Biomechanical Evaluation of Two Plating Techniques for Repair of the Mandibular Angle Fracture

OBJECTIVE

The aim of this investigation was to evaluate and compare the biomechanical stability of the monoplanar strut and Champy techniques for the repair of mandibular angle fractures.

INTRODUCTION

Craniomaxillofacial trauma results in 3 million emergency room visits in the United States annually. Nalliah et al. estimated over 21,000 US hospitalizations primarily associated with facial trauma management in 2008, with an associated 93,000 hospital days and $1.06 billion in cost.\(^1\) Proper evaluation and treatment of facial trauma are key to maintain desirable function and appearance.

The mandible is the second most commonly injured facial bone, and its angle is involved in 20-42% of mandibular fractures.\(^2\) Treatment options for mandibular angle fractures are numerous and include: closed reduction, open reduction with nonrigid fixation (transosseous wires, circum-mandibular wires), and rigid fixation incorporating reconstruction plates, dynamic compression plates, mini-dynamic compression plates, lag screws, or noncompression plates; yet, the optimal management of mandibular angle fractures remains controversial. Open reduction and rigid fixation techniques are thought to provide the best repair outcomes in terms of stability, least limitation on diet and activity, and fastest return to pre-injury function. The monoplanar strut and Champy plating techniques are two commonly accepted, yet different fixation approaches.\(^3,4\) Recent literature has reviewed the advantages and disadvantages of each approach, but little has been written regarding the inherent stability of each repair.

We tested the biomechanical stability of the Champy and strut plating approach of the angle fracture in a Synbone (Laudquart, Switzerland) mandible model.

MATERIALS AND METHODS

Fifty Synbone mandible models were used in this investigation. All models were potted in methyl methacrylate, to anchor the glenoid and coronoid processes. Four models were left intact, and acted as the control group; the remaining 46 models were sectioned in a uniform manner to create a left simple, non-comminuted angle fracture. Twenty-three models were repaired with a single monocortical strut plate (Stryker low-profile mandible osteosynthesis system?), and 23 models were repaired with the Champy technique, employing a single monocortical plate along the external oblique line (Figures 1 and 2). Plates were adapted to the mandibular model contour after satisfactory reduction of fracture was obtained with manual stabilization. Two mini-screws were placed on each side of the fracture. All plating was done by the same investigator for greatest consistency.

We used Instron Lloyd LXR 8800 equipment to load the mandible model with vertical, upward force from 0-700N. The first molar of the model was drilled out slightly to better seat the hook of the Instron around the mandible. The experimental end-point was defined as 700N or model fracture. The Optotrack Certus 3D image capture was used to delineate the superior and inferior borders of the mandibular angle and gapping distance at the repair site. Figure 3 shows the mandible model, with a left angle fracture repaired with Champy plate, anchored at its coronoid and glenoid processes. Intron equipment uses a hook to generate preset, vertical force at the drilled-out first left molar. Optotrack posts allow stereotactic image delineation of the superior and inferior mandibular borders, and gapping distance, about the fracture repair site. Microsoft Excel software was used to calculate gapping angles about the repair site, and for data analysis. Gapping distance and angle data were analyzed at 0-700N range, and at pre-determined force points of 350N (signifying physiologic masticatory force) and 700N (signifying supra-physiologic masticatory force). Mean and standard deviations were derived and compared, with a p-value of 0.05 considered statistically significant.

RESULTS

Results for deformation distance and angle for the two repair techniques at 350N (physiologic masticatory force) are shown in Table 1. On average, the displacement angle for the strut plate was 3.21 degrees, which was not significantly different from the 2.83 degrees of deformation for the Champy plate (p=0.15). At 700N, considered supra-physiologic force, the gapping angle for the strut plate was 5.62, slightly smaller than the 6.50 degrees for the Champy plate. This difference was statistically significant, with a p-value of 0.02 (Table 1).

![Figure 1. Strut plate repair](image1)

![Figure 2. Champy plate repair](image2)

![Figure 3. Mandible testing set-up](image3)

DISCUSSION

Rigid fixation provides the most appealing option for the treatment of mandibular angle fractures, in that optimal outcomes include immediate return to function, bone healing with minimal complication, and minimal cosmetic change. AO recommendations, the current US standard, for the treatment of the mandibular angle fracture include either a reconstruction plate (load-bearing technique) or a miniplate technique (load-sharing technique). Champy et al. advocated a single 2mm miniplate placed along the oblique line of the angle region, with 6 weeks of load avoidance, with this being standard of care in most of Europe and Asia since its introduction in the 1970s.\(^5,6\) The reconstruction plate carries with it the need for wide exposure, with increased risk to neurovascular structures, but allows an immediate return to load-bearing. The Champy technique requires smaller exposure, and offers greater technical ease and shorter operative time; some describe its drawbacks as the associated need for load avoidance and greater complication rate, though recent evidence has not bourn this out. Fox and colleagues and Levy et al demonstrated low complication rates for two noncompression miniplate repair of angle fractures, in contrast to the earlier work by Ellis and Walker.\(^7,8\) In his randomized prospective clinical trial, Danda showed no significant difference in outcomes between a single noncompression miniplate (consistent with the Champy technique) and two miniplates in the treatment of angle fractures.\(^9\)

![Figure 4. The Law of Cosines: c^2=a^2+b^2-2ab (cos γ)](image4)

Where γ denotes the angle contained between sides of lengths a and b and opposite side of length c. The Law of Cosines was used to calculate gapping angles about the fracture repair site from the deformation distances measured stereotactically.

![Figure 5. Comparison of a single noncompression miniplate versus 2 noncompression miniplates in the treatment of mandibular angle fractures.](image5)

REFERENCES