KINEMATIC ANALYSIS OF BASKETBALL SHOOTING. PRELIMINARY RESULTS

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INTRODUCTION

The purpose of the present study is to analyse the effects of ball size on some mechanical parameters of shooting technique.

The majority of coaches identify shooting as the most important skill of basketball. It doesn't deny the importance of other skills - dribbling, passing or footwork - but only assumes that all offensive actions end in shooting. With this level of significance in the game, all fundaments in the teaching methodology of shooting should be assured by coaches. Usually it's based on permanent adjustment of theoretical sentences of performance and individual characteristics of the players. Shooting is the first technical content of basketball that youngsters want to learn. The youngster's feeling of success in the game results from the efficacy of shooting performance (Krausse, 1984). The quality of the shooting learning process is very important in the development of young players. Such a process must be conducted by coaches with care and knowledge. "It is reasonable to accept the theory that shooters are not born but made" (Newell and Benington, 1962). Development of basketball players needs talent but also technical qualities which is the reason why youngsters must know the basic principles of technique.

Several studies about basketball shooting are subjective or based on empirical observations. Whatever the analysis perspective or methods used, some authors have demonstrated that the contextual adaptations of basketball could affect youngsters performances in specific contents of the game (Skerlyk,1985; Satern et. al.1989; Chase et. al., 1994).

Some studies have examined the influences of basket-height and ball-size on shooting performance. The relationship between ball size/weight and basketball performance was studied by Skerlyk (1985) at the intercollegiate level players. Upper body strength (arm and wrist strength) and other subject's hand antropometric measures were related with five basketball skill tests. Significant relationships between shooting performance and wrist strength for heavy-balls were found. No considerations about kinematics view were done. Satern, Messier and Keller-MacNulty (1989) investigated the effects of ball size and basket height on the mechanics of the free throw. No significant differences were found for ball size on kinematics parameters, but the change of basket height affected some parameters of foul shooting performance of seventh-grade youngster.

METHODS

Eight fourteen-year-old right-handed basketball players were the subjects in this study. The subjects' mean height was 162.4 (+/-8,07) cm and mean weight was 50.82 (+/-6.39) kg. Two ball sizes were used: NBA Spalding Official as a regular size ball (613 gr weight, 76.5 cm perimeter) and Mikasa Official 1110 as a adapted-size-ball (608 gr weight, 74 cm perimeter). Two video cameras were utilized to recover the videographic material on frontal and lateral views of shooters. One was located at 6.75 m from the front of the shooter in the middle of the court and below the basket; another was located at 10 m from the right side of the shooter on free throw extension line.

Three free throws of each player were digitalized and analysed with biodimentional software named BIOSIST. A total of twenty four shots were digitalized and analysed in video system with 25 frames per second.

Based on Hudson (1985) and Satern et. al. (1989) six mechanical parameters were selected related to the shooter segment on ball release: shoulder angle, elbow angle, wrist angle, hand height, linear hand velocity and hand. The maximum elbow flexion which occurs during shooting was also determined. To provide additional information about stability and shooter arm work, some descriptive parameters were investigated: displacement of centre of gravity (cg), its relationship with support surface and angular behaviour of three parts of the shooter's arm (shoulder, elbow and wrist).

To define the beginning and the end of the shot kinematics parameters were used. The beginning of the shot is the precise instant where the initial flexion of knees is inititialized; the last frame where the fingers contact the ball is considered the end of the shot.

Pearson product-moment correlation were calculated to examine the relationship between hand height/standing height and angle hand/standing height. All kinematics parameters were compared by Anova One Way. The criterion level for all analysis performed was $p<0.05$.

RESULTS

Means, standard deviations and p values of each parameter analysed are shown:

Kinematics Param.	Adpat. Ball Size		Reg. Ball Size		F ratio	p
Rel. Ang. Shoulder	74.91	(+/-21.64)	74.96	(+/-22.45)	0.665	0.99
Rel. Ang. Elbow	80.05	(+/-11.40)	82.61	(+/-6.20)	0.311	0.58
Max. Elbow Flexion	53.10	(+/-11.45)	54.48	(+/-12.19)	0.054	0.81
Rel. Ang. Wrist	119.84	(+/-9.62)	115.79	(+/-15.36)	0.456	0.51
Height Hand Release	1.64	(+/-0.12)	1.59	(+/-0.16)	0.608	0.44
Linear Vel. Hand Rel.	4.40	(+/-0.57)	4.63	(+/-0.52)	0.716	0.41
Ang. Hand Release	65.65	(+/-4.01)	64.02	(+/-6.93)	0.329	0.57

The differences obtained between intersegmental angles can demonstrate a general tendency for the shooter to employ more force on regular-ball than on the adapted-size-ball. As indicated above, the same values for release angle shoulder on two ball sizes were obtained. Although the differences obtained in the release angle elbow, maximum flexion elbow and release angle of wrist, were relatively smaller it appears that the shooter must produce more work with the larger ball. It probably indicates that the adapted-size-ball could promote better conditions for youngsters who have low levels of upper body strength or technical difficulties in shooting performance.

Martinez (1983) and Satern (1989) found higher values for shoulder release angle than the results indicated on the abovementioned table. In a kinematics comparison of two feet positions on free throw shooting, Martinez (1983) found

values between 133-134 degrees for shoulder release angle; and 143-146 degrees for elbow release angle. Satern (1989) obtained 123.2-124.9 degrees for shoulder release angle. The differences between our results and Martinez' (1983) and Satern's (1989) studies could be in the performers technical quality or in the different methodological criteria used in each study. In the last contact, shooter hand and ball make an unique biomechanical system. Therefore the hand linear velocity, hand height and angle are nearly the same as that of the linear ball velocity, height and angle of release. Higher values of height (1.64; +/-0.12) and angle release (65.65;+/-4.01) were obtained with the adapted-size-ball. It seems that an increase of linear velocity on shooting performers is needed. In fact, the linear velocity found for regular-ball was slightly higher than for adapted-size-ball.
Significant correlation were obtained between hand height on ball release and standing height ($r=0.85; p<0.05$ for adapted and regular size ball). This confirms the natural tendency for an increase of the vertical point of ball release as an increase of the standing height of the shooter. No significant relationship was found when hand angle on release and standing height were tested ($r=0.35$, $p<0.05$ for adapted ball size; $r=0.54$, $p<0.05$ for size).
As shown in the abovementioned table, significant differences were found between two ball sizes among all seven kinematics parameters.
Figures 1 and 2 show the displacement of cg respectively on horizontal and vertical plans. The displacement of cg demonstrated by illustrations are a function of the initial position on the absolute referential.

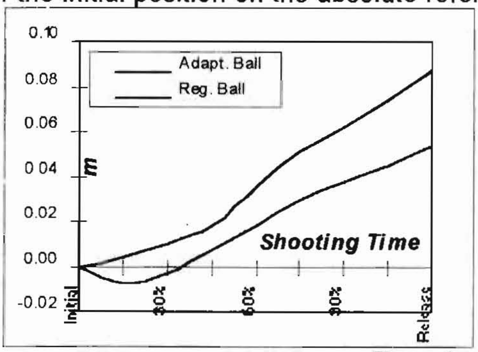


Figure 1.

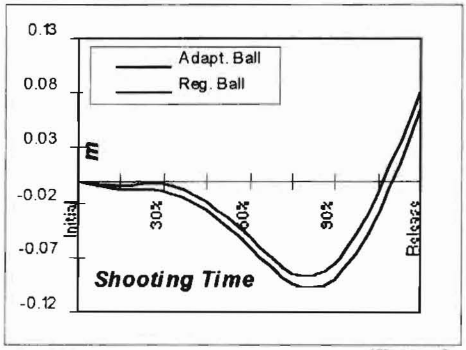
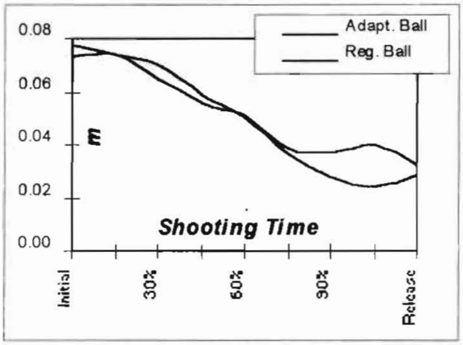


Figure 2.

On the horizontal plan, the path of cg has an ascendant inclination which is more accentuated with the regular-ball than with the adapted-ball-size. This suggests that, when youngsters perform with a larger and weightier ball, the horizontal path of cg is higher than when performed with adapted-ball-size.
The pattern of vertical displacement of cg is generally the same. This suggests that the displacement of cg. with two ball sizes tended to be similar, whereas the values of adapted ball size were always higher. The difference between the initial instant of shooting and ball release instant is 0.16 (+/-12) m with smaller ball and only 0.07 (+/-0.03)m with regular-ball. The behaviour of vertical projection of cg. on support surface is a kinematics parameter of stability of the shooter. Figure 3 illustrates the distance variation between the vertical projection of cg. and the middle anterior point of support surface during the shot.



It appears that before ball release (70% after the beginning of the shot) the differences between two ball sizes were increased. Shooting with regular ball size presented an irregular line as demonstrated in figure 3.

The descriptive behaviour of linear velocity of cg. and intersegmental angles of the shooting arm were similar when compared with two ball sizes.

Figure 3.

CONCLUSIONS

In absolute terms, results obtained for kinematics parameters were different from other previous studies like those of Martinez (1983) and Satern (1989). Different technical quality of subjects and different methods utilized might be possible reasons for this fact. Statistical views for shooting performance with two ball sizes selected were similar to those of previous researches (Skerlik, 1985; Satern, 1989). No statistical differences were found for those two ball sizes in performance shooting. Smaller differences were obtained on kinematics parameters; the descriptive analysis of cg's displacement suggests attendance for a higher horizontal path when shooting with regular-ball. Despite the small differences in the quantitative results, this probably indicates that young players are less efficient on energy transfer with regular-ball than with adapted-size-ball. This leads up to the hypothesis that the adaptation of ball size to particular characteristics of each age scale will create better conditions for young players to learn the correct principles of the shooting technique. Future studies should also gather the relationships with kinematical analysis and shooting accuracy. Technical quality of subjects should be improved and similar methods must be used to have a large data base for confrontation.

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