EFFECTS OF BALL HEIGHT PLACEMENT ON VOLLEYBALL SPIKE MECHANICS USING A MARKERLESS MOTION CAPTURE SYSTEM

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INTRODUCTION

Volleyball is a game of earning points and being mechanically consistent in multiple skills. Furthermore, advancement in motion capture technology has assisted in the mechanical evaluation of sport specific movements.

PURPOSE

The aim of this study was to determine the effects of ball height placement on upper limb mechanics during a volleyball spike using a markerless motion capture system.

METHODS

Ten healthy, collegiate female athletes (n=10; $\bar{X}\pm SD$; age=20±1.9 yrs, height=177.5±4.1 cm, weight=72.3±8.7 kg). The participants were collegiate student-athletes playing competitive volleyball and predominantly playing as pin hitters at their primary position. All subjects completed two experimental sessions (pre-testing session, and volleyball testing session). Subjects completed three approach vertical jumps using a vertec (Jump USA, Sunnyvale, CA) and the average height was determined from all three jumps. The average approach jump reach height was determined by the maximal touch point per each subjects. During the volleyball testing session, two ball height placements were determined by the maximal touch point. The maximal ball height (MAX) was positioned two inches lower than the average touch height, and the second ball height (LOW) was positioned six inches lower than the average touch height. Subjects completed ten spike repetition at both

METHODS (continued)

ball heights in a randomized order. Accuspike Individual Trainer (Accuspike, Benton, AR) was positioned two feet from the antenna and three feet off the net to position the ball in the air at each height. Subjects were instructed to hit down the line in front of the approach in front of the radar gun position along the baseline. A three-dimensional markerless motion capture system (DARI Motion, Lenexa, KS) using 8 cameras surrounding the hitting zone was used to determine the total-body spike mechanics per each ball height at ball contact. Repeated measure ANOVA were conducted using condition (LOW, HIGH) x spike mechanics (ball velocity, thoracic rotation, lumbar rotation, shoulder abduction, elbow flexion) on kinematic data ($p<0.05$).

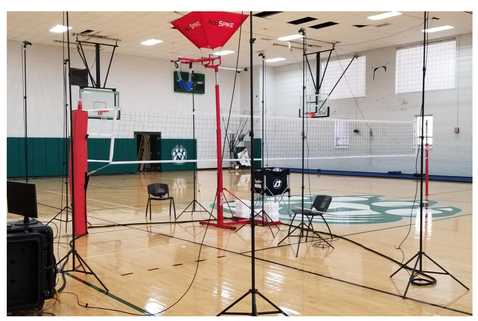

Figure 1a

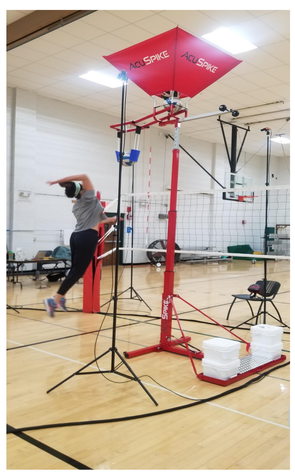

Figure 1b

Figure 1a, 1b. Displays the markerless motion capture system (MCS) used for investigation (Figure 1a) and example of a volleyball spike repetition at one of the ball heights (Figure 1b).

RESULTS

Significant two-way interaction between condition and spike mechanics ($p=0.02$). Follow-up analysis indicated significant differences between ball velocity ($p<0.01$), and elbow flexion ($p<0.05$).

DISCUSSIONS

These results indicate significant mechanical alterations due to ball position at ball contact. Thus, the lower ball position resulted in greater elbow flexion with a greater ball velocity.

Table 01. Effects on Volleyball Spike Mechanics at Different Ball Position Heights

	Low (Touch Height - 6)	Max (Touch Height -2)
Ball Velocity (km/hr)	53.7 ± 5.3*	44.2 ± 5.2
Thoracic Rotation (°)	1.83 ± 20.7	1.2 ± 12.3
Lumber Rotation (°)	0.7 ± 10.6	1.0 ± 4.9
Shoulder Abduction (°)	76.4 ± 187.3	169.5±186.8
Elbow Flexion (°)	78.5 ± 44.0*	59.1 ± 46.8

Mean ± SD. Two-way ANOVA ($p=0.02$). (*) indicates significant difference ($p<0.05$).

PRACTICAL APPLICATION

Coach and athletes should understand the importance of ball contact height and performance alterations. Proper ball positioning and approach jump timing may result in a point and improve spike technique.