Morphologic Study of the Midshaft Clavicle

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Introduction

Clavicle fractures occur relatively frequently, representing up to five percent of all fractures and 44 percent of those in the shoulder girdle. Eighty percent of clavicular fractures in adults occur in the middle one-third of the bone.[5]

Operative plate fixation of displaced midshaft clavicle fractures has been shown to improve the functional outcomes and decrease the likelihood of non-union over non-surgical techniques. One study showed that the risk of nonunion after plating was 2.5 percent, which was significantly lower compared to 5.9 percent for the non-operative treatment. For displaced fractures, the risk of nonunion after plating was 2.2 percent, which was significantly lower compared to 15.1 percent for non-operative treatment.[6]

Recent studies have demonstrated that precontoured anatomic plates have not been as conforming in certain patients.[2,3] The use of shorter and straighter plates with less cortices (two on each side of the fracture instead of three) seem to have better outcomes in midshaft clavicle fracture repair. However, no studies have been conducted to investigate the average length and subtle contours of this segment of the clavicle in order to design the ideal plate.

The purpose of this study was to characterize the morphology of the straight midshaft segment of the clavicle to examine the potential for using shorter, straight superior plates that could ultimately improve treatment, reduce surgical morbidity and cost.

Methods

Specimens:
One hundred sixty-three skeletally mature cadaveric clavicles (81 male, 82 female) were obtained from the Hamann-Todd Collection at the Cleveland Museum of Natural History. Specimens ranged from 18 to 60 years of age at the time of death.

Clavicular Anatomy:
Clavicles were analyzed with use of a digitizer and three-dimensional modeling software. Total clavicle length was measured as the direct distance between the sternal and acromial ends of the clavicle. The length of the straight segment of the midshaft (defined by the maximum length that would accommodate a straight, 10 mm wide plate without overhang) was measured.

The superior surface of the clavicle was recreated using Rhinoceros modeling software (McNeel, Seattle, WA). Radii of curvature of the superior surface were measured at the most lateral point, midpoint, and most medial point of the straight segment. Radii of curvature were calculated using a best fit circle at these locations.

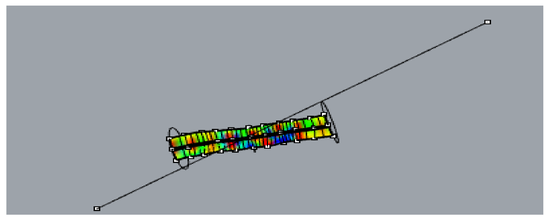

Figure 1: View of the reconstructed superior surface of the straight segment. Total length is represented by the single black line.

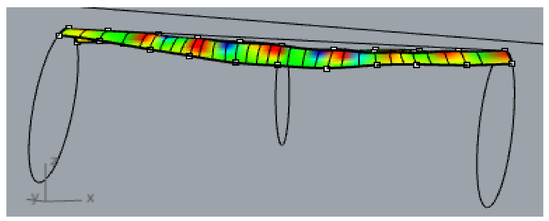

Figure 2: Radii of curvature represented by the best fit circles along the superior surface of the straight segment.

Results

The compiled data from the study can be seen below in Table 1.

The mean total clavicle length was 143 ± 11 mm. This data is in agreement with other anatomical studies that used alternative measurement methods.[1,4]The mean straight segment length was 49 ± 11 mm. A statistically significant difference was found for total length and straight segment length in males (150.7 ± 8.4 mm, 54.5 ± 9.8 mm) compared to females (135.8 ± 7.7 mm, 43.1 ± 8.4 mm) ($p < .01$).

The mean radius of curvature of the superior surface of the straight segment was 11.4 ± 4.6. The radius of curvature of the most lateral point of the straight segment (17.6 ± 8.1) was significantly greater than both the medial (8.9 ± 4.7) and midpoint (8.8 ± 3.7) radii of curvature ($p < .01$). There was no significant difference in the radii of curvature between specimens from male and female donors.

TABLE 1. *Clavicle Measurement Results*

Measurement	All (n=163)	Male (n=81)	Female (n=82)
Total Clavicle Length (mm)	143.2 ± 11.0	150.7 ± 8.4	135.8 ± 7.7
Straight Segment Length (mm)	48.8 ± 11.0	54.5 ± 9.9	43.1 ± 8.9
Superior Surface Radius of Curvature			
Mean Radius of Curvature	11.4 ± 4.6	11.4 ± 4.6	11.4 ± 5.1
Lateral Radius of Curvature	17.6 ± 11.0	15.8 ± 8.1	18.9 ± 13.2
Middle Radius of Curvature	8.8 ± 3.7	9.2 ± 3.2	8.5 ± 4.2
Medial Radius of Curvature	8.9 ± 4.7	10.5 ± 5.8	7.3 ± 2.2

NOTE. Data are presented as mean ± SD.

Conclusion

Recent studies have shown that operative plate fixation of displaced midshaft clavicular fractures demonstrate better functional outcomes than those that are treated nonoperatively. Furthermore, the use of shorter plates with fewer screws has the potential to decrease surgical morbidity, time and cost as it relates to less surgical exposure and drill holes, as well as potentially allowing for a smaller plate inventory and less technical difficulty in applying a shorter straight plate to the midshaft clavicle fracture.

Understanding clavicular anatomy is important for better plate design and fixation. Using 3-D modeling we were able to characterize the length and radius of curvature of the clavicle straight segment. Our data provides potentially important information for the design of shorter, more anatomic plates that could decrease the length of surgical exposure, cost and morbidity associated with superior plating of midshaft fractures of the clavicle.

References

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