Original Research Article

Significance of 3 dimensional radiology in diagnosing and planning maxillofacial trauma: a hundred case comparative study

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Abstract

3D CT scan evaluation is increasingly becoming a valuable tool in maxillofacial trauma. The aim of this study is to guage the role of three dimensional CT in contrast to traditional radiography within the diagnosis and management of CRANIO-MAXILLOFACIAL trauma. Optimal positioning of mini-plates are essential for successful treatment of facial deformity correction in line with AO principle .Conventional plain radiographs are the primary line of investigation in maxillofacial trauma but bear limited advantages.3DCT scan of face is now a preferred diagnostic tool because of its accurate diagnosis. During this study we did a Meta analytical comparative study of conventional radiographs and 3D CT within the evaluation of maxillofacial trauma based solely on Oral and Maxillofacial surgeon's perspective what proportion an Oral and Maxillofacial surgeon finds radiographs / 3DCT of face valuable within the diagnosis and management of cranio-maxillofacial trauma patients). Further 3DCT scan of face is superior in evaluating the extent of fractures and comminution in addition as for displacement and it provides Additional conceptual information as compared to standard radiographs in majority of patients having cranio-maxillofacial trauma. Diagnostic imaging is sort of always required, and is critical in determining patient management. Multi-detector CT (MDCT) appears consistently within the literature because the gold-standard imaging modality for facial bones, but leads to/ends up a high radiation dose to the patient. This makes the application and advancement of dose reduction and dose optimization methods vital. This presents study is a critical appraisal of the literature concerning diagnostic imaging of facial bone trauma, with a stress on dose reduction methods for MDCT.Investigations of more innovative techniques also appear within the literature, including diagnostic cone-beam CT (CBCT), intraoperative CBCT and dual-source CT (DSCT), but further research is required to verify their clinical value.

Keywords: CT scan,Facial injuries, maxillofacial trauma

Introduction

Facial injury may range from simple tear to craniofacial detachment from skull base with severe soft tissue damage. Management of facial injuries is challenging for the Surgeon as they're more often critical in nature and can have serious functional and cosmetic complication. This makes accurate diagnostic evaluation essential. Single or combinations of conventional plain films form basic radiographic screening assessment for the investigation of cranio-maxillofacial trauma. Their diagnostic accuracy has been shown as 38% for orbital and maxillary fractures which they significantly underestimate the extent of blowout, Le fort I, and Le fort II fractures [1]. Also practical interpretation of cranio-maxillofacial trauma using conventional radiographs becomes quite difficult for limited experience staff and for skilled staff too. These limitations are overcome by Spiral CT which provides rapid acquisition (less than 20 seconds) of thin section axial CT data and facilitates multiplanner reformatted (MPR) 2-dimensional (2D) and 3D image reconstruction assisting fracture detection. CT's accurate representation of cranio-maxillofacial trauma and their spatial relationships facilitates surgical exploration, fracture reduction, and thus the choice and contouring of rigid reconstruction plates. CT, therefore, decreases complications resulting from delays in diagnosis and treatment. Recent introduction of 3D reconstructions have further facilitated the diagnosis and treatment of facial injuries [2, 3], and are superior to 2D CT for pre-surgical planning in complex trauma [2, 4]. The external part may be a private esthetic identification. Losses of facial esthetics due to cranio-maxillofacial trauma are more common today with increasing road traffic accidents. There is also other etiological factors like interpersonal violence, falls, sports injuries and industrial trauma etc. Clinical examinations along with conventional radiography are playing a significant role within the diagnosis and treatment planning of cranio-maxillofacial injuries. Superimposition of bony structures and hindered visualization of underlying fractures by soft tissue swelling and hemorrhage, however, may necessitate further investigation. In these cases the X-radiation has become the modality of choice system has been developed which will produce three dimensional images from routine CT data.Images may

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be rotated and split and anatomic structures may be separated and individual images of various tissues types may be generated. 3D images provide an overall spatial concept that enables better understanding of the complexity on multiple 2D axial CT imaging. With 3D CT we are able to concentrate on specific areas of clinical and surgical concern. We will easily appreciate the post-operative repair and therefore the postoperative complications which will occur.

3D reconstruction is beneficial in visualizing bone fragments from all angles and planes. Not only the extent of fracture fragments but a suggestion of the mechanism of the injury may be readily assessed. Moreover, 3D CT reformations have helped lots in patient and family education. Within the present study, a shot has been made to check the role of 3D CT as diagnostic aid within the management of cranio-maxillofacial trauma.

Methods

Hundred patients with cranio-maxillofacial trauma who were noted TRAUMA CENTRE , associated with Gajaraja Medical College & JAH Group Of Hospital Gwalior (M.P), were included during this study from 11/03/2019 to 11/12/2020.The patients selected for this study were requested to sign a consent form, if conscious and adult, or by his/her attendant/ guardian, if unconscious or a minor. there are 88 males and 12 females with ages 3-55 years. Their age, sex and region wise distribution has been shown in Table 1. Hundred patients of cranio- maxillofacial fractures were included during this study. After clinical examination patients were subjected to plain radiographs. All patients were evaluated clinically and then with the normal plain radiographs e.g., PA view mandible, Waters view,Submentovertex view, Occlusal view, Orthopant-omogram etc. per the need, followed by non-contrast CT scan of the face. The CT examination was performed on the Siemens (spiral rotating system) at settings of 130 kVp, 90 mA and scan time of 20s.The examination was performed in axial and coronal scans on a bone window basis. 5mm contiguous axial and coronal sections of the face were obtained and 3D CT SCAN OF FACE was performed on the axial images, using the brink technique, at a threshold of +150 HU employing a 512x512 matrix. Cases were divided into three groups.In each case, the normal radiographs and 3D CT images were analyzed under the headings of fracture sites detection, Extent of fractures and comminution and fragment displacement were detected. The Surgeon studied each case separately for fracture detection employing a score [Table 2] so gave an overall score for extent of fractures and comminution also as for displacement for that case. The information for extent of fractures and comminution and fragment displacement were recorded employing a organisation (Table 3)[5]. The findings of the standard radiographs and 3D CT were recorded on especially designed format then studied, compared and reviewed. The results of the study for fracture sites.

Table 1:Age,sex and class distribution

	LEFORT CLASS		MANDIBLE		LEFORT,MANDIBLE	
	AGE	SEX	AGE	SEX	AGE	SEX
1	08	M	07	M	19	F
2	23	M	19	M	22	M
3	35	M	28	F	34	M
4	03	F	34	M	45	M
5	17	M	03	M	55	M
6	40	M	45	M	12	M
7	33	M	30	M	10	M
8	13	M	17	F	09	M
9	45	M	41	M	48	M
10	48	M	33	M	21	F
11	29	F	39	M	20	F
12	54	F	31	M	43	M
13	38	M	23	M	31	M
14	15	M	52	M	46	M
15	53	M	05	M	27	M
16	14	M	26	M	18	M
17	09	M	16	M	13	M
18	18	F	07	M	54	M
19	26	M	37	M	30	M
20	49	M	44	M	44	M
21	-	-	18	F	51	M
22	-	-	55	M	32	M
23	-	-	30	M	26	M
24	-	-	14	M	20	M
25	-	-	16	M	20	M
26	-	-	17	M	50	M
27	-	-	13	M	42	M
28	-	-	20	M	33	M
29	-	-	34	M	17	F
30	-	-	53	M	09	M
31	-	-	49	M	17	M
32	-	-	04	F	17	M
33	-	-	50	M	28	M
34	-	-	22	M	18	M
35	-	-	28	M	25	M
36	-	-	12	M	50	M

37	-	-	21	M	14	M
38	-	-	30	M	16	M
39	-	-	30	M	38	M
40	-	-	10	M	13	M

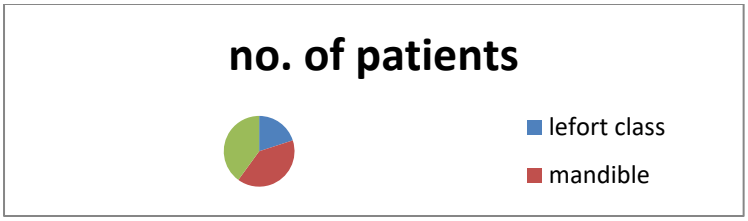

Fig 1: Pie chart showing Distribution of injuries according to region

Table 2: Score for fracture detection

I	**No fracture site diagnosed**
II	**Fracture site/ sites diagnosed**

Table 3: Comparative scoring system: 3D CT SCAN Vsconventional Radiography

Score	**3-D Assessment**
I	Inferior
II	Similar
III	Superior-similar information more rapidly accessed
IV	Superior-additional conceptual information provided

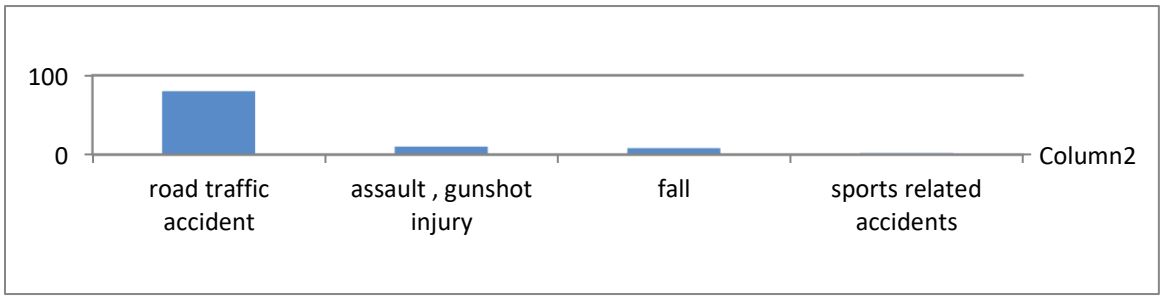

Fig 2: Column chart showing aetiology of the fractures

Table 4: Fracture assessment (CONVENTIONAL RADIOGRAPHS Vs 3D CT)

Sr. No	Region of face involved	Total No. of fracture sites detected by both conventional radiographs and 3D CT	Total No. of fracture sites detected by conventional radiographs	Total No. of fracture sites detected by 3D CT	Result	% of patients with scores for extent of fractures and comminution	% of patients with scores for displacement
I	Lefort Class	87	37	87	Z=8.4,p<0.001 (significant)	82.5%(4) 8.2%(3) 9.3%(2)	98%(4) 02%(3)
II	Mandible	69	42	69	Z=5.8, p<0.001 (significant)	88.4%(4) 2.6%(3) 9.0%(2)	90.1%(4) 6.8%(2) 3.1%(1)

III	Lefort, Mandible	48	45	41	Z= 1.3,p>0.05 (not significant)	41.5%(4) 15.75%(3) 36.5%(2) 6.25%(1)	48.2%(4) 10.5%(3) 28.2%(2) 13.1%(1)
IV	Total (n=100)	204	124	197	Z=8.8,P<0.001 (significant)	68.2%(4) 9.6%(3) 16.7%(2) 5.5%(1)	85.1%(4) 4.45%(3) 8.4%(2) 2.05%(1)

Fig 3: 3D CT scan showing LEFORT CLASS, I, II, III, with mandible or without mandible

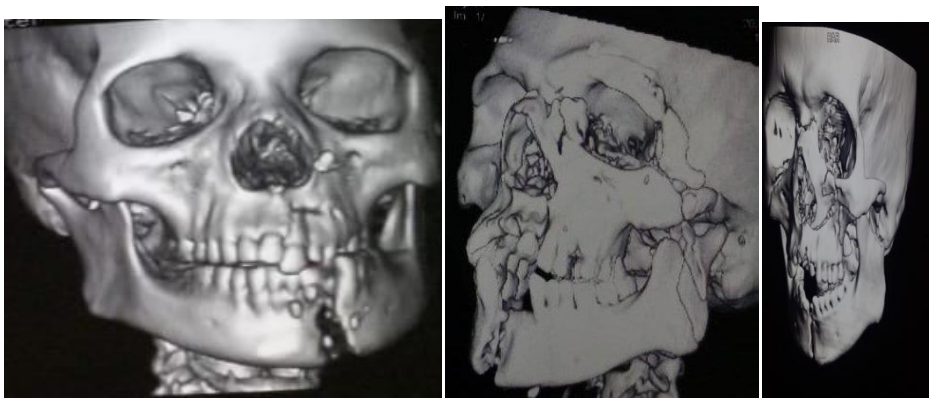

Fig 4: conventional radiography showing PNS, OPG, lateral obilque view of skull with gunshot injury

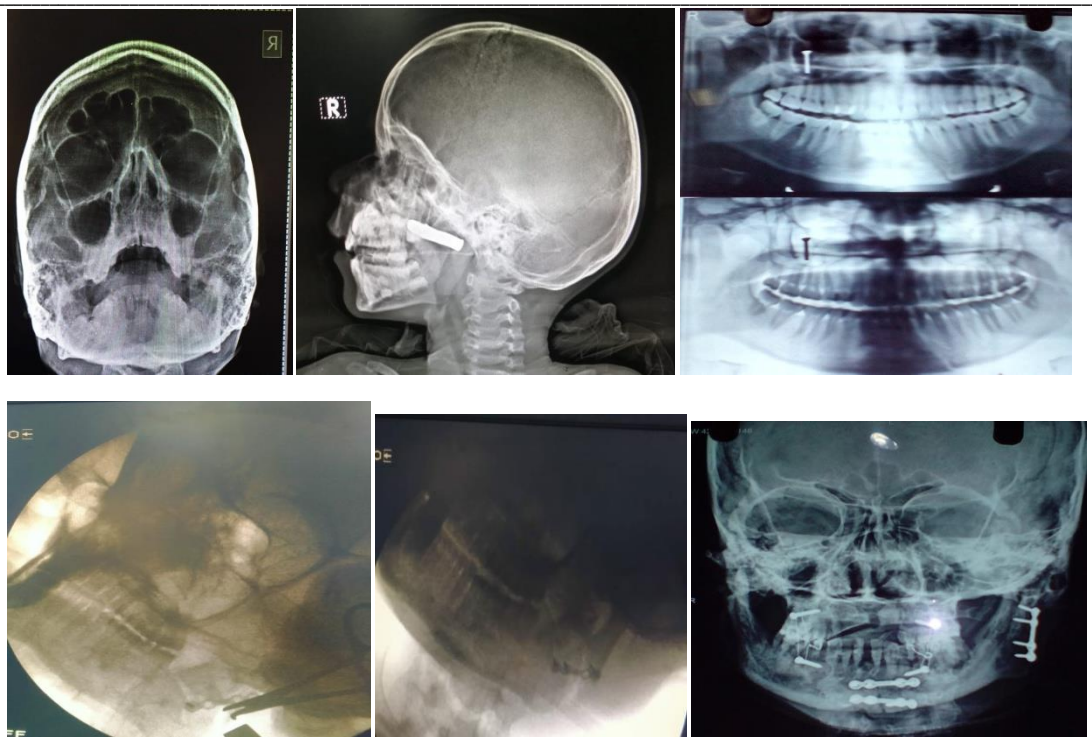

Fig 5: Intraoperative imagaing by using c-arm to check the position of implant and reduction

Discussion

Combined clinical examination and accurate imaging of affected cranio-maxillofacial skeleton is important for correct anatomic reduction of fractured segments. Conventional Radiography has limited significance in detecting cranio-maxillofacial trauma because it produces inadequate contrast between bone and soft tissue and makes it further difficult distinguish the fractured site. Development of three dimensional (3D) CT scan of face further helps in evaluation and treatment plan of Cranio-Maxillofacial Trauma. Variety of authors have described the diagnostic efficacy of 3D CT in Cranio-maxillofacial trauma [6,7,8,9]. The aim of this study was to match and evaluate the employment of plain radiographs and 3D CT in Cranio- maxillofacial trauma patients and satisfying results were obtained in our study.In the 35.5% cases of isolated mandibular fractures 35 fracture sites were detected on conventional radiographs and 30 fracture sites were detected on 3D CT. No statistical difference was obtained between 3D CT and traditional radiographs for fracture detection of mandible. It means for isolated fracture of mandible, conventional radiographs are equally useful as 3D CT for fracture site detection. Our study corroborates the observation by Gentry et-al [10] that mandibular fractures are often adequately diagnosed by using clinical examination and standard plain X- ray film including panorex. it absolutely was his impression that CT scanning was not required during this injury and our findings confirm that 3D CT do not detect more fracture sites than conventional radiographs. Mayer et al [6] also found that an accurate diagnosis of fracture mandible was obtained without the help of 3DCT.Howeverthe results of our study found that in majority of patients with fracture mandible 3D CT is superior in displaying extent of fracture and comminution further as displacement. Costa et al also concluded that 3D imaging provided better visualization of the position and displacement of bone fragments, similarly because the comminution of fractures[11].

In the 28.8% cases of isolated midface fractures, 49 fracture sites were detected on 3D CT and only 22 fracture sites were detected on conventional radiographs. Moreover, 3D CT was found statistically more significant in terms of fracture sitesdetection compared to standard radiographs We found that 3D CT was superior in displaying extent of fractures and comminution further as fragmentdisplacement and it provided additional conceptual information as compared to standard radiographs. Out of 13 patients involving midface fractures, 92.4%patients scored 4 and seven.6% patients scored 2. Similar was the lead to terms of assessment for displacement. This is often in accordance with a study done by Mayer et al [6] who found 3D CT to be accurate and precise within the display of fractures of the midface. Alder et al [12] concluded that 3D images are of greatest benefit for the assessment of mid-face injuries. 35.5% patients were having both midface and lower third facial skeleton fractures. 87 fracture sites were detected on 3D CT and only 37 fracture sites were detected on conventional radiographs. In comparison,3D CT was found statistically more significant in terms of fracture sites detection compared to traditional radiographs .Also 3D CT was superior in displaying extent of fractures and comminution in addition as displacement and it provided additional conceptual information as compared to standard radiographs. In terms of extent of fractures and comminution detection, out of 16 patients 87.5% scored 4, 6.25% scored 3, 6.25% scored 2. In terms of displacement, 100% patients scored 4. Overall out of total of 173 fracture sites as detected by both conventional radiographs and 3D CT in 45 patients, 94 fracture sites were detected onconventional radiographs and 166 fracture sites were detected on 3D CT. 3D CT was found statisticallymore significant ($Z= 8.8$, $p<0.001$) in terms of fracture sites detection as compared to standard radiographs for patients having maxillofacial trauma .In terms of extent of fractures and comminution detection, 71.1% patients scored 4, 8.9% patients scored 3, 17.78% patients

scored 2 and a pair of.22% scored 1. In terms of displacement, 80% patients scored 4, 4.45% patients scored 3, 13.33% patients scored 2 and a couple of.22% scored 1. Thus in majority of the patients of maxillofacial trauma 3D CT was found superior in displaying extent of fractures and comminution still as for displacement and it provided additional conceptual information as compared to traditional radiographs. Gillespie et al [13] in their study found 3D to be of greatest value in patients with severe trauma andmultiple fractures but less useful in minor trauma where there was no fragment displacement. We found that a lot of linear undisplaced fractures especially just in case of midface(e.g. fracture of lateral and posterior antral wall, fracture of surface,medial orbital wall etc.) weren't detected on 3D CT but was detected on axial or coronal images. this is often because of the very fact that 3D CT shows only the surfaceskeletal deformity, the inner anatomy (posterior antral region, pterygoid, septum, sphenoid wings etc.) being hard to guage. Gillespie et al and Mayer et al [6,13] found that overall 3D CT is inferior to standard CT in terms of actualfracture detection, especially within the undisplaced linear fracture of orbits and malar complex regions.Thus we conclude that although 2D axial and coronal CT images detect more fracture sites than 3D CT, overall 3D CT is more significant in terms of fracture sites detection compared to standard radiographs. Our observations also indicate that 3D CT enable clinicians to higher assess the localization of bone fragments and their direction of displacement.We also found 3D CT to greatly enhance diagnostic speed and accuracy. The interpretation of 3D CT took less time than conventional radiographs. From the detailed information available with 3D CT, we were ready to plan the precise placement of internal fixation devices, whether or not they are wires or plates. Since stabilization is mostly applied along the facial pillars, 3D CT proved to be advantageous because it provided accurate preoperative localization of the fracture lines involving the most important buttresses. Since the degree of comminution is best appreciated on 3D CT, surgeons can anticipate preoperatively that standard internal fixation techniques might not be applicable and first bone grafting or external fixation is also required. Thus technical results are improved, efficiency is improved, and operating time is reduced. Patients will benefit because anesthesia time are reduced,

and they may be more accurately and completely informed about the surgery. the underside line is that surgeons aren't any longer entering the operating room blind with only a non specific idea of where the fractures lie. They now can have a close three dimensional reconstruction of the injury to consult with and guide the surgical approach. Reuben et al [14] reported that individuals at different levels of experience showed differential appreciation for the traumatic injuries illustrated by radiograph, 2D CT, and 3D reconstruction.

Non radiologist viewers correctly diagnosed the fractures in 75.7% of 3D cases, 71.5% of radiographs, and 64.7% of conventional CT. Viewers showed a preference for 3D CT over conventional CT over radiograph in an exceedingly survey conducted as an element of this study. Thus we found 3D CT to be more useful in terms of fracture sites detection as compared to traditional radiographs especially in midface and sophisticated maxillofacial trauma. Because plain radiographs in severe midface injuries failed to offer sufficient information for either the diagnosis or operation planning, they're not indicated in the slightest degree. However for isolated mandibular fracture conventional radiographs was found to be equally useful as 3D CT for fracture sites detection. Also 3D CT was found to be more valuable in detecting extent of fracture and commin-ution additionally as fragment displacement in maxillofacial trauma either involving middle third or lower third of facial skeleton.

Conclusion

The results of this study show that axial, coronal and 3D computed tomography is of utmost importance to assess the extent of Cranio-maxillofacial trauma. It should be prioritized for all suspected comminuted and displaced fractures over plain radiographs. There should be a multidisciplinary approach in detecting the Cranio-maxillofacial trauma because it helps in reducing the radiation exposure to the patient, sort of a neurosurgeon advises for a comprehensible CT Head where as a maxillofacial surgeon for a 3D CT scan of a face, and also in reducing the burden of required expenses. 3D CT should even be advised for comminuted fractures of the mandible.

This system also helps in surgical operation required to scale back the fracture. it's not of much help in minimally displaced fractures.

Conflict of Interest: Nil
Source of support:Nil

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