

SHOULDER BIOMECHANICS IN VOLLEYBALL SPIKING: IMPLICATIONS FOR INJURIES

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INTRODUCTION

The potential for overuse injuries in volleyball has been linked to impact magnitude, impact frequency, rate of loading, and number of years of competition.

The purpose of this study was to determine the reaction forces and torques at the shoulder during the volleyball spike and to investigate the relationship between shoulder biomechanics and the potential for injury.

METHODS

Shoulder biomechanics of 11 collegiate volleyball players (6 female, 5 male) were determined using 120 Hz video analysis. Subjects performed at least 10 maximum effort spiking trials toward a region 6 to 9 meters from the center of a regulation height volleyball net.

Retroreflective markers were affixed to the subjects at anatomical landmarks and to the ball. A motion analysis system (Motion Analysis Corporation, Santa Rosa, CA) was used to collect digital images of the volleyball spike. Cameras were positioned to allow image capture from all sides and EVA 6.0.3 software (Motion Analysis Corporation) was used to capture and digitize the spiking trials.

Two trials from each subject were digitized; a DLT algorithm was incorporated to determine the 3D coordinates of the markers. Raw positional data were exported to a custom program for analysis.

RESULTS AND DISCUSSION

Mean maximum ball velocity compared favorably to similarly skilled athletes (Chung, 1988; Chung et al., 1990). A strong positive correlation was found between maximum ball velocity and maximum shoulder compressive force ($r = 0.872$, $p < 0.001$).

While the impact magnitudes (~46-94% BW) and loading rates (~5-15 BW/s) reported herein are relatively small when compared to activities such as running or jumping, the ability of the shoulder to handle impact loading is limited. The dynamic stability of the shoulder complex is generally sufficient for most activities, but any situation that compromises the health of the shoulder musculature can increase the potential for overuse injuries (Norkin and Levangie, 1992).

Cumulative fatigue in the rotator cuff muscles, associated with repetitive overhead motions and/or technique errors, may impair their ability to stabilize the humerus, resulting in superior translation and entrapment of soft tissues, leading to

or exacerbating tendinitis and/or impingement. Accumulated microtrauma to the rotator cuff muscles and soft tissues of the shoulder may result in increased symptoms and may limit participation (Briner & Kacmar, 1997; Schaeffle, 1993; Watkins, 1994).

SUMMARY

The magnitude and rate of impact loading during volleyball spiking constitute considerable potential for shoulder overuse injuries among volleyball hitters. They are especially prone to biceps tendinitis and impingement syndrome (Briner & Kacmar, 1997; Schaeffle, 1993; Watkins, 1994).

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(mean ± SE)	Units	Male	Female
Maximum Shoulder Internal Rotation Torque	Nm	48.7±4.5	28.3±4.1
	ms ^a	-30.0±4.0	-44.4±3.6
Maximum Shoulder Joint Reaction Force (Compressive)	% BW	89.5±4.8	50.6±4.4
	ms ^a	23.3±2.7	28.4±2.5
	BW/s	14.2±1.0	6.0±1.0
Maximum Shoulder Adduction Torque	Nm	114.7±15.4	63.1±14.0
	ms ^a	34.2±7.1	45.1±6.5
Maximum Ball Velocity (mean ±SD)	m/s	31.2±1.1	19.0±1.0

a. milliseconds before (-) or after (+) start of ball impact.