Clavicular motion after surgical shortening

[1]Robert-Jan Hillen and [2]DirkJan Veeger
MOVE Research Institute, [1]VU medical center, department of Orthopaedics, [2]Department of Human Movement Sciences;
email: h_e_j_veeger@fbw.vu.nl

INTRODUCTION

Conservative treatment of clavicle fractures often results in a shortening of the clavicle. Reports on the effect of clavicle shortening in the literature vary from excellent to a considerable loss in shoulder function. The reason why shortening of the clavicle causes complaints is yet unclear. In this study we intended to quantify the effect of clavicle shortening on its kinematic behaviour during arm elevation.
It was expected that clavicle shortening would lead to significantly different acromioclavicular resting angles (due to the effect of clavicle length on scapula position) but not in ranges of motion.

METHODS

Six shoulders from three fresh-frozen specimen (2 male, one female) were selected for analysis. To allow free motion, the upper torso of a specimen was strapped into a custom-made frame. The experiment comprised:

- a calibration session in which anatomical coordinate systems were defined relative to technical frames. Anatomical coordinate systems and landmarks were defined following Wu et al [1];
- measurement of passive shoulder motion during abduction and forward flexion, brought about by the experimenter. Each motion measurement consisted of five maximal arm elevations;
- surgical intervention: shortening of the clavicle by 1.2, 2.4, or 3.6 cm; followed by a repetition of the passive shoulder measurements.

After each resection, ends of the clavicle were fixated using a Peri-Loc locking clavicular plate (Smith&Nephews, USA)
Segment and joint angles were calculated following the ISB proposal for the upper extremity [1].
Clavicular motion was quantified as:

- the rotation of the clavicle relative to the thorax and relative to the scapula (see Table 1 for decomposition order)
- the rotation of the clavicle relative to the thorax from 30° arm elevation to 120° arm elevation, expressed as the total rotation around a helical axis.

Differences between conditions were analysed using ANOVA.

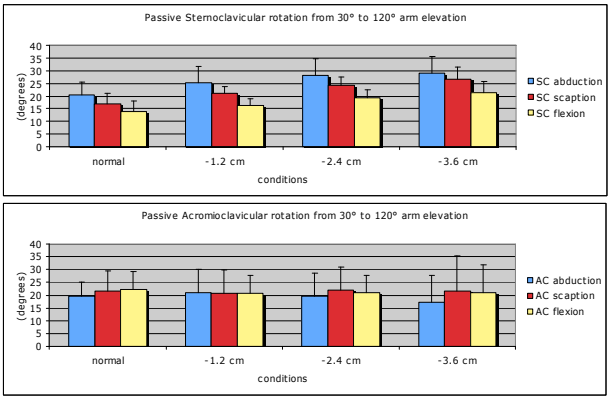

Figure 1: Rotation for abduction, scaption and forward flexion from 30° to 120° arm elevation and for normal and shortened conditions. Top: Sternoclavicular rotation. Bottom Acromioclavicular rotation.

RESULTS AND DISCUSSION

SC and AC orientation at 30° arm elevation were significantly related to clavicle shortening.
Total SC rotation for arm elevation from 30° to 120° arm elevation was increased after shortening and was largest for abduction (Figure 1). Almost all of the increase in sternoclavicular rotation was due to an increase in Axial rotation.
Acromioclavicular rotation did not differ between conditions and tasks and was on average 20.5±7.5°.

CONCLUSIONS

Clavicle shortening leads to a clear difference in clavicle resting position, an increase in sternoclavicular rotation, but no significant change in acromioclavicular rotation.

REFERENCES

1. (Wu et al (2005) ISB recommendation on definitions of joint coordinate systems ... J. Biomech. 38: 981-999.

ANGLE (degrees)	Normal	1.2 cm shortening	2.4 cm shortening	3.6 cm shortening	
SC - Pro/Retraction	1.9±1.0	0.6±1.9	-1.7±4.4	-1.8±3.2	NS
SC - Depression/Elevation	-13.9±7.1	-13.7±5.4	-12.7±4.1	-13.1±8.9	NS
SC - Axial rotation	-42.4±12.0	-39.8±12.1	-38.1±12.0	-36.6±9.0	*
AC - Pro/Retraction	74.9±5.3	79.3±5.2	88.3±4.2	93.4±4.8	*
AC - Lateral/Medial rotation	-1.4±7.4	1.6±5.2	2.9±6.7	2.7±6.3	NS
AC - Anterior/Posterior Tilt	12.0±3.4	9.2±3.5	6.1±3.0	2.9±6.1	*

Table 1: Sternoclavicular (SC) and Acromioclavicular (AC) angles at 30° arm abduction for four different conditions: normal, and a 1.2, 2.4 and 3.6cm shortened clavicle.