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Communication

Assessing the Shooting Velocity According to the Shooting Technique in Elite Youth Rink Hockey Players

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Abstract: This study aimed to report the shooting velocities and to assess the differences in shot velocity according to the techniques used in elite youth male rink hockey players. Fifteen rink hockey players (age = 18.40 ± 1.44 year; body mass = 73.52 ± 6.02 kg; height = 1.76 ± 0.06 m; BMI = 23.61 ± 2.12; sports experience = 6.44 ± 1.76 years) participated in this cross-sectional study. Shooting velocities were assessed for four techniques: slap shot without approach run, drive shot without approach run, slap shot with approach run, and drive shot with approach run. Shooting velocity measurements were conducted using a radar Stalker ATS systemTM. The results demonstrated that drive shots consistently achieved higher velocities compared to slap shots ($F_{(3,56)} = 23.9$ $p < 0.01$, $\eta_p^2 = 0.58$). Additionally, incorporating an approach run significantly increased shooting velocities for both techniques ($p < 0.01$). These findings hold significant implications for coaches and players seeking to optimize shooting performance in rink hockey.

Keywords: roller hockey; biomechanics; shooting technique; performance enhancement

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1. Introduction

Rink hockey, also known as roller hockey, quad hockey, or hardball hockey, is a team sport played by two teams of five players on a rectangular rink (40 m × 20 m) surrounded by a one-meter-high barrier, on classic skates (two pairs of parallel wheels) and with a stick used to handle a solid, round ball. Regarding its physical demands, it is a fast-paced intermittent team sport [1,2] characterized by different unilateral high-intensity actions (accelerations, tackles, changes of direction, or sudden braking) [3,4].

Among the various specific skills in rink hockey, as in most implement sports like tennis [5,6], baseball [7], or golf [8], shooting velocity stands out as a critical factor. Moreover, in rink hockey like in many team sports with throwing actions and other hockey modalities [9–11], shooting velocity is a key performance indicator since it influences goal-scoring efficiency and overall team performance. Thus, its assessment has garnered significant attention from coaches, researchers, and athletes in the quest to improve performance and gain a strategic advantage on the field.

The ability to generate high shooting velocity in many sports is influenced by various factors, including shooting technique, the player's physical attributes, material properties, and playing surface characteristics [12,13]. Thus, understanding how shooting technique affects shooting velocity is essential for optimizing training strategies and player development [14]. In rink hockey, two main shooting techniques exists: the drive shot and the slap shot [15]. The drive shot is considered the natural shot and is generally easier to learn and control. The player positions the ball on the left side of their body (for a right-handed player, the right hand is in the upper position) and performs a motion with the stick backward and then forward to strike the ball. The shot is executed on the left side of the body, involving the rotation of the torso and shoulders to the right. The right leg is placed forward to provide stability during the shot. The drive shot primarily involves activation of the upper body muscles, especially the pectoral, deltoids, biceps, and triceps, to generate the required force and speed in the stick movement. Additionally, the muscles of the torso, such as the obliques and abdominals, are also engaged to provide rotational power and stabilization. The legs, particularly the left leg, help generate force through the momentum and weight transfer during the shot [15]. In the slap shot, the player positions the ball on the right side of their body (for a right-handed player) and performs a reverse motion with the stick, taking it backward and then forward. During the slap shot, the torso, shoulders, and hips rotate to the left, while the left leg is placed forward to provide stability and balance during the shot. The main muscles involved to provide force and power in the stick movement are similar to the drive shot. However, the implication of the torso muscles, such as the obliques, is more important to generate the necessary rotation during the motion. The legs also play an important role, with the right leg providing momentum and weight transfer during the shot [15].

Despite the recent increase in rink hockey investigations [16,17], and while previous research has provided valuable insights into the determinants of shooting velocity [18], the relationship between shooting technique and shooting velocity in rink hockey players remains relatively unexplored. Only Vaz et al. [18] have reported values of the shooting velocity with an approach run (115.4 $\pm$ 7.2 km/h) and without an approach run (102 $\pm$ 4.6 km/h) in a sample of top-elite Portuguese rink hockey athletes. Therefore, the aims of this study were (1) to report the shooting velocities from drive and slap techniques both with players using an approach run and with players shooting from a static position; and (2) to assess the differences in shot velocity according to the techniques used. It was hypothesized that rink hockey players would obtain higher velocities when using the drive technique, especially when using an approach run.

2. Materials and Methods

The current study employed a cross-sectional design to assess the differences in shooting velocity according to the kind used in a group of elite youth rink hockey players. To determine the shooting velocity, a shooting test was assessed at the end of the competitive season.

2.1. Participants

Fifteen highly skilled male rink hockey players were recruited through convenience sampling to participate in this research. The participants' demographic details, including age, height, mass, BMI, and playing experience, were provided by the club's medical department, and are presented in Table 1. All players were involved in a talent development program at the time of this study, dedicating a minimum of four training sessions per week, comprising approximately 8 to 12 h weekly, for 8–9 months annually. Moreover, they regularly competed in matches, with at least one game scheduled every weekend throughout the season. To ensure the participants' optimal physical condition, athletes with any existing acute or chronic injuries or illnesses that could hinder their maximum effort during the tests were excluded from this study. Prior to the commencement of the research, written informed consent was obtained from all participants and from parents/tutors, adhering to the ethical principles outlined in the Declaration of Helsinki (revised in Fortaleza, Brazil, 2013). The Ethics Committee of the Ramon Llull University in Barcelona approved the research design (ref. no. 1819005D), and the technical department of the club granted official consent for the study's conduction.

Table 1. Participants characteristics.

	Mean	SD
Age (years)	18.40	1.44
Height (m)	1.76	0.06
Body mass (kg)	73.52	6.02
BMI (kg·m^2)	23.61	2.12
Sports experience (years)	6.44	1.76

2.2. Procedures

The shooting velocity was evaluated on an indoor court. During the testing day, a standardized warm-up protocol was implemented to adequately prepare the participants for the ensuing assessments. Initially, all subjects performed a standardized 15 min warm-up with sneakers (continuous moderate-intensity running; joint mobility exercises for the trunk, shoulders, and wrists; movements at different speeds on the track; and progressive speed changes up to maximum intensity). Following the warm-up with sneakers, participants engaged in 10 min of maximal, progressively intense specific activities with skates involving sprints, direction changes, acceleration/deceleration, ball controls, and shootings. Throughout the warm up, the participants were under the supervision of a certified strength and conditioning coach, who ensured correct techniques and delivered consistent feedback. Subsequently, the shooting velocity was measured for each technique: (1) slap shot without approach run; (2) drive shot without approach run; (3) slap shot with approach run; and (4) static slap shot with approach run (Figures 1 and 2). The running approach distance was set between 4 and 6 m. Both the order of the kind of shot and the participants were randomized using the “true random number generator” program.

(**A**) (**B**)

Figure 1. (**A**) Drive shot and (**B**) slap shot techniques without approach run.

(**A**) (**B**)

Figure 2. (**A**) Drive shot and (**B**) slap shot techniques with approach run.

Subjects shot a standard rink hockey ball (mass 160 g, circumference 23 cm) as fast as possible toward a standard goal (without goalkeeper), using their personal technique and managing their personal stick. Each subject performed a total of two attempts for each type of shot, with at least two minutes of rest between each attempt. The shoot was measured using a radar Stalker ATS systemTM (Radar Sales, Minneapolis, MN, USA) handheld at shoulder level. Immediately after each shot, the athlete was informed of the achieved velocity. The highest values obtained from the two attempts of the same technique were used for further analysis.

2.3. Statistical Analysis

The statistical analyses were conducted using JAMOVI® v.2.3.24 software. Mean and standard deviation (SD) were used to express the data for all variables. To assess the normality of the variables, the Shapiro–Wilk test was employed. Furthermore, the within-session reliability of test measures was evaluated using an average-measures 2-way random intraclass correlation coefficient (ICC) with an absolute agreement, with 95% confidence intervals [19]. ICC values were categorized as follows: >0.9 = excellent, 0.75–0.9 = good, 0.5–0.75 = moderate, and <0.5 = poor [20]. Additionally, the coefficient of variation (CV) was calculated, and a value of <10% was considered acceptable [21].

To analyze the differences in shooting speed based on the shooting technique employed (slap shot without approach run; drive shot without approach run; slap shot with approach run; static slap shot with approach run), a one-way analysis of variance (ANOVA) was performed. Post hoc Bonferroni tests were utilized to observe the pairwise differences between the groups. The significance level for all statistical analyses was set at $p < 0.05$.

Moreover, effect sizes were reported as partial eta-squared (η_p^2), with cut-off values of 0.01–0.05, 0.06–0.13, and >0.14 indicating small, medium, and large effects, respectively [22]. For pairwise comparisons, Cohen's d effect size was calculated [22], and the magnitude of the effect size was interpreted as follows: <0.2 = trivial; 0.2–0.6 = small; 0.6–1.2 = moderate; 1.2–2.0 = large; >2.0 = very large [23].

3. Results

Descriptive statistics and reliability measures for all tests are shown in Table 2. Almost all the assessments showed good within-session ICC values ($\geq$ 0.9) and had acceptable consistency with CV values <10%.

Table 2. Mean test scores and within-session reliability data.

	Mean ± SD	ICC	95% CI	CV (%)
Slap shot without approach run (km/h)	85.3 ± 8.39	0.86	0.57–0.96	9.84
Drive shot without approach run (km/h)	98.3 ± 8.08	0.88	0.64–0.96	8.22
Slap shot with approach run (km/h)	94.6 ± 7.08	0.89	0.68–0.97	7.48
Drive shot with approach run (km/h)	110.4 ± 8.25	0.91	0.71–0.97	7.47

Key: ICC = intraclass correlation coefficient; CI = confidence intervals; CV = coefficient of variation.

Figure 3 shows the comparison of shooting velocity (expressed in km/h) according to the technique used. The comparison between the drive and slap technique shows that drive shots had higher velocities than slap shots ($F_{(3,56)} = 23.9$ $p < 0.01$, $\eta_p^2 = 0.58$), both without an approach run ($p < 0.01$; $d = 1.63$ (0.88 to 2.46) and with an approach run ($p < 0.01$; $d = 1.98$ (1.13 to 2.83). In both techniques, shooting with an approach run also provides higher shooting velocities ($p = 0.02$; $d = 1.18$ (0.38 to 1.97) for the slap shot; $p < 0.01$; $d = 1.52$ (0.71 to 2.34) for the drive shot).

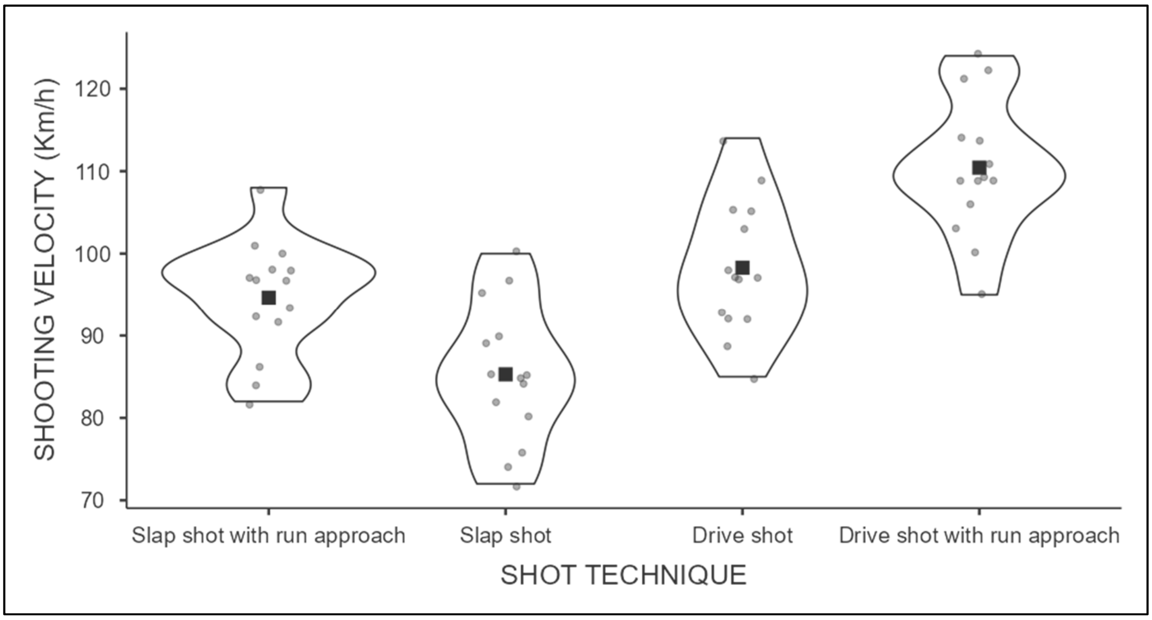

Figure 3. Comparison between the shooting velocity according to the different shooting techniques used.

4. Discussion

The present study aimed to assess and compare the shooting velocities from the main shooting techniques (the drive shot and the slap shot, both with and without an approach run) in elite youth rink hockey players. The main findings were that significant differences in shooting velocities across the various techniques used were found, with the drive shots demonstrating higher velocities compared to slap shots.

The analysis of shooting velocities based on the different techniques revealed notable differences in shot velocity. Unsurprisingly, the drive shot technique exhibited higher velocities compared to the slap shot (110.4 ± 8.25 km/h vs. 98.3 ± 8.08 km/h for the drive shots and 94.6 ± 7.08 km/h vs. 85.3 ± 8.39 km/h for the slap shots), which can be explained by the dominance of the drive shot among most rink hockey players [15]. This difference can be attributed to the biomechanical characteristics of the two techniques. The drive shot's stick motion allows for more effective force generation from the upper body muscles, resulting in higher velocities compared to the slap shot's stick motion [15]. The drive shot primarily activates the muscles of the upper body, particularly the pectorals, deltoids, biceps, and triceps, to produce the necessary force and speed in the stick's motion. Furthermore, the muscles of the torso, such as the obliques and abdominals, are also involved in supplying rotational strength and stabilization. The legs, notably the left leg, contribute to generating force by leveraging momentum and transferring weight during the shot. In this vein, the drive shot involves rapid and forceful movements, requiring players to exert maximal power in a short period, which can be advantageous during gameplay, especially in goal-scoring situations or set-pieces actions (one of the most important offensive actions in rink hockey games) [24,25]. However, the slap shot involves a different movement pattern, where the player uses a rotational motion and trunk rotation to generate power. Although the arm and shoulder muscles are still involved, the primary emphasis in the slap shot is on rotational power and coordination and there is a higher implication of the stabilators and core muscles.

In addition, this study also highlighted the impact of incorporating an approach run on shooting velocities. Both the slap shot and the drive shot exhibited higher velocities when players used an approach run (110.4 ± 8.25 km/h for drive and 94.6 ± 7.08 km/h for slap shot when using an approach run vs. 98.3 ± 8.08 km/h for the drive and 85.3 ± 8.39 km/h for the slap slop when not using an approach run). When a running approach is used, the athlete benefits from accumulating speed and kinetic energy while moving toward the target. This additional speed translates into an increase in the velocity of the body part involved in the shot. The kinetic energy generated by the approach is transferred to the ball at the moment of the shot, resulting in higher velocities. Conversely, shooting from a stationary position requires the athlete to generate all the necessary force and power from a static position. In this case, power largely depends on the athlete's muscular strength and technique. Since there is no accumulated kinetic energy from a run up, efficient technique and the ability to generate explosive force from a static starting position are crucial to achieve a powerful throw. This is especially relevant in penalty situations, when the player has to shoot from a static position [26]. Moreover, the shot's rotational movements involving the torso and shoulders to the right, combined with the leg's force generation, contribute to its superiority in generating shooting velocities. These findings are consistent with the results reported by Vaz et al. [18] in a study involving top-elite rink hockey athletes, where similar values were observed (115.4 $\pm$ 7.2 km/h vs. 102 $\pm$ 4.6 km/h).

Despite the valuable insights provided by this study, certain limitations should be acknowledged. Firstly, the relatively small sample size and the exclusive focus on elite youth male rink hockey players from a specific club may limit the generalizability of the findings to other player populations or different levels of play. To enhance the robustness of future research, larger and more diverse samples should be considered. Secondly, the cross-sectional design used in this study hinders the establishment of causal relationships, and the measurements were taken at a specific point in time (end-season). Considering the potential impact of season timing on the results, and more especially in youth athletes [27], longitudinal studies would be beneficial. Additionally, the current study only assessed shooting velocity, neglecting other influential factors like biomechanics movement, the kind of sticks used, or accuracy in shots. More comprehensive investigations encompassing a broader range of variables would provide a more holistic understanding of shooting performance in rink hockey.

Furthermore, the involvement of specific muscles during shooting actions may vary depending on the particular technique employed [15]. Incorporating electromyographic (EMG) analysis in future studies could shed light on muscle activation patterns during different shooting techniques in rink hockey. This deeper insight into the biomechanical aspects underlying shooting performance could identify specific muscle groups contributing to higher shooting velocities and further enhance training and performance optimization strategies.

5. Conclusions

In conclusion, the current study revealed that the drive shot run exhibited higher velocities than the slap shot. Additionally, both the drive and slap techniques demonstrated higher shooting velocities when executed with an approach run compared to shooting from a static position. Furthermore, this study provides baseline data on shot velocities for each technique in elite youth rink hockey players. Coaches and players can utilize these findings to develop targeted training programs aimed at optimizing shooting performance in rink hockey. These training programs should focus on optimizing shooting techniques to maximize ball speed. Players should receive coaching on proper body positioning, arm and shoulder coordination, and trunk rotation to generate the greatest amount of force and precision during shots. Biomechanical analysis, such as motion capture technology, could provide valuable feedback and guidance to players in refining their shooting technique.

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Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are available on reasonable request from the corresponding author.

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