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Proposed Diagnostic Pathway in Various Conditions / Diseases Leading to Urgent Cases of Acute Abdomen

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Abstract: ***Background: The sensitivity of medical history, physical examination, and laboratory values are higher for differentiating urgent acute abdomen from non-urgent cause. Radiological tests like x-ray, ultrasonography (USG), and CT scans are needed in cases of diagnostic uncertainty. However, it increases the overall cost and waiting time. The present study was performed to study the diagnostic accuracy of clinical evaluation and imaging to detect urgent acute abdomen so that a diagnostic pathway may be formulated for resource deficient countries. Methodology: 60 patients, who presented with acute abdomen, were categorised as urgent and non urgent surgical condition and underwent laparotomy. A detailed history of all the patients was taken along with thorough clinical examination and laboratory investigation findings; thereafter various radiological imaging modalities were used in a prescribed way. Diagnosis after clinical evaluation and various imaging modalities was made separately and compared to the final diagnosis. Results: The overall diagnostic accuracy of clinical evaluation alone was 58.33%. But the diagnostic accuracy in cases of obstructed hernia, adhesive acute intestinal obstruction, appendicular perforation, post D&C perforation, and enteric perforation with a history of fever was 100%. In patients where the decision to undergo emergency laparotomy was clear after clinical evaluation/USG, a CT scan was not done. Hence, the overall diagnostic accuracy after conditional imaging was 71.67% only. However, the 7 cases in which CT scan was done, had an accuracy of 100%. Conclusion: Patients of obstructed hernia, post operative adhesive obstruction, appendicular perforation, gastric and duodenal perforation, post D&C perforation, and enteric perforation with a history of fever and sigmoid volvulus can be taken up for emergency laparotomy after clinical evaluation with or without X-Ray/ USG. However, in patients of carcinoma colon, carcinoma pancreas, Koch's abdomen, enteric fever without history of fever, sealed perforation, diverticular and Meckel's perforation, mesenteric ischemia cause SMA thrombosis and acute pancreatitis, CT scan/ MRI for pre-operative diagnosis is advisable, provided the patient is stable.***

Keywords: Acute abdominal pain, Diagnostic accuracy, USG, CT scan, X-ray, Laparotomy

1. Introduction

Acute abdominal pain, also known as acute abdomen, is defined as abdominal pain of non-traumatic origin with a duration of more than 2 hours up to 5 days (which has a maximum score when being described through the VAS – visual analogue score scoring system) and may require immediate treatment.[1] Approximately 5-10% of emergency department (ED) visitations are due to acute abdominal pain.[2] As per the CDC reports, 11% of patients that presented in the ED in 2008 were of abdominal pain and comprised of 12.5% of the urgent patients.[3]

Acute abdomen can be classified into urgent and non-urgent causes and the classification used in this study was the one proposed by Lameris et al.[2] He classified non-urgent conditions as those that did not require treatment within 24 hours to prevent complications and urgent conditions as those that required treatment within 24 hours.

The acute abdomen diagnosis pattern varies widely per individual physician's preferences. Various studies have reported the decreased accuracy of clinical evaluation to detect the correct specific diagnosis. The sensitivity of medical history, physical examination, and laboratory values is higher for differentiating urgent from non-urgent conditions than for a specific diagnosis. Therefore, radiological imaging tests like X-ray, ultrasonography (USG), and CT scans are done.[4]

Prior to a few decades ago, when imaging was less common and had a lower diagnostic accuracy, patients would go straight to the operating room. But this led to the high rate of negative laparotomies.[5] And this further led to the advent of radiology with various imaging modalities.

A study by Gans et al claimed that computed tomography, especially after negative ultrasonography, yields a better workup than plain radiography alone.[6] USG is a traditional imaging modality for acute abdomen as it is inexpensive, portable, readily accessible, does not use any harmful ionizing radiation as well as produces high diagnostic accuracy. However, USG is a subjective study with a high range of inter- examiner variability. Hence, came the concept of conditional imaging where we use additional imaging modalities (especially CT scan) when the previous ones are inconclusive.[7]

However, there are drawbacks to the increased use of imaging modalities. Imaging can result in higher costs, a longer patient wait time at the ER, and a higher chance of unfavourable side effects such as ionising radiation exposure and contrast-induced nephropathy. Till today, the effect of the increased use of imaging on cost effectiveness of management of patients with acute abdominal pain remains unknown.[8]

Hence this study was performed to study the diagnostic accuracy of clinical evaluation and conditional imaging to detect urgent conditions in acute abdominal pain and hence, to propose a diagnostic pathway for the same.

Aim
The aim was to propose a diagnostic pathway in various conditions causing urgent cases of acute abdomen.

Primary objectives
The primary objective was to propose a diagnostic pathway in various conditions/diseases causing urgent cases of acute abdomen before undergoing surgical management.

Secondary Objectives
The secondary objectives were to study the diagnostic accuracy of clinical evaluation alone to detect urgent conditions in acute abdominal pain; to compare the diagnostic accuracy of clinical evaluation and conditional imaging and to evaluate the perioperative morbidity and mortality rates in acute abdomen requiring surgical management.

2. Methods

This study was a prospective study conducted in the Department of General Surgery in King George's Medical University, Lucknow, Uttar Pradesh, India for a duration of approximately two years.

Inclusion criteria
Patients giving written informed consent; patients with nontraumatic acute abdominal pain of duration more than 2 hours and less than five days presenting in the emergency department and clinically diagnosed as urgent condition; and patients aged 18-70 years were included in the study.

Exclusion criteria
Patients with non-urgent conditions of acute abdominal pain; paediatric patients within the age group (12 years and below); traumatic cases (blunt and penetrating); patients who are discharged from the emergency department with no imaging considered by the necessary team; pregnant and haemorrhagic shock patients; and patients not giving consent were excluded.

Sample size estimation
The sample size (n) was calculated using the formula,

$$n = \frac{Z^2 P\,(1-P)}{d^2}$$

assuming 0.05 level significance (Zα/2=1.96), =59.

Considering any dropouts, we enrolled 60 acute abdominal pain patients with urgent conditions,

This study was approved by Institutional Ethics Committee Written and informed consent was taken by all the patients.

Methodology
A detailed history of all the patients presenting to the Emergency Department of General Surgery Department, King George's Medical University, Lucknow with complaints of acute abdominal pain was taken followed by thorough clinical examination and routine laboratory investigations. After this we differentiated the non-urgent and urgent conditions based on clinical evaluation alone and the patients with non-urgent conditions were prescribed necessary medication, sent home, and called for review after 24 hours. The patients with the urgent condition were enrolled in the study (60 patients) and further workup was done.

Based on clinical evaluation and laboratory blood investigations like CRP, WBC, etc. a provisional diagnosis was made which was the clinical diagnosis.

Thereafter various imaging modalities were used in a prescribed way, including conventional radiography like plain radiography abdomen erect AP view first followed by USG. X-Ray and USG were done on all the patients. In cases of inconclusive USG findings and where the specific diagnosis could not be specified, CT/MRI was done. In patients where the decision to undergo emergency laparotomy was clear after clinical evaluation/USG, a CT scan was not done.

After conditional imaging, again a provisional diagnosis was made and was compared with the clinical diagnosis. Also, the results after every imaging modality were also compared.

Further management of acute abdomen was made as per established usual international/national/institutional/departmental protocols. Intraoperative findings were recorded and a final diagnosis was made after evaluating all records.

Clinical diagnosis and diagnosis after every imaging modality was compared with the final diagnosis and with each other and diagnostic accuracy was calculated.

Peri-operative morbidity in every patient was also recorded (as per Clavien Dindo Classification-for grading adverse events/complications as a result of surgical procedure) and the complications were managed.[9]

Based on the overall results, an elaborative analysis was done and a diagnostic pathway for various conditions/ diseases causing urgent cases of acute abdomen was proposed.

Urgent and non-urgent diagnosis
Diagnoses assigned by the surgical consultant based on clinical evaluation alone and clinical evaluation with conditional imaging were classified as urgent surgical conditions or as conditions not requiring urgent surgical intervention (urgent non-surgical conditions and non-urgent conditions). Urgent surgical conditions were defined as abdominal conditions requiring surgical intervention within the next 24 hours. The patients requiring surgical management were evaluated for intra-operative findings. The imaging findings were correlated with the pre-operative findings and peri-operative outcomes were evaluated. A final diagnosis was assigned to every patient after evaluating all the records of the patient after discharge.

Statistical analysis
The statistical analysis was done using SPSS (Statistical Package for Social Sciences) Version 21.0 Statistical Analysis Software. The values were represented in number (%) and mean±SD. Sensitivity, specificity, negative

predictive value (NPV), and positive predictive value (PPV) were recorded.

3. Results

Table 1 depicts the demographic characteristics of the study participants in the study. The percentage of ≤20 years, 21-30 years, 31-40 years, 41-50 years, 51-60 years, and >60 years of age were 6.67%, 31.67%, 15.00%,15.00%, 16.67%, and 15.00%, respectively. The mean age was 41.10±16.60 years. The male: female ratio was 2.0. Co-morbidities were found in 51.67% of patients (Table 1).

The diagnostic accuracy of clinical vs. provisional diagnosis is shown in Table 2. Patients with an obstructed hernia, post operative adhesive obstruction, enteric perforation with history of fever, appendicular perforation, and post D & C perforation were diagnosed with 100% accuracy with clinical evaluation alone as shown in Table 2. The diagnostic accuracy of sigmoid volvulus was 100% after plain abdominal X-Ray. USG aided in the diagnosis of one additional case of Koch's abdomen and one of carcinoma pancreas where it was suggestive of the same and was further confirmed by CT scan. CECT whole abdomen was done in these 2 cases and additional 5 more cases (4 cases of carcinoma colon, 1 other case of Koch's abdomen and 1 case of carcinoma pancreas) only, where it was noted to be 100% diagnostic. So, the total cases accurately diagnosed after clinical evaluation + all the radiological imaging modalities were 43 out of 60 cases (71.67%).

The overall diagnosis showed perforation peritonitis as the highest with 55% of patients and 20% each for acute intestinal obstruction and Koch's abdomen (Figure 1). Figure 2 shows the overall diagnostic accuracy. The diagnostic accuracy (of making a definitive diagnosis) of clinical diagnosis was 58.33%, after including X-ray was 61.67%, after including USG was 65.00%, and after including CT/MRI was 71.67%. 60 patients who were enrolled in the study were clinically detected as urgent surgical conditions causing acute abdomen out of which 59 were diagnosed as urgent surgical conditions in the final diagnosis. So, the diagnostic accuracy of clinical evaluation alone to detect urgent surgical conditions is 98.33%.

Table 1: Demographic characteristics

Demographics	Number	Percentage
Gender		
Male	40	66.66
Female	20	33.33
Age group (in years)		
≤20	4	6.67
21-30	19	31.67
31-40	9	15.00
41-50	9	15.00
51-60	10	16.67
>60	9	15.00
Total	60	100
Mean ± SD	41.10±16.60	
Co-morbidity		
Present	31	51.67
Absent	29	48.33

Table 2: Diagnostic accuracy of clinical diagnosis and provisional diagnosis

Accuracy	n	Clinical diagnosis		Provisional diagnosis					
				After X-Ray		After USG		After CT/MRI	
		N	%	N	%	N	%	N	%
Obstructed hernia	5	5	100.00	5	100.00	5	100.00	-	-
Adhesive obstruction	1	1	100.00	1	100.00	1	100.00	-	-
Carcinoma colon	4	1	25.00	1	25.00	1	25.00	4	100.00
Sigmoid Volvulus	2	0	0.00	2	100.00	2	100.00	-	-
Koch's abdomen	12	7	58.33	7	58.33	8	66.67	2	100.00
Gastric perforation	12	11	91.67	11	91.67	11	91.67	-	-
Duodenal perforation	4	3	75.00	3	75.00	3	75.00	-	-
Enteric perforation with history of fever	4	4	100.00	4	100.00	4	100.00	-	-
Enteric perforation without history of fever	6	0	0.00	0	0.00	0	0.00	-	-
Carcinoma pancreas with biliary peritonitis	1	0	0.00	0	0.00	1	100.00	1	100.00
Sealed perforation	1	0	0.00	0	0.00	0	0.00	-	-
Appendicular perforation	1	1	100.00	1	100.00	1	100.00	-	-
Diverticular perforation	1	0	0.00	0	0.00	0	0.00	-	-
Meckel's perforation	1	0	0.00	0	0.00	0	0.00	-	-
Mesentric ischemia cause SMA thrombosis	1	0	0.00	0	0.00	0	0.00	-	-
Transverse colon perforation	1	0	0.00	0	0.00	0	0.00	-	-
Acute pancreatitis	1	0	0.00	0	0.00	0	0.00	-	-
Post D&C perforation	2	2	100.00	2	100.00	2	100.00	-	-
Total	60	35	58.33	37	61.67	39	65.00	43 (7)	71.67 (100.00)

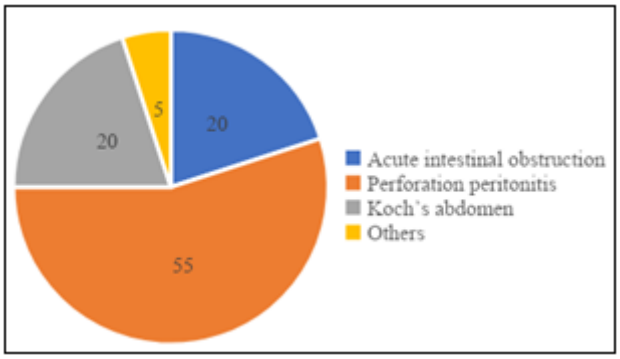


Figure 1: Overall final diagnosis

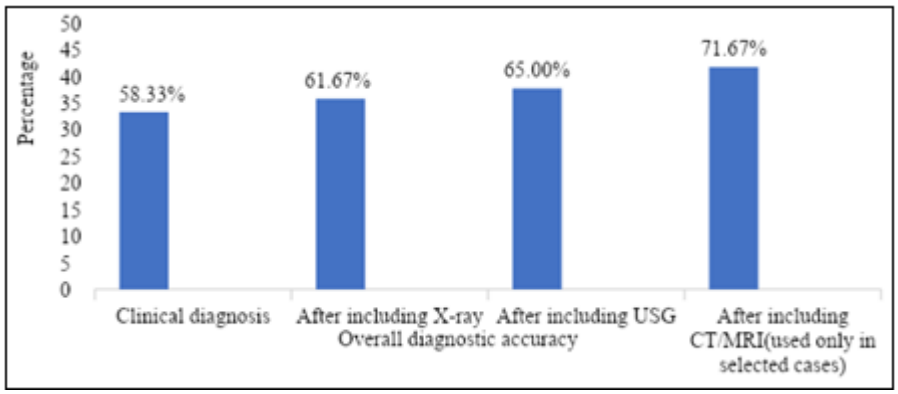


Figure 2: Overall diagnostic accuracy

Table 3: Sensitivity, specificity, PPV, NPV of clinical diagnosis and provisional diagnosis for acute intestinal obstruction, perforation peritonitis and Koch's abdomen

Diagnosis	Sensitivity	Specificity	PPV	NPV
Clinical diagnosis				
Acute intestinal obstruction	100	91.67	75	100
Perforation peritonitis	100	87.10	89.10	100
Koch's abdomen	58.33	100	100	90.57
Provisional diagnosis				
Acute intestinal obstruction	100	91.67	75	100
Perforation peritonitis	100	93.10	94.29	100
Koch's abdomen	66.67	100	100	92.31

The sensitivity, specificity, PPV, and NPV parameters for both clinical and provisional diagnosis were measured as shown in Table 3. The PPV was highest in both clinical and provisional diagnosis for Koch's abdomen, i.e., 100%.

Table 4: Distribution of patients according to Clavien-Dindo class.[7]

Clavien-Dindo class	N	%
1	12	20.00
2	29	48.33
3a	12	20.00
3b	0	0.00
4	1	1.67
5	6	10.00

Table 4 shows the distribution of patients for morbidity assessment according to Clavien-Dindo class. The percentage of 1, 2, 3a, 3b, 4, and 5 Clavien- Dindo class were 20.00%, 48.33%, 20.00%, 0.00%,1.67%, and 10.00%, respectively.

Table 5: Mortality rate

Mortality rate	N	%
Discharged	54	90.0%
Expired	6	10.0%

Table 5 shows the mortality rate. Out of 60, a total 6 (10%) patients expired and 54 (90.0%) patients were discharged.

A negative explorative laparotomy was defined as a laparotomy without any evidence of intra-abdominal injury. Figure 3 shows the rate of negative laparotomy. The percentage of diagnostic laparotomy was 98.33%(59/60 cases) and negative was 1.67%(1/60 case).

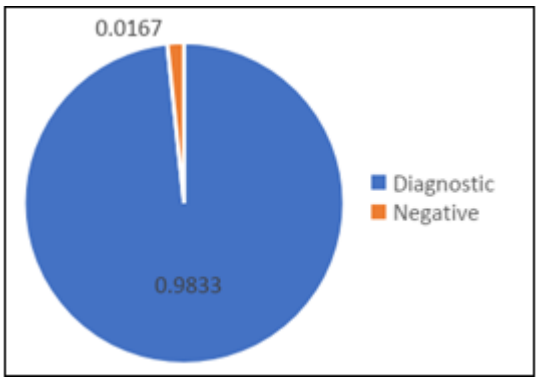


Figure 3: Rate of negative laparotomy

4. Discussion

Acute abdomen comprises almost 5-10% of the cases visiting the emergency department and an early and accurate diagnosis results in more accurate management and subsequently, leads to better outcomes.[3] Our study was conducted over a period of almost 2 years and enrolled 60

patients presenting to the Emergency Department of General Surgery Department, King George's Medical University, Lucknow with an urgent condition causing acute abdominal pain.

In a study by Danish, the frequency of acute abdomen in males was higher than in females in most of the acute abdomen cases, similar to our study results.[10] Intestinal infection or acute appendicitis was more frequently caused in patients aged <20 or 20-39 years age, according to a study done by Murata et al.[11] In our study similar results were found with the highest number of patients also falling under the age group of 21-30 years (31.67%).

Based on the results, the diseases causing urgent cases of acute abdomen can be divided into two groups. The overall diagnostic accuracy of clinical evaluation was 58.33% (35/60 cases) in this study. However, in a group consisting of cases of obstructed hernia, post operative adhesive obstruction, appendicular perforation, gastric and duodenal perforation, post D&C perforation, and enteric perforation with a history of fever, the diagnostic accuracy of clinical evaluation alone is 93.10% (27/29 cases). The 2 cases that weren't diagnosed accurately were one of each, duodenal and gastric perforation and were diagnosed as a case of ileal perforation clinically. X-Ray and USG too has no role in diagnosing these cases accurately.

In the other group, consisting of cases of carcinoma colon, carcinoma pancreas, sigmoid volvulus, Koch's abdomen, enteric fever without history of fever, sealed perforation, diverticular and Meckel's perforation, mesenteric ischemia cause SMA thrombosis and acute pancreatitis, the diagnostic accuracy of clinical evaluation was 25.80% (8/31 cases). Sigmoid volvulus needed plain abdominal X-ray for 100% (2/2 cases) accuracy in diagnosis. Overall diagnostic accuracy based on clinical evaluation + X-Ray was 61.67% (37/60 cases). In these cases, USG did not have any superadded role. Similarly, in a study done by Giljaca et al, the sensitivity and specificity of USG was much lower as compared to a physical examination. Patients that needed additional imaging modalities were usually referred to a CT scan.[12] USG was done in all the cases in this study and its accuracy was similar to that of clinical evaluation with an added diagnostic advantage in only 2 cases, one of Koch's abdomen and carcinoma pancreas each, increasing the overall diagnostic accuracy of clinical evaluation + X-Ray + USG to 65% (39/60 cases).

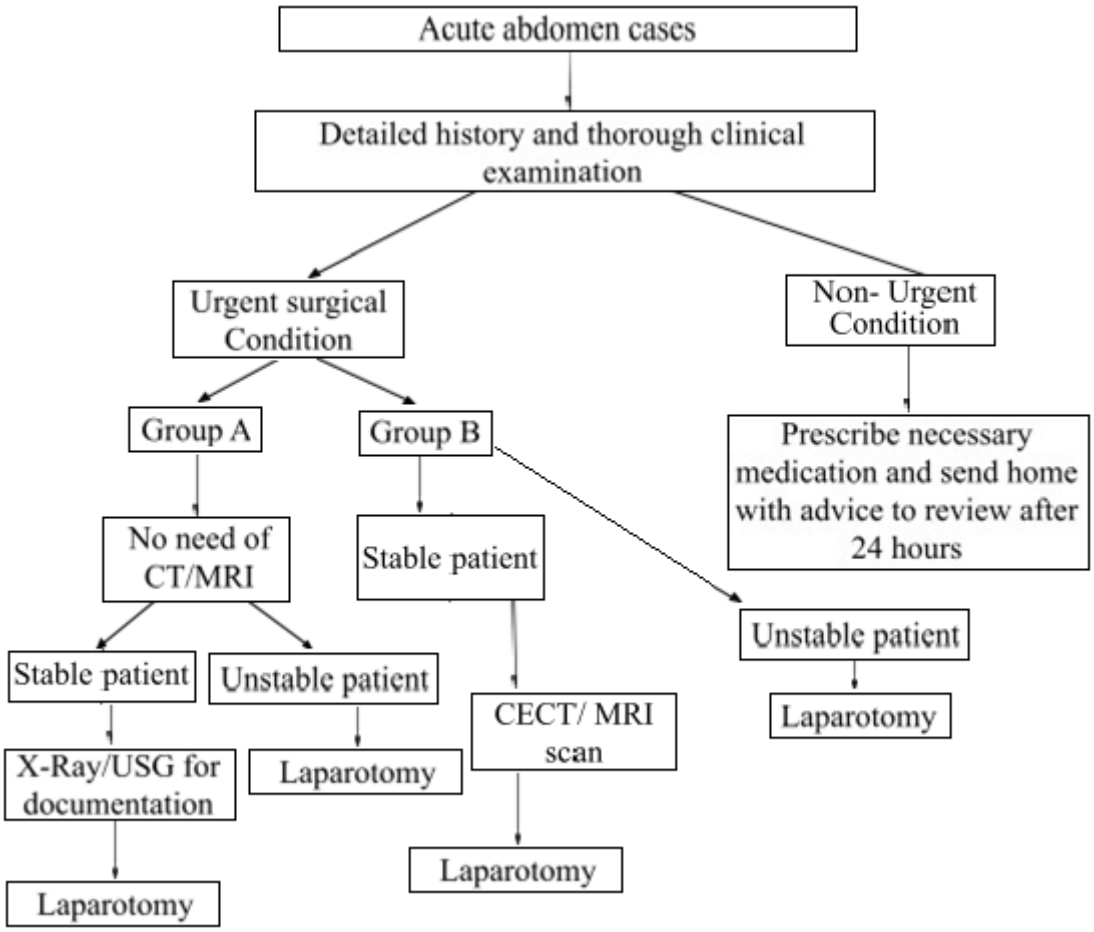
In this study, CT scan was done in only 7 cases (4 cases of carcinoma colon, 1 case of carcinoma pancreas and 2 cases of Koch's abdomen). In patients where the decision to undergo emergency laparotomy was clear after clinical evaluation/USG, a CT scan was not done. Hence, the overall diagnostic accuracy after conditional imaging was low (71.67%; 43/60 cases). However, the diagnostic accuracy of CT scan in the 7 cases was 100%. Lameris et al conducted a study in which conditional strategy with CT after a negative USG resulted in the highest sensitivity and was concluded to be an effective diagnostic imaging modality.[2]

The overall mortality rate was 10% (6/60 cases) in our study. One reason for this high mortality rate could be the institute of study being a tertiary care centre receiving most of the poor prognosis cases referred from various lower centres. A study conducted by Arenal et al showed a nearly 22% mortality rate in the elderly population 13 Similar mortality rates were observed in other studies as well.[14,15]

We had one case of negative laparotomy (1.67%) in our study which was diagnosed as a case of acute intestinal obstruction after clinical evaluation followed by USG and was explored. However, no positive findings were found per-operatively. Final diagnosis after further evaluation was acute pancreatitis with paralytic ileus. Patient had presented with distended abdomen, abdominal pain and inability to pass faeces and flatus. Ultrasonography had documented dilated bowel loops and missed pancreas due to excess bowel gas. CT scan in this case might have led to an accurate pre-operative diagnosis. Study conducted by Sabhnani et al also showed that a correct collaboration between clinical and the radiological findings adds to lower the negative laparotomy rates and hence lowers patient morbidity related to unnecessary surgeries.[16]

Also, in cases of sealed perforation, diverticular perforation, Meckel's perforation and mesenteric ischemia cause SMA thrombosis, CT scan was not done despite the absence of pre-operative definitive diagnosis after clinical evaluation and USG due to urgency of laparotomy. However, if done, would have led to increased diagnostic accuracy.

Hence, keeping all these results and discussion in mind, an elaborative analysis was done and the following diagnostic pathway for urgent cases of acute abdomen was proposed.



Group A- cases of obstructed hernia, post operative adhesive obstruction, appendicular perforation, gastric and duodenal perforation, post D&C perforation, and enteric perforation with a history of fever and sigmoid volvulus

Group B- cases of carcinoma colon, carcinoma pancreas, Koch's abdomen, enteric fever without history of fever, sealed perforation, diverticular and Meckel's perforation, mesenteric ischemia cause SMA thrombosis and acute pancreatitis

5. Limitations

Most of the USG examinations in this study were done in the emergency department by the radiology residents. This may have led to decreased diagnostic accuracy of USG in our study. Patients who were sent home with advice to review after 24 hours were not followed. Our study was done in a tertiary care centre (highest referral centre). This resulted in a relatively high prevalence of urgent conditions and especially higher prevalence of cases of perforated viscus or conditions which needed urgent surgical management. Therefore, the prevalence and spectrum of urgent conditions may differ between different settings. CT scan was done in a very few cases. In patients where the decision to undergo emergency laparotomy was clear after clinical evaluation/USG, CT scan was not done.

6. Conclusion

The overall accuracy of clinical evaluation alone to diagnose urgent cases of acute abdomen is 58.33%. The urgent causes of acute abdomen can be divided into 2 groups. The diseases listed in the first group (obstructed hernia, post operative adhesive obstruction, appendicular perforation, gastric and duodenal perforation, post D&C perforation, and enteric perforation with a history of fever) have a diagnostic accuracy of 93.0% using clinical evaluation while the diagnostic accuracy of clinical evaluation for the second group (consisting of carcinoma colon, carcinoma pancreas, Koch's abdomen, enteric fever without history of fever, sealed perforation, diverticular and meckel's perforation, mesenteric ischemia cause SMA thrombosis and acute pancreatitis) is 25.8%. X-Ray and USG have no superadded advantage over clinical evaluation except in cases of sigmoid volvulus. Hence, we conclude that in a case of acute abdomen, we should first differentiate between urgent and non-urgent causes. Those with the non-urgent condition would be prescribed medicine on an OPD basis and advised for review after 24 hours. For urgent cases belonging to the first group, clinical evaluation with or without X-Ray/USG is sufficient to proceed for laparotomy and such patients can be protected from the unnecessary side-effects of a CT scan. However, for patients belonging to the second group, CT/MRI is advisable for making a definitive diagnosis before proceeding towards laparotomy, provided the patient is stable.

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