Repeatability of Shoulder Elevation in the Scapular Plane Using Different Assistance Methods

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Summary

Shoulder elevation in the scapular plane (scaption) is a task of high clinical importance. The intra and inter-subject repeatability of scaption is necessary for monitoring the rehabilitation progress and for multi-center studies. The study found statistically significant differences in the shoulder plane of elevation between various types of guidance for performing scaption and evaluated a new laser device to enhance precision.

Introduction

Scaption, or shoulder elevation in the scapular plane, is a task that combines flexion and abduction. It is relevant in rehabilitation, especially after labral repairs or reverse shoulder arthroplasty, as it reduces tension on repaired structures [1]. Three different guidance methods for performing scaption were compared, with the aim of investigating the repeatability of the elevation plane joint angle among a sample of subjects.

Methods

Seven volunteers (M/F: 5/2, right/left-handed: 6/1, mean age: 27 years, no shoulder pathologies) participated in the study. After palpation, markers were placed on the thorax landmarks, scapula (AA, AI, TS, PC, AC), and humerus epicondyles (ME, LE) of the dominant limb. Clusters were positioned on the acromion (AMC, Fig. 1a), upper arm, and thorax [2]. The bone-embedded frames were defined as recommended by the ISB and tracked with the clusters [3]. Each volunteer was asked to perform 5 complete cycles of scaption from the resting position to 120°, marked by an horizontal bar placed at the previously measured height. The task was repeated for each of the following aids in order: visual demonstration by the operator (None), tape on the floor (Fig. 1b), side pole (Fig. 1b) and a new laser guide (Fig. 1a). The laser guide was placed over the middle third of the scapular spine (Fig. 1a). During the elevation phase of the cycle, at the humerothoracic (HT) elevation angle of 90°, the glenohumeral (GH) plane of elevation (PoE) was measured. The Shapiro-Wilk test was performed on each group to determine normality. Pairwise comparisons of guidance methods were conducted using the Mann-Whitney U test with significance set at $p < 0.05$.

Results and Discussion

From the analysis in Table 1, laser guiding showed the lowest variability (SD = 13.62°) and a narrower IQR (20.64°), suggesting higher consistency and better inter-subject repeatability compared to the other methods. In contrast, the tape demonstrated the widest IQR (37.31°), showing greater variability and a potentially lower repeatability. Shapiro-Wilk tests revealed that only laser's data followed a normal distribution ($p = 0.116$), while the others significantly deviated from normality ($p < 0.05$). Pairwise comparisons revealed significant differences between Laser and Poles ($p = 1.46\times10^{-5}$), Laser and Tape ($p = 0.0045$), None and Poles ($p = 0.0045$), and Poles and Tape ($p = 0.033$) while no significant difference was observed between Laser and None ($p = 0.285$) and between None and Tape ($p = 0.077$). The lack of difference between None and Tape may result from the tape's reference being lost at small elevation angles, causing inconsistent guidance.

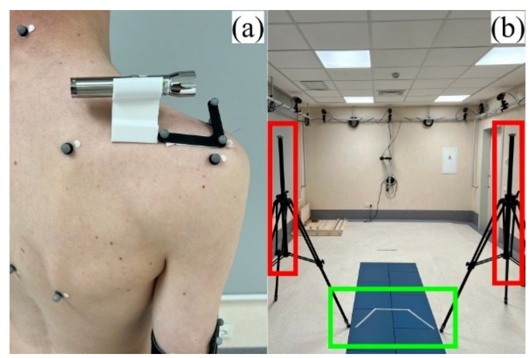

Figure 1: (a) Scapula marker setup with the laser guiding device (white) and AMC (black). (b) Experimental environment with poles (red) and tape (green).

Conclusions

The performance of laser guiding device and the other assistance methods will be further investigated across multiple HT elevation angles, considering both the dominant and non-dominant limb, as well as comparing unilateral and bilateral movement.

References

[1] Kolber et al. (2012) *Physiother Theory Pract* **28** 161-168
[2] Warner et al. (2015) *J. Vis. Exp.* **96** e51717
[3] Wu et al. (2005) *J. Biomech.* **38** 981-992

Table 1: Mean, standard deviation (SD), median and interquartile range (IQR) for GH PoE are reported for each aid method in degrees [°].

Aid	Mean	SD	Median	IQR
Laser	-1.63	13.62	-0.80	20.64
Poles	18.87	19.51	15.79	32.54
Tape	11.90	18.50	10.63	37.31
None	4.85	18.52	-2.04	32.30