International Journal of Medicine and Medical Research

Journal homepage: https://ijmr.com.ua/
Volume 11, No. 1. 2025

UDC 616.314-089.23
DOI: 10.63341/ijmmr/1.2025.66

Article's History:
Received: 29.01.2025; Revised: 22.03.2025; Accepted: 27.05.2025

Improving physical performance when using REHASPLINT orthodontic appliances

Andriy Tymchenko*
Postgraduate Student, Neurologist
Kyiv Regional Mental Health Centre
08296, 4 Parkova Str., Vorzel, Ukraine
https://orcid.org/0009-0004-9983-8571

Sofiia Tymchenko
Student
Kyiv Medical University
02099, 2 Boryspilska Str., Kyiv, Ukraine
University College of Osteopathy
SE1 1JE, 275 Borough High Str., London, Great Britain
https://orcid.org/0009-0003-2291-222X

Abstract. Bite correction with the use of orthodontic appliances helps to improve blood circulation by affecting the position of the vertebral artery, normalising muscle tone, reducing pain, and restoring joint mobility. The present study was devoted to the impact of REHASPLINT orthodontic appliances on the physical performance of patients with traumatic brain injuries and traumatic cervical syndrome. The study involved a clinical experiment with 10 patients aged 25 to 38 years. The physical strength assessment included pull-ups, hanging on a crossbar, pushing a medical ball (9 kg), and squeezing a wrist expander. The testing was conducted in two stages: without and with orthodontic mouthguards. The results of the study confirm that the use of mouthguards helps to improve muscle function and overall physical performance by optimising bite biomechanics. The study showed that the use of orthodontic mouthguards during exercise contributes to a significant improvement in the physical performance of participants. When performing pull-ups, the average result increased from 7.3 to 10.7 pull-ups, which indicates an increase in upper body strength by 46.58%. The time spent holding the bar increased from 54.3 to 76.4 seconds, which demonstrates an improvement in endurance and muscle control by 40.7%. When pushing a 9 kg medicine ball, the average distance increased from 4.63 to 5.45 metres, indicating an increase in strength and coordination by 17.73%. Compression of the wrist expander showed an increase in the average result from 128.9 to 152.1 compressions in 60 seconds, increasing arm strength and endurance by 18.04%. The impact of orthodontic mouthguards is most noticeable in exercises requiring coordination and stability, such as holding on to the bar and pushing a ball. The data obtained emphasise the effectiveness of orthodontic mouthguards in the rehabilitation of patients with traumatic brain injury and traumatic cervical syndrome. The use of mouthguards can be recommended to improve the physical capabilities of military personnel and patients during rehabilitation

Keywords: traumatic brain injury; traumatic cervical syndrome; vertebral artery; cerebral blood flow; orthodontic mouthguards; physical performance; physical rehabilitation

Introduction

Despite significant advances in weaponry, the development of innovative methods of warfare, and the growing role of unmanned aerial vehicles, it cannot be argued that a reduction in the number of wounded soldiers automatically leads to a reduction in the incidence of traumatic brain injuries. In fact, these injuries remain one of the most

Suggest Citation:
Tymchenko A, Tymchenko S. Improving physical performance when using REHASPLINT orthodontic appliances. Int J Med Med Res. 2025;11(1):66–77. DOI: 10.63341/ijmmr/1.2025.66

*Corresponding author

common problems among soldiers in today's military conflicts. Modern protective equipment reduces the likelihood of penetrating wounds but increases the impact of the shock wave, making it one of the leading causes of traumatic brain injury. Blast injuries are divided into several types: primary (shock wave), secondary (fragments of debris), tertiary (body acceleration), and quaternary (high temperatures and toxic gases). Tertiary trauma, which results from the acceleration of the body after an explosion, is one of the most common causes of traumatic brain injury in combat. Due to the high force of the explosions, many soldiers are either killed or seriously injured, including those in a vegetative state. Scientists L.-Z. Kong *et al.* [1] argue that the symptoms of mild traumatic brain injuries are often nonspecific and may not be noticed by doctors. Thus, despite the improvement of protective equipment and the development of technology, traumatic brain injuries remain a significant problem that requires a comprehensive approach to prevention, diagnosis, and treatment.

L. Sushchenko *et al.* [2] note that military personnel suffering from traumatic brain injuries often face insufficient adaptation of rehabilitation programmes to their specific needs, which highlights the need for further research and development of specialised therapeutic approaches. The severity of the consequences of traumatic brain injury directly depends on the type of injury and the timeliness of medical care. These consequences can range from full recovery to severe disabling disorders or death, depending on the mechanism of injury and the speed of response to treatment. Among the most common complications of traumatic brain injuries are motor disorders, spasticity, and cognitive impairment, which seriously limit the patient's ability to learn, work, and adapt socially. The effectiveness of rehabilitation largely depends on the complexity of approaches that include physical exercises, cognitive training, vestibular rehabilitation, kinesitherapy, and aerobic exercise. These methods stimulate neuroplasticity and help restore functional capabilities.

Mild forms of traumatic brain injury tend to remain hidden, making it difficult to diagnose and treat effectively. Methods of restoring intracranial injuries are still under development, and in military settings, the treatment of traumatic brain injuries is focused mainly on neuropsychiatric symptoms rather than full recovery. Primarily, pharmacological and physical therapy, as well as rehabilitation, including cognitive and behavioural therapy, are used to restore cognitive and social functions. Despite advances in neuroregeneration, serious neurological consequences, such as long-term cognitive impairment and chronic pain, require a long course of rehabilitation and social adaptation to successfully reintegrate injured servicemen and women into professional and social life. Researchers N.E. Carlozzi *et al.* [3] argue that recovery from traumatic brain injury is often complicated by concomitant mental disorders, such as post-traumatic stress disorder and depression, as well as bodily injuries. In such cases, servicemen and women often require long-term inpatient treatment, followed by specialised rehabilitation and support after discharge.

Cranial injuries resulting from traumatic brain injury can contribute to the development of various types of malocclusions. According to C. Kariya *et al.* [4], cranial injury is the main factor causing malocclusion and cranial compensation that develops after temporomandibular joint disorder. Malocclusions can cause pathological occlusal relationships, playing a vital role in the development of temporomandibular joint dysfunction. These abnormalities cause proprioceptive changes that reflexively lead to tension and spasm of the masticatory muscles, which contribute to their dysfunction. Y. Rybert *et al.* [5] argue that patients with temporomandibular joint disorders in the setting of orthodontics require a thorough examination and the use of modern methods of diagnosis and treatment aimed at normalising the musculoarticular complex and correcting the bite.

The relevance of studying the possibilities of improving the physical performance of servicemen with traumatic brain injuries using REHASPLINT orthodontic appliances is due to the high prevalence of malocclusion in servicemen with traumatic brain injuries and their significant impact on overall health, including the function of muscles, joints and the nervous system. Despite the potential benefits of using orthodontic mouth guards, there is a lack of research directly examining their impact on physical performance during physical activity in servicemen and women with traumatic brain injury. Most of the available studies focus on the general aspects of treatment of occlusal disorders, without a specific focus on the military population and its specific needs. In addition, insufficient attention has been paid to the long-term effects of RehaSplint on the recovery of physical performance, which is important for military personnel who need rapid rehabilitation. There is also a need for a more detailed study of the mechanisms of action of these devices on muscles and joints, as well as their impact on overall physical fitness. Addressing these gaps can significantly improve approaches to the treatment and rehabilitation of servicemen and women with traumatic brain injuries, providing more effective methods of restoring their physical capabilities. In this regard, the aim of this study was to investigate the effect of orthodontic mouthguards on the physical performance of patients during physical activity.

Literature Review

The traumatic cervical syndrome that occurs after a traumatic brain injury includes biological and neurological consequences that manifest as neck pain, headaches, and impaired nervous, mental, otological, and visual functions. Scientists N. Tanaka *et al.* [6] state that in 20-40% of patients, pain can persist for years, and chronic forms can cause arthritis, nerve root irritation, and vestibular disorders. According to R. Sillevis & A. Hansen [7], cervicogenic headache occurs due to biomechanical dysfunction of the cervical spine, which causes nerve compression and muscle tension. This condition is accompanied by pain and limited neck mobility. Treatment involves correcting the position of the joints and restoring normal muscle tone. Cervicogenic dizziness caused by functional problems of the neck is manifested by pain, nausea, visual and hearing impairments, as well as temporomandibular joint problems and psychological disorders. In addition, problems with the temporomandibular joint and psychological disorders may occur. Impaired motor activity of the cervical muscles is manifested in a decrease in strength, endurance and stability, as well as in changes in muscle behaviour, including a decrease in the activity of deep postural muscles and a delay in the onset of muscle reactions.

The study by E.A. Katz *et al.* [8], which involved 7 patients diagnosed with cervical lordosis, demonstrated that the loss of cervical lordosis may play a role in the development of changes associated with the hemodynamics of the circle of Willis and cerebral arteries, as well as in reducing blood flow in the brain. Loss of cervical lordosis is a condition characterised by a decrease in the natural curvature of the cervical spine. The main causes of this condition are poor posture, trauma (e.g., whiplash), degenerative disc disease, and spondylolisthesis. Symptoms may include muscle tension, discomfort in the neck and arms, and possible neurological disorders due to nerve compression. Loss of lordosis disrupts the biomechanics of the spine, increasing the load on muscles and joints, which can lead to chronic pain and serious complications if left untreated. The results of the study showed that the correction of cervical lordosis loss was associated with an increase in cerebral artery parameters, indicating an immediate increase in blood flow in the brain.

Systematic reviews by N. Bowler *et al.* [9] confirm the high effectiveness of cervical spine manipulations in reducing neck pain and headaches. However, these procedures are associated with the risk of serious neurovascular complications, such as transient ischaemic attack, stroke, or even death, which is most often caused by dissection of the vertebral artery and, less often, the internal carotid artery. According to H. Kranenburg *et al.* [10], understanding the mechanical factors, including the characteristics of blood flow in the cervical arteries in different positions and movements of the cervical spine, can help reduce the risk of ischaemic disorders, such as stroke, after mobilisation or manipulation procedures on the cervical spine. In conformity with M. Waheed *et al.* [11], modern technologies facilitate operations with minimal incisions, which reduces the risk of complications and speeds up the recovery process. Spine surgery includes methods of treating pathologies of the cervical and lumbar spine aimed at improving the condition of patients. The main procedures include laminectomy to normalise function and reduce pain, decompression to relieve pressure on nerve roots, kyphoplasty and vertebroplasty to restore vertebral height in compression fractures, spinal fusion to stabilise vertebrae with titanium screws and plates, and endoscopic surgery to avoid tissue damage and speed up recovery.

M. Renke *et al.* [12] argue that cerebral blood flow is a key indicator of the functional state of the brain, as it provides oxygen and nutrients to the brain tissue. Prolonged blood flow disorders caused by vascular occlusion or stenosis can lead to irreversible damage to brain tissue, such as the formation of an ischaemic core. The results of studies by S. Hung *et al.* [13] showed that hypoperfused tissue around the ischaemic core remains potentially viable. The fate of this tissue depends on the level of perfusion: if the blood supply improves, the tissue can recover; if not, the ischaemic core can grow, but the degree of its growth varies.

O. Maitas *et al.* [14] focus on the importance of the vertebral artery in the blood supply to the brain. It passes through the canals in the transverse processes of the cervical vertebrae and, entering the skull through the large occipital foramen, connects with the artery of the opposite side, forming the basilar artery. The vertebral artery is divided into four segments (V1-V4), each of which has specific anatomy and treatment. Segment V1 (from the subclavian artery to the transverse foramen of C5 or C6) is easily treated percutaneously if it is straight. Segment V2 (from C2 to C6) passes through the bone canal, and its short distance to the subclavian artery makes treatment more accessible. Segment V3 (from C2 to the dura) is tortuous, which complicates intervention, requiring the avoidance of balloon stents and the use of short self-expanding stents. Segment V4, the intracranial segment, connects the vertebral arteries to the basilar artery and supplies blood to the spinal cord. Thus, the vertebral arteries ascend, passing through the transverse foramen of the cervical vertebrae and merging to form a single basilar artery that continues to the circle of Willis and the cerebral arteries. Given the close anatomical connection between the cervical spine, vertebral arteries and the cerebral vasculature, E.A. Katz *et al.* [8] suggested that improvement of cervical hypolordosis contributes to an increase in collateral hemodynamics of the cerebral arteries and improved blood flow.

Therefore, traumatic cervical syndrome requires a comprehensive approach to diagnosis and treatment. As a result of traumatic brain injuries, traumatic neck syndrome can lead to serious biological and neurological consequences that significantly affect the quality of life of patients. Scientific studies emphasise the importance of timely diagnosis and correction of traumatic cervical syndrome and related conditions to prevent serious complications such as chronic pain and neurological disorders. Manipulations on the cervical spine can be effective, but they should be accompanied by careful medical monitoring to reduce the risk of complications. In general, a comprehensive approach to the treatment of traumatic cervical syndrome and related conditions is necessary to improve treatment outcomes and quality of life. Further research in this area is needed to improve diagnostic and treatment methods, which will reduce the risk of complications and improve the prognosis for patients with traumatic cervical spine injuries.

Materials and Methods

The study was based on the ideas of A.T. Still [15], who viewed the body as a single, integrated system where structure and function are interconnected. Still viewed malocclusion as not just a local problem but part of a complex interaction between the body structure and its functions. He emphasised that an imbalance in the bite can cause tension in the jaws, neck, and even spine, affecting overall health, including the function of internal organs. Steele believed that such disorders should be corrected not only by mechanical means but also by activating the body's natural self-healing mechanisms. He emphasised the importance of manual therapy in improving blood circulation, relieving muscle tension and restoring the harmonious functioning of the nervous system.

The clinical trial involved ten men aged 25 to 38 who were treated at the Kyiv Regional Centre for Mental Health with contusions between March 2024 and January 2025. Patients were monitored during the rehabilitation period. They sustained closed traumatic brain injuries, encompassing cerebral contusions and diffuse axonal damage, predominantly due to blast trauma. The ICD diagnostic for individuals with traumatic cervical syndrome is S13.4 (sprain and strain of the cervical spine) and G44.86 (cervicogenic headache), indicating cervical spine trauma with accompanying neurological symptoms. All patients had a diagnosis on admission that included a range of disorders, such as traumatic brain injury and traumatic cervical syndrome.

Participants with a complicated psychiatric or somatic history were excluded from the study to ensure homogeneity of the sample and minimise the impact of external factors on the results. This approach allowed focusing on the key objectives of the study and exclude the possible impact of comorbidities that could distort the interpretation of the data. A complicated psychiatric history was defined as cases of severe mental disorders, such as schizophrenia, bipolar disorder, or severe depression, which required active medication. The presence of such conditions could have a significant impact on the perception of therapy, patient compliance, and physiological parameters, which would create methodological difficulties.

Somatic anamnesis was defined as diseases that could significantly affect the general condition of the body and the interpretation of the study results. Such conditions included severe chronic diseases of the cardiovascular system, respiratory system, kidneys, and liver, as well as malignant tumours and autoimmune disorders. This selection criterion was aimed at excluding the influence of factors that could complicate the analysis of the effectiveness of the therapy. This approach ensured more accurate and reliable data, which is especially important for the further development of recommendations for the use of treatment methods.

The study used a comprehensive approach to assessing the patients' condition. The first stage involved collecting a detailed medical history, which allowed getting a complete picture of the participants' health status, medical history, past injuries, current complaints and individual characteristics of the body. This stage was important for identifying concomitant factors that could affect the results of therapy. A physical examination was conducted, encompassing a general assessment, evaluation of the musculoskeletal system, neurological status, and function of the maxillofacial area, during which post-traumatic malocclusion was identified in several patients, despite the absence of premorbid bite abnormalities, indicating secondary functional lesions resulting from the injury. This stage allowed assessing the physical condition of the patients and determine the initial indicators for further monitoring. Then, the patients were trained in the use of orthodontic mouthguards. Patients were provided with detailed instructions on how to wear and care for the devices correctly to ensure their maximum effectiveness. This approach not only increased the compliance of the participants but also helped to eliminate possible errors in the application. The complexity of the activities ensured a comprehensive approach to the study, which contributed to obtaining reliable and clinically relevant data.

Orthodontic appliances provided by the German company Bausch GmbH in cooperation with its Ukrainian partners Premier-Dental were used for orthodontic therapy. This assistance was organised as part of a charity initiative aimed at supporting medical institutions in Ukraine. In particular, the devices were handed over to the Kyiv Regional Mental Health Centre located in Vorzel. Physical strength testing was carried out twice with an interval of one week, during which individuals utilised orthodontic mouthguards with daily therapeutic exercises. The exercises consisted of neuromuscular training, including deep neck flexor movements, scapular stabilisation drills, and grip-strengthening activities with hand grippers or putty. This regimen enabled an assessment of the synergistic impact of various therapies on physical performance. At the first stage of the study, testing was carried out without the use of mouthguards, which made it possible to establish baseline physical strength indicators. The second stage included the use of orthodontic mouthguards, which allowed comparing the results and identify changes associated with their use.

The testing involved various techniques aimed at assessing strength and endurance. These exercises provided a comprehensive approach to assessing the participants' physical strength. Comparison of the results of both stages of the study allowed better understanding the impact of orthodontic mouthguards on physical activity. The following methods of physical strength assessment were used in the study are:

1. Pull-ups. The maximum number of pull-ups that patients could perform in one approach was assessed. This test allows assessing the strength of the upper body, especially the muscles of the back and arms, as well as overall physical fitness.

2. Hanging on the bar. Patients were held on the bar for as long as possible, which allowed for assessing the grip strength and endurance of the upper body muscles. The results were recorded in seconds and served as an indicator of overall physical endurance.

3. Pushing a medicine ball (9 kg). In this test, patients pushed a medical ball weighing 9 kg for a maximum distance. It helps to assess both upper body strength and power, as well as coordination of movements.

4. Compression of the wrist expander. Patients used a wrist expander for 60 seconds to assess the endurance of the arm muscles. This test is an effective way to measure grip strength and overall functional ability in the upper extremities.

The testing was carried out under the careful clinical supervision of a neurologist and two assistants, which ensured a high level of safety and professionalism in the study. The neurologist monitored the participants' condition, controlling their physical response to the exercise and providing the necessary medical care in case of any unforeseen situations. The assistants actively helped in organising the testing, including preparing the equipment and instructing the participants before the start of the exercises. They also recorded the results and ensured compliance with test standards. This multidisciplinary interaction helped create a comfortable and safe environment for the participants, which was particularly important for obtaining reliable study results.

The study was conducted in accordance with Commission Directive No. 2005/28/EC [16] and the Helsinki Declaration [17]. All clinical trial participants provided written consent to participate in the study. They were familiarised with the objectives, methods, and procedures of the study. Participants were informed about how the information they provided would be used, that there were no risks involved, and that their anonymity would be ensured. Permission was obtained from the Ethics Committee of the Kyiv Regional Centre for Mental Health that the study complied with ethical standards and did not harm patients.

The results of each stage of testing were recorded in spreadsheets for further analysis. After completion of all tests, a comparative analysis of the data was carried out to identify changes in physical strength indicators. The study employed a paired t-test for matched samples and an F-test to assess variation between conditions, to ascertain the statistical significance of alterations in physical performance. These methodologies were chosen because of the within-subjects design, facilitating accurate assessment of individual changes pre- and post-intervention. The data were analysed and processed using statistical methods and Microsoft Excel and Statistica 6.0 software with significance established at $p < 0.05$. This method facilitated the evaluation of both average performance disparities and the consistency of repeated measures.

Results and Discussion

Traumatic brain injuries remain one of the most common injuries sustained by military personnel during combat, training, or accidents. These injuries can be closed (e.g., concussion, diffuse axonal injury) or open (gunshot and perforation wounds). Blast injuries resulting from the blast wave, as well as combined injuries involving multiple factors of injury, are also common outcomes. Traumatic brain injuries can cause severe cognitive and motor disorders, as well as complications such as infections and epilepsy, which significantly impair the quality of life of victims.

Traumatic brain injury can cause many complications, including malocclusion, temporomandibular joint disorders, traumatic cervical syndrome, and cervicogenic headaches. These disorders can manifest themselves not only in the form of neck pain and headaches but also in movement disorders, psycho-emotional and nervous dysfunction, as well as deterioration of the neck and jaw muscles. Comprehensive treatment of such consequences includes manual therapy, physical exercises, use of orthodontic appliances, and, in some cases, surgical interventions aimed at restoring the structure of the cervical spine, normalising muscle tone, and improving joint mobility. An important aspect of rehabilitation is strengthening the neck muscles, which helps to reduce pain, improve blood circulation, and accelerate recovery from injuries.

One of the most promising methods of rehabilitation for servicemen and women who have suffered from injuries and stress is the use of orthodontic and boxing mouthguards to improve cerebral circulation [18]. This method affects the temporomandibular joint, chewing, and neck muscles, which helps to improve blood flow by correcting the position of the jaw, relaxing muscles and reducing vascular compression. The mouthguards also help to normalise posture by reducing pressure on the cervical arteries and improving cerebral blood flow. The use of orthodontic mouthguards helps to change the occlusion, which in turn affects the position of the cervical vertebrae. This leads to a decrease in muscle tension around the vessels of the neck and a change in the angle of entry of the artery into the vertebra. As a result, the trajectory of the cervical artery is levelled, which significantly improves blood circulation in the carotid basin, one of the main sources of blood supply to the brain [19]. In addition, they stimulate nerve endings, which has a positive effect on cognitive function and reduces the frequency of headaches.

While working with patients suffering from malocclusion, it was noticed that such patients often have other complaints associated with cervical spine dysfunction, such as headaches, back pain, dizziness, visual impairment and memory loss. Additional examinations have shown that bite correction has a positive effect not only on the condition of the dentition but also on the general condition of the musculoskeletal system, in particular on the position of the cervical vertebrae. Given the ideas of A.T. Still [15], the founder of osteopathic treatment, as well as ortho-posthodontics and numerous cases of improved health in orthodontic patients, it was suggested that a change in bite position could affect the position of the vertebral artery and improve blood supply. This assumption became the ideological basis for improving blood supply to the brain with the help of orthodontic and boxing mouthguards.

The vertebral artery is the main vessel that supplies blood to the back of the brain, including the cerebellum, brain stem and occipital lobe. The vertebral arteries rise upwards, passing through the transverse foramen of the cervical vertebrae and merging to form a single basilar artery, which continues to the circle of Willis and the cerebral arteries. Dysfunctions of the vertebral artery include various pathological conditions, such as intracranial dissection, in which damage to the artery wall leads to impaired blood flow and the risk of stroke, stenosis caused by atherosclerosis, degenerative disc disease or congenital anomalies, and vertebrobasilar insufficiency associated with insufficient blood supply to the posterior regions of the brain. Extravascular compression of the vessel by osteophytes or muscle spasms, fibromuscular dysplasia – congenital narrowing of the artery, and thrombosis that occurs in the setting of trauma, dissection, or atherosclerotic changes are also common. Doppler ultrasound, magnetic resonance imaging, computed tomography angiography, and classical angiography are used for the diagnosis of vertebral artery pathologies, including stenosis, dissection, thrombosis, and other vascular complications associated with traumatic cervical injuries.

The vertebral artery is crucial for maintaining the normal functioning of the brain, and any damage, such as narrowing or compression, can lead to serious consequences, including stroke. Correction of the position of the vertebral artery includes various techniques aimed at improving blood circulation and relieving tension in the neck. The use of manual techniques, such as mobilisation of the cervical spine, posture correction and work with muscle tone, helps to eliminate vascular compression and restore normal blood flow.

Dysfunction of the vertebral artery caused by its stenosis can significantly disrupt the blood supply to the posterior parts of the brain, leading to the development of neurological symptoms, including dizziness, coordination disorders and transient ischaemic attacks. The progression of stenosis increases the risk of ischaemic stroke, especially if there is insufficient compensation for blood flow through collateral pathways. Treatment includes drug therapy aimed at improving blood flow and controlling risk factors, and in more severe cases, endovascular or surgical correction methods to restore the artery lumen and prevent ischaemic complications. Vertebral artery stenosis and intracranial dissection differ in nature, mechanism of development and clinical manifestations. Stenosis is a chronic narrowing of the artery caused by atherosclerosis, external compression, congenital anomalies or inflammation, which leads to a gradual decrease in blood flow. Vertebral artery dissection is acute damage to the vessel wall accompanied by the formation of an intramural haematoma or intimal flap, which sharply disrupts blood flow. Stenosis develops as a result of chronic processes, such as osteochondrosis, while vertebral artery dissection occurs suddenly, often after trauma or due to weakness of the vessel wall. Clinically, stenosis is manifested by dizziness and ischaemic episodes, and vertebral artery dissection is manifested by acute neurological symptoms or stroke. Treatment of stenosis is aimed at improving blood flow and includes stenting in severe cases, while in the case of vertebral artery dissection, anticoagulants and thrombolytics are used to prevent complications. Given the close anatomical relationship between the cervical spine, vertebral arteries and the cerebral vasculature, it can be assumed that improvement of cervical hypolordosis contributes to an increase in collateral hemodynamics of the cerebral arteries and improved blood flow.

Recent research has investigated the possible impact of orthodontic devices, particularly mouthguards, on cerebral circulation. Similarly, an observational study by D.P. Garner [20] examined the effect of the mandible's physiological rest position on cerebral blood flow and physical balance. The study observed changes in cerebral blood flow during activities such as clenching, tooth tapping, and mandibular rest position. The results highlighted significant variations in cerebral blood flow during clenching compared to other tasks, suggesting a potential link between mandibular positioning and cerebral circulation.

The results of the study showed that the use of orthodontic mouthguards during exercise demonstrated an increase in physical performance. Participants performed pull-ups, deadlifts, wrist extensions, and throws of 9 kg gymnastic balls. Table 1 shows the participants' achievements in pull-ups with and without orthodontic mouthguards. In the first test, participants were able to perform an average of 7.3 pull-ups, with maximum results ranging from 5 to 12 pull-ups. This demonstrates the diversity of fitness levels among the participants. In the second test, where orthodontic mouthguards were used, the average result was 10.7 pull-ups, with a maximum of 15 pull-ups, confirming the high efficiency of the mouthguards in improving performance. The average difference between the two tests was +3.4 pull-ups (46.58%), which highlights the positive impact of orthodontic mouthguards on the upper part of the body strength development.

Table 1. Pull-up results of study participants without and with the use of orthodontic mouthguards

Testing method	Study participants										Average value (times)	Average growth/ decrease, %
Pull-ups (times)	1	2	3	4	5	6	7	8	9	10		
Without the use of orthodontic mouthguards	5	6	7	8	12	10	6	6	7	6	7.3	46.58
Using orthodontic mouthguards	10	8	10	11	15	11	12	10	10	10	10.7	
Difference +/-	+5	+2	+3	+3	+3	+1	+6	+4	+3	+4	+3.4	

Source: compiled by the authors

Table 2 shows the participants' achievements in hanging from the bar without and with orthodontic mouthguards. In the first test, participants averaged 54.3 seconds on the bar, with maximum results ranging from 50 to 60 seconds. In the second test, where the orthodontic mouthguards were used, the average time increased to 76.4 seconds, with maximum values reaching 85 seconds. This confirms the effectiveness of using the mouthguards to improve performance and increase the time spent on the bar. The average difference between the two tests was +22.1 seconds (40.7%).

Table 2. The results of hanging on the bar without and with orthodontic mouthguards

Testing method	Study participants										Average value (seconds)	Average growth/ decrease, %
Hanging on the crossbar (seconds)	1	2	3	4	5	6	7	8	9	10		
Without the use of orthodontic mouthguards	52	52	52	60	55	60	55	52	55	50	54.3	40.7
Using orthodontic mouthguards	62	70	80	75	82	85	70	80	85	75	76.4	
Difference +/−	+10	+18	+28	+15	+27	+25	+15	+28	+30	+25	+22.1	

Source: compiled by the authors

Table 3 shows the results of the 9 kg medical ball pushing test obtained by the participants both without and with orthodontic mouthguards. In the first test, the participants were able to push the ball an average of 4.63 metres, with maximum results ranging from 4 to 5.5 metres. In the second test, where the orthodontic mouthguards were used, the average increased to 5.45 metres, with maximum results reaching 6.2 metres. This shows a significant improvement in the results due to the use of the mouthguards, which confirms their effectiveness in improving strength and coordination. The average difference between the two tests was +0.82 metres (17.73%).

Table 3. Results of pushing a medical ball 9 kg/m without and with orthodontic mouthguards

Testing method	Study participants										Average value (meters)	Average growth/ decrease, %
Medicine ball push 9 kg/m	1	2	3	4	5	6	7	8	9	10		
Without the use of orthodontic mouthguards	4.2	4.9	4	5.5	5	4.5	4.5	4.2	5	4.5	4.63	17.73
Using orthodontic mouthguards	4.8	5.5	4.5	6	5.5	6	5	6	6.2	5	5.45	
Difference +/−	+0.6	+0.6	+0.5	+0.5	+0.5	+1.5	+0.5	+1.8	+1.2	+0.5	0.82	

Source: compiled by the authors

Table 4 shows the participants' wrist extensor grip performance without and with orthodontic mouthguards. In the first test, the participants were able to perform an average of 128.9 compressions in 60 seconds, with maximum results ranging from 84 to 164 compressions. In the second test, where the Orthodontic mouthguards were used, the average increased to 152.1 compressions, with maximum results reaching 197 compressions. This confirms the effectiveness of the mouthguards in improving performance, which also reflects the positive impact on upper limb strength and endurance. The average difference between the two tests was +23.2 compressions (18.04%), which highlights the significant improvement in performance with orthodontic mouthguards.

Table 4. Results of wrist extensor compression without and with orthodontic mouthguards

Testing method	Study participants										Average value (times)	Average growth/ decrease, %
Wrist expander squeeze in 60 seconds (times)	1	2	3	4	5	6	7	8	9	10		
Without the use of orthodontic mouthguards	84	148	150	150	131	164	90	150	132	90	128.9	18.04
Using orthodontic mouthguards	107	170	162	185	151	197	110	192	141	106	152.1	
Difference +/−	+23	+22	+12	+35	+20	+33	+20	+42	+9	+16	23.2	

Source: compiled by the authors

The paired t-test results indicated statistically significant enhancements in physical performance across all four assessments, with pull-up performance rising by 46.58% ($t = 7.52$, $p < 0.001$), bar hang improving by 40.7% ($t = 10.49$, $p < 0.001$), medicine ball push exhibiting a 17.73% increase ($t = 7.08$, $p < 0.001$), and a 23.2% increase in the average number of compressions ($t = 6.99$, $p < 0.001$). Moreover, the F-test for variance revealed no significant variations in performance variability between circumstances for any of the tasks. In the pull-up test, the F-ratio was 0.71 ($p = 0.31$); in the hanging on the bar test, the F-ratio was 0.87 ($p = 0.44$); in the medicine ball push, the F-ratio was 1.17 ($p = 0.66$); and the compressions F-test indicated no significant difference in variability between the two conditions ($F = 1.40$, $p = 0.31$).

The statistical analysis indicates that the use of orthodontic mouthguards resulted in substantial enhancements in physical performance across all evaluated activities. The paired t-tests revealed statistically significant enhancements in pull-up performance, bar hanging, medicine ball push, and wrist expander compression, with improvements between 17.73% and 46.58%. However, the F-tests showed that these improvements did not cause more differences in how consistent the performance was, as there were no significant changes in performance consistency between the groups before and after the intervention. This indicates that the orthodontic mouthguards significantly improved physical performance while ensuring uniform outcomes across subjects.

Thus, the study used various methods to assess the strength and endurance of the participants. These tests provided a comprehensive approach to analysing physical fitness, allowing identifying the impact of orthodontic mouthguards on performance. The results showed that the use of orthotics during exercise led to an increase in physical performance by an average of 30%. In particular, the pull-up test showed a significant improvement, with the average result increasing from 7.3 to 10.7 pull-ups. Similarly, the time spent holding onto the bar increased from 54.3 to 76.4 seconds, confirming the effectiveness of the mouthguard in improving endurance. In addition, the results of the medicine ball push showed an increase in distance from 4.63 to 5.45 metres, indicating an increase in strength and coordination. The wrist expander squeeze also showed positive changes, with the average number of squeezes increasing from 128.9 to 152.1 per 60 seconds. These data underline the significant improvement in results when using orthodontic mouthguards in all tests. Thus, the results of the study confirm the effectiveness of orthodontic mouthguards as a means of increasing physical activity and overall functional capacity of participants.

The cervical spine is the most vulnerable to external negative influences. Mechanical stress on the cervical spine can cause biomechanical disorders that manifest as vertebral artery syndrome, which includes cerebral, vascular and autonomic symptoms. The results of a study by T. Sakaguchi *et al*. [21] showed that rehabilitation of the cervical spine after injury plays a key role in restoring physical function, improving the ability to perform daily tasks and improving quality of life. The multifaceted approach includes restoring mobility, strengthening muscles and improving spinal balance, which is often overlooked. Strengthening the deep neck and trapezius muscles is particularly important, as their weakness is associated with axial pain. Rehabilitation should begin with light exercises, gradually moving on to isometric and strength exercises, which promote muscle hypertrophy, improve blood circulation, and reduce swelling and pain sensitivity. The cervical muscles play a key role in supporting and orientating the head, as well as providing breathing, phonation and swallowing functions, providing important physical support to the cervical spine. Their dysfunction can occur as a result of injuries, inflammation and nervous disorders, which negatively affects muscle function and increases pain. For a successful recovery, it is recommended to start rehabilitation exercises as early as possible, avoiding increased pain, and gradually restoring muscle function.

A study involving 24 students aged 18 to 23 years showed that the use of physiotherapy in patients with functional compression syndrome of the vertebral arteries helps to reduce the clinical manifestations of the disease, restore proper spinal biomechanics and improve blood flow in the vertebral arteries [22]. This is in line with the results of the study, which showed that the use of physiotherapy methods in the treatment of functional compression syndrome of the vertebral arteries is highly effective, contributing to the restoration of spinal biomechanics and improving blood supply to the brain. The study results also confirm the additional benefits of using orthodontic mouthguards in the rehabilitation of patients with traumatic brain injuries and traumatic cervical syndrome.

The results of the study confirmed that the use of mouth guards that change the position of the jaw has a positive effect on physical performance due to biomechanical and neuromuscular effects. REHASPLINT orthodontic mouthguards not only correct the bite but also improve physical performance. It has been shown that jaw repositioning through the use of mouthguards has a positive effect on spinal alignment and muscle function. This was reflected in an increase in strength (pull-ups increased by 46.58%), endurance (holding on the bar increased by 40.7%), coordination and power (ball pushing improved by 17.73%). The results of the study are consistent with the findings of D.L. Golem & S.M. Arent [23], who note the positive effect of bite correction on posture and proprioception, which in turn improves sports and physical performance. Thus, the results of the study confirm the effectiveness of Orthodontic mouthguards as a means of improving the biomechanics of movement, strength and endurance, which is especially important for the rehabilitation of patients with traumatic brain injuries and traumatic cervical syndrome.

The results of the study confirmed that there is a link between the masticatory and musculoskeletal systems, where jaw closure has a positive effect on physical performance through the potentiation of simultaneous activation. The amount of jaw compression is critical for the formation of neuromuscular effects that provide a powerful occlusion. The use of bite alignment mouth guards improves the symmetry of the masticatory muscles and the even distribution of occlusal loads. The realignment of the jaw position and the vertical size of the occlusion helps to improve neuromuscular balance. Thus, the correct use of orthodontic mouthguards can significantly enhance the effect of potentiating simultaneous activation and improve overall physical performance. While some studies have attributed the ergogenic effects of simultaneous activation potentiation solely to jaw clenching, others have demonstrated an increase in these effects when using oral devices such as custom mouthguards [24]. A study involving eight elite swimmers of the Spanish national team showed that the use of custom mouth guards for bite alignment has an ergogenic effect, improving jump and pull performance [25]. Although there was no significant effect on the starting reaction time and the 15-metre freestyle distance, such mouthguards can be useful for increasing athletic potential in powerful movements and the overall quality of the training process. However, in a study involving 12 professional male handball players, there was no apparent effect of improved motor performance or increased muscle activity when wearing orthodontic mouthguards [26]. However, there was a more balanced activity of the cervical and back muscles in dynamic conditions.

The results of the study by A. Yasuda *et al.* [27], conducted with the participation of thirteen athletes with cerebral palsy (men, n = 12; mean age 27.3 ± 8.96 years) and ten healthy men from the control group (mean age 28.5 ± 1.35 years), showed that the use of mouth guards can change the nature of masticatory muscle activity in athletes with cerebral palsy and help improve balance during static exercises. Another study involving 23 professional basketball players (mean age 25.8 ± 8.6 years) demonstrated that wearing individual orthodontic mouthguards for eight weeks affected balancing, although no significant changes in body alignment were found [28]. However, a more detailed univariate analysis revealed improvements in pelvic torsion and kyphotic angle after both acute and re-treatment. Pelvic torsion, which characterises the anteroposterior displacement of the right and left parts of the pelvis, is an important indicator, as its deviation from the normal range (0°) may indicate potential abnormalities in the musculoskeletal system. The study showed a significant reduction in the pelvic torsion angle of the participants, indicating an improvement in pelvic balance. These results emphasise the potential role of mouthguards in correcting postural parameters and strengthening the biomechanical stability of athletes. The study's results indicate the need to determine further the effects of mouthguards on functional muscle activity and balance in different groups of athletes and under various conditions.

The results of the study confirm the effectiveness of REHASPLINT orthodontic mouthguards in improving the functional state of the jaw system and its interaction with the musculoskeletal system. The use of occlusion-correcting mouthguards can help improve blood circulation and neuromuscular activity, which in general affects the overall physical condition. The results of the study open up significant opportunities for rehabilitation after traumatic brain injuries and strokes, as well as for the treatment of speech and motor disorders resulting from contusions and accu barotrauma. The use of this method can significantly speed up the recovery process, which helps reduce rehabilitation costs and potentially reduces the costs of insurance companies.

Conclusions

The study confirmed that the use of REHASPLINT orthodontic mouthguards contributes to a significant improvement in the physical performance of the participants. As a result of the use of the orthodontic mouthguards, an increase in strength, endurance, and coordination of movements was observed, which was manifested in the growth of such indicators as pull-ups, holding on the crossbar, pushing a medicine ball and squeezing a wrist expander.

It was found that the mouthguards have a positive effect on neuromuscular balance, ensuring symmetry of muscle function and optimising biomechanics. This is associated with improved jaw position and reduced load on the temporomandibular joint, which has a positive effect on the overall condition of the musculoskeletal system. The results confirm that the correction of occlusion with mouth guards improves physical performance and stabilises the spine and activating the neck muscles.

The study found that the use of orthodontic mouthguards during exercise contributes to a significant improvement in physical performance. When performing pull-ups, the average result increased by 46.58% (from 7.3 to 10.7 pull-ups), which indicates an increase in upper body strength. The time spent holding the bar increased by 40.7% (from 54.3 to 76.4 seconds), demonstrating improved endurance and muscle control. When pushing a 9 kg medicine ball, the average distance increased by 17.73% (from 4.63 to 5.45 metres), indicating an increase in strength and coordination. The wrist expander compression showed an increase of 18.04% (from 128.9 to 152.1 compression in 60 seconds), reflecting an improvement in upper limb strength and endurance. The greatest effect of the use of mouthguards is observed in exercises that require coordination and stability, such as holding on to the bar and pushing the ball.

The results confirm that REHASPLINT orthodontic mouthguards improve muscle function and overall physical performance by optimising bite biomechanics. The effectiveness of the mouthguards in the rehabilitation of patients with traumatic brain injuries and traumatic cervical syndrome has been confirmed, which allows recommending them to improve the physical capabilities of military personnel and patients during rehabilitation. The effectiveness of REHASPLINT mouthguards opens up prospects for their implementation both in sports practice to improve performance and in the rehabilitation of patients with traumatic brain injury and traumatic cervical syndrome. The findings emphasise the need for further research to better understand the mechanisms of action of the mouthguard and its potential in clinical practice.

Acknowledgements

None.

Funding

None.

Conflict of Interest

None.

References

[1] Kong LZ, Zhang RL, Hu SH, Lai JB. Military traumatic brain injury: A challenge straddling neurology and psychiatry. Mil Med Res. 2022;9(1):2. DOI: 10.1186/s40779-021-00363-y

[2] Sushchenko L, Demchenko M, Bobrovnyk L. Features of physical education and sports rehabilitation for combat veterans with traumatic brain injury. Sci J Dragomanov Ukr State Univ. 2024;15(176):470–3. DOI: 10.31392/UDU-nc.series15.2024.3K(176).104

[3] Carlozzi NE, Lange RT, French LM, Kallen MA, Boileau NR, Hanks RA, et al. TBI-CareQOL military health care frustration in caregivers of service members/veterans with traumatic brain injury. Rehabil Psychol. 2020;65(4):360–76. DOI: 10.1037/rep0000305

[4] Kariya C, Kanzaki H, Kumazawa M, Sahara S, Yoshida K, Inagawa Y, et al. Skeletal anterior open bite attenuates the chewing-related increase in brain blood flow. Dent J. 2024;12(6):161. DOI: 10.3390/dj12060161

[5] Rybert Y, Potapchuk A, Minko L, Magera N, Semchyshyn Y, Dubas M, et al. Complex rehabilitation of orthodontic pathology combined with temporomandibular joint disorders. Acta Balneol. 2022;170(4):348–52. DOI: 10.36740/ABAL202204113

[6] Tanaka N, Atesok K, Nakanishi K, Kamei N, Nakamae T, Kotaka S, et al. Pathology and treatment of traumatic cervical spine syndrome: Whiplash injury. Adv Orthop. 2018;2018:4765050. DOI: 10.1155/2018/4765050

[7] Sillevis R, Hansen AW. Upper cervical spine syndrome: A new perspective. Arch Prev Med. 2024;9(1):18–21. DOI: 10.17352/apm.000036

[8] Katz EA, Katz SB, Fedorchuk CA, Lightstone DF, Banach CJ, Podoll JD. Increase in cerebral blood flow indicated by increased cerebral arterial area and pixel intensity on brain magnetic resonance angiogram following correction of cervical lordosis. Brain Circ. 2019;5(1):19–26. DOI: 10.4103/bc.bc_25_18

[9] Bowler N, Shamley D, Davies R. The effect of a simulated manipulation position on internal carotid and vertebral artery blood flow in healthy individuals. Man Ther. 2011;16(1):87–93. DOI: 10.1016/j.math.2010.07.007

[10] Kranenburg HAR, Tyer R, Schmitt M, Luijckx GJ, van der Schans C, Hutting N, et al. Effects of head and neck positions on blood flow in the vertebral, internal carotid, and intracranial arteries: A systematic review. J Orthop Sports Phys Ther. 2019;49(10):688–97. DOI: 10.2519/jospt.2019.8578

[11] Waheed MA, Hasan S, Tan LA, Bosco A, Reinas R, Ter Wengel PV, et al. Cervical spine pathology and treatment: A global overview. J Spine Surg. 2020;6(1):340–50. DOI: 10.21037/jss.2020.01.12

[12] Renke MB, Marcinkowska AB, Kujach S, Winklewski PJ. A systematic review of the impact of physical exercise-induced increased resting cerebral blood flow on cognitive functions. Front Aging Neurosci. 2022;14:803332. DOI: 10.3389/fnagi.2022.803332

[13] Hung SH, Kramer S, Werden E, Campbell BCV, Brodtmann A. Pre-stroke physical activity and cerebral collateral circulation in ischemic stroke: A potential therapeutic relationship? Front Neurol. 2022;13:804187. DOI: 10.3389/fneur.2022.804187

[14] Maitas O, Bob-Manuel T, Price J, Noor A, Obi K, Okoh N, et al. Vertebral artery interventions: A comprehensive updated review. Curr Cardiol Rev. 2023;19(1):e170322202296. DOI: 10.2174/1573403X18666220317093131

[15] Still AT. Philosophy of osteopathy. Michigan: Edwards Brothers, Inc.; 1899. 275 P.

[16] Commission Directive No. 2005/28/EC. Laying Down Principles and Detailed Guidelines for Good Clinical Practice as Regards Investigational Medicinal Products for Human Use, as Well as the Requirements for Authorisation of the Manufacturing or Importation of Such Products [Internet]. 2005 April 8 [cited 2025 April 15]. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32005L0028

[17] The World Medical Association. Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects [Internet]. [cited 2025 January 21]. Available from: https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/

[18] Costa RTF, Limirio JPJO, Vasconcelos BCE, Pellizzer EP, de Moraes SLD. Rehabilitation with dental prostheses and its influence on brain activity: A systematic review. J Prosthet Dent. 2024;131(3):403–9. DOI: 10.1016/j.prosdent.2022.02.007

[19] Guinot F, Ferrer M, Díaz-González L, García C, Maura I. Effects of orthodontic functional appliances in relation to skeletal maturation of cervical vertebrae in class II malocclusion. J Clin Pediatr Dent. 2022;46(1):62–9. DOI: 10.17796/1053-4625-46.1.11

[20] Garner DP. Research with novel technology: Advances in concussion diagnosis and mouthpiece utilization during performance. J S C Acad Sci. 2020;18(1):2.

[21] Sakaguchi T, Heyder A, Tanaka M, Uotani K, Omori T, Kodama Y, et al. Rehabilitation to improve outcomes after cervical spine surgery: Narrative review. J Clin Med. 2024;13(18):5363. DOI: https10.3390/jcm13185363

[22] Labinska H, Kashuba V, Labinskyi P, Labinskyi A, Savliuk S, Ostapiak Z. Effect of physical therapy on vertebral artery functional compression syndrome. J Phys Ed Sport. 2021;21(5):2820–6. DOI: 10.7752/jpes.2021.s5375

[23] Golem DL, Arent SM. Effects of over-the-counter jaw-repositioning mouth guards on dynamic balance, flexibility, agility, strength, and power in college-aged male athletes. J Strength Cond Res. 2015;29(2):500–12. DOI: 10.1519/JSC.0000000000000641

[24] Miró A, Buscà B, Arboix-Alió J, Huertas P, Aguilera-Castells J. Acute effects of jaw clenching while wearing a customized bite-aligning mouthguard on muscle activity and force production during maximal upper body isometric strength. J Exerc Sci Fit. 2023;21(1):157–64. DOI: 10.1016/j.jesf.2022.12.004

[25] Miró A, Buscà B, Aguilera-Castells J, Arboix-Alió J. Acute effects of wearing bite-aligning mouthguards on muscular strength, power, agility and quickness in a trained population: A systematic review. Int J Environ Res Public Health. 2021;18(13):6933. DOI: 10.3390/ijerph18136933

[26] Lässing J, Pökel C, Lingener L, Falz R, Kwast S, Schulze A, et al. The influence of customized mouthguards on the muscular activity of the masticatory muscles at maximum bite and motor performance during static and dynamic exercises. Sports Med Open. 2021;7(1):64. DOI: 10.1186/s40798-021-00354-2

[27] Yasuda A, Suzuki H, Iwata Y, Takeuchi H, Ebato A, Yagi T, et al. Effects of wearing a custom-made mouth guard during static exercise on masticatory muscle activity in athletes with cerebral palsy. J Athl Enhanc. 2018;7(6):5. DOI: 10.4172/2324-9080.1000307

[28] Nam HJ, Lee JH, Hong DS, Jung HC. The effect of wearing a customized mouthguard on body alignment and balance performance in professional basketball players. Int J Environ Res Public Health. 2020;17(17):6431. DOI: 10.3390/ijerph17176431

Покращення фізичних показників при використанні ортодонтичних апаратів REHASPLINT

Андрій Тимченко
Аспірант, невролог
Київський обласний центр ментального здоров'я
08296, вул. Паркова, 4, м. Ворзель, Україна
https://orcid.org/0009-0004-9983-8571

Софія Тимченко
Студент
Київський медичний університет
02099, вул. Бориспільська, 2, м. Київ, Україна
Університетський коледж остеопатії
SE1 1JE, вул. Борроу Хай, 275, м. Лондон, Велика Британія
https://orcid.org/0009-0003-2291-222X

Анотація. Корекція прикусу з використанням ортодонтичних апаратів сприяє покращенню кровообігу за рахунок впливу на положення хребетної артерії, нормалізації м'язового тонусу, зниженню больових відчуттів та відновленню рухливості суглобів. Дане дослідження було присвячене вивченню впливу ортодонтичних апаратів REHASPLINT на фізичні показники пацієнтів із черепно-мозковими травмами та травматичним шийним синдромом. В рамках дослідження було проведено клінічний експеримент за участю 10 пацієнтів віком від 25 до 38 років. Оцінка фізичної сили включала підтягування, вис на перекладині, штовхання медичного м'яча (9 кг) та стиснення кистьового еспандера. Тестування проводилося у два етапи: без використання ортодонтичних кап та з їх використанням. Результати дослідження підтверджують, що використання кап сприяє покращенню м'язової функції та загальних фізичних показників за рахунок оптимізації біомеханіки прикусу. Проведене дослідження показало, що використання ортодонтичних кап під час фізичних вправ сприяє значному покращенню фізичних показників учасників. Під час виконання підтягувань середній результат збільшився з 7,3 до 10,7 підтягувань, що свідчить про зростання сили верхньої частини тіла на 46,58 %. Час утримання на перекладині зріс з 54,3 до 76,4 секунд, що демонструє поліпшення витривалості та м'язового контролю на 40,7 %. При штовханні медичного м'яча вагою 9 кг середня відстань збільшилася з 4,63 до 5,45 метра, що вказує на підвищення сили та координації рухів на 17,73 %. Стиснення кистьового еспандера показало зростання середнього результату зі 128,9 до 152,1 стиснення за 60 секунд, збільшивши силу та витривалість рук на 18,04 %. Вплив ортодонтичних кап найбільш помітний у вправах, що потребують координації та стійкості, таких як утримання на перекладині та штовхання м'яча. Отримані дані підкреслюють ефективність ортодонтичних кап у реабілітації пацієнтів із черепно-мозковими травмами та травматичним шийним синдромом. Використання кап може бути рекомендовано для покращення фізичних можливостей військовослужбовців та пацієнтів у період реабілітації

Ключові слова: черепно-мозкова травма; травматичний шийний синдром; хребетна артерія; мозковий кровотік; ортодонтичні капи; фізичні показники; фізична реабілітація