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3DCT and MPR in Craniofacial Fractures

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ABSTRACT

Aim: This study aimed to evaluate sensitivity of multi planer and 3D of CT image in patients with craniofacial bone fractures.

Methodology: Descriptive analytical study was conducted. Patients referred for CT skull examination after trauma and diagnosed with fracture.

Results: In this study sample size was (150 patients) and frequency of male was 105 with percent 70%, female was 45 with percent 30%.

Most bone fracture appear in 3DCT was facial, parietal and temporal with frequency (30), (29), (22), respectively.

Most bone fracture appear in axial cut in MPR was facial, parietal and temporal with frequency (30), (28), (22), respectively.

Most bone fracture appear in sagittal cut in MPR was facial, parietal and temporal with frequency (32), (29), (15), respectively.

Most bone fracture appear in coronal cut in MPR was parietal, facial and temporal with frequency (29), (23), (19), respectively.

Conclusion: In evaluation the difference between MPR and 3D images to determining fractures in traumatic patients we found that any depressed fracture appeared in MPR will be clearly appeared in 3DCT, but linear fracture depend on MPR appearance.

Recommendations: Specification of bone under study will ease up findings and data acquisition.

Keywords: 3DCT, MPR

INTRODUCTION

A CT scan makes use of computer-processed combinations of many X-ray images taken from different angles to produce cross-sectional (tomographic) images (virtual “slices”) of specific areas of a scanned object, allowing the user to see inside the object without cutting [1].

Digital geometry processing is used to generate a three-dimensional image of the inside of the object from a large series of two-dimensional radiographic images taken around a single axis of rotation. Medical imaging is the most common application of X-ray CT. Its cross-sectional images are used for diagnostic and therapeutic purposes in various medical disciplines. The rest of this article discusses medical-imaging X-ray CT; industrial applications of X-ray CT are discussed at industrial computed tomography scanning [2].

3D imaging

Three-dimensional rendering could not have been developed without advances in computer hardware, software and display technology. Progress has been incremental and often limited by the state of the art in any one of these technologies on which development depends. Despite these constraints, SSD and MIP have remained functional by making use of only about 10% of the available CT data and implementing very simple rendering schemes [3], although this compromise limits the accuracy of rendered images. Volume rendering incorporates the entire data set into a 3D image [4,5]. Initially, image processing and display was very time consuming: Several hours were required to render an animation loop for viewing. However, recent advances in computer hardware have made volume rendering a practical,

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interactive technique that allows processing and display to occur in real time (minimum, 5-10 frames/s) at relatively inexpensive workstations [5].

LITERATURE REVIEW

Imaging of maxillofacial and skull base trauma

In this study they consider explaining that CT is image of choice for suspected craniofacial fracture and after they finished decided that analysis with MIPs is a useful addition to obligatory MPRs [6].

A study of diagnostic performance of CT, MPR and 3DCT imaging in maxillofacial trauma

In this study they to elaborate that CT imaging of complex maxillofacial fractures is common practice now. Sensitivity and specificity were calculated to measure observer performance. It was found that 3D and CT had a similar performance in fracture detection and both were markedly better than MPR. It was concluded that CT and 3D are comparable in detecting mid-facial fractures and both are superior to MPR. 3D reconstructions are superior for localization of complex fractures involving multiple planes [7].

A study of validity of multi-slice computerized tomography for diagnosis of maxillofacial fractures using an independent workstation.

In this study they explain the CT images of 36 patients with maxillofacial fractures (symptomatic to orbit region). The images were interpreted based on 5 protocols, using an independent workstation. All methods evaluated in this study showed high specificity and sensitivity for the diagnosis of orbital fractures according to the proposed methodology. This protocol can add valuable information to the diagnosis of fractures using the association of axial/MPR/3D with multi-slice CT [8].

MATERIALS AND METHODS

Materials

Study design: Descriptive analytical study was conducted.

Study area and duration: The study was conducted in Khartoum state, included hospitals:

- Ibrahim Malik Hospital
- Yastabshiroon Al-Khartoum Hospital
- Altamayoz for Emergency
- Al Zaytuona Hospital

Study duration: From 2017-June 2019

Study population: Patients referred for CT skull examination after trauma and diagnosed with fracture.

Sample size and sampling: 150 patients admitted to all previous hospitals.

Inclusion criteria: Traumatic patient with a diagnosed craniofacial fracture under CT scan.

Exclusion criteria: Craniofacial CT scan diagnosed as normal.

Variable under study: Gender, age side of fracture, area of fracture, type of fracture. Visualization in MPR and 3D.

Methods

CT technique of craniofacial imaging:

Patient position: That patient lies supine on the examination couch with their head within the head holder. The head is adjusted so that the entry papillary line is parallel to the couch and the head is straight. The patient is positioned so that the longitudinal alignment light lies in the midline and the horizontal alignment light passes through the nasion. Straps and foam pads are used for immobilization.

Equipment:

- Head holder
- Immobilization foam pads

Data collection tools and techniques: All data was collected from traumatic patients referred for craniofacial CT examination and then we used SPSS version 16 to analyze data and represented in tables, pie chart and graphs.

Methods of measurements: Fractures were visualized under (sagittal, axial and coronal) MPR and 3D images.

RESULTS AND DISCUSSION

In this study sample size was (150 patients) and frequency of male was 105 with percent 70%, female was 45 with percent 30% **(Table 1 and Figure 1)**.

Table 1. Shows frequency table for gender.

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	45	30.0	30.0	30.0
	Male	105	70.0	70.0	100.0
	Total	150	100.0	100.0	

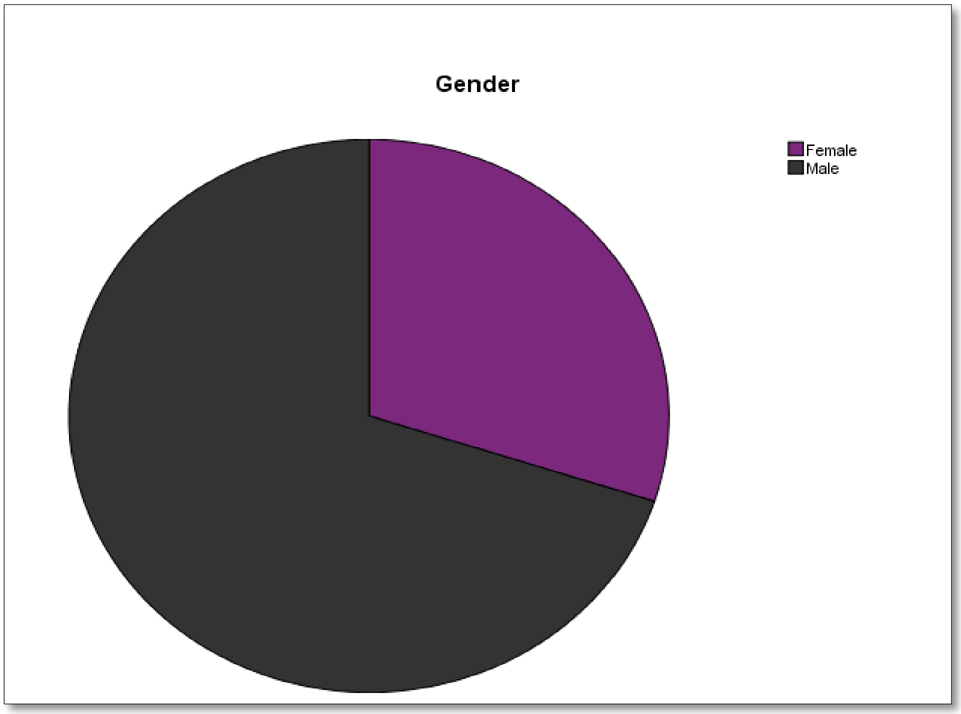

Figure 1. Shows gender distributions.

In **Table 2** mean of age included in this study was 35 ranges of minimum and maximum respectively (6-89).

Table 2. Shows frequency table for age.

Statistics		
Age		
N	Valid	150
	Missing	0
Mean		35.1267
Median		32.0000
Std. Deviation		1.58991E1
Range		83.00
Minimum		6.00
Maximum		89.00

Table 3 shows frequency of bone fracture and the most bone fractured was fracture of facial bone and parietal bone fracture with equal percent (22.7%) and then temporal bone (14.7%) frontal bone (10.7%), occipital bone (10.7%), base of skull (8%), temporal + parietal + frontal (6%), facial + base of skull (1.3%) parietal + frontal (1.3%), parietal + frontal + facial (0.7%), temporal + frontal (0.7%), temporal + parietal (0.7%).

Table 3. Shows frequency table for bone distribution.

Bone					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Base of skull	12	8.0	8.0	8.0
	Facial	34	22.7	22.7	30.7
	Facial + Base of skull	2	1.3	1.3	32.0
	Frontal	16	10.7	10.7	42.7
	Occipital	16	10.7	10.7	53.3
	Parietal	34	22.7	22.7	76.0
	Parietal + Frontal	2	1.3	1.3	77.3
	Parietal + Frontal + Facial	1	0.7	.7	78.0
	Temporal	22	14.7	14.7	92.7
	Temporal + Frontal	1	0.7	0.7	93.3
	Temporal + Parietal	1	0.7	0.7	94.0
	Temporal + Parietal + Frontal	9	6.0	6.0	100.0
	Total	150	100.0	100.0	

According to fracture type **Table 4 and Figure 2** we found that frequency of depressed fracture (90) with percent 60% and frequency of linear fracture (60) with percent 40%.

Table 4. Shows frequency table for fracture type distribution.

FxType					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Depressed	90	60.0	60.0	60.0
	Linear	60	40.0	40.0	100.0
	Total	150	100.0	100.0	

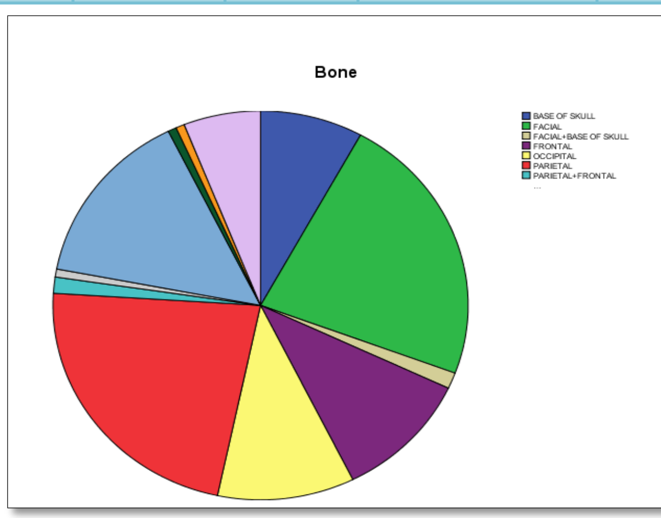

Figure 2. Shows frequency table for bone distribution.

Tables 5-9 and Figures 3-8 shows fractures that appear in 3DCT from total of 150 patient s and the result show that there is 127 with percent 84.7 appear in CT.

Table 5. Shows frequency of axial cut in MPR.

Axial					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No	12	8.0	8.0	8.0
	Yes	138	92.0	92.0	100.0
	Total	150	100.0	100.0	

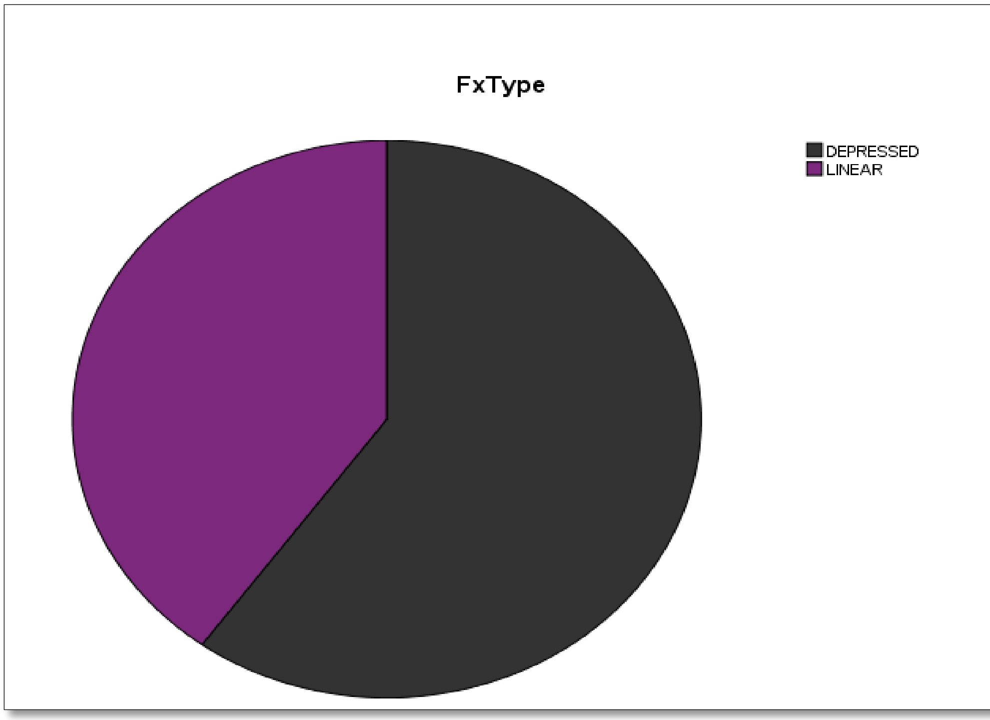

Figure 3. Shows frequency table for fracture type distribution.

Table 6. Shows frequency of axial cut in MPR.

Sagittal					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No	35	23.3	23.3	23.3
	Yes	115	76.7	76.7	100.0
	Total	150	100.0	100.0	

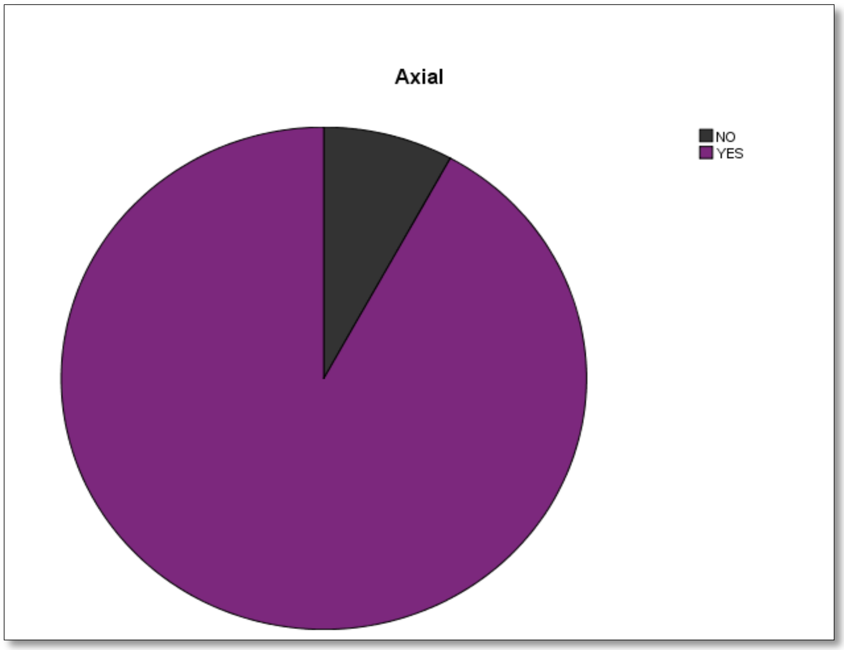

Figure 4. Shows frequency of axial cut in MPR.

Table 7. Shows frequency of coronal cut in MPR.

Coronal						
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No	40	26.7	26.7	26.7
	Yes	110	73.3	73.3	100.0
	Total	150	100.0	100.0	

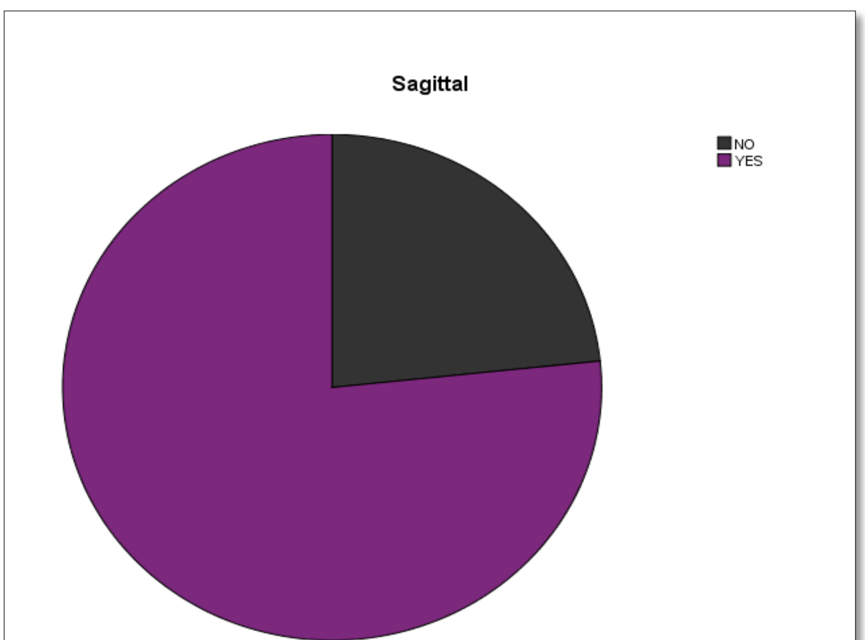

Figure 5. Shows frequency of sagittal cut in MPR.

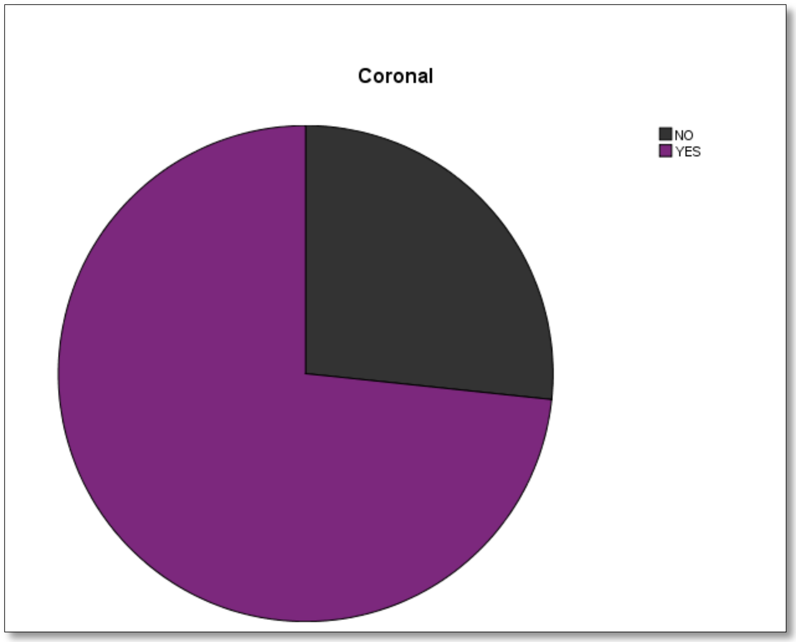

Figure 6. Shows frequency of coronal cut in MPR.

Table 8. Shows frequency of three dimensions CT.

ThreeD					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No	23	15.3	15.3	15.3
	Yes	127	84.7	84.7	100.0
	Total	150	100.0	100.0	

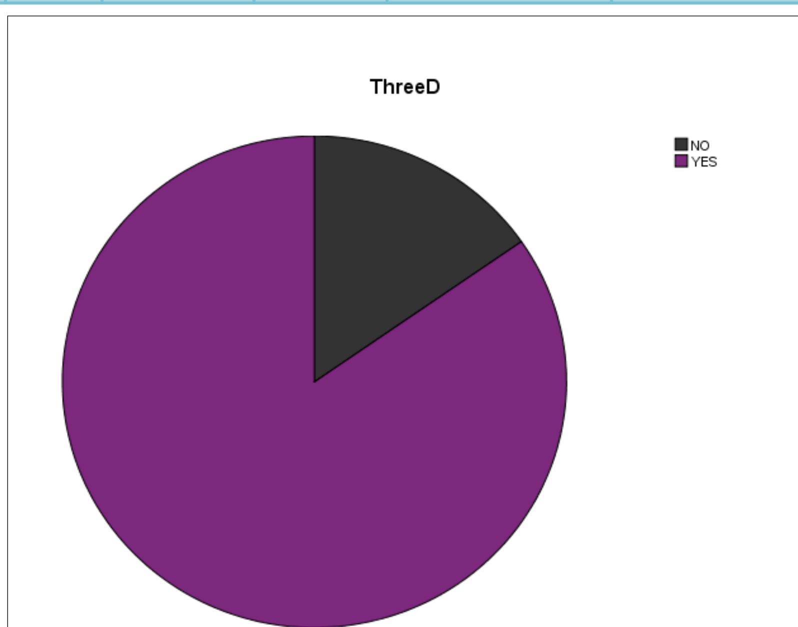

Figure 7. Shows frequency of three dimensions CT.

Table 9. Relation between bone and three dimensions CT.

Bone * ThreeD Cross-tabulation				
Count		ThreeD		Total
		No	Yes	
Bone	Base of skull	11	1	12
	Facial	3	31	34
	Facial + Base of skull	0	2	2
	Frontal	0	16	16
	Occipital	3	13	16
	Parietal	5	29	34
	Parietal + Frontal	0	2	2
	Parietal + Frontal + Facial	0	1	1
	Temporal	1	21	22
	Temporal + Frontal	0	1	1
	Temporal + Parietal	0	1	1
	Temporal + Parietal + Frontal	0	9	9
Total		23	127	150

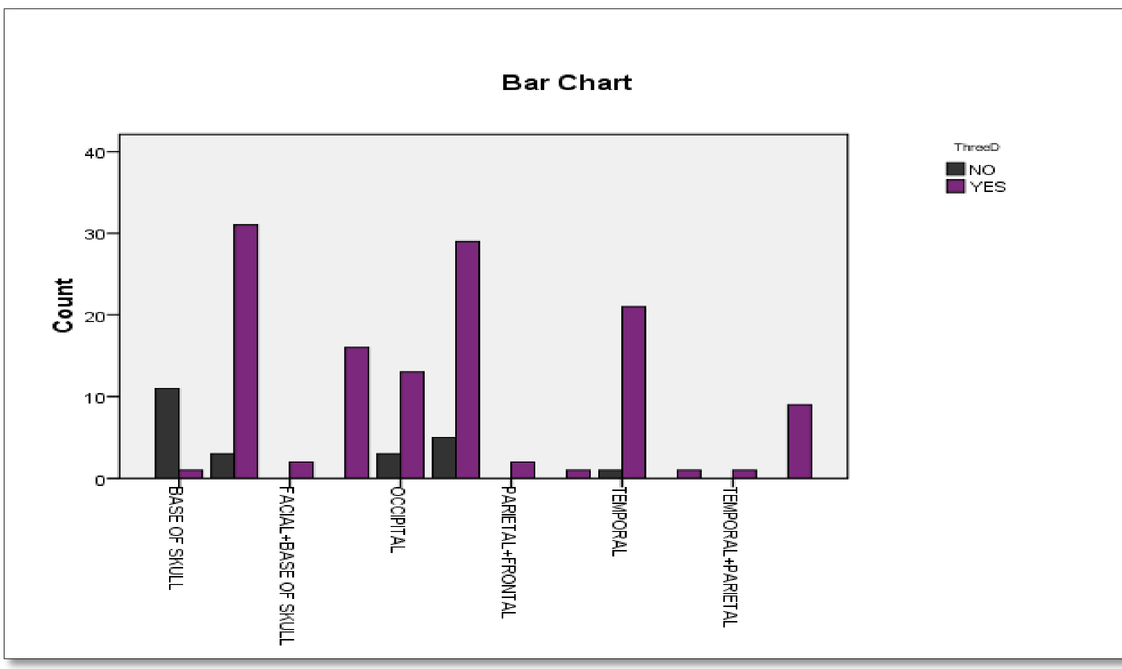

Figure 8 Shows relation between bone and three dimensions CT.

Frequency of most bone fractures that appear was facial bone (31), parietal bone (29) and then temporal bone (21) **(Table 10)**.

Table 10. Relation between fracture type and three dimensions CT.

FxType * ThreeD Cross-tabulation				
Count		**ThreeD**		**Total**
		No	**Yes**	
FxType	Depressed	0	90	90
	Linear	23	37	60
Total		23	127	150

Table 11 shows the relation between type of fracture and 3DCT and result was that total of 90 depressed fractures appear in 3DCT, but linear fracture with total (60) there was only 37 appear in 3DCT.

Table 11. Relation between fracture type and axial cut in MPR.

FxType * Axial Cross-tabulation				
Count		**Axial**		**Total**
		No	**Yes**	
FxType	Depressed	9	81	90
	Linear	3	57	60
Total		12	138	150

When we compared MPR with 3DCT **(Tables 12 and 13)** the result was similar in depressed fracture appearance in axial and sagittal which was (81 out of 90) in both. But in linear fracture type in axial (57 out of 60) and in sagittal (34 out of 60).

Table 12. Relation between fracture type and sagittal cut in MPR.

FxType * Sagittal Cross-tabulation				
Count		**Sagittal**		**Total**
		No	**Yes**	
FxType	Depressed	9	81	90
	Linear	26	34	60
Total		35	115	150

Table 13. Relation between fracture type and coronal cut in MPR.

FxType * Coronal Cross-tabulation				
Count		**Coronal**		**Total**
		No	**Yes**	
FxType	Depressed	11	79	90
	Linear	29	31	60
Total		40	110	150

Tables 14-17 we compared MPR with 3DCT and result was there is (117 out of 138) appear in axial and 3DCT and (109 out of 115) appear in sagittal and (105 out of 110) appear in coronal.

Table 14. Relation between axial cut in MPR and three dimension CT.

Axial * ThreeD Cross-tabulation				
Count		**ThreeD**		**Total**
		No	**Yes**	
Axial	No	2	10	12
	Yes	21	117	138
Total		23	127	150

Table 15. Relation between sagittal cut in MPR and three dimension CT.

Sagittal * ThreeD Cross-tabulation				
Count		**ThreeD**		**Total**
		No	**Yes**	
Sagittal	No	17	18	35
	Yes	6	109	115
Total		23	127	150

Table 16. Relation between coronal cut in MPR and three dimension CT.

Coronal * ThreeD Cross-tabulation				
Count		**ThreeD**		**Total**
		No	**Yes**	
Coronal	No	18	22	40
	Yes	5	105	110
Total		23	127	150

Table 17. Relation between bone and three dimension CT.

Bone * ThreeD Cross-tabulation				
Count		**ThreeD**		**Total**
		No	**Yes**	
Bone	Base of skull	11	1	12
	Facial	3	31	34
	Facial + Base of skull	0	2	2
	Frontal	0	16	16
	Occipital	3	13	16
	Parietal	5	29	34
	Parietal + Frontal	0	2	2
	Parietal + Frontal + Facial	0	1	1
	Temporal	1	21	22
	Temporal + Frontal	0	1	1
	Temporal + Parietal	0	1	1
	Temporal + Parietal + Frontal	0	9	9
Total		23	127	150

This result match with most literature.

Most bone fracture appears in 3DCT **(Table 18)** was facial, parietal and temporal with frequency (30), (29), (22), respectively.

Table 18. Relation between bone and axial cut in MPR.

Bone * Axial Cross-tabulation				
Count		Axial		Total
		No	Yes	
Bone	Base of skull	0	12	12
	Facial	4	30	34
	Facial + Base of skull	0	2	2
	Frontal	2	14	16
	Occipital	0	16	16
	Parietal	6	28	34
	Parietal + Frontal	0	2	2
	Parietal + Frontal + Facial	0	1	1
	Temporal	0	22	22
	Temporal + Frontal	0	1	1
	Temporal + Parietal	0	1	1
	Temporal + Parietal + Frontal	0	9	9
Total		12	138	150

Most bone fracture appear in axial cut in MPR **(Table 19)** was facial, parietal and temporal with frequency (30), (28), (22), respectively.

Table 19. Relation between bone and sagittal cut in MPR.

Bone * Sagittal Cross-tabulation				
Count		Sagittal		Total
		No	Yes	
Bone	Base of skull	12	0	12
	Facial	5	29	34
	Facial + Base of skull	0	2	2
	Frontal	1	15	16
	Occipital	4	12	16
	Parietal	2	32	34
	Parietal + Frontal	0	2	2
	Parietal + Frontal + Facial	0	1	1
	Temporal	11	11	22
	Temporal + Frontal	0	1	1
	Temporal + Parietal	0	1	1
	Temporal + Parietal + Frontal	0	9	9
Total		35	115	150

Most bone fracture appear in sagittal cut in MPR **(Table 20)** was facial, parietal and temporal with frequency (32), (29), (15), respectively.

Table 20. Relation between bone and coronal cut in MPR.

Bone * Coronal Cross-tabulation				
Count		Coronal		Total
		No	Yes	
Bone	Base of skull	12	0	12
	Facial	11	23	34
	Facial + Base of skull	0	2	2
	Frontal	3	13	16
	Occipital	6	10	16
	Parietal	5	29	34
	Parietal + Frontal	0	2	2
	Parietal + Frontal + Facial	0	1	1
	Temporal	3	19	22
	Temporal + Frontal	0	1	1
	Temporal + Parietal	0	1	1
	Temporal + Parietal + Frontal	0	9	9
Total		40	110	150

Most bone fracture appear in coronal cut in MPR was parietal, facial and temporal with frequency (29), (23), (19), respectively.

CONCLUSION

This study concludes that the visible fractures under 3D images were facial, parietal and temporal, respectively.

In evaluation the difference between MPR and 3D images to determining fractures in traumatic patients we found that any depressed fracture appeared in MPR will be clearly appeared in 3DCT,but linear fracture depend on MPR appearance.

RECOMMENDATIONS

About 3DCT should be added as a routine imaging.

Specification of bone under study will ease up findings and data acquisition.

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