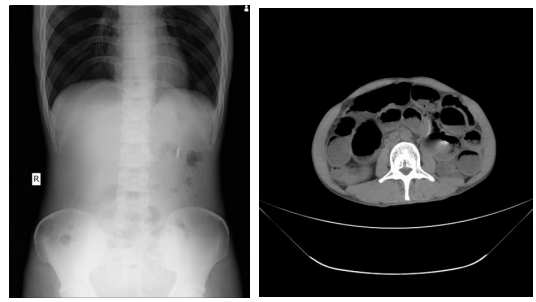


Fig 4 (A, B):
Normal X-Ray of 28Y/M who presented with complaint of constipation and abdominal 2 days duration. Multiple air fluid levels which can not be appreciated in this X-Ray.

CT image shows dilated small bowel with air and faeces giving “air faeces sign”. These findings are consistent with small bowel obstruction.

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