ORIGINAL ARTICLE

Clinical and Radiographic assessment of Dental Occlusion after Surgical Management of Maxillary and/or Mandibular Fractures

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Abstract

Background: ***Maxillofacial injuries affect a significant proportion of traumatic patients, either isolated or associated with other serious injuries.***

Aim: ***This study aimed to evaluate the clinical and radiological outcomes of dental occlusion using three-dimensional (3D) CT after surgical management of maxillary and/or mandibular fractures.***

Patients and methods: ***This study was a randomized, prospective study conducted on 30 patients at Al-Azhar University Hospitals, specifically AL-Hussein and AL-Sayed Galal hospitals, from December 2023 to December 2024 by staff of Al- Azhar university.***

Results: ***Out of the 30 patients, preoperative the majority had Class I occlusion (90.0%), followed by Class II (6.7%) and Class III (3.3%) which improved postoperative; all patients had class I occlusion. the most frequent bite type was normal (46.7%), followed by anterior open bite with cross bite (26.6%). Other types included cross bite alone (6.7%), anterior open bite alone (10.0%), and posterior open bite (3.3%), which improved significantly postoperatively. Twenty-nine patients (96.67%) had a normal bite postoperatively, while one patient (3.33%) had an anterior open bite. The mean preoperative maximum mouth opening was 29.07 mm, which increased significantly to 32.37 mm early postoperatively and further to 37.93 mm late postoperatively. Paired sample t-tests confirmed significant improvements in mouth opening from preoperative to early (mean increase of 3.300 mm, $p = 0.037$) and late postoperative periods (mean increase of 8.867 mm, $p < 0.001$).***

Conclusion: ***Clinical and radiographic assessment of dental occlusion using three dimensional (3D) CT after surgical intervention in patients with Mandibular and/or maxillary fractures serving as a critical predictor of long-term functional success. The study highlights the importance of optimizing early postoperative care to enhance overall outcomes.***

Keywords: Dental occlusion; Surgical management; Maxillary; Mandibular fractures

1. Introduction

Maxillofacial injuries affect a significant proportion of traumatic patients, either isolated or associated with other serious injuries. Maxillofacial injuries are often associated with functional, cosmetic, and psychological morbidity. The epidemiology of maxillofacial trauma varies widely across countries and often even within the same country, depending on cultural and socioeconomic factors.[1]

Teeth in natural dentition may be in contact in a static or dynamic manner. Static contacts usually occur in maximal intercuspation or in centric occlusion, while dynamic contacts occur during eccentric mandibular movements such as laterotrusion, mediotrusion, and protrusion.[2]

Malocclusion is a common hard tissue complication of maxillofacial trauma. The literature has reported its incidence as ranging between 5 and 20%. It can be manifested in the maxillary arch, mandibular arch, anterior segments, posterior segments, or any combination of these.[3]

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Computed tomography (CT) is gaining increasingly more acceptance in the evaluation of facial trauma.[4,5] as it can often visualize complex injuries with a precision unattainable by conventional radiography or clinical examination.[6] Furthermore, CT aids in the evaluation of the fracture lines, patterns, and volume changes and comparison to the contralateral or uninjured side. It can depict significant fractures that could be missed or incompletely diagnosed by plain radiography.[7]

This study aimed to evaluate the clinical and radiological outcomes of dental occlusion using three-dimensional (3D) CT after surgical management of maxillary and/or mandibular fractures.

2. Patients and methods

This study was a randomized, prospective study conducted on 30 patients at Al-Azhar University Hospitals, specifically AL-Hussein and AL-Sayed Galal hospitals, from December 2023 to December 2024, by staff of Al- Azhar university.

Inclusion Criteria: Adult Patients, full Permanent Dentition, maxillary and/or Mandibular Fractures and Time within two weeks from trauma.

Exclusion Criteria: Isolated cranial Fractures, Child Patients, Pathologic Fractures and time after two weeks from trauma.

Ethical Considerations

Approval for the study obtained from the Scientific Ethics Committee of Al-Azhar University. All participants required to provide written informed consent before inclusion in the study. The consent form outlines the nature of the study, the procedures involved, potential risks, and the participants'participants' right to withdraw at any time.

Methods

All patients were subjected to the following:

Preoperative Assessment: History was taken from the patient. Clinical Examination: This examination included evaluating the preoperative maximum mouth opening and canting of the occlusal plane. Photographic documentation of all steps was taken throughout the whole work, and all views of occlusion were captured, including Anterior, both lateral views and occlusal surfaces of teeth. Virtual surgical planning of Occlusal Repositioning wafers: Visualization of a surgical procedure in a 3D imaging computer software, including reduction of the fracture, obtaining normal occlusion and 3D printing of occlusal, which aids in the achievement of the final planned position and occlusion.

Surgical Management

Surgical Intervention: Patients underwent surgical repair of the maxillary and/or mandibular fractures. The specific surgical techniques employed depend on the type and severity of the fractures. Techniques may include open reduction and internal fixation, as well as the use of fixation plates and screws. Postoperative Care: Postoperative care included pain management, infection control, and monitoring for potential complications. Follow-up appointments were scheduled to assess healing and recovery.

Postoperative Assessment

Early Postoperative Assessment: Patients are evaluated within 2 weeks of surgery to assess early changes in dental occlusion, bite type, and maximum mouth opening. Measurements of maximum mouth opening. Early postoperative 3D CT scans were obtained to assess initial healing and fracture alignment. Late Postoperative Assessment: A follow-up evaluation was conducted 1 month and 6 months after surgery. This assessment includes changes in dental occlusion, bite type, clinical measurements of maximum mouth opening, as well as 3D CT imaging for measurement of overjet and overbite, long-term outcomes, and the final alignment of the fractures.

Data Collection: Type of fracture, dental occlusion: patients'patients' type of occlusion was classified according to angle classification of occlusion and was collected preoperative and 1,3 months postoperatively, assessment of occlusion was done using clinical and photographic examination, CT-3D, and dental cast and bite type was collected preoperative and 1,3 months postoperative.

Clinical Measurements

Maximum Mouth Opening: Maximum mouth opening was measured using a calliper at three time points: preoperative, early postoperative, and late postoperative. Measurements were taken in millimeters (mm) and Overjet and Overbite: Overjet and overbite measurements were recorded late postoperative clinically and using computer software in CT-3D.

Radiographic Imaging

3D CT scans: 3D CT scans were performed preoperatively, early postoperatively, and late postoperatively to assess fracture patterns, alignment, and changes in occlusion. CT images were analyzed using dedicated software to evaluate the quality of fracture reduction, the presence of any residual malocclusion and measuring overjet and overbite.

Data Management and statistical analysis

Data was collected and recorded in a secure database. All patient information were anonymized to maintain confidentiality. Statistical analysis was performed using appropriate software (e.g., SPSS, Excel) to ensure accuracy and reliability of results. The following tests were used descriptive Statistics and Paired Sample T-Tests.

3. Results

The postoperative period of a dental procedure saw an increase in the range of mouth openings, with the mean increasing from 34.43 mm to 40.1 mm. Overjet measurements ranged from 0.0 mm to 3.0 mm, while overbite ranged from -2.0 mm to 3.0 mm. Out of 30 patients, 26.7% were female and 73.3% were male. The majority had Class I occlusion (90.0%), followed by Class II (6.7%) and Class III (3.3%). The most frequent bite type was normal (46.7%), followed by various types of anterior open bite with cross bite (26.6%). Other types included cross bite alone (6.7%), anterior open bite alone (10.0%), and posterior open bite (3.3%). Out of the 30 patients, 56.7% had no canting of the occlusal plane, while 43.3% had canting. All patients (100.0%) had Class I occlusion after the surgery. (Table 1)

Table 1. Summary of Patient Variables and Distributions

VARIABLE	RANGE	MINIMUM	MAXIMUM	SUM	MEAN	SD
AGE	44	17	61	993	33.10	12.37
MAXIMUM MOUTH OPENING PREOPERATIVE (MM)	33	12	45	872	29.07	9.84
MAXIMUM MOUTH OPENING EARLY POSTOPERATIVE (MM)	36	14	50	1033	34.43	7.25
MAXIMUM MOUTH OPENING LATE POSTOPERATIVE (MM)	38	12	50	1203	40.1	7.02
OVER JET (MM)	3.0	0.0	3.0	61.4	2.08	0.74
OVER BITE (MM)	5.0	-2.0	3.0	59.6	1.98	0.94

This table integrates all the relevant data categories, including descriptive statistics and distribution detail N=Number, SD= standard deviation

The table highlights a higher prevalence of male patients (73.3%) and shows that most cases (90.0%) had preoperative Class I occlusion. Post-surgery, all patients achieved Class I occlusion, with 96.67% having a normal bite. This demonstrates the high effectiveness of the surgical intervention in correcting occlusal and bite issues. (Table 2)

Table 2. Distribution of Patients by Sex, Preoperative and Postoperative Occlusion and Bite Types, and Canting of Occlusal Plane

CATEGORY	SUBCATEGORY	NUMBER (PERCENTAGE %)
SEX	Female	8 (26.7%)
	Male	22 (73.3%)
PREOPERATIVE OCCLUSION TYPE	Class I	27 (90.0%)
	Class II	2 (6.7%)
	Class III	1 (3.3%)
PREOPERATIVE BITE TYPE	Anterior Open Bite	3 (10.0%)
	Anterior Open Bite, Cross Bite	10 (33.3%)
	Cross Bite	2 (6.7%)
	Normal	14 (46.7%)
	Posterior Open Bite	1 (3.3%)
CANTING OF OCCLUSAL PLANE	No	17 (56.7%)
	Yes	13 (43.3%)
POST-OPERATIVE OCCLUSION TYPE	Class I	30 (100.0%)
POST-OPERATIVE BITE TYPE	Anterior Open Bite	1 (3.33%)
	Normal	29 (96.67%)

The paired samples t-test also showed statistically significant increase in maximum mouth opening from preoperative to late postoperative measurements. (Table 3)

Table 3. Paired Samples Test for Maximum Mouth Opening

PAIR N	PAIR	STD. ERROR MEAN	95% CONFIDENCE INTERVAL OF THE DIFFERENCE Lower	Upper	P-VALUE
PAIR 1	maximum mouth opening early post operative (mm) - maximum mouth opening preoperative (mm)	1.508	0.216	6.384	0.037
PAIR 2	maximum mouth opening late post operartive (mm) - maximum mouth opening preoperative (mm)	1.572	5.652	12.081	0

CASE PRESENTATION

First case: Male patient 24 yo presented to ER post RTA with rt body and lt subcondylar fracture of 24h duration, patient presented with cross bite as shown in figure (1)

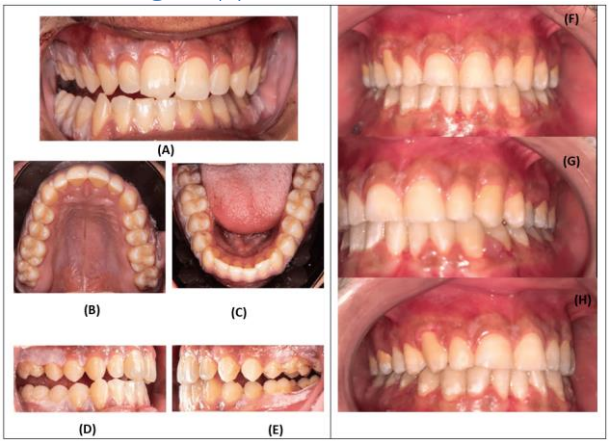

Figure 1. (A,B,C,D,E) preoperative photos of occlusion with cross bite. (F,G,H) photos of occlusion 6months postoperative with class I occlusion.

Case (2): Male patient 22 yo presented to ER post RTA with rt Sup orbital ridge, rt ZMC, anterior maxillary wall and dentoalveolar fracture of upper jaw of 24h duration as shown in figure (2).

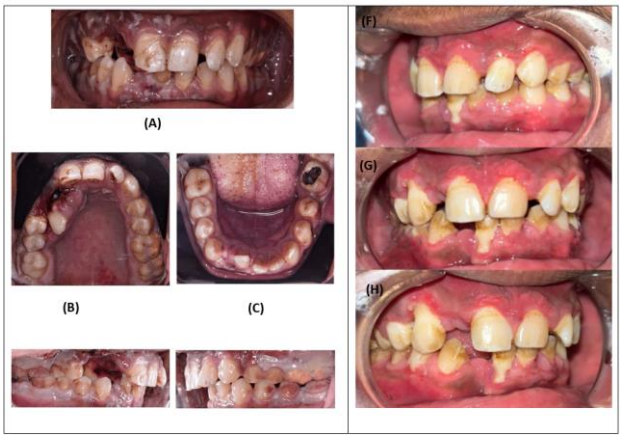

Figure 2. (A,B,C,D,E) photos of occlusion preoperative with overjet (F,G,H) photos of occlusion 6months postoperative.

Case (3)

Male patient 37yo presented to ER post RTA with Leforte III , RT ZMC fracture of 1week duration. Patient presented with cross bite and limited maximum mouth opening about 15 mm as shown in figure(3), preoperative virtual surgical planning of occlusal wafer was done using DICOM file of CT with reconstructed 3D images as shown in figure (4), intraoperative; occlusal settling was done using wafer then arch bar was applied as shown in figure (5), postoperative assessment of occlusion and measurement of maximum mouth opening was done as shown in figure(6), post operative CT-3D was done for assessment of occlusion and final alignment of the fracture and measurement of overjet and overbite as shown in figure(7).

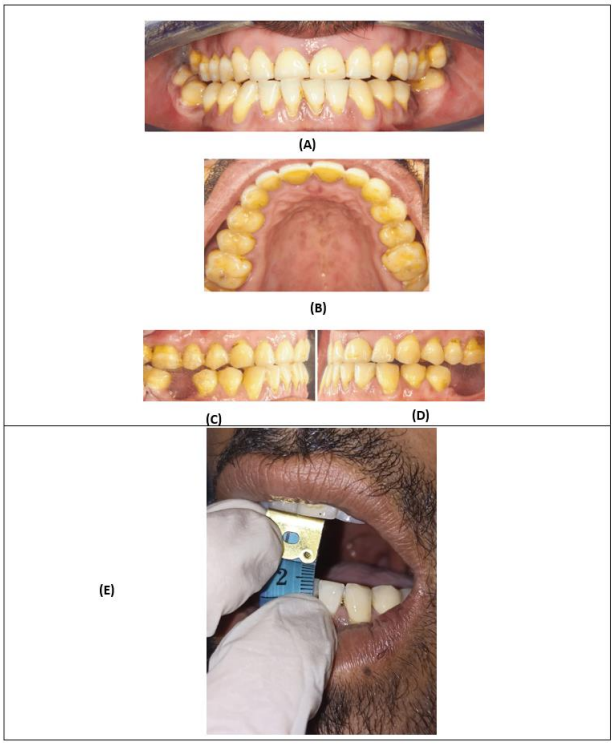

Figure 3. (A,B,C,D) photos of occlusion preoperative with cross bite . (E) limited maximum mouth opening preoperative about 15mm.

Figure 4. (A,B) preoperative virtual surgical planning of reduction of fracture occlusal wafer (C,D) 3D printing of occlusal wafer.

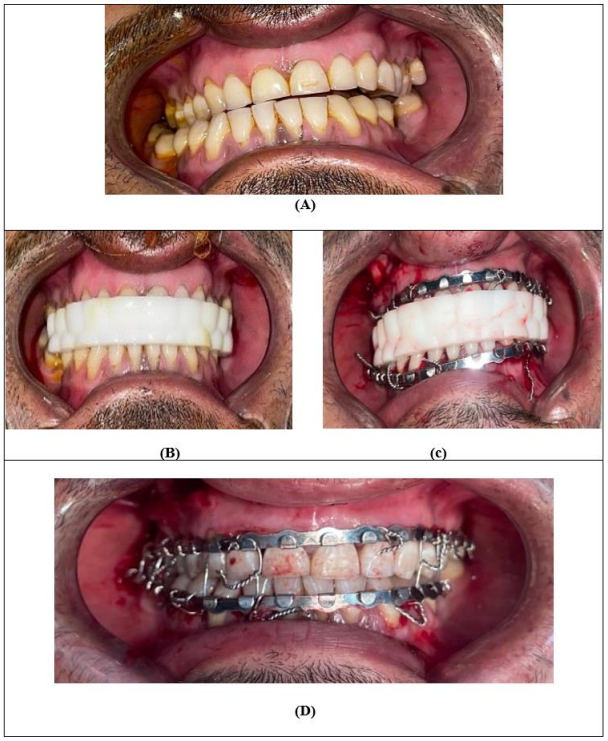

Figure 5. (A) intraoperative photo of occlusion with cross bite (B,C) application of occlusal wafer with correction of bite and setting of arch bar.

(D) intra operative photo of occlusion after fixation of fracture with IMF

Figure 6. (A) Postoperative photos of occlusion with good occlusal settling 1month post operative (B) postoperative photos of maximum mouth opening with improvement about 30mm.

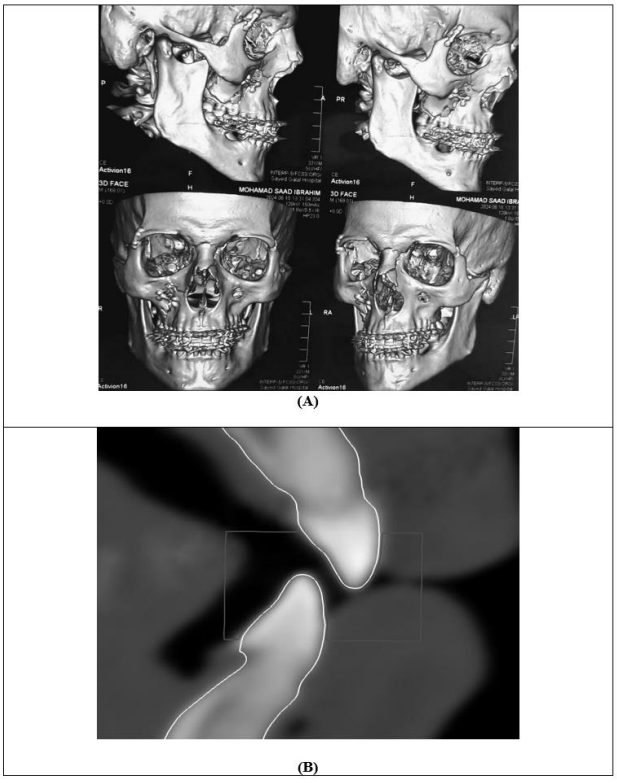

Figure 7. (A) postoperative CT 3D 1 month postoperative (B) Measurement of overjet and overbite

4. Discussion

A fracture of the mandible and maxilla are common trauma presentation among young males aged between 16 and 30 years.[8] The current study showed that the mean age of the studied patients was 33.10 ±12.37 years with male predominance (73.3%). In agreement with the current study Barry et al.,[9] revealed that the majority of patients with mandible fractures were males (76%) with mean age of 32 years.

In the current study, the main fracture aetiology was road traffic accidents. This was consistent with ALRayes et al.,[10] who revealed that the cause of trauma was a road traffic accident in 75%, while (16.6%) were due to a fall from a height and (8.3%) due to violence.

Regarding maximum mouth opening, the study demonstrates a clear and significant improvement in maximum mouth opening following the surgical management of maxillary and/or mandibular fractures. The average increase in mouth opening from 29.07 mm preoperatively to 37.93 mm in the late postoperative period highlights the effectiveness of surgical intervention in restoring mandibular function. Statistically significant changes between preoperative and both early and late postoperative measurements ($p = 0.037$ and $p < 0.001$, respectively) confirm the success of the surgical approach in facilitating recovery of mouth opening—a key functional outcome.

In line with the current study, Prakash et al.,[11] compared the outcomes of open reduction and internal fixation (ORIF) (n = 11 cases) with closed reduction and maxillomandibular fixation (MMF) (n = 11 cases) in the management of condylar fractures. The study utilized cone beam 3D-CT radiographs to assess outcomes. The study found a significant improvement in mouth opening at each follow-up. The ORIF group showed a maximum mean mouth opening of 37.36 mm, while the closed reduction group had a mean of 33.64 mm. Importantly, the increase in mouth opening was significantly greater in the ORIF group compared to the closed reduction group ($p = 0.001$),

highlighting the superior effectiveness of ORIF in promoting recovery of mandibular function. This supports the conclusion that open reduction offers better outcomes in terms of mouth opening restoration compared to closed reduction.

Regarding the outcomes of Occlusion and Bite Types, the current study revealed that the surgical approach was highly effective in correcting occlusal and bite abnormalities, leading to a remarkable improvement in the majority of patients. The correction of occlusion and the shift toward Class I occlusion underscores the procedure's success in restoring normal, functional bite alignment, contributing to

both aesthetic and functional outcomes for the patients.

In line with the current study Aboelnaga et al.,[12] managed 11 patients with mandibular fractures by open reduction and internal fixation (ORIF), panorama 3D-CT was used to assess the outcome. The study revealed that all patients achieved normal occlusion. The mouth opening of all patients was greater than 40 mm.

Postoperative 3D-CT radiographs taken at baseline and at both early and late follow-ups showed good bone healing in all cases, with adequate alignments.

In agreement with the current study, Melek et al.,[13] in 3D-CT radiological (by cone beam CT) evaluation of open reduction and internal fixation of mandibular fractures showed that there was a good reduction in all cases, with alignment of the osseous borders of the mandible and inferior alveolar canal, when crossed by the fracture. Moreover, the radiographic results of this study show that the increase in mean bone density was statistically significant from preoperative to 6 weeks postoperative, from 6 weeks to 3 months, and from 3 months to 6 months postoperatively, consistent with the progress of fracture bone healing.

In the current study, a preoperative 3D-CT assessment was conducted for all cases, playing a crucial role in enhancing the outcomes of surgical treatment for maxillary and/or mandibular fractures. This detailed preoperative evaluation allowed for precise visualization of the fracture anatomy, facilitating accurate surgical planning. By providing a comprehensive understanding of the fracture's location, complexity, and relation to surrounding structures, the 3D-CT assessment contributed significantly to optimizing surgical precision, leading to better alignment, fixation, and overall recovery. Thus, preoperative 3D-CT

Imaging proved to be a vital component in improving the effectiveness and predictability of surgical outcomes in managing facial fractures.

In line with the current study, Shakya et al.,[14] conducted a randomized controlled trial with 50 patients who underwent surgical management of mandibular condylar fractures. The study emphasized the significant benefits of incorporating virtual surgical planning (VSP) into the surgical workflow. VSP was shown to assist surgeons by enhancing surgical precision, reducing operative time, and improving both the rate and accuracy of anatomic reduction. These factors highlight VSP's crucial role in both the diagnosis and treatment of condylar fractures. The study utilized 3D-CT radiographs to assess outcomes. At the 3-month follow-up, the VSP group outperformed the control group in several key areas, including a better range of mouth opening, more accurate occlusal alignment, and improved temporomandibular joint function

Occlusal repositioning wafers, often referred to as orthognathic wafers, are integral to achieving precise surgical outcomes in orthognathic procedures. They help ensure that the jaws are accurately positioned according to the surgical plan, reducing the potential for errors that can occur during complex maxillofacial surgeries. These wafers are particularly important when dealing with multi-step operations, as they provide a reliable guide for each stage.[15]

In the current study, the strategic use of orthognathic wafers played a pivotal role in improving surgical results. By focusing on precise intraoperative positioning, the study demonstrated that wafers contribute significantly to the overall success of orthognathic surgery, leading to better functional and aesthetic outcomes for patients.

In line with Gateno et al.,[17] who highlighted the significance of using advanced 3D surgical planning in orthognathic procedures, particularly focusing on the role of occlusal wafers for achieving precise outcomes. In their study, they found that 3D planning, when combined with accurate occlusal wafers, allows for the virtual surgical plan to be effectively translated into real-life results. This method is especially valuable in complex surgical cases where small deviations can lead to significant functional and aesthetic issues.

4. Conclusion

We concluded that clinical and radiographic assessment of dental occlusion using three dimensional (3D) CT after surgical intervention in patients with Mandibular and/or maxillary fractures serving as a critical predictor of long-term functional success. The study highlights the importance of optimizing early postoperative care to enhance overall outcomes.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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There are no conflicts of interest.

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