SPORT - Science & Practice, Vol. 11, №2, 2021, pp. 77-81.

Original scientific paper

SHOOTING VELOCITY DIFFERENCES BETWEEN SHOOTING POSITIONS IN TOP LEVEL HANDBALL[1] [2]

UDC: 796.322.012.574
DOI: 10.5937/snp2102077F

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Abstract: Shooting velocity is one of the most important features that influence successful shooting performance in handball. Therefore, the aim of this study was to determine differences in shooting velocity between shooting positions in top level handball. A total of 784 shots were analyzed. Shooting velocity was measured with iBall (SELECT, Denmark), that has a built-in chip for tracking and distributing data in real time regarding ball velocity, shot detection, shot position and the position of the ball in the goal (Kinexon, Germany). Shooting position (SP) is defined as a geometrical point and a tactical situation from which a shot was taken. Differences between shooting positions were calculated using the Kruskal-Wallis test. Significant difference in shooting velocity was noticed between shooting positions (Chi-Square=95.83). Post-hoc analysis revealed that shots executed outside the nine meter perimeter are significantly faster than from other shooting positions. Shots taken outside the 9-meter perimeter require the fastest shots since players cannot outsmart goalkeepers with modified slow shots (e.g. lob shot, shot with rotation or "dry leaf" shot). Modified slow shots are commonly used in closer distance shots like wing shot, fast break shot, breakthrough shot or penalty shot. In these situations, players have more demanding angle in which shooting velocity is not always an advantage.

Keywords: *shot velocity, ball velocity, professional handball, throwing, team sport*

INTRODUCTION

Throwing is considered to be a fundamental motor skill. Its execution is very natural and athletes learn it at early stages of sports development (Bompa, 1996; Raudsepp & Päll, 2006). As such, throwing motion is very common in a majority of team ball games. It can be found in a variety of sports' techniques in which athletes are required to score using their hand. In some sports scoring is more oriented on aiming and precision (e.g. basketball, rugby) while in others throwing action is more affected by explosive power (e.g. water polo, American football).

Handball belongs to the category of sports in which throwing should be executed as explosively as possible without losing precision. Control on the ball is maintained by the ball size (its volume and weight) and special glue

[1] Paper received: 28 April 2021, accepted for publication: 10 June 2021.
[2] This paper was presented orally on 14 May 2021 at the 4th International Scientific Conference "Health, Sport, Recreation " held in Belgrade and organized by the College of Sports and Health.
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that helps players manipulate the ball and perform specific shots (e.g. rotational shot). As handball throwing on goal is always accompanied by technical-tactical requirements, it is more precise to call it "shooting". Shooting though implies a more complex cognitive and motor action and should be put in the context of specific game situations.

Nevertheless, a majority of studies dealing with throwing/shooting in handball have been conducted from the biomechanical perspective (Serrien et al., 2015; Van Den Tillaar & Cabri, 2012; Wagner et al., 2011). Serrien et al. (2015) researched ball velocity and three-dimensional kinematics between male and female handball players. They found faster shooting in male players and distinct strategies in generating and transferring momentum through the kinematic chain. Male players showed more activity in the transverse plane whereas female players showed more activity in the sagittal plane (Serrien et al., 2015). Granados et al. (2008) studied one handball season which they noticed resulted in significant increases in throwing velocity of elite female handball players. In their study, Fieseler et al. (2017) reported that throwing velocity was in correlation with BMI (r=-0.50) among the third German handball league players.

However, no study explored shooting velocity in different shooting positions. During play, different players can find themselves in a shooting position that is not typical for the geometry of their own playing position. The dynamics of modern handball force players to be efficient in a variety of situations. Universality is becoming a more and more important quality for every player regardless of their "typical position". For any player, a shooting action can occur outside the 9-meter perimeter, in fast break, penalty shot, in breakthrough or from the 6-meter line. Knowing that shooting velocity is one of the factors that significantly influence performance in handball, understanding the nature of this feature in different shooting positions could help a lot to coaches in terms of selection and composition of a training program. Hence, the aim of this study was to conduct a research of shooting velocity differences among different shooting positions in top level handball.

METHOD

Samples

Participants in this study involved 118 handball players who took part in the 2020 European Handball Championship held in Austria, Norway and Sweden.

Variables

Shooting velocity was reported only for scored goals. A total of 784 shots/goals scored in 15 games were analysed. Apart from shooting velocity, other variables included 7 typical shooting positions that are part of standard parameters of situational efficiency in handball: shots taken outside the nine-meter perimeter (9m), shots taken between 9m and the goalkeeper area (6m), shots taken from right- and left-wing positions (W), breakthrough shots (BT), penalty shots (7m), fast break shots (FB), and flying throw shots (FT).

Data collection techniques

Shooting velocity (SV) was collected using iBall (SELECT, Denmark), with a built-in chip that tracks and distributes data in real time (Kinexon, Germany). The values of shooting velocity are presented in kilometres per hour (km/h).

Statistical analysis

Statistical analysis involved the calculation of descriptive statistical parameters (arithmetic means and standard deviations, minimum and maximum measurement values and the Kolmogorov-Smirnov test for testing normality of distribution) and correlation analysis (Pearson's product-moment) to determine the relationship between the observed variables. For all analyses, Statistica 13.0 (TIBCO Software Inc, USA) was used, and a p-level of 95% was applied.

RESULTS

Table 1 shows the results of descriptive statistics calculated for shots taken from 7 different shooting positions. Uneven distribution is noticed in shooting velocity for all positions (ALL). Consequently, the nonparametric Kruskal-Wallis test was applied to determine the differences in shooting velocity between shooting positions.

Table 1. *Descriptive statistics*

Shooting positions	N	MEAN	SD	MIN	MAX	KS	P
9 m	212	108.80	16.90	61.00	137.00	0.08	p< .10
6 m	134	90.74	20.37	25.00	133.00	0.05	p> .20
W	151	89.11	20.12	28.00	127.00	0.08	p> .20
7 m	16	81.31	27.70	37.00	130.00	0.06	p> .20
BT	111	94.95	19.65	26.00	136.00	0.11	p< .10
FB	91	88.37	21.20	36.00	123.00	0.08	p> .20
FT	16	81.31	27.70	37.00	130.00	0.14	p> .20
ALL	787	95.41	21.23	25.00	137.00	0.05	p< .05*

Legend: N – number of subjects, **MEAN** – arithmetic mean, **SD** – standard deviation, **MIN** – minimum, **MAX** - maximum, **KS** – Kolmogorov-Smrinov test, **9m** – shots taken outside the nine meter perimeter presented in km/h, **6m** – shots taken between nine meters and the goalkeeper area presented in km/h, **W** – shots taken from right- and left-wing positions presented in km/h, **BT** – breakthrough shots presented in km/h, **7m** – penalty shots presented in km/h, **FB** – fast break shots presented in km/h, **FT** – flying throw shots presented in km/h

The average shooting velocity from different shooting position is presented in Figure 1. Evidently, shots taken outside the 9 meter perimeter are the fastest (108.80 km/h) while the slowest shots were executed from flying throw and penalty shots (81.31 km/h, respectively).

Table 2 shows the results of the Kruskal-Wallis test that calculated the differences between shooting positions. Multiple comparisons of z' values in the Kruskal-Wallis test showed significant differences between the analysed variables (H=132,1004 p =0.000). Post-hoc analysis revealed significant differences between 9m shots and shots from all other shooting positions. Differences between shooting positions other than 9m were not established.

DISCUSSION

Irregular distribution could be the cause of a vast value span. Namely, when analysing different shot types in handball it is well known that some of them could not be performed at high velocity. On the contrary, to execute them correctly and efficiently, a significant reduction in velocity is required. This means that in the total amount of analysed shots there is big share of “slow” shots that disturb the normality of distribution.

Table 2. *Differences between shooting positions (Kruskal-Wallis test)*

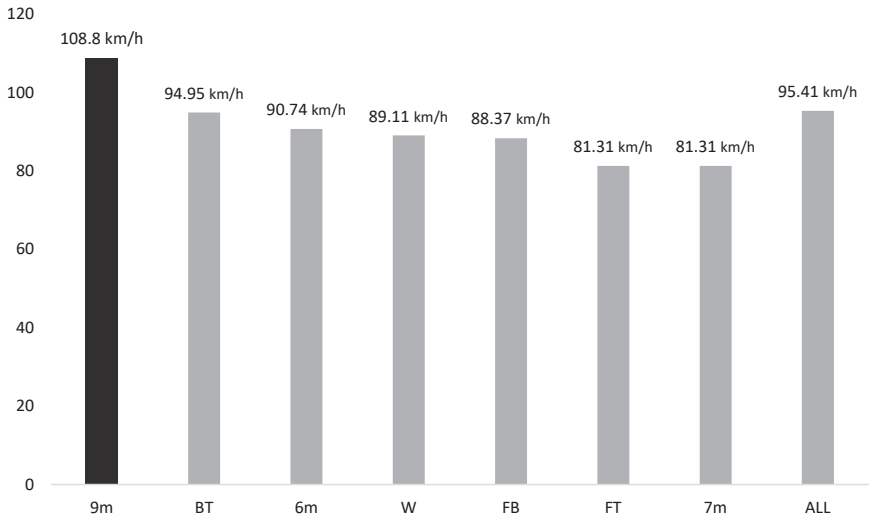
Shooting positions	9M R:542,17	6M R:339,50	BT R:391,73	W R:322,84	FB R:318,06	FT R:275,16	7M R:334,29
9M							
6M	8.08*						
BT	5.65*	1.79					
W	9.06*	0.62	2.42				
FB	7.87*	0.69	2.29	0.16			
FT	4.53*	1.07	1.92	0.80	0.70		
7M	6.70*	0.16	1.67	0.35	0.45	0.94	

Legend: 9m – shots taken outside the nine-meter perimeter presented in km/h, **6m** – shots taken between nine meters and the goalkeeper area presented in km/h, **W** – shots taken from right- and left-wing positions presented in km/h, **BT** – breakthrough shots presented in km/h, **7m** – penalty shots presented in km/h, **FB** – fast break shots presented in km/h, **FT** – flying throw shots presented in km/h

The most important finding of this study are the significant differences in shooting velocity between shots taken outside the 9-meter perimeter and shots from other shooting positions. Explanations should be sought in 2 factors: (I) the characteristics of players who perform shots from the given shooting positions, (II) the characteristics of the shots used in the given shooting positions.

Literature review suggests that 59.15% of the shots from 9 meters are performed by shooting over the block technique. This type of shooting is much more frequently found among back players than in other playing positions. Over 95% of all 9-meter shots are performed by LB, RB or CB players. In some rare situations wing players perform them as well (Foretic et al., 2013; Foretić et al., 2010). The typical somatotype and fitness profile of back players in handball is well documented. They are tall, lean and powerful athletes, mostly significantly taller than players in other positions (Massuça & Fragoso, 2011; Srhoj et al., 2002; Šibila & Pori, 2009). Their longitudinal dimensions, such as height, arm span and/or arm length allow them to execute distance shots more efficiently than other players (Sporiš et al., 2010). For a majority of expert coaches, longitudinal dimensions are the most important criteria in the selection of back players. After observing game situations and position demands it is logical to say that tall player will have more advantage in shooting actions from distance than shorter ones. Along with explosive power, longer arms, hands and height will produce more velocity during shooting actions (Van den Tillaar & Ettema, 2004). Most probably in our study, a majority of players that performed shots from 9 meters were back players and their somatotype and explosiveness contributed to the velocity differences between shooting positions.

Figure 1. *Average shooting velocity distribution from different shooting positions*



Legend: 9m – shots taken outside the nine-meter perimeter presented in km/h, **6m** – shots taken between nine meters and the goalkeeper area presented in km/h, **W** – shots taken from right- and left-wing positions presented in km/h, **BT** – breakthrough shots presented in km/h, **7m** – penalty shots presented in km/h, **FB** – fast break shots presented in km/h, **FT** – flying throw shots presented in km/h

Another factor is characteristic of shots that players use during different technical-tactical situations. Observations of shots that are executed closer to the goal indicate that in those situations' players use a variety of shots. A significant amount of those shots does not have to be performed with high ball velocity but using a high level of skill. Good examples are shots from wing position when players have very small shooting area, breakthrough shots when player jumps directly "at the goalkeeper" or penalty shots in which player tries to outsmart the goalkeeper with a feint or a "cunning shot". On the contrary, when shooting from a long distance, a player cannot outsmart the goalkeeper, but rather "pass the goalkeeper" with the fastest shot possible.

CONCLUSION

This study provides an interesting insight in the characteristics of shooting velocity in standard shooting situations in top level male handball. Significantly, the fastest shots are those performed from 9 meters. The differ-

ences between other shooting positions are irrelevant. All in all, although not recorded, it is obvious that the types of shots and shooting technique used in a particular position, along with players' morphology and fitness, influence shooting velocity in shooting positions. This is the logic in handball but it should also be monitored and statistically calculated. Since this was not encompassed in our study, it represents a limitation but also a direction for future research in the area of shooting velocity in handball. The results of this research can help handball coaches in the selection of players for particular positions and in developing an efficient conditioning program for specific power and velocity training.

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