Comparison of Fixation Strength of Mandibular Angle Fracture with Different Lengths of Miniplate and Screw Using the Champy Technique in Sheep

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Introduction: This study sought to compare the fixation strength of mandibular angle fracture with 4- and 6-hole miniplates and different screw lengths using the Champy technique in sheep. **Materials and Methods:** This is an *in vitro* study in 10 sheep mandibles. The soft tissue was removed and the mandibles were sectioned at the symphysis to obtain 20 hemimandibles. An artificial fracture was induced at the mandibular angle 1 cm farther from the most distal tooth using a saw. The hemimandibles were then randomly divided into two groups (n=10) for fixation with 4- or 6-hole miniplates without a bar. Each group was then randomly divided into 2 subgroups (n=5) for using 6 or 8-mm screws. The plates were adapted over the external oblique ridge. The distance from the closest hole to the fracture line was minimally 1 mm. Next, the hemimandibles were fixed to the holding arm of the universal testing machine by self-cure acrylic resin. Compressive load was applied to an occlusal jig prepared on the occlusal surface of mandibular molars at 3 cm distance from the fracture line at a crosshead speed of 1 mm/min until fracture. Data were analyzed using SPSS version 23. **Results:** The mean fixation strength was not significantly different between 6-mm and 8-mm screws (P=0.243). The mean fixation strength in 6-hole miniplate group was significantly higher than that in 4-hole miniplate group (P=0.028). **Conclusion:** The mean fixation strength in 6-hole miniplate group was significantly higher than that in 4-hole miniplate group. It seems that 6-hole miniplates provide higher fixation strength than 4-hole miniplates, irrespective of screw length. The mean fixation strength was not significantly different between 6-mm and 8-mm screws.

Keywords: Fixation Strength; Miniplate; Mandibular Angle Fracture; Screw

Introduction

The incidence of craniofacial traumas has increased in the recent years due to the growing frequency of motor vehicle accidents [1]. Mandibular fracture is among the most common fractures in trauma patients, and fracture of the angle of mandible accounts for 27% of all mandibular fractures, followed by fracture of the symphysis and body of mandible (21.3%), condyles (18.4%), ramus (5.4%), alveolar ridge (2.9%) and coronoid process (1%). The frequency of multiple fractures is 7.4% [1].

Elimination of maxillomandibular fixation generally result in greater patient satisfaction because of lower level of postoperative discomfort, earlier return of normal jaw function, easier oral hygiene and better nutrition [2]. At present, titanium plates are the standard for mandibular fractures due to their high biocompatibility, optimal stability, high resistance to corrosion, and being affordable [3].

In fractures of the angle of mandible, the ideal line for osteosynthesis is on the external oblique ridge. Champy *et al.*,[4] in 1987 introduced a novel technique for management of simple fractures of the mandibular angle. In the Champy technique, the surgeon should select a 4- or 6-hole miniplate for adaptation to the external oblique ridge. The minimum size of miniplate is 2.0 mm in this technique. The plate is rotated about 90° at the center to adapt to the inferior border of the mandible at the angle area. The two posterior holes are positioned medially relative to the

external oblique ridge and the two anterior holes are fixed to the lateral cortex. First, a screw is placed in the posterior hole closest to the fracture line. Then, a screw is placed in the anterior hole closest to the fracture line. The third and fourth screws are then placed in the most anterior and most posterior holes, respectively [5].

Evidence shows that the Champy fixation technique has minimal postoperative complications [6]. Several methods have been introduced for approximation of the broken pieces at the fracture line and increasing the fixation strength such as angulated placement of screws and dynamic compression plates [3]. This study sought to compare the fixation strength in mandibular angle fracture using 4- and 6-hole miniplates with different screw lengths using the Champy technique in sheep.

Materials and Methods

This study conducted in 10 sheep mandibles. It shuld be noted that no sheep was sacrificed for the purpose of this study and heads were purchase from a slaughterhouse. Sample size was calculated to be 20 hemimandibles assuming alpha=0.05, beta=0.2 and study power of 80%. The mandibles all belonged to adult male sheep and were obtained from a slaughterhouse. All sheep had similar dental condition. The soft tissue was removed and the mandibles were split in half at the symphysis to obtain 20 hemimandibles. The coronoid process was then separated from the hemimandibles. Next, an artificial fracture was created at the angle of mandible 1 cm farther from the most distal tooth using a saw. The hemimandibles were then randomly divided into two groups (n=10) for fixation with 4-hole or 6-hole miniplates. Next, each group was divided into two subgroups (n=5) for fixation with 6-mm or 8-mm screws. Fixation of the fracture was performed using 4- or 6-hole miniplates without a bar (Jeilplating System,Korea) and 6- or 8-mm screws.

The plates were adapted to the external oblique ridge and the distance between the closest hole to the fracture line was minimally 1mm. Fixation was first performed in two holes close to the fracture line and then farther holes were drilled (Figure 1).

The samples were then placed in a universal testing machine (Kopa, Iran) to measure the fixation strength. Each hemimandible was fixed to the holding arm of the machine at the ramus area using self-cure acrylic resin (Acropars, Tehran, Iran).Compressive load was applied to an occlusal jig prepared on the occlusal surface of a mandibular molar (Figure 2).

Figure 1: Fixation of mandibular angle fracture

Compressive load was applied to the molar tooth at 3 cm distance from the fracture line at a crosshead speed of 1 mm/min until fixation fracture, which was defined as formation of a 4-mm gap at the fracture line according to Ribeiro-Junior *et al.*, [7].

Data were analyzed using SPSS version 23 (SPSS Inc., IL, USA). Levene's test was used to assess the equality of variances. Independent t-test was applied to compare the mean fixation strength based on the screw length and type of miniplate. ANOVA was used to compare the four subgroups regarding the fixation strength. Level of significance was set at 0.05.

Figure 2: Load application to measure the fixation strength

Results

Independent t-test revealed no significant difference in fixation strength between the two groups with 6-mm (168.00±53.96 N)

and 8-mm (138.40±52.01 N) screws (*P*=0.243, Table 1). Independent t-test compared the fixation strength of 4-hole (127.00±47.15 N) and 6-hole (178.40±48.79 N) plates and revealed that the mean fixation strength was significantly higher in the 6-hole miniplate group than the 4-hole miniplate group (*P*=0.028, Table 2). shows the mean fixation strength in the four subgroups. ANOVA was used to compare the mean fixation strength among the four subgroups, which revealed no significant difference (*P*=0.906, Table 3).

Table 1: Fixation strength (N) according to screws length (n=10)

Screw length	Number	Mean	Std. deviation	Std. error	*P*-value
6 mm	10	168	53.96	17.06	0.243
8 mm	10	138.40	52.01	16.44	0.243

Table 2: Fixation strength (N) according to miniplates hole(n=10)

Screw length	Number	Mean	Std. deviation	Std. error	*P*-value
4-hole	10	127	47.15	14.91	0.028
6-hole	10	178.40	48.79	15043	0.028

Table 3: Mean fixation strength (N) in the four subgroups (n=5)

Miniplate	Screw length	Mean	Std. deviation	Std. error	Minimum	Maximum	*P*-value
4-hole	6 mm	140.00	36.74	16.43	110	200	0.906
	8 mm	114.00	56.83	25.41	30	170	
6-hole	6 mm	194.00	58.13	58.13	120	280	
	8 mm	162.80	37.00	16.54	114	210	

Discussion

This study compared the fixation strength in mandibular angle fracture with 4- and 6-hole miniplates and different screw lengths using the Champy technique in sheep.

Several methods are available for fixation of fracture pieces. Internal fixation by use of miniplate and screws is currently the most efficient, standard technique, which is extensively used for this purpose. Use of miniplates for management of bone fractures dates back to the 19th century. It was first used in maxillofacial surgery in around 1960. Use of miniplates can decrease the complications, accelerate rehabilitation and shorten the hospital stay. It also increases patient satisfaction, eliminates the need for intermaxillary fixation and improves occlusal relationship [8].

However, the main question here is to choose the best fixation technique with miniplates. Some previous studies compared different fixation methods with miniplates. For instance, Bayramet *et al.*, [9] compared the strength of titanium miniplates with resorbable plates for fixation of mandibular angle fractures in sheep. The results showed that the strength provided by miniplates was higher than resorbable plates, although not significantly. Kroonet *et al.*, [10] assessed the use of miniplates for mandibular fractures in dogs and showed that management of mandibular angle fractures in dogs required two plates instead of one plate in order to preventthe movement of fracture segments during function. Dolanmazet *et al.*, [11] compared the stability of resorbable miniplates and titanium miniplates in the mandibular ramus area and reported that in case of using resorbable miniplates, intermaxillary fixation may be required for the early postoperative period. Esenet *et al.*, [12] in an experimental study compared the stability of titanium plates and a resorbable plate system in management of

mandibular angle fractures. They compared 21 sheep mandibles in three groups managed by one titanium plate, one resorbable plate, and two resorbable plates. The results showed a significant difference in the magnitude of movement among the three groups. Results revealed more favorable biomechanical behavior for the titanium plate. Also, the group with two resorbable miniplates showed more favorable biomechanical behavior compared with the group with one resorbable miniplate. They concluded that titanium plate would provide higher resistance against occlusal forces compared with resorbable plates.

Different fixation methods have been evaluated in previous studies, and the fixation strength provided by one and two plates has been compared. Evidence shows that the miniplate technique is often preferred among different fixation methods for mandibular fractures. Thus, this study compared the fixation strength based on the number of plate holes and screw length. The results showed that the mean fixation strength provided by 6- and 8-mm screws was almost the same with no significant difference. However, the mean fixation strength provided by 6-hole miniplates was significantly higher than that providedby 4-hole miniplates. Pektaset *et al*., [13] compared the fixation strength provided by 4-hole plates with different screw lengths and found no significant difference. Their results were in agreement with ours. Korkmaz *et al*., [14] evaluated the efficacy of different miniplates for fixation of a broken mandible and found that number of screws or miniplate length had no significant effect on stability of fracture segments.

One limitation of this study was difficult simulation of trauma to the mandibular angle, which is highly complex and is influenced by the site of muscle attachments, stability of occlusion, magnitude and direction of load, and quality of bone. Perfect simulation of this type of trauma requires complex instruments. Future studies are required to assess the fixation strength on complete jaw models with unilateral and bilateral mandibular angle fractures. Also, retrospective studies on fixation strength in patients would provide more valuable results on this topic.

Conclusion

The mean fixation strength in 6-hole miniplate group was significantly higher than that in 4-hole miniplate group. It seems that 6-hole miniplates provide higher fixation strength than 4-hole miniplates, irrespective of screw length. The mean fixation strength was not significantly different between 6-mm and 8-mm screws.

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Conflict of Interest: 'None declared'.

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