JOINT VELOCITY SEQUENCE OF THE UPPER EXTREMITY DURING FLY-CASTING

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INTRODUCTION

Segmental chain analysis of the upper extremity can contribute to a deeper understanding of the coordination and control strategies used during overhand throwing tasks. The fly-casting stroke parallels throwing tasks in that the ultimate goal is accurate placement of a projectile at some distance from the body. Previous studies have shown differences in the sequence of peak joint velocities, based on the skill vs. power required for the task [1,2]. The focus of this study is to determine whether upper extremity sequencing during fly-casting is proximal-distal or distal-proximal. Establishing the order of sequence should add to the basic understanding of coordination involved in fly-casting.

METHODS

The sample consisted of six subjects (five males, one female) ranging in age from 22 to 38. Each subject signed an informed consent and was medically evaluated for upper extremity health. Within the medical evaluation, subjects were asked to state the number of days spent fly-fishing per year. Responses varied from 3 days/year to over 100 days/year indicating a variety of experience. Segments of the upper body were defined by 25 spherical, reflective markers placed on bony landmarks (adapted from Rab et al. [3]). Marker position data were collected at 200 Hz using a 6-camera Vicon 460 system (Vicon Motion Systems, Lake Forest, CA).

Subjects were required to perform a series of casting trials, including 2-3 "false casts" followed by the "shooting" cast. The shooting cast from each of three trials was evaluated for each subject.

The upper extremity was modeled as a system of rigid bodies connected by pin joints. The wrist was modeled with a two-axis pin joint, the elbow as a one-axis pin joint, and the shoulder as a three-axis ball and socket joint. Time and magnitude of peak angular velocities were examined during the forward cast. Angular velocities were calculated using the central difference method and smoothed with a 4th order Butterworth low pass filter (cutoff = 2Hz). The peak velocities examined included shoulder internal rotation, elbow extension, and wrist ulnar deviation.

RESULTS AND DISCUSSION

The motion of fly-casting includes a back cast in which the line is lifted and brought behind the caster followed by a pause. During the pause, the line is drawn behind the caster due to the inertial force. This causes the line to load the rod at which point the caster will enter the forward cast. It is during this last phase that the line is directed to the target.

Segmental chain analysis revealed a pattern of proximal-to-distal motion of the upper extremity during the final forward casting phase. Figure 1 shows an example trial of the peak wrist, elbow and shoulder velocities as they occurred during the forward cast. Overall, the shoulder velocity peaked at an average of 80.5% (± 8.5%) of the total casting time, elbow velocity at 86.3% (± 8.3%), and wrist velocity at 89.1% (± 8.8%). Each subject's time to peak velocity is presented in Table 1.

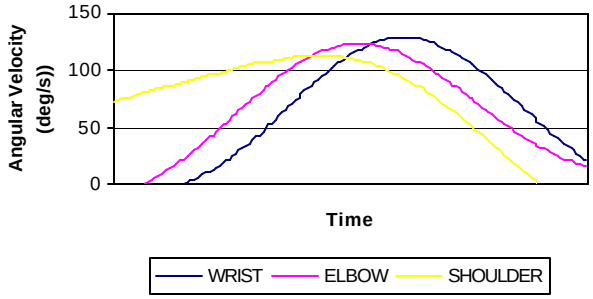

Figure 1: Peak angular velocities during the forward cast.

Peak velocities generally corresponded to the expertise of the fly-caster. Those who fished 10 days/year or less were more likely to have a wrist velocity much higher than shoulder or elbow velocities and those who were more experienced (i.e. fishing guides) had a much higher shoulder velocity.

CONCLUSIONS

Initial findings of this study indicate a proximal-to-distal sequence for angular velocities of the upper extremity joints during fly-casting. Though generally considered a skill-driven motion, a secondary goal is to produce high line velocities during the forward cast. This goal may require a more forceful coordination sequence similar to overhand throwing.

REFERENCES

1. McDonald PV, et al. *J Mot Behav* **21**, 245-264, 1989.
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3. Rab G, et al. *J Biomech* **15**, 113-119, 2002.

Table 1: Percent time to peak velocity.

% Total Time to Peak Velocity	Subject					
	1	2	3	4	5	6
Wrist	87.68%	83.74%	91.46%	93.07%	89.77%	89.20%
Elbow	85.91%	80.51%	90.28%	90.81%	80.41%	85.44%
Shoulder	76.31%	80.89%	85.15%	78.98%	79.24%	82.26%