Original Article

Evaluation of Injuries in Patients with Blunt Abdominal Trauma by Ultrasonography taking Computerized Tomography as Gold Standard Imaging Modality-Experience at Liaquat National Hospital

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ABSTRACT

BACKGROUND: Consequent upon blunt abdominal trauma liver, spleen and kidneys are most vulnerable organs to be affected. Rapid diagnosis and appropriate management are key factors to reduce the risk of preventable death. More than 25 years ago Ultrasonography (US) was described for evaluation of injuries in blunt abdominal trauma and presently is being used as the primary imaging modality.

OBJECTIVE: To determine the diagnostic accuracy of Ultrasonography in evaluation of injuries in patients with blunt abdominal trauma by comparing findings with computed tomography taken as the gold standard imaging modality.

METHODOLOGY: Total 100 patients of blunt abdominal trauma having clinical suspicion of intra-abdominal injury such as abdominal pain, tenderness, hematuria and decreasing hemoglobin level were studied. Ultrasound using a convex probe with frequency of 3.75 MHz was performed. Images were taken in serial transverse and longitudinal planes. Computed tomography after oral and intravenous contrast administration was also performed in all cases. Sensitivity, specificity, PPV, NPV, and accuracy of Ultrasonography were calculated using Computerized Tomography as gold standard imaging modality.

RESULTS: The mean age of study population was 33.9 ±12.8 years. There were 52 (52%) males and 48 (48%) females. Sensitivity of ultrasound for evaluation of injuries in these traumatic patients was 91.9%, specificity was 84.6%, positive predictive value was 94.4%, negative predictive value was 78.6% and accuracy was 90% in the evaluation of injuries in blunt abdominal trauma.

CONCLUSION: Ultrasonography is an effective, safe and easily available imaging modality with high diagnostic value for evaluation of patients with injuries due to blunt abdominal trauma, and therefore may be used as the primary imaging modality in blunt abdominal trauma

KEY WORDS: Abdominal injuries, Ultrasonography, CT scan abdomen, Non-penetrating trauma.

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INTRODUCTION

Abdomen is one of the common and important regions in respect to trauma. Liver, spleen and kidneys are most vulnerable organs to be affected. The morbidity and mortality can increase significantly in blunt abdominal trauma if there is any delay in early diagnosis and prompt treatment. If not diagnosed and treated early results in 25-35% deaths. Mostly the causes of blunt abdominal trauma are automobile-pedestrian and motor vehicle accidents[2]. Other causes are fall, recreational or industrial etiologies. Peak incidence occurs in persons aged 14-30 years indicated by most studies[3].

Ultrasonography (US) is considered as the primary modality of choice for evaluation of intra abdominal injuries in blunt abdominal trauma. Other diagnostic modalities include computed tomography (CT) and diagnostic peritoneal lavage (DPL)[4].

While evaluating any patient of blunt abdominal trauma main focus is to detect free fluid which assumed to be hemoperitoneum. Ultrasonography is a noninvasive, rapid, accurate, portable, relatively in expensive examination, serial examinations can be performed and it can be done in unstable patients during resuscitation. Limitations of ultrasonography include its dependence on operator's skills, its utilization in obese patients where it may be difficult for adequate assessment of organ parenchyma and its limited ability to detect bowel and mesenteric injury[5].

In hemodynamically stable patients of blunt abdominal trauma, the diagnostic modality of choice is CT which is considered gold standard radiographic modality having sensitivity of 100%. The differentiation between hemoperitoneum and other fluid collections can easily be done on CT scan. The conditions that require definite laparotomy like diaphragmatic injuries, bowel perforation, mesenteric injuries, injury to gall bladder, injury to solid viscera like liver, spleen, kidneys and pancreas, ruptured urinary bladder and traumatic bony lesions [6,7]. Disadvantages include its higher cost, burden of radiation, contrast reaction, transportability of patient and scanning of critically unstable & pregnant patients[8,9].

This study would determine the usefulness of ultrasonography in evaluation of injuries due to blunt trauma in patients at a tertiary care teaching hospital which may be helpful in reducing unnecessary CT examinations and providing early and prompt treatment without any delay. Computed Tomography was performed in all included cases, provided that the patient is stable to reduce the risk of any missed injury as it is the imaging modality of choice.

The objective of this study was to determine the diagnostic accuracy of Ultrasonography in evaluation of injuries in patients with blunt abdominal trauma by comparing findings with computed tomography taken as the gold standard imaging modality.

METHODOLOGY

Patients of both genders, age 18yearsand above having any clinical suspicion of intra abdominal injury such as abdominal pain, tenderness, hematuria and decrease hemoglobin level were included in this cross -sectional study for detection of injuries in traumatic patients secondary to blunt traumatic abdominal injuries and checking diagnostic accuracy of ultrasonography by comparing findings with computed tomography taken as the gold standard imaging modality. Patients having penetrating abdominal trauma, vitally unstable and in whom laparotomy has already been performed were excluded. Sample size of 95 rounded off to 100 patients was calculated by expected sensitivity 0.91, expected specificity 0.94, expected prevalence 0.17, and desired precision 0.12, confidence level 0.90. Sampling Technique was non probability, purposive[10]. The study design was observational and cross sectional. The study was conducted in radiology department through emergency department of Liaquat National Postgraduate Medical Centre, Karachi, from January 2012 to July 2014. The approval of institutional research & ethical committee and informed consent was taken prior to commencement of the study.

Ultrasound was performed using a 3.75 MHz convex probe abdominally and images were secured in serial transverse and longitudinal planes. Computed tomography after oral and intravenous contrast media administration was done in all cases. By taking Computerized Tomography as gold standard imaging modality, the sensitivity, specificity, positive predictive value, negative predictive value and diagnostic accuracy of ultrasonography was calculated.

Ultrasonography criteria for intra abdominal injuries in blunt abdominal trauma includes, the presence of ascites with or without internal echoes within the abdominal cavity is taken as hemoperitoneum and visceral organ injury include hematoma, laceration and any echo textural heterogenity. Free fluid and or visceral injury is taken as intra abdominal injury. These patients whether diagnosed of having free fluid and visceral injury on ultrasound or with negative ultrasound for intra abdominal injury but still going for computed tomography on any strong clinical suspicion based on abdominal tenderness, distension, hematuria and decreasing hemoglobin level was included in the study. Ultrasound and CT findings were recorded on Performa. Data was entered and analyzed by using SPSS version 16. Frequency and percentage were calculated for Ultrasonography and Computerized Tomography findings. Age was presented by Mean ±SD. Sensitivity, specificity; positive and negative predictive values of Ultrasonography were calculated by 2 x 2 tables taking CT scan as gold standard imaging modality.

RESULTS

One hundred patients were enrolled in this study. The mean ±standard deviation age of study population was 33.9 ±12.8 years. There were 52 (52%) males and 48 (48%) females. There were 14 (14%) [8 males & 6 females] patients in the <20 years of age group, 60 (60%) [30 males & 30 females] patients in the 20-40 years of age group and 26 (26%) [14 males & 12 females] patients in the 41-60 years of age group (p=0.860). 60 (60%) [31 males & 29 females] patients had blunt trauma due to road traffic accident, 16 (16%) [7 males & 9 female] sustained trauma after fall from height, 13 (13%) [9 males & 4 females] due to assault and 11 (11%) [5 males & 6 females] due to other causes (p=0.537).

Blunt abdominal trauma diagnosed by ultrasound scan in 72 (72%) [37 males & 35 females] patients (p=0.844) and by CT scan in 74 (74%) [41 males & 33 females] patients (p=0.250) (Table, I & II).

As per comparison of ultrasound findings, 68 (68%) [35 males & 33 females] patients had true positive, 22 (22%) [9 males & 13 females] had true negative diagnosis, 04 (4%) [2 males & 2 females] had false positive diagnosis and 06 (6%) [6 males] patients had

false negative diagnosis of blunt abdominal trauma, as compared to the CT scan (p=0.084) (Table III).
Sensitivity of ultrasonography in the diagnosis of injuries in blunt abdominal trauma was 91.9%, specificity was 84.6%, positive predictive value was 94.4%, negative predictive value was 78.6% and accuracy was 90% in the diagnosis of injuries in blunt abdominal trauma (Table IV).

TABLE I: GENDER DISTRIBUTION OF BLUNT ABDOMINAL TRAUMA AS DIAGNOSED BY ULTRASOUND SCAN

Gender	Blunt abdominal trauma diagnosed by ultrasound	
	Yes	No
Male	37 (71.2%)	15 (28.8%)
Female	35(72.9%)	13(27.1%)

P=0.844

TABLE II:
GENDER DISTRIBUTION OF BLUNT ABDOMINAL TRAUMA AS DIAGNOSED BY CT SCAN

Gender	Blunt abdominal trauma diagnosed by CT scan	
	Yes	No
Male	41(78.8%)	11(21.2%)
Female	33(68.8%)	15(31.3%)

P=0.250

TABLE III: GENDER DISTRIBUTION OF TRUE POSITIVE, TRUE NEGATIVE, FALSE POSITIVE AND FALSE NEGATIVE CASES

Gender	True positive	True negative	False positive	False negative
Male	35(67.3%)	9(17.3%)	2(3.8%)	6(11.5%)
Female	33(68.8%)	13(27.1%)	2(4.2%)	0(0%)

TABLE IV: ANALYSIS OF SENSITIVITY, SPECFICITY, PPV, NPV AND ACCURACY

Variable	Percentage
Sensitivity	91.9%
Specificity	84.6%
PPV	94.9%
NPV	78.6%
Accuracy	90%

DISCUSSION

Abdominal injuries are the third common cause of traumatic death after head and chest injuries. Diagnostic peritoneal lavage (DPL) has been done historically to detect hemoperitoneum. The introduction of ultrasonography provides an accurate, noninvasive, readily available and time saving tool for patient with blunt abdominal trauma. Ultrasound has become a standard of care in most emergency departments[10,11]. Ultrasound has proven to be highly sensitive and specific
in detecting visceral intra abdominal injury[12,13]. The idea of focused ultrasonography is to specifically identify the presence of fluid, i.e., blood or enteral contents in the peritoneal cavity, pleura or pericardium was mooted by McKenney et al in 1996[14].
In several recent articles[15] there is citation of the limitations and benefits of ultrasonography following injuries in blunt abdominal trauma. In many studies ultrasound was performed by surgeons and there are variations in studies regarding selection criteria and methodology. The ultrasound examination may either consists of detailed abdominal study including assessment of organs parenchyma or includes brief survey for free fluid[16,17]. The surgeons do a survey for fluid detection in abdomen in trauma patients by analyzing the four quadrants of abdomen and this sort of examination is called the focused abdominal sonography for trauma[18]. It is also labeled as focused assessment for the sonographic examination of the trauma patient[19] or FAST. Many authors [20]have described the only criterion of positive study finding when they found free fluid on ultrasonography. Others [21] considered positive screening when they suspect other findings like free air, free fluid, or parenchymal abnormalities.
Our results differ from those of previous authors large proportion of our study has false positive findings due to possibility of similarity in appearance of findings of non traumatic and traumatic injuries. In our study we used ultrasonography as first tool or screening examination and when we find or suspect any abnormality we suggest that case for further evaluation and due to this we considered this as positive ultrasound finding. In our study we were more focused in evaluation of the main intra-abdominal injury rather than the detection of fluid so we labeled those cases as false positive in which Computerized Tomography also detects the fluid due to non traumatic reason. This finding is considered as positive by some previous authors even in absence of any injury. Initially at our institution all women who have free fluid on ultrasound were advised for CT

scan but our experience suggested that this fluid was physiologic in many patients. With appropriate clinical surveillance these women having isolated pelvic fluid were not considered for further investigations[22].

In our study there were twenty-two patients who underwent surgery for repair of injuries. All twenty-eight injuries were depicted by ultrasonography which required immediate laparotomy and out of 72 patients, 64 patients require surgery. Therefore, screening ultrasound for detection of injuries that required laparotomy, the sensitivity was 89 % (64 out of 72 cases), and for detection of injuries in which emergency laparotomy was required the sensitivity was 100 %(28 out of 28 cases). Figures 1 and 2 demonstrate hepatic laceration on Ultrasound and Computed Tomography of abdomen.

Ultrasonography can be ideal in situation when emergency surgical intervention is required as it can be done by surgeon and can take decision if urgent laparotomy is required even in operation theatre and all those patients who were clinically stable can be regarded as potentially unstable. The time taken during computerized tomography, the injured patient may further deteriorate, can be reduced by ultrasonography. With these great advantages of ultrasonography our institutional practice has been considerably changed.

Peritoneal lavage nowadays performed very rarely. When there is strong suspicion of injuries clinically, the modality like computed tomography is used despite of negative findings on ultrasound or when ultrasound findings are positive or when there is unavailability of ultrasound. The success of this in our institute is because we assume that all patients are at risk of occult injuries of abdomen even in cases where screening ultrasound findings are negative. They were advised to get admission in hospital and were carefully observed. Such type of protocol provokes the use of other studies when patient deteriorates clinically.

Those patients who have negative findings on computed tomography, the period of observation is similar at our hospital. There is no consensus among trauma surgeons as to the minimum observation period necessary after abdominal Ultrasound or CT with negative findings, and at our hospital there is no recommendation of only use of ultrasound at hospitals where an observation period is not routine practice. There is a strong believe and certainty that in scenarios of injuries in blunt abdominal trauma the ultrasonography is an excellent screening modality but it should be used only in centers where a period of clinical observation is a part of trauma protocol.

FIGURE I: TRANSABDOMINAL ULTRASOUND DEMONSTRATE HEMORRHAGIC LACERATION IN RIGHT LOBE OF LIVER ULTRASOUND

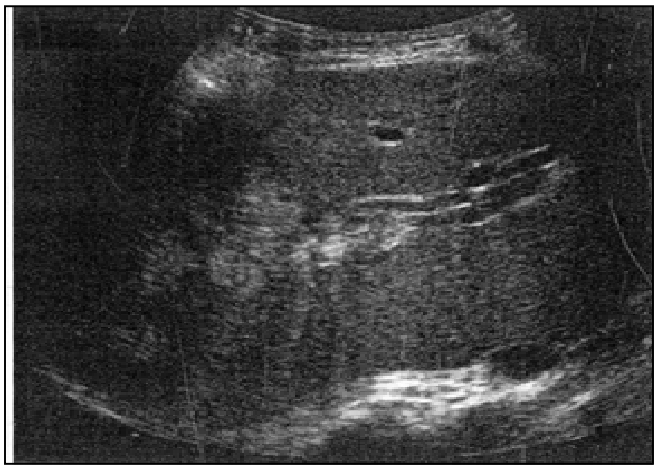
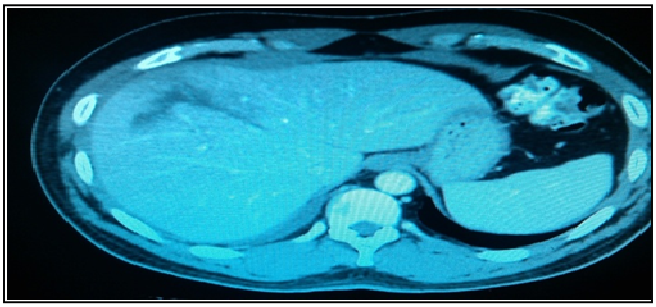


FIGURE II:
COMPUTED TOMOGRAPHY CONFIRMED THE LACERATION DEMONSTRATED ON



CONCLUSION

For patients with blunt abdominal trauma the use of ultrasonography in conjunction with clinical assessment has high diagnostic yield. Ultrasound is a useful and valuable modality which is easily available, easy to use, cost effective and has no radiation burden. Because of its high negative predictive value, we recommend that clinical examination and follow up with ultrasound is adequate for patients whose US results are negative for intra-abdominal organ injury.

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