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3DCT & MPR in Craniofacial Fractures

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Research Article

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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.

Result: In this study sample size was (150 patients) and frequency of male was 105 with 70%, female was 45 with 30%. Most bone fracture appear in 3DCT was facial, parietal and temporal with frequency (31),(29),(21) 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 parietal, facial and temporal with frequency (32),(29),(11) 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; Frequency; Craniofacial Imaging; Bone Fracture; Skull Base Trauma

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, interactive technique that allows processing and display to occur in real time (minimum, 5-10 frames/sec) at relatively inexpensive workstations [6].

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 [7-10].

A Study of Diagnostic Performance of CT, MPR and 3DCT Imaging in Maxillofacial Trauma

In this study they 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 midfacial fractures and both are superior to MPR. 3D reconstructions are superior for localization of complex fractures involving multiple planes [11].

A Study of Validity of Multislice 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 multislice CT [12].

Material and Methods

Material

Study design

Descriptive analytical study was conducted.

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

a) Ibrahim Malik Hospital

b) Yastabshiroon Alkhartoum Hospital

c) Al Tamayoz for Emergency

Alzaytuona Hospital

Study duration: From 2017-June2019

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

The patient lies supine on the examination couch with their head within the head holder. The head is adjusted so that the enter-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

a) Head holder

b) 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

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

Table 1: Shows frequency table for age.

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**	

Table 2: Shows frequency table for gender.

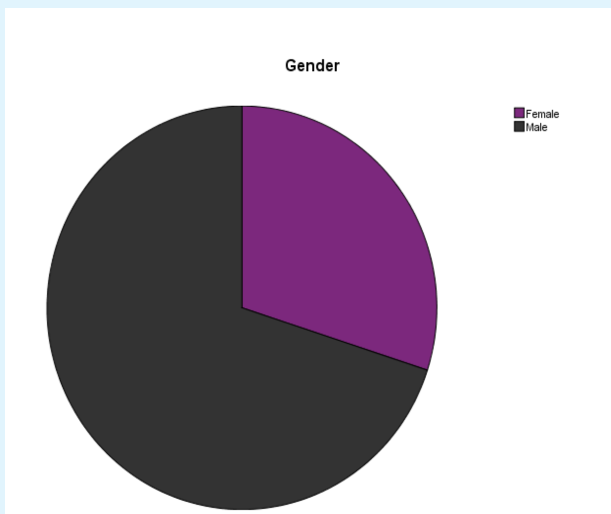

Figure 1: Shows gender distributions.

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	0.7	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**	

Table 3: Shows frequency table for bone distribution.

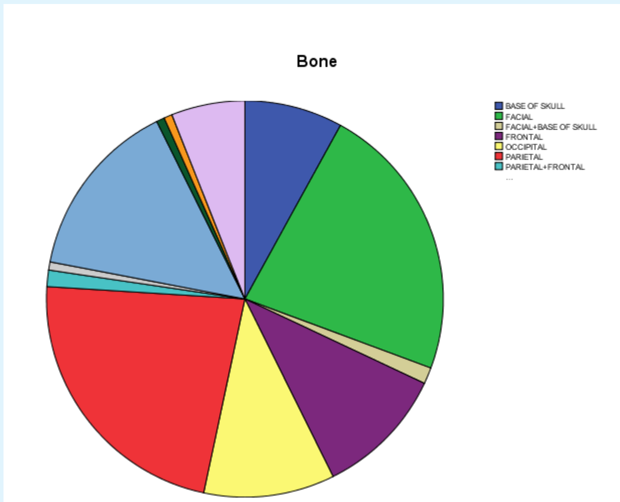

Figure 2: Shows frequency table for bone distribution.

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**	

Table 4: Shows frequency table for fracture type distribution.

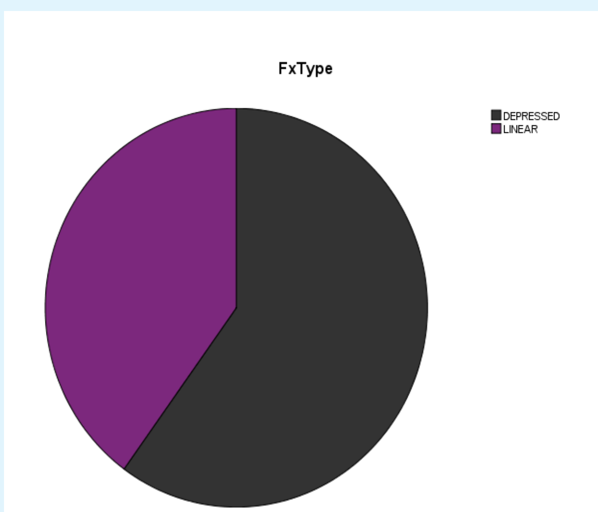

Figure 3: Shows frequency table for fracture type distribution.

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**	

Table 5: Shows frequency of axial cut in MPR.

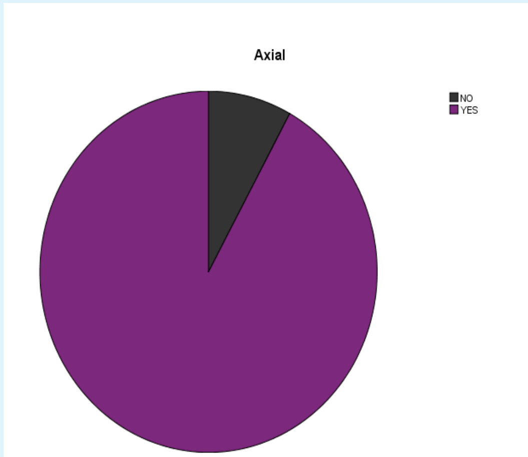

Figure 4: Shows frequency of axial cut in MPR.

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**	

Table 6: Shows frequency of axial cut in MPR.

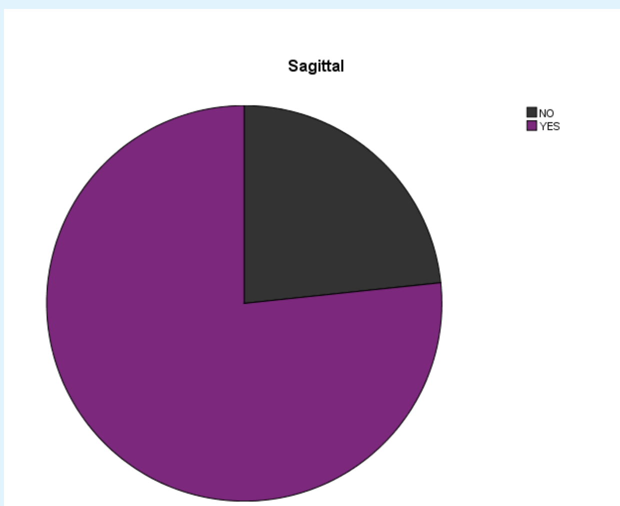

Figure 5: Shows frequency of sagittal cut in MPR.

Coronal					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No	40	26.7	26.7	26.7
	Yes	110	73.3	73.3	100
	Total	**150**	**100**	**100**	

Table 7: Shows frequency of coronal cut in MPR.

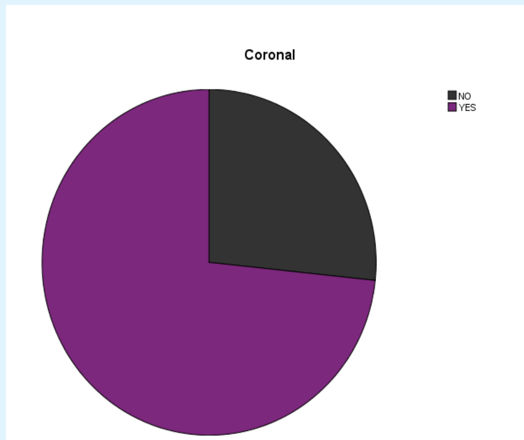

Figure 6: Shows frequency of coronal cut in MPR.

Three D					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	No	23	15.3	15.3	15.3
	Yes	127	84.7	84.7	100
	Total	**150**	**100**	**100**	

Table 8: Shows frequency of three dimensions CT.

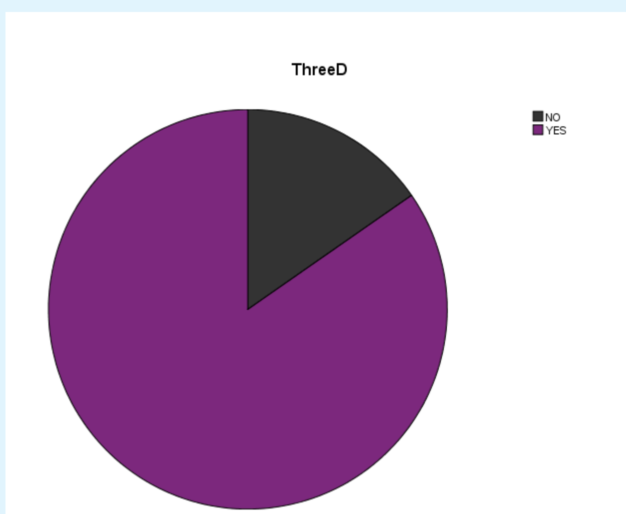

Figure 7: Shows frequency of three dimensions CT.

Bone * Three D Crosstabulation				
Count				
		Three D		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**

Table 9: l Relation between bone and three dimensions CT.

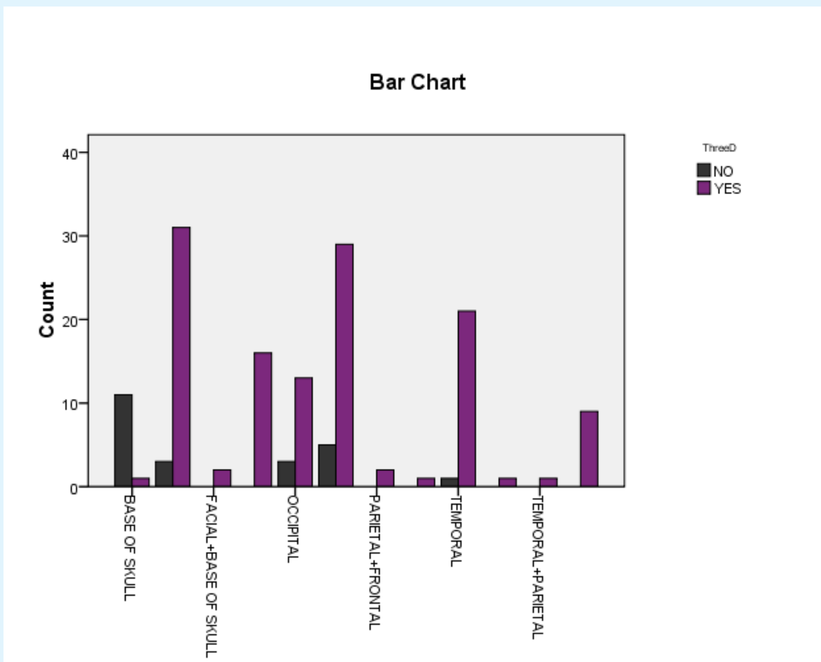

Figure 8: Shows Relation between bone and three dimensions CT.

FxType * Three D Crosstabulation				
Count				
		Three D		Total
		NO	YES	
FxType	Depressed	0	90	90
	Linear	23	37	60
Total		**23**	**127**	**150**

Table 10: Relation between fracture type and three dimension CT.

FxType * Axial Crosstabulation				
Count				
		Axial		Total
		NO	YES	
FxType	Depressed	9	81	90
	Linear	3	57	60
Total		**12**	**138**	**150**

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

FxType * Sagittal Crosstabulation				
Count				
		Sagittal		Total
		NO	YES	
FxType	Depressed	9	81	90
	Linear	26	34	60
Total		**35**	**115**	**150**

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

FxType * Coronal Crosstabulation				
Count				
		Coronal		Total
		NO	YES	
FxType	Depressed	11	79	90
	Linear	29	31	60
Total		**40**	**110**	**150**

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

Axial * Three D Crosstabulation				
Count				
		Three D		Total
		NO	YES	
Axial	No	2	10	12
	Yes	21	117	138
Total		**23**	**127**	**150**

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

Sagittal * Three D Crosstabulation				
Count				
		Three D		Total
		NO	YES	
Sagittal	No	17	18	35
	Yes	6	109	115
Total		**23**	**127**	**150**

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

Coronal * Three D Crosstabulation				
Count				
		Three D		Total
		NO	YES	
Coronal	No	18	22	40
	Yes	5	105	110
Total		**23**	**127**	**150**

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

Bone * Three D Crosstabulation				
Count				
		Three D		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**

Table 17: Relation between bone and three dimension CT.

Bone * Axial Crosstabulation				
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**

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

Bone * Sagittal Crosstabulation				
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**

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

Bone * Coronal Crosstabulation				
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**

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

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 2, Figure 1). In table 1 mean of age included in this study were 35 ranges of minimum and maximum respectively (6-89). 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%). According to fracture type Table 4 we found that frequency of depressed fracture (90) with percent 60% and frequency of linear fracture (60) with percent 40%.

Table 9 shows fractures that appear in 3DCT from total of 150 patient s and the result show that there are 127 with percent 84.7 appear in CT. Frequency of most bone fractures that appear was Facial bone (31), parietal bone (29) and then temporal bone (21). Table 10 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. When we compared MPR with 3DCT (Tables 11&12) 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). In Tables 14,15&16 we compared MPR with 3DCT and result was there is (117out of 138) appear in axial and 3DCT, and (109 out of 115) appear in sagittal, and (105 out of 110) appear in Coronal. This results match with most literature.

Most bone fracture appear in 3DCT (Table 17) was facial, parietal and temporal with frequency (31),(29),(21) respectively. Most bone fracture appear in axial cut in MPR (Table 18) was facial, parietal and temporal with frequency (30),(28),(22) respectively. Most bone fracture appear in sagittal cut in MPR (Table 19) was facial, parietal and temporal with frequency (29),(32),(11) respectively. Most bone fracture appear in coronal cut in MPR (Table 20) 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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