CLINICAL METHODS FOR DIAGNOSING MUSCULAR DISORDERS DURING LONG PERIODS OF BASKETBALL PRACTICE

ORIGINAL ARTICLE
ARTIGO ORIGINAL
ARTÍCULO ORIGINAL

MÉTODOS CLÍNICOS PARA DIAGNÓSTICO DE DISTÚRBIOS MUSCULARES DURANTE LONGOS PERÍODOS DE PRÁTICA DO BASQUETEBOL

MÉTODOS CLÍNICOS PARA EL DIAGNÓSTICO DE TRASTORNOS MUSCULARES DURANTE LARGOS PERÍODOS DE PRÁCTICA DEL BALONCESTO

Qi Zhang[1]
(Physical Education Professional)
Chen Guangzhong[2]
(Physical Education Professional)

1. National University of Ukraine on Physical Education and Sport, Department of Innovation and Information Technologies in Physical Culture and Sports, Kyiv, Ukraine.
2. Sichuan University, Jinjiang College, Department of Physical Education, Meishan City, Sichuan Province, China.

Correspondence:
Qi Zhang
Kyiv, Ukraine. Qi.Zhang7528-3@educ.com.pl

ABSTRACT

Introduction: There are many drawbacks in sports, one of the main problems being injuries. Objective: This work aimed to study the effect of prolonged basketball practice and associated sports injuries on electrophysiological indicators about the functional state of the neuromuscular apparatus in specialized athletes. Methods: A study was conducted in which 14 basketball players participated voluntarily: 7 basketball players aged 17 to 23 years with first category sports qualifications, relatively healthy, with a history of knee and ankle injuries, and seven non-athletes with no history of injuries. Psychophysiological and electrophysiological methods were used for the study, designed to diagnose strength and endurance, measure rhythmic dynamics in hand movements, evaluate the mobility of neural processes, and the functional state of the central nervous system and processes in the central nervous system. Results: It was established that regular sports training leads to morphological and functional changes in the neuromuscular system. Conclusion: Due to repeated injuries, basketball players experience a decrease in the conduction velocity of the electrical pulse in the neural fiber pathway and in the level of reflex excitability in the neuronal motor ensemble of the lumbosacral segments of the spinal cord that innervate the bilateral muscles of the lower limbs; a weakening of the nervous system resistance, mobility of the nervous processes, deterioration of the functional state of the central nervous system and analyzers was noted. ***Evidence level II; Therapeutic studies - outcomes research.***

Keywords: Soft Tissue Injuries; Musculoskeletal System; Electric Stimulation; Athletes; Muscles.

RESUMO

Introdução: Há muitos inconvenientes no esporte, sendo um dos principais problemas as lesões. Objetivo: O objetivo deste trabalho foi estudar o efeito da prática prolongada do basquetebol e as lesões esportivas associadas sobre os indicadores eletrofisiológicos sobre o estado funcional do aparelho neuromuscular em atletas especializados. Métodos: Foi realizado um estudo no qual 14 jogadores de basquetebol participaram voluntariamente: 7 jogadores de basquete de 17 a 23 anos com qualificações esportivas da primeira categoria, relativamente saudáveis, com histórico de lesões no joelho e tornozelo; e 7 não-atletas sem histórico de lesões. Métodos psicofisiológicos e eletrofisiológicos foram utilizados para o estudo, que foram desenvolvidos para diagnosticar a força e resistência, mensurando a dinâmica rítmica nos movimentos das mãos, avaliando a mobilidade dos processos neurais, assim como o estado funcional do sistema nervoso central e os processos nervosos no sistema nervoso central. Resultados: Foi estabelecido que o treinamento esportivo regular leva a mudanças morfológicas e funcionais no sistema neuromuscular. Conclusão: Devido as repetidas lesões, os jogadores de basquetebol experimentam uma diminuição da velocidade de condução do pulso elétrico no trajeto das fibras neurais e do nível de excitabilidade reflexa no conjunto neuronal motor dos segmentos lombossacrais da medula espinhal que inervam os músculos bilaterais dos membros inferiores. Além disso, notou-se um enfraquecimento da resistência do sistema nervoso, mobilidade dos processos nervosos, deterioração do estado funcional do sistema nervoso central e dos analisadores. ***Evidência nível II; Estudos terapêuticos – pesquisa de resultados.***

Descritores: *Lesões dos Tecidos Moles; Sistema Musculoesquelético; Estimulação Elétrica; Atleta; Músculos.*

RESUMEN

Introducción: Existen muchos inconvenientes en el deporte, siendo uno de los principales problemas las lesiones. Objetivo: El objetivo de este trabajo fue estudiar el efecto de la práctica prolongada del baloncesto y las lesiones deportivas asociadas sobre los indicadores electrofisiológicos del estado funcional del aparato neuromuscular en atletas especializados. Métodos: Se realizó un estudio en el que participaron voluntariamente 14 jugadores de baloncesto: 7 jugadores de baloncesto de entre 17 y 23 años con titulación deportiva de primera categoría, relativamente sanos, con antecedentes de lesiones de rodilla y tobillo; y 7 no deportistas sin antecedentes de lesiones. Para el estudio se utilizaron métodos psicofisiológicos y electrofisiológicos, destinados a diagnosticar la fuerza y la resistencia,

midiendo la dinámica rítmica en los movimientos de la mano, evaluando la movilidad de los procesos neurales, así como el estado funcional del sistema nervioso central y los procesos nerviosos en el sistema nervioso central. Resultados: Se estableció que el entrenamiento deportivo regular produce cambios morfológicos y funcionales en el sistema neuromuscular. Conclusión: Debido a las lesiones repetidas, los jugadores de baloncesto experimentan una disminución de la velocidad de conducción del impulso eléctrico en el trayecto de las fibras neuronales y del nivel de excitabilidad refleja en el conjunto neuronal motor de los segmentos lumbosacros de la médula espinal que inervan los músculos bilaterales de las extremidades inferiores. Además, se observó un debilitamiento de la resistencia del sistema nervioso, la movilidad de los procesos nerviosos, el deterioro del estado funcional del sistema nervioso central y de los analizadores. ***Nivel de evidencia II; Estudios terapéuticos - investigación de resultados.***

Descriptores: *Traumatismos de los Tejidos Blandos; Sistema Musculoesquelético; Estimulación Eléctrica; Atletas; Músculos.*

DOI: http://dx.doi.org/10.1590/1517-8692202329012022_0423 Article received on 08/04/2022 accepted on 08/23/2022

INTRODUCTION

The relevance of the injury problem is confirmed by statistics in recent years, about 40% of injuries occur in basketball.[1] Increased, constantly recurring overload of the musculoskeletal system, namely synchronous loads are harmful since they destroy the upper layers of tissues. As a result, a cascade of destructive reactions is triggered and functions are disrupted. This is manifested by pathological changes in blood vessels and metabolic disorders. Following this, the tissue trophic is disrupted and their morphological changes appear.[2] To date, the question of the aetiology and pathogenesis of chronic injury or disease of skeletal muscles remains open, not fully resolved. The study of the depth of the processes underlying the muscle pathology requires its detailed resolution using immunological, biomechanical, electron microscopic study methods.

As a result of excessive and monotonous loads, overstrain is in muscles, in places of transition to the tendon, in tendons, in places of attachment to bone tissue. This often results in a painful feeling and the inability to continue training.[3] The state of detraining, which follows a sports injury, leads to a decrease in the basic physical qualities, techniques of motor actions and skills in the chosen sport.

Objective: to study the effect of prolonged basketball practice and associated sports injuries on the electrophysiological indicators of the functional state of neuromuscular apparatus of athletes.

MATERIALS AND METHODS

Psychophysiological and electrophysiological research methods were used to study the functional state of the neuromuscular apparatus of athletes specialising in basketball. Psychophysiological ones include: tap test, which is designed to diagnose the strength and endurance of nervous processes by measuring the dynamics of the pace of hand movements; a visual motor reaction method that allows assessing the mobility of nervous processes, as well as the functional state of the central nervous system and analysers; a method of discrimination reaction aimed at measuring the mobility of nervous processes in the central nervous system.[1] The electrophysiological method includes the registration of evoked motor responses of the bilateral muscles of the lower extremities during percutaneous electrical stimulation of the spinal cord at the level of T11-T12 vertebrae.[4]

According to the localisation of injuries of the musculoskeletal system, basketball representatives have distinguished injuries to the knee and ankle joints. The method of magnetic stimulation of various structures of the nervous system is used in neurophysiological, sports, neurological, traumatological, and orthopaedic practice.[5] This work was carried out using this method to analyse changes in the central nervous system in various functional states of the motor system.[6]

With transcranial magnetic stimulation (TMS) of the motor cortex of the right lower extremity muscles (rectus femoris, biceps femoris, flounder muscle, anterior tibial muscle), which was carried out using a magnetic stimulator Magstim Rapid (Magstim Somrapu Ltd, Great Britain), an angular coil with a magnetic field power of 1.4 T was placed above the craniometric point on the vertex skull. During magnetic stimulation of the spinal segments at the level of T12-L1 vertebrae, a flat single coil with a diameter of 70 mm with a magnetic field power of 2.6 T was used. The registration of evoked motor responses (EMR) of the studied thigh and lower leg muscles was carried out in the position of the subjects lying on the couch and in a state of relative muscular rest. The following parameters of evoked motor responses were evaluated: threshold (T, %), amplitude (mV), latency (ms), time of central motor conduction (ms). Studies with the magnetic stimulation method were conducted in the National University of Ukraine on Physical Education and Sport, on the participants' voluntary basis. Data analysis of digital material was carried out using the licensed statistical package Statistica 10.0.[7]

For each parameter studied, the mean value (M) and the error of mean (m) were determined. For statistical comparative analysis, nonparametric criteria (Mann Whitney and Wilcoxon) were used under the condition of abnormal distribution of numerical values in the samples determined using the Shapiro Wilk test. The differences were considered statistically significant at $p<0.05$. The use of modern neurophysiological methods and transcranial magnetic stimulation allows assessing the condition of the upper and lower parts of the cortical-spinal tract, as well as analysing the functional reserves of cortical motor neurons and segmental reflex circuits activated with the involvement of cortical-spinal pathways and signals from the periphery, in normal and pathological conditions. There is much information in the literature about the displacement of the cortical motor projection zones of the leg muscles and other functional rearrangements in the motor cortex with injuries of the musculoskeletal system of the lower extremities. The specific features of the organisation of spinal motor neuron projections of the lower extremities muscles under the influence of external conditions remain understudied.[8]

A study was conducted in which 14 basketball players took part on a voluntary basis: 7 basketball players aged 17 to 23 years with sports qualifications of the first category, relatively healthy, who have a history of knee and ankle injuries, namely ruptures of the anterior and posterior crucial ligaments, meniscus injuries, patellar dislocations, sprains of the ligamentous capsule apparatus, tears and ruptures of the lateral ligaments of the ankle joint, paratenonitis, achillobursitis; and 7 non-athletes who do not have a history of injuries.

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration

and its later amendments or comparable ethical standards. A study was approved by National Ethics Commission of the Ministry of Health of Ukraine, January 23, 2022, No 2021-A. All participants were aware of the ongoing research and gave their written consent.

RESULTS AND DISCUSSION

Neurophysiological research has established that with magnetic stimulation of the structures of central nervous system, basketball players who have not been subjected to transcranial magnetic stimulation are characterised by lower indicators of motor excitation thresholds, latency, and time of central motor conduction, as well as a large amplitude of evoked motor responses of the tested muscles compared with the data of injured basketball representatives. There were no considerable differences between the two groups in the characteristics of the evoked motor responses of the thigh and lower leg muscles. In transcranial magnetic stimulation, mean group values of the maximum amplitude of induced motor responses of the rectus femoris and tibialis anterior muscles in basketball players who underwent transcranial magnetic stimulation were lower respectively by 40.6 and 47.1% than in athletes without injury ($p<0.05$; $p<0.01$), while statistically they were not considerably different from those of persons engaged in professional activities ($p>0.05$).[9] The study has shown lower threshold indicators and higher amplitude indicators of the evoked motor responses of the tested muscles in basketball players who had no history of diagnosed injuries and diseases of the musculoskeletal and other body systems, compared with those in the group of people who had a history of occupational injuries. This indicates a higher level of excitability of cortical neurons and motor neurons of the lumbar spinal segments regulating neuromuscular reactions in the proximal and distal parts of the lower extremities in basketball players than in non-athletes.[10]

It was established that in basketball players without a history of transcranial magnetic stimulation, with magnetic stimulation of the motor cortex and at the level of lumbar thickening of the spinal cord, the latency indicators of the evoked motor responses of the thigh and lower leg muscles, as well as the time of central motor conduction, were considerably lower than in persons not engaged in professional sports, which indicates a significantly higher conductive ability of the cortical-spinal tract in the former compared with the latter. The differences found in the course of these studies in the excitability and conductivity of neuromuscular structures in the subjects are associated with the influence of a genetic factor on plastic rearrangements in the functioning of the central and peripheral links of the neuromotor system. It is known that athletes of gaming, cycling and power sports differ in the characteristics of the nervous system, the composition of muscle fibres, the nature of energy supply, and these differences are genetically determined.[11,12] The study of possible neuronal adaptive changes in the functioning of the motor system of athletes caused by various types of motor activity is becoming increasingly common. The opinion that plasticity of the central and peripheral links of the neuromotor system may be the result of adaptation to increased activity of skeletal muscles is discussed by researchers.[13,14]

The changes in the functions of cortical and spinal structures found in the course of this study in basketball players who underwent transcranial magnetic stimulation indicate a weakening of the excitability of motor cortex and neuronal structures of the spinal cord, as well as a deterioration in the condition of the central conductors of the nervous system. These players have shown an increase in the level of cortical-spinal excitability and conduction, it appeared to be as close as possible to that of athletes without injuries and significantly higher than that of people not involved in professional sports. Electrophysiological testing allowed establishing that basketball players who suffered injuries and diseases of the musculoskeletal system showed a decrease in the speed of conducting an electric pulse along nerve arcs and a decrease in the level of reflex excitability of the motor neuron pool of the lumbosacral segments of the spinal cord innervating the bilateral muscles of the lower leg and foot, compared with a group of relatively healthy basketball players.[15,16] This conclusion was made based on higher thresholds and latency, along with lower indicators of the maximum amplitude of evoked motor responses of the tested muscles in sports players with musculoskeletal disorders compared with basketball players without them.

It was established that relatively healthy basketball players have greater strength and endurance of the nervous system, as well as mobility of nervous processes than those who have suffered injuries and diseases of the musculoskeletal system. Against the background of repeatedly suffered injuries and diseases of the musculoskeletal system, basketball players have a decrease in the speed of conducting an electric pulse along the nerve arcs and the level of reflex excitability of the motor neuron pool of the lumbosacral segments of the spinal cord innervating the bilateral muscles of the lower leg and foot, as well as a decrease in the strength and endurance of the nervous system, mobility of nervous processes, and deterioration of the functional state of the central nervous system and analysers.

Basketball representatives have distinguished injuries to the knee and ankle joints. To prevent pathological conditions and restore the functional capabilities of the athlete's body after injuries and diseases, it is necessary to include a mandatory structural component in the system of long-term training, a rehabilitation and prevention.[17] This is relevant at the stage of resuming training after injuries. The method of magnetic stimulation of various structures of the nervous system is widely used in neurophysiological, sports, neurological, traumatological, and orthopaedic practice. This study was conducted using this method to analyse changes in the central nervous system in various functional states of the motor system. Distinctive features of the functioning of the motor cortex and spinal motor control systems in persons who are not engaged in professional sports and in qualified basketball players were identified.[18]

The structure of sports injury is dominated by soft tissue injuries in the form of abrasions, bruises, wounds, which by severity relate to minor injuries. Injuries to muscles, tendons, ligaments occur as a result of direct mechanical injury or sharp muscle contractions when running, playing football, basketball, in weightlifters etc. Joint injuries of ankles or knees occupy an important place in the structure of sports injuries. The mechanism of joint injuries is caused by excessive, forced movements, as well as sudden uncoordinated muscle contractions, leading to overstrain of the fibrous capsule of the joint and its ligaments.[19]

The knee joint is in the first place among traumatic injuries. Joint injury is characterised by damage to the menisci, lateral and crucial ligaments. Typical for the mechanism of meniscus injury is simultaneous retraction, slight flexion and rotation to the outside of the lower leg in the knee joint, followed by its extension. The medial disc moves deeper into the joint, there is a tension of the tibial ligament. The meniscus attached to it is subjected to a sharp pull and ruptures longitudinally or breaks away from the tibial ligament.[20] Injuries to the crucial ligaments occur when the lower leg is turned inward, when the ligament is twisted around its longitudinal axis, as well as a sharp overextension of the lower leg in the knee joint, followed by the tension of the anterior crucial ligament and its transverse compression due to compression by the interstitial elevation. Damage to the lateral ligaments of the knee joint occurs with a sharp withdrawal or reduction of the bent lower leg with a fixed hip. Fingers are also injured as a result of sprains of the phalangeal joints and tendon ruptures at the level of the distal joints of the phalanges.[3]

CONCLUSIONS

The study has shown lower threshold indicators and higher amplitude indicators of the evoked motor responses of the tested muscles in basketball players who had no history of diagnosed injuries and diseases of the musculoskeletal and other body systems, compared with those in the group of people who had a history of occupational injuries. This indicates a higher level of excitability of cortical neurons and motor neurons of the lumbar spinal segments that regulate neuromuscular reactions in the proximal and distal parts of the lower extremities in basketball representatives than in non-athletes. It was established that in basketball players without a history of transcranial magnetic stimulation, with magnetic stimulation of the motor cortex and at the level of lumbar thickening of the spinal cord, the latency indicators of the evoked motor responses of thigh and lower leg muscles, as well as the time of central motor conduction, were considerably lower than in persons not engaged in professional sports, which indicates a significantly higher conductive ability of the cortical-spinal tract in the former compared with the latter.

The differences in excitability and conductivity of neuromuscular structures found in the subjects in the course of these studies are associated with the influence of a genetic factor on plastic rearrangements in the functioning of the central and peripheral links of the neuromotor system. High mobility of nervous processes is necessary not only for a rapid change in the structure and pace of players movements but also for a corresponding change in the activity of numerous functional systems, in particular respiratory and cardiovascular, which should be quickly involved in intensive work and quickly recover after its completion. The method of magnetic stimulation of various structures of the nervous system is used in neurophysiological, sports, neurological, traumatological, and orthopaedic practice. The important components and mechanisms for developing a competent approach to the control and effective management of motor activity of representatives of various age and gender groups and the training process are complex instrument diagnostics and scientific interpretation of indicators of the functional state of the body.

All authors declare no potential conflict of interest related to this article

AUTHORS' CONTRIBUTIONS: Each author made significant individual contributions to this manuscript. QZ: writing and revision; CG: methodology and analysis of the data.

REFERENCES

1. Lanskaya OV. Electrophysiological study of the neuromuscular system in basketball players with post-traumatic knee joint diseases [Internet]. 2018 Available at: http://novainfo.ru/article/11646.
2. Lanskaya OV, Andriyanova EY. Mapping of the spinal projections of the muscles of the lower extremities in basketball players with knee injuries [Internet]. 2012 Available at: https://mos.ngmu.ru/?id=579.
3. Auriat AM, Neva JL, Peters S, Ferris JK, Boyd LA. A review of transcranial magnetic stimulation and multimodal neuroimaging to characterize post-stroke neuroplasticity. Front Neurol. 2015;6(226):25. https://doi.org/10.3389/fneur.2015.00226.
4. Linnichenko ER. The problem of injuries in modern sports. Abnorm Pathol and Pathol Physiol. 2014;9(2):12-21.
5. Stepanov KS, Konyakhina GP. Basketball injuries and prevention [Internet]. 2016 Available at: http://elib.cspu.ru/xmlui/bitstream/handle/123456789/37.
6. Lanskaya OV, Lanskaya EV. Analysis of changes in the neurophysiological characteristics of basketball players under the influence of sports and rehabilitation training. J Med Biol Res. 2020;8(2):139-48.
7. Doroncev AV, Zinchuk NA, Ermolina NV, Yaroshinskaya AP. Evalution of the amplitude exercises use for the sports injuries prevention in basketball. Pedagog Psychol Med Biol Probl Phys Cult Sports. 2020;15(3):24-8.
8. Artyushkevich VS. Trauma as a risk factor for ehe health and life of athletes. Issues of Criminol, Forensics and Forensic Exam. 2014;2(36):14-6.
9. Avdonina LG. Injury prevention measures in senior schoolchildren involved in the basketball section. Sci.-2020: Improv Syst Phys Educ Sports Train. 2020;6(22):99-103.
10. Korol VV. Formation of a high level of school safety culture as one of the most important components of the integrated safety of an educational institution. Sci.-2020: Curr Trends Sci Technol Educ. 2018;9(25):5.
11. Portable trainer for improving the defensive actions of basketball players [Internet]. 2019 Available at: http://www.freepatent.ru/patents/2259857.
12. Korchagina NL. NBA draft results as an indicator of youth basketball development. Sci Pract Reg. 2019;1:93-6.
13. Sports Injury Statistics [Internet]. 2019 Available at: http://www.sportmedicine.ru/sport_statistics.php.
14. Gonchar SN. Self-efficacy as a professional quality of future educational psychologists. Moscow: Buki-Vedi; 2012.
15. Gorskaya GB. Organizational stress in sports: sources, specificity of manifestations, research directions. Phys Cult Sports Sci Pract. 2012;4:74-6.
16. Dovzhik LM, Bochaver KA. Sports injury psychology. Moscow: Sports; 2019.
17. Kuchugurova AO, Dubovova AA, Parkhomenko EA. Features of the relationship between procrastination and perfectionism in adolescent athletes. Sci Notes PF Lesgaft. 2018;7:349-50.
18. Kharitonova IV, Bosenko YuM, Raspopova AS. Psychology of physical culture and sports. Krasnodar: Kuban State University of Physical Culture, Sports and Tourism; 2019.
19. Pukhov AM, Ivanov SM, Machueva EN, Mikhailova EA, Moiseev SA. Plasticity of the human motor system under the influence of local physical activity. Ulyanovsk Med Biol J. 2017;1:114-22.
20. Lanskaya OV, Sazonova LA, Lysov AD. The Influence of rehabilitation training sessions on the psychophysiological functions of athletes with injuries of the musculoskeletal system. Adapt Phys Cult. 2020;1(81):43-6.