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Influence of Pre-Shooting Activity on Three-Points Jump Shot Parameters Between Junior and Senior Regional Level Basketball Players

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Abstract

The aims of this study were: 1. to investigate the influence of pre-shooting activity on the three-point jump shot entry angle and release time in regional level basketball players; 2. to examine age related differences in these parameters between juniors and seniors. Thirty three perimeter players , were assigned to juniors (n=16, age=17.34±0.54 years; height=191.3±8.18 cm; weight= 77.08±7.41 training experience=6.75±2.30 years) and seniors (n=17, age=22.79±4.47 years; height =194.4±7.47 cm; weight= 80.42±7.45d; training experience=12.18±3.17 years) had three sets of 5 shots, with a different preparatory phase for every set: 1. spot shot, 2. after two forward steps, or 3. after one dribble. Only successful shots (n= 233) were analyzed. The difference between groups was determined with ANOVA, while the differences in shot accuracy were determined by the chi-square test. Study results reported no statistically significant differences in entry angle and release time for 3 different pre-shooting patterns. Seniors had significantly higher shooting accuracy (X2=3.097; p=0.048, φ=-0.089) higher entry angle ($p < 0.001$) and lower release time ($p < 0.001$) than juniors for all successful shots combined, and significantly higher ($p < 0.001$) entry angle for every set independently. Significant difference in shooting accuracy with medium effect size (X2= 6.645; p=0.010, φ=-0.20) was observed in shots after movement. Seniors had statistically lower release time for set 1 (p=0.004) and 2 (p=0.002) independently. Age-related group differences in shooting parameters should be considered to optimize training prescription for basketball players.

Keywords: *entry angle; shot release time; basketball shot; shooting accuracy; 94Fifty®*

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Introduction

To succeed in elite basketball, it is required of players to possess an optimal level of a variety of performance factors, with physical fitness, physiological and psychological aspects repeatedly addressed in literature (Ziv & Lidor, 2009). Basketball players are required to also have a technical-tactical skill-set (Trninić & Dizdar, 2000) adequate to the competitive level. Among these, shooting has been found to be crucial for players' success, with field goal percentage extensively proclaimed as the crucial game-related statistic that discriminate between winning and losing (Okazaki et al., 2015). Mandic et al. (2019) have revealed the jump shot as being the most efficient and frequently used shooting technique by players. Hence, exploring the jump shot is important to improve our understanding about the key factors considered essential for the shooting accuracy and consequently to enhance both players and team's basketball performance.

The jump-shooting motion is the most complex basketball technique (Okazaki et al., 2015). It has been theorized that the ball should leave the hand within 0.65s with optimal velocity and angle of entry into the basket following the moment the ball was received, at or close to the end of ascending phase of vertical jump (Dobovičnik et al., 2015). A basketball shot released with an angle entry close to 50 seems superior as it enables a large enough area for the ball and the smallest possible release time (Brancazio, 1981; Miller & Bartlett, 1993; Okazaki & Rodacki, 2012). The angle at which ball leaves the shooter's hand is directly related to the angle at which the ball passes through the hoop (Miller & Bartlett, 1993), and the release angle of 55-60° leads to an entry angle of 45-50 degrees (Brancazio, 1981). The ball entry-angle has been recognized as the leading determinant of shooting accuracy (Miller & Bartlett, 1993; Okazaki & Rodacki, 2012), found also to be distance-dependent (Brancazio, 1985).

Studies elaborating on shooting kinematics are scarce in basketball, examining the shooting accuracy (Oudejans et al., 2012; Slawinski et al., 2018), biomechanical and proprioception parameters of shooting performance (Miller & Bartlett, 1993), and even nutritional interventions and their influence on shooting achievements (Baker et al., 2007). Most of them used complex kinematic analysis with 3-D motion capture systems analyzing well known biomechanical parameters such as release height, center of mass displacement, joint angles etc. (Okazaki et al., 2015). However, new trends in basketball practice show an increasing interest in innovative technologies which enable quick interpretation of dominantly ball trajectory kinematics such as ball release time, release angle or entry angle (Marty & Lucey, 2017). At least 2500 middle and high USA schools' athletes regularly train with this innovative technology (Noah Basketball Shooting System), clearly indicating its potential for everyday practice (Marty & Lucey, 2017).

Only a few studies reported the players' jump-shot release time, with a total time of 0.62 s reported in a 2 players sample-size study (Fontanella, 2006). Dobovičnik et al. (2015) registered durations of 0.76, s for guards with a sample of 7 youth Serbian basketball teams plus Serbian U20 national team, while Stojanović et al. (2019) showed no differences in terms of release time and entry angle between centers and other playing positions in elite male Serbian basketball players. However, to the best of our knowledge differences in shooting parameters in various age groups have not been reported yet. More studies seems prudent. to develop age-specific guidelines for basketball practice. Furthermore, inferring differences in aforementioned parameters between groups might have practical application with research-derived coaching cues (release the ball faster/slower, increase/decrease release angle) likely inducing specific shooting technique- corrections and adopting more optimal shooting pattern in basketball players.

Shooting varies as a function of time, competitive standard, and playing experience (Erčulj & Štrumbelj, 2015). A greater speed of the ball at release and greater accuracy have been reported in experienced field hockey and soccer players compared with recreational players (Anderson & Sidaway, 1994; Kerr & Ness, 2006). Information's are lacking in basketball, with only one study reporting greater consistency in the kinematic patterns of free throw for experienced vs. unexperienced players (Button et al., 2003). Three point -jump shot have become prevalent in modern basketball, (Mandić et al., 2019), with over 50% shots unopposed and shooting accuracy during final stages of the game showed to be a major determinant of success (Ardigò et al., 2018). Moreover, pre-shooting movement pattern has been shown to influence shooting kinematics (Okazaki et al., 2015), indicating that elaborating kinematic parameters of jump-shooting with various preparatory movements has practical merit due to high ecologic validity.

The first aim of the present study was to evaluate influence of pre-shooting activity on three-points jump shot parameters in junior and senior regional-level basketball players. The second aim was to examine differences in three-point jump shooting-parameters (entry angle and release time) between junior and senior regional level basketball players. We assumed that there would be statistically significant differences in jump shot-parameters between three distinct pre-shooting patterns and that senior players would demonstrate superior shooting-parameters values in all jump-shooting variants.

Methods

Participants

Thirty-three perimeter male basketball players (n=33; age=20.15±4.21 years; height=192.91±7.86; training experience=9.55±3.88 years), members of the teams participating to the highest national League (Serbia First League) were recruited for this study and divided in two groups. The first group (juniors) consisted of 16 players, (n=16, age=17.34±0.54 years; height=191.3±8.18 cm; weight= 77.08±7.41 training experience=6.75±2.30 years), competing in the Serbian Quality Junior league. The second group (seniors) consisted of 17 senior players (n=17, age=22.79±4.47 years; height =194.4±7.47 cm; weight= 80.42±7.45d; training experience=12.18±3.17 years). The inclusion of solely perimeter players was deliberate because of their three-point shooting proficiency (Sindik & Jukiç, 2011). The participants trained 7.5 hours per week (5* 1.5 hours), with an additional basketball game every weekend.

The participants were with more than 4 years of training experience, injury free for 6 months and at least 10 games played for 15+ minutes during the season. They were asked to abstain from heavy training, alcohol, tobacco and caffeine use and to avoid sleep deprivation for at least 2 days before the testing sessions. All players were familiar with the purpose of the research and accepted to participate in the study after signing a consent form. The protocol was reviewed and approved by the ethics committee of University of Novi Sad, Serbia. (Ref. No. 44-01-02/2019-3)

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Procedures

The 94Fifty smart sensor basketball (InfoMotion Sports Technologies, Inc.) was used to measure the shooting-parameters. This ball contains 9 accelerometers that measure force, speed, ball rotation and ball arc. The parameters collected in this study were the entry angle and release time (angle at which the ball enters into the basket, and time from the moment the shooters catches the ball to the moment ball leaving shooter's hands). Abdelrasoul et al. (2015) and Rupčić et al. (2016) confirmed high reliability of measurements using a 94Fifty ball, comparing it to Dartfish and Kinovea software, respectively.

A standardized warm up (5 min jogging and 5 minutes of basketball specific dynamic warm up) with an addition of five trial three-point jump shots was carried out before each data collection. After a 2-3 minutes rest a test protocol consisting of 3 series of 5 three-point jump-shots, with a 3-minute of rest period between each series, was submitted. Three sets of shooting differentiate considering the jump-shot preparation phase. In the first set players received the ball in spot, without moving, and shot immediately. In the second set players performed two steps toward the three-point line, receive the ball and deliver a shot. In the last set, players received the ball around 1.5 m from the three-point line, and shot after one dribble towards the basket. For all shots, the ball was received in triple-threat position with an immediate proceeding with predetermined task, as fast as possible game-like shot or dribble. In total out of 495 recorded shots, an amount of 233 successful shots were obtained for release time and entry angle and were used for further analysis. Accuracy was entered by the tester into the table, along with the entry angle and the release time.

Statistical Analysis

Data was presented as mean and standard deviation. Kolmogorov-Smirnov test showed normal distribution for the entry angle (p=0.052) and release time (p=0.075). Levene's test for the assessment of homoscedasticity was applied. The one-way ANOVA was used to analyze the difference between groups. Partial eta-squared (η2p) was used as a measure of effect size, and values were interpreted as no effect (η2p < 0.04), minimum effect (0.04 < η2p < 0.25), moderate effect (0.25 < η2p < 0.64), and strong effect (η2p > 0.64). The significance of the difference in shooting accuracy between groups was analyzed by using 2 × 2 contingency chi-squared analysis. Magnitude of these differences was evaluated with Cramer's phi (φ) according to the following criteria: φ < 0.3 was considered as a small, φ = 0.3–0.5 as a medium, and φ > 0.5 as a large effect.

The significance for all statistical tests was set as $p < 0.05$. All statistical analyses were performed using the SPSS (Version 20 for Windows; IBM, Armonk, NY, USA).

Results

When comparing the influence of the pre-shooting activity for all successful shots, juniors and seniors combined, there were no statistically significant differences in entry angle and release time (Table 1). In addition, there was no difference in shooting accuracy between three distinct sets of three-point jump shots (45.5% vs 49.1% vs 46.7%; spot shots vs shots after movement vs shots after dribble, respectively; X2= 0.454; p=0.797).

Table 1. Differences related to pre-shooting activity for all successful shots

	Entry Angle			Release Time		
	Spot shot	Shot after movement	Shot after dribble	Spot shot	Shot after movement	Shot after dribble
N	75	81	77	75	81	77
Mean	45.25	45.89	45.92	0.90	0.90	0.87
SD	3.91	3.55	3.46	0.14	0.09	0.17
Min	38	39	40	0.65	0.67	0.60
Max	55	53	54	1.30	1.20	1.34
Sig. Between Groups		0.443			0.187	

N—number of successful shots; Mean—arithmetic mean; SD—standard deviation; Min—Minimum; Max—Maximum; Sig.—statistical significance of the differences

For the spot shots, significant differences with minimum effect size were observed for both release time ($p < 0.001$; η2p = 0.110) and entry angle ($p = 0.000$; η2p = 0.221) (Table 2). In addition, no significant difference (X2 = 0.040; p=0.842) in shooting accuracy was observed (46.3% vs 44.7%, juniors vs seniors, respectively).

Table 2. Differences between juniors and seniors in kinematic parameters according to pre-shooting activity

		Category						
		Juniors			Seniors			
		N	Mean	SD	N	Mean	SD	Sig.
Spot shots	Entry angle	37	43.41	2.64	38	47.05	4.17	0.001
	Release time	37	0.95	0.13	38	0.86	0.12	0.004
Shots after movement	Entry angle	31	43.97	2.74	50	47.08	3.49	0.001
	Release time	31	0.94	0.81	50	0.88	0.94	0.002
Shots after dribble	Entry angle	34	44.06	2.32	43	47.40	3.52	0.001
	Release time	34	0.91	0.19	43	0.84	0.17	0.55

N—number of successful shots; Mean—arithmetic mean; SD—standard deviation; Sig.—statistical significance of the differences

For the three point jump-shots after movement (Table 2), seniors showed significantly higher entry angle ($p < 0.001$; $\eta 2p = 0.184$; 47.08°±3.49 vs 43.97°±2.74), and faster release time ($p=0.002$; $\eta 2p = 0.117$; 0.88±0.94s vs 0.94±0.81s, respectively), with minimum effect sizes. Significant difference in shooting accuracy (38.8% vs 58.8%, juniors vs seniors, respectively), with medium effect size ($X2= 6.645$; $p=0.010$, $\varphi =-0.20$) was also observed.

Seniors showed significantly higher results compared to juniors for entry angle ($p < 0.001$; $\eta 2p = 0.233$; 47.40°±3.52 vs 44.06°±2.32, respectively) (Table 2), but not for release time ($p =0,055$) in three-point jump-shots after dribble. There was no difference ($X2 = 1.083$; $p=0.298$) in shooting accuracy (42.5% vs 50.6%, junior vs seniors, respectively).

When comparing the influence of the pre-shooting activity for all successful shots, juniors and seniors combined, there were no statistically significant differences in entry angle and release time (Table 3). There was no difference in shooting accuracy between three distinct sets of three-point jump shots (45.5% vs 49.1% vs 46.7%; spot shots vs shots after movement vs shots after dribble, respectively; $X2= 0.454$; $p=0.797$).

Significant differences with minimum effect for release time ($p < 0.001$; $\eta 2p = 0.212$) and entry angle ($p < 0.001$; $\eta 2p = 0.212$) for all successful shots were registered (Table 3). Juniors had a significantly lower shooting accuracy, (42.5% vs 51.4%) with small effects size ($X2=3.097$; $p=0.048$, $\varphi =-0.089$) .

Table 3. Differences between juniors and seniors for entry angle and release time for all successful shots.

	Category						
	Juniors			Seniors			
	N	Mean	SD	N	Mean	SD	Sig.
Entry angle	102	43.79	2.56	131	47.18	3.67	0.001
Release time	102	0.93	0.14	131	0.86	0.13	0.001

N—number of successful shots; Mean—arithmetic mean; SD—standard deviation; Sig.—statistical significance of the differences

Discussion

This study aimed to: 1. investigate potential influence of pre-shooting activity on the three-point jump shot entry angle and release time in junior and senior regional level basketball players; and 2. examine age related differences in three-point jump shooting-parameters (entry angle and release time) . The first finding of this research showed that there was no influence of pre-shooting activity on the observed three-point jump shot parameters nor shooting accuracy. The second finding showed a statistically significant difference in favor of seniors for both jump shooting parameters with entry angle and release time closer to optimal values of 50° and 0.7s (Rupčić et al., 2016), and shooting accuracy for all three jump-shot protocols combined. Moreover, seniors were found to have significantly higher entry angle for each jump-shot protocol separately, as well as faster release time for two out of three jump-shot protocols (jump-shot after receiving ball in spot and jump-shot after two steps towards the ball). Finally, seniors proved to have significantly better shooting accuracy of jump shots after movement.

The stability of the three-point jump-shot parameters irrespective of pre-shooting activity we found is contrary to some previous findings (Mack, 2001; Oudejans et al., 2012). It is reasonable to assume that extensive training enforces stable shooting technique with similar shooting mechanics irrespective of pre-shooting movement strategy. Slawinsky et al. (2018) reported no changes in the three point jump-shot kinematics ($p > 0.05$), or the ball release variables ($p > 0.05$) following fatiguing protocol in young basketball players (age: 16.3±1.2 years), supporting our reasoning for the obtained results. It has been previously reported that players with less accurate shooting technique release a ball with lower entry angle compared to proficient players (Okazaki & Rodacki, 2018). Hence, we can speculate that senior players are more proficient in shooting biomechanics due to training history (12.18 vs 6.75years), as previously suggested (Okazaki & Rodacki, 2018). In addition, it is reasonable to assume that the senior players are physically superior to the junior ones, with fitness attributes proved to be related to enhanced shooting performance, especially with increasing shot-distance (Justin et al., 2006). A clear positive relationship between several fitness attributes and basketball-specific shooting accuracy was recently presented (Pojskic et al.,2011; Pojskic et al., 2018). Our results are in line with some previous studies done on similar populations (Okazaki et al., 2015; Okazaki & Rodacki, 2012; Stojanović et al., 2019). It has been presented that elite Serbian basketball players performed jump-shot entry angles of 40.54±4.76°, similar to our study findings for young players but lower in comparison to seniors and shot release times of 1.10±0.23s which is substantially different than we found. A 0.62s average jump shot release time was reported by Fontanella (2006), with little slower release time of 0.76, s for guards, reported in young Serbian basketball players (Dobovičnik et al., 2015). Also, the lower entry angle of the subjects in the mentioned study indicates lower release angle during shot, which affects both the release time and accuracy. Both these studies reported faster jump-shot release times compared to those obtained in our study.

Such discrepancy could be attributed to the superior shooting technique of study participants. It has been shown that top level players tend to both substantially decrease preparatory phase for the shot and prolong shooting hand-ball contact time (Podmenik et al., 2017). This enables them to fine tune shooting mechanics using visual and proprioceptive feedback and increase likelihood of scoring, while still producing shorter release time as net effect (Podmenik et al., 2017). Also, the jump-shot release time is proved to be strength-dependent (Pojskic et al., 2018). Altogether, in our study the senior players released the ball faster than juniors. In addition, seniors had significantly higher entry angle for every set of shots independently, along with significantly lower release time reported when they were shooting immediately after receiving the ball in spot and after two steps toward the ball. These somewhat surprising findings could also be attributed to differences in training experience between seniors and juniors. Miller and Bartlett (1996) argued that guards, compared to centers, demonstrated less variable shooting mechanics for greater distance as a consequence of experience.

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Spot shot accuracy was similar (46.3% vs 44.7%, juniors vs seniors, respectively), but juniors shot slower and at a lower entry angle. It is reasonable to assume that experienced players were able to master the technique and execute movement patterns more efficiently and faster, especially the preparatory phase of the shot, which represents a 60% of the total shot time (Pojskic et al., 2011). Consequently, these players will receive the ball in a better body position and with an impulse that will finally produce faster jump-shots and reduced release time. The difference found in spot jump-shot is generally in line with the aforementioned explanation. The specific way of stopping after two steps requires players to lower the body before he catches the ball, which affects the time of the shot, but also significantly affects the accuracy of the shot (38.8% vs 58.8%, juniors vs seniors, respectively). It seems beneficial for young players to adopt the correct preparation for receiving the ball so they can continue in the jump-shot immediately after receiving the ball.

During the three-point shot after a dribble, the players were asked to make a longer step forward when dribbling. We can speculate that junior players mastered the jump-shot after dribbling with a high level of proficiency, which enabled them to be as good as seniors in release time. On the other hand, juniors lower body strength deficits could lead to specific jump-shot mechanics, with ball release in ascending phase of jump shot in order to optimize ball propulsion (Brancazio, 1981). This specific way of shooting produces higher entry angles as well as faster release times, but it may affect the accuracy of shooting (42.5% vs 50.6%, junior vs seniors, respectively).

A limitation of this study was the recruitment of a small sample size. Moreover, the study design did not consider other shooting parameter-determinants that could affect the performance (lower and upper body strength, vertical jump etc.), nor other important shooting-kinematics parameters (release height, joint angles etc.). Finally, only unopposed three-point jump shots were considered.

The present results show a significant difference in three-point jump shot shooting kinematics between junior and senior regional level basketball players, with superior entry angles and faster release times for seniors. There was no influence of pre-shooting activity on the release time and entry angle. Finally, seniors were proved to have significantly better shooting accuracy for all shots and jump shots after movement. These findings highlight that both three-point jump shot kinematic parameters differentiate between junior and senior players and provide comparative data for Serbian senior and junior basketball players. It seems that juniors could be advised to adopt shooting technique which enables increased entry angle and shorter release time in order to increase shooting accuracy.

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Disclosure statement

The authors declare that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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