ANALYSIS OF THE VOLLEYBALL SPIKE: RELATIONSHIPS BETWEEN SEVERAL PARAMETERS AND THE SPEED OF THE BALL





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Literature

- In volleyball, the spike's effectiveness is a determining element of the team's success (Selinger & Ackermann-Blount, 1992).
- To perform at a high level, a player must be able to produce spikes characterized by a high speed of the ball that increases the defence's uncertainly.
- Several spike's techniques were identified (Oka et al., 1976) but no difference was underlined in the final performance. Rokito et al. (1998) described the muscles involved in the five phases of the spike (windup, cocking, acceleration, deceleration and follow-through).
- A high speed spike needs a combination of technical skills and muscular qualities explaining why training pays a large attention to that skill.
- Nevertheless, as in other overhead movement sports, the shoulder of the volleyball player is often a source of pain (Lo et al., 1990) that can reduce the athlete's effectiveness.
- This underlines that to a better understanding of the factors contributing to the effectiveness of the spike, it is essential to follow a multivariable approach.

Goals of the study

- This study is a part of a larger research project.
- Its specific goals were:
  - To identify the differences in some technical, physical, morphological and training characteristics of the spike in two groups of players differing according to their competition level.
  - To identify among these variables those which were related to the speed of the ball in the spike.

Methods

Subjects

- Two groups of male volleyball players were involved in the study.
  - Group 1 (G1) comprised 11 athletes playing in the two highest Belgian national divisions.
  - Eight players of the third division were included in the group 2 (G2).
- Each subject participating into the study followed a standardized experimental protocol comprising four steps (approximately 4 hours).

General information

- A questionnaire was filled in by the player. It allowed researchers to collect data about age, dominant arm, volleyball experience, training characteristics, past injuries.

Field tests

- Measure of the ball speed in a standardized spiking task. After warming up, the player had to hit balls at position 4 towards a delimited target zone (diagonal); standardization was obtained through the participation of an experienced setter, the use of a device allowing the set up trajectory control and the opportunity given to the player to reject an incorrect trial. The test lasted until 6 correct actions were achieved. A 30 seconds rest period was imposed after each trial (validated or rejected). The speed of the spike was measured by a calibrated radar (Trainer Rid Out, Timint Box).
- Analysis of the spike. Each trial was videotape recorded with a digital camcorder. A graduated panel was set perpendicularly to the net to assess the hitting height. Several skill characteristics of the best trial were identified (arm's position at the contact, angle between "shoulder-ball" axis and vertical axis on the shoulder (AEIV), movement of the elbow during cocking phase). Inter observer reliability reached 90% for each variable.
- Ability to jump was measured with the method of Bosco et al. (1983): squat jump (SJ), counter movement jump (CMJ), CMJ with arms (CMJa) and repeated jumps during 15 seconds (R15). Only CMJa was processed here (spring, cm).
- Anthropometric measures (height, dominant arm reach, weight, BMI, percentage of fat by Katch, span).
- Throwing performance. A 800 gr ball was thrown on a soccer field with dominant arm and an outstretched arm starting position.

Clinical examination and muscular strength assessment

- Four shoulder tests (tests of Neer, Hawkins, Yocum and apprehension) were proposed as well as the assessment of the dominant and non dominant shoulders' flexibility.
- After a warming up, shoulder (internal and external rotators, IR-ER) and elbow (flexors and extensors, F-E) strength of the dominant arm were measured following a validated isokinetic protocol using a Cybex Norm dynamometer (Forthomme et al., 2003).

Data processing

- T test for independent sample was used for both groups comparison while Pearson's linear correlation coefficients were calculated.

Results

Comparison between both groups

Ball speed

- It was higher in G1 (100.91 km/h Vs 90.37 G2; p = .001).

General data

- G1 players were older than G2 players (26.2 Vs 21.1 years old; p = .018) and they practiced more fitness training weekly (2 hours Vs 20 minutes; p = .001).

Anthropometric data

- No difference was underlined between both groups.

Technical analysis

- Even if they were not taller, G1 players hit the ball 17 cm higher (321.8 Vs 305 cm; p = .001) than G2 players. Both groups did not differ concerning the angle between the vertical axis at the shoulder and shoulder-ball axis (AEIV) (12° Vs 10.6°). Except for one player of G2, the hitting arm was always outstretched at the ball contact. The distribution of the elbow movement patterns was similar in the both groups.

Physical performances

- G1 players presented a better performance in CMJa's spring (56.5 Vs 51.2 cm; p = .005) and throwing test (distance: 33 Vs 28.5 m; p = .025).

Isokinetic muscular testing

- No significant difference was identified between G1 and G2 through strength measurement although highest level athletes showed moderately increased performances.

		G1 (n = 11)	G2 (n = 8)	p
Max. speed (km/h)		100.9 (5.99)	90.4 (8.33)	.001
Age (years)		26.2 (5.4)	21.1 (3)	.005
Year of experience		11.5 (4.4)	10.1 (5)	NS
Training (h/week)		8.7 (1.4)	9.2 (3.8)	NS
Strength train. (h/w)		2.1 (1.5)	.3 (.7)	.001
Height (cm)		193.9 (2.8)	191.1 (5.7)	NS
Span (cm)		199.6 (6.2)	195 (7)	NS
Arm reach (cm)		254.5 (5.7)	249.8 (7.5)	NS
Weight (kg)		89.5 (6.4)	85 (14.7)	NS
BMI		23.8 (1.5)	23.2 (3.6)	NS
Katch (% body fat)		10.8 (1.4)	11.4 (3.3)	NS
Height of hit (cm)		321.82 (10.79)	305 (7.56)	.001
AEIV (degrees)		12	10.6	NS
Arm (n)	Outstret.	11	7	-
	Bended	0	1	-
Elbow mvt. (n)	↑	5	4	-
	→	5	4	-
	↓	1	0	-
CMJa (cm)		56.5 (4.6)	51.2 (2.3)	.005
Heavy ball throw (m)		32.58 (4.4)	28.01 (4.9)	.025
Internal rotators at 400°/sec conc. (N.m)		36.1 (7.6)	30.9 (8.9)	NS
External rotators at 400°/sec conc. (N.m)		22.3 (2.3)	22.3 (5.2)	NS
Ratio ER/IR (%)		64 (12)	74 (14)	NS

Correlations between the ball speed and the other variables (all subjects)

- A positive correlation was demonstrated between ball speed and the height of the hit (r = .509; p= .026), throwing performance (r = .504; p = .028) and CMJa's spring (r = .444; p = .056).
- Other correlations were also identified between ball speed and muscular strength (IR conc. 60,240,400; EF conc.60, 180; EE conc.180).

	r	p
Time designed to strength training per week	.463	.046
Weight	.445	.056
BMI	.474	.04
Height of hit	.509	.026
CMJa (spring)	.444	.056
Heavy ball throw	.504	.028
Internal rotators at 400°/sec conc. (N.m)	.466	.044
Ratio ER/IR (%)	-.621	.005
Elbow flexors at 60°/sec conc.	.592	.008

Discussion

- The study permitted to highlight specific differences between G1 and G2.
- Nevertheless, despite of the limited number of subjects involved in the study, athletes playing at the highest level clearly showed the best performances for the speed of the ball. Even if tactical aspects should be considered, that result confirms that such a variable could be used as a discriminating factor for athletes' selection.
- Comparison of both groups underlined also differences concerning variables directly related to physical qualities (height of the hit, spring and throw). Players who were at the top spent more time in strength training. They tended to present better upper limb muscular performances tested by an isokinetic protocol. These findings support the emphasis given to physical preparation in the modern volleyball.
- The role of technical aspects in the speed of the spike was not evidenced. Players seem to develop their own movement allowing them to reach effectiveness.
- Correlations between the speed of the spike and the other variables confirmed the previous findings and added the role of athlete's weight. That means that if the player has the power to elevate his body to hit the ball very high, his weight will provide him an inertial advantage to spike strongly.

Conclusions

- The measure of the speed of the spike in a standardized situation can be considered as a promising approach for athletes' selection.
- The development of the players' physical qualities should be considered as an essential aspect in the modern volleyball training.
- Trainers should encourage their players to find their own spiking skill in order to find most efficient movement providing highest ball speed.

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References can be asked to the first author (Marc.Cloes@ulg.ac.be)