Original Article

Biomechanical Comparison of Transoral and Transbuccal Lateral Cortical Plate Fixation for the Management of Mandibular Angle Fractures

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Abstract

Objectives: The purpose of this experimental study was to compare the biomechanical behaviors of two different types of osteosynthesis that are used in the treatment of mandibular angle fractures. **Materials and Methods:** Twenty synthetic polyurethane human mandible replicas, with medullar and cortical portions, were used in this study. These polyurethane hemimandibles were randomly divided into two groups (n = 10). The transbuccal group (Group A) was fixed with 7 mm long self-tapping 2.0 mm titanium screws at 85° to the reference line and the transoral group (Group B) was fixed with the same screws at 15° to the reference line. All testings were performed on a servo-hydraulic testing machine. The data were transmitted directly from the load cell to a computer, which showed the emergent results of the material characteristics under resisted forces as a graphic containing force and displacement. The peak point loading and displacement for each subject were measured. **Results:** The comparison between the groups was analyzed with an independent-samples *t*-test, and $P < 0.05$ was considered to be significant. The results show that there were no significant differences between the groups for the peak loads and displacement values at the peak loads. **Conclusion:** The results of this experimental study demonstrated that there were no significant differences between the transbuccal and transoral methods in terms of fixation stability. In other words, the screw position and angle seemed to no have influence on the fixation stability in single miniplate treatments of a mandibular angle fracture.

Keywords: *Miniplate fixation, stability, transbuccal*

Introduction

Mandibular angle fractures are the most common mandibular fractures, accounting for 30% of all mandibular fractures.[1] Moreover, a mandibular angle fracture generates more complications than other mandibular fractures, with an incidence ranging from 0 to 32%, while the anatomical position and biomechanics of the angle make the treatment of fractures in this region difficult.[2] To reduce complications and generate immediate function, an anatomical reduction of the fracture is required, together with functionally stable fixation.[3] The miniplate screw fixation system is widely used in the management of mandibular angle fractures, following the principles described by Michelet *et al*.[4] and Champy *et al*.[5] Moreover, there are numerous well-established techniques for osteosynthesis in the literature, and the placement of a single, four-hole monocortical osteosynthesis plate has been considered to be acceptable.[6,7]

Champy *et al*.[5] described the placement of a single miniplate on the superior aspect of the mandibular angle along the "ideal lines of osteosynthesis." The placement of this miniplate can be achieved with two different surgical techniques. The transoral technique involves an intraoral incision made through the oral mucosa, whereas

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the transbuccal approach involves an intraoral incision, plus a small incision on the facial skin, which allows for the use of a transbuccal trocar.[6,8,9] The transbuccal trocar is used widely for drill and screwdriver placement in the treatment of mandibular angle fractures.[6,9] As this procedure exposes the fracture site completely, it provides an excellent visibility;[3,10] however, in the transbuccal approach, there is a minimal requirement to bend the plate, and it facilitates the placement of the plate in the neutral midpoint area of the mandible.[8] Despite all the advantages of this method, it does have certain limitations, and this approach can only be undertaken if the complete armamentarium is available. Moreover, the transbuccal approach is sensitive, and the surgeon must know how to use a trocar cannula.[6,10] When the miniplate is placed intraorally in the lateral surface of the mandible, without a trocar, the screws can be inserted angularly. There is no study in the literature comparing the fixation stability between the transbuccal approach when screws are placed at an almost vertical angle (85° to the reference line) and the intraoral approach when the screws are placed at an angle 15° from the reference line.

The purpose of this experimental study of synthetic mandible replicas was to compare the biomechanical behaviors of the two different types of osteosynthesis that are used in the treatment of mandibular angle fractures.

Materials and Methods

Twenty synthetic polyurethane human mandible replicas with medullar and cortical portions (Synbone CF 8596; Malans, Switzerland) were used in this study. The subject homogeneity was achieved by using polyurethane mandibles, and the twenty polyurethane hemimandibles were randomly divided into two groups (n = 10). Sectioning was done with an acrylic guide to simulate the fracture line.

All of the osteotomies were performed on a standard basis. The superior border of the osteotomy was set 3 mm distal to the last molar of the mandible, and a straight line to the mandibular angle corner was drawn. This was adopted as the osteotomy line, and sectioning was performed using a steel disk. For screw insertion, a reference drawing was made from the upper point of the ramus to the upper point of the osteotomy line. After sectioning, the transbuccal group (Group A) was fixed with 7 mm long self-tapping 2.0 mm titanium screws (Titanium Implant System; Ankara, Turkey) at 85° from the reference line, whereas the transoral group (Group B) was fixed with the same screws at a different angle [15° to the reference line; Figure 1]. A specially produced biomechanical fixation appliance, which could be fixed to a servo-hydraulic test device (Shimadzu AGIS 100 kN; Kyoto, Japan), was used to immobilize the hemimandibles under force [Figure 2]. This appliance contained three vertical parts: Two for distal portion fixation and one for the prevention of lateral movement of the free parts under force. Each hemimandible was fixed, in turn, from the same point in the testing machine, and the occlusal plane was made parallel to the ground plane. Before the actual loading, 10 N of preload was applied for standardization.

All testings were performed on a servo-hydraulic testing machine (Shimadzu AGIS 100 kN; Kyoto, Japan). The data were transmitted directly from the load cell to a computer showing the emergent results of the material characteristics under resisted forces as a graphic image containing the force and displacement (Trapezium 2i Version 2.15; Kyoto, Japan). In this way, the peak point loading and displacement for each subject were measured.

Results

The statistical analyses were performed using SPSS version 15.0 (SPSS Inc., Chicago, IL, USA), and the comparison between the groups was analyzed using

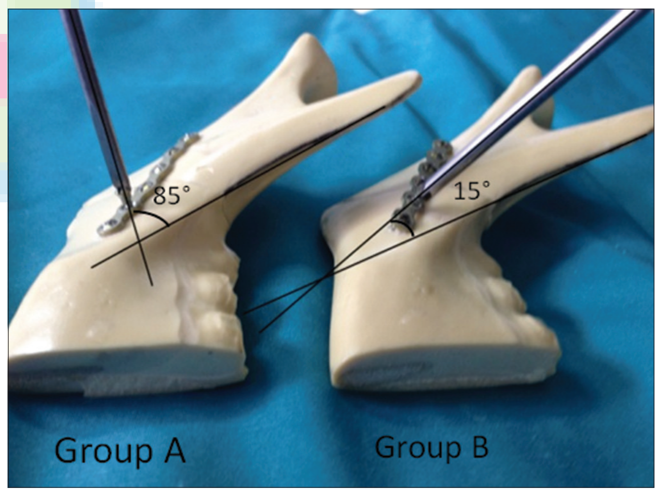

Figure 1: Fixation groups with transbuccal (Group A) and transoral approaches (Group B)

Table 1: Some descriptive statistics and comparisons of the groups*

Groups	Fixation techniques	*n*	Peak load (*N*)	*P*	Peak displacement (mm)	*P*
A	Transbuccal approach group	10	140	.222	4.31	.465
B	Transoral approach group	10	149	.222	4.16	.465

*Compared to groups, the independent-samples t-test, P<0.05

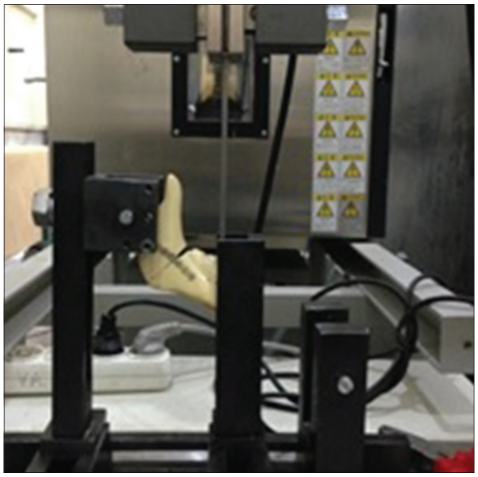

Figure 2: Application of the forces in the servo-hydraulic test device

the independent-samples *t*-test, with $P < 0.05$ being significant. The results show that there were no significant differences between the two groups in the peak loads and displacement values at the peak loads. The *P* values, mean peak loads, and mean peak displacements for the groups are shown in Table 1.

Discussion

The mandibular angle is one of the most commonly fractured sites in the mandible, and it has the highest rate of complications.[3,11] The method of treatment for mandibular angle fractures involves either a closed reduction with intermaxillary fixation (IMF) or an open reduction and internal fixation with or without IMF.[6,9-11] Open reduction and internal fixation allow good anatomical repositioning and immediate functional jaw movement.[12] The treatment of angle fractures with rigid internal fixation has become more popular with the advances in miniplates/screw systems and the understanding of biomechanical principles.[11,13,14] However, there is still no consensus on the optimal treatment of mandibular angle fractures.

A few studies have been done to compare the differences between the transoral and extraoral approaches for mandibular angle fractures.[8,10,15] The treatment methods most often chosen depend on the type of fracture, anatomical location of the fracture line, amount of displacement of the fractured segments, and dentition of the patient.[10,15] The extraoral approach to open reduction and internal fixation is through a skin incision in the submandibular area,[10] which has the disadvantage of leaving an unesthetic scar with a greater risk to the facial nerve. However, the advantages include better visualization and easy application of the fixation plate.[10] The use of an intraoral approach has become more popular, since it avoids extraoral scarring and injury to the facial nerve; however, there has been difficulty in adapting and positioning the plate and controlling the proximal fragments, especially in unfavorable fractures.[10,16] After considering the advantages and disadvantages of both of these techniques, another approach called the transbuccal approach was advocated.

In the transbuccal approach, the exposure of the fracture site and reduction of the fracture are accomplished mostly via the intraoral approach, with a small incision on the facial skin to allow the use of a transbuccal trocar to permit instruments, such as the drill or screwdriver, to be passed through.[9,10] Although a few articles exist in the literature that have clinically compared the transbuccal and transoral techniques,[3,8,9] there are no studies that have compared the biomechanical behavior of these techniques. In this study, we aimed to evaluate the fixation reliability in the early postoperative healing period in mandibular angle fractures. For this purpose, we tested a titanium miniplate/screw system inserted using the transbuccal approach (6-hole miniplate and 7 mm titanium screws, at 85° to the reference line) and the intraoral approach (6-hole miniplate and 7 mm titanium screws, at 15° to the reference line).

In 1973, Michelet *et al*.[4] described the treatment of mandibular fractures using easily bendable noncompression miniplates placed transorally using monocortical screws. Champy *et al*.[5] later performed a series of experiments with miniplates that described the ideal osteosynthesis lines of the mandible. Overall, the ideal plate placement for angle fractures is along the superior border above or just below the superior oblique ridge.[14,17] Kroon *et al*.[18] stated that one-miniplate osteosynthesis on the buccal side of the fracture, or along the external oblique line, was sufficient to withstand masticatory forces, but the fixation in these regions did not resist the lateral forces. In this study, because the double miniplate application via the intraoral approach is quite difficult, a single miniplate was preferred. In the transbuccal group (Group A), a 6-hole single miniplate with 7 mm titanium screws at 85° from the reference line was applied to the lateral surface of the mandible. In the transoral group (Group B), a 6-hole single miniplate with 7 mm titanium screws at 15° from the reference line was applied to the lateral surface of the mandible. In other words, we compared the biomechanical stability of the placed miniplate using screws at different reference lines, and our results showed no statistical difference between the two references lines. Although previous studies comparing the results of the two clinical approaches indicated that there were statistical differences,[3,9] the present study results showed that there were no significant differences between the transbuccal and transoral methods in terms of fixation stability.

In 2011, Kumar *et al*.[8] evaluated the complication rate between three different plating techniques (intraoral, extraoral, and transbuccal/intraoral combined techniques) and reported no significant differences in the complication rates between the three techniques. Wan *et al*.[9] clinically compared the transoral and transbuccal approaches in the internal fixation of mandibular angle fractures. The authors suggested that the use of the transbuccal technique produces fewer postoperative complications, when compared with the transoral technique, and the cumulative incidence of screw loosening, plate exposure, infection, and plate removal was higher in the transoral group. According to the authors, this can be explained by the anatomical position of the transoral plate, which sits over the external superior oblique ridge of the mandible. In addition, the authors reported that the mechanism of screw loosening in the transoral technique was due to an infective/inflammatory cause rather than a mechanical failure. In comparison, in the transbuccal technique, the screws loosened due to mechanical failure at the bone/screw interfaces. However, the authors stated that there have been numerous biomechanical studies on transoral plates, but biomechanical studies on transbuccal plates are missing from the literature.

Following a fracture of the mandible, the occlusal force in the early postoperative period is considerably less than that of a healthy person's bite force. This condition might be explained by traumatic or operative trauma to the masseter muscles or to the protective neuromuscular mechanisms of the masticatory system.[19,20] Therefore, when attempting to compare the biomechanical behavior of various fixation techniques, it is important to consider the clinically relevant parameters to provide a meaningful information.[11] However, the most important mechanical measurement from the clinical standpoint is that point at which permanent deformation of the system occurs, which takes into consideration both the yield load and yield displacement.[13] In the present study, we considered the peak loads and displacement values at the peak loads, and the results revealed no statistically significant differences between the groups.

In this study, synthetic polyurethane hemimandibles were used, due to their standardized size and anatomical shape, density, coefficient, and similarity to the human mandible.[21-23] The synthetic polyurethane replica hemimandibles were created from the impression of actual human cadaver mandibles, and in all dimensions, they match exactly with the human anatomy.[23] They provide a more uniform and consistent sampling than cadaver bone. In addition, they have a porous inner layer designed to replicate cancellous bone and a dense outer layer, which is intended to represent the cortical bone.[23] For this reason, in the literature, we observe that most of the studies used synthetic polyurethane mandible models.[13,14,21,22]

Conclusion

The results of this experimental study have demonstrated that the screw position and angle seem to no have influence on the fixation stability in the single miniplate treatment of a mandibular angle fracture. In other words, there were no significant differences between the transbuccal and transoral methods in terms of fixation stability. However, the results of biomechanical studies do not correspond to clinical outcomes, and biomechanics is the only one factor to consider when treating fractures. A clinician's decision on which of the two treatment methods should be used depends on the results of prospective clinical studies supporting the biomechanical studies.

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Conflicts of interest

There are no conflicts of interest.

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