USE OF A PASSIVE MARKER MOTION CAPTURE DEVICE FOR MEASURING SCAPULAR KINEMATICS: A FEASABILITY STUDY

[1] Martin Warner, [1]Sarah Mottram, [1]Maria Stokes, [2]Paul Chappell and [3]Dylan Morrissey

[1]Schools of Health Sciences and [2]Electronics and Computer Sciences, University of Southampton, UK

[3]Queen Mary, University of London, UK

email: m.warner@southampton.ac.uk

INTRODUCTION

Patients with shoulder dysfunction have been shown to exhibit abnormal scapular movements, which include reduced upward rotation of the scapula during arm elevation [1,2].

Measuring scapular kinematics, however, is difficult due to the scapula's large flat surface, which glides beneath the skin. Normal skin mounted markers attached to bony landmarks would not track the dynamic movement of the scapula as it glides beneath. To overcome these difficulties many studies have adopted an acromion based sensor, or marker set. Results have shown this method to be valid up to 120° arm elevation [3-4].

An acromion based marker set, or sensor, has only been used with electromagnetic or active marker motion tracking systems and not with a passive marker system, such as those commonly used for gait analysis. Therefore the aim of the present study was to investigate the feasability, with reference to previous literature, of using an acomion based marker set to track scapular movement from a passive marker motion capture system.

METHODS

Six participants (5 male and 1 female, mean age = 44.3 years, standard deviation ± 14.7) with a history of (but not current) shoulder pain and 14 controls (5 male and 9 female, mean age = 30.6 years, standard deviation ± 8.9) were studied. A six-camera Vicon 460 motion capture system was used to record scapular kinematics at 120Hz. Technical marker sets consisting of at least three retro-reflective markers were applied to the participant's thorax, right acromion, right upper arm and right forearm. Anatomical landmarks were digitized and placed in the local co-ordinate frame for the corresponding technical marker set. Rigid body segments, local co-ordinate frames and Euler angle sequences were defined according to ISB recommendations [5]. Participants completed three repetitions of right arm elevation (to approximately 90°) in the sagittal plane.

RESULTS AND DISCUSSION

Participants with a history of shoulder pain demonstrated a significant decrease ($p = 0.03$; mean difference = 6.3°, standard deviation ± 5.3°) in upward rotation of the scapula at 90° arm elevation compared to healthy controls (Figure 1).

Table 1: Scapular upward rotation during arm elevation. * denotes significant difference between groups ($p<0.05$)

	Scapular upward rotation (mean ± standard deviation)	
Arm elevation	**0°**	**90° ***
Control n=14	0.1° ± 4.2°	-14.1° ± 4.5°
History of pain n=6	3.3° ± 7.3°	-7.8° ± 5.3°

These results indicated that the technology used was able to demonstrate a difference between normal and abnormal movement. This has implications for the potential use of this technology for research in patients with shoulder dysfunction. Passive marker motion capture systems offer a high degree of accuracy at high sampling frequencies and are often not limited by the number of markers or segments that can be defined; a limiting factor of electromagnetic systems.

The combination of a passive marker motion capture system with an acromion based technical marker set has not, to our knowledge, been investigated previously. Studies in the literature have mainly used an electromagnetic system, with an acromion based sensor, which have also found a decrease in upward rotation of 4.1° and 5.7° of the scapula in participants with shoulder dysfunction at 60° and approximately 90° arm elevation respectively [1,2].

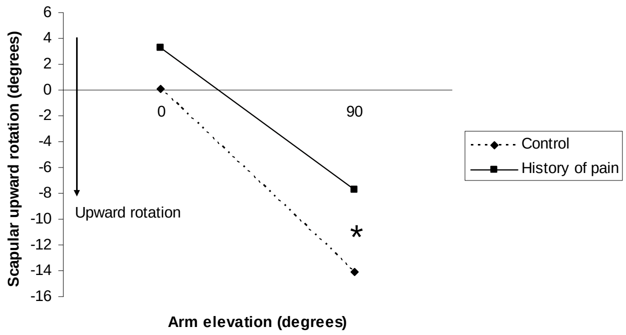

Figure 1: Upward rotation of the scapula between history of shoulder pain group and controls at rest (0° arm elevation) and arm elevation (approx: 90°). * denotes significant different between groups. See Table 1 for standard deviation.

CONCLUSION

The present study has shown similar results for scapular movement to previous literature whilst using a passive marker motion capture system. This suggests that the acromion method for measuring scapular movement could be valid for use with passive marker motion capture systems. Further work is currently being conducted to investigate the validity and reliability of this method, to establish its potential use for measuring scapular movement.

ACKNOWLEDGEMENTS

The authors thank the Private Physiotherapy Education Foundation and Vicon (Oxford, UK) for financial support (M. Warner is supported by a Vicon PhD studentship), Faizura Fadzil for technical assistance and the participants for taking part in the study.

REFERENCES

1. Ludewig PM, Cook, TM. *Phys Ther* **80**: 276-291, 2000.
2. Lin, JJ. et al. *Phys Ther* **86**: 1065-1074, 2006.
3. Karduna AR. et al. *J Biomech* **123**: 184-190, 2001.
4. van Andel C. et al. *Gait Posture* **27**: 120-127, 2008.
5. Wu G. *J Biomech* **38**: 981-992, 2005.