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Radiology Section

A Comparative Evaluation of Various Imaging Findings with Per Operative Findings in Acute Abdomen

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ABSTRACT

Introduction: Abdominal pain, severe in nature, that requires immediate medical and or surgical care may be referred to as acute abdomen. In view of its morbidity and mortality, it becomes essential for a prompt and accurate diagnosis. Due to the non-specific nature of presentation the clinical diagnosis is often challenging. Imaging plays an important role in the treatment and management of these patients.

Aim: To compare various imaging modalities and per-operative findings in acute abdomen with associated evaluation of sensitivity, specificity, positive and negative predictive values as well as accuracy of the same.

Materials and Methods: This was time bound prospective study in which 50 patients referred to the Department of Radiodiagnosis with clinical history of acute abdomen were taken in a period of 18 months from December 2014 to August 2016. They underwent Plain Radiography, Ultrasonography and Computed Tomography Examination after eliciting adequate history. Later the imaging findings were correlated with the per-operative findings. Results were statistically analysed using SPSS version 18.0.

Results: Out of the 32 males and 18 females of varying age groups the most common age of presentation was between 21 to 30 years. Acute appendicitis followed by intestinal perforation and obstruction were the most common cause for pain abdomen.

Sensitivity, Specificity, Positive Predictive Value (PPV), Negative Predictive Value (NPV) and diagnostic accuracy in diagnosing hollow viscus perforation were 84.62%, 97.30%, 91.67%, 94.74% and 94% respectively for X-ray erect, were 76.92%, 97.30%, 90.91%,92.31% and 92% respectively for USG and 100% throughout for CT.

Likewise, for diagnosing intestinal obstruction radiography was 100% throughout, while abdominal ultrasonography was 90%, 97.50%, 90%, 97.50% and 96% respectively, as compared to computed tomography which remained 100% throughout.

In diagnosing appendicular pathology sonography was 91.30%, 96.20%, 95.45%, 92.86% and 94% respectively, as compared to computed tomography which remained 100% throughout. Imaging findings of acute abdomen were correlating well with per operative findings (98%).

Conclusion: It was found that Plain radiograph of abdomen was useful in patients with hollow viscous perforations and intestinal obstruction. Sonography remained the primary technique of choice in acute abdomen especially in pediatric patients (two), thin young adults (eleven) and pregnant patients (one). Computed tomography was the most sensitive and specific investigation for pain abdomen.

Keywords: Appendicitis, Hollow viscus perforation, Intestinal obstruction, Intussusception, Jejunitis, Pericecal abscess, Sub diaphragmatic abscess

INTRODUCTION

The term “acute abdomen” encompasses a clinical syndrome presenting with un-diagnosed abdominal pain lasting less than one week [1]. The spectrum may range from those that are benign and self-limiting to those that require immediate surgical management. There are roughly around eight conditions which contribute to 90% of patients who are referred to the hospital. Gastric perforation, pancreatitis, intestinal obstruction,

diverticulitis, renal colic, cholecystitis and acute appendicitis are some of the commonly encountered conditions. Abdominal pain which do not require surgical management such as acid peptic disease and constipation are also seen [2,3]. Early diagnosis with protocol based management aids in improving the morbidity and mortality for such conditions [3]. A large scale review involving over 30 thousand patients with pain abdomen conducted by Dombal et al., [4] revealed that 28% of the patients had appendicitis while 9% has cholelcystitis while intestinal obstruction and gynecological conditions contributed to 4% each. Acute pancreatitis and renal colic contributed for about 2-3%. In one third of patients, no cause could be determined. Diagnosis of a case of an acute abdomen can often be limited clinically as the physical findings and clinical features may be non-specific.

Since, clinical evaluation is non-specific and limited in such cases imaging plays a rather crucial role [5].

Following the history and clinical examination, plain film radiographs have traditionally been one of the first and most useful methods of further investigation. Despite advances in imaging techniques and modalities the plain radiograph still tends to be the most crucial initial investigation [6].

Commonly employed strategy involves use of USG as first line of investigation followed by CT study in cases where USG remains non-diagnostic. Thus, minimising the cost and radiation factors [5].

Pediatric patients, thin young adults, pregnant patients, ultrasound is primary imaging method (avoids excessive radiation). Computed tomography for patients with inconclusive ultrasound, if perforation suspected or if obese [7].

CT scan has become the mainstay imaging modality in most conditions as it provides accurate reproducible results. Also, CT findings have been demonstrated to be less time consuming and relatively cost effective in management of acute abdominal pain.

With the exception of cases of acute cholecystitis, CT has become pivotal in evaluating cases of acute abdomen [5].

In a clinical scenario of bowel obstruction, the use of conventional radiology is minimized with the advent of CT.

However, multidetector CT has surpassed this as well. CT has proven to be sensitive in cases of bowel perforation, where not just the presence of free air but the cause for it may be ascertained too. Certain signs are highly specific in cases of bowel ischemia and thus provide invaluable timely information [5].

Due to limitations of plain abdominal radiographs, CT has become an important technique for the diagnosis of small bowel obstruction [8].

Acute abdomen requires prompt diagnosis and timely management. Pre-laparotomy diagnosis of cause for acute abdomen minims the need for unnecessary operations especially where the diagnostic facilities are limited and reduces the morbidity and mortality [9].

Advancements in the field of ultrasound and colour Doppler, multidetector CT and MRI has reduced the need for diagnostic laparotomy and raised the confidence level in management of such clinical conditions [10].

In the present study, our objective was to study effectiveness of radiological investigations in diagnosing acute abdomen and its influence on clinical decision making.

Comparison of conventional radiography, ultrasonography and computed tomography examination findings with per-operative findings in non-traumatic cases of acute abdomen with emphasis on various statistical measures to determine the accuracy of each.

MATERIALS AND METHODS

This was time bound prospective study in which patients referred to the Department of Radio diagnosis, KIMS Hospital and Research Centre, Bangalore with clinical history of acute abdomen were included in a period of 18 months from December 2014 to August

All patients aged above 18 years with a clinical presentation of acute abdomen were considered for the study.

Patients who underwent medical line of management were excluded from the study.

Written consent of the patients were obtained prior to enrolment in the study. Patients had right to either participate or decline to participate in the study.

A detailed history of all patients included in the study was taken along with thorough clinical examination and laboratory investigation findings as per proforma.

After history taking and clinical examination all patients underwent Plain Radiography abdomen erect AP view, Ultrasonography and Computed Tomography Examination.

Plain radiography, ultrasonography and CT examinations were done on 800 mA high frequency X ray machine, voluson ultrasound machine and GE Bright Speed multidetector 16 slice CT respectively.

Imaging and Diagnosis of acute abdomen was made as per departmental protocols.Imaging findings were recorded. Later patients were followed up for per operative findings.

The imaging findings was correlated with the per-operative findings, final outcome was evaluated.

Statistical Methods

Sensitivity, specificity, positive predictive value, negative predictive value ‘t’ test and chi square test was used. The

Statistical software namely SPSS version 18.0 was used for the analysis of the data and Microsoft word and Excel was used to generate graphs, tables etc.

RESULTS

The following observations were made based on the 50 patients with ages ranging from 18 to 82 years who presented with acute abdomen to the emergency room and who required surgical intervention.

In the present study there were 32 males and 18 females of varying age groups with approximately male to female ratio of 2:1 [Table/Fig-1]. Patients presented with generalized pain abdomen (64%), localized right iliac fossa pain (36%), fever (46%), vomiting (64%) [Table/Fig-2]. On physical examination, generalized abdominal tenderness (58%), right iliac fossa tenderness (42%), rigidity (42%), and abdominal distension (30%) were noted [Table/Fig-3]. Clinical diagnosis includes acute appendicitis (n=25, 50%), perforated hollow viscus with peritonitis (n=14, 28%) and intestinal obstruction (11, 22%) [Table/Fig-4].

Plain X-ray of erect abdomen was performed in all patients which showed Pneumoperitoneum suggestive of hollow viscous perforation (n=12, 24%) [Table/Fig-5] and multiple air fluid levels along with dilated small bowel suggestive of intestinal obstruction (n=10, 20%) [Table/Fig-6]. All other x-rays of abdomen were normal.

Ultrasound findings were suggestive of acute appendicitis (n=22, 44%) [Table/Fig-7], hollow viscous perforation (n=11, 22%) [Table/

Age in years	No. of the patients	Male	Female	%
< 20	2	2	0	4
21- 30	15	9	6	30
31-40	7	5	2	14
41- 50	8	5	3	16
51- 60	11	7	4	22
61-70	5	3	2	10
71-80	1	0	1	2
>80	1	1	0	2
Total	50	32	18	100

[Table/Fig-1]: Age distributions of patients studied.

Symptoms	No. of the patients	%
Generalised pain abdomen	32	64
Localised pain abdomen	18	36
Fever	23	46
Vomiting	32	64

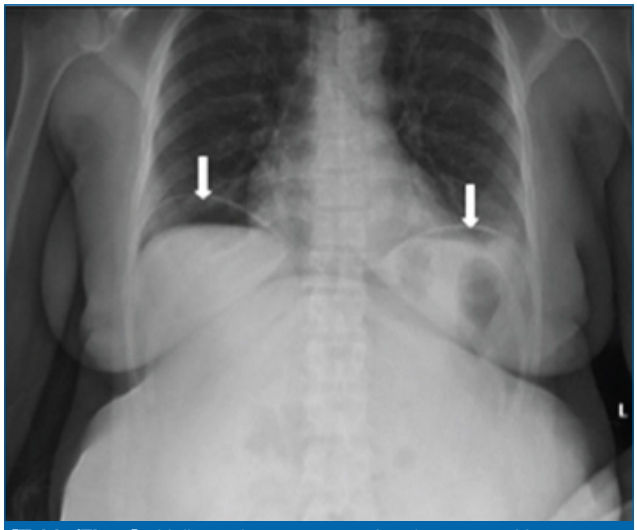
[Table/Fig-2]: Symptom distribution of patients studied.

Physical findings	No. of the patients	Male	Female	%
Generalized abdominal tenderness	29	16	13	58
Regional abdominal tenderness	21	10	11	42
Guarding/Rigidity	21	9	12	42
Abdominal distension	15	8	7	30

[Table/Fig-3]: Physical findings distribution in patients studied.

Clinical diagnosis	No. of the patients	Male	Female	%
Appendicitis	25	18	7	50
Peritonitis due to perforation	14	9	5	28
Intestinal obstruction	11	5	6	22
Total	50	32	18	100

[Table/Fig-4]: Clinical diagnosis distribution in the patients studied

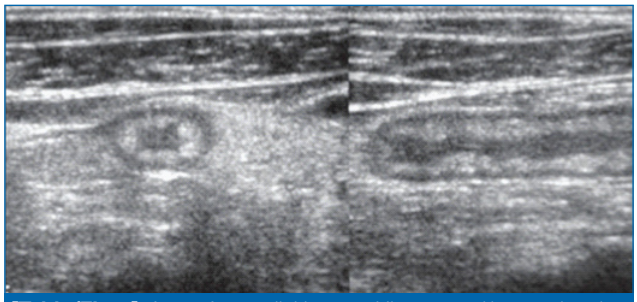


[Table/Fig-5]: Hallow viscus per perforation case: X ray erect abdomen showing Air under dome of diaphragm.

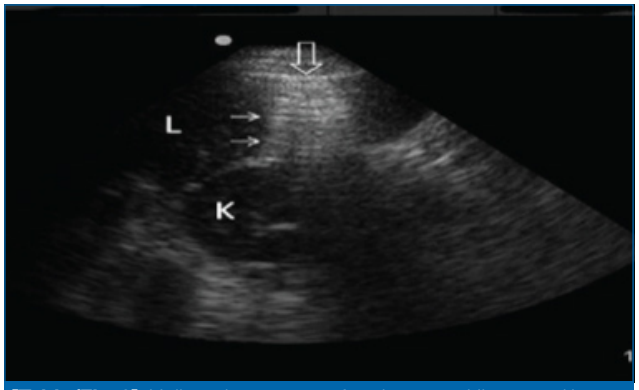
[Table/Fig-6]: Intestinal obstruction case: Erect film demonstrates multiple air-fluid levels in a case of distal small bowel obstruction.

Fig-8] and intestinal obstruction (n=10, 20%) [Table/Fig-9].

Computed tomography findings were suggestive of acute



[Table/Fig-7]: Acute Appendicitis case: Ultarasound image showing inflamed Appendix.

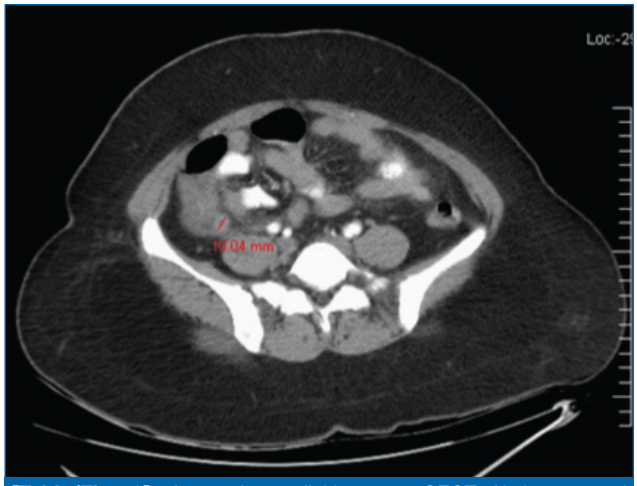


[Table/Fig-8]: Hallow viscus per perforation case: Ultrasound image showing reverberation artifacts s/o pneumoperitoneum.

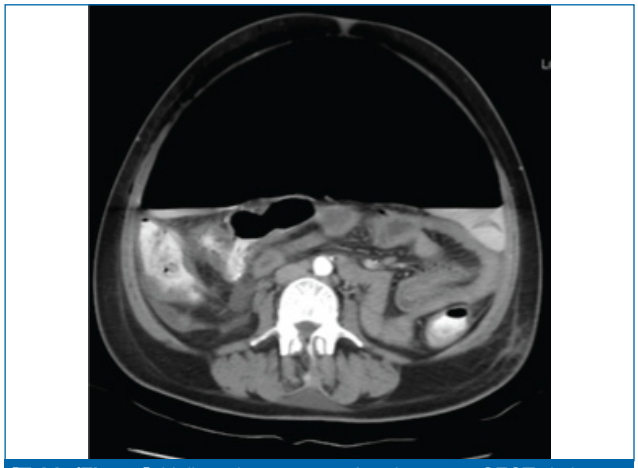
[Table/Fig-9]: Intestinal obstruction case: Ultrasound image showing dilated bowel loop.

appendicitis (n=23, 46%) [Table/Fig-10], hollow viscous perforation (n=13, 26%) [Table/Fig-11], intestinal obstruction (n=10, 20%) [Table/Fig-12], sub diaphragmatic abscess (n=1, 2%), pericaecal abscess (n=1, 2%), intussusception (n=1, 2%) and jejunitis (n=1, 2%) [Table/Fig-13].

Final diagnosis was derived from per operative findings which showed acute appendicitis (n=23, 46%), perforated hollow viscus with peritonitis (n=13, 26%) Intestinal obstruction (n=10, 20%), Meckel's Diverticulitis (n=1, 2%), pericaecal abscess (n=1, 2%), intussusception (n=1, 2%) and sub diaphragmatic abscess (n=1, 2%) [Table/Fig-14].



[Table/Fig-10]: Acute Appendicitis case: CECT Abdomen and Pelvic study showing inflamed appendix.



[Table/Fig-11]: Hallow viscus per perforation case: CECT abdomen image showing pneumoperitoneum DUP.

[Table/Fig-12]: Intestinal obstruction case: CECT abdomen and pelvis showing dilated small bowel loops due to narrowing at ileum.

Imaging findings	No. of the patients	Male	Female	%
Appendicitis	23	17	6	46
Hollow viscus perforation	13	8	5	26
Intestinal obstruction	10	5	5	20
Pericaecal abscess	1	0	1	2
Sub diaphragmatic abscess	1	1	0	2
Intussusception	1	1	0	2
Jejunitis	1	0	1	2
Total	50	32	18	100

[Table/Fig-13]: Imaging findings distributions in patients studied.

Per Operative findings	No. of the patients	Male	Female	%
Retrocaecal Appendix	14	11	3	28
Pelvic Appendix	5	3	2	10
Paracaecal Appendix	3	2	1	6
Subhepatic Appendix	1	1	0	2
Duodenal Ulcer Perforation	10	6	4	20
Gastric Ulcer Perforation	3	2	1	6
Intestinal Obstruction	10	5	5	20
Pericaecal Abscess	1	0	1	2
Subdiaphragmatic Abscess	1	1	0	2
Intussusception	1	1	0	2
Meckel's Diverticulitis	1	0	1	2
Total	50	32	18	100

[Table/Fig-14]: Per operative findings distributions in patients studied.

Sensitivity, Specificity, positive predictive value, negative predictive value and diagnostic accuracy of plain X-ray erect abdomen in diagnosing hollow viscus perforation were 84.62%, 97.30%, 91.67%, 94.74% and 94% respectively, whereas, that of abdominal ultrasonography were 76.92%, 97.30%, 90.91%,92.31% and 92% respectively, as compared to computed tomography which remained 100% throughout.

Sensitivity, Specificity, positive predictive value, negative predictive value and diagnostic accuracy of plain X-ray erect abdomen in diagnosing intestinal obstruction was 100% throughout, whereas, that of abdominal ultrasonography were 90%, 97.50%, 90%, 97.50% and 96% respectively, as compared to computed tomography which remained 100% throughout.

Sensitivity, Specificity, positive predictive value, negative predictive value and diagnostic accuracy of abdominal ultrasonography in diagnosing appendicular pathology were 91.30%, 96.20%, 95.45%, 92.86% and 94% respectively, as compared to computed tomography which remained 100% throughout [Table/Fig-15].

I X-ray					
Parameters	**Sensitivity (%)**	**Specificity (%)**	**PPV**	**NPV**	**Accuracy**
Appendicitis	-	-	-	-	-
HVP	84.62	97.30	91.67	94.74	94.0%
IO	100.00	100.00	100.00	100.00	100.0
II USG					
Appendicitis	91.30	96.20	95.45	92.86	94.0%
HVP	76.92	97.30	90.91	92.31	92.0%
IO	90.00	97.50	90.00	97.50	96.0%
III CT					
Appendicitis	100.00	100.00	100.00	100.00	100%
HVP	100.00	100.00	100.00	100.00	100%
IO	100.00	100.00	100.00	100.00	100%

[Table/Fig-15]: Sensitivity, Specificity, positive predictive value, negative predictive value and diagnostic accuracy of imaging modalities in acute abdomen.

DISCUSSION

The term "acute abdomen" encompasses a clinical syndrome presenting with undiagnosed abdominal pain lasting less than one week. The spectrum may range from those that are benign and self-limiting to those that require immediate surgical management. In the present study, distribution of acute abdomen vary according to age and sex, correlation of radiological findings with the final diagnosis (Intra-operative findings) was evaluated. Radiological findings correlate well with the final diagnosis.

A total of 50 patients are included in the study out of which 32 were male and 18 were female patients. The patients ranged from18-83 yrs. The highest incidence was seen in patients with acute abdomen is between 20 -30 yrs. of age.

Kamlesh Gupta et al., [11] demonstrated that second to third decade was the most common age group followed by third to fourth decade with the mean age being 28 years. Of the total 100 individuals the male to female ratio was 1.63:1.

Ray S et al., [12] study shows the most common age of presentation is 21- 30 yrs.

A study including 586 individuals conducted by Memon et al. [13], with pain abdomen showed a male preponderance of 70% and age group preponderance of 21-30 years.

In a study done by Datubo-Brown DD et al [14] in university of PORT hart court teaching hospital showed the highest incidence in an age group between 10-30 yrs.

In the present study, the highest incidence of pain abdomen was seen in between 20-30yrs of age which is similar to

Kamlesh Gupta et al., Ray s et al., and Aijaz et al., studies. In the present study male to female ratio is approximately 2.1. Male predominance noticed in this study is similar to Kamlesh Gupta et al., and Aijaz et al., studies.

Dombal et al., [4] in a review of 30000 patients observed that the most common cause for pain abdomen was acute appendicitis accounting for 28%, acute cholecystitis accounting for 10% and other causes accounting for less than 5% each.

Stoker J et al., [5] described acute appendicitis, diverticulitis, cholecystitis, and bowel obstruction are common causes of acute abdominal pain.

In the present study most common cause of acute abdomen is acute appendicitis which is correlating with Dombal et al., and stoker J et al., studies.

In the present study Sensitivity, Specificity, diagnostic accuracy of plain X-ray abdomen in diagnosing hollow viscous perforation were 84.6%, 97.3% and 94% respectively. Sensitivity, Specificity, and diagnostic accuracy of plain X-ray abdomen in diagnosing intestinal obstruction were all 100%.

Low grade vs high grade obstruction as demonstrated by Maglinte DD et al., revealed sensitivity of above 80% for X-ray and CT [15].

Small bowel obstruction showed a sensitivity range from 60-90% amongst six reviewers in a study by Thompson WM et al., However, the mean sensitivity, specificity and accuracy was well over 80% among the same [16].

Small bowel obstruction has been traditionally diagnosed with the help of an abdominal plain radiograph and carries a sensitivity of 45-90% and a specificity of 50% [17].

In the diagnosis of pneumoperitoneum, radiography demonstrated higher sensitivity, specificity and positive predictive value in comparison with ultrasound as demonstrated by Hebbar et al [18].

Similar findings were demonstrated by Lane et al., in a comparative study of radiography and sonography [19].

In evaluation of pneumoperitoneum by sonography versus radiography by Braccini G et al., [20] it was seen that radiography had a higher sensitivity, slightly lower specificity and a higher positive predictive value on comparison.

In the present study plain X-ray abdomen in diagnosing hollow viscous perforation and intestinal obstruction was closely correlating with Maglinte, DD et al., Thompson WM et al., Hebbar, Ashwin, Braccini G et al., and Scchen et al., studies.

Abdominal ultrasonography in diagnosing hollow viscous was also closely correlating with Hebbar, Ashwin et al., Braccini G et al., and Sc chen et al studies.

In the present study Sensitivity, Specificity, positive predictive value, negative predictive value and diagnostic accuracy of abdominal sonography in diagnosing appendicitis were 91.3%, 96.20%, 95.45%, 92.86% and 94.0% respectively.

Jang TB et al., [21] in a study on graded compression demonstrated sensitivity of 86% and specificity of 81% with a PPV of 85%.

A Korean meta-analytic study on efficacy of graded compression in sonography revealed a sensitivity of 86.7% and specificity of near 90%.

An appendiceal diameter of 6mm and above was considered as the most consistent finding in a study conducted by Kessler N et al., which demonstrated a sensitivity and specificity of 98% [23].

Graded compression sonography was seen to depict variable sensitivity and specificity in a study by Pinto Fabio et al., the reason cited it being operator dependent, presence of bowel gas artefact, increased subcutaneous fat. The gold standard for confirmation however was pathological confirmation after appendectomy [24].

In the present study Sensitivity, Specificity, positive predictive value, negative predictive value and diagnostic accuracy of abdominal sonography in diagnosing appendicitis were 91.3%, 96.20%, 95.45%, 92.86% and 94.0% respectively as the majority of cases were retrocecal appendix, however our study was correlating well with Terasawa et al., Kessler et al., and Pinto, Fabio et al., studies.

In the present study Sensitivity, Specificity, positive predictive value, negative predictive value and diagnostic accuracy of abdominal sonography in diagnosing intestinal obstruction were 90%, 97.5%, 90%, 97.5% and 96% respectively.

CT in the evaluation of intestinal obstruction as seen in a study by Suri Sudha et al., demonstrated higher sensitivity, specificity and accuracy in diagnosing as well as determining the level or cause of obstruction in comparison with X-ray and Sonography [25].

Jang TB et al., study [21] showed Dilated bowel had 91% sensitivity and 84% specificity for SBO.

In Schmutz, G.R. et al., [26] study on role and contribution of sonography in Small bowel obstruction showed Sensitivity 95%, specificity 82.1% and Accuracy of 89% with US versus 71% for plain abdominal films.

In the present study ultrasound findings were correlating well with Suri, Sudha et al., Jang et al., study and Schmutz, G.R. et al., studies.

In the present study Sensitivity, Specificity, positive predictive value, negative predictive value and diagnostic accuracy of computed tomography of abdomen and pelvis in diagnosing appendicitis, hollow viscus peroration, and intestinal obstruction was all 100%.

In a study by Poortman P et al., [28] when sonography proved to be of limited value a post contrast CT of the abdomen was

performed where clinical follow-up and inpatient observation for nonsurgical patients showed sensitivity and specificity of CT 100%.

Gaitini D et al., [29], in 2008 did a retrospective study on consecutive adult patients referred for US for suspected appendicitis with 132 patients also undergoing follow-up 16-MDCT (oral and IV contrast) showed sensitivity of 100% and specificity of 99% in diagnosing appendicitis.

Pickuth D et al., [30] did a study on "suspected acute appendicitis: is ultrasonography or computed tomography the preferred imaging technique? "The sensitivity of CT was 95% and of US 87%. The specificity however was 89% and 74% whilst the PPV was 97% and 92% respectively.

A study on GDP (gastroduodenal perforation) by Lee D et al., [31] revealed the presence of extra luminal gas as the most common feature of GDP (97%) followed by fat stranding (89%), free fluid (89%), ulcers (84%) as well as wall thickening (72%). Combination of findings showed a sensitivity of 95% and specificity of 93% for demonstration of site of perforation. Thus, MDCT was found to be effective in diagnosing presence and site of gastroduodenal perforation.

CT remained the gold standard in diagnosing small bowel obstruction as seen in a study by Megibow AJ.

Trott AT et al., describes CT has a sensitivity of 81–94% and a specificity of 96% for diagnosing high-grade obstructions [2].

In this study computed tomography of abdomen and pelvis in diagnosing appendicitis, hallow viscus peroration, and intestinal obstruction was correlating well with Stroman DL et al., Poortman et al., fcGaitini et al., and Lee D et al., [32] studies.

Amongst the anatomical locations of appendix, it was seen that the most common position was retrocaecal followed by pelvic, post ileal and subcaecal as seen in a study by Shashikala Patel et al., [33].

According to Mwachaka, Philip et al., [34] the most common position of the appendix overall was retrocecal, followed by the pelvic type.

In our study retro cecal followed by pelvic position was common which was correlating with above studies.

From Vinod Kumar B A et al., [35] study of 31 cases of hollow viscous perforation they concluded most common age group affected is 40-60 years. Hollow viscous perforation is more commonly seen in males. Duodenum ulcer perforation is the most common hollow viscous perforation. Peptic ulcer was found to be most common cause of perforation.

In A.Sai Datta et al., [36] study the most common cause of hollow viscus perforation in their study was duodenal ulcer perforation (56%) mainly due to acid peptic disease.

In this study duodenal ulcer perforation was most common which was correlating with Vinod Kumar B A et al., and A.Sai Datta et al., studies.

In this study, plain abdominal radiography in patients with acute appendicitis showed appendicolith in one case, localized ileus in RIF in four cases and obliteration of pro peritoneal fat lines with scoliosis to left in four cases. Plain abdominal radiography findings were abnormal in 39% of acute appendicitis cases. In this study it was found that plain abdominal radiography had limited value in diagnosing acute appendicitis, which were correlating well with Ahn SH et al., [37] and Roa PM et al., [38] Studies.

In this present study imaging findings of acute abdomen were correlating well with per operative findings. (98%).

Plain abdominal radiography is the initial investigation requested in emergency department for patients presenting with pain abdomen, which do not play major role in the management of these patients except for high grade bowel obstruction and pneumoperitoneum.

Abdominal ultrasonography is the primary technique of choice in acute abdomen especially in paediatric patients, thin young adults and pregnant patients because of lack of ionizing radiation, less cost and easy availability.

Computed tomography is the most sensitive and specific investigation for pain abdomen, however it should be indicated for the patients with inconclusive ultrasonography, suspected perforation and obese patients.

LIMITATIONS

The sample size included in evaluation of patients with pain abdomen who also underwent surgical evaluation. Patients who were not operated but had significant imaging findings were excluded from the sample size.

CONCLUSION

Acute appendicitis and hollow viscus perforation are the most frequently encountered causes for acute abdomen. Plain X ray erect abdomen has a limited role in patients with acute abdomen other than suspected cases of hollow viscus perforation and intestinal obstruction. Computed tomography is the most sensitive and specific investigation for pain abdomen, however it should be indicated for the patients with inconclusive ultrasonography, suspected perforation and obese patients. In this present study imaging findings of acute abdomen were well correlating with per operative findings. (98%). A prompt and accurate diagnosis can be done with help of imaging to minimize patient's morbidity and mortality because clinical evaluation results can be inaccurate.

Thus emphasizing the fact that imaging plays a crucial role in

management of acute abdomen.

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