TEMPORAL AND STRUCTURAL CHARACTERISTICS OF DIFFERENT ATTACK TECHNIQUES IN VOLLEYBALL

Thomas Jaitner[1] and Cornelius Brach[2]
[1]TU Kaiserslautern, Kaiserslautern
[2]University of Leipzig, Leipzig, Germany

A process oriented approach was chosen to identify attack techniques in volleyball. Male subjects were filmed with two high speed video cameras while they performed three attack techniques. Subject's movement was described by the time courses of angles and angular velocities of the main joints and analyzed by a procedure including distance measures and cluster analysis. Cluster analysis classified movement patterns of spikes, and top spin shots, by individual while patterns of lobs were mainly grouped by technique criteria. Except for the quick attacker, lobs are identified if only variables are considered that describes the movement of the arm during take off. From a practical view, the results suggest that a defender should focus on the arm of the attacker during take off to recognize the attackers intention early.

KEY WORDS: volleyball, analysis of sports techniques, pattern recognition, kinematics

INTRODUCTION: Highly skilled volleyball players know several attack techniques to gain a point even when the opponent's block is well positioned. Beside forceful spikes lobs placed shortly behind the block and well placed top spin shots are common techniques. These attacks are more promising the later the opponent recognizes the intent of the attacker. Therefore, the attackers are often told to perform the approach and the take off in the same way as for the spike when playing a shot. On the other hand, the defender tries to anticipate the attack as early as possible. Based on expert's reports and analyses of gaze direction it was shown that successful defenders fix their eye on the movement of the attacker's shoulder and arm during the flight (Voigt and Westphal, 1995; Allard and Starkes, 1980). Overall, the statements in the volleyball specific literature how varying attack techniques should be processed seem relatively consistent. But there is no further proof by biomechanical analysis that attack techniques can be identified mainly by the movement of the arm close to ball contact and not more recently by any other movements. The aim of our study was to investigate biomechanically at what time and by which variables attack techniques in volleyball can be discriminated. A process oriented approach was chosen to analyze time-continuous kinematic data of three attack techniques of male volleyball players. In comparison with the more common analyses of time discrete data which describe the athlete's performance at given times or positions but lack information on how the movement has been processed in-between this approach has the advantage that more detailed knowledge about the movement processing is available (Bauer and Schöllhorn, 1997; Bauer and Schöllhorn, 1997; Jaitner, 2002).

METHODS: 5 right handed male volleyball players (1st and 2nd national league) performed spikes (SP), lobs (LB) and top spin shots (TS) under simulated competitive conditions. Altogether 38 trails were filmed with two highspeed video cameras (Fa. Redlake) at 125 Hz. DLT and a panning algorithm was used for calibration. For each trial 3D coordinates of 10 body landmarks were determined from the beginning of the take off to the first contact with the ball. The resultant time courses were smoothed with a recursive 4th order Butterworth filter. To describe the subject's movement, time courses of angles and angular velocities of the main joints were calculated by the time courses of the body markers. The distances between the time and amplitude normalized time courses were determined for all data sets according to Schöllhorn (Schöllhorn, 1999). Distance matrices of various sets of variables were analyzed by cluster analysis using the single linkage algorithm (Figure 1). Beside the holistic pattern analysis (including all variables) the movement was partitioned by somatotopic criteria (variables of upper/lower body) and by time criteria into 4 phases (jumping phase, flight phase, swing to strike phase, striking phase).

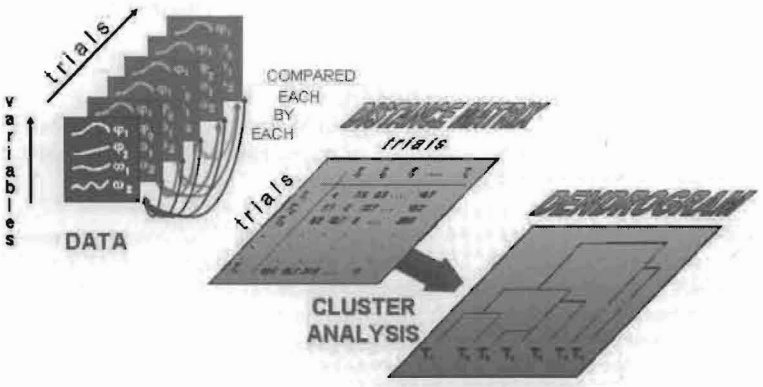

Figure 1 Scheme of data procession.

RESULTS AND DISCUSSION: At this time, the results for three subjects are presented while data of the remaining subjects are still under processing. Figure 2 shows as example the results of the cluster analysis including all angles from the beginning of the take off to the first ball contact. Cluster analysis separates the trials in four main clusters. The first cluster contains all trials of subject TK. A further subdivision of spikes (SP) and lobs (LB) can be identified. Next two clusters contain spikes and top spin shots of one individual each. Clearly separated is the fourth cluster, in which lobs of several subjects are grouped. The separation of lobs is typical for most analyses and can also be stated if variables of the upper right body are analyzed during take off (Figure 3). Top spin shots (TS) are mainly clustered with spikes, but there are no further criteria for these classifications to be recognized.

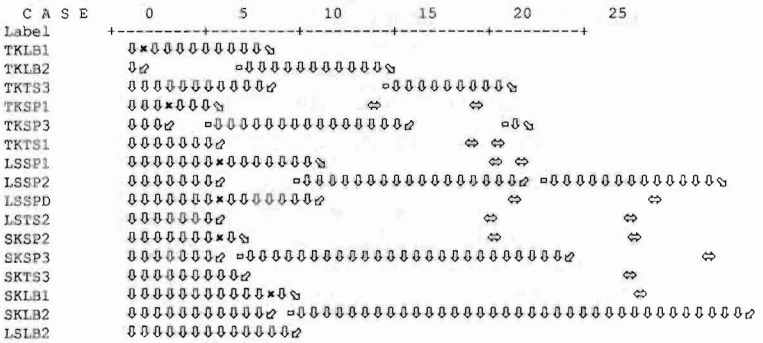

Figure 2 Cluster analysis of volleyball attacks including all angles. Movements were analyzed from the beginning of the take off to the first ball contact. First two characters define the subjects, characters 3 and 4 indicated the attack technique (SP=spike, TS=top spin shot, LB=lob).

Overall, individual movement patterns for spikes and top spin shots as well as specific movement patterns for lobs can be identified. For subject TK who is a quick attacker the movement patterns of all attack techniques are more similar to patterns of a different technique of the same individual than to patterns of the same technique of different subjects. For the other subjects movement patterns of the lob seem more general and technique specific. While these subjects normally attack from different positions than subject TK, the movement patterns might be dependent of playing position or preferred attack mode (e.g. quick attack). Considering time and somatotopic criteria, lobs of subjects LS and SK (not for the quick attacker) can be identified early by the movement of the arm during take off. From

a practical view, the results suggest that a defender should focus on the arm of the attacker during take off to recognize the attackers intention early.

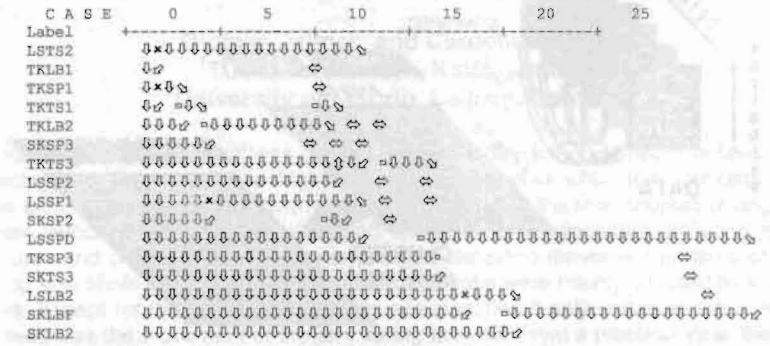

Figure 3 Cluster analysis of upper body variables during take off.

CONCLUSION: The process oriented approach used in this study allows identification of different attack techniques in volleyball by an analysis of time oriented kinematic data. Based on differentiated analyses by time and somatotopic criteria, advise for volleyball training in defense and attack might be driven. Because of the limited data sets the study presented must be characterized as explorative and conclusions must be handled with great care. Further analysis is necessary to support the results.

REFERENCES:

Allard, F. & Starkes, J.L. (1980). Perception in sport: Volleyball. *Journal of Sport Psychology* pp. 22-33.

Bauer, H.-U. & Schöllhorn,W.I. (1997). Self-organizing maps for the analysis of complex movement patterns. *Neural Processing Letters*, pp. 193-199.

Jaitner, T. (2002). Comparative analysis of the takeoff in pole vault and long jump based on time-continuos data. In: Gianikellis,K.E. (ed) *Scientific Proceedings of the XXth International Symposium On Biomechanics In Sports*. Universidad De Extremadura, Carceres, pp 133-136.

Schöllhorn, W.I. (1999). Complex individual movement styles identified by means of a simple pattern recognition method. In Parisi, P., Pigozzi, F., Prinzi, G. (eds) *Proceedings of the 4th annual Congress of the European College of Sports Science.* Rome, p. 494.

Voigt, H.-F. & Westphal, G. (1995). *Wahrnehmungsschulung im Volleyball (*perception training in volleyball*)*. Muenster.

Acknowlegdment

This study was funded by the Federal Institute for Sports Science, Germany (BISp project VF 0407/05/04/2003-2004).