ICE HOCKEY PLAYERS PRODUCE A UNIQUE POSTURAL SWAY CHARACTERISTIC

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The purpose of this study was to examine postural sway patterns of ice hockey players and compare them with other athletes and also physically active non athletes. Balance training has become an integral part of sports training and is often included in knee injury and rehabilitation programs. We collected postural sway data for subjects during double and single legged stance for 30 seconds. The data was analyzed using traditional postural sway measures of range, length of path (or speed) as well as with Sample Entropy. Data show that ice hockey players display a different postural sway characteristic than both non athletes and American football players. This supports the idea that balance training for sport as well as rehabilitation should be designed with regards to sport specific conditions.

KEY WORDS: Postural Sway, Ice Hockey, Sample Entropy

INTRODUCTION: Ice hockey players have a unique set of balance parameters. The blade on their skate foot produces a fulcrum that allows for rotation around the longitudinal axis of the foot with a point of rotation well below the plantar surface of the foot. In most land based sports the point of rotation during balance tasks is either the inside or outside edge of the athlete's shoe. Additionally, because of the low friction characteristic of the skate blade on ice, the skate can easily glide both in front and behind their center of pressure easily without being lifted from the ground. Furthermore, ice hockey players do not typically have a flight phase when skating. Thus, they continually experience either single leg or double leg support throughout almost the entire game, in contrast to running wherein up to 60% of time is spent airborne.
Because of the unique balance requirements of ice hockey we hypothesize that ice hockey players develop different balance characteristics, particularly when standing on one foot when compared with other athletes or physically active college students. Since balance training is part of the training of athletes in various sports, as well as for rehabilitation, the development of sport specific balance demands would help us to better design balance training protocols for athletes. Schmidt (2005) reported athletes from different sports demonstrating different balance characheristics. The purpose of this study is to examine the postural sway characteristics of ice hockey players and a comparison group during several balance tasks and determine if ice hockey players demonstrate unique balance abilities, which would warrant customized training.

METHODS: To test this, we recruited 16 physically active college students, 16 NCAA division 1 ice hockey players, and 47 Division 1 football players. All subjects provided their informed consent to participate in this project. Descriptive data of the participants can be seen in Table 1.
On data collection day, subjects reported to the biomechanics lab where we collected descriptive data. Each subject was then asked to perform 3 balance tasks, a double leg stand, and single right and left leg stands. The balance tasks were performed in a counterbalanced order and with the eyes open. For each trial, participants were asked to stand still, barefoot on a 60 x 90 cm in-ground forceplate (Bertec, USA, model #6090-15) with feet placed approximately shoulder's width apart and arms crossed over the chest. While in this position, COP was recorded in the AP and ML directions at a sampling rate of 100 Hz for trials of 30 s.

Descriptive data

Table 1. Descriptive data of the subjects

Group	*n*	Age (yrs)	Height (cm)	Body mass (kg)
Physically active	16	21.6 (1.0)	180.5 (7)	81.8 (13)
Ice Hockey	16	21.4 (1.3)	184.6 (5.4)	86.8 (10)
Football	47	19.3 (1.0)	184.4 (6.3)	97.8 (15)

During all trials, participants were asked to direct their visual attention towards a 5 x 5 cm piece of cardboard fixed at eye level one meter in front of the participant. If a participant lost their balance during a trial, the trial was repeated until the subject successfully performed the trial. The data was analyzed, separately, in both AP and ML directions. Analysis of the data included use of standard balance measures of range and path length, as well as sample entropy (SEn) to examine the temporal structure of the sway path. Sample Entropy is a nonlinear analysis used to measures the complexity of the physiological time series data such as postural sway patterns. More complex signals have been associated with health and performance (Schmidt, 2005, Lake, 2002) ANOVAs with post hoc Tukey Tests were used to detect differences between the groups for each measure under the different conditions.

RESULTS AND DISCUSSION: There were no significant differences among the groups for AP or ML range for the double or single leg stance trials.
Significant differences were detected for AP and ML path length for all conditions. Exact values (group mean) and significant differences are presented in table 2.

Table 2. Results for single and double leg path length measures [1] and [2] note significance with the physically active and hockey groups respectively. AP refers to the postural sway in the anteroposterior direction and ML to the mediolateral direction

	Physically active	Ice Hockey	Football
Measure	mm	mm	mm
AP path length - double leg	1036 (158)	319.(59)[1]	369 (255) [1]
AP path length - left leg	1428 (222)	1557 (293)	856 (179) [1,2]
AP path length- right leg	1450 (269)	1407 (275)	888 (210) [1,2]
ML path length - double leg	1426 (208)	448 (50) [1]	367 (144) [1]
ML path length - left leg	1823 (318))	1433 (310) [1]	829 (186) [1,2]
ML path length - right leg	1797 (447)	1288 (182) [1]	866 (232) [1,2]

Since the instructions were to stand still, lower path length values would tend to indicate the subjects are performing the assigned task better. As expected, the athletes tended to perform better than the non-athletes. The football players produced significantly lower values than the control group in every condition, and the ice hockey players produced lower values that the control group in most conditions. These results agree partially with our hypothesis that ice hockey players would develop a unique balance characteristic in the mediolateral direction, due to the unique demands of the sport of ice hockey (e.g. standing on the edge of a blade). When considering the traditional measures the shorter path lengths of both athlete groups during the double leg stand could be interpreted positively. However, during the single leg stand the ice hockey players path length resembles that of the control group. Of the groups, we anticipated

the ice hockey players producing the best results. During the game of ice hockey ice hockey players balance on a thin blade during single leg support. Because of this thin base of support slight deviations in ML center of pressure result in instability. It is plausible therefor, that ice hockey playersare more sensitive to mediolateral deviations and are constantly correcting their center of pressure deviations resulting in more movement back and forth past the center of the skate blade resulting in a longer path length, while other athletes (in this case football players) are comfortable having their center of pressure over a range of widths between the medial and lateral sides of the foot and don't feel the need to immediately return the center of pressure to a specific position.
The SEn results show that the athlete groups produced significantly lower SEn values than the control group for each condition. The ice hockey and football groups produced similar values for all mediolateral measurements but significantly different values for all AP conditions. Exact values (group mean) and significant differences are presented in table 3.

Table 3. Results for single and double leg Sample Entropy measures. [1] and [2] note significance with other groups.

	Physically active	Ice Hockey	Football
AP SEn double leg	0.55 (0.32)	0.09 (0.04) [1]	0.22 (0.12) [1,2]
AP SEn left leg	0.31 (0.08)	0.22 (0.04) [1]	0.18 (0.04) [1,2]
AP SEn right leg	0.27 (0.05)	0.21 (0.04) [1]	0.18 (0.04) [1,2]
ML SEn double leg	0.39 (0.20)	0.06 (0.02) [1]	0.07 (0.03) [1]
ML SEn left leg	0.27 (0.13)	0.11 (0.04) [1]	0.10 (0.04) [1]
ML SEn right leg	0.25 (0.08)	0.11 (0.02) [1]	0.11 (0.03) [1]

A higher SEn value indicates a more complex pattern. More complex and more chaotic postural sway patterns have been associated with better balance (Schmit, 2005). It is unclear why the ice hockey and football players produced lower values in this case. Regarding ice hockey players, one possibility is that when performing AP balance on the ground plantar and dorsiflexion would likely be used to help control postural sway. This is different than on ice. When ice hockey players are on ice AP balance can be regulated by sliding the foot forward and backward which makes plantar and dorsiflexion less important to performance. This free AP sliding is unique to ice sports and is one indication that balance training and diagnostics should be performed with consideration of sport specific demands. Regarding both ML and AP measures, ice hockey players demonstrated more complex postural sway when on one leg relative to during the double leg stance. As mentioned above, during ice hockey both the AP and ML balance regulation is different than in land based movement. At this time we are not able to fully explain the SEn data..

CONCLUSION: Our hypothesis was confirmed that ice hockey players develop unique balance strategies than non-athletes and athletes of other sports. More research needs to be performed to better explain the mechanisms behind these different strategies, and how sport specific training might be particularly beneficial to master the unique ice hockey-specific stability parameters afforded by standing on the edge of a blade.

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