Теорія та методика фізичного виховання
Physical Education Theory and Methodology
Teorìâ ta Metodika Fìzičnogo Vihovannâ

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

Original scientific article

Interaction of Skating Agility Tests and Postural Stability in Hockey Players

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Accepted for Publication: February 8, 2024
Published: February 29, 2024

DOI: 10.17309/tmfv.2024.1.08

Abstract

Study purpose. In this work, we point out the interaction of complex postural stability (CPS) and skating agility tests among pupils in the hockey club HK Nové Zámky. We determined postural stability using the SEBT and agility with skating tests. We expected a significant interaction between performance in skating agility tests and CPS for both standing legs, which was most closely identified with the eight-item SEBT test.

Materials and methods. The level of CPS was characterized by descriptive statistics. Laterality between right and left standing leg was assessed by t-test and Cohen's "d". The relationships between CPS and skating agility tests were determined by Pearson's correlation coefficient "r". Predictors were selected by stepwise regression. Statistical significance of differences and relationships was assessed at the 5% significance level.

Results. The results showed no differences in the laterality of the CPS between the right and left standing leg. Correlation analysis demonstrated the interactions of the left and right standing leg with all skating agility tests. Stepwise regression was used to select the tests that were most identified with the performance on the eight-item SEBT test in terms of their skating expression. The Illinois test has the most significant informational power for CPS.

Conclusions. The presence of positive interactions between skating agility and CPS in hockey players point to the importance of a balanced and stable stance of both legs in all directions. The perfect balance and stability of hockey players eliminates the fluctuations caused by skating movement in all directions and facilitates their execution without major changes in dynamic performance. The chance of shortening the activation time of the muscle chains involved in the technique of performing the test also increases significantly, or in the very structure of technique – the economics of ice hockey players' skating.

Keywords: hockey, postural stability, skating agility, interactions.

Introduction

A high ability to maintain postural stability means keeping the vertical projection of our center of gravity at the basic support level; it is essential in sports (Andreeva et al., 2021).

Hockey is included in sports games that require the comprehensive readiness of the players of the entire team. Players are able to produce high skating speed during the game, but with sudden changes of direction (Alpini et al. 2008; Antara et al. 2023). One of the inseparable parts of preparedness is precisely postural stability.

In the literature, postural stability is characterized by maintaining balance and control over your body during movement, thanks to which we are able to adequately react to the situation during the game, such as: contact with an opponent (Bournival et al. 2023).

The precise definition of the term "agility" was brought to us by Sheppard et al. (2014), who describe it in the literature as the athlete's ability to change the speed and direction of movement quickly and accurately during the reaction to a specific stimulus from the external environment.

Young et al. (2015) include situations in sports games as specific stimuli. These stimuli may vary in terms of intensity and spatiotemporal conditions.

However, Plisk (2008) states that when performing any agility test, it is due to the non-constant speed while covering the distance.

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In the studies, we are able to find models containing specific determinants according to the authors. Jeffreys (2011) lists perceptual limitations (ability to focus, attention), cognitive limitations (situation recognition, concentration, problem-solving ability), physical limitations (strength, muscle fiber typology) and motor limitations as determinants. For comparison, Sheppard et al. (2014) state that agility is determined by perception and decision-making (knowledge of the given situation), change of direction and speed, technique (acceleration/deceleration of movement, body posture), sprint speed, muscle properties of the lower limbs (leg strength, reaction speed, muscle imbalance right/left leg) and anthropometry.

Tests focused on speed, maximum strength or endurance are known in the literature. Compared to testing motor skills such as "agility", they remain in the background even in current literature (Hojka et al., 2016; Bakhsis, 2023).

In the sports performance of hockey players, postural stability and agility is a directly limiting factor because correct postural stability significantly affects the technique of hockey players and their ability to perform correct movements. Players with a high level of postural stability are better able to maintain the correct position of the body during skating, shooting or blocking a shot.

Materials and methods

Study participants

The research was carried out on a group of hockey players in the category of younger pupils from Slovakia (n = 20).

Study organization

Dynamic postural stability was determined using the eight-position Star Excursion Balance Test (SEBT) and movement performance in skating agility tests 6x9 m, 30 m, 36 m forward, 36 m backward, Illinois test, Circle forward, Circle backward and Square.

The SEBT test was performed in the directions Posterior, Posteromedial, Medial, Anteriomedial, Anterior, Anteriolateral, Lateral, Posterolateral for the right and left standing leg (Figure 1).

The output measurements for the right and left training leg are assessed from the point of view of the average value from 3 attempts (cm), the maximum measured value (cm), and the relative value (Relative – normalized distance in each direction (%) = Average distance in each direction / length lower limb*100). Complex postural stability (KPS) in both legs = average of average values from 3 SEBT attempts (composite scores) (Garret et al. 2012; Calatayud et al. 2017).

Statistical analysis

The DPS level and hockey players' sports performance was characterized by descriptive statistics (M, SD, Max, Min). Statistical and material significance of differences was assessed by t-test and Cohen's "d". The relationships between KPS and skating agility tests were determined by Pearson's correlation coefficient "r". Skating agility tests were selected by stepwise regression, which showed the highest closeness with KPS. For the models, we present the stepwise regression parameters (R Square, ANOVA parameters F, p value, partial share Beta*r). Statistical significance of differences and relationships was assessed at the 5% and 1% significance levels.

Results

By comparing the complex postural stability in the right (RSL) and left standing leg (LSL), we found no differences in laterality (tables 1 and 2) in average values $t_{(19)} = 0.959$, $p = 0.350$, $d = 0.166$, maximum values $t_{(19)} = 1.365$, $p = 0.188$, $d = 0.356$ and not even for relative values $t_{(19)} = 0.959$, $p = 0.350$, $d = 0.166$.

Correlation analysis showed interactions of KPS in the left and right standing leg with all skating agility tests ($p<0.05$). The 36 m backward skating test did not uniquely show significant relationships (p = n.s.) with KPS on the right standing leg (Tables 3 and 4). We do not report the calculated correlations of the relative parameters of the KPS due to the same values as the average ones.

A high correlation tightness (r = 0.70-0.90) with KPS was demonstrated by the Illinois skating test (LSL & RSL $p<0.01$), 36 m forward (LSL & RSL $p<0.01$) and 6x9m (LSL $p< 0.01$). Low tightness (r = 0.30-0.50) was observed in the 36 m backward skating test (LSL $p<0.05$; RSL $p<0.10$).

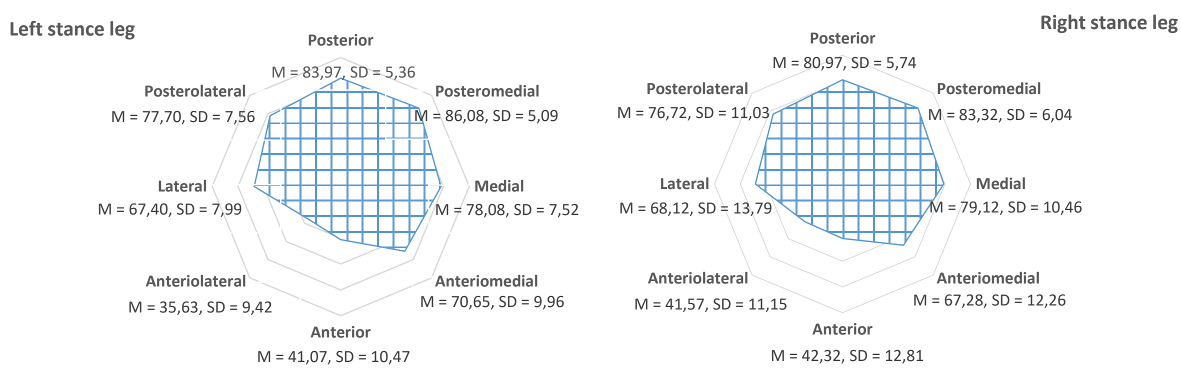

Fig. 1. Level of postural stability of hockey players on the right and left standing leg tested with the eight-way SEBT test

Table 1. Level of complex dynamic postural stability (DPS) and performance in skating agility tests

	Variables	M	SD	Max	Min
Left stance leg	Average (cm)	67.57	7.07	79.62	52.00
	Maximum (cm)	69.61	7.26	81.62	53.37
	Relatively (cm)	77.67	8.13	91.52	59.77
Right stance leg	Average (cm)	67.43	9.52	86.25	44.62
	Maximum (cm)	69.63	9.54	89.37	46.75
	Relatively (cm)	77.50	10.94	99.13	51.29
Skating agility	6×9 m (s)	18.89	2.53	27.01	27.01
	30 m (s)	4.84	0.65	6.30	4.10
	36 m forward (s)	6.78	0.79	8.21	5.38
	36 m back (s)	9.25	1.22	13.40	7.59
	Ilinois test (s)	20.0	2.45	24.12	16.48
	Circle forward (s)	29.6	4.15	40.43	25.31
	Circle back (s)	30.9	4.62	44.21	26.04
	Square (s)	19.20	3.72	29.01	15.25

Table 2. Differences of complex DPS between left and right standing leg

Variables	Diferencies Left and Right leg			
	d	t	p	d
Average (cm)	0.148	0.164	0.871	0.018
Maximum (cm)	0.025	0.028	0.978	0.003
Relatively (cm)	0.170	0.164	0.871	0.018

Labels: M - average, SD - standard deviation, Max - maximum, Min - minimum, d - difference of means, t - value, p - value, Cohen's "d"

Table 3. Correlations between KPS in the right and left standing leg with skating agility tests (Pearson's correlation coefficient "r" and p value) - average values

Variables		Average value			
		Left stance leg		Right stance leg	
		r	p	r	p
Skating agility	6×9 m	-0.769	0.000	-0.653	0.002
	30 m	-0.563	0.009	-0.645	0.002
	36 m forward	-0.762	0.000	-0.809	0.000
	36 m back	-0.475	0.033	-0.405	0.075
	Ilinois test	-0.873	0.000	-0.858	0.000
	Circle forward	-0.564	0.009	-0.507	0.022
	Circle back	-0.574	0.007	-0.507	0.021
	Square	-0.628	0.003	-0.578	0.007

The remaining skating tests 30 m, Circle forward & back and Square showed moderate correlations (r = 0.50-0.70, p<0.01).

By stepwise regression, two tests were selected, most identified with the performance of the eight-way SEBT test due to their skating expression (Table 5). The Illinois test (left leg 58.09% – 76.24% and right leg 73.63% – 73.92%) has the greatest information power for KPS before the 6x9m skating test (left leg 25.10%). The remaining skating tests were not selected despite the high tightness. All regression models showed statistical significance (p<0.01) and a high degree of tightness, respectively. dependence (R^2 = 73.62%-83.19%).

Table 4. Correlations between KPS in the right and left standing leg with skating agility tests (Pearson's correlation coefficient "r" and p value) – maximum values

Variables		Max value			
		Left stance leg		Right stance leg	
		r	p	r	p
Skating agility	6×9 m	-0.785	0.000	-0.669	0.001
	30 m	-0.565	0.009	-0.489	0.027
	36 m forward	-0.758	0.000	-0.812	0.000
	36 m back	-0.482	0.030	-0.423	0.062
	Ilinois test	-0.883	0.000	-0.860	0.000
	Circle forward	-0.563	0.009	-0.527	0.016
	Circle back	-0.573	0.008	-0.530	0.015
	Square	-0.639	0.002	-0.511	0.020

Discussion

Alpini et al. (2008), Bakhsis (2023) points out that ice hockey players can produce high skating speed during the game and the situations are characterized by sudden accelerations, decelerations and changes of direction.

Recorded positive interactions between agility tests on ice and PS in hockey players are supported by the research of Behm et al. (2005) because hockey skating performance is significantly correlated with balance and sprint tests, which points us to the important role that postural stability plays in skating speed in players.

In the databases, we find studies that investigatied the differences between hockey players' left and right legs or compared the performances in dynamic-static balance of ice hockey players and ordinary individuals (Hansen et al., 2016; Arboix-Alió & Aguilera-Castells, 2021; Kara et al., 2022).

Hansen et al. (2016) investigated the differences between the left and right foot in a group of hockey players (n=28). A lateral jump on a force platform was used as a test to compare both legs. The task of the probands was to stabilize the movement. The authors concluded they did not notice statistically significant differences between the left and right legs when performing the test.

The authors Arboix-Alió & Aguilera-Castells (2021) similarly investigated the differences between left and right legs in hockey players (n= 25). The Triple Hop Test was performed with both legs. The results showed that the recorded left and right leg differences are not statistically significant.

The results of both authors mentioned above (Hansen et al. 2016; Arboix-Alió & Aguilera-Castells, 2021) fully support our achieved results.

Comparative testing of dynamic-static balance between ice hockey players (n=37) and ordinary individuals (n=37) was carried out in a study by Kara et al. (2022). The

Table 5. Step regression parameters of selected skating agility tests to KPS for the right and left standing leg

Variables		Average value		Max value		Relatively value	
		Left	Right	Left	Right	Left	Right
6×9 m	Beta*r			0.251			
	r			-0.785			
Ilinois test	Beta*r	0.7493	0.7363	0.5809	0.7392	0.7624	0.7362
	r	-0.858	-0.858	-0.884	-0.860	-0.873	-0.858
ANOVA	R^2	0.7624	0.7363	0.8319	0.7392	0.7624	0.7362
	F	57.77	50.27	42.05	51.02	57.76	50.24
	p	0.00	0.00	0.00	0.000	0.00	0.00

Labels: R^2 - Square, Pearson coefficient “r”, ANOVA parameters F, p value, partial proportion Beta*r

experimental group was made up of professional hockey players and the control group was made up of men with no sports activity in the past. The authors report results without significant differences between the experimental and control groups in dynamic-static balance tests. We assumed significant differences between the groups, as hockey players regularly implement a training process with a focus on dynamic-static balance.

Chauhan et al. (2023) point to the finding that a training process with a focus on stability, which is regularly implemented, leads to better postural stability and dexterity of the players during the game. However, the recorded performance in individual tests of postural stability is often influenced by factors such as: heartbeat or respiratory muscle activity (Zemková, 2004).

Postural stability is related not only to the optimal performance of the athlete, but also to the sustainability of the player in the sport in the long term. Players with balanced and adequately strengthened muscle fibers are not as prone to back injuries, joints or other problems related to incorrect posture (Sahin, 2020).

For coaches, we see regular testing of their players in static and dynamic positions in the future, where they can evaluate the performance level of hockey players and then compare the results with other clubs.

Conclusion

The topic of complex postural stability is gradually becoming one of the basic building blocks of properly implemented sports performance. Players with a high level of complex postural stability can better control their body during the game, properly manage tense situations that come with the match and may be less prone to possible injuries.

The positive interactions we recorded between skating agility tests and KPS prove to us how important it is for hockey players to have a stable and balanced stance on both legs in all directions of movement. A high level of stability in hockey players can largely eliminate fluctuations that occur during skating and, on the contrary, facilitate their performance.

The identification of the agility test of Illinois with the eight-way test of complex postural stability shows us their mutual predictive possibilities, which could be the subject of interest and implementation of further research in the future.

For this reason, training focusing on postural stability should not be neglected, but on the contrary, should become a regularly implemented and inseparable part of every hockey player. Hockey clubs should include the chosen program in their training units.

Conflict of interest

The authors declare that they have no conflict of interest.

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Взаємозв’язок тестів на спритність при пересуванні на ковзанах та показники постуральної стійкості у хокеїстів

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Реферат. Стаття: 6 с., 5 табл., 1 рис., 19 джерел.

Мета дослідження. У цій роботі ми вказуємо на взаємозв’язок комплексної постуральної стійкості (КПС) та тестів на спритність при пересуванні на ковзанах у вихованців хокейного клубу ХК “Nové Zámky”. Ми визначали постуральну стійкість за допомогою тесту SEBT (балансувальний тест «рух траєкторією зірки») і тестів на спритність при катанні на ковзанах. Ми очікували на значний взаємозв’язок між показниками тестів на спритність при пересуванні на ковзанах та КПС для обох ніг в положенні стоячи, що було найбільш тісно пов’язано з тестом SEBT, що складається з восьми позицій.

Матеріали та методи. Рівень КПС характеризували за допомогою методів описової статистики. Латеральність між правою та лівою ногою в положенні стоячи, оцінювали за допомогою t-критерію та методикою d Коена. Взаємозв’язок між КПС та тестами на спритність при пересуванні на ковзанах визначали за допомогою коефіцієнта кореляції Пірсона (позначають “r”). Предиктори були обрані за допомогою покрокової регресії. Статистичну значущість відмінностей і взаємозв’язків оцінювали на 5% рівні значущості.

Результати. Результати не показали відмінностей у латеральності КПС між правою та лівою ногою в положенні стоячи. Кореляційний аналіз продемонстрував взаємозв’язок лівої та правої ноги в положенні стоячи з усіма тестами на спритність при пересуванні на ковзанах. Покрокова регресія була використана для відбору тестів, які найбільше ідентифікуються з показниками тесту SEBT, що складається з восьми позицій, з точки зору їх вираженості при пересуванні на ковзанах. Іллінойський тест має найбільш значну інформативність для КПС.

Висновки. Наявність позитивних взаємозв'язків між спритністю пересування на ковзанах та КПС у хокеїстів вказує на важливість збалансованого та стабільного положення обох ніг у всіх напрямках. Оптимальний баланс і стабільність хокеїстів усуває коливання, викликані рухами під час пересування на ковзанах у всіх напрямках, і полегшує їх виконання

без значних змін у динамічних показниках. Також значно збільшується шанс скорочення часу активації м'язових ланцюгів, задіяних в техніці виконання тесту, або в самій структурі техніки – економічність катання хокеїстів на ковзанах.
Ключові слова: хокей, постуральна стійкість, спритність при пересуванні на ковзанах, взаємозв'язки.

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Cite this article as: Broďáni, J., Guzman, M., Vala, R., & Huszár, V. (2024). Interaction of Skating Agility Tests and Postural Stability in Hockey Players. *Physical Education Theory and Methodology, 24*(1), 66–71. https://doi.org/10.17309/tmfv.2024.1.08

Received: 08.01.2023. Accepted: 08.02.2024. Published: 29.02.2024