"ROLE OF ULTRASONOGRAPHY IN THE EVALUATION OF BLUNT ABDOMINAL TRAUMA"

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ABSTRACT

Background: Blunt abdominal trauma constitute cases where there is an injury to one or more abdominal viscera with or without hemoperitoneum in the absence of external penetrating injury to the abdomen. Objectives: The aims of the present study were - To discuss various aspects of Blunt Abdominal Trauma, To evaluate the ability of US in detecting Haemoperitoneum, Intraperitoneal visceral injuries. Analysis of sonographic findings and its correlation with clinical background, laboratory investigations, conventional and contrast radiographic procedures, CT-scan and operative findings wherever possible. To evaluate the role of US in the follow-up of patients with BAT. Methodology: Prospective observational study on 40 cases with blunt trauma in Government Hospital Kurnool. Results: Road traffic accident was the major cause. Ultrasound was able to identify free fluid, solid organ injuries (lacerations, contusions, hematomas and rupture) and perivisceral fluid collection. The overall sensitivity of US in evaluation of BAT was 83%and specificity was 96%. The sensitivity

of US in detecting free fluid in our study was 100% because not all cases were confirmed by CT or laparotomy. Amongst the visceral injuries, spleen, liver and kidney were the most common abdominal organs injured with incidence of 25%, 20% and 10% respectively. Also plays a major role in followup of patients with BAT. Conclusion: Thus the ability of US to accurately detect the presence of free fluid andto pin point the injured organ, helps the clinician in contemplating and planning the appropriate therapeutic approach to a patient with suspected blunt abdominal trauma.

Key words: Blunt trauma, Abdomen; Injuries, abdominal; abdominal sonography; solid organ injury; haemoperitoneum.

INTRODUCTION

Blunt abdominal trauma constitute cases where there is an injury to one or more abdominal viscera with or without hemoperitoneum in the absence of external penetrating injury to the abdomen

Blunt abdominal trauma (BAT) on a routine basis occur as a result of vehicular motor accidents(MC), an assault over the abdomen, fall from a height/steps, fall of heavy objects over the abdomen, industrial accidents, crush injuries and even blast injuries

BAT is an important common cause of morbidity and mortality among all age groups worldwide, with thousands of cases reporting to the emergency department every day

With increasing population worldwide, there is an increased incidence of road traffic accidents and violent assaults. This leads to the famous quote "civilisation and violence seem to advance hand in hand"

An intra-abdominal injury diagnosis is challenging in polytrauma, even for the

most well trained and talented surgeons, especially in an unreliable physical examination, in patients with an associated closed head injury, spinal cord injury, or substantial intoxications with a depressed or altered sensorium. These intra-abdominal injuries may be missed in 15 to 45% of patients.

With the worldwide trend shifting towards nonoperative/selective management of abdominal trauma due to enhanced diagnostic and therapeutic modalities, hazards of missed or delayed diagnosis are common. Delay in diagnosis and treatment substantially increases morbidity and mortality due to ongoing intraabdominal bleeding from solid organ injury/vascular injury or infection fromperforation of a hollow viscous landing the patient in peritonitis.

Besides, special population groups(children, elderly, immunosuppressed, anticoagulated, morbidly obese, etc.) pose unique management challenges.

In the emergency room, while evaluating a polytrauma patient, time is of paramount importance. The diagnostic studies should not interfere with resuscitation. So the amount of imaging used to assess a trauma patient must be inversely proportional to the severity of injuries.

The most important management of patients with BAT is resuscitating, evaluating, and ascertaining the need for laparotomy. Thus the screening test must be highly sensitive, quick, easy to perform and give the operating surgeon a clear advantage if the same test is sensitive enough for citing the organ of injury.

Root et al.[1,2] first described Diagnostic peritoneal lavage (DPL) in 1965. Despite being sensitive, in ascertaining the presence of intraperitoneal haemorrhage, its invasiveness and a significant rate of non-therapeutic laparotomies/negative laparotomies led to decreased usage of this method. Nonetheless, it can be performed

in the absence of any imaging modality, or it can be performed under imaging guidance, thus increasing its sensitiveness.

Computed tomography (CT) scan, even though noninvasive and accurate, it is costly, not readily available, time-consuming, requires injection of contrast, radiation exposure and difficulties in shifting patients against time thereby limiting its use.[3,4]

With the development of Ultrasonography (US), there is a paradigm shift worldwide in evaluating and managing patients with BAT. In recent years, abdominal ultrasonography has taken quantum leaps in its utility, accuracy, and acceptance by the medical fraternity as it is easy to perform, quick, cost-effective, non-invasive, no radiation exposure or no toxic contrast material injection. It can be repeated as often as required.[5,6,7]

Hence the US provides the advantages of both DPL (Fast and accurate) and CT (Noninvasive and accurate).[8]

However, Sonographic results are highly variable and dependent on the technical expertise of the sonologist.[6,9] Appropriate training plays a role in the sensitivity and specificity of ultrasonography.

This study discusses the blunt injury abdomen and assesses the diagnostic validity of US imaging in guiding proper evaluation and management of BAT cases.

AIMS AND OBJECTIVES

- To discuss various aspects of blunt injury abdomen

- To evaluate ultrasound's ability in detecting

1) Intraperitoneal free fluid collection / Heamoperitoneum

2) Intraperitoneal visceral (solid organ/hollow viscus/vascular) injury.

- Analysis of sonographic findings and its correlation with a clinical background, lab investigations, conventional and contrast radiographic procedures, CT scan and correlation with operative findings.
- To evaluate the role of USG in the follow-up of patients with BAT.

MATERIALS & METHODS

This study was a Prospective Observational study carried out on 40 patients with a history of blunt injury abdomen, presenting to the emergency room and referred to the Department of General Surgery over two years from November 2018 to October 2020 at Government General Hospital, Kurnool affiliated to Kurnool Medical College, Kurnool.

Inclusion criteria:-

- All patients with blunt abdominal trauma.
- Patients are included irrespective of age, sex, mode of injury.

Exclusion criteria:-

- Moribund patients in hypovolaemic shock at the time of presentation and expired at resuscitation before taking up for investigations.
- Dead on arrival
- Penetrating injury abdomen

All the cases were initially resuscitated, critically evaluated and correlated with a clinical background, laboratory investigations, conventional and radiographic procedures, CT scan and operative findings whenever possible.

OBSERVATIONS AND RESULTS

A total of 40 patients were evaluated sonographically with a history of blunt abdominal trauma.

TABLE 1: SEX DISTRIBUTION OF STUDY GROUP

Sex	No of Cases (n=40)	Percentage
Male	29	72.5%
Female	11	27.5%

Out of 40 patients evaluated sonographically, 29 were males, and 11 were females. Thus an overall male predominance of 72.5% was noted.

TABLE 2 : AGE DISTRIBUTION

Age	No of Cases (n=40)	Percentage
1-10	4	10%
11-20	5	13%
21-30	10	25%
31-40	14	35%
41-50	5	13%
51-60	1	3%
61-70	1	3%

In this study, the youngest patient was of age 4 yrs and eldest of 67years. The

peak incidence of 35% was present in the 4th decade and a second peak of 25% in the 3rd decade of life.

TABLE 3 : CAUSE OF TRAUMA

Causes of Trauma	No of Cases (n=40)	Percentage
Road Traffic Accident	24	60%
History of Assault/Hit by bull	10	25%
History of Fall	4	10%
Fall of Object	2	5%

As is evident, road traffic accidents were the commonest cause of blunt abdominal trauma (60%), followed by the history of assault/hit by a bull (25%) in our study.

TABLE 4 : CLINICAL PRESENTATION

Clinical Presentation	No of Cases (n=40)	Percentage
Pain Abdomen	33	82.5%
Abdominal Distention	13	32.5%
Guarding & Rigidity	26	65%
Heamodynamic instability	12	30%
Hematuria	3	7.5%
Vomiting	4	10%

Pain abdomen (82.5%) and guarding & rigidity (65%) were the most predominant signs and symptoms, followed by abdominal distention (32.5%) and

hemodynamic instability(30%)

Out of 4 patients with renal injury, three patients presented with haematuria.

TABLE 5 : TYPE OF LESIONS

Type of Lesion	No of Cases (n=40)	Percentage
Haemoperitoneum	20	50%
Spleen	10	25%
Liver	8	20%
Kidney	4	10%
Pancreas	2	5%
Bowel Perforation	1	2.5%
Mesentric Haematoma	1	2.5%
Adrenals	0	0
Urinary Bladder	0	0

Free fluid was detected in 20 cases (50%). Among abdominal viscera, solid organs (spleen, liver, kidneys and pancreas) taken together (92%), were more often injured than hollow viscus. Hollow viscus (Bowel) was injured in 2.5%. Spleen, liver and kidneys are the organs commonly injured with the spleen (25%) most often injured, followed by liver (20%) and kidney (10%).

TABLE 6: USG DETECTED SOLID ORGAN INJURY AND CHARACTERISATION

Type of Lesion	No of Cases (n=40)	Percentage
Spleen		

Laceration	1	11%
Rupture	4	44%
Intraparenchymal Haematoma	3	33%
Subcapsular Haematoma	1	11%
Liver		
Laceration	4	57%
Haematoma	2	28.5%
Contusion	1	14%
Kidney		
Laceration	1	20%
Haematoma	2	40%
Perinephric Collection	2	40%
Pancreas		
Pseudocyst of Pancreas	2	100%

The spleen was injured in 10 cases (25%), out of these nine were detected onthe US. The commonest type detected was splenic rupture (44%) followed by intraparenchymal haematoma (33%). The other injuries present were subcapsular haematoma (11%) and laceration (11%).

Hepatic injuries were demonstrated in 8 patients (20%). Out of these 7 cases were detected on ultrasonography. The commonest lesion detected was laceration (57%), followed by haematoma (28.5%) and contusion (14%).

In our study, four patients had renal injuries (10%). Out of these, haematoma and the perinephric collection was noted in 2 cases each (40%), and 1 case of renal laceration noted (renal laceration and the perinephric collection was noted togetherin one case). The US detected all cases of renal injuries.

TABLE 7 : LAP FINDINGS MISSED ON US

Organs Injured	No of Cases (n=40)	Percentage
Liver Laceration	1	12.5%
Spleen Laceration	1	10%
Bowel Perforation	1	100%
Mesentric Haematoma	1	100%

USG detected almost all the solid organ injuries. However, one liver laceration (12.5%), one spleen laceration (10%) was missed on sonography detected on laparotomy.

USG failed to detect 1 case of bowel and 1 case of mesenteric injuries directly. In one patient, a false-positive diagnosis of splenic hematoma was made which was not confirmed at surgery.

TABLE 8: INJURIES SEEN ON USG ASSOCIATED WITH HEMOPERITONEUM

Type of Injury	No of Cases (n=40)
Insignificant Injury	8
Significant Injury (Needed Laparotomy)	12
Spleen	8
Liver	5
Kidney	1
Pancreas	1
Bowel Perforation	1
Mesentric Haematoma	1

Out of 20 cases of haemoperitoneum, 12 cases needed laparotomy and 8 were treated conservatively due to insignificant injury.

Most of the splenic and liver injuries were associated with hemoperitoneum; however, out of 4 patients with renal injuries, 1 case was associated with hemoperitoneum (25%).

TABLE 9: INJURIES SEEN ON USG NOT ASSOCIATED WITH HP

Type of Injury	No of Cases (n=40)
Spleen Subcapsular hematoma	1
Liver Laceration	1
Liver Contusion	1
Renal Laceration	1
Renal Hematoma	2

Pseudocyst of Pancreas	1

1 case of a spleen injury, 2 cases of liver injury, 3 cases of renal injury and 1 case of pseudocyst of pancreas did not show free fluid.

TABLE 10: USG INDICATOR OF LAPAROTOMY

USG Indicator of Laparotomy	No of Cases (n=40) / Percentages
USG Suggested Laparotomy	12
True Positive	11
False Positive	1
True Negative	24
False Negative	4
Sensitivity	73%
Specificity	96%
Positive Predictive Value	91%
Negative Predictive Value	86%

The US Suggested Laparotomy in 12 cases. No injury was detected in one operative case, although USG was positive for splenic hematoma and HP.US was negative for organic injuries in 4 cases. On EL were detected to be 1 case of bowel perforation, 1 case of mesenteric haematoma and 1 case each of liver and splenic lacerations.

DISCUSSION

Blunt abdominal trauma continues to be a significant diagnostic challenge, even to the experienced surgeon. The sensitivity of clinical examination alone in detecting intra- abdominal injuries is low. So additional diagnostic methods are necessary, especially in comatose patients with multiple injuries. Timely management is crucial because blood loss is time-dependent and diagnostic procedures must be quick and accurate, and decision making must be prompt and correct. The most important objective in managing the patient with blunt abdominal trauma is to decide whether or not an emergency laparotomy is needed and not the diagnosis of the specific organ injury.

Ultrasonography examination is non-invasive, rapid to perform, relatively inexpensive, portable for bedside evaluation in the emergency room, free from radiation and can be repeated at any time without contraindications.

In this series, a total number of 40 cases of blunt abdominal trauma were evaluated by real-time sonography.

In our series, out of 40 patients, there were 29 male and 11 female patients. Thus an overall male predominance (72.5%) over female was found. The higher incidence of males could be attributed to more outdoor nature of the occupation, alcohol addiction, and violence in males than females.

In our series, the youngest patient's age was seven years and the eldest 69 years. A peak incidence of 35% was found in the 4th decade of life and the second peak of 25% was found in the 3rd decade of life. The problem of blunt trauma assumes its importance because it affects the young productive members of society. In this series, the road traffic accident was the commonest cause of the injury. Out of40 cases, in 24 cases (60%) vehicular accident was responsible for trauma followed

by an injury caused due to assault/due to hit by a bull (25%). The reasons for which could be an increase in the population, leading to an increase in the number of vehicles on the road, with poor maintenance of roads and rash, drunken driving.

Out of 40 patients in our study, 33 patients came with symptoms of pain abdomen, and on examination, 26 patients had guarding and rigidity.

Pain abdomen (82.5%) and guarding & rigidity (65%) were the most predominant signs and symptoms in our study, followed by abdominal distention (32.5%).

Out of 4 patients with renal injury, three presented with a history of haematuria.

Twelve patients (30%) were hemodynamically unstable with falling blood pressure, and low pulse rates and all underwent exploratory laparotomy.

X-ray chest AP views showed, out of 8 cases of hepatic injury 2 cases were associated with right lower rib fractures (25%). Out of 10 splenic injury cases, two were associated with left lower rib fractures (20%). One case of bowel perforation was associated with pneumoperitoneum (100%).

Findings on ultrasound included hemoperitoneum, solid organ injuries (lacerations, contusions, haematomas, rupture) and perivisceral collections.

Free fluid :

Free fluid was detected in 20 cases (50%). Out of 20 cases with free fluid, 12 cases (60%) were operated and had significant organ injuries along with fluid in the peritoneal cavity. Eight cases were treated conservatively in whom lesions resolved on follow up scans.

The accuracy of ultrasound in detecting free fluid was 100% in our study. The true sensitivity of sonography may not be revealed in our study because CT or Laparotomy confirmed not all cases.

Kimura et al.[10], in their study, noted that ultrasound findings of hemoperitoneum

should be an integral part for evaluating laparotomy indication in blunt abdominal trauma.

Rothlin et al.[11], in their study of 312 patients, found the sensitivity of ultrasound for the detection of free fluid close to 98%.

Most of the splenic and hepatic injuries were associated with free fluid, however, out of 4 patients with renal injuries one was associated with free fluid (25%)

SOLID ORGAN INJURIES :

Spleen Injuries :

The spleen was the single most common organ injured in blunt abdominal trauma in the present study.

The spleen was injured in 10 cases (25%), out of these nine were detected on the US.

The commonest type detected was splenic rupture (44%) followed by intraparenchymal haematoma (33%). The other injuries present were subcapsular haematoma and laceration.

His correlates well with the study of Reinhard Hoffman et al[12], where splenic rupture was the commonest type of injury (71%) in splenic trauma.

One case of splenic laceration was missed on the US probably due to the initial isoechogenicity of the splenic injury and the presence of excess bowel gas andinability to scan in different planes uncooperative patient.

The US detected 1 case of splenic haematoma, but on laparotomy, it was normal.

8 cases out of 9 were associated with free fluid. However, 1 case of subcapsular haematoma did not show free fluid.

5 cases out of 9, underwent exploratory laparotomy follow up scans were uneventful except in 1 case, where a patient died due to ARDS and septicemia. 4

cases were treated conservatively and on follow up scans resolution of lesions noted.

Liver injuries :

Hepatic injuries were demonstrated in 8 patients (20%). Out of these 7 cases were detected on ultrasonography. The commonest lesion detected was laceration (57%) followed by haematoma (28.5%) and contusion. (14%).

In the series by R. Gruessner et al. [13] the major hepatic injuries were laceration and haematoma.

One case of hepatic laceration was missed on US (20%).

5 out of 7 cases detected on the US were associated with free fluid. 1 case each of liver laceration and contusion did not show free fluid.

3 cases underwent exploratory laparotomy. Follow up scans were uneventful. Remaining 4 cases were treated conservatively. Follow up scans showed complete resolution. 1 case was lost.

Renal injuries :

In our study, 4 patients had renal injuries (10%). Out of these, haematoma and the perinephric collection was noted in 2 cases each (40%), and 1 case of renal laceration noted. (renal laceration and the perinephric collection was noted together in one case). The US detected all cases of renal injuries.

One case with prior bilateral polycystic renal disease haematoma was noted in the right kidney.

CT was done in a case of renal laceration, and another case of renal haematoma in prior bilateral PCKD and US findings were confirmed.

1 patient underwent partial nephrectomy while others were conservatively treated.

Out of 4 cases, one was associated with free fluid. 2 cases of haematomas and one case of renal laceration did not show free fluid.

Follow up scans showed complete resolution of perinephric collection and haematomas, while the postoperative scan was uneventful.

Pancreatic injuries :

2 patients presented to us with history of blunt injury abdomen 2-3 weeksback and showed pseudocyst of the pancreas. One case was associated with free fluid and left-sided minimal pleural effusion.

Both were treated conservatively. On follow up complete resolution was noted in 1 case while the other was lost in follow up.

HOLLOW VISCUS :

Bowel and mesenteric injuries :

Bowel injury occurred in 1 patient in our study. Free gas under the diaphragm was noted on erect abdominal radiography.

It was not diagnosed directly by ultrasound. However, the US revealed free fluid and absent peristalsis.

Terminal ileal perforation was confirmed on laparotomy. Follow up scan was uneventful.

The mesenteric injury was seen in 1 patient, missed on the US. It was associated with free fluid. Was confirmed on exploratory laparotomy to be a case of a mesenteric haematoma. Follow up scan was uneventful.

None of the present study patients had an injury to diaphragm, adrenals great

vessels and urinary bladder.

Thus in our series, the commonest visceral injury was spleen (25%), followed by liver (20%) and kidney (10%).

Table 11: Comparison of our study with other authors

Authors	US detected cases	Spleen injury	Liver injury	Kidney injury
Francois I Luks et al[14]	116	44	08	40
Ming Liu et al[15]	55	16	4	1
Mu Shun Huang et al[16]	49	22	12	0
Rothlin MA et al [11]	52	22	7	10
R. Grussner et al[13]	35	18	13	0
Our study	21	10	8	4

Thus from above, it is concluded that in most of the studies, the spleen is the most common organ to be injured in BAT and liver or the kidney are the commonest organs involved after spleen.

Thus, in 21 abnormal scans (positive for organ injury), a complete misdiagnosis was made only in one patient. US findings were splenic haematoma with free fluid; however, on subsequent exploratory laparotomy spleen was normal, giving a percentage false positivity of 6.2%.

Out of 19 normal US findings (no organ injury), four false-negative scans were reported. One patient with ileal perforation, one case of a mesenteric haematoma, 1 case each of liver and spleen lacerations was missed, giving false negativity of 16%. Thus out of 40 patients evaluated by the US, a true positive of 20 and a true negative value of 15 was obtained, giving a sensitivity of 73% and a specificity of 96% on the US.

The positive predictive value is 91%, and a negative predictive value is 86%.

Table 12: Comparison of sensitivity and specificity, positive and negative predictive value ofUS in blunt abdominal trauma with studies

Authors	No. of cases	Sensitivity (%)	Specificity (%)	*PPV (%)	*NPV (%)
Grussner R et al[13]	71	84%	86%	89%	-
Akio Kimura et al[10]	72	86.7%	100%	-	-
Hoffmann R et al[12]	291	89%	97%	94%	95%
Frankois Luk's et al [14]	259	89%	96%	-	-
Ming Liu et al[15]	55	91.7%	94.7%	-	-
Our study	40	73%	96%	91%	86%

- PPV – Positive predictive value * NPV – Negative predictive value

Thus from above, it is evident that our study is comparable with above other studies for sensitivity, specificity and predictive values of ultrasound in the evaluation of blunt abdominal trauma.

Technical difficulties during US examination also had a role in the evaluation of blunt abdominal trauma. Subcutaneous emphysema, excessive bowel gas or to some extent pneumothorax causes a total reflection of sound waves and so underlying organic lesions can be missed. In very fat or obese patients, adequate resolution is impossible, which leads to false-positive and false-negative results.

Sometimes organic bleeding starts only after successful shock treatment and so can be missed in the initial sonography examination.

Artefacts secondary to improper positioning of transducer or bony structures like ribs are most commonly encountered in the examination of the spleen and left kidney and hence alter the diagnosis.

Thus, by considering the above factors, which can lead to false-positive and false-negative results, our study may differ to some extent with most of the other studies performed, in its sensitivity, specificity and predictive values.

Thus, the US's ability to accurately detect the presence of free fluid and pinpoint the injured organ helps the clinician contemplate and plan the appropriate therapeutic approach to a patient with suspected blunt abdominal trauma.

CONCLUSIONS

Thus, a total of 40 patients of blunt abdominal trauma were evaluated by ultrasonography, and positive findings (for organ injury) were detected in 21 patients. It is noted that ultrasonography is very useful and highly reliable screening modality in such cases. It is cheap and noninvasive and rapid to perform, portable for bedside evaluation in the emergency room, without any radiation to the patient, requires no administration of contrast medium and can be repeated at any time without contraindication.

The overall sensitivity of ultrasonography in evaluating blunt abdominal trauma was 83%, and specificity was 93.7%.

Intraperitoneal free fluid collection was the commonest abnormality detected. The sensitivity of real-time ultrasonography was 100% in our study because CT or Laparotomy confirmed not all cases.

Among the visceral injuries, spleen, liver, and kidney were the most common abdominal organs injured with 25%, 20% and 10% respectively. The percentage of false-positive in our study was 6.2%, and the percentage of false-negative was 16%. Compared to the sensitivity (83%) and specificity (93.7%), this percentage is negligible.

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