Research article

Ultrasound Imaging in Settings of a Natural Disaster: Experience from October 8th 2015 Earthquake in Pakistan

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Abstract

Ultrasound (U/S) imaging has a broad spectrum of applications in medical practice. The earthquake of October 8, 2005 was one of the most severe in the history of Pakistan, claiming around 80,000 lives in the region of Azad Kashmir. U/S imaging was the only diagnostic radiological investigation available in the region. The study was aimed to evaluate the role of U/S in diagnosing internal injuries among victims of the earthquake. All the patients referred for U/S imaging at Abbas Institute of Medical Sciences (AIMS)were accordingly examined and the data was recorded on a proforma. The procedures included examination of chest, abdomen, pelvis, extremities and fetal wellbeing (FWB). U/S findings were correlated with clinical, laboratory or surgical exploratory findings. A total of 87 patients, 22 males and 65 females, were examined. Definitive diagnoses were established in 16.8% of abdominal examination cases, 76.6% of abdomen/pelvis examinations and 78.6% of Gynae & Obstetric examination cases. The course of management was changed completely using U/S observations in 36% of the cases of chest examinations, 71.9% of the cases of abdominal & pelvic examination and 75.8% of the cases of Gynae & Obstetrics. It was concluded that U/S is a useful diagnostic modality in the settings of a natural disaster. Head and spine injuries, however, cannot be assessed with this diagnostic modality and needs special consideration.

Keywords: Ultrasound, Kashmir, earthquake disaster

Introduction

Ultrasound (U/S) imaging has a broad spectrum of applications in medical practice. It is a non-invasive technique used to assess internal body structures/organs. The findings are often definitive and have pivotal role in disease management. Of particular importance is the use assessment of pregnancy. Ultrasound works on waves generated by piezoelectric transducer at frequencies that are in-audible to humans (i.e. >20,000 Hz)[1].

On October 8, 2005, a series of earthquakes measuring a maximum of 7.6 on the Richter scale struck Kashmir and other Northern areas of Pakistan. The epicenter was about 19 kilometers northeast of Muzaffarabad (the capital of Pakistan administered Kashmir), and 100 kilometers north-northeast of Islamabad, Pakistan. The catastrophe resulted in widespread damage, wiping out entire villages and flattening towns and cities. It was the most severe disaster in the history of Pakistan, claiming around 80,000 lives and severely injuring another 80,000. Most hospitals were destroyed and limited medical facilities were available in the immediate aftermath. Building collapse was associated with widespread crush injuries[2-5]. From a practical point of view, all the radiological instruments, along with others, were out of order for several weeks.

A group of volunteers from Jinnah Postgraduate Medical Centre (JPMC), the National Institute of Child Health (NICH) and the National Institute of Cardiovascular Diseases (NICVD) comprised of 20 members, including: four orthopedic surgeons, 02 thoracic surgeons, 01 cardiac surgeon, 01 radiologist, 02 postgraduate trainees and 10 paramedics. Our team reached Mansehra on the 2nd day of the disaster. The roads were blocked due to land sliding. There was no electric supply in Muzaarabad. We settled in the Abbas Institute of Medical Sciences (AIMS). It took more than two days to establish generator based electric supply. The 600 mAs X–ray machine of AIMS could not be operated by the generator based electric supply.

The only Radiologist/Sonologist in the city of Muzaffarabad & its surroundings was from the team mentioned above. The radiologist was equipped with a portable U/S machine (Facuda®) and performed sonography of all body regions. All the radiological modalities, along with others, were out of order, the role of portable U/S was assessed in injured earthquake victims to confirm or change the clinical diagnosis.

The current study shares experience of this group regarding utility of ultrasound imaging in settings of a natural disaster as the only radiological investigation modality.

Methods

All the patients who were referred to AIMS for ultrasonographic assessment were enrolled into the study. Data was recorded on a proforma excluding patients who could not be followed. Examinations included that of chest, abdomen, pelvis, fetal well-being (FWB) and extremities. Examination of the chest and abdomen were considered as separate entities. U/S findings were compared with clinical, laboratory and/or surgical exploratory findings.

The cases diagnosed as hemothorax (with supportive history based evidence) on U/S were also measured for depth; if less than 4.0 cm, a diagnostic tap was performed. In those with >4.0-cm deep hemothorax, an urgent tube thoracostomy was performed by a thoracic surgeon. Cases of hemopneumothorax, hemothorax, pneumothorax and subcutaneous/surgical emphysema were also confirmed by diagnostic tap, tube thoracostomy and/or X-raychest.

Results

Thirty two patients were evaluated for abdomen and/or pelvic diseases, of which 14 were males and 18 were females. A total of 25 cases were sent for chest examination. The U/S findings in these cases are listed in Table 1. Two of the patients having spinal trauma and distended Urinary Bladder (UB) were diagnosed as having large fibroids by the gynecologist and general surgeon. U/S confirmed that it was simply a distended UB on both occasions; after catheterization 900 ml & 700 ml of urine was collected respectively and the distension disappeared. UB rupture cases were diagnosed and confirmed as mentioned above. Pseudokidney sign was observed in three patients, two females and a male; all three were found to have colonic pathology. In pseudokidney sign, the diseased large gut, in some situations, give appearance similar to that of kidneys on U/S examination. In cases of peritonitis due to perforation of gut, fluid collection in the abdomen was confirmed on diagnostic tap and then laparotomy. In case of pneumoperitoneum, free gases with posterior acoustic shadowing were noted deep to the anterior abdominal wall. In case of paralytic ileus, no bowel movement was noted on U/S. Cases of renal & gall bladder calculi did not need further confirmation. Worm infestation of the small intestine was found in two children. A case of large renal cortical cyst measuring 50 ml was also found and dealt with accordingly. In total, 35 cases were referred for abdomino-pelvic examinations. their description is provided in Table 2.

The total number of patients evaluated for FWB and Gynae/Obs was 29. Most of the pregnancies were in range of 3 to 4½ months of gestation. These were suspected to have Intra-uterine deaths (IUDs) and/or placental hemorrhage and were referred accordingly. Among these cases, three IUDs and two complete abortions were confirmed on U/S. One suspected case of early pregnancy revealed no sonological signs of conception i.e. Decidual reaction etc. and was confirmed on pregnancy test. The findings and confirmative tests are presented in Table 3.

One male patient was evaluated for deep venous thrombosis (DVT) on U/S lower limb. A clot popliteal vein was observed in this case. Blood flow pattern could not be detected as we had Gray scale U/S machine.

The management was changed completely using U/S observations in 36% of the cases of chest examinations, 71.9% of the cases of abdominal & pelvic examination and 75.8% of the cases of Gynae & Obstetrics. On cumulative scale the management was altered in 52 (62%) out 87 cases based on U/S findings. Confirmatory tests were performed in 49 cases which were in concordance with U/S findings.

Table 1. Findings on U/S Chest

	No. of pts	%
Unilateral pneumothorax	1	4
Unilateral mild hemothorax	3	12
Unilateral moderate hemothorax	3	12
Bilateral moderate hemothorax	1	4
Unilateral hemopneumothorax	4	16
Bilateral hemopneumothorax	2	8
Consolidation	4	16

Table 2. Findings on U/S Abdomen

	No. of pts	%
Distended Urinary bladder	3	8.5
Urinary bladder rupture	2	5.7
Peritonitis due to perforation of gut	2	5.7
Blood clot in urinary bladder	2	5.7
Growth in colon	2	5.7
Gut distended with gasses	1	2.8
Absent bowel movements (paralytic ileus)	1	2.8
Pneumoperitoneum	1	2.8

Table 3. Confirmatory Tests for U/S findings

	No. of pts	%
X - ray chest	14	28.6
Diagnostic tap	8	16.3
Tube thoracostomy unilateral	8	16.3
Foley's catheterization	7	14.3
Tube thoracostomy bilateral	2	4.1
Evacuation	3	6.1
Laparotomy	2	4.1
Flatus tube	1	2.0

Diaphragmatic injury	1	4
Surgical/sub-cutaneous emphysema	2	8
Normal U/S chest	4	16
Total	**25**	**100**

Cholelithiasis	1	2.8
Enlarged prostate	2	5.7
Worms in small intestine	2	5.7
Renal calculi	2	5.7
Large renal cortical cyst	2	5.7
Cystitis	1	2.8
Polycystic kidneys disease	1	2.8
Normal U/S abdomen	10	28.5
Total	**35**	**100**

Recommendations for colonoscopy & biopsy †	2	4.1
Pregnancy test	1	2.0
Urine D/R	1	2.0
Total	**49**	**100**

† The facility was not available there, on that occasion

D/R, detailed report

Discussion

In the current study we found ultrasound to be of significant diagnostic value in the settings of natural catastrophe. Among the major challenges faced was inadequate experience with disaster medicine. The psychological consequences seem to be long-lasting especially for those who have survived with elevated degree of exposure to trauma[6]. Agility and pro-activeness is expected from field hospitals in their mode of functioning[7].In the current study we found ultrasound to be of significant diagnostic value in the settings of natural catastrophe. Among the major challenges faced was inadequate experience with disaster medicine. The psychological consequences seem to be long-lasting especially for those who have survived with elevated degree of exposure to trauma[6]. Agility and pro- activeness is expected from field hospitals in their mode of functioning[7].

When kinetic energy transfers to human body it frequently results in blunt trauma to chest. This may inflict severe injuries including thoracic skeleton fractures, pleural space disintegration, pulmonary parenchymal laceration and mediastinal structural damage. An organ-based assessment for thoracic trauma can be followed as a systematic approach. Conventional radiography primarily helps in diagnosing thoracic trauma, accompanied by ultrasonic checkup of abdomen and pleura (EFAST & FAST) one after another.

It has been established that CT scan serves as vital innovation for evaluation of thoracic trauma. Time consuming procedures in critically traumatized patients are being replaced potentially by fast helical CT scanning. It is helpful to spot intraperitoneal fluid and free air, detect the level of solid organ injury, spot injuries of retroperitoneal and often useful in deciding for conventional treatment. The time of patient to stay in CT scan room is reduced by rapidly performing helical CT. Additionally; coronal and sagittal reconstruction images have been improved over the years; help is hence attained in spotting ruptured diaphragm[8-12]. Nonetheless, importance of U/S imaging in the absence/unavailability of CT scan is of prime consideration[13]. Same was the case observed in our situation in Kashmir, Muzaffarabad where all other service related to radiological modality was found. Extended focused assessment with sonography for trauma(EFAST) has comparable utility as that of chest X-ray (CXR); the specificity of U/S rather exceeds in cases of occult pneumothoraces (OPTXs)[14,15]. A previous study found U/S to be comparable with CT scanning in assessment of OPTXs[16]. Similarly sonographic findings are more accurate in diagnosis of fractures as compare to radiography[17].

Despite advances in trauma care, significant morbidity and mortality exists which could be minimized provided all the injuries are immediately identified. Mass disasters compound this challenge further due to delayed referral. Two treatable factors are hypoxia and hypovolemia which may occur secondary to haemorrhage into the chest and abdomen. Pneumothorax is also a frequent cause of preventable trauma death. Clinical examination is often limited and attending physicians/surgeons often rely on radiological imaging[18-21]. In the current study, U/S findings significantly altered the course of management in cases with pneumothorax. Besides diagnosis, U/S can be of great utility in therapeutic interventions in such cases. An ultrasound-guided thoracentesis not only facilitates the procedure but improves its safety[22].

Feussner H & co-workers stated that lethality and morbidity of blunt abdominal trauma are directly dependent on the immediately valid diagnostic work-up. Since blunt abdominal trauma usually occurs in the setting of multisystem injury and patients are no longer cooperative, clinical methods of diagnosis are unreliable. Since the facilities to perform ultrasound are provided in all emergency units and knowledge of ultrasonography is an essential part of surgical training, contemporary diagnostic procedures like peritoneal lavage have almost completely lost their former important clinical role. Similarly, diagnostic laparoscopy is, in contrast to abdominal perforations, no longer of importance[23]. Griffin XL and co-worker found peritoneal lavage as a safe diagnostic strategy[24]. We, hoever, did not perform any peritoneal lavage because the sensitivity and specificity of ultrasonography in detection of free intraperitoneal fluid is over 90%[25]. In our case, the detection rate was 100%.

U/S is easy and quick to perform, it permits an accurate diagnosis with a low ratio of error. Particularly, it gives the chance to operate in emergency patients with steady haemodynamic conditions and to follow up those with partial parenchymal lesions, monitoring the clinical status in order to properly choose between conservative treatment and delayed surgery. Hence, unnecessary laparotomies are now uncommon, and a wide array of interventional radiological techniques can be used to treat abdominal emergencies without surgery[26-29]. A major drawback of ultrasound is its operator dependency, but when applied by a proficient examiner using a goal-directed, time sensitive protocol, does not delay patient management and provides diagnostic and therapeutic benefit[30]. In addition, a study performed by Abu- Zidan FM and co-workers at University hospital, Kuwait, showed that the sensitivity was lesser in the hands of the surgeon than the radiologist (67% compared with 90%)[31].

Conclusion

We concluded that U/S imaging in establishing diagnosis has a pivotal importance in settings of natural disasters. U/S served useful information in cases of abdomen, pelvis, gynecological/obstetric and thoracic trauma. The diagnostic modality, however, did not prove to be of significant help in those with Head & Spinal injuries.

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Conflict of Interest

We hereby declare that we do not have any conflict of interest related to publication of this article.

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None

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