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THE EFFECT OF HOCKEY STICK STIFFNESS AND ENERGY TRANSFER ON PUCK VELOCITY FOR WRIST AND SLAP SHOTS

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INTRODUCTION

Constructing a hockey stick shaft from composite materials has allowed for altering the stiffness of the stick, thereby enabling increased storage and return of elastic energy. However, previous studies examining the effects of shaft stiffness on performance have had mixed results [1,2]. In these studies, stick stiffness appeared to influence the storage and return of energy but the athlete's ability to transfer this energy from the stick to the puck was not optimized. It is believed that the stick-puck contact interface may be a critical link between this energy transfer. Therefore, the purpose of this study was to determine the effects that stick stiffness, shaft deformation, blade-puck contact time, and energy transferred from the stick to the puck have on maximum puck velocity. The information in this study will be used in developing a stick fitting system that will be invaluable to players in order to optimize performance.

METHODS AND MATERIALS

22 ice hockey players performed eight slap shots and eight wrist shots with three composite Easton Synergy ST sticks of varying stiffness; 85 flex (6400 N/m), 100 flex (7400 N/m) and 110 flex (8000 N/m). This report is based on results from 14 subjects. Players performed shots on a synthetic ice surface into a hockey net approximately five meters away. Two 350 ohm resistance strain gauge sensors were attached to each shaft to measure the stick deflection during each shot and to calculate the total energy storage and return of the stick. Six force sensors were placed evenly beneath the taped blade to measure the contact time between the stick and puck. The puck velocity during each shot was measured using a Stalker ATS professional radar gun. All data was analyzed using custom made software (MATLAB 2012a, Mathworks). The average of the eight trials for each subject was compared between conditions using a repeated measures ANOVA at a significance level of $\alpha=0.05$.

RESULTS

On average, stick stiffness had an influence on puck velocity for both the wrist and slap shot. For the wrist shot, the most flexible stick resulted in a 2.7% higher velocity ($\alpha<0.05$) and a 28.3% greater peak deflection ($\alpha<0.05$) than the stiffest stick. For the slap shot, the stiffest stick resulted in a 3.2% greater puck velocity ($\alpha<0.05$) and a 11.3% lower shaft deflection ($\alpha<0.05$) than the most flexible stick. Eight athletes performed their best wrist shots with the 85 flex stick and 11 performed their best slap shots with the 110 flex stick. Optimal stick stiffness varied among subjects. Athletes were therefore divided into groups based on their best and worst stiffness in order to analyze their performance (Figure 1). Under these groupings, significant differences were seen in puck velocity (for both wrist and slap shots) and peak shaft deflection (for wrist shots) while a trend of increased impulse for both the wrist and slap shot was also seen.

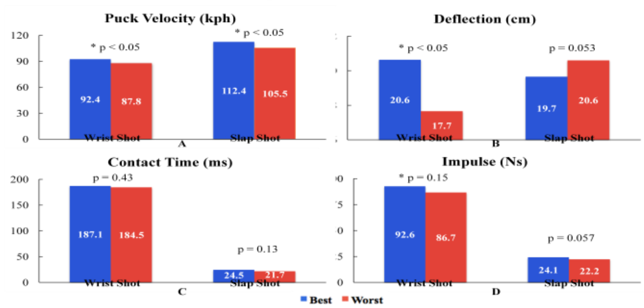

Figure 1. Results from athletes' best (blue) and worst (red) stick stiffness for the wrist and slap shot (n=14). Best stiffness was defined as the stick in which the player had the highest puck velocity.

DISCUSSION AND CONCLUSIONS

This study found that stick shaft stiffness can influence puck velocity during both a wrist and slap shot. When athletes were grouped based on their best and worst stiffness of stick, a trend was seen indicating that when an athlete is shooting with a stick of optimal stiffness, the impulse that the stick imparts on the puck is increased. This increased impulse may be due to the timing of the release of energy from the stick to the puck. To optimize this energy transfer, future studies may consider using blade-puck contact information to provide further insight into the relationship between the timing of puck release and a deflected stick's return to equilibrium.

REFERENCES

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2. Hannon, A., et al. *Sports Eng*, 47, 57-65, 2011.