SHOULDER MAXIMUM EXTERNAL ROTATION IN THE TENNIS SERVE IS NOT RELATED TO SHOULDER PASSIVE EXTERNAL ROTATION FLEXIBILITY

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INTRODUCTION

Shoulder external rotation (ER) is extreme in overhand athletics (figure 1). Both costs and benefits are associated with excessive shoulder ER. The cost is injury potential. Pitchers and tennis players have a high incidence of elbow and shoulder injuries. The potential benefit is the performance enhancement. Shoulder maximum ER in the baseball pitch is positively correlated with throwing velocity (Matsuo et al., 2000). It is important to understand factors that influence shoulder ER.

In this study we attempted to determine if shoulder passive ER flexibility is related to the shoulder ER achieved in the tennis serve. Analysis of shoulder passive ER flexibility is limited for overhand athletics. Previous studies have focused on passive range of motion (ROM) measures exclusively. The rotational resistance associated with acquiring the passive ROM has yet to be quantified. Resistance measures may help to more thoroughly describe shoulder passive ER flexibility. Novotny et al., (2000) demonstrated that it is possible to quantify shoulder passive ER rotational resistance using a custom device. We developed a similar device catered to overhand athletics. To our knowledge, relationships between ER passive flexibility measures and end ROM in overhand athletics have yet to be examined. The purpose of this study was to determine if relationships exist between shoulder ER flexibility measures and the end ROM in the tennis serve.

METHODS

Twenty-six advanced (NTPR rating > 5.0) male tennis players (age = 22.4 ± 7.0 yrs) participated in the study. Kinematic data were collected using a 7-camera Hawk Digital Motion Analysis system at 200 frames per second. A custom program was written in LabView software to analyze the shoulder maximum ER during the serve. The torso was modeled using a triad of markers on the upper back (Wight et al., 2004). The upper arm and forearm were modeled using markers placed upon the medial and lateral humeral epicondyles and the medial and lateral wrist.

Shoulder passive ER flexibility measures were collected using a custom device (figure 2). Measures included the resistance onset angle (ROA), defined as the ER angle at 1 N·m of resistance, the passive end ROM (end ROM), and the stiffness (slope of torque vs. ER angle best fit line).
Passive flexibility measures variables were first analyzed singly for all subjects. Pearson product moment correlations were used to determine if relationships existed between the flexibility measures and serving ROM. The two resistance measures (ROA and stiffness) were then assessed simultaneously to form a flexible (n=5) and inflexible (n=5) group. The flexible group consisted of individuals that had a late ROA (>95°) and a low stiffness (< 0.37 N•m/°). The inflexible group consisted of individuals that had an early ROA (<85°) and high stiffness (>0.41 N•m/°). Independent T-tests (alpha set at 0.05) were used to determine if differences in passive and serving end ROM occurred between the groups.

**Figure 2:** The researcher slowly pulled on a rope to externally rotate the subject’s arm. The rope ran through a pulley that was attached to a load cell (to measure rotational resistance). A potentiometer was mounted to the bicycle wheel (to measure ROM).

**RESULTS AND DISCUSSION**

Means and standard deviations were calculated for all individuals (ROA = 94.0 ± 14.7°, stiffness = 0.41 ± 0.9 N•m/°, passive end ROM = 121.1 ± 17.2°, serving end ROM = 164.9 ± 17.9°). The 3 flexibility measures did not significantly predict the shoulder maximum ER in the serve (ROA: r = 0.14, p = 0.51; passive ER ROM: r = 0.29, p = 0.15; ER stiffness: r = 0.11, p = 0.58). No significant differences (p=0.9) were detected in the serving end ROM between the flexible (164.4 ± 6.2°) and inflexible (166.4 ± 33.8°) groups. This data suggests that both flexible and inflexible players were able to obtain excessive ROM during the tennis serve.

A significant group difference was approached (p=0.09); the flexible group achieved a greater passive end ROM (136.6 ± 17.3°) than the inflexible group (106.8 ± 12.2°). This data demonstrates the potential to gain further insight about shoulder flexibility properties by accounting for multiple flexibility variables.

**SUMMARY/CONCLUSIONS**

A thorough analysis of shoulder passive external rotation was completed by measuring the resistance to rotation. Both flexible and inflexible athletes were able to obtain excessive shoulder ER during the tennis serve. Future research should attempt to determine if ER flexibility influences the shoulder and elbow loads experienced while externally rotating the shoulder during overhand athletics.

**REFERENCES**

