THE ICE HOCKEY SLAP SHOT, ELITE VERSUS RECREATIONAL

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Stationary ice hockey slap shots performed by five elite and five recreational players were compared. Each hockey player performed 5 shots. Three-dimensional kinematics of the stick and upper body were recorded using an electromagnetic tracking device, the Ultratrak®, (Polhemus Inc., Burlington, VT, USA). Joint centers were calculated using the sphere fitting method. Elite players shot significantly faster than recreational players (29.14 ± 1.39 m/s and 26.46 ± 0.66 m/s). Velocity due to translation movement was greater for recreational players compared to novice players (13.14 m/s and 9.08 m/s). Investigation in maximal angular velocities of the body movement sequences indicated that elite players' maximal velocities moved from the core to the extremities where as recreational players exhibited no such pattern. The results of this study suggested that there are differences in technique when performing the stationary slap shot which may contribute to the increased performance of the ice hockey slap shot.

INTRODUCTION: In ice hockey the primary tool for puck control and shooting is the ice hockey stick. There are several ways to shoot the puck: the two most common methods being the wrist shot and the slap shot. The wrist shot is generally accepted as a more accurate technique for puck projection where as the slap shot's advantage is higher puck release velocities (i.e. typical maximum velocities of 20m/s and 30 m/s for wrist and slap shots respectively, (Pearsall et al, 1999). Though numerous coaching manuals present general guides for technique development exist, (Gendron 1957, Randy 1956, Haché 1970, Dowbiggin 2001) beyond the emphasized repetitive practice drills to improve both accuracy and speed of the shot, the ability to define the underlying mechanics of the shot remains relatively unknown. In the never-ending search for a more competitive edge, there has been a push to use new equipment designs, materials and construction methods to enhance sport performance. In most sports, both kinematics and kinetics are rarely measured despite being most relevant in enhancing equipment performance. Biomechanical analysis of how the equipment is used may lead to optimal performance. Without an in depth knowledge of the stick function, how can a stick be designed to increase the performance? Part of the answer can be revealed by a detailed 3D kinematics analysis. This can help with the design of not just hockey sticks, but of all other sports equipment used. The objective of this study was to compare gross movement patterns between elite and recreational ice hockey players performing a stationary slap shot and determine what these differences may be.

METHODS: Ten male subjects were recruited to perform in this study. Five of the subjects (mean age: 23.0 ± 1.6 years, mean height: 184.9 ± 9.1 cm, mean mass: 88.6 ± 9.1 kg) were recruited from the McGill Redmen Ice Hockey team to form the elite group. Five other recreational players (mean age: 23.8 ± 3.1 years, mean height: 181.9 ± 6.9 cm, mean mass: 80.5 ± 9.7kg) who played less than 2 times a week during the winter season were selected to form the REC group. All subjects were healthy and showed no physical injury that would prevent them from performing the task.

Fifteen surface electromagnetic sensors were placed on the subject and secured using 3MTM surgical tape. Specifically, sensors were placed on the dorsal part of the hands over the third mid-metacarpal, dorsal part of the wrist on the dorsal tubercle of the radius, the upper arms posterior to the olecronon fossa, acromion processes, over C7 spinous process, the greater trochanters and the lateral maleolies. The remaining two sensors were on the trail side of a wooden Bauer Supreme 3030 ice hockey stick 24.0 cm and 145.0 cm from the heel of the blade.

An electromagnetic tracking device, the Ultratrak®, (Polhemus Inc., Burlington, VT, USA) was used to collect the kinematic data at 60Hz while the subjects performed the slap shot trials. Filmbox® versions 1.5 software (Kaydara, Montreal, CAN) was used to control the Ultratrak® data recording and MatLab® (version 6.0.0.88 release 12.0)(MathWorks inc., Natick, MA, USA)

programming scripts were used to analyze and process the data. The electromagnetic transmitter was situated on a wooden platform 50 cm high, 240 cm deep and 720 cm long that was covered with polyethylene sheets to simulate low friction ice surfaces (Pearsall, 1999; Wu et al., 2003). Each subject performed calibrated movements to determine joint centers of the wrist, elbow and shoulder for both right and left side (Cappozzo, 1984; Leardini et al, 1999; Piazza, Okita and Cavanaugh, 2001; States 1997). Subjects wore their own skates and gloves and took five practice shots to acclimatize themselves prior to the testing. Verbal confirmation was used to determine if the subjects were comfortable with the shooting setup.
Each trial consisted of a stationary slap shot into the designated target. Successful completion of the trial was determined by verbal confirmation from the subject approving the slap shot, and hitting the target (130 cm x 113 cm) 334 cm away with the puck. Five trials were recorded for each of the ten subjects.

RESULTS: The velocity of the blade for the elite players was significantly faster at impact than the recreational players, 29.14 m/s and 26.46 m/s. The velocities of the blades attributed by the angular displacement of the stick were 16.00 m/s and 17.38 m/s for the elite and novice players respectively. Thus 13.14 m/s and 9.08 m/s were attributed to the translational movements of the stick for the elite and recreational players (Figure 1).

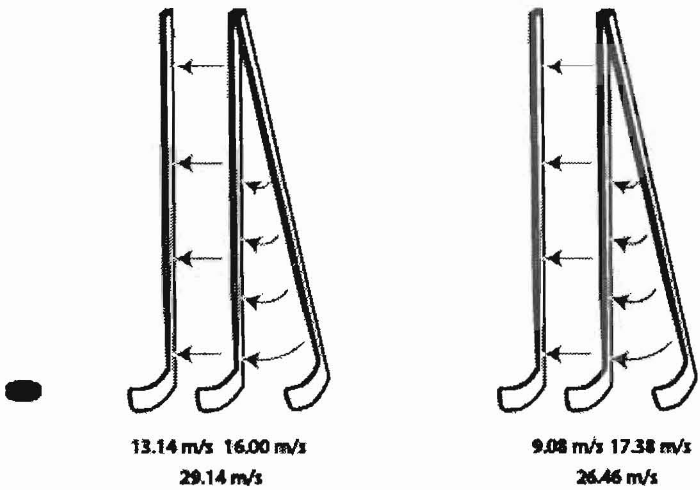

Figure 1: Blade velocities showing the breakdown of the velocities due to translation and rotation.

Both elite and recreational players exhibited different movement sequences. These sequences may be defined In part by identifying the instant of peak joint angular velocity. Sequence in peak velocity for the elite players were; trunk rotation, pelvis rotation, lead shoulder horizontal adduction, trail shoulder vertical adduction, lead shoulder vertical adduction, trail shoulder horizontal adduction, lead elbow flexion finishing with trail elbow extension. The peak joint angular velocity sequence for the novice players went as follows: trail shoulder vertical adduction, trail elbow extension, lead shoulder vertical adduction, trunk rotation, lead elbow flexion, lead shoulder horizontal adduction, pelvis rotation and trail shoulder horizontal adduction (Figure 2).

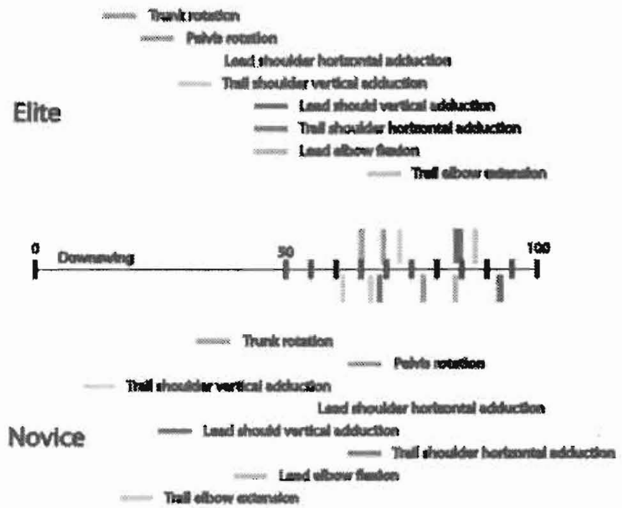

Figure 2: Peak angular velocity movement sequences of the upper body during the downswing of the slap shot movement of elite and recreational ice hockey players.

DISCUSSION: Few studies have looked at the ice hockey slap shot (Hayes, 1964; Alexander et al., 1963; Hoerner, 1989). Of these studies none have looked at body and stick kinematics from start to impact. The purpose of this study was to quantify the upper body and stick kinematics from start to impact of elite and recreational players performing a stationary slap shot and determine if there were any differences. In general, the kinematics at the start, top, and impact were similar for both elite and recreational groups. However there appeared to be differences in the movement patterns during the various phases of the swing leading to each event. Blade velocity was significantly greater for the elite players (29.14 m/s to 26.46 m/s). These velocities were similar to those reported by Wu et al. (2003) and Pearsall et al. (1999). Where do these differences lie? The velocities of the blades attributed by the angular displacement of the stick were 16.00 m/s and 17.38 m/s for the elite and novice players respectively. Thus 13.14 m/s and 9.08 m/s were attributed to the translation movements of the stick for the elite and recreational players. There was a 4.04 m/s difference in the stick velocity due to the translation.

The translation movement of the stick appeared to account for the difference in the blade velocity between the elite and novice players. What would cause this difference? One variable that may be the cause of the difference in translation velocity is the sequence of body movements. The elite players seemed to move in a specific sequence, starting with the core, followed by the upper arms, then forearms.

CONCLUSION: This study found the kinematic differences in upper body movements during the stationary ice hockey slap shot that may explain the performance differences between elite and recreational players. Future studies looking more closely at the forearm pronation/ supination may provide further insight in the underlying mechanics of the ice hockey slap shot.

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