COMPARATIVE ASSESSMENT OF ULTRASONOGRAPHY (USG) AND CONVENTIONAL RADIOGRAPHY FOR REVEALING THE BONY FRACTURES IN ADULTS

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Abstract
Rapid developments in computing hardware and microelectronic technology have facilitated technological advancement in ultrasonography (USG) in the last 3 decades, making it applicable not only to soft-tissues, but also to bony lesions. This has increased interest in evaluating ultrasound imaging as an alternative to conventional radiography. Hence, based on above literate findings the current study was planned to assess that comparative evaluation of the Ultrasonography and conventional radiography in the detection of the bone fracture in the patients referred to Department of Radiography.

The study was planned by enrolling 25 patients identified as fracture cases. The patients were referred to the Department of Radiology in the Narayan Medical College and Hospital from May 2017 to Dec 2017 was enrolled in the present study. The patients were examined by the Ultrasonographic as well as conventional radiographic techniques. Open, unstable or suspected compound fractures, unstable patients with deranged vitals and pregnant females were excluded from the present study.

Ultrasoundography is a very rapid, cost-effective, and radiation free imaging technique for detection of superficially situated bone fracture. Based on the findings of the present analysis, screening performance characteristic of ultrasonography in detection of fractures was found to be higher than radiography. USG can replace conventional radiography in cases of isolated uncomplicated fractures. In cases of doubtful fracture, combination of USG and conventional plain films may be considered to avoid unnecessary exposures from higher imaging like CT scan.

Keywords: Ultrasonography, Conventional Radiography, Bony Fractures, USG, etc.

Introduction:
A bone fracture (sometimes abbreviated FRX or Frx, Fx, or #) is a medical condition in which there is a partial or complete break in the continuity of the bone. In more severe cases, the bone may be broken into several pieces.[1] A bone fracture may be the result of high force impact or stress, or a minimal trauma injury as a result of certain medical conditions that weaken the bones, such as osteoporosis, osteopenia, bone cancer, or osteogenesis imperfecta, where the fracture is then properly termed a pathologic fracture.[2]

Both high- and low-force trauma can cause bone fracture injuries. Preventive efforts to reduce motor vehicle crashes, the most common cause of high-force trauma, include reducing
distractions while driving. Common distractions are driving under the influence and texting or calling while driving, both of which lead to an approximate 6-fold increase in crashes. Wearing a seatbelt can also reduce the likelihood of injury in a collision.[3]

A common cause of low-force trauma is an at-home fall. When considering preventative efforts, the National Institute of Health (NIH) examines ways to reduce the likelihood of falling, the force of the fall, and bone fragility. To prevent at-home falls they suggest keeping cords out of high-traffic areas where someone could trip, installing handrails and keeping stairways well-lit, and installing an assistive bar near the bathtub in the washroom for support. To reduce the impact of a fall the NIH recommends to try falling straight down on your buttocks or onto your hands. Finally, taking calcium vitamin D supplements can help strengthen your bones. [4]

Although bone tissue itself contains no nociceptors, bone fracture is painful for several reasons:[5]

- Breaking in the continuity of the periosteum, with or without similar discontinuity in endosteum, as both contain multiple pain receptors.
- Edema of nearby soft tissues caused by bleeding of broken periosteal blood vessels evokes pressure pain.
- Involuntary muscle spasms trying to hold bone fragments in place.
- Hematoma on the fracture site.

Damage to adjacent structures such as nerves, muscles or blood vessels, spinal cord, and nerve roots (for spine fractures), or cranial contents (for skull fractures) may cause other specific signs and symptoms.

Some fractures may lead to serious complications including a condition known as compartment syndrome. If not treated, eventually, compartment syndrome may require amputation of the affected limb. Other complications may include non-union, where the fractured bone fails to heal or mal-union, where the fractured bone heals in a deformed manner.

Complications of fractures may be classified into three broad groups, depending upon their time of occurrence. These are as follows –

- Immediate complications – occurs at the time of the fracture.
- Early complications – occurring in the initial few days after the fracture.
- Late complications – occurring a long time after the fracture.

The natural process of healing a fracture starts when the injured bone and surrounding tissues bleed, forming a fracture hematoma. The blood coagulates to form a blood clot situated between the broken fragments. Within a few days, blood vessels grow into the jelly-like matrix of the blood clot. The new blood vessels bring phagocytes to the area, which gradually removes the non-viable material. The blood vessels also bring fibroblasts in the walls of the vessels and these multiply and produce collagen fibres. In this way, the blood clot is replaced by a matrix of collagen. Collagen’s rubbery consistency allows bone fragments to move only a small amount unless severe or persistent force is applied.

At this stage, some of the fibroblasts begin to lay down bone matrix in the form of collagen monomers. These monomers spontaneously assemble to form the bone matrix, for which bone crystals (calcium hydroxyapatite) are deposited in amongst, in the form of insoluble crystals. This mineralization of the collagen matrix stiffens it and transforms it into bone. In fact, bone is a mineralized collagen matrix; if the mineral is dissolved out of bone, it becomes rubbery. Healing bone callus on average is sufficiently mineralized to show up on X-ray within 6 weeks in adults and less in children. This initial "woven" bone does not have the strong mechanical properties of mature bone. By a process of remodelling, the woven bone is replaced by mature "lamellar" bone. The whole process may take up to 18 months, but in adults, the strength of the healing bone is usually 80% of normal by 3 months after the injury.
Several factors may help or hinder the bone healing process. For example, tobacco smoking hinders the process of bone healing,[6] and adequate nutrition (including calcium intake) will help the bone healing process. Weight-bearing stress on bone, after the bone has healed sufficiently to bear the weight, also builds bone strength.

Although there are theoretical concerns about NSAIDs slowing the rate of healing, there is not enough evidence to warrant withholding the use of this type analgesic in simple fractures.[7]

A bone fracture may be diagnosed based on the history given and the physical examination performed. Radiographic imaging often is performed to confirm the diagnosis. Under certain circumstances, radiographic examination of the nearby joints is indicated in order to exclude dislocations and fracture-dislocations. In situations where projectional radiography alone is insufficient, Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) may be indicated.

Rapid developments in computing hardware and microelectronic technology have facilitated technological advancement in ultrasonography (USG) in the last 3 decades, making it applicable not only to soft-tissues, but also to bony lesions. This has increased interest in evaluating ultrasound imaging as an alternative to conventional radiography. Hence based on above literate findings the current study was planned to assess that comparative evaluation of the Ultrasonography and conventional radiography in the detection of the bone fracture in the patients referred to Department of Radiography.

Methodology:

The study was planned by enrolling 25 patients identified by the fracture. The patients were referred to the Department of Radiology in the Narayan Medical College and Hospital May 2017 to Dec 2018 was enrolled in the present study. The patients were examined by the Ultrasonographic as well as conventional radiographic techniques. Open, unstable or suspected compound fractures, unstable patients with deranged vitals and pregnant females were excluded from the present study.

Each patient was subjected to detailed history, local examination, and conventional radiography with appropriate views. This was followed by ultrasonography using real time scanner (GE Logic 9) with a high frequency linear transducer in both longitudinal and transverse planes. The results of radiography and ultrasonography were compared to see their relative efficacy in the detection of fractures.

All the patients were informed consents. Approval of the institutional ethical committee was taken prior to conduct of the study. The aim and the objective of the present study was conveyed to the patients.

Results & Discussion:

Ultrasonography is a quick, noninvasive diagnostic imaging modality with no risk of radiation exposure as it only uses sound waves. It was originally used for soft-tissue evaluation. Gross swelling and tenderness over the fracture can make the procedure uncomfortable for the patient and can also make scanning of the bony outlines difficult, decreasing the accuracy of the process. In this present study, there was not much difficulty in examination of patients with gross swelling and tenderness. Reduced tenderness may be because of the analgesic effect of medications taken by the patients.

The purpose of the present study was to investigate whether ultrasonography can be used as a diagnostic tool to study fractures. We found that ultrasonography, when performed and interpreted by experienced ultra-sonographers, had high accuracy as a diagnostic modality for the evaluation of suspected fractures. There were no systematic differences between the results of ultrasound and those of conventional radiography, and ultrasound had a high sensitivity and specificity. This finding indicates that ultrasonography can be used as a diagnostic tool to exclude fractures.
Table 1: Demographic Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>No. of Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td></td>
</tr>
<tr>
<td>20 – 30 years</td>
<td>3</td>
</tr>
<tr>
<td>31 – 40 years</td>
<td>5</td>
</tr>
<tr>
<td>41 – 50 years</td>
<td>8</td>
</tr>
<tr>
<td>51 – 60 years</td>
<td>9</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>15</td>
</tr>
<tr>
<td>Female</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 2: Association of the results of radiography with result of USG

<table>
<thead>
<tr>
<th>Type of bone</th>
<th>Result of radiography</th>
<th>Result of USG: Negative</th>
<th>Result of USG: Positive</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long Bone</td>
<td>Negative</td>
<td>6</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>0</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>6</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Flat Bone</td>
<td>Negative</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>0</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Short Bone</td>
<td>Negative</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Positive</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

Fractures of the humerus, forearm, ankle, and long bones in general can be diagnosed with very high sensitivity and specificity. Fractures to bones of the hands and feet are more likely to be overlooked on ultrasound and should therefore be ruled out using another imaging procedure. In addition, our analyses showed ultrasound to be of greater diagnostic value in children and adolescents than in adults.

Figure 1: Conventional Radiography
These findings are in line with those of previously published systematic reviews. Joshi et al. [8] summarized the findings of 8 relevant studies on the diagnostic value of ultrasound for fractures to the extremities and proposed the use of ultrasound in addition to x-ray. Katzer et al. [9] reported on 8 studies that investigated forearm fractures in children only. They found ultrasound to be of comparable diagnostic value to x-ray and superior to it in terms of patient comfort, time required, and cost-efficiency. Douma-den Hamer et al. [10] included 16 studies in a meta-analysis that investigated the accuracy of ultrasound in distal forearm fractures. As noted by Douma den Hamer et al., the fact that occult and other fractures that were detected on ultrasound but not on x-ray were counted as false positives may result in systematic underestimation of the accuracy of ultrasound for other fracture locations too, such as those of the forearm [10].

The use of ultrasound has increased significantly over the last decade. During this period, focus has swerved toward using ultrasound in the ED and in the pre-hospital setting [11]. The E-FAST (Extended Focused Assessment Sonography in Trauma) is affirmed as well as using in patients with major trauma [12]. Additional emergency use of ultrasound includes diagnosis of pulmonary problems in children, the evaluation of ophthalmic trauma and aid to achieve vascular access in the patients with hypovolemic shock [13]. Despite the use of radiography as gold standard in the evaluation of orthopaedic injuries, use of the bedside ultrasound has
several potential supremacy than plain radiography include to desist from exposure with ionizing radiation in particular patients such as pregnant women and paediatric patients, in the prehospital environments, and to reduce exposures of consecutive ionizing radiation due to radiographs following fractures reduction, extensive access, affordable, and being bedside. The potential of ultrasound to diagnose fractures of the ribs and sternum should be evaluated separately. Most publications on this subject were excluded from our review due to unsuitable study design [14]. X-ray cannot be considered the gold standard for these fractures, as some studies found ultrasound to be superior to it in diagnosing fractures of the ribs and sternum. Future studies on the accuracy of ultrasound in diagnosing fractures of the ribs and sternum should therefore select a reference standard that can establish the outcome correctly, such as MRI or strict follow-up examinations to detect callus formation, as proposed by Rainer et al. [15]. Low sample volumes and lack of control group are two important limitations of the present study, which undermine the generalizability of the results. Conforming to trauma guidelines, ultrasound can be helpful for evaluation of some cases such as intra-peritoneal fluid, organ damage and pneumothorax. It is recommended that more studies be performed in this regard to infer its role in trauma guidelines.

**Conclusion:**

Ultrasonography is a very rapid, cost-effective, and radiation free imaging technique for detection of superficially situated bone fracture. Base on the findings of the present analysis, screening performance characteristic of ultrasonography in detection of fractures was found to be higher than radiography. USG can replace conventional radiography in cases of isolated uncomplicated fractures. In cases of doubtful fracture, combination of USG and conventional plain films may be considered to avoid unnecessary exposures from higher imaging like CT scan.

**Reference:**

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