PREDICTORS OF SCORING ACCURACY: ICE HOCKEY WRIST SHOT MECHANICS

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INTRODUCTION

In the sport of ice hockey the stick is used to control and shooting the puck (hard rubber cylindrical disk) while points gained by scoring (i.e. putting the puck in opposing team's net The wrist shot is generally accepted as a more accurate technique for puck projection[1]. There has been little attempt to compare the stick behavior with the performance outcome during shooting. In throwing or striking tasks, the projection angle and velocity release are crucial for the accuracy outcome [2,3,4]. The purpose of this study is to identify the kinematics patterns of the ice hockey stick from a wrist shot that correspond to the accuracy of puck trajectory.

METHODS AND PROCEDURES

A total of twenty five male subjects ranging in skill participated in this study. Each subjects executed 10 successful wrist shots on four targets (Figure 1). All subjects were performing shots standing with their skates on low friction synthetic polymer surface (to simulate ice). Reflective markers (14mm diameter) were attached on the ice hockey stick and puck. Performances were evaluated by simultaneously recording the movements of the stick's shaft and blade and of the puck with a 6 six cameras infra-red based motion capture (Vicon®) system (240 Hz). These data were used to calculate stick and puck velocities, shaft flexion angles and a series of gross blade projection angles (see Table 1) measured with respect to the blade local coordinate system, in order to quantify the behavior of the ice hockey stick during the execution of the stationary wrist shot.

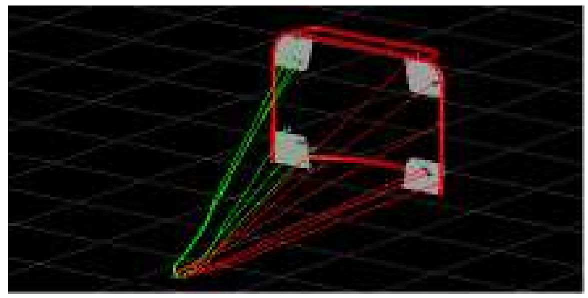

Figure 1: Hockey net with the four different targets and the corners identification relative to the subject shooting side (RH – Right handed, LH – Left handed)

The coordinates of the center of all four targets were used to obtain the vertical (Z-dis) and horizontal (Y-dis) RMS of every shot according to the puck's intercept point with the net's plane. Multiple regression analysis was used with the release parameters to predict accuracy score.

Table 1 Calculated release parameters and their abbreviations

Shaft bend (θ_{SB})	Yaw at release (Ψ_r)
Blade velocity (v_h)	Pitch at release (Φr)
Puck release velocity (v_{p-r})	Roll at release (βr)
Puck spin (ω_p)	Delta Yaw (ΔΨ)
Time of puck contact (Ct)	Delta Pitch (ΔΦ)
Puck contact distance (Cd)	Delta Roll (Δβ)

RESULTS AND DISCUSSION

With regards to the accuracy scores by target, a height main effect was observed regardless of players caliber (p>0.05) for top and bottom corners accuracy scores (65% and 45% respectively). Similarly, when considering the variables of shooting precision Y-dis, Z-dis and radial distances were found to be significantly different between the bottom and top corners ($p>0.05$). The radial RMS from the center of the targets was greater for the top targets primarily due to the larger vertical variance (Z-dis).

For the bottom corners, the principal predictors of accuracy were the blade's heel velocity (km/h) and the position of the puck relative to the blade heel. These derived regression equations explained 36% and 40% of the variance in overall accuracy for BC and BI respectively. For the top corners, six parameters were found to be significant predictors of accuracy: puck release velocity ($v_{p\text{-}r}$), blade heel velocity (v_h), shaft bend (θ), release roll (β) and changes in blade orientation angles: $\Delta\Phi$ and $\Delta\Psi$. These six parameters explained 76% of the accuracy variance for both TC and TI. The results indicate that accurate shooters tended to alter release parameters (puck release orientation and velocity), loading mechanics and blade orientation to achieve proper puck trajectory.

Relative to coaching terms, taking a wrist shot at one of the top targets will require the shooter to "scoop" under the puck (i.e. moving the blade under the puck to permit application of a vertical force component to the puck) in order to lift it and provide the optimal puck's velocity vector to intercept the target window. Therefore, a substantial amount of change in the pitch angle ($\Delta\Phi$) throughout the contact phase In addition to the "scoop" mechanism, the wrist shot is characterized by a rapid "flick" during the end contact phase between the blade and puck. This descriptive term "flick" corresponds to the fast change in blade orientation ($\Delta\Phi$ and $\Delta\Psi$) and concurrent stick bend recoil ($\Delta\theta$).

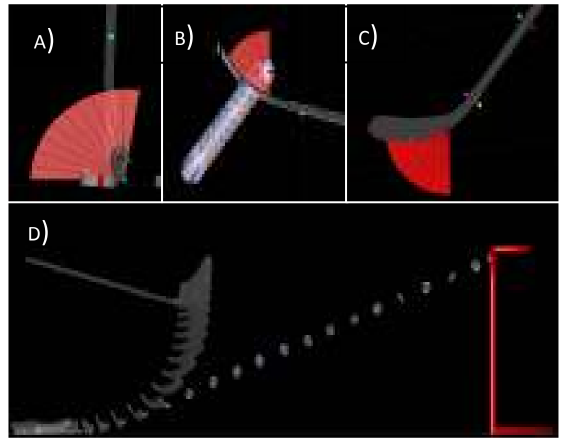

Figure 2. 3-D visualization of the calculated pitch (A), yaw (B) and roll (C) angles. 3-D reconstruction of a top corner wrist shot (D).

SUMMARY

This study has provided a unique insight into the ice hockey stick usage associated with accuracy of stationary wrist shots. As such these findings provoke a series of additional research questions (e.g. the role of the whole body kinematics associated with stick behavior) relevant to design engineers, as well as coaches and athletes.

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