CLINICAL STUDY

THE ROLE OF THREE DIMENSIONAL COMPUTED TOMOGRAPHY AS A DIAGNOSTIC AID IN THE TREATMENT OF MAXILLOFACIAL TRAUMA

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ABSTRACT

The three dimensional computed reconstruction of CT scans provide maxillofacial surgeons with an exciting interactive display of clinical anatomy. The 3-D CT reconstruction of complex maxillofacial anatomic parts permits preoperative analysis and surgical planning. The three dimensional computed tomography permits a clear perception of the extent of fracture comminution and resulting displaced fragments.3-D CT produces the high quality three dimensional images that can be used for diagnostic imaging and treatment planning of trauma.

Key Words: Three dimensional computed tomography, 3D-CT, Maxillofacial trauma

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INTRODUCTION:

As our society has become highly mobile and crowded, trauma has emerged as one of our leading health hazards. Maxillofacial trauma occurs most frequently now a days. Conventional radiography along with history and clinical examination have been playing a major role in diagnosis and treatment planning of maxillofacial injuries. Superimposition of bony structures and hindered visualisation of underlying fractures by soft tissue swelling and haemorrhage ,however may necessitate further investigation. In these cases the computed tomography has become the modality of choice.

The use of computed tomography in clinical diagnosis was first described by Hounsfield in 1973[8]. In 3D-CT ,three dimensional images can be produced using routine CT data. Images can be rotated, split and anatomic structures can be separated and individual images of different tissue types can be generated. In addition the system can be linked to computer controlled milling machine. This allows the manufacture of solid models. 3D rendered images of CT data have been reported to benefit the diagnosis and treatment planning of trauma, enhance pre surgical treatment planning.

In the present study, an attempt have been made to evaluate the role of 3-CT as a diagnosis aid in the treatment of maxillofacial trauma.

MATERIAL AND METHODS:

In this study , 35 adult patients were included with maxillofacial injuries. The selection of the patients were random irrespective of sex ,caste , creed and socioeconomic status. All the patients underwent routine clinical examination for swelling of face ,echymosis , deformity of face, tenderness, abnormal mobility , step defect at the fracture site, disturbance of occlusion, loss of function , bleeding from mouth, nose or ear , CSF leak from nose or ear and subconjuctival haemorrhage.

After clinical examination, patients were subjected to conventional radiography. Routine conventional radiographs were taken to reach the diagnosis. Radiographic criteria were based on the examination of break in the continuity of bone ,displacement of bony fragments, haziness of sinuses and also for any artefacts. Working diagnosis before 3D-CT will be made on the basis of history , clinical examination and routine radiographic examination. To arrive at the correct diagnosis and treatment plan, each patient was subjected to 3D facial reconstruction. The CT unit used in this study was a Seimens whole body scanner. The slice thickness used in this study was 3 mm. The pitch used in this study was 2. Scan area diameter was 12 cm. Continuous volume scan was taken in axial plane for the region extending from the chin to a point 3-4 cm above the supra orbital margin with 50% overlapping of images. For the best results gentry tilt should be zero for 3D reconstruction . Spiral scan cycle time was approximately 34 seconds. In the present study the threshold CT number for the skeletal images was set at 150 HU and for the soft tissue image at -300 HU.

OBSERVATIONS

The study was undertaken in 35 patients of maxillofacial trauma. The age range of the patients was 60 years averaging 37.60 years. The highest incidence of fractures was seen in age group 20-30 years (Table I). In this study, only 28 cases(80%)were males

and 7cases(20%) were females giving a male to female ratio 4:1(Table II).This shows males were more prone to maxillofacial trauma. Road traffic accidents 25(71.42%) were the most frequent cause of maxillofacial trauma followed by assaults 6(17.14%), falls 2(5.72%) and sports related accidents 2(5.72%).(Table III)

In this study , in 24 cases (68.58%) 3D-CT did not play much role in the final treatment as in these cases diagnosis made by clinical radiological examination was confirmed by 3D-CT. In 10 cases(28.57%) 3D-CT had significant bearing on final treatment. In one case(2.85%) 3D-CT failed to make complete diagnosis.(Table IV)

Additional 14 fractures(77.78%) related to zygomatico-maxillary complex in 10 cases, 3 fractures(16.67%) related to orbital complex and one fracture(5.55%) related to nasal bone were detected by 3D-CT.(Table V)

Amongst the additional 14 fractures, related to zygomatico-maxillary complex, 8 fractures(57.14%) of maxilla, 2 zygomatic arch fractures(14.28%), 4 comminuted fractures(28.58%).(Table VI) Additional findings related to orbital complex fractures were found in 3 cases. In these cases, 2 fractures(66.7%) involving the floor of orbit and one fracture(33.33%) involving the lateral wall of orbit were detected by 3D-CT scan(Table VII).

One fracture(100%) related to nasal bone was found in one case(Table VIII). No additional fractures relating to the mandible was found by 3D-CT, but extent and displacement of fracture lines were better appreciated.

TABLE-I

Table Showing Age Wise Distribution of Patients

Age Group in years	NO. OF PATIENTS	PERCENTAGE
20-30	13	37.14
30-40	08	22.85
40-50	09	25.71
50-60	03	08.58
60-70	01	02.86
70-80	01	02.86
Total	35	100.00

TABLE-II

Table Showing Sex Wise Distribution of Patients

SEX	NO. OF PATIENTS	PERCENTAGE
MALE	28	80.00
FEMALE	07	20.00
TOTAL	35	100.00

TABLE-III

Pie Chart Showing Aetiology of The Fractures Involving Facial Skeleton

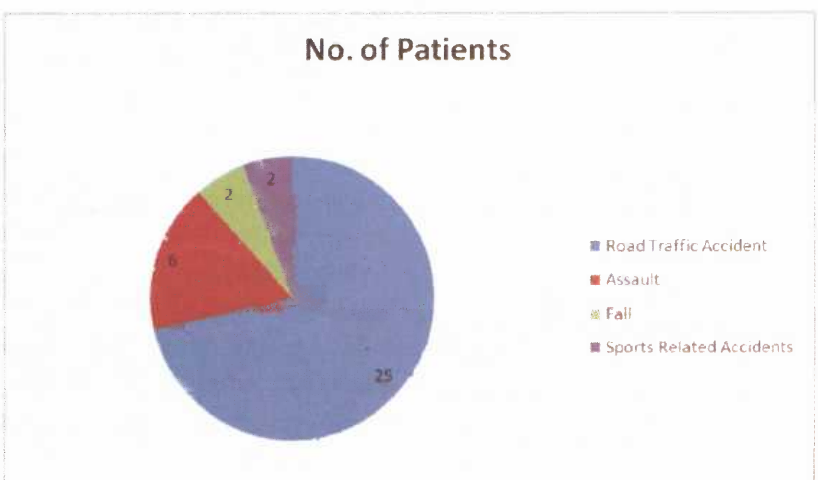

TABLE-IV
Bar Chart Showing Role of 3-D CT in Fracture Diagnosis

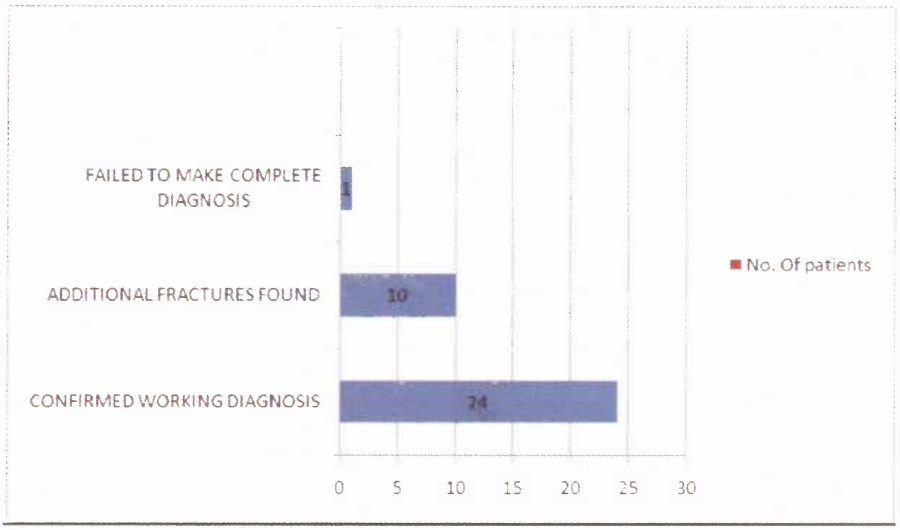

TABLE-V
Bar Chart Showing Additonal Fractures found By 3-D CT

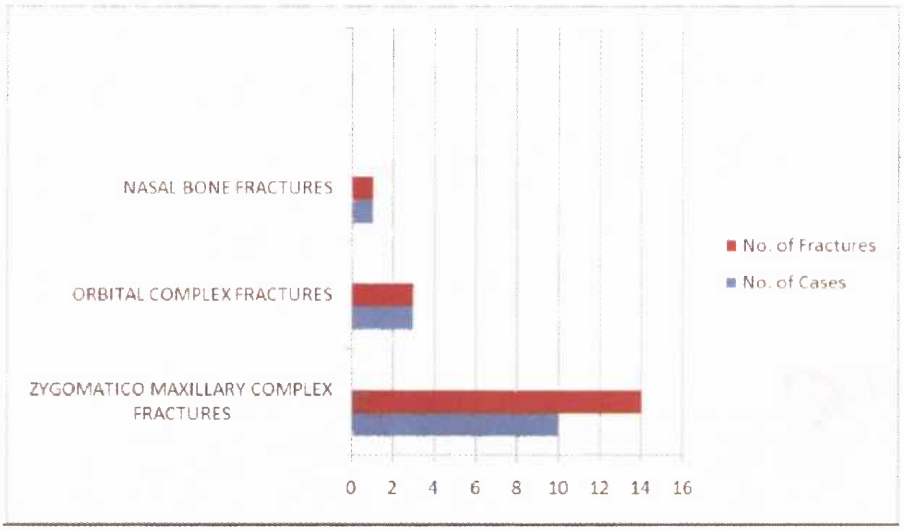

TABLE-VI
Table Showing Zygomatico_Maxillary Complex Fractures Detected By 3-DCT

FRACTURE SITES	NO. OF CASES	NO. OF FRACTURES		EFFECT OF TREATMENT
		NO.	%	
FRACTURE OF MAXILLA	6	8	57.14	BONE PLATING DONE
ZYGOMATIC ARCH	2	2	14.28	CONSERVATIVE
COMMINUTED FRACTURES	4	4	28.58	CONSERVATIVE TREATMENT DONE
TOTAL	12	14	100	

TABLE-VII

Table Showing Orbital Complex Fractures Detected by 3-DCT

FRACTURE SITES	NO. OF CASES	NO. OF FRACTURES		EFFECT OF TREATMENT
		NO.	%	
FLOOR OF ORBIT	2	2	66.67	OPHTHALMOLOGIST'S CONSULTATION SOUGHT BEFORE TREATMENT
POSTERIOR LATERAL WALL OF ORBIT	1	1	33.33	
MEDIAL WALL OF ORBIT	--	--	--	
ROOF OF ORBIT	--	--	--	
TOTAL	3	3	100	

TABLE-VIII

Table Showing Additional Fractures Involving The Nasal Bone Found By 3-DCT

FRACTURE SITES	NO. OF CASES	NO. OF FRACTURES		EFFECT OF TREATMENT
		NO.	%	
NASAL	1	1	100.00	BONEPLATING DONE

LEGENDS

CASE NO.I

Postero-anterior view of maxilla

3-D CT scan showing fracture of bilateral maxilla and right nasal bone

CASE NO.II

Postero-anterior view of maxilla in water's position

Postero-anterior view of maxilla in full open mouth position

CASE NO. III

3-D CT scan showing fracture of right coronoid process and right zygomatic arch

Postero-anterior view of maxilla in water's position

3-D CT scan showing fracture of floor of right orbit

DISCUSSION

As we know that the facial injuries produces the gross oedema which complicate the clinical examination and obscure the underlying bony injuries by producing haziness on conventional radiographs. Where as in 3D CT there is no need to wait for facial oedema to subside (Frame and Wake 1982)[3]. In conventional radiography, anatomy is depicted in only two dimensions. For complete evaluation of morphology of a structure, data related to third dimensional is essential. For this 3D CT has had a dramatic impact.

Fractures of facial region are difficult to diagnose on the conventional radiography because of the complex anatomy of the face and superimposition of thin bones of face which produces gross artifacts leading to misinterpretation of fractures. The rationale of present study was to evaluate the reliability of 3D CT scanning in the diagnosis of fractures of the facial skeleton and its superiority over the conventional radiography.

In this study, it was found that the incidence of facial fractures were highest in the 20-30 years of life followed by 40-50 years of age group. It was found the 80% patients were male and 20% female patients. Allen BP and Daley CG (1990)[1], Gassner R et al (1995)[4] also noted that male patients were more prone than female patients. It was seen that road traffic accidents (75%), accounted for the largest number of fractures, Hogg NJ et al (2000)[7] found the same in the study.

In this study, three dimensional computed tomography examination has got a significant bearing on final treatment in 10 cases (28.57%) where as in 24 cases (68.58%), 3D CT did not play much role in the treatment planning of fractures as the working diagnosis made by clinical and radiological examination was confirmed by 3D CT images. Additional finding related to zygomatico-maxillary complex region which had significant bearing on final treatment plan were made out in 10 cases. This clearly shows the value of 3D CT in delineating the complex fractures involving the zygomatico-maxillary complex region. Levy RA et al (1991)[10], Juliana Newman (1998)[9] also reported the usefulness of 3D CT in complex zygomatico-maxillary fractures. From the detailed information available with 3D CT maxillofacial surgeons are able to plan the exact placement of internal fixation devices, whether they by wires of plates. 3D CT provides accurate pre-operative localisation of the fracture line involving the facial buttresses . The relative size and shape of the fracture segments are useful in determining, if adequate bone is available for purchase of fixation devices and this is clearly demonstrated by 3D CT. Since degree of comminution is better appreciated on 3D CT, surgeons can anticipate preoperatively that internal fixation or external fixation or conservative treatment is required. Thus improving the technical results and saving the operating time and increasing the efficiency.

Additional findings related to fractures of the orbital complex region have significant bearing in the clinical management patients and needed opthalmologist consultation. No addition finding have made regarding inferior or medial walls and roof the orbit which corroborates with finding of Gillespie et al (1987)[6]. The extent and displacement of fractured orbital floor were better demonstrated by 3D CT than standard radiographs.

In one case, fracture of nasal region were diagnosed by 3D CT which was missed by plain film radiograph. The rotation of major nasal fragment was clearly depicted in 3D CT as compared to conventional radiography.

In case of mandibular fractures, no additional findings have been found. This finding corroborates with the observations made by Gentry et al (1983)[5]. 3D CT failed to make a diagnosis in one case which has got a hairline fracture involving the lateral orbital rim.

Three dimensional CT reconstruction is increasingly becoming a valuable tool in the maxillofacial trauma. Improved diagnosis of fracture line and specific pattern of comminution in mid face fracture is possible only with 3D CT. The tripod fractures are better displayed in 3D CT which allow an improved demonstration of rotational components of fractured segments. The 3-D format conveys spatial information in an assimilated and familiar anatomical format, and facilitates the accurate and rapid communition of this information to other observers. 3D-CT is much less useful in minor trauma. Demonstration of minor fracture lines was also unreliable on 3D CT. The results of this study indicate that 3D reformations can make a valuable contribution to the clinical management of patients with severe maxillofacial trauma.

SUMMARY AND CONCLUSIONS

In the present study,35 patients of facial fractures have been studied using clinical examination, plain film radiography and three dimensional computed tomography. In this study, almost all the fractures involving the mandible were diagnosed by plain film radiography. But superior definition of fracture line (especially horizontal) was there & extent size & displacement of fractured fragments was better appreciated by 3D CT.

Fractures of middle third of face were difficult to detect by plain film radiography because of complex anatomy of middle 3rd of facial skeleton. It is thus concluded that

improved diagnosis of fractured lines and the specific pattern of comminution on mid face fracture is made possible with 3D CT and also provides clear perception of the extent of fracture comminution and resulting displaced fragments. The improve diagnostic capability reduces the operating room time and decreases the likelihood of unforeseen difficulties during surgery.

The present study suggest that where ever the three dimensional CT is available it should be modality of choice for complete diagnosis and treatment planning of complex fractures of facial skeleton.

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