

Finite Element Analysis of Three Patterns of Internal Fixation of the Mandibular Subcondylar Fractures [Comparative Study]

Thesis submitted to the Faculty of dentistry, Ain Shams University. In partial fulfillment of the requirements for Master Degree in Oral and Maxillofacial Surgery

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Dedication

I'm dedicating this thesis to my family for their undying support, their unwavering belief that I can achieve so much.

So thank you all.....

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First and foremost, I thank Allah for letting me live to see this thesis through.

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List of Abbreviations

AO	Arbeitsgemeinschaft für Osteosynthesefragen Association for study of internal fixation
AT	anterior temporalis
CT	Computed tomography
DCP	Dynamic compression plate
FEA	Finite Element Analysis
FEM	Finite Element Model
ILP	Inferior lateral pterygoid
IMF	Inter-maxillary fixation
MT	Middle temporalis
MP	Medial pterygoid
ORIF	Open reduction internal fixation
PT	Posterior temporalis
SORG	Strasbourg Osteosynthesis Research Group

SM	Superficial masseter
TMJ	Temporomandibular Joint
VM	Von Mises
3D	Three Dimensional

Introduction

Introduction

Mandibular condylar fractures are of high incidence accounting for 25–45% of all mandibular fractures⁽¹⁾

Management of mandibular condyle fractures is one of the most frequent fractures that a maxillofacial surgeon has to handle, remains controversial.

The closed reduction has been used for a long time regardless of the type of fracture and displacement. Since then, open reduction internal fixation (ORIF) has become widely used. Surgical management is the only way to achieve the proper reduction of a displaced fracture and should avoid intermaxillary fixation. Despite these advantages, this treatment has a bad reputation due to the possible complications; the main one is the possibility of damaging the facial nerve with resulting facial palsy. In addition, there are questions remaining about the best osteosynthesis material.⁽²⁾

Condylar fracture is considered a protective mechanisms to the brain as the condylar neck represents the weakest region of the entire mandible and is therefore the most susceptible to fracture. Condylar fractures usually result from indirect forces that transmitted along the mandible from other sites such as the angle, body or symphysis regions. It usually occurs with an open mouth at the time of injury so that some of the impacting force is transmitted along the mandible to the weakest area of the condylar neck..⁽³⁾

For decades, closed reduction was the preferred treatment, but requires varying periods of maxillomandibular fixation and long term complications like pain, ankylosis, internal derangement of (TMJ), as well as the improper restoration of the posterior facial height.

The debate continues over the management of subcondylar fractures and the question of which fractures should be treated surgically has yet to be answered. However, in recent years, due to the development of the osteosynthesis and surgical techniques, the attitude towards the treatment of a condylar neck fracture has changed from a nonsurgical approach to surgical treatment.

Recently, anatomical reduction and early mobilization of the jaw following surgery have been considered important for the functional rehabilitation of the TMJ.⁽⁴⁾

Regarding finite element analysis, the principal goal of engineering computations is to obtain information concerning the response of physical systems to certain imposed conditions, generally called loads. This information is then used for making or justifying engineering decisions. The computations transform some information (input) into another type of information (output) which fits the needs of engineering decision making process.⁽⁵⁾

The most stable pattern of internal fixation for fractures of the mandibular condyle is a matter for ongoing discussion.⁽⁶⁾

In this study we investigated the stability of three patterns of plate's fixation, (single 2.3mm plate, double 2.0mm miniplate and rhombic plate) and constructed finite element models of a simulated mandibular condylar fracture.

Review of Literature

Review of Literature

The management for condylar neck and subcondylar fractures remains one of the most controversial issues of mandible surgery despite the high incidence of these fractures.⁽⁴⁾

Classification of mandibular condyle fractures:

In correspondence to Lindahl⁽⁷⁾ (Figure 1), condyle fracture classified as follows:

- According to fracture position, It is classified into condylar head, condylar neck, and subcondylar fracture

- Condyle head fracture is called intracapsular fracture as the joint capsule exists till the condyle neck.

-Condyle neck fracture occurs at the inferior attachment area of the joint capsule, refers to the area that becomes narrow from the condyle head. It is an extra capsular fracture because it is not included the joint capsule, and exists at the inferior attachment area of the lateral pterygoid muscle.

-Subcondylar fracture, which exists inferior to the condyle neck, between the mandibular sigmoid notch and mandibular posterior border.

- According to the degree of fracture fragment displacement, condyle fracture is classified into:

- Non-displaced fracture a fracture that has no displacement of the fracture site.

-Deviated fracture where fracture fragments are displaced but some of them still in contact with the temporomandibular joint.

-Displaced fracture where fracture fragment is separated from the mandibular body and displaced, but still exists in the TMJ.

- Dislocation where the fractured condyle head is displaced out from the TMJ.

The fractured segment is put mainly in traction by the masseter, lateral pterygoid, and temporalis muscles. The most common displacement of the condyle head is that which displaced into the anteromedial side, which is shown in a fracture that occurs inferiorly to the lateral pterygoid muscle.⁽⁸⁾

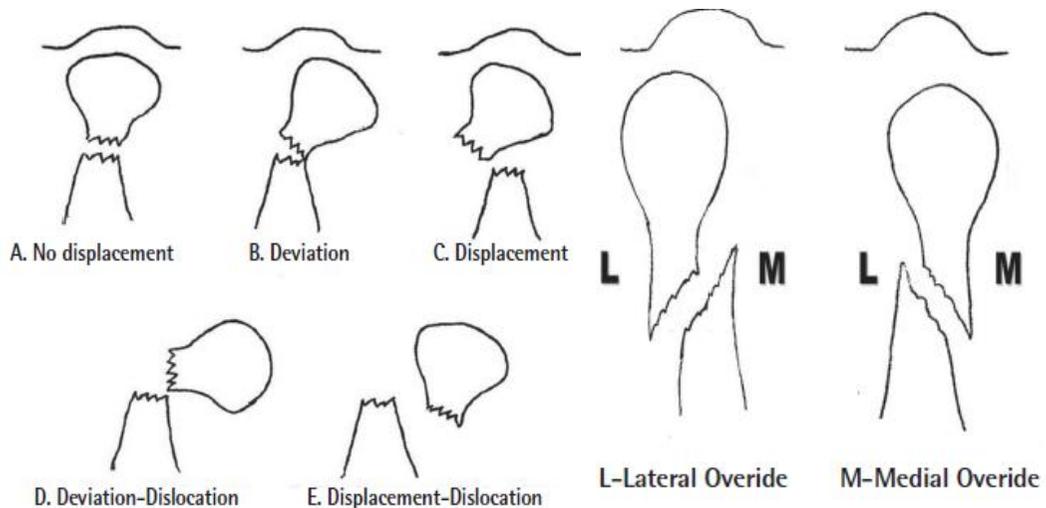


Figure 1: Lindahl classification of condylar fractures.

Cited from *Condylar fractures of the mandible* (7)

The sub-classification represented by Loukota et al⁽⁹⁾. Is also adopted by the Strasbourg Osteosynthesis Research Group (SORG). This classification was found to be simple and can help to predict treatment needs and outcome as follow (figure 2):

1. . **Fracture of the condylar neck:** The fracture line starts somewhere above line A and in more than half runs above the line A in the lateral view. Line A is the perpendicular line through the sigmoid notch to the tangent of the ramus
2. . **Fracture of the condylar base:** The fracture line runs behind the mandibular foramen and, in more than half, below line A.
3. . **Diacapitular fracture (through the head of the condyle):** The fracture line starts in the articular surface and may extend outside the capsule.

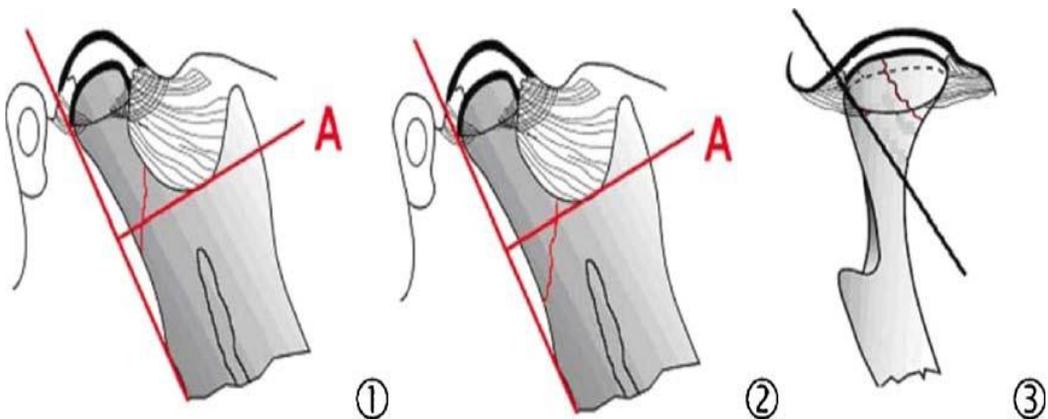


Figure 2: SORG classification of condylar fractures.

Cited from Subclassification of fractures of the condylar process of the mandible (9)