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Short Communication

Treatment of mandibular angle fracture: Revision of the basic principles

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ABSTRACT

Biodynamics of mandibular angle fractures has been extensively discussed in the literature in search for the best way to fixate and expedite recovery of trauma patients. Pioneers like Michelet and Champy had the greatest impact on evolving of osteosynthesis in maxillofacial traumatology; they introduced their basic principles frequently used to describe the biomechanics of mandibular fixation. Their concept states when a physiologic load is applied on mandibular teeth a negative tension will be created at superior border and a positive pressure will appear at inferior border. These simple definitions are the basis for the advent of fixation modalities in mandibular angle fracture. This article sought to reassess these principals based on load location via finite elements method.

Introduction

The mandibular angle fracture is second most hospitalized emergency admission of facial fractures and it has the most complication reports.[1] The internal fixation is used as definitive treatment. There are many methods availed for internal fixations and the Champy's method is one of more acceptable method for internal fixation of mandibular angle fracture. In Champy and Michelet original report they placed force on mandibular anterior teeth of this model and developed principles that are the basis for nearly all treatment modalities (Fig. 1).[2–5] While a trauma patient who has undergone internal fixation even under the best conditions will never apply force on anterior teeth for several weeks, even patients are instructed to not use their anterior teeth. Many authors believe posterior loading will completely change the biomechanics.[6] Failure of internal fixation device during function will cause infection and other complication which is bring more morbidity specially psychosocially and long-term inter maxillary fixation.[7–15] Since posterior loading is major source of function. The assessment of posterior load would be more logical. Many author simulate the stress distribution of implanted devices in mandibular under functional load by finite element method (FEM).[16–21] We assess stress distribution on a fractured mandible in a finite element model while we load the mandible clenching (Fig. 2), which is more probable function in a post-operative trauma patient to compare with anterior loading (Fig. 3) and discuss possible changes simple modifications will make on our understanding of biomechanics of mandibular angle fracture.

Methods

A 3-dimensional model was fabricated from a computed tomography scan of a human mandible. Serial axial sections of were converted to 0.3-mm segments, and the 3-dimensional model was constructed via Catia software (Dassault Systemes, Vélizy-Villacoublay, France; v 7) and assessed via ANSYS software (v 10; ANSYS, Canonsburg, PA) for nonlinear stress analysis with FEM. The condyle was selected as a fulcrum where occlusal forces were simulated in two stages namely:

Placement of linear vertical load on the middle third (molars and premolars) perpendicularly to the occlusal plane (200N). Fraction of force on the first premolar, second premolar, first molar, and second molar locations was 10%, 20%, 50%, and 20%, respectively (Fig. 2), for loading.

Placement of linear vertical load on anterior teeth (200N) as proposed by Champy in original method (Fig. 3).

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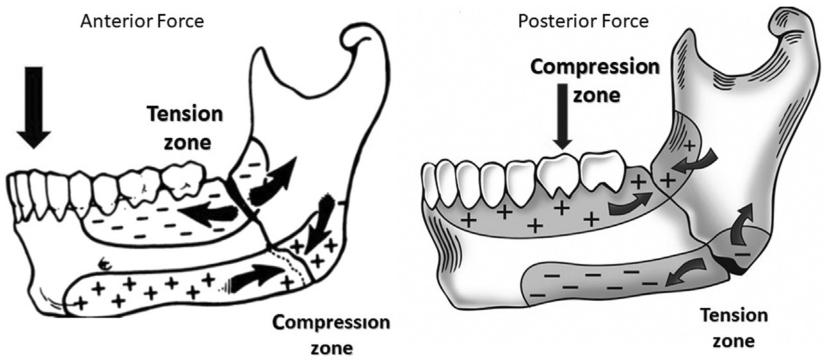

Fig. 1. Stress distribution in anterior mandibular loading: tensile stress is created at the superior border and compressive forces will be generated on inferior border while stress distribution in posterior mandibular loading: in contrast to anterior loading, compressive forces are seen at the superior border and tension is see at the inferior border.

Then stress distributions at the mandibular angle at the buccal cortex were assessed.

Results

The von Misses stress at the mandibular angle was analyzed in the two aforementioned conditions by the FEM; a color scale presented the stress distribution upon loading. The tridimensional model (Figs. 2 and 3) was loaded once at the posterior part of mandible (as normal physiologic jaw clenching force, Fig. 2) and once on anterior teeth as proposed by Champy (Fig. 3). Posterior loading reversed the pattern of stress distribution completely (Fig. 2) shows that there is compressive force on superior border while tension is seen at the inferior border.

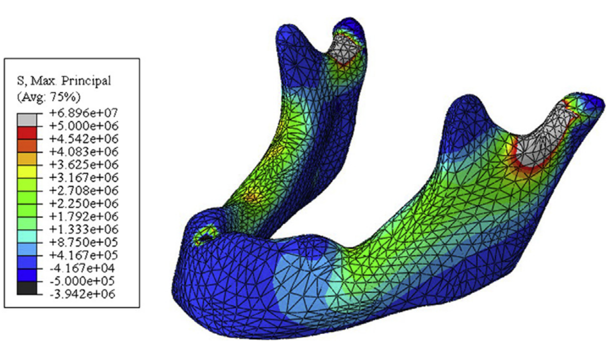

Fig. 2. Finite element model in anterior loading shows that a negative strain or tension is mostly seen on the superior border.

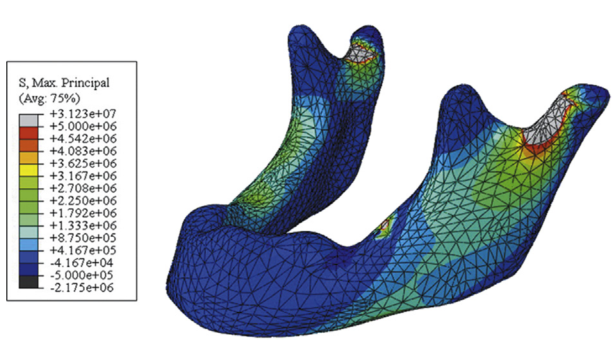

Fig. 3. Finite element model in posterior loading shows that strain distribution pattern is completely modified and tension zone is transferred to the inferior border.

Discussion

Tridimensional movements of the lower jaw, effects of masticatory muscles on fractured bone and existence of teeth have prevented a unanimous solution for mandible angle fractures. Creating a biomechanical model is a known method for analyzing fracture dynamics in all bones of the skeleton; in these models usual functional forces are posed to find the best place and best technique to repair these fractures. Champy and Mechilet were among the first who used these orthopedic principles and applied these models in mandibular fracture lines; tension band compression zone and neutral zone are some basic terms that are subsequently introduced by them and then frequently repeated in maxillofacial literature.[2–5,22–24] Many studies were designed to find the best technique with the least complications.[7–9,25–33] We prepared a similar tridimensional model (Figs. 2 and 3) and applied a load of 200 N once on the posterior part of the mandible (as normal physiologic force in clenching movements of the jaw (Fig. 2) and on the anterior teeth (as was proposed by Champy, Fig. 3); it was seen that in posterior loading the pattern of stress distribution changed. Compressive force on superior border was seen while tension was seen at the inferior border.

This modeling was purely to re-evaluate the basic stress patterns; we did not assess fixation techniques. If we consider the common modalities evaluated by Gear et al[32] in 2005 the aforementioned findings may potentially change the optimal line of fixation originally advocated by Champy et al.[2,3,22–24]

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None.

Ethical statement

This article does not contain any studies with human participants or animals performed by any of the authors.

Conflicts of interest

The authors declare that they have no conflict of interest.

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