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THE INFLUENCE OF VESTIBULAR LOAD ON THE HEART VESSEL SYSTEM OF HIGH QUALIFICATION FENCER

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Abstract

Introduction. The article analyzes the scientific data about cardiovascular, motor and sensory reactions of athletes to vestibular irritation. The results of experimental studies which are aimed at determining influence of vestibular loading on cardiovascular indices system of fencers of high qualification of all ages.

Purpose. The aim of this reserch is to investigate the effect of vestibular loading on the cardiovascular system of high qualification fencers.

Methods. The research was conducted on the basis of the National University of Physical education and sports of Ukraine. The study involved 30 fencers of high qualification, having a sports rank of the master of sports (MS) and who are members of the national team of Ukraine. Experimental data were analyzed with methods of mathematical statistics. The reliability of the difference in mean values were determined according to T-criterion of Student. To assess the impact of Vestibular load, the reaction of the cardiovascular system for changes in blood pressure, calculated the magnitude of pulse pressure, endurance ratio was studied.

Results. Studies have shown that the mean values of change AT and HR in response to a vestibular test in different age groups have a certain orientation. The least increase in

heart rate turned out to be 23-year-old athletes. Prevailing focus on reducing the response to the rotational load in this group, there are changes in systolic pressure. In the group of 16-year-old athletes SAT has increased. And, a significant decrease in diastolic pressure was found in 16-years athletes, and athletes in age of 23 GAO have increased. Information provided will allow to improve the efficiency of medical and biological provision in sports training of fencers in different age groups. It should also be carry out further research to find correlations between the indicators of the vestibular stability of fencers and their sporting result.

Originality. For the first time we have studied the effect of vestibular loading on the cardiovascular system of high qualification fencers.

Conclusion. Under the influence of fencing exercises, as the athletes develop their qualifications, the direction of the cardiovascular system's response to vestibular irritation is changing, and its severity is largely determined by the laws of age's development of the subjects. These studies lead to the conclusion that it is important for fencers to train vestibular apparatus to improve the technique of exercising. It should also be noted that a large number of athletes showed high values of changes in the cardiovascular system.

Key words: cardiovascular system, systolic, diastolic, heart rate, pulse pressure, coefficient of endurance, vestibular loading, vestibular stability, vegetative reaction, fencers.

Статья посвящена исследованию влияния вестибулярной нагрузки на сердечно-сосудистую систему фехтовальщиков высокой квалификации. Проанализирована научная литература об исследованиях сердечно-сосудистых, двигательных и сенсорных реакций спортсменов на вестибулярное раздражение. Приведены результаты экспериментальных исследований, целью которых было определение влияния вестибулярной нагрузки на показатели сердечно-сосудистой системы спортсменов-фехтовальщиков высокой квалификации разного возраста. Исследования проводились на базе Национального университета физического воспитания и спорта Украины. В исследовании принимали участие 30 фехтовальщиков высокой квалификации, имеющих спортивный разряд мастера спорта и члены сборной команды Украины. Экспериментальные данные анализировались методами математической статистики. Достоверность различия средних величин определяли по t-критерию Стьюдента. Для оценки влияния вестибулярной нагрузки изучали реакцию сердечно-сосудистой системы по изменениям артериального давления, рассчитывали величину пульсового

давления, коэффициент выносливости. Исследования показали, что средние величины изменений артериального давления и частоты сердечных сокращений (ЧСС) в ответ на вестибулярную пробу в разных возрастных группах испытуемых имеют определенную направленность. Наименьшее повышение ЧСС оказалось у 23-летних спортсменов. Преимущественную направленность на уменьшение в ответ на вращательные нагрузки в этой группе имеют изменения систолического давления. В группе 16-летних спортсменов САД увеличилось. И наоборот, значительное уменьшение диастолического давления обнаружено у спортсменов 16 лет, а у спортсменов 23 лет ДАД увеличилось. Представленная информация позволит повысить эффективность медико-биологического обеспечения спортивной подготовки фехтовальщиков разных возрастных групп. Также следует проводить дальнейшие исследования для поиска корреляции между показателями вестибулярной устойчивости фехтовальщиков и их спортивным результатом.

Ключевые слова: сердечно-сосудистая система, систолическое артериальное давление, диастолическое артериальное давление, частота сердечных сокращений, пульсовое давление, коэффициент выносливости, вестибулярная нагрузка, вестибулярная устойчивость, вегетативные реакции, фехтовальщики.

У статті наведені результати експериментальних досліджень впливу вестибулярного навантаження на показники серцево-судинної системи спортсменів-фехтувальників високої кваліфікації різного віку. Описана методика досліджень. Вивчення реакції серцево-судинної системи здійснювалося за змінами артеріального тиску, розрахунками величини пульсового тиску та коефіцієнту витривалості. Результати дослідження дозволять підвищити ефективність медико-біологічного забезпечення спортивної підготовки фехтувальників різних вікових груп.

Ключові слова: серцево-судинна система, систолічний артеріальний тиск, діастолічний артеріальний тиск, частота серцевих скорочень, пульсовий тиск, коефіцієнт витривалості, вестибулярне навантаження, вестибулярна стійкість, вегетативні реакції, фехтувальники.

Introduction. The interest in studying the vestibular analyzer was and remains quite high. A considerable amount of work is devoted to the study of the influence of vestibular irritations on a human body and the discovery of various labyrinthine reflexes. And this is

natural, because the vestibular nerve in its structure, functional properties and significant connections within the CNS sharply differs from all the cranial nerves, namely with its irritation there is not a narrow-angle reaction, and there is an effect on a large number of functions of an organism.

Among all the cranial nerves, the effect of the vestibular nerve on a body is similar to that of the vagus nerve, which affects the entire vegetative system and some processes in the transverse muscle. The vestibular analyzer is unique among specialized sensory systems in a sense that its secondary fibers are extremely widely distributed in the central nervous system [1].

Literature review. A constant component of the reaction of an organism to the irritation of the vestibular apparatus is vegetative reactions associated with the state of the labyrinth and the vegetative system as a whole, due to which they are very diverse and cover almost all the internal organs and systems: the gastrointestinal tract, the vascular system, secretory organs and metabolism. Many works were devoted to the study of these reactions. Initially, the objects of the research were people of different professions, whose activities required high resistance to deflection (pilots, sailors, astronauts) [2, 3]. A bit later, a focus of the research was shifted to athletes of different types of sport, including those in which high coordination abilities do not play the most important role [4,5,6]. However, cardiovascular, motor and sensory responses of athletes of various specializations on the vestibular irritation are insufficiently studied and require further investigation. There is also very little data on the functional state of the vestibular analyzer in these works, despite the fact that their specific activity is related to the constant irritations in a form of varied accelerations and preservation of equilibrium is a very significant task.

Particularly important is the study of the vestibular function of single-player sportsmen, since during a fight with an enemy, the key role is played by movements, the effectiveness of which is determined by the accuracy of spatial orientation, which, in its turn, depends on the functioning of the vestibular apparatus [7]. However, specialists who are preparing skilled fencing athletes ignore researches of this kind. This is unjustified, since a fencer during a battle is always subject to vestibular loading due to rapid changes in the direction of movements, deviations and sharp turns, and the accuracy of athlete's movements is one of the most important conditions for obtaining a result. In this case, training sessions in this type of sport at all stages of the annual cycle are full of exercises that serve as stimuli for the vestibular apparatus.

Purpose and tasks of the research. According to everything mentioned above, the study of the effect of vestibular loading, in particular on the cardiovascular system of athletes of different ages, is an actual task of sportive and age-related physiology. The purpose of the article is to investigate the effect of vestibular loading on the cardiovascular system of high-qualified fencers.

Materials and methods. To study the effect of vestibular loading on the cardiovascular system of high-skilled fencers, 30 athletes with a sport rank of the Master of Sports (MS) and members of the Ukrainian national team participated in the study. Changes in the frequency of heart rate (HR) and blood pressure (AP) of the subjects were used to assess the effect of vestibular loading. The vestibular load was created by means of a rotational test in the armchair of the Ram according to Voyachech's method [1]. As a result of the data obtained before and after the rotational test, the following were determined:

a) the reaction of the cardiovascular system following changes in blood pressure and heart rate; blood pressure and heart rate were determined from the left hand using the electronic automatic tonometer A&D UA-777 of the Japanese company A&D Medical; calculated the pulse pressure (PP) using systolic (SAT) and diastolic (DAT) blood pressure indicators;

b) the coefficient of endurance (CE) (according to Balandin and others) [8], which is an integral value, uniting the heart rate, SAT and DAT; it is determined by the formula: CE = HR = 10 / PP. The research was conducted on the basis of the National University of Physical Education and Sports of Ukraine. All surveyed were informed about the survey process and provided written consents in accordance with the Helsinki Ethical Declaration.

The experimental data was analyzed by using mathematical statistics. The reliability of the differences in average values was determined by the Student's t-criterion.

The results of the research and the discussion of them. In the course of the study, the following results were obtained: all fencers of high qualification corresponded to the vestibular loading of changes in the cardiovascular system. The changes in heart rate ranged from 0 to 28 beats per a minute, and the average pulse of athletes varied at 10 percent. It should also be noted that not all athletes responded to the use of vestibular loading with an increase in heart rate. 12 people had decreased heart rate, and one athlete had unchanged one. This is in accordance with the data of scientists that not all people have the same vegetative reaction to vestibular irritations [9, 10].

The study has shown that blood pressure and heart rate in response to a vestibular test for different objects may increase, decrease or remain unchanged, but the average values of

changes in groups have a certain orientation. The heart rate of athletes of all age groups in response to the vestibular load increases. The increase in age groups of 16, 19 and 23 years was 4,31 ± 1,57; 4,33 ± 0,66 and 3,38 ± 0,92 beats per a minute, respectively ($p < 0,05$). The 23-year-old athletes showed the least increase in heart rate.

Consequently, the increase in heart rate of the trained objects should be considered as an adequate response to the vestibular test, which indicates greater stability of the vestibular apparatus to the proposed load.

Reactions of systolic pressure on the rotational load of athletes also have significant differences, especially in age groups of 16 and 23 years. Thus, the SAT of 16 year old athletes increased by 3.21 ± 0.94 mm of mercury ($p < 0.01$). The same SAT trend of changes was found in the subjects of the research group of 19 year old sportsmen, when the average values increase by 2.13 ± 0.87 mm of mercury ($p < 0.05$). At the age of 23 years, the SAT changes in response to the rotational load have a preferential tendency to decrease by 2.85 ± 0.80 mm of mercury respectively.

Concerning the reaction of diastolic pressure on the rotational load, its trend in all the studied groups is the opposite to the SAT changes. The most significant reduction in DAT was found at 16 year old athletes (2.73 ± 1.02 mm of mercury), and 23 year old athletes' DAT increased respectively (2.67 ± 0.86 mm of mercury).

Consequently, the response to the rotational load, both by the reactions of SAT and DAT, among athletes of different age groups was the largest in the age group of 16 years.

The divergent nature of the reactions of SAT and DAT on the rotational load influenced the expressiveness of pulse pressure changes in the studied groups. In the age groups of 16 and 19 years, there was a marked decrease in this figure for athletes: at 5.50 ± 2.09 and 4,06 ± 0.87 mm of mercury accordingly.

Thus, the dynamic of age-related changes in the PP in response to the rotational load, in essence, repeats the trend of the DAT changes.

After the vestibular load, a moderate increase of the CD in a group of 16 year old athletes is observed (3.53 ± 0.70 ($p < 0.01$). The growth of CD indicates weakening of the cardiovascular system [11], which ultimately leads to an unsatisfactory adaptation of an organism to the action of a vestibular stimulus. In groups of 19 and 23 year old athletes, there is a tendency to the CD decrease: at 19-year-old sportsmen at 1.40 ± 0.98, at 23-year-old athletes at 0, 91 ± 0.62.

Table 1.

Changes in the cardiovascular system under the influence of vestibular loading

Age group	The average value of changes in the work of the cardiovascular system			
	HR (ld / min)	SAT (mm of mercury)	DAT (mm of mercury)	PP (mm of mercury)
16 years old	4.31 ± 1.57	3.21 ± 0.94	2.73 ± 1.02	5.50 ± 2.09
19 years old	4.33 ± 0.66	2.13 ± 0.87	2.69 ± 0.93	4.6 ± 0.87
23 years old	3.38 ± 0.92	2.85 ± 0.80	2.67 ± 0.86	3.76 ± 0.73

Reduced HR of the studied athletes of 19 and 23 years in response to the vestibular loading indicates positive changes in a functional state of the cardiovascular system and the increase of adaptability of the heart muscle to the vestibular irritations.

The data indicates a different reaction of heart rate and blood pressure of the athletes during the rotational test in the Baran's chair, which corresponds to the figures that the vestibular analyzer has a strong connection with the central nervous system and in a case of low sensitivity and high stability of the vestibular apparatus the vegetative reactions occur less noticeable.

Conclusions. It is shown that under the influence of fencing exercises, as the athletes' qualifications grow, the trend of the cardiovascular system's response to the vestibular irritation changes, and its severity is largely determined by the the age of the subjects being tested. The data leads to the conclusion that training of the vestibular apparatus is important for fencing to improve the technique of exercising. It should also be noted that a large number of athletes showed high changes in the work of the cardiovascular system, indicating that their level of vestibular stability is quite low. This suggests that the athletes do not use methods of vestibular stability training in their professional activities, which can prevent them from obtaining high sports results in fencing. Therefore, further research should be carried out to find a correlation between the indicators of the vestibular stability of fencers and their results.

Список використаних джерел

1. Воячек В. И. Современное состояние вопроса о физиологии и клинике вестибулярного аппарата [Текст] / В. И. Воячек // Журнал ушных, носовых и горловых болезней. – 1923. – № 3–4. – С. 36–42.

2. Коротков Ю.А. Вестибулярная устойчивость моряков [Текст] / Ю.А. Коротков, С.С. Маркарян // Журнал ушных, носовых и горловых болезней. – 1987. – № 5. – С. 48–50.

3. Young L.R. Vestibular reactions to spaceflight: human factors issues [Text] / L.R. Young // Aviat Space Environ Med. – 2000. – № 71(9). – P. 100–104.

4. Чинкин А. С. Вестибулярная устойчивость спортсменов разных видов спорта [Текст] /А. С. Чинкин. – Поволжский: ГАФКСИТ, 2011. – 167 с.

5. Моисеенко Е. К. Оценка уровня вестибулярной устойчивости волейболистов и баскетболистов команд ХГАФК [Текст] / Е. К. Моисеенко, И. В. Ширяева, Ю. А. Горчанюк, Н. А. Пащенко // Спортивные игры. – 2016. – №. 1. – С. 25-28.

6. Помещикова І. П. Вплив вправ вестибулярної спрямованості на рівень техніко-тактичної підготовленості баскетболісток студентської команди [Текст] / І. П. Помещикова // Фізична культура: теорія і практика: Часопис кафедри теорії і методики фізичного виховання, адаптації та масової фізичної культури ПНПУ ім. В. Г. Короленко. – 2016. – №3. – С.195-200.

7. Минин В. В. Влияние вестибулярных раздражений на показатели центральной кардиогемодинамики у боксеров с различным уровнем вестибулярной устойчивости [Текст] / В. В. Минин // Фізичне виховання, спорт і культура здоров'я в сучасному суспільстві: зб.наук.пр. Волин. нац ун-ту ім. Лесі Українки. – 2012.– №4 (20). – С.447-450.

8. Баландин В.И. Оценка состояния вегетативной нервной системы моряков в плавании [Текст] / В.И. Баландин, В.И. Кулешов, Н.И. Мозоль // Военно-медицинский журнал. – 1975. – №6. – С. 63-64.

9. Янов Ю.К. Методология теории самоорганизации в развитии представлений о физиологических механизмах вестибулярных реакций [Текст] / Ю.К. Янов, К.В. Герасимов // Успехи физиологических наук. – 2000. – Т.31, №2. – С.79-88.

10. Тарабрина Н.Ю. Роль активной тракционно-ротационной миорелаксации в коррекции реакций сердечно-сосудистой системы спортсменов с различным исходным вегетативным тонусом на действие вестибулярной нагрузки [Текст] // Вісник Харківського національного університету імені В.Н.Каразіна. Серія: біологія. – 2012. – Вип. 15. – С.217-225.

11. Байченко, И.П. О совершенствовании функционального состояния вестибулярного анализатора у юных лыжников-гонщиков [Текст] / И.П. Байченко, Е.И.

Степанов, Е.Н. Федоров [Текст] // Теория и практика физической культуры. – 1972. – № 1. – С. 60-63.

References

1. Voyachek V. I. (1923). Sovremennoye sostoyaniye voprosa o fiziologii i klinike vestibulyarnogo apparata [The current state of the question of physiology and the clinic of the vestibular apparatus]. Journal of ear, nose and throat diseases, 3–4, 36–42.

2. Korotkov YU.A., Markaryan S.S. (1987). Vestibulyarnaya ustoychivost' moryakov [Vestibular stability of sailors]. Journal of ear, nose and throat diseases, 5, 48–50.

3. Young L.R. (2000). Vestibular reactions to spaceflight: human factors issues. Aviat Space Environ Med, 71(9), 100–104.

4. Chinkin A. S. (2011). Vestibulyarnaya ustoychivost' sportsmenov raznykh vidov sporta [Vestibular stability of athletes of various sports]. Povolzhskyy, Russia: HAFKSYT, 167.

5. Moiseyenko Ye. K., Shiryayeva I. V., Gorchanyuk YU. A., Pashchenko N. A. (2016). Otsenka urovnya vestibulyarnoy ustoychivosti voleybolistov i basketbolistov komand KHGAFK [Assessment of the level of vestibular stability of volleyball and basketball players of the HGAFK teams]. Sports games, 1, 25-28.

6. Pomeshchikova Í. P. (2016). Vpliv vprav vestibulyarnoĭ spryamovaností na ríven' tekhníko-taktichnoĭ pídgotovleností basketbolístok students'koĭ komandi [Influence of exercise of vestibular direction on the level of technical and tactical preparation of basketball players in the students team]. Physical Culture: theory and practice, 3, 195-200.

7. Minin V. V. (2012). Vliyaniye vestibulyarnykh razdrazheniy na pokazateli tsentral'noy kardiogemodinamiki u bokserov s razlichnym urovnem vestibulyarnoy ustoychivosti [Influence of vestibular irritations on indicators of central cardioghemic dynamics of boxers with different levels of vestibular stability]. Physical Education, Sports and Health Culture in Modern Society, 4 (20), 447-450.

8. Balandin V.I., Kuleshov V.I., Mozol N.I. (1975). Otsenka sostoyaniya vegetativnoy nervnoy sistemy moryakov v plavanii [Estimation of the state of the autonomic nervous system of sailors in sailing]. Military&Medical Journal, 6, 63-64.

9. Yanov YU.K., Gerasimov K.V. (2000). Metodologiya teorii samoorganizatsii v razvitii predstavleniy o fiziologicheskikh mekhanizmakh vestibulyarnykh reaktsiy [Methodology of the theory of self-organization in the development of ideas about the

physiological mechanisms of vestibular reactions]. Advances in physiological sciences, 31 (2), 79-88.

10. Tarabrina N.YU. (2012). Rol' aktivnoy traktsionno-rotatsionnoy miorelaksatsii v korrektsii reaktsiy serdechno-sosudistoy sistemy sportsmenov s razlichnym iskhodnym vegetativnym tonusom na deystviye vestibulyarnoy nagruzki [The role of active traction-rotational miorelaksation in correction of reactions of cardiovascular system of athletes with different initial vegetative tone on the influence of vestibular load]. The Journal of V.N.Karazin Kharkiv National University. Series "Biology", 15, 217-225.

11. Baychenko, I.P., Stepanov Ye.I., Fedorov Ye.N. (1972) O sovershenstvovanii funktsional'nogo sostoyaniya vestibulyarnogo analizatora u yunykh lyzhnikov-gonshchikov [About the improvement of the functional state of the vestibular analyzer of young skiers-racers]. Theory and Practice of Physical Culture, 1, 60-63.