Clinical Notes

Biomechanical Comparison of a New Technique of Mandibular Angle Fractures: Biplanar and Bicortical Superior Proximal 3 Holes and Bicortical Inferior Plate Fixation

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Miniplates have been used for mandibular angle fractures during the past 2 decades. The technique of placing single miniplate at the upper border based on the tension lines of the fracture was proposed by Michelet and Champy. The need for a second miniplate to be applied to the lower mandible has been discussed recently. Biomechanical comparison of biplanar and monoplanar dual-miniplate fixation techniques was investigated by Haug. Our hypothesis is in dual-miniplate fixation; the proximal 3 holes of superior border miniplate could be fixated by bicortical screws. The first 2 are at the proximal bone segment and are not related to the tooth and also superior to the alveolar nerve. Generally, the third molar tooth is extracted because it is at the fracture site. Hence, the proximal third hole could also be fixated by bicortical screws. We define a biplanar dual-miniplate technique in which the lower plate and the proximal 3 holes of the upper plate are fixated by bicortical screws. We have designed a study for biomechanical comparison of our method and popular types of mandibular fixation methods.

Key Words: Mandibular angle fractures, biomechanical comparison, miniplate

Mandibular angle fractures are most commonly seen after blunt trauma.[1–3] Mandibular angle is involved in 23% of jaw fractures. This can be attributed to its relatively thin cross-sectional area and its location near the third molar tooth socket.[4] Angle fractures generate more complications than other mandibular fractures, with incidence ranging from 0 to 32.[5,6]

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The need for a second miniplate to be applied to the lower mandible has been discussed recently.[7,8] Biomechanical comparison of biplanar and monoplanar dual-miniplate fixation techniques was investigated by Haug.

In dual-miniplate fixation techniques, the plate at the lower border is placed by monocortical or bicortical screws, and the one at the upper zone is placed by monocortical screws. It was previously reported that plate placement by biplanar orientation is superior to monoplanar plate placement.[9]

Our hypothesis is in dual-miniplate fixation; the proximal 3 holes of superior border miniplate could be fixated by bicortical screws. The first 2 are at the proximal bone segment and are not related to the tooth and also superior to the alveolar nerve. Generally, the third molar tooth is extracted because it is at the fracture site. Hence, the proximal third hole could also be fixated by bicortical screws. We define a biplanar dual-miniplate technique in which the lower plate and the proximal 3 holes of the upper plate are fixated by bicortical screws.

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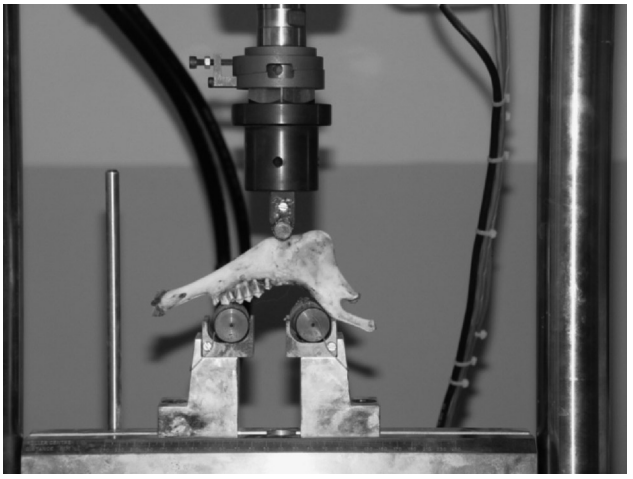

Fig 1 Three-point bending test.

We have designed a study for biomechanical comparison of our method and popular types of mandibular fixation methods.

Materials and Methods

Seventy-two hemimandibles taken from similar sheep (from the same abattoir, slaughtered similar) were used in this investigation. All soft tissues were stripped off the sheep mandibles. The mandibles were sectioned at the midline cut from the second incisive teeth. To simulate the angle fracture, all mandibles were sectioned from the angle region in a uniform manner. The mandibles were divided into 12 groups of 6, and each of 3 groups was fixated with 4 different plating techniques (Figs 4–7). Titanium 4-hole noncompression miniplates and 11-hole reconstruction plates (Elektron Medikal, Trimed, Turkey) were used in this investigation. Six-millimeter monocortical screws, 13-mm bicortical screws, and 13-mm reconstruction screws were used. The screws were nonlocking and self-tapping. Two segments of mandible were repositioned and fixed in proper position. Three-point bending, compression, and side-bending biomechanical test were made for fixation groups.

A custom-made 3-point biomechanical test model (Fig 1) was adapted to an Instron 8511 machine. Three-point bending forces simulated the masticator loads and were applied from the angle of the mandible until a 1-mm displacement had occurred.

To evaluate anterior and lateral forces, compression (Fig 2) and side-bending (Fig 3) test were made with Instron 8511 machine.

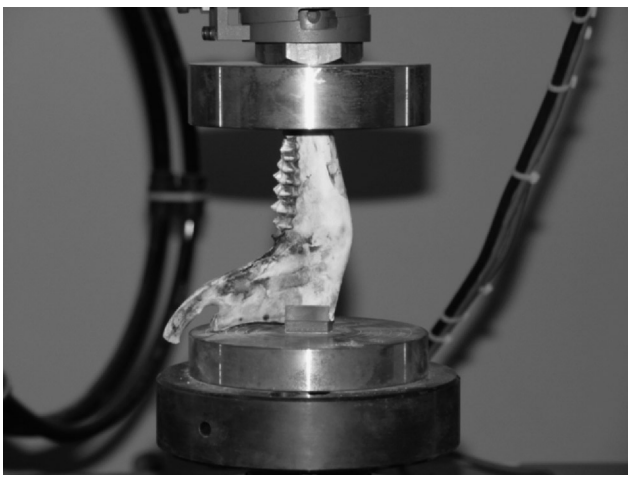

Fig 2 Compression test.

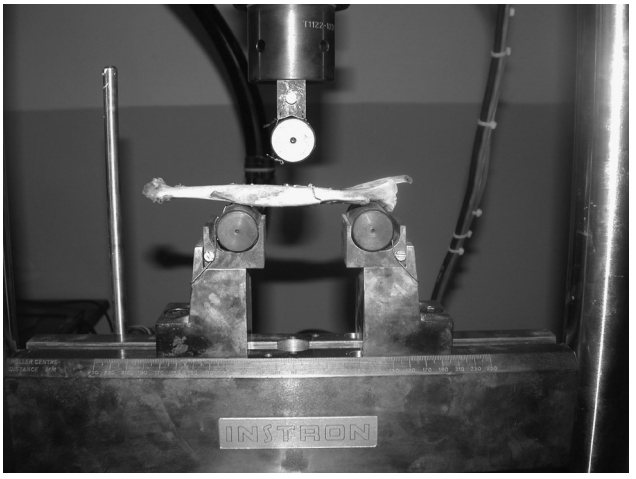

Fig 3 Side-bending test.

Fig 4 Group A: single plate upper border (Champy technique).

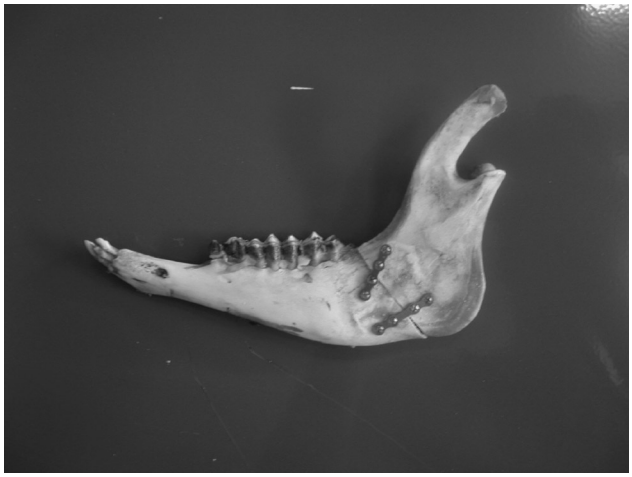

Fig 5 Group B: biplanar dual-miniplate, upper border–proximal 3 holes bicortical fourth hole monocortical, lower border–bicortical.

Testing apparatus recorded force versus displacement. One-millimeter displacement was determined as the end point of bone screw plating system. Compression and bending forces were recorded in MPa unit.

The statistical analyses were made with GraphPad Prisma V.3 program in this study. The data were evaluated with descriptive statistical methods (mean, standard deviation). In addition, groups were compared with Kruskal-Wallis test and subgroups were compared using the Dunnett T3 multiple comparison test (Fig 4).

Fracture fixation is made by one 4-hole miniplates placed with monocortical screws across the superior border of fracture in a fashion consistent with the repair lines defined by Champy et al[10] (Fig 5).

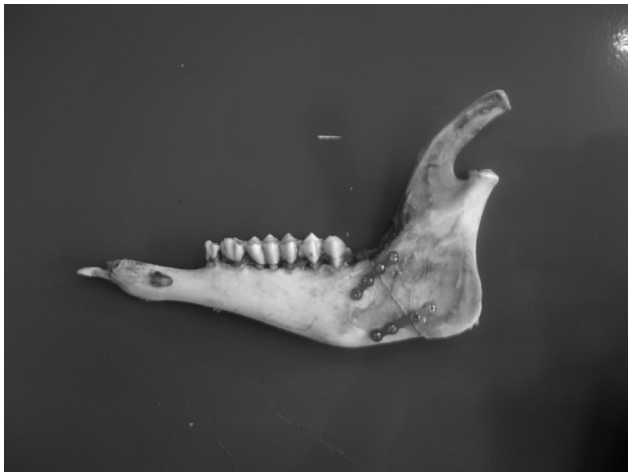

Fig 6 Group C: biplanar, dual-miniplate, upper border–monocortical, lower border–bicortical.

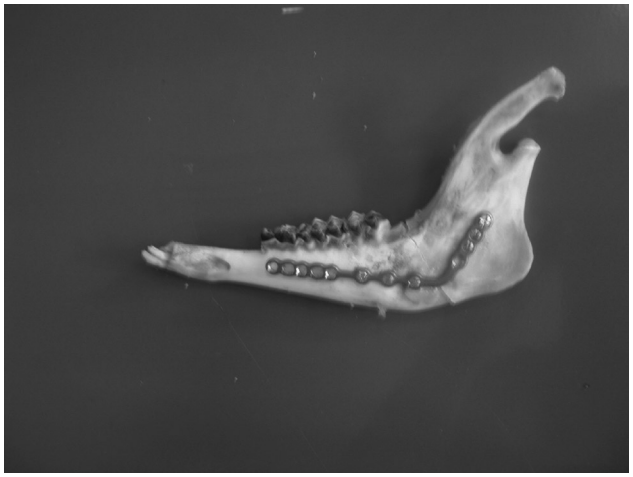

Fig 7 Group D: reconstruction plate.

Fracture fixation was made by two 4-hole miniplates. The proximal 3 holes of the superior plate that are not related to the roots and alveolar nerve were fixated with bicortical screws. Monocortical screw was placed into the distal fourth hole of the superior plate. Bicortical screws were placed into the plate at lower border (Fig 6).

Fracture fixation was made by two 4-hole miniplates. Monocortical screws were used across the superior border of fracture, and bicortical miniplates were used in the lower border of the mandible. Plates were placed in a fashion consistent with the repair lines defined by Champy et al[10] (Fig 7).

Fracture fixation was made with 11-hole reconstruction plate. Bicortical reconstruction screws were placed into proximal 3 hole and distal 3 hole.

RESULTS

Seventy-two hemimandibles were analyzed in this experiment with 18 in each group. Standardization of all experimental factors except repair

Table 1. Mean Loads and Standard Deviation of Test Groups

	3-Point Bending	*Compression*	*Side Bending*
Group A	0.31 ± 0.10	181.81 ± 40.4	6.98 ± 1.53
Group B	2.77 ± 0.71	302.58 ± 37.44	8.57 ± 1.24
Group C	1.07 ± 0.54	238.3 ± 65.77	6.46 ± 2.22
Group D	1.98 ± 0.72	196.27 ± 46.56	14.7 ± 2.54
KW	18.98	12.23	15.9
P	0.000	0.007	0.001

Table 2. *P* Values of Dunnett T3 Multiple Comparison Test

	Compression	*Bending*	*Side Bending*
Group A/Group B	0.002	0.002	0.338
Group A/Group C	0.082	0.437	0.997
Group A/Group D	0.011	0.990	0.001
Group B/ Group C	0.006	0.307	0.330
Group B/Group D	0.365	0.009	0.005
Group C/Group D	0.169	0.738	0.001

technique (i.e., plate type, plate placement, screw size, and fracture placement) was performed between groups.

Each fixation group that contains 18 hemimandibles was divided into 3 and tested with 3-point bending, compression, and side-bending biomechanical test. The mean loads that created 1-mm displacements are shown in Table 1. The comparison of subgroups with each other is shown in Table 2.

We have found statistical difference between group B (biplanar dual-miniplate, upper border—proximal 3 holes bicortical fourth hole monocortical, lower border—bicortical) and group A in compression and bending tests. There is also statistical difference between groups B and C in compression testing. The comparison of group B with group D yielded significant statistical difference in bending and side-bending tests.

Group B (biplanar dual-miniplate, upper border—proximal 3 holes bicortical fourth hole monocortical, lower border—bicortical) has superior results regarding other fixation methods we had tested.

Discussion

In 1973, Michelet et al[11] described the treatment of mandibular fractures using easily bendable small noncompression miniplates placed trans-orally and anchored with monocortical screws. Champy et al[10] later performed a series of experiments with miniplates that delineated ideal lines of osteosynthesis within the mandible. Ideal plate placement for angle fractures was along the superior border above or just below the superior oblique ridge.

Kroon et al[12] and Choi et al[13] both observed bony gaps along the inferior border with 1 miniplate fixation technique that Champy had described. A second plate was suggested to reduce anterior-posterior separation of the fracture line as well as lateral displacement.[14] This method is used to achieve a good anatomic repositioning and stable fixation of the fracture. All biomechanical tests in which a second miniplate has been fixed to the mandibular margin revealed less mobile fracture ends.

Application of 2 miniplates, one in superior border and one in the inferior border, can be done at monoplanar plane or biplanar plane. It showed that biplanar plate placement is superior to monoplanar plate placement.[15]

The superior miniplate of dual-miniplate fixation system is applied with monocortical screws. Fedok et al[15] showed that bicortical or monocortical application of miniplates is an important variable in mandibular repair. However, there is no report or study about the fixation of superior miniplate with bicortical screws.

The first 2 holes of superior border miniplate are at the proximal bone segment, and these are not related to the tooth and also superior to the alveolar nerve. Generally, the third molar tooth is extracted because it is at the fracture site. Hence, the proximal third hole could also be fixated by bicortical screws. We suggest that the lower miniplate and the proximal 3 holes of the upper plate could be fixated by bicortical screws.

Because the biplanar dual-plate fixation proved superior to the monoplanar technique, we compared bicortical biplanar fixation with[15] bicortical biplanar monocortical fixation, fixation with Champy method, and fixation with reconstruction plate.

Several biomechanical studies that compared different forms of mandibular angle fractures were performed.[15–19] Fedok et al[15] and Haug et al[20] compared mandibular angle fractures with the different fixation methods in a detailed study. However, these studies were performed with polystyrene mandible models. A polystyrene model cannot substitute a bone model. In literature, there are studies that used sheep mandible as a model for biomechanical comparison of mandibular condyle fractures[21] and sagittal split osteotomy models. Mandibles were obtained from animals that were killed for commercial reasons, so we did not give any additional harm to these animals.

In the current study, greater biomechanical stability is provided with bicortical biplanar dual-plate method in 3-point bending and compression tests. Only in side-bending test reconstruction plate has greater stability than bicortical biplanar dual-miniplate synthesis.

This study showed us only by applying bicortical screws instead of monocortical screws in proximal 3 holes of the superior plate the fracture stability can be strengthened. The amount of periosteal stripping is not changed because the placement of the plates is the same as the standard biplanar dual-plate placement.

In conclusion, without affecting the fracture vascularity, fixation of the superior plate with bicortical screws results in a more stable fracture site.

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