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PAIN AFTER STROKE (CLINICAL CASE)

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Abstract: Pain after a stroke is a common clinical problem that is insufficiently diagnosed and treated, which is due to differences in approaches to solving the problem: there are different definitions of the type of pain, research designs, cohorts of patients examined and, often, neglect of active patient questioning in connection with this complaint. This article describes the most common pain syndromes, including central post-stroke pain, post-stroke shoulder pain, complex regional pain syndrome and pain associated with spasticity. The frequency of occurrence of various types of post-stroke pain, their clinical manifestations and risk factors for development are presented. A clinical example is presented that reflects the problem — post-stroke hemiplegic shoulder pain is often found in practice, persists over time and requires diagnosis at each hospitalization in the rehabilitation department with the selection of individual treatment depending on the specific clinical situation.

Keywords: post-stroke pain syndromes, ischemic stroke, risk factors, medical rehabilitation.

Introduction. Pain is the most common symptom found in neurological practice. Pain is a subjective sensation with pronounced individual differences in its perception. According to the definition of the International Association for the Study of Pain (IASP), "pain is an unpleasant sensory and emotional experience associated with existing or possible tissue damage" (1994) [1]. Various pain syndromes are often found after a stroke [2]. The prevalence of post-stroke pain (PSP) is 34-80% [3] and varies in different studies, due to differences in the design of studies, the definition of pain type and cohorts of patients examined. There is a general opinion that the reported frequency of PSP is underestimated, since patients themselves do not always report certain pain symptoms, and doctors do not always conduct active

questioning [4]. However, even if PSP is detected, adequate and sufficient treatment is not always prescribed. In one retrospective study, it was found that two thirds of patients with central pain received inadequate or no treatment at all [5]. Patients with pain have more pronounced cognitive and functional impairments [6], decreased quality of life [2], fatigue [7] and depression [8]. The severity of pain correlates with the severity of cognitive impairment and depression [9]. It has been shown that PSP can be a predictor of suicide [10].

The World Health Organization has issued a "call to action", which emphasizes the importance of strengthening rehabilitation services as a key health strategy in the 21st century [11]. It is important that health should be considered not only in connection with the diagnosis, but also in connection with the level of functions performed, which is crucial for the patient's subjective perception of his state of health. A successful rehabilitation process includes an assessment of the functional state, determination of rehabilitation goals, selection of measures and regular assessment of ongoing rehabilitation activities with the participation of the patient and relatives. The necessary resource is an interdisciplinary team with a set of knowledge and skills that ensure the implementation of an individually selected rehabilitation program [12]. Rehabilitation is a problem—solving process framed in the context of a holistic biopsychosocial model of the disease, carried out taking into account human interests [13]. Rehabilitation planning follows the assessment of the patient's functional condition and the formulation of the rehabilitation goal. Planning is based on the wishes and values of the patient, combined with knowledge about the prognosis and available interventions, and sets long-term goals with the solution of intermediate tasks [14].

An individually selected set of rehabilitation measures helps post-stroke patients to restore lost skills, but the presence of PSP leads to an elongation (and, as a result, an increase in the cost) of the rehabilitation process. Patients with PSP recover 2 times slower compared to patients without pain [2, 15]. Constant pain in a post—

stroke patient is a severe ordeal [8]. The presence of PSP has a negative impact on the implementation of rehabilitation measures. For example, the appearance or intensification of pain during passive or active development of paretic limbs in stroke patients leads to the fact that they begin to resist therapeutic measures. Motivation decreases, which negatively affects the outcomes of rehabilitation.

Multiple factors contribute to the development of PSP, including central and peripheral mechanisms, psychological factors and autonomic disorders. Premorbid features of the patient are an independent risk factor for the development of PSP [6]. Ischemic stroke is more often associated with the development of PSP than hemorrhagic stroke [15]. Stroke localization also plays a role. Thus, pain develops more often in patients who have suffered a stroke in the thalamus and brainstem [15]. It has been shown that the incidence of pain syndromes increases with the age of patients [16]. Clinical signs such as increased muscle tone, decreased mobility of the upper extremities, and sensory deficits are associated with the development of PSP [16].

The most common subtypes of pain after stroke are central PSP (most often thalamic syndrome), pain caused by painful spasms of spastic paretic muscles, pain syndrome in post-stroke arthropathy, complex regional pain syndrome and headache. At the same time, patients after a stroke may have several types of pain [6, 15].

Central PSP

Central PSP refers to a neuropathic type of pain, which, according to the IASP definition, is caused by a primary lesion or disease of the somatosensory nervous system at any level: from the spinal cord to the cerebral cortex [17, 18]. Central PSP is a common pain syndrome; according to various estimates, it accounts for more than a third of all cases of PSP [19]. Thus, in the study by A. Kumar et al. [20], conducted with the participation of 319 stroke patients, it was found that the prevalence of central PSP is 20.7% with lesions of both thalamic and extrathalamic localization. At the same time, 57.6% of lesions were localized on the right. In

another prospective study, H. Harno et al. [21], it was revealed that 5.9% of 824 young patients 8.5 years after stroke had central PSP. Patients who have had an ischemic stroke have a higher incidence of PSP (86.1%) than patients after hemorrhagic stroke (13.9%) [22]. The onset of central PSP is observed within 1-3 months after a stroke [23], but may take up to 1-6 years [24]. According to A.H. Bashir et al. [25], central PSP in 50% of patients occurred 3 months after stroke. Risk factors for the development of central PSP include young age, depression, current smoking, and a more pronounced severity of stroke [6, 21]. A. Osama et al. [26] demonstrated in their study that smokers (30.4%) are more likely to develop central PSP than non-smokers (7.1%), while smoking is considered a trigger factor.

The mechanisms of development of central PSP remain an unexplored problem. Most researchers believe that the central PSP is based on 2 mechanisms: increased excitability of neurons in damaged structures of the lateral part of the nociceptive system and inadequate functioning of inhibitory antinociceptive sensory pathways [27].

The pain is often severe and unrelenting, with pain-free intervals not exceeding several hours [28]. Pain symptoms in patients with central PSP are mainly manifested by dysesthesia, allodynia and hyperalgesia [23]. In patients with central PSP, the phenomena of tactile and promotional allodynia (perception of non-painful irritation as painful), hyperpathy (including hypersthesia and hyperalgesia), as well as the phenomenon of delayed dystonia are revealed [29]. Classical central PSP is described by patients as a burning sensation resembling the burning of a hand immersed in ice water, and often takes the form of a kind of temperature dysesthesia [15], which can be caused by various triggers such as touch, movement, stress or cold [25]. N. Harno et al. [21] when assessing the clinical characteristics of central PSP in 964 patients, it was shown that hyperalgesia occurs in 57% of cases, mechanical allodynia — in 51%, cold hyperalgesia — in 40%, about 70% of patients did not feel the temperature

difference from 0 to 50 °. It is noted that several types of different pain sensations can be observed in the same patient.

The strategy of central PSP therapy includes pharmacotherapeutic and non-pharmacotherapeutic approaches. According to the results of various studies, tricyclic antidepressants (amitriptyline), a selective serotonin reuptake inhibitor (fluvoxamine), selective serotonin and norepinephrine reuptake inhibitors (venlafaxine, milnacipran and duloxetine) can be used as drug therapy. However, the use of these drugs after stroke in elderly patients requires careful monitoring [30, 31].

Antiepileptic drugs are largely the drugs of choice in the treatment of neuropathic pain syndromes. Among them, gabapentin and pregabalin are second-line drugs for the treatment of central PSP. The administration of an antidepressant together with gabapentin as a combination therapy provides a more pronounced reduction in pain, and a reduced dose of each of them eliminates side effects [31].

The opioid analgesic tramadol has pronounced efficacy in the treatment of neuropathic pain, unlike other opioids [31]. In therapeutic doses, tramadol does not develop dependence, unlike other opioids such as morphine [32].

Nonpharmacological approaches include transcranial magnetic stimulation (TMS), deep brain stimulation (DBS), physical therapy and some other methods [23]. One of the directions of the rehabilitation process, which is of great interest in the treatment of motor disorders observed after a stroke, is considered to be mirror therapy [33].

Post-stroke shoulder pain

Shoulder pain is a common problem after stroke, and a recent meta-analysis has shown that its incidence is 10-22% [34]. Post-stroke arthropathies are accompanied by pain syndrome of varying degrees of intensity, which significantly limits the possibilities of rehabilitation measures. The occurrence of post-stroke arthropathies contributes to the formation of contractures. With the development of these conditions, due to severe pain in the joints during active and passive

movements, their volume is significantly limited, preventing the restoration of impaired motor functions, slowing down the rate of recovery and interfering with kinesiotherapy [35]. The causes of hemiplegic shoulder pain can be various processes, including shoulder subluxation, complex regional pain syndrome, tendinitis, rotator cuff abnormalities, adhesive capsulitis, increased muscle tone, etc. [36].

Post-stroke arthropathies develop more often in the joints of the upper extremities, among which the shoulder joint is most often affected (in 58% of cases) [28, 29], less often the elbow and wrist joints. The high frequency of involvement in the pathological process of the shoulder joint is associated both with the peculiarities of anatomy and biomechanics, and with the functional requirements imposed on it in everyday life [10]. Already in the first week after a stroke, PSP in the shoulder develops in 17% of patients, in 55% — after 2 weeks, in 87% — during the next 2 months. and in 75% — during the first year after a stroke [11-13]. According to a recently published study conducted by Y. Li et al. [14], among 239 stroke patients who were hospitalized in the rehabilitation department and examined for one year, the prevalence of hemiplegic shoulder pain was 55.6% (133/239) upon admission, 59.4% (142/239) after 2 months and 55.1% (130/236) after 4 months.

It has been established that a decrease in the motor function of the arm after a stroke or during the rehabilitation period is one of the risk factors for the development of pain syndrome in the shoulder in the future [21, 25]. In addition, hemiplegic shoulder pain is more common and usually more severe in patients with left-sided hemiplegia [26, 27]. In a recently published review by D. Corbetta et al. [34] the most significant identified predictors of hemiplegic shoulder pain were age (younger than 70 years), female gender, increased tone, sensory disorders, left-sided hemiparesis, hemorrhagic stroke, neglect syndrome (syndrome of visual-spatial disorders), history of stroke and more pronounced severity on the stroke scale of the National Institutes of Health of the USA (NIHSS).

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Hemiplegic shoulder pain includes functional disorders of the upper limb, limiting dexterity of movement with subsequent difficulties in everyday life [18]. This deficiency may persist in 30-66% of stroke survivors after 6 months, which negatively affects further rehabilitation and leads to depression and deterioration of quality of life [16, 19, 20]. In this context, rehabilitation can play a key role in the clinical treatment of hemiplegic shoulder pain using various methods, including physiotherapy, taping, anesthetic blockade of the supra-scapular nerve, intramuscular injections of botulinum toxin type A, injections of glucocorticosteroids, dry acupuncture at trigger points, repetitive TMS, stimulation of peripheral nerves and other methods [11].

Complex regional pain syndrome

Complex regional pain syndrome (CRPS) is a neuropathic pain disorder caused by trauma with nerve damage, immobilization of limbs, stroke, spinal cord injury, etc. [12, 13]. Type 1 CRPS (reflex sympathetic dystrophy) and type 2 CRPS (causalgic syndrome) are characterized by pain, which according to The intensity is disproportionate to morphological tissue damage, impaired function of peripheral and/or central autonomic innervation, and dystrophic limb changes, often (but not always) resulting from trauma [14]. CRPS was first described after a stroke in a retrospective study in 1977, in which 68 (12.5%) of 540 inpatient rehabilitation patients were diagnosed with shoulder and arm pain syndrome [15]. The prevalence of post-stroke CRPS ranges from 12.5 to 50% [16-18], in a recent study its value was 18.6% (19/102) [19].

The exact pathological mechanism underlying the formation of CRPS currently remains unclear. Studies demonstrate an association between type 1 CRPS, spasticity, and sensitivity disorders [10, 11]. Damage to the soft tissues of the shoulder in hemiparesis in combination with a pathological process in the brain is of great importance [12]. Previous studies have reported that risk factors associated with post-stroke CRPS also included length of hospital stay, shoulder subluxation, soft tissue

lesions of the shoulder, severe arm paralysis, brachial plexus injury, depression, etc. [13-15]. In addition, a recent meta-analysis showed that other risk factors for developing CRPS after stroke included female gender, left-sided hemiplegia, severe hand paralysis and impaired daily activities [16].

The main symptoms of post-stroke CRPS include pain, hyperalgesia, allodynia, swelling, and redness of the wrists and hands [12]. A distinctive feature of this pain syndrome is the presence of pronounced vegetative-trophic disorders caused by impaired microcirculation and excessive release of neurotransmitters, including outside the synaptic cleft [17].

Complex regional pain syndrome and its treatment have been widely studied, although specific studies concerning people with stroke are limited. In any neurological deficit after a stroke, physical therapy and early mobility are vital to reduce long-term disability and appear to help with symptoms associated with CRPS [17]. More than 12% of rehabilitation programs for patients with hemiplegia are often seriously hampered by the development of type 1 CRPS [15]. Kinesiophobia is a condition in which the patient experiences excessive debilitating fear of physical movements [17]. Since kinesiophobia has a negative impact on the outcome of rehabilitation, this phenomenon should be taken into account in the clinical situation. Cognitive behavioral therapy (CBT) is a psychological management strategy that can be useful for reducing pain and kinesiophobia by treating related psychological and behavioral factors [18-20]. CBT can be effective in reducing the fear associated with pain and thus reducing pain and improving function.

Pain associated with spasticity

Worldwide, 12 million people suffer from upper or lower limb spasticity [21, 22]. This occurs in 19 and 39% of cases 3 and 12 months after stroke, respectively [23]. Limb spasticity is one of the common complications of stroke, which has a particularly serious effect on the functional recovery of the upper extremities [24].

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There is no clear definition of spasticity, but it is often defined as a motor disorder characterized by an increase in tonic stretching reflexes (muscle tone) with increased tendon reflexes due to hyperexcitability of the stretching reflex as one of the components of upper motor neuron syndrome [25, 26]. Spasticity of the upper limb is more serious than that of the lower one [27], as it can cause problems related to passive function (for example, wearing, eating and washing hands), with the development of pain and joint contractures [28]. This can directly affect the quality of patients' daily lives, complicate recovery, and increase the economic burden on the patient's family and society as a whole [19-21]. A prospective observational study has demonstrated a strong association between the development of spasticity and pain: in patients with spasticity, pain developed in 72% of cases, while in patients without spasticity only in 1.5% [22]. The nature of the relationship between spasticity and pain is not fully understood. There are potential neuropathic and nociceptive mechanisms by which they are linked [8]. It was noted that patients with a higher degree of spasticity have lower Bartel index, quality of life and greater pain severity [22].

There are various treatments for post-stroke spasticity, but currently there is no specific treatment for upper limb spasticity. Muscle relaxants (e.g. baclofen, tizanidine) reduce muscle tone by affecting the central nervous system, but they can cause systemic side effects such as lethargy or drowsiness [23]. Therefore, rehabilitation measures are carried out to treat spasticity: physiotherapy, drug therapy with botulinum toxin A, external mechanical adjuvant therapy [24-26].

Thus, effective rehabilitation interventions for patients with various types of PSP include a set of specific actions adapted to the patient's priorities, needs and goals, covering (if necessary) all areas of the biopsychosocial model of the disease and regularly evaluated for their benefits and harms to determine whether they should be continued, modified or abandoned.

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For a more detailed presentation of this pathology, we present a clinical example of a patient with a shoulder injury that lasts for two years after a stroke. During this hospitalization in the rehabilitation department, the emphasis was placed on the possibility of reducing this pain, which became the main goal of medical rehabilitation at this stage and showed the need for individualized treatment depending on the specific clinical situation.

Clinical case

Patient G., 68 years old, retired. He was admitted to the Department of Medical Rehabilitation (DMR) 2 years after acute cerebrovascular accident (ACVA) with complaints of weakness in his left arm and leg, increased tone in them, pain in his left shoulder.

Anamnes morbi. He considers himself ill since 05/16/2021, when weakness appeared in the left extremities with a cooling of the left arm. It was found in the garage at 20:00. The ambulance team was taken to the emergency with the main diagnosis: hemorrhagic stroke from 05/16/2021 according to the type of acute mixed intracerebral hematoma in the right thalamus with left-sided hemiplegia, hemihypesthesia, dysarthria. Concomitant diagnosis: hypertension of stage III, 3rd degree, the target blood pressure level has been reached. Hypertrophy of the left ventricle. Dyslipidemia. Atherosclerosis of the brachiocephalic arteries, risk 4. Chronic heart failure 2A, functional class not evaluated. Stage 1 chronic kidney disease. He repeatedly underwent a course of rehabilitation treatment in the DMR.

Upon admission to the DMR, the somatic status is without features. Neurological status: consciousness is clear, there are no meningeal signs. Eye slits, pupils D=S. The movement of the eyeballs in full. The fields of view are not changed by the indicative method. There is no nystagmus. Hearing is preserved on both sides. Swallowing is not impaired. The pharyngeal reflex is preserved. Speech without violations. Hypesthesia is present on the right side of the face in the area of innervation of the orbital and mandibular nerves. The left nasolabial fold has been

smoothed. The tongue is to the left of the middle line. Left—sided hemiparesis: paresis of the left arm: proximally — 3 points, distally - 2 points, paresis of the left leg: proximally — 3 points, distally — 1 point, strength in the right extremities is preserved. Reflexes from the upper extremities: carporadial, bicipital, tricipital (D — low, S — high), pathological reflexes are absent on the right, positive ones on the left. Reflexes from the lower extremities: knee, Achilles D<S (D — low, S — high), there is a pathological extensor reflex of Babinsky and flexor of Zhukovsky on the left. Muscle tone is increased in the left extremities according to the spastic type, in the arm according to the Ashfort scale: proximally — 1 point, distally — 2 points, in the leg: proximally — 1 point, distally — 2 points, in the other extremities — uniform, sufficient. Left-sided hemihypesthesia. There are no reflexes of oral automatism. It's not worth it in the Romberg pose. The finger test on the left does not perform, on the right — satisfactorily; the knee-heel test on the left does not perform, on the right — satisfactorily. Pain in the left shoulder is 6 points on a visual-analog scale (VAS). The volume of passive movements in the left shoulder joint is limited due to the occurrence of pain syndrome: when bending the shoulder, pain occurs at 115 ° (normal 180 °), when withdrawing the shoulder at 100 ° (normal 180 °), pain occurs, when bending the shoulder with internal rotation at 90 °, pain occurs when extending, internal and external There was no pain during rotation (in a sitting position). The tests of Nir, Hawkins—Kennedy are positive. He walks within the department, staggering, leaning on a multi-support cane. The indicator on the rehabilitation routing scale is 3. Motor mode IIIA (patient staying in a sitting position during wakefulness, getting up and walking around the ward up to 100 m, walking along the corridor up to 200 m, using a shared toilet, physical training in the hall). Test results: according to the short scale of assessment of mental status (Mini-Mental State Examination, MMSE) — 27 points, according to the hospital scale of anxiety and depression HSAD — 6 and 6 points, respectively.

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The patient was examined by a multidisciplinary team, which, based on the existing symptoms, taking into account the patient's wishes to reduce pain and increase the volume of movements in the joints, drew up a medical rehabilitation plan with the goal of reducing pain by 1-2 points according to VAS and increasing the volume of movements by 10-20 ° in 10 days. During the treatment at the DMR, where all rehabilitation measures were carried out for six days a week, positive dynamics was noted: the level of pain in the left shoulder was estimated at 4 points according to VAS, the volume of passive movements in the left shoulder joint during flexion was 130 °, when the shoulder was withdrawn — 120°. The set rehabilitation goals have been fully achieved.

Discussion

Stroke is the leading cause of death and long-term disability worldwide. A frequent disabling consequence of stroke is upper limb dysfunction [27], which significantly affects the daily activities of patients.

Rehabilitation is an important aspect of the treatment of post-stroke complications in order to improve the quality of life of patients [28] and, as a necessary condition, includes an interdisciplinary approach. One of the main goals of rehabilitation after stroke is to improve the function of the upper extremities. Sufficient consistency of the upper limbs provides stroke survivors with the ability to perform daily self-care activities [29]. Currently, various approaches are used in clinical practice to restore upper limb function in stroke patients, with evidence of their therapeutic effects [30, 31] and includes various methods [32-34]. As in our case, a number of studies have shown that goal-oriented treatment is superior to traditional approaches to rehabilitation [31, 35, 36].

Conclusion

Thus, PSP is a complex phenomenon encompassing both the nociceptive and neuropathic etiology of pain. PSP consists of many disorders, of which the most common are central PSP, CRPS, spastic and hemiplegic shoulder pain. The treatment

of these syndromes includes pharmacological and non-pharmacological methods that are prioritized as part of the medical rehabilitation of patients after stroke. For optimal treatment of each patient, an individually tailored rehabilitation program is often required, which uses combinations of different therapies.

References

1. Stucki G., Bickenbach J., Gutenbrunner C. et al. Rehabilitation: The health strategy of the 21st century. J Rehabil Med. 2018;50:309–316. DOI: 10.2340/16501977-2200.

2. Wade D.T. Rehabilitation — a new approach: Overview and part one: the problems. Clin Rehabil. 2015;29:1041–1050. DOI: 10.1177/0269215515601174.

3. Li D., Jin M., Bao P. et al. Clinical characteristics and results of semen tests among men with coronavirus disease 2019. JAMA Netw Open. 2020;3:e208292. DOI: 10.1001/jamanetworkopen.2020.8292.

4. Barbosa L.M., da Silva V.A., de Lima Rodrigues A.L. et al. Dissecting central post-stroke pain: A controlled symptom-psychophysical characterization. Brain Commun. 2022;4:fcac090. DOI: 10.1093/braincomms/fcac090.

5. Widyadharma I., Eka P., Tertia C. et al. Central post stroke pain: What are the new insights? Rom J Neurol. 2021;20:28–34. DOI: 10.37897/RJN.2021.1.4.

6. Bashir A.H., Abdullahi A., Abba M.A., Mukhtar N.B. Central Poststroke Pain: Its Profile among Stroke Survivors in Kano, Nigeria. Behav Neurol. 2017;2017:9318597. DOI: 10.1155/2017/9318597.

7. Osama A., Abo Hagar A., Elkholy S. et al. Central post-stroke pain: Predictors and relationship with magnetic resonance imaging and somatosensory evoked potentials. Egypt J Neurol Psychiatr Neurosurg. 2018;54:40. DOI: 10.1186/s41983-018-0041-z.

8. Mohanan A.T., Nithya S., Nomier Y. et al. Stroke-Induced Central Pain: Overview of the Mechanisms, Management, and Emerging Targets of Central Post-Stroke Pain. Pharmaceuticals (Basel). 2023;16(8):1103. DOI: 10.3390/ph16081103.

9. Choi H.R., Aktas A., Bottros M.M. Pharmacotherapy to Manage Central Post-Stroke Pain. CNS Drugs. 2021;35:151–160. DOI: 10.1007/s40263-021-00791-3.

10. Subedi M., Bajaj S., Kumar M.S., Mayur Y.C. An overview of tramadol and its usage in pain management and future perspective. Biomed Pharmacother. 2019;111:443–451. DOI: 10.1016/j.biopha.2018.12.085.

11. Corbetta D., Sarasso E., Agosta F. et al. Mirror therapy for an adult with central post-stroke pain: A case report. Arch Physiother. 2018;8:4. DOI: 10.1186/s40945-018-0047-y.

12. Anwer S., Alghadir A. Incidence, Prevalence and Risk Factors of Hemiplegic Shoulder Pain: A Systematic Review. Int J Environ Res Public Health. 2020;17(14):4962. DOI: 10.3390/ijerph17144962.

13. Kumar P. Hemiplegic shoulder pain in people with stroke: present and the future. Pain Manag. 2019;9(2):107–110. DOI: 10.2217/pmt-2018-0075.

14. Fitterer J.W., Picelli A., Winston P. A novel approach to new-onset hemiplegic shoulder pain with decreased range of motion using targeted diagnostic nerve blocks: the ViVe algorithm. Front Neurol. 2021;12:668370. DOI: 10.3389/fneur.2021.668370.

15. Li Y., Yang S., Cui L. et al. Prevalence, risk factor and outcome in middle-aged and elderly population affected by hemiplegic shoulder pain: An observational study. Front Neurol. 2023;13:1041263. DOI: 10.3389/fneur.2022.1041263.

16. Marotta N., Demeco A., Moggio L., Ammendolia A. The adjunct of transcranial direct current stimulation to Robot-assisted therapy in upper limb post-stroke treatment. J Med Eng Technol. 2021;45(6):494–501. DOI: 10.1080/03091902.2021.1922527.

17. De Sire A., Moggio L., Demeco A. et al. Efficacy of rehabilitative techniques in reducing hemiplegic shoulder pain in stroke: Systematic review and meta-analysis. Ann Phys Rehabil Med. 2022;65(5):101602. DOI: 10.1016/j.rehab.2021.101602.

18. Katsura Y., Ohga S., Shimo K. et al. Post-Stroke Complex Regional Pain Syndrome and Upper Limb Inactivity in Hemiplegic Patients: A Cross-Sectional Study. J Pain Res. 2022;15:3255–3262. DOI: 10.2147/JPR.S379840.

19. Altas E.U., Onat Ş.Ş., Konak H.E., Polat C.S. Post-stroke complex regional pain syndrome and related factors: experiences from a tertiary rehabilitation center. J Stroke Cerebrovasc Dis. 2020;29(9):104995. DOI: 10.1016/j.jstrokecerebrovasdis.2020.

20. Kim J.Y., Yoon S.Y., Kim J. et al. Neural substrates for poststroke complex regional pain syndrome type I: a retrospective case-control study using voxel-based lesion symptom mapping analysis. Pain. 2020;161(6):1311–1320. DOI: 10.1097/j.pain.0000000000001816.

21. Lee J.I., Kwon S.W., Lee A. et al. Neuroanatomical correlates of poststroke complex regional pain syndrome: a voxel-based lesion symptom-mapping study. Sci Rep. 2021;11(1):13093. DOI: 10.1038/s41598-021-92564-7.

22. Su Y.C., Guo Y.H., Hsieh P.C., Lin Y.C. A meta-analysis and meta-regression of frequency and risk factors for poststroke complex regional pain syndrome. Medicina. 2021;57(11):1232. DOI: 10.3390/medicina57111232.

23. Bordeleau M., Vincenot M., Lefevre S. et al. Treatments for kinesiophobia in people with chronic pain: A scoping review. Front Behav Neurosci. 2022;16:933483. DOI: 10.3389/fnbeh.2022.933483.

24. Wieters F., Weiss Lucas C., Gruhn M. et al. Introduction to spasticity and related mouse models. Exp Neurol. 2021;335:113491. DOI: 10.1016/j.expneurol.2020.113491.

25. Jia S., Liu Y., Shen L. et al. Botulinum toxin type A for upper limb spasticity in poststroke patients: a meta-analysis of randomized controlled trials. J Stroke Cerebrovasc Dis. 2020;29:104682. DOI: 10.1016/j.jstrokecerebrovasdis.2020.104682.

26. Tranchida G.V., Van Heest A. Preferred options and evidence for upper limb surgery for spasticity in cerebral palsy, stroke, and brain injury. J Hand Surg Eur Vol. 2020;45:34–42. DOI: 10.1177/1753193419878973.

27. Salazar A.P., Pinto C., Ruschel Mossi J.V. et al. Effectiveness of static stretching positioning on post-stroke upper-limb spasticity and mobility: systematic review with meta-analysis. Ann Phys Rehabil Med. 2019;62:274–282. DOI: 10.1016/j.rehab.2018.11.004.

28. Guo J., Qian S., Wang Y., Xu A. Clinical study of combined mirror and extracorporeal shock wave therapy on upper limb spasticity in poststroke patients. Int J Rehabil Res. 2019;42:31–35. DOI: 10.1097/MRR.0000000000000316.

29. Gandolfi M., Vale N., Dimitrova E.K. et al. Effectiveness of robot-assisted upper limb training on spasticity, function and muscle activity in chronic stroke patients treated with botulinum toxin: a randomized single-blinded controlled trial. Front Neurol. 2019;10:41. DOI: 10.3389/fneur.2019.00041.

30. Yang J.D., Liao C.D., Huang S.W. et al. Effectiveness of electrical stimulation therapy in improving arm function after stroke: a systematic review and a meta-analysis of randomised controlled trials. Clin Rehabil. 2019;33:1286–1297. DOI: 10.1177/0269215519839165.

31. Gracies J.M., Pradines M., Ghédira M. et al. Guided self-rehabilitation contract vs conventional therapy in chronic stroke-induced hemiparesis: NEURORESTORE, a multicenter randomized controlled trial. BMC Neurol. 2019;19:39. DOI: 10.1186/s12883-019-1257-y.

32. Subramaniam S., Varghese R., Bhatt T. Influence of chronic stroke on functional arm reaching: quantifying deficits in the ipsilesional upper extremity. Rehabil Res Pract. 2019;2019:5182310. DOI: 10.1155/2019/5182310.

33. Stinear C.M., Lang C.E., Zeiler S., Byblow W.D. Advances and challenges in stroke rehabilitation. Lancet Neurol. 2020;19:348–360. DOI: 10.1016/S1474-4422(19)30415-6.

34. Israely S., Leisman G., Carmeli E. Improvement in arm and hand function after a stroke with task-oriented training. BMJ Case Rep. 2017;17:219–239. DOI: 10.1136/bcr-2017-219250.

35. Alt M.M., Björkdahl A., Forsberg-Wärleby G., Persson C.U. Implementation of evidence-based assessment of upper extremity in stroke rehabilitation: From evidence to clinical practice. J Rehabil Med. 2021;53:1977–1986. DOI: 10.2340/16501977-2790.

36. Antipenko E.A., Sedyshev D.V., Sorokina A.A. Post-stroke arthropathy: experience in the use of chondroprotective therapy. RMJ. 2022;3:51–54 (in Russ.).