Proceeding

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The effect of eccentric hamstring strength on the change of direction speed of professional ice hockey players

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ABSTRACT

Introduction: Ice hockey is a sport that requires high acceleration of players for optimal performance. The speed of athletes is influenced by several factors. The aim of this research was to determine the effect of the eccentric hamstring strength of ice hockey players on speed with directional changes. Methods: The sample consisted of 15 members of the Slovak national ice hockey team; the average age was 27, the average height was 186.46 cm (SD ± 5.04), and the average body weight was 90.87 kg (SD ± 5.91). The players completed a NordBord Nordic Hamstring Test to determine the eccentric force of their hamstrings. We used the 5-10-5 test to determine their speed with directional changes. Results: We measured a small correlation (.129, $p > .05$) between the eccentric muscle strength of hamstrings and the speed with directional changes in the 5-10-5 test. The average ice hockey player's hamstring strength was 456.13 N (SD ± 51.28) and the average time achieved in the 5-10-5 test was 4.984s (SD ± 0.15). We also found a small correlation between right hamstring force and the right side of the 5-10-5 test ($r = .228$, $p > .05$), and there was no correlation between left hamstring force and the left side of the 5–10-5 test ($r = -.004$, $p > .05$). Conclusion: According to our study, hamstring eccentric strength does not correlate with speed directional changes. However, more intervention studies are needed.

Keywords: Eccentric hamstring strength; Speed with directional changes.

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INTRODUCTION

A typical hockey game is very dynamic and involves exposure to intermittent high-intensity activity, typically in 30 second shifts (Bond et al., 2018; Vigh-Larsen et al., 2020). Players require an extensive, yet balanced range of physiological capabilities to compete at the highest level (McGuinness et al., 2020). Both high-velocity collisions and unpredicted changes of directions are common (McGuinness et al., 2020). This demand for ability requires the athlete to be able not only to accelerate and decelerate repeatedly, but also to change direction intermittently while remaining in motion (Chaabène et al., 2012). The ability to quickly change direction on the field or court separates the great athletes from the good ones. This fact also applies to ice hockey players.

Ice skating is a series of muscle contractions that generate the force to move the skater across the ice (Polglaze et al., 2020). The stronger those muscles are, the more force they can generate and the faster the skater will be. The capacity to quickly change direction while sprinting, also widely known as a cutting manoeuvre or change of direction speed, is an important performance determinant in many team sports. In modern ice hockey, there are so many situations where the players have to change the direction of skating in the game for different purposes (Robbins et al., 2020). For example, when they want to evade an opponent in an attack, or in the case that they lose the puck in the attacking area and immediately have to turn and skate back. When changing direction or taking off after a loose puck, more powerful athletes are able to generate their maximum force more quickly, translating into a more explosive first few strides and an advantage over less powerful athletes.

The eccentric strength of hamstrings plays an important role in sprinting (Hedayatpour & Falla, 2012; Vogt & Hoppeler, 2014). Sprint biomechanics require the significant activation of eccentric muscle strength during the swing phase. Sprinting is essential for successful sport performance (Sharma & Kailashiya, 2018). Eccentric muscle strength is especially needed to decelerate and stabilize the body during tasks.

The main muscles which are engaged in skating are the glutes (m. gluteus maximus, m. gluteus medius, m. gluteus minimus), the hamstrings (m. semitendinosus, m. semimembranosus, m. biceps. femoris), the m. quadriceps (m. quadriceps – m. rectus femoris, m. vastus medialis, m. vastus lateralis, m. vastus intermedius), and the abdominal muscles (m. rectus abdominis, m. internal oblique, m. external oblique, m. erector spinae – m. iliocostalis, m.longissimus, m. spinalis) (Buckeridge et al., 2015). The m. gluteus maximus and the m. quadriceps muscle groups are mainly responsible for force production during the push phase (Shell et al., 2017). The m. biceps femoris plays an important role during the push phase and especially in the glide phase, where it is active in an eccentric character of work. Hockey players are forced to develop the strength of their glute and hamstring muscles because, in addition to force generation, they maintain the strength and balance between knee and hip joints.

Hence, this is the reason why change of direction speed is one of the most important abilities in this sort of sport. In our study, we focused on the role of a specific muscle group, the hamstrings, in the mechanics of deceleration and re-acceleration. The question is whether it is mainly the eccentric strength of this muscle group that is one of the contributing factors to change of direction speed.

Aim

The aim of this study was to determine the effect of the eccentric hamstring strength of ice hockey players on speed with directional changes.

MATERIALS AND METHOD

The sample

The sample consisted of 15 members of the Slovak national ice hockey team; the average age was 27, the average height was 186.46 cm (SD ± 5.04), and the average body weight was 90.87 kg (SD ± 5.91). The research took place in July 2019, with assistance from the FiT Factory facility in Nemce, Banská Bystrica.

NordBord

We chose NordBord to test eccentric hamstring strength. This system evaluates the average and maximal force by applying force to ankle hooks to two force cells which are primarily generated by athletes' hamstrings. The NordBord Hamstring Testing System is a device based on the measurement of eccentric and isometric hamstring strength. The majority of the NordBord area consists of an area for athletes to kneel on. The ankle hooks include a sensor that measures the force of the muscle activity (in Newtons). To successfully complete the test, the NordBord sensors must be in a perpendicular position to the ground.

Hockey players performed 2 tries of maximal eccentric effort with both limbs at the same time. Before this specific test, the athletes performed their standard "*pre-strength training*" warm-up. In between these two tries the hockey players had a 1-minute break.

Figure 1. NordBord Hamstring Testing system.

5-10-5 Shuttle

The 5-10-5 shuttle test consists of rapid directional changes in a linear plane. This test has also been referred to as the pro-agility test. It is used as part of player assessment in different sports. The setup for this test is very simple since it only requires three cones that are placed 5 yards (5 m) apart in a straight line. The meter distances were measured, and the lines were marked at 0.5- and 10-meter points. One pair of Microgate photocells was used and placed exactly at a 5-meter distance. The players started in the middle, right between the photocell 's beam, in a low stance with one hand placed on the ground facing the photocell. When the player was ready, he started sprinting 5 meters in the same direction as the hand that was placed on the ground, followed by crossing the line with the leg opposite the hand that was placed, cutting, and changing direction to the opposite side. When he ran 10 meters, he cut on the same leg again and ran back to the middle at full speed. Each player performed two attempts on each side. Microgate Polifemo photocells work as a coaxial optical system. Also, the Polifemo line employs an intelligent link to a timer using a standard 2-wire connection.

Figure 2. 5-10-5 Shuttle run test.

Statistical processing
We used Pearson Correlation. We have clarified the correlation relationship between the variables using a correlation matrix and graphically. We used a significance level equal to α = .05. We have created a correlation analysis using RStudio statistical software. We calculated the data distribution in IBM SPSS software V19.

RESULTS

15 members of the Slovak national ice hockey team participated in tests to measure eccentric hamstring strength as well as a test to determine speed with the change of direction. The results are presented in Table 1.

Table 1. Test performance summary.

	Left Hamstring Force (N)	**Right Hamstring Force (N)**	**Difference L:R (%)**	**5-10-5 R (sec.)**	**5-10-5 L (sec.)**
Average	452.93	459.33	0.15	4.95	5.02
SD	48.8	56.3	5.0	0.16	0.13

The average team score and the score variability is presented via the standard deviation value.

Most of the hockey players had a stronger dominant right leg and achieved a faster time on the right side of the 5-10-5 test. Specifically, we measured an average left hamstring force of 452.93 N (SD 48.8) and right hamstring force of 459.33 N (SD 56.3). The difference between the average hamstring force of both limbs was 0.15% (SD 5.0). The average time of the 5-10-5 shuttle run test was 4.95 s (SD 0.16) for the right side and 5.02 s (SD 0.13) for the left side. We calculated the data distribution in IBM SPSS software V19. The Shapiro-Wilk test results revealed that the data were normally distributed within a sample in each variable. Therefore, we used a Pearson correlation non-parametric test ($\alpha = .05$) to calculate if any correlation exists between hip adductor isometric force and speed with changes of direction. Interpretation of the Pearson correlation test: r = .10 small (weak) relation, r = .30 medium (strong) relation, r = .70 great (strong) relation. The results are presented in Table 2.

Table 2 Pearson correlation results.

	Pearson correlation results
Right leg hamstring force vs Right side COD test	r = .228, p > .05
Left leg hamstring force vs Left side COD test	r = -.004, p > .05
Right and Left leg hamstring force vs COD test	r = .129, p > .05

Based on Table 2, we can declare that there is only small (weak) correlation between right leg hamstring force and the ability to change direction with the right leg ($r = .228$, $p > .05$). We can also declare a small correlation between the average force of the left and right hamstrings and the ability to change direction to the left and right sides (.129, $p > .05$). There is no correlation between left leg hamstring force and the left side of the change of direction test (-.004, $p > .05$).

DISCUSSION

When it comes to speed with changes of direction, most of the players are able to cut and change direction faster on the right side (meaning decelerate and re-accelerate with the right leg).

Therefore, we wanted to determine whether hamstring eccentric strength level has any effect on speed with changes of direction.

In the study, hamstrings' eccentric strength did not correlate with sprint speed based on a 30 m sprint. A potential explanation can be that it is difficult to isolate one factor which would relate to speed when changing direction. This study demonstrates just a small correlation (.129, $p > .05$) between hamstring strength and speed with directional changes (5-10-5 test). Our study provides a new insight into the relationship between speed with directional changes and hamstring strength because no other research has dealt with the same research problem.

The generalizability of the results is limited by the fact that we only used one test (the NordBord eccentric Nordic strength test) to proclaim the final correlation. NordBord offers many other testing positions and options (Isometric 30° test, Isometric prone test, etc.) that can be used in later research. The next question for us is if there is possibly positive correlation between change of direction 5-10-5 tests and isometric hamstring tests. Our findings challenge the existing assumptions and therefore create space for further research.

The results of our study indicate that there are other muscle groups and movement qualities that make a difference in final performance. This research illustrates little to no association between the chosen variables, but the question of the most important muscle group involved in changing direction remains. Further research is needed to determine the relationship between the strength of the hamstring muscle group and speed with changes of direction. Eccentric exercise is not the only type of exercise used by hockey players to improve speed. Another type of exercise is plyometric exercise. Singh et al. (2018) tested the effect of plyometric training on speed and change of direction Ability in Elite Field Hockey Players. The sample consisted of seventeen elite male and female field hockey players who were randomly allocated into either low-to-high (L-H, n = 8) or high-to-low (H-L, n = 9) training groups. Differences between the groups for 10 m and 20 m sprint performance failed to reach statistical significance, and no significant differences were observed within or between groups for 5-10-5 times.

Timmins et al. (2016) in the 2014-2015 realized preseason and season tests, which showed a correlation between hamstring strength and the risk of hamstring strain injuries in football. Players whose eccentric strength (in the Nordic Hamstring test, measured on NordBord system) was under 337 Newtons (N) of force at the end of the 2014-15 preseason, had on average a 4.4 times higher chance of having a hamstring strain injury in the upcoming season. Their research also showed that eccentric hamstring strength could also overcome unmodifiable risk factors such as age and previous injury.

A previous hamstring injury increases the risk of return by about 16% according to Brukner et. al. (2015). Specifically, players scoring over 500 (N) on each leg showed indistinguishable levels of hamstring injury risk. Early detection of strength deficits or laterality allows appropriate intervention as required (Bahr et al., 2015). Part of these assessments also indicates when an athlete is ready for increased resistance in exercise, progression of exercise, or higher workloads in general. The aim of the study by Líška et al. (2019) was to test the size of eccentric muscle strength in professional hockey players and football players. The tested group consisted of 30 professional hockey players and 30 football players. The average values of eccentric muscle strength in hockey players were 419.8 N on the left hamstring and 420.9 N on the right hamstring. For football players, the average values of eccentric muscle strength reached the following values: left hamstring 419.6 N and right hamstring 428.6 N. There was no statistically significant difference between football players and hockey players in terms of the size of the hamstrings' eccentric strength.

The limitation of this study was the use of observational methodology. We selected Slovak national hockey players and we tested the correlation between speed with changes of direction and the eccentric muscle strength of hamstrings. Slovak national hockey players represent a valid sample from the point of view of the quality of the hockey players because they are part of the national team. However, it is difficult to do an intervention study directly, which would help to clarify the issue. This is because each hockey player has his own club and his own training process, which cannot be influenced. We chose correlation testing for it. A limiting factor in testing the correlation of force and velocity with changes in direction is that velocity is affected by several factors and it is difficult to expect a positive correlation with only one factor.

CONCLUSION

According to our study, hamstring strength does not correlate with speed directional changes. However, more intervention studies are needed.

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