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CONTRIBUTION OF 3D VOLUME RENDERING COMPUTED TOMOGRAPHY IN THE ASSESSMENT OF BONE FRACTURES

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Article Info

Abstract

The imaging of fractures in radiology departments is the most vital step after bony trauma where 3D volume rendering CT gives immediate and through examination of musculoskeletal system. Volume rendering images has proved particularly significant for the diagnosis of subtle abnormalities. 3D (VR) is a technique of creating a realistic 2-D image that intuitively conveys 3-D relationships which can be easily understood by non-radiologists. Prospective cross-sectional study was conducted to evaluate the contribution of 3D (VR) computed tomography for the assessment of bone fractures at District Headquarter Hospital Timergara Dir (Lower), KPK, Pakistan. A total of 110 subjects with the history of trauma (bone fracture) confirmed on both X-ray and CT scan with 3D VR were recruited in the study. Toshiba X-ray and Toshiba Asteionsuper 4 CT scan machines were used. Exposures were taken in axial views of the region of interest with 5-10mm slice thickness at 100-250 KV. Predesigned questionnaires were used for data collection, which was then transferred on EXCEL software and then finally analyzed using MEDCALC. In our study the two main causes of trauma included history of fall and road traffic accident. The results showed that the complete and comminuted fractures were the commonest type of fractures among these patients. 3D rendered images on CT showed high accuracy in findings of number of fragments, fracture line type, soft tissue extension and detection of damage to the blood vessels. Only one brachial artery damage by humeral fracture remained undetected on CT which was revealed on intra-operatively. It is concluded that the three-dimension volume rendering technique is feasible, flexible and clinically accurate.

Keywords:
3D Volume Rendering (VR), Computed Tomography (CT) Fracture Imaging, Musculoskeletal Trauma, Radiological Assessment Accuracy.

INTRODUCTION

The visualization of cracked bone is the most incessant practice in Radiology Department (1]. Diverse and traditional imaging methodologies include X-ray (first step to diagnose bone fractures) and Computed Tomography (CT) [2]. Advance technology incorporates 3D Reconstruction with volume rendering and spiral CT, grant expedious and scrutiny of musculoskeletal system. X-ray has some constraints in identification of subtle and non-displaced fractures as well as in complex anatomic areas. Volume rendering is distinct from thin slice tomography and 3D model projections, such as maximum intensity projections (MIP). All volume renderings become projections when viewed on a two-dimensional display, blurring the distinction between projections and volume renderings. However, the volume rendering models use a combination of techniques to create realistic and/or perceptible representations, such as coloring and shading [3]. The method of creating a realistic 2-D image that naturally expresses 3-D relationships and can be comprehended by non-radiologists is known as three-dimensional rendering. The resulting 3-D image's form, quality, and utility are all influenced by the rendering technique. [4] [5]. The two main rendering techniques used in radiology are surface rendering and volume rendering. To objectively analyze the elements and recognize the restrictions of each technique in making therapeutic judgments, it is vital that the physician knows all the fundamental concepts and methods applied in each rendering process, as well as the images that result from them [6] Subcortical lesions, slightly displaced fractures, and concealed areas of interest are efficiently shown with little artifacts using volume rendering techniques [7]. VR has two privileges over surface rendering: First, percentage classification renders volume-averaged CT data in a physically realistic manner. Second, it merges the whole data from the volume into the image that is displayed. The depicted intensity is concerned with the quantity of bone encountered along a line going across the volume, and it might indicate numerous overlaying and interior features [8]. To improve 3-D understanding of volume produced images, apply surface shading and enhanced opacity [9]. The increased computing cost and difficulty in comprehending 3-D relationships in exceptionally transparent volume-rendered images are the main disadvantages of volume rendering [10].

Volume rendering technique was developed to overcome for the accurate representation of surfaces in the iso-surface techniques. Scientific and engineering applications that demand viewing of three-dimensional datasets rely on volume rendering [11]. In addition to different reconstructions and slices, volume rendering is commonly used to display CT and MRI data. Volume rendering is used to aid in the depiction of human anatomy, surgical treatment, and medical education. Although volume rendering is less commonly employed in general ultrasonography, it has been used in echocardiography [12].3D CT is proving to be more than just a problem-solving tool. The boon of spiral CT along with 3D (VR) is that it is swift and bestow all the imperative guidance in a sole radiologic study to address particular queries by interactively exploring discrete characteristics of the dataset which needed two or more studies before. [13] [14] On contrary to the accelerating quandary of infobesity due to current scanners' high capture rates, 3D (VR) has the ability to make the normal radiologic examination concise [15]. Application of 3D (VR) includes volume data management, in which acquisition, re-sampling editing of the data set and rendering parameters which includes window width and level, opacity, brightness, percentage classification and image display are involved [16] 3D volume rendering has wider applications, but at present, it has been used in commercially available medical imaging software packages [17].

LITERATURE REVIEW

Brief History:

The skeleton of vertebrate animals is made up of a rigid organ called bone which protects other organs and give support to body, allow mobility and along with producing white red blood cells it also stores minerals [23]. It is composed of dense connective tissue having a honeycomb-like matrix internally, giving rigidity to it. Three distinct cell types are fond in bone tissues: osteoblasts and osteocytes (responsible for its formation and mineralization) and osteoclasts (involved in bone resorption). [26]. A bone fracture is a pathological condition in which the continuity of the bone is broken, either partially or completely [20]. In worse states it may be broken down into several pieces. The two main causes of trauma (history of fall and Road Traffic Accident RTA) are most common causes of bone fractures. The bone fractures can be detected using radiological technologies (X-rays technology, CT scan technology, MRI technology, 3Dreconstruction with volume rendering (VR) technology). The first step for the identification of bone fractures is conventional X-ray. However, it has constraints in detection of subtle and non-displaced fractures, as well as complex anatomical regions. The use of spiral CT and 3D volume rendering reconstruction enables a quick and thorough examination of the musculoskeletal system

Classification of Bone Fractures:

Fractures can be of following types:

- **On Mechanism Basis:**

A. Traumatic fracture:

A Fracture caused by some sustained trauma (e.g.: caused by a fall, fight or a roadside accident).

B. Pathologic Fracture:

A type of fracture which results in bone weakness due to some underlying disease is known as pathological fracture (e.g.: due to metastasis leading to bone weakness and fracture and osteoporosis).

C. Peri-prosthetic fracture:

Fracture caused at the point of mechanical weakness such as at the end of an implant.

On Soft Tissue Involvement:

A. Closed fracture:

The type of fracture in which breakage of bone occurs that does not penetrate the skin. A severe soft-tissue injury can be associated with these cases.

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B. Open/compound fractures:

An open fracture also known as compound fracture, results in an open wound that usually results due a fragment of bone piercing through the skin at the time of injury.

- **On Basis of Displacement:**

A. Non-displaced fracture:

Those fractures in which bone is not displaced from its original position but cracks either part or all of the way through. However, maintains its proper alignment.

B. Displaced fracture:

Those in which bone (fragments) are displaced from its original position.

- **On Basis of Patterns of Fracture:**

A. Linear fracture:

The fracture type in which there is one thin fracture line parallel to bone's axis, without any splitting of fracture line and formation of compression or distortion in bone.

B. Transverse fracture:

Fracture that is perpendicular to the bone's long axis is known as transverse fracture. This typically occurs when a blow or an abundant force hit perpendicular to the bone.

C. Oblique fractures:

A fracture occurring oblique to the plane of long axis of bone is known as oblique fracture, the break caused is oblique or at an angle to the bone and most often prone to angulation.

D. Spiral fracture:

The type of fracture in which a rotating force (torque) is applied along the axis of a bone.

E. Compression fracture/ wedge fracture:

It mostly occurs in vertebrae, due to osteoporosis when the front portion collapses in spine.

F. Comminuted fracture:

The type of fracture in which the bone breaks into various pieces is known as comminuted fracture. Small bone such as those of hands and feet are more prone to comminuted fractures.

G. Impacted fracture:

The fracture in which bone fragments are driven into one another is called impacted fracture. In this type the broken ends are jammed into each other due to injury. On x-ray, it shows up as an area of increased opacity.

H. Avulsion fracture:

The physical trauma causing the fragment of a bone to tear way from the rest of the bone is termed as avulsion fracture. It is an injury to the bone at a point where a tendon or ligament is located which then pulls off a piece of bone.

Diagnosis of Bone Fractures:

- Take History.
- Perform Physical Examination.
- Radiographic Findings (In some cases, a radiographic evaluation of surrounding joints is required to rule out dislocations and fracture-dislocations.) (40)
- (CT) or (MRI) (When radiological findings alone are not enough, (CT) or (MRI) are recommended).
- spiral CT and 3D reconstruction with volume rendering (VR) (the complex of both gives immediate and detailed exam. 3D (VR) images are significant for detecting subtle abnormalities, aiding in diagnosis.)

volume rendering 3D reconstruction

The 3D (VR) involves volume data management, rendering parameters, and image display. It is a process through which volume data is moved from the scanner to the work station screen.

- **Volume Data Management**

Data management is concerned with numerous functions such as acquisition, editing and resampling of data set. Early alterations performed in 3D rendering were to introduce new and more efficient methods for pre-processing of data, to enhance the computing speed and to make it easier to visualize the anatomy.

Acquisition

For 3D volume rendering, the transition traditional to spiral CT has its benefits. The original spiral CT scanners were only able to get thinner or wider sections from small and larger areas of body due to tube heating. Longer acquisition times are possible with newer scanners, resulting in bigger amounts of such a high-resolution data (47). Spiral CT scanner advancements provides us various functional gains as higher resolution vascular imaging and advances in conventional imaging techniques such as higher sensitivity and specificity allows detection of liver lesions and lung nodules. These high-resolution data are perfect for 3D volume rendering. Spiral CT allows axial images to be reconstructed at any intervals, improving multi-planar and 3D reconstruction standards (49).

- **Resampling**

It is done using an algorithm that converts a data set into a new or usually smaller data set.one usually a smaller one, to speed up the image processing and is also useful in both dynamic and static displays. Resampling is divided into two distinct operations. Scaling of axial sections is carried out on x and y axis to minimize the size of data set. (e.g., from 512 × 512 to 256 ×256). Spiral CT scans are rebuilt with volume rendering methods, the z axis units have to be calibrated in units equal to those of x and y axis to ease computations; on other work stations, this is not very essential.

- **Editing**

Manual refurbishment is used to remove things from adjacent structures such as organs. It is necessary to make the outline of the selected area for each original axial image, segmenting the image into data to be presented or hidden. (53) The opacity of the suppressed voxels is set to 0. This may lessen the quantity of effective size of the data set along with speeding up the rendering process. Manual refurbishment could be an exacting process, consuming about 30 to 60 minutes in modifying a single image set. Contiguous portions can be combined together and modified as a slab using simple procedures that have been devised to speed up the process. Segmentation is presently a sphere of study. Similar to other editing procedures Clip-plane editing is a technique for altering the 3D image in real time. (58).

- **Rendering Parameters**

Rendering settings influence the appearance of the image and are applied to the entire volume data set. The functions of window width and level are comparable to those of ordinary CT scanners and workstations. Transfer functions are algorithms which govern the process of data collection and its transformation into presentation. Transfer function converts input data values (such as Hounsfield units for CT) into illumination attributes that volume rendering methods require.

- **Window Width and level**

Usually, data is segmented based on voxel attenuation in volume rendering. Window width and level adjustments are used, comparable to ones applied in axial CT image presentation. The window can be set to show liver, bone, lungs or soft tissue; although, real-time rendering also allows us to modify the window configuration interactively and observe the alterations immediately presented in 3D image. This interactive ability enables the user to quickly adjust the view to explicit circumstances with different levels of contrast augmentation and attenuation ranges [62].

- **Opacity**

The degree to which structures looking in close proximity to the viewer conceal structures appearing a bit further is referred to as opacity. The opacity can be set anywhere between 0% and 100%. The appearance of high opacity values is comparable to that of surface rendering, which aids in the depiction of complicated 3D relationships. To see through the structures low opacity values are used, significant for things like detecting thrombus within a vascular lumen or assessing bone deformities (e.g., tumor present below the cortical surface).

- **Brightness**

Brightness influences the image's appearance by scaling the value of each pixel by the percentage set. This has no bearing on accuracy; unlike opacity, brightness has no effect on the observable diameter of depicted structures. Similar to opacity, brightness can also be adjusted up to 100 percent. Brightness settings are purely personal and determined by individual user's choices. Almost all applications benefit from a setting of 100 percent.

- **Percentage Classification**

Percentage classification was a required pre-requisite to rendering in early stages of volume rendering software. It is now largely used to apply transfer functions to specific ranges of attenuation values within a volume data set which helps to distinguish disease from tissue based on color or reduce the opacity of obstructing materials like bone. The idea behind percentage classification is the voxels which represents a specific tissue creating a Gaussian distribution of intensities around a central peak value, which presumably represents 100% of that specific tissue. The ranges of intensities above and below this peak value show a probability distribution of voxels containing the tissue of interest ranging from 0% to 100%.

MATERIALS AND METHODS

A prospective cross-sectional study was performed at District Headquarter Hospital (DHQ) Timergara Dir Lower Pakistan for duration of 4months from February2020to May2020. Patients presenting with history of trauma, diagnosed with bone fracture on plane X-Ray and referral to radiologic examination on 2D and 3D Computed Tomography irrespective of gender, age were recruited in the study through a convenience sampling technique.

Data collection procedure and analysis:

The patients presenting with clinical doubt of fracture were investigated first with plain conventional X ray to confirm the presence of fracture. After that CT scan with 3D VR was performed as a part of clinical investigative protocol of the department. Toshiba X-ray and Toshiba Asteion super 4 CT scan machines were used for conventional radiography and CT respectively. Exposures were taken in axial views of the region of interest with 5-10mm slice thickness at 100-250KV. Data was then analyzed by using EXCEL and MEDCALC softwares.

RESULTS AND ANALYSIS

110 patients consisting of both males (80) and females (30) were included in the study. The mean age (years) ± SD was 35.06±18.24 for males and 26.40±11.78 for females (Table andGraph1). Age range was 7-50 years and 2-85 years for female and male patients respectively.

Frequency distribution of age

TableNo1:	Total	Minimum	Maximum	Mean	Standard deviation
Male	80	2	85	35.06	18.24
Female	30	7	50	26.40	11.78

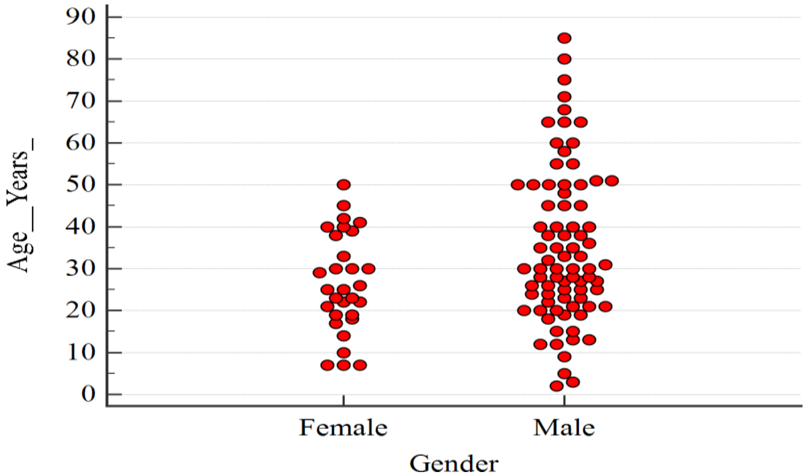


Fig:01: Descriptive statistics of age

TableNo2: Frequency distribution for mode of trauma among patients.

	Mode of Trauma			
Gender	**HOF**	**RTA**	**Sports injury**	**Total**
Female	26(23.6%)	4(3.6%)	0(0.0%)	**30(27.3)**
Male	43(39.1%)	33(30.0)	4(3.6%)	**80(72.7)**
Total	**69(62.7%)**	**37(33.6)**	**4(3.6)**	**110**

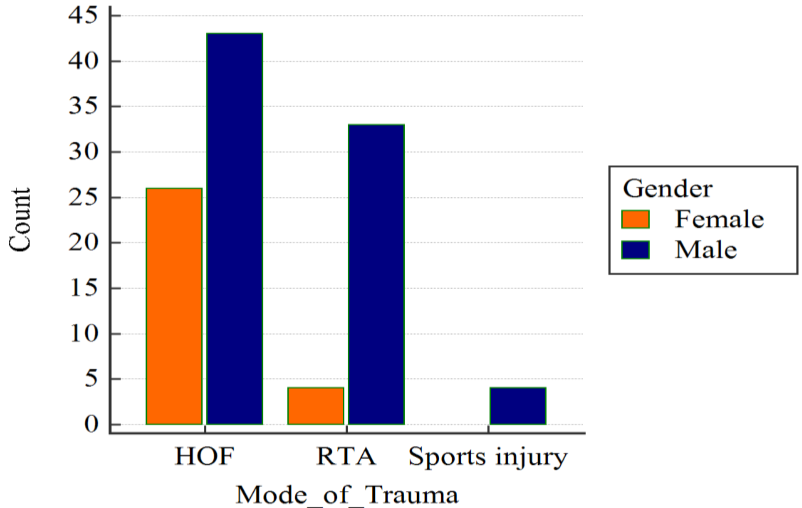


Fig:02: Graphical representation of mode of trauma

The two main causes of trauma included history of fall and road traffic accident in most of the cases, in both male and female patients followed by sports injuries, shown in Table 2

TableNo3: Fracture types on X-ray

	Types of X- Ray				
Gender	**Comminuted**	**Complete**	**Compressin**	**Partial**	**Total**
Female	11(10.0%)	9(8.2%)	1(0.9%)	9(8.2%)	30(27.3)
Male	36(32.7%)	24(21.8)	4(3.6%)	16(14.5)	80(72.7)
Total	47(42.7%)	33(30.%)	5(4.5%)	25(22.7)	110

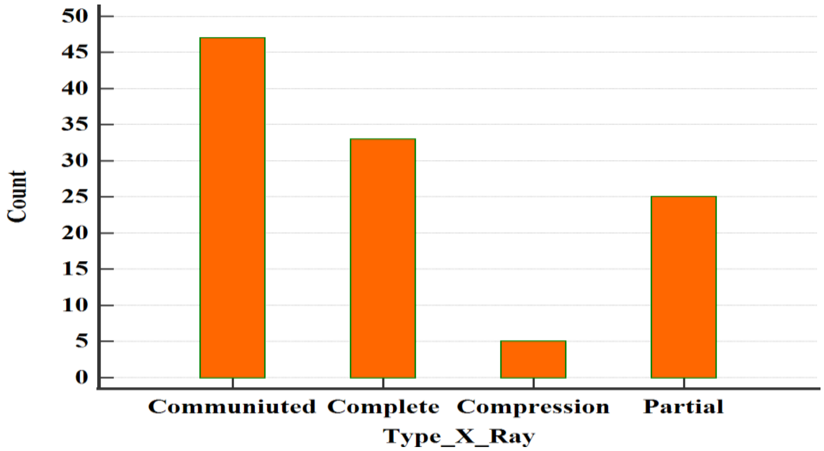


Fig:03. Fracture types on x-ray

Complete and comminuted fractures were the commonest type of fractures among these patients

Table 04: Showing sites of bone fractures

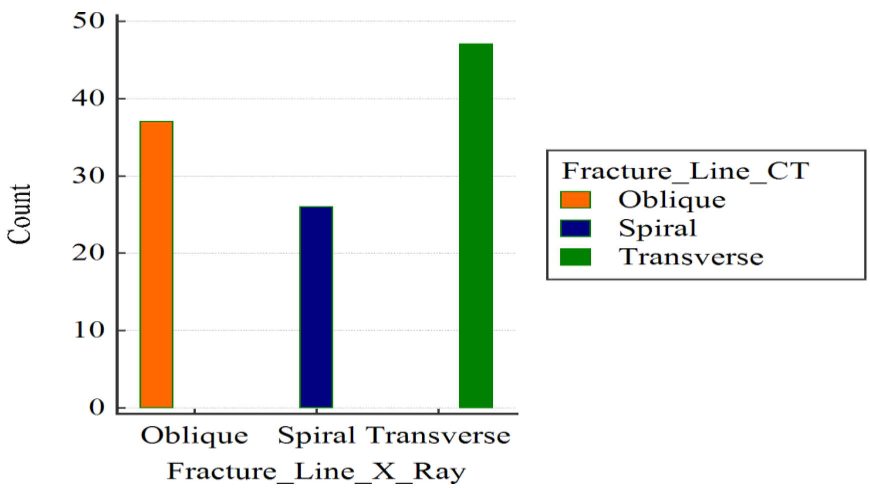
	Gender		
SiteX-ray	**Male**	**Female**	Percent
Ankle Joint	1 (0.9%)	0 (0.0%)	1(0.9%)
Cervical Spine	1 (0.9%)	1 (0.9%)	2 (1.8%)
Clavicle	2 (1.8%)	3 (2.7%)	5(4.5%)
Facial Bones	1 (0.9%)	2 (1.8%)	3(2.7%)
Femur	2 (1.8%)	5 (4.5%)	7(6.4%)
Fibula	1 (0.9%)	5 (4.5%)	6(5.5%)

Hand	0 (0.0%)	2 (1.8%)	2(1.8%)
Humerus	3 (2.7%)	6 (5.5%)	9(8.2%)
Humerus and Radius	1 (0.9%)	0 (0.0%)	1(0.9%)
Knee joint	0(0.0%)	1(0.9%)	1(0.9%)
Lumber Spine	4(3.6%)	11(10.0%)	15(13.6%)
Patella	0 (0.0%)	3(2.7%)	3(2.7%)
Pelvis	1(0.9%)	0(0.0%)	1(0.9%)
Radius	4(.3.6%)	43(.6%)	8(7.3%)
Radius and Ulna	1(0.9%)	4(3.6%)	5(4.5%)
Ribs	3(2.7%)	2(1.8%)	5(4.5%)
Ribs/radius/ulna	0(0.0%)	1(0.9%)	1(0.9%)
Scaphoid	0(0.0%)	3(2.7%)	3(2.7%)
Scapula	0(0.0%)	1(0.9%)	1(0.9%)
Shoulder joint	0(0.0%)	1(0.9%)	1(0.9%)
Skull	3(2.7%)	14(12.7%)	17(15.5%)
Skull/Facial	0(0.0%0	2(1.8%)	2(1.8%)
Talus	0(0.0%)	1(0.9%)	1(0.9%)
Tibia	1(0.9%)	2(1.8%)	3(2.7%)
Ulna	0(0.0%)	3(2.7%)	3(2.7%)
Wrist joint	1(0.9%)	2(1.8%)	3(2.7%)
Zygomatic &Maxilla	0(0.0%)	1(0.9%)	1(0.9%)
	30(27.3%)	80(72.7%)	110

Frequency of each site of bone fractures in both the genders was also calculated. In our study, major site of injury in male is skull and in female is lumbar spine.

Table No 5: Comparison of finding of fracture line type on X-ray and CT

	Fracture Line X-Ray			
Fracture Line CT	**Oblique**	**Spiral**	**Transverse**	
Oblique	37(33.6%)	0(0.0%)	0(0.0%)	37(33.6%)
Spiral	0(0.0%)	26(23.6%)	0(0.0%)	26(23.6%)
Transverse	0(0.0%)	0(0.0%)	47(42.7%)	47(42.7%)
	37(33.6%)	26(23.6%)	47(42.7%)	110



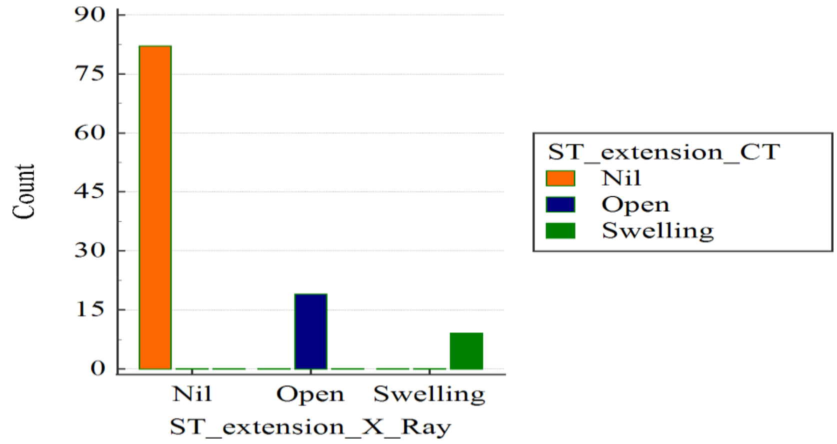
Graph No 4: Graphical representation of fracture line in X-ray and CT

X-Ray and CT showed an excellent association for the finding of fracture line type.

Table No 6: Comparison of soft tissue extension detection on X-ray and CT

	Soft tissue extension X-ray			
Soft tissue extension CT	**Nil**	**Open**	**Swelling**	Total
Nil	82(74.5%)	0(0.0%)	0(0.0%)	82(74.5%)
Open	0(0.0%)	1(17.3%)	0(0.0%)	19(17.3%)

Swelling	0(0.0%)	0(0.0%)	9(8.2%)	9(8.2%)
Total	82(74.5%)	19(17.3%)	9(8.2%)	110

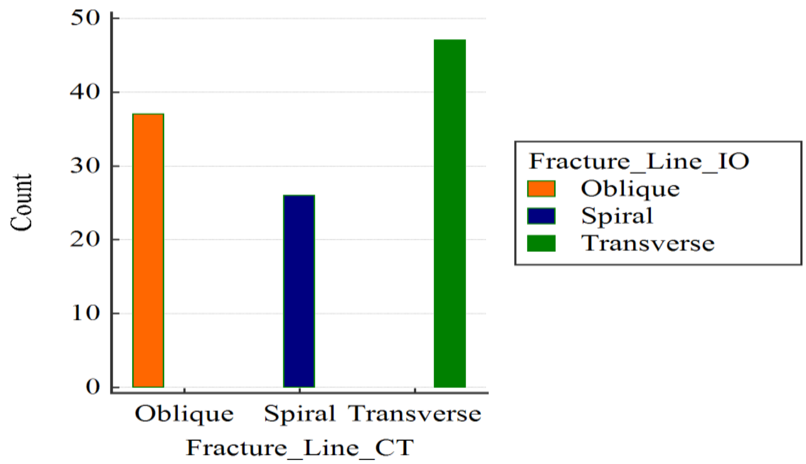


Graph No 5: Graphical representation soft tissue extension detection on X-ray and CT

3D rendered images on CT showed high accuracy in findings of number of fragments, fracture line type, soft tissue extension and detection of damage to the blood vessels. Only one brachial artery damage by humeral fracture remained undetected on CT which was revealed on intra-operatively.

TableNo7: Comparison of fracture line among CT and Intra-operatively

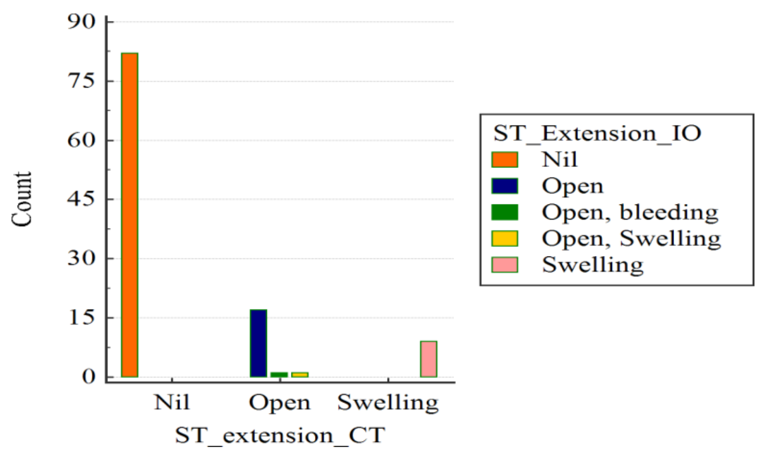
	Fracture Line-CT			
Fracture Line–IO	**Oblique**	**Spiral**	**Transverse**	**Total**
Oblique	37(33.6%)	0(0.0%)	0(0.0%)	37(33.6%)
Spiral	0(0.0%)	26(23.6%)	0(0.0%)	26(23.6%)
Transverse	0(0.0%)	0(0.0%)	47(42.7%)	47(42.7%)
Total	37(33.6%)	26(23.6%)	47(42.7%)	110



Graph No 6: Graphical representation of fracture line on CT and IO

Table No 8: Comparison of detection of soft tissue extension on CT and Intra-operatively

	Soft tissue Extension CT			
Soft tissue Extension Intra-Operatively	**Nil**	**Open**	**Swelling**	
Nil	82(74.5%)	0(0.0%)	0(0.0%)	82(74.5%)
Open	0(0.0%)	17(15.5%)	0(0.0%)	17(15.5%)
Open, bleeding	0(0.0%)	1(0.9%)	0(0.0%)	1(0.9%)
Open, Swelling	0(0.0%)	1(0.9%)	0(0.0%)	1(0.9%)
Swelling	0(0.0%)	0(0.0%)	9(8.2%)	9(8.2%)
	82(74.5%)	19(17.3%)	9(8.2%)	110



Graph No.7 Graphical representation of detection of soft tissue extension on CT and Intra-operatively

Only one brachial artery damage by humeral fracture remained undetected on CT which was revealed on intra-operatively.

Table No 9: Comparison of Blood vessel damage detection by CT and Intra-operatively.

	BV damage CT									
BV damage-IO	**Axillary Artery**	**Brachial Artery**	**Digital Arteries**	**Femoral Artery**	**Nil**	**Peroneal Artery**	**Radial Artery**	**Ulnar Artery**	**Vertebral Artery**	
Axillary Artery	3	0	0	0	0	0	0	0	0	3 (2.7%)
Brachial Artery	0	1	0	0	1	0	0	0	0	2 (1.8%)
Digital Arteries	0	0	2	0	0	0	0	0	0	2 (1.8%)
Femoral Artery	0	0	0	3	0	0	0	0	0	3 (2.7%)
Nil	0	0	0	0	94	0	0	0	0	94 (85.5%)
Peroneal Artery	0	0	0	0	0	1	0	0	0	1 (0.9%)
Radial Artery	0	0	0	0	0	0	3	0	0	3 (2.7%)
Ulnar Artery	0	0	0	0	0	0	0	1	0	1 (0.9%)
Vertebral Artery	0	0	0	0	0	0	0	0	1	1 (0.9%)
Total	3 (2.7%	1 (0.9%)	2 (1.8%)	3 (2.7%)	95 (86.4%)	1 (0.9%)	3 (2.7%)	1 (0.9%)	1 (0.9%)	110

Table No 10: Comparison of number of fragments detected on X-Ray and CT

	Fragments Xray								
Fragments CT	**Eight**	**Five**	**Four**	**Nil**	**Seven**	**Six**	**Three**	**Two**	**Total**
Eight	1	0	0	0	0	0	0	0	1

									(0.9%)
Five	0	5	0	0	0	0	0	0	5 (4.5%)
Four	0	0	16	0	0	0	0	0	16 (14.5%)
Nil	0	0	0	29	0	0	0	0	29 (26.4%)
Seven	0	0	0	0	1	0	0	0	1 (0.9%)
Six	0	0	0	0	0	2	0	0	2 (1.8%)
Three	0	0	0	0	0	0	23	0	23 (20.9%)
Two	0	0	0	0	0	0	0	33	33 (30.0%)
	1 (0.9%)	5 (4.5%)	16 (14%)	29 (26.4%)	1 (0.9%)	2 (1.8%)	23 (20.9%)	33 (30.0%)	110

Table No 11: Comparison of number of fragments detected on CT and Intra-operatively.

	Fragments CT								
Fragments IO	**Eight**	**Five**	**Four**	**Nil**	**Seven**	**Six**	**Three**	**Two**	
Eight	1	0	0	0	0	0	0	0	1 (0.9%)
Five	0	5	0	0	0	0	0	0	
Four	0	0	16	0	0	0	0	0	16 (14.5%)

Loss of v.body	0	0	0	1	0	0	0	0	1 (0.9%)
Nil	0	0	0	28	0	0	0	0	28 (25.5%)
Seven	0	0	0	0	1	0	0	0	1 (0.9%)
Six	0	0	0	0	0	2	0	0	2 (1.8%)
Three	0	0	0	0	0	0	23	0	23 (20.9%)
Two	0	0	0	0	0	0	0	33	33 (30.0%)
	1 (0.9%)	5 (4.5%)	16 (14.5%)	29 (26.4%)	1 (0.9%)	2 (1.8%)	23 (20.9%)	33 (30.0%)	110

DISCUSSION

Spiral

Discussion

In musculoskeletal trauma, spiral CT plays two important roles. These are used to analyze the extent of fracture, as well as to determine or exclude or take out a fracture that was ambiguous on plain radiography and so provide therapy guidance. [68]. Spiral CT will show osseous anatomy and provide extra information regarding soft-tissue abnormalities, particularly in anatomically complex locations such as scapula, spine and pelvis, where conventional radiological techniques are sometimes restricted in its capacity to show fractures. Traditional radiography series are often hard to undertake in the setting of trauma due to inability of patients to cooperate with all positioning requirements. [69]. In contrast with trauma radiography, which frequently produces low-quality results, (VR) spiral radiography produces better outcomes. CT is a tremendous advancement in trauma imaging, as well as a considerable time saver for patients in the radiology department. Because of the limited contrast resolution, traditional X-ray in complicated anatomic parts cannot be performed optimally [70]. A CT scan should be conducted in this case to check the extent of the fracture, bone fragments, and soft tissue alterations. However, CT images cannot provide the best spatial orientation. [71] The main disadvantage of CT procedures is this. The shortcomings of both systems can be eliminated using 3D VR techniques [72]. Most orthopedists are aware of the benefits and importance of 3D VR imaging in the identification of bone fractures, which is why orthopedists prefer 3D VR images for the identification of fractures, particularly in difficult anatomic areas. [73].

In our study comprised on 110 subjects we assessed that the males had the greater ratio of bone fractures as compared to females. Deborah Pate and her colleagues observed in 1986 that 3D rendering worked better on high-contrast tissues like bone than on lower-contrast tissues like soft tissues. By raising the contrast of the tissues relative to that of nearby structures can help, although adequate 3D CT displays of ligaments, muscles, or cartilage are hard to produce.

We found in our results that the 3D volume rendered CT showed excellent accuracy in the diagnosis/detection of fracture type and line, number of segments, soft tissue extension and blood vessel injury. Similar findings were also reported by Etlik et. al [1] who reported that all the images of MIP and VR with optimum resolution were produced through 3D reconstructions. Concluding that 3D VR technique is a significant tool for the identification of bone fractures making it more appropriate than other radiological modalities.

To the best of our knowledge this is the first study describing the findings of 3D volume rendered CT are compared to the intra-operative findings.

CONCLUSION

It is concluded that the three-dimension volume rendering technique is feasible, flexible and clinically accurate. The accurate three-dimension (3D) technique can help the Radiology Professionals and clinician for more effective interpretation of set of volume data which is generated by multi slice CT scanners. To gain acceptable and reliable results. However, the radiologist must understand the effect of different parameters selection on the resulting image, with the availability of immidiate, inexpensive work stations that can support volume rendering.

RECOMMENDATION

We recommend that both diagnostic modalities (i.e., X-ray and CT) are necessary for evaluation of bony fracture i.e., hair line fracture is best visualized and described on X-ray (2D) while complex fracture and displacement of bone is better demonstrated on computed tomography. However, 3D VR technique produces advanced diagnostic yield.

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