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Plating systems for 3D stability of subcondylar fracture: A research article with review of literature

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Abstract
Mandibular condylar fractures are the most commonly seen fractures. Three dimensional Stable fixation is necessary for providing better stability. Comparison of different finite element studies and some base level pilot study correlating the imaging technique and implant material will enlighten the advantage of different plates as per different situations.

Keywords: plating system, subcondylar fracture, easy hypothesis for fracture fixation

Introduction
Mandibular condylar fractures are the most commonly encountered mandibular fractures, being 17.5–52% of all mandibular fractures. The most common unilateral fracture is subcondylar, and the most common bilateral fracture is of the condylar heads, mostly caused by direct trauma, but may also be due to indirect forces. Treatment of condylar fractures depends on physical and imaging evidence of the fracture, extent of injury (whether unilateral or bilateral), the level of fracture, the degree of displacement and dislocation, the size and position of the fractured condylar segment, and the dental malocclusion, etc [1-4].
Stable fixation is very important as the interfragmentary mobility can lead to nonunion, fibrous union, or temporomandibular disorders. Fixation with very rigid miniplates provides more stability than transosseous wiring [5, 6]. Although single miniplates can be adequate if the fragments are aligned properly, functional forces actually exceed the rigidity of one miniplate, and therefore the use of two has been proposed alternatively, as they offer more resistance to rotation and 3-point bending [2, 4, 5]. However, in the condylar neck, the amount of bone is not always adequate to permit placement of 2–3 screws per fragment. To overcome this problem, various plate designs have been put forward [4].
The aim of this study was to compare different finite element analysis and biomechanical studies regarding the efficacy of different plates in subcondylar fractures to provide three dimensional stability and to postulate a hypothesis for ease in the treatment of condylar fracture.

Material and Methods
In this study, a review of 10 articles had been done where comparison of different plating systems were done. Among all the available plating systems till date for subcondylar fracture the chosen options were 4 hole single mini plate, two 4 hole double mini plate, Delta plate, inverted Y mini plate, Trapezoidal plate and Lambda plate. We have measured the anteroposterior width of condylar neck, base and ramus at the level of pterygoid fovea, sigmoid notch and masseteric tuberosity on CT scans of 10 hemimandibles of healthy individuals and also gone through the measurements of the width and length and thickness measurement of different profile (lambda, trapezoidal and delta plates) to give dimension to the quest on this matter.

Results
The standard double 4-hole straight mini plates with self-tapping screws were the most reliable with a maximum load of more than 500 N, a value that allowed subsequent functional and

biomechanical stability [1].

In terms of rigidity of fixation. The study of 5 plating techniques showed different ranges of displacement but the trapezoidal plate was clearly superior. Its peak displacement was very close to that seen in the normal mandibular model. In contrast, the single straight plate showed the greatest peak displacement, achieving as much as twice that in the normal mandibular model [2].

In the study of pilling *et al* it had been showed that highest lateral to medial bending force was best carried by the application of two 4 hole miniplate [3].

The amount of stress deformity was also less than the detrimental level in Trapezoidal plate, though it varies from material to material [2].

In the finite element study of aquilina *et al*, it also had been described that the angulated position of placement of two 4 hole miniplate can show promising results in terms of diminishing displacement [4].

The von Mises stress deformity of the screw was at the maximum in the 1-plate model when it is compared to different other models [5]. In the study of de Jesus *et al*, It had been showed that the von mises stress of trapezoidal plate statistically differs from 4 hole two mini plates and it is considerably less [6]. In the literature of de souza *et al*, straight plates withstand mechanical force better when forces are applied to the condyle in the anteroposterior direction [8].

The study of Albogha *et al* dictated that the rigidity of osteosynthesis is higher in trapezoidal plate and Trapezoidal plate also showed lower strain as it accommodated the horizontal arrangement of screws in the distal segment. Where it had said that the lambda plate bears least rigidity among all the 3D plates [9].

Discussion

The normal mandibular model predicted a high concentration of strain at the base of the condyle neck, a zone where subcondylar fracture likely occurs under excessive non-functional loads [2].

Von mises stress deformity is also another important consideration for holding the secondary stability. It is related to the bone strain. Higher amount of von mises stress crosses the compression strength limit of plate and leads to deformation of plate and jeopardize fracture healing [5].

Different authors through ages raised a concern that should be considered is the distance between the screws and the line of the fracture. This fact supports the decision of the study by Meyer *et al*. to select a different design of trapezoidal shaped plate, having taking into account the anatomical circumstances [3].

Few literatures had reported that 2 plates in an offset pattern provided greater stability than 2 parallel plates. Based on the vectors of muscle pull, they had experienced that 2 angulated plates would be far better able to resist the applied forces than the parallel arrangement. These results indicated that the expected effect of force vectors from the temporalis and lateral pterygoid muscles may be less than envisaged. An alternative explanation is that the sum force vector is better resisted by the parallel configuration of plates [4].

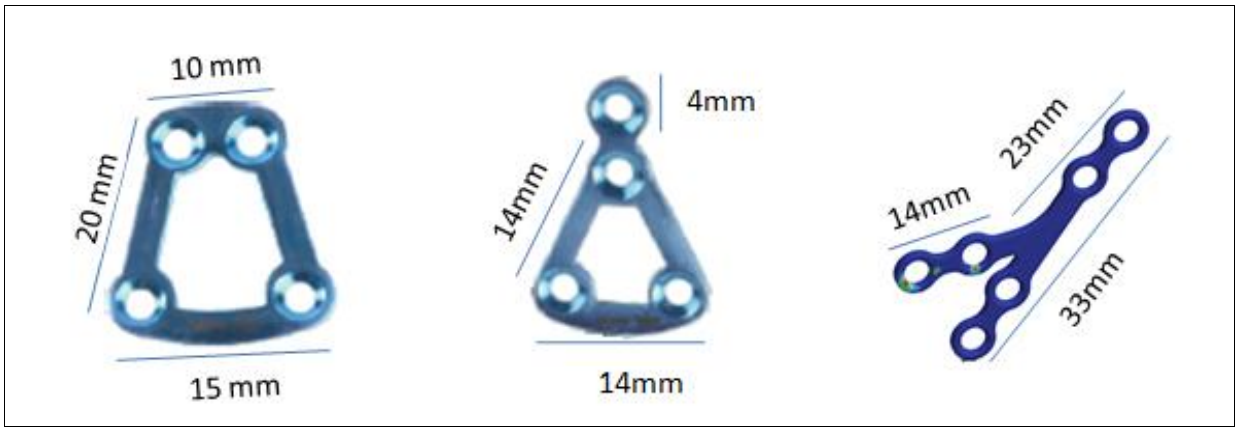

Fig 1: Shows the average measurements of different profiles of plate

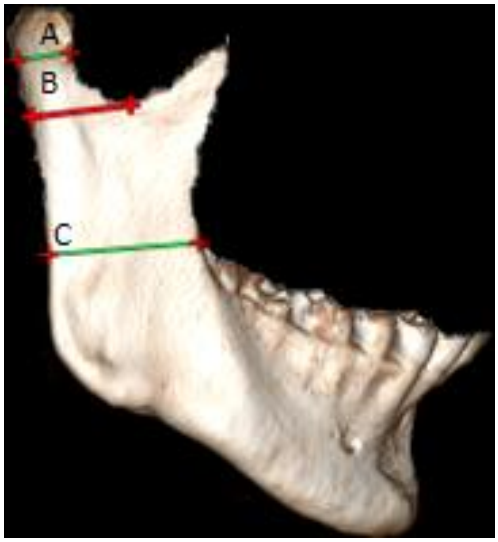

Fig 2: A-P width of different level of condylar neck base and ramus

Table 1: Shows the average of the measurement on CT scans

Landmark	Distance(mm)
A	8-9
B	15-16
C	22-27

The anteroposterior width of the condyle is narrower near the upper portion of neck and gradually it widens as it reaches near to the sigmoid notch. After gathering all the recent best level evidences and measurement of standard titanium plate profile thickness, width and length and anatomical measurement on CT scan of healthy individual an "Easy hypothesis" can be concluded. When the high condylar neck

fracture is to be treated, the access will determine the plating options. If there is ample amount of space, it is better to fix delta plate as it provides better stability rather than Two straight 4 hole mini plates. The two straight 4 hole Titanium miniplates can be alternatively used in high condylar fracture where the access is less. In case of lower condylar neck and base fracture, it is always amenable to fix trapezoidal plate for providing better rigidity. Our hypothesis is also supported by the study of land mark study of Meyer *et al* [10].

Conclusion

Trapezoidal plate provides greater stability due to its shape and configuration. It is advantageous as one plate fulfils the criteria of functionally stable osteosynthesis on the condylar neck, large surface area between two plate arms and minimal periosteal stripping and maximum preservation of proximal blood supply results in better healing. This result is followed by the application of delta plate and two 4 hole straight miniplate. Lambda plate is least used and only indicated for the cases where the bone near the sigmoid notch is very thin in nature.

Consent

Written informed consent were obtained from the patients for publication of this research article and accompanying images.

Conflict of interest: None.

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