FUNCTIONAL FATIGUE DECREASES THREE-DIMENSIONAL MULTIJOINT POSITION REPRODUCTION IN OVERHEAD ATHLETES

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INTRODUCTION

The sensorimotor system (SMS) is responsible for providing the awareness, coordination and feedback to maintain stability and function. Therefore, acuity of this system is a major component of injury-free athletic performance. Evidence suggests that muscular fatigue [1,2] and injury [3] compromise SMS function in the upper-extremity. However, investigations of joint position sense often employ methods that hamper our ability to apply results to functional activity. The purpose of this study was to examine the effect of functional fatigue on unconstrained, multijoint position reproduction of the upper-extremity. We measured position reproduction acuity of the upper-extremity as a functional unit and acuity of four individual joints.

METHODS

We used a single-session repeated-measures design. Subjects consisted of 16 healthy male NCAA baseball players (21.0 ± 1.6 years, 175.8 ± 10.2 cm, 82.8 ± 4.3 kg). We recorded position of the throwing-side thorax, scapula, humerus, forearm and hand using an electromagnetic tracking device (Ascension Technology, Burlington, VT, USA) and MotionMonitor software (Innovative Sports Training, Chicago IL). We blindfolded subjects and tested their ability to reproduce two self-selected upper-extremity positions (arm-cock and ball-release) before and after a fatigue protocol. Subjects were in a single-knee stance position for the testing and throwing protocol. Subjects identified a target position followed by three-reposition trials. The functional fatigue protocol was a single bout of throwing a baseball at a target with maximum velocity (1 every 5 seconds). After every 20 throws, subjects rated their local (upper-extremity) exertion level on the Borg Rating of Perceived Exertion scale [4]. We considered subjects fatigued after reaching a level greater than 14. Immediately after the throwing protocol, we retested participants in the same manner as prefatigue measures. Post-testing began within 1 minute after completion of the throwing protocol and both positions were completed within 3 minutes. We calculated 3-dimensional variable error scores (3DVE) to represent overall reposition acuity for each arm position using hand position in relation to the thorax. We calculated additional 3DVE scores for each individual joint (scapulothoracic, glenohumeral, elbow and wrist).

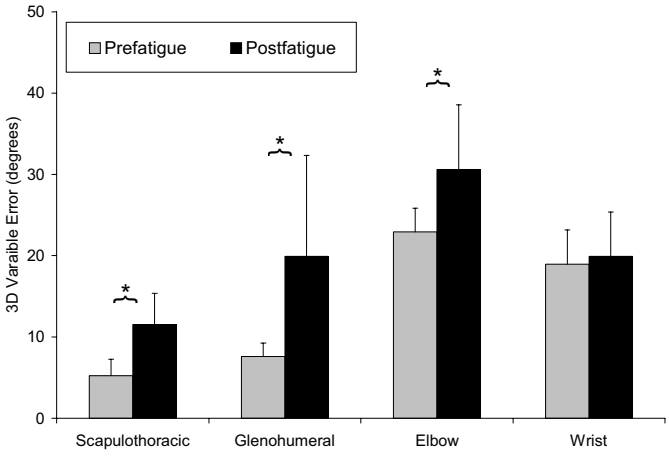

Figure 1: Comparison of prefatigue to postfatigue acuity scores (3DVE) for the arm-cock position.
* Significant difference between conditions ($P < 0.05$)

RESULTS AND DISCUSSION

Subjects were fatigued after 62 ± 28 throws. We used Wilcoxon matched-pairs sign-rank tests to compare prefatigue to postfatigue error scores. Fatigue had a significant effect on position reproduction acuity (increasing 3DVE scores) for the arm-cock (12.4 to 24.1mm) and ball-release positions (20.8 to 41.7mm) ($P < .001$). Comparisons of prefatigue 3DVE scores for scapulothoracic, glenohumeral, elbow and wrist joints with postfatigue reveal decreased acuity for both the arm-cock (Figure 1) and ball-release (Figure 2) positions.

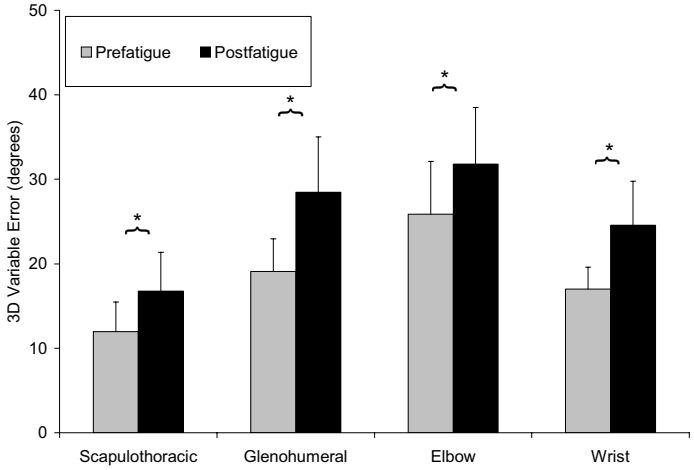

Figure 2: Comparison of prefatigue to postfatigue acuity scores (3DVE) for the ball-release position.
* Significant difference between conditions ($P < 0.05$)

CONCLUSIONS

Using multijoint, 3-dimensional measures and a functional throwing protocol, we demonstrated fatigue reduced 3D position reproduction acuity in both positions tested and at multiple upper-extremity joints. Our results indicate that after prolonged throwing, SMS deficits effect the entire upper-extremity and may put multiple joints at risk for injury.

REFERENCES

1. Carpenter JE, et al. *Am J Sports Med* **26**, 262-265, 1998.
2. Myers JB, et al. *J Athl Train* **34**, 362-367,1999.
3. Lephart SM et al. *J Shoulder Elbow Surg* **3**, 371-380, 1994.
4. Borg G. *Borg's Percieved Exertion and Pain Scales,* Human Kinetics, Champaign, Il. 1998.