MOVEMENT PATTERN CHANGES OF BASKETBALL JUMP SHOOTING IN RELATION TO DISTANCE BASED ON THE ANALYSIS OF TIME COURSES

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The purpose of this study was to identify changes in movement patterns of basketball jump shooting in relation to distance based on the analysis of time courses. One experienced female player practised jump shots from 4, 5, and 6 m distance which were filmed in the sagittal plane. Cinematic parameters of three successful shots from each distance were analysed by process oriented methods. The hierarchical duster analysis divided the movement patterns in two main branches representing the shots of middle (4 m) and long (5-6 m) distance. The factor analysis s-technique identified different time courses for the angular velocity of the hip, shoulder and the orientation of the upper arm. The results also indicate that process oriented methods represent a different quality of movement pattern analysis than methods based on time discrete variables.

KEY WORDS: basketball, jump shot, movement pattern, process oriented analysis.

INTRODUCTION: The purpose of this study was to identify changes in movement pattern in relation to the distance of the jump shot from the basket. Former studies (e.g. Elliott and White 1989, Miller and Bartlett, 1993,1996, Walters et al. 1990) already proved the influence of shooting distance on the release parameters (release height, release velocity and angle of release) and selected movement variables (e.g. angular displacements and velocities of bunk, shoulder and elbow at release). These analyses of movement technique based on time discrete variables reduce the movement process and the time courses of variables to statuses. It does not take into consideration that, due to the variety of mechanical degrees of freedom of the human movement system, it is possible to start from the same initial position and achieve identical final position with different partial movements. On the other hand, identical or similar time courses of the variables describing a movement may start from and finish in different positions. Therefore, the identification of differences conceming time discrete variables is not sufficient for the differentiation of movement patterns. In order to compare movement patterns Schöllhorn (1995) proposed a time continuous oriented approach based on orthogonal reference functions.
As the above mentioned literature about changes of shooting technique with increasing distance exclusively applies analysis methods based on time discrete variables, the aim of this case study was the application of process oriented methods in order to identifiy changes of movement patterns in basketball jump shooting due to increasing distance from the basket.

METHODS: The subject of the case study was a femal athlete playing in the German Premier National League (centre player, height: 1.88 m). By these characteristics she can be considered as a very good short and middle distance scorer. Jump shots from 4 m, 5 m, and 6 m distance from the basket were filmed in the sagittal plane from the throwing arm side (16mm film, Locam high speed camera operating at 100 f/s). The jump shots were preceeded by a 5 m approach dribbling at a velocity established by the athlete. For each throwing position three successful jump shots were digitized in order to determine the following 18 cinematic variables in the sagittal plane:

- angles and angular velocities of the knee, hip, shoulder and elbow of the throwing arm side;
- orientation angles and angular velocities of orientation of the thigh, trunk, upper arm, forearm and hand of the throwing arm side.

The displacement-time curves of the digitized landmarks were smoothed by a digital lowpass filter based on an algorithm of Winter (1974).

In order to analyse the movement patterns, the time courses of these variables were transformed to vectors and matrices respectively by the use of 4 orthogonal reference functions (Taylor polynomials) as decribed by Schöllhorn (1995).
The correlation of the time courses of the 18 variables with the 4 reference functions results in a (18 x 4) matrix representing the movement pattern of each analysed jump shot. Subsequently the correlation matrices were compared by an algorithm developed by Gebhardt (1967) which calculates a similarity coefficient for every pair of matrices. The resulting matrix of similarity coefficients was then structured by a hierarchical cluster analysis. In order to identify those variables which define the differences of the coordination pattern of the main branches of the dendrogram, the time courses of all variables and shots were analysed by the s-factor analysis. Different factors of the s-factor analysis represent different time courses of the analysed variable.

RESULTS: The movement patterns of all throws are separated into two main clusters (Fig.1), representing the 4 m shots in one main branch and the 5 m and 6 m shots in the other one. The similarity of the movement structure is greater between the 5 m and 6 m shots than between the 4 m and 5 m (6 m) shots.

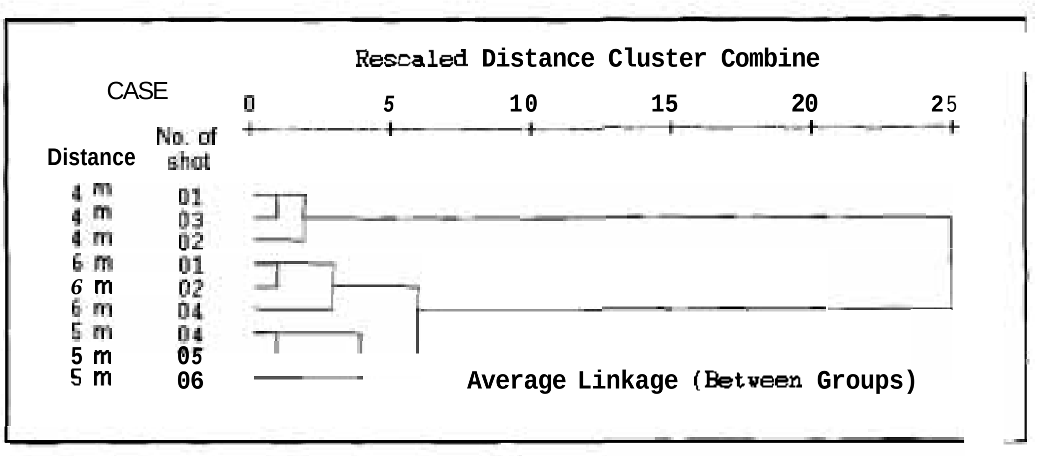

Figure 1 - Results of the cluster analysis

The results of the s-factor analyses show differences only between the two main clusters which concern the time courses of the angular velocity of the hip and shoulder and the orientation angle of the forearm. The identified 2-factor structure reveals that one factor represents the time course of the 4 m shots and the other factor those of the 5 m and 6 m shots. Different time courses between the shots from 5m and 6m distance could not be identified. The figures 2 to 4 show the time characteristics of those shots which have the highest loadings with the corresponding factor.
The time courses of the other variables are very similar and do not represent differences as shown in figure 5 for the time course of the angular velocity of the elbow.

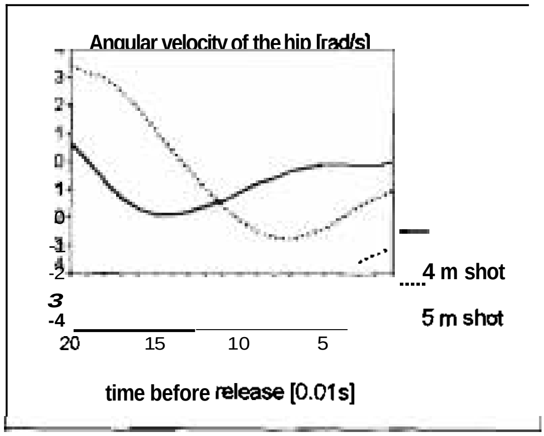

Fig. 2 Time course of the angular velocity of the hip

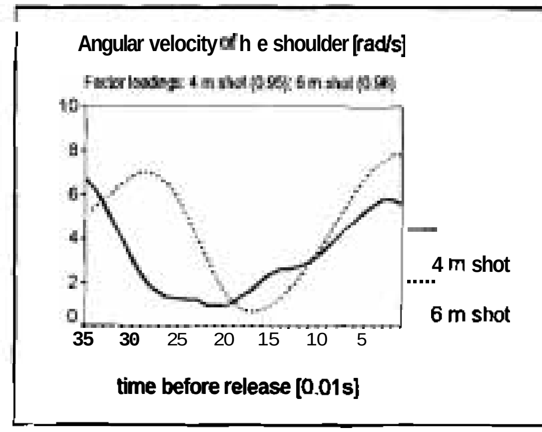

Fig. 3 Time course of the angular velocity of the shoulder

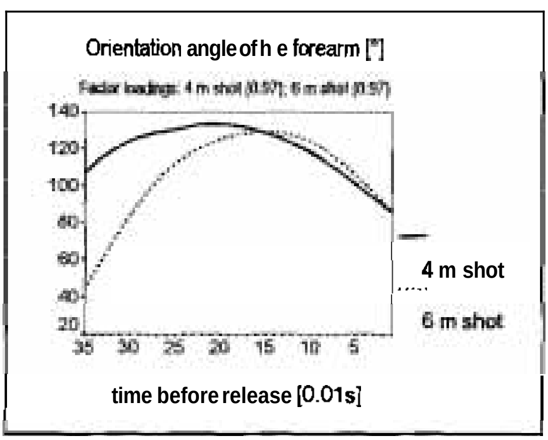

Fig. 4 Time course of the angle of the forearm

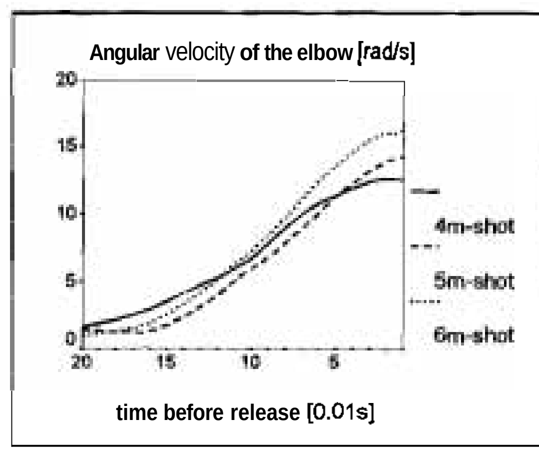

Fig.5 Time course of the angular velocity of the elbow

DISCUSSION: The results of this study indicate that it should be possible to identify different intra-individual movement patterns - represented by the time courses of their biomechanical variables - for jump shots with increasing distance from the basket. The number of movement patterns and the distance from the basket where they change might be interindividually different. In this specific case study the results of the s-technique factor analysis indicate two different movement patterns for jump shots from short/medium and long distance. For the subject that practiced in this study, the critical distance for the change of movement pattern seems to be between 4 m and 5 m. Differences between the movement patterns of 5 m and 6 m shots could not be identified.

It could also be proved that the degree of coincidence of variables at the time of release is not a sufficient parameter for the identification of different movement patterns as shown in fig.4. The orientation angle of the forearm at the time of release shows little differences comparing the shots from 4 m, 5 m and 6 m distance, but different time courses could be identified for the medium and long distance shots.

On the other hand, the increase of angular velocity of the elbow that was found in former studies as shooting distance increased, is in accordance with the results of this study (fig. 5) althoug a test of significance could not be performed (only three shots at each distance). However, the time courses do not show differences between the shots of medium and long distance. This means that there is a better coincidence concerning the angular velocity of the elbow than the orientation angle of the forearm for jump shots from different distances.

CONCLUSION: Although the results of this case study cannot be generalized, it seems that the identification of variables quantifying the change of movement pattern of a basketball jump shot with increasing distance depend on the point of view. This means if the movement pattern should be reduced to statuses represented by time discrete variables or if the movement pattern should be analyzed by the time courses of the variables. Miller and Bartlett (1996, 245) are talking about "the shooting process", but the methods they applied did not analyze the time courses of the biomechanical variables. As proved by the orientation angle of the forearm no differences of middle and long distance shots might be identified if only the angle at release is analyzed (fig. d) whereas the analysis of the time courses identify two different patterns for these shots. On the other hand the angular velocity of the elbow at release increases with increasing shooting distance whereas the time courses are the same for all distances.

For motor learning and optimisation of shooting technique it seems to be important if the alteration of discrete variables (e.g. at release) is or can be carried out with or without maintaining the original caracteristics of the time course of the variables. This might finally answer the question if an adequate analysis of movement pattern can disregard the time courses and be restricted to the analysis of time discrete variables.

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