SIQ BASKETBALL AS A TOOL FOR KINEMATIC ANALYSIS OF BASKETBALL FREE THROW SHOOTING

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Abstract:
Modern technology in the field of sports is improving every day. Coaches are using new tools trying to improve the efficiency of their players physical and motor abilities, skill acquisition and recovery. The area of skill acquisition is very interesting considering that actual technique is fundamental of success in any sport. When it comes to basketball, shooting is the most important skill, and free throw shooting can sometimes be vital to success of a team. This paper aims to present the research that analyzed release angle and spin rate of sixteen U16 basketball players playing in the top basketball division in Serbia. Participants were divided into two groups based on their in-game efficiency. They shot free throws (5x10, 10x2) with the SIQ Basketball which has Bluetooth sensors in it, connected to the app on a mobile device. The ball measured the player's kinematic parameters and showed immediate data. This data was then compared between groups. The stats were obtained from the official league website. Results showed that release angle can be used as a statistically significant predictor of free throw efficiency, unlike spin rate, which cannot. This paper shows that there is a great opportunity for the use of SIQ Basketball at official competitions to track data and give coaches valuable information on players shooting tendencies.

Keywords:
Release angle, Spin rate, Skill acquisition, Diagnostics, Shot testing.

INTRODUCTION

Sports is a growing industry, and opportunity for the use of modern technologies that will help players and coaches in improving the process of training is one of the most popular branches in both sports and electronic development. Informational technologies (IT) are included in all aspects of sports, especially for coaches and players, but also for the officials and spectators [1]. These tools could possibly help with faster skill acquisition [2], monitoring training load and minimizing injury risk [3, 4], and testing, diagnostics and analysis of objective parameters related to sports performance [5, 6].

Basketball is a very dynamic sport that relies on explosiveness, agility, strength, but also technical skill. No doubt, the most important of them is shooting. Free throw shooting is one the crucial factors when it comes to success of a basketball team.

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Besides, most of the shooting analysis is performed on this shot type because it is the only shot during game that is performed under same conditions [7, 8, 9]. A team makes around 15 to 20 points from the free throw line on average [10], which means that a large portion of teams points are directly connected to the result of effective shooting. The free throw, although it looks easy, is a complex shot with different physical [11], technical [12] and psychological [13] challenges. With that being said, it is, perhaps more than the other types of shots, reliant on good technique. Also, there are different interfering parameters that can still affect the shooting performance like the importance of the shot, by taking free throws at key moments during game [13].

The most common way to analyse technique is the biomechanical shot analysis [14]. This is where different kinematic parameters are measured to determine if a player has efficient technique based on the values presented in some theoretical models [15]. Previous research showed that different form of technologies was used to analyse free throw shooting technique such as cameras [16], motion-tracking sensors [17] and an augmented-reality (AR) based systems [18]. Based on the author's knowledge, few studies have examined the relationship between the kinematic parameters during tests and the actual effectiveness of players in basketball games.

One of the new products that can show reliable data are basket balls which have sensors installed that can show precise data like release angle and spin rate during shooting [19]. One of these basketballs is SIQ Basketball [20]. It is a smart ball with Wi-Fi and Bluetooth sensors that can be connected a device via an application. When a player shoots the ball, the app shows the values of the shooters kinematic variables (release angle and spin rate).

When it comes to kinematic analysis, there were not many studies that used smart basketballs to measure the already mentioned parameters (release angle and spin rate). Smart basketballs, such as the SIQ Basketball could be a valuable tool for measuring the kinematic parameters of basketball free throw shooting in a convenient, quick and efficient way. Because of that, use of SIQ Basketball could possibly make gathering data from training and games much easier and more practical than other tools.

Therefore, the aim of this research was to use the SIQ Basketball to measure release angle and spin rate of basketball free throw shooting and to try and to determine if there is a difference between more efficient and less efficient shooters. Based on previous research, the first hypotheses states that more successful shooters would have release angles that are closer to those presented in theoretical models (H1). The second hypotheses concern the spin rate. Considering the lack of research on this topic, it is not expected that there would be a statistically significant difference in spin rate between the groups.

2. METHODS

Sixteen U16 basketball players that play in the highest level youth league (*srp.* Triglav KLS – Triglav kadetska liga Srbije) were participants in this study. The participants were divided into two groups based on their free throw shooting efficiency in basketball games with the cut-off being 70% (<70% = 7; >70% = 9). Sample characteristics are presented in Table 1.

All stats and data were gathered from the official league site for all participants. Testing was performed after the end of the basketball season and all the participants were healthy and capable at the time of the experiment. The protocol consisted of each participant shooting a set number of free throws (5x10 and 10x2) with a 10 free throw shots as a warm-up before the testing started. Each participant shot a total of 70 free throws, for a total sample of 1120 shots. The data on release angle and spin rate were collected using the SIQ Basketball ball and app connected via Bluetooth. Total shots, makes, misses, swishes, release angle and spin rate were recorded for each shot and each participant.

Statistical analysis included descriptive statistics showing the measures of central tendency (mean) and measures of dispersion (SD and cv%) and t-test for independent samples in order to define the differences between the groups. The level of statistical significance was set at 95% ($p < 0.05$). Data was entered using Microsoft Excel (Microsoft Corporation 2016, USA). All data was analysed using IBM SPSS statistical software (Statistic Package for Social Sciences – IBM SPSS software (Armonk, NY, United States: IBMCorp).

Table 1. Sample characteristics.

Variable	Mean	SD	Minimum	Maximum	Range
Body height	62	108	46	83	11.36
(cm)	196.4	9.5	180	211	31
Free-throw	20	31	11	25	3.09
(%)	67.3	11.7	45	89	44
Free-throw attempts (per game)	3.5	3.4	1.3	15.5	14.2

Table 2. Descriptive statistics.

Group	Variable	Efficiency	N	Mean	SD	cV%
Total Sample	Release angle [°]	Miss	273	46.05	3.85	8.35
		Make	847	48.51	3.28	6.75
		Total	1120	47.91	3.58	7.47
	Spin rate [Hz]	Miss	273	1.90	0.50	26.39
		Make	847	1.95	1.09	56.06
		Total	1120	1.94	0.98	50.69
>70%	Release angle [°]	Miss	119	47.55	3.33	7.00
		Make	371	49.38	2.89	5.84
	Spin rate [Hz]	Miss	119	1.87	0.36	19.46
		Make	371	1.93	1.00	51.61
<70%	Release angle [°]	Miss	154	44.90	3.83	8.54
		Make	476	47.82	3.40	7.11
	Spin rate [Hz]	Miss	154	1.92	0.59	30.47
		Make	476	1.96	1.16	59.25

Table 3. Independent Samples T-test.

Group	Variable	t	p	Mean Difference	Standard Error of Measurement
>70%	Release angle [°]	-8.977	0.000*	-2.921	0.325
	Spin rate [Hz]	-0.386	0.700	-0.0376	0.0974
<70%	Release angle [°]	-5.813	0.000*	-1.837	0.316
	Spin rate [Hz]	-0.669	0.504	-0.0624	0.0933

3. RESULTS

Results of descriptive statistics are shown in Table 2. As seen from the table spin rate cannot be used as a statistically valid factor when trying to measure free throw shooting efficiency (cV% = 19.46 - 59.25), while release angle can be used as a valid factor when looking at coefficient of variation (cV% = <10%). Both groups shot over 70% during the experiment (<70% = 75.5%; >70% = 75.7%) which shows the importance of specific game-like conditions.

T-test for independent samples can be seen in Table 3. There were statistically significant differences for both groups when it comes to release angle ($p < 0.05$). No differences were found regarding the spin rate.

4. DISCUSSION

The aim of this study was to compare more successful and less successful free throw shooters kinematic parameters (release angle and spin rate) and to see if they affect in-game percentages. It was hypothesized that more successful free throw shooters would have release angle values that are closer to those presented in previous theoretical models [14, 15, 21], while there would be no differences between the groups regarding spin rate. From the given results it can be observed that release angle can be used as a valid factor when it comes to predicting free throw efficiency of players in games. Spin rate was not a statistically significant factor, indicating that different shooting technique can be used (e.g. shooting with big spin rate, or without spin) in order to score.

The release angle values presented in this research are different than the values presented in previous studies [14, 15, 21] that all have higher release angles as optimal. One of the possible reasons is that participants were sixteen years old, so their shooting technique is not yet fully established. It would be interesting to observe the same players over a longer period of time to see if any changes in their technique with more years of training would result in different release angle values. Also, even though the SIQ Basketball is a regulation ball, this was the first time the participants used it. It could be the case that the learning effect altered the shooting technique. Using the SIQ Basketball as a part of the training process could result in changes to overall release angle data. Also when the percentages during testing were observed it can be seen that both groups didn't shoot a very high percentage from the free throw line (<70% = 75.5%: >70% = 75.7%). Even though the participants included elite level Serbian U16 basketball players, it is perhaps the case that these were not necessarily the best free throw shooters in the league. It could be the case that the values would be closer to those presented in before mentioned theoretical models and studies had the participants been selected based on the criteria of highest free throw shooting percentage. It is assumed that there haven't been many studies that examined spin rate, so more research is needed in order to have better understanding when it comes to this topic.

SIQ Basketball as a tool could be a valuable asset to coaches in helping with player's skill acquisition and correction. The advantages of this basketball as a tool compared to previously used technologies [8, 9, 10] is that it is much simpler to use and offers quicker gathering, analysis and interpretation of results. Also, when used for testing purposes, more players can be tested at one time and there is no need for a complex set up which is a disadvantage of previous models. Perhaps the most important advantage of SIQ Basketball, since it is a regulation ball, is that there is space for its use in official basketball games so that data can be gathered in real time conditions. KINEXON Sports already has handball that is used in European Handball Championships and in the German Bundesliga. It also has sensors and one of its main features is that it is able to track player's stats, data and parameters in real time, offering coaches and others specialists in the field of sports and exercise science the opportunity to analyze the most specific type of data which is regarding how players are performing in actual games. The SIQ Basketball could possibly be used in a similar manner, which can give coaches a chance to have immediate data regarding players shooting performance which could help them further with internal and external load and fatigue management, planning and programming of training variables and skill acquisition and correction.

When it comes to this research, the results regarding the given variables have to be put into context. Participants were in a controlled environment without any internal or external distractions. Also they were well rested, since the testing protocol was performed before basketball practice. Further research on this topic should include the same procedure in different controlled environment that is more game-like (shooting under pressure, including different psychological distractors, or different training load) or in actual games with external distractions such as opposition, crowd, referees etc. Also the participants were youth basketball players, indicating that there is an opportunity to perform similar research with participants from different age groups in order to better understand the differences.

5. CONCLUSION

The results from this research indicate that release angle is a significant factor when discussing and measuring free throw shooting efficiency and that SIQ Basketball, as a tool, can accurately measure it. The SIQ basketball can be a nice addition to coaches and other sports and exercise science specialists and experts when working with players, because of its simplicity, specificity and diversity. There is potential for future research using this tool when it comes to kinematics of basketball shooting.

Furthermore, opportunity for adding this ball, or sensors to official basketballs that are used in actual games should be explored in order to give reliable, real-time information about players shooting technique and tendencies, primarily to coaches, but also to players and others working in this field.

There is more opportunity for further research to examine the kinematic parameters in the context of game-specific situations (crowd, distractions, fatigue etc.). Also this research was done on participants which were 16 years old, indicating that there is an opportunity for further research to investigate the kinematic analysis of free throw shooting for players of different age groups. One more limitation of this research is that it was done on elite level basketball players in Serbia. These participants, even though they are young, have a lot of years in the training process and have been working with coaches from a very young age.

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