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MIRROR THERAPY IN THE TREATMENT OF PHANTOM PAIN. A CASE REPORT

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Abstract

Phantom pain is a common problem in patients with amputated limbs. It can lead to symptoms of depression for its chronicity and high intensity. It also interferes with prosthetic rehabilitation and reduces the quality of life of patients. Due to the complex pathogenesis, there is no generally accepted method of treatment for phantom pain. We present in this article the case of using mirror therapy in a University Hospital, the positive clinical result of which has been proven in multiple studies.

Keywords: *phantom limb, phantom pain, mirror therapy.*

Резюме

ЗЕРКАЛЬНАЯ ТЕРАПИЯ В ЛЕЧЕНИИ ФАНТОМНЫХ БОЛЕЙ. КЛИНИЧЕСКИЙ СЛУЧАЙ

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Фантомная боль является распространенной проблемой у пациентов с ампутированными конечностями. Она может приводить к симптомам депрессии из-за своей хронизации и высокой интенсивности. Она препятствует протезной реабилитации и снижает качество жизни пациентов. Из-за сложного патогенеза общепринятого метода лечения фантомных болей не существует. В этой статье мы приводим случай использования зеркальной терапии в университетской клинике, положительный клинический результат которой был доказан в многочисленных исследованиях.

Ключевые слова: *фантомная конечность, фантомная боль, зеркальная терапия.*

Түйіндеме

ФАНТОМДЫ АУЫРСЫНУ ЕМІНДЕГІ АЙНА ТЕРАПИЯСЫ: КЛИНИКАЛЫҚ ЖАҒДАЙ

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Фантомдық ауырсыну - дене мүшесі ампутацияланған науқастарда кең таралған мәселе. Ол созылмалылығы мен жоғары қарқындылығы үшін депрессия симптомдарына әкелуі мүмкін. Протездік реабилитацияға да кедергі келтіріп, науқастардың өмір сүру сапасын төмендетеді. Патогенезі күрделі болғандықтан фантомдық ауырсынудың емінде жалпыға ортақ қабылданған әдіс жоқ. Біз бұл мақалада оң клиникалық нәтижесі көптеген зерттеулерде дәлелденген айна терапиясын университет ауруханасында қолданған жағдайды келтіреміз.

Түйінді сөздер: *фантомдық мүше, фантомдық ауырсыну, айна терапиясы.*

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Introduction

Phantom pain is a complex, chronic pain syndrome in patients who have undergone limb amputations. It develops in 50–85% of cases after arm amputation [7]. Amputation of a limb is common and is endured by more than 1 million people a year worldwide [2]. In 54% of events, it is caused by vascular disease due to diabetes mellitus and peripheral arterial disease, and in 45% by trauma [26]. According to the International Diabetes Federation, the number of people with diabetes will increase 1.5-fold by 2030, likely leading to an increase in peripheral vascular complications and amputations. Pain syndromes after amputation are an important problem in patients' lives, in addition to postoperative wound infection, disability, adaptation to a new life, and prosthetic problems. After amputation, two types of pain syndromes can develop: residual stump pain and phantom pain. The latter is more common and usually chronic, whereas residual pain occurs mainly in the acute period after amputation and disappears with time. Chronic phantom pain is multifactorial, and its pathogenesis corresponds to neuropathic pain, which is difficult to treat [17]. It is usually paroxysmal and atypical in nature; the patient feels pain as if his phantom limb is being twisted or crushed. The intensity is mainly up to 7–10 points, occurring immediately or within a few days after amputation [24]. Although the frequency and intensity of pain decrease over time, there are cases where the level of phantom pain remains unchanged or increases [18]. This can negatively affect the quality of life, leading to sleep disorders and depression. Moreover, the economic burden of chronic pain is higher than that of many diseases due to the high cost of treatment and public services provided [5]. The pathogenesis of phantom pain is unclear and not fully studied, so there is no standard treatment [8]. The diagnosis is made clinically. Opioids, anticonvulsants, and antidepressants are used in pharmacological management. Most patients get prescribed several drugs together, and the negative consequences of such polypragmasy may be severe [12]. In addition to drug therapy, phantom pain is influenced by non-drug approaches such as mirror therapy, motion imaging, and virtual reality techniques. Among them, the most proven method is mirror therapy [14].

In Kazakhstan, mirror therapy is not yet included in the list of rehabilitation measures specified by clinical protocols. In Semey, it was first implemented in the Hospital of Semey Medical University in spring 2021, but due to changes in inpatient conditions caused by pandemic COVID-19, its use was delayed for several years. For now, mirror therapy is mainly administered to neurological patients who have post-stroke motor deficits. In this article, we present our first experience using mirror therapy for a patient with phantom pain in his amputated arm.

Objective: to analyze the clinical case of using mirror therapy for a patient with chronic phantom limb pain and assess its efficacy in the given case; to review current literature about treatment options for phantom pain. The patient gave his consent to the publication of material with his participation.

Clinical case.

A 37-year-old man consulted a neurologist, complaining of pronounced pain in his phantom arm. According to the patient, at the age of 19, as a result of an industrial injury, the right arm was amputated at the level of the shoulder joint. The patient was unconscious in the intensive care unit for 4 days. The feeling of a ghostly hand bent at the elbow joint occurred immediately after regaining consciousness. In subsequent years, these sensations persisted and did not cause discomfort; periodically, the phantom hand itched or there was a pulsation below the wrist. Over the past 5 years, the patient began to be disturbed by phantom pain in the wrist area of a persistent nature. He had been feeling his arm extensively twisting and pronating; the intensity was at 7 points, according to the Visual Analogue Scale. In the spring-autumn periods, the nature of the pain turned into a paroxysmal form, the intensity reached 10 points, the patient's sleep and well-being were disturbed, and the pain continued for up to several days. The patient described it as a deep, excruciating pain in the tendons of the phantom arm. This affected his general condition and led to irritability and anxiety. The patient associated the exacerbation of pain with changes in the weather and psycho-emotional stress. With the appearance of phantom pain, he repeatedly consulted with a neurologist, took NSAIDs (ketorolac, lornoxicam), massaged the amputation area, used local anesthetics, and resorted to alternative medicine methods. The effect of the treatment was insignificant and short-lived. During the examination, the general condition was close to satisfactory. The right arm was amputated at the level of the shoulder joint; there were no signs of inflammation over the scar; palpation was normal; and no subcutaneous formations were detected. The neurological status is unchanged. No signs of inflammation were found in the blood test. As a treatment for phantom pain, mirror therapy was proposed, in which a mirror was placed in front of the patient along the midline, and the reflection of the healthy hand in it was perceived as an amputated hand. Thus, a visual illusion is created about the latter, which leads to a decrease in the severity of phantom pain. The first mirror therapy session, lasting 10 minutes, was conducted in the neurology department under the supervision of a physical

therapy instructor. According to the patient, the 7-point-intensity pain that preceded the mirror therapy completely disappeared within a few minutes during the procedure. Phantom pain resumed after 3 days when the patient was driving. After understanding the way mirror therapy works, the man tried to visualize the image of a normally functioning right hand to relieve pain. Along with mirror therapy, this method of fantasizing in the mind movements in amputated or paralyzed arms and legs is successfully used in rehabilitation ("motor imagery"). However, compared to it, mirror therapy is more effective, apparently because of the visual feedback provided [1].

The patient immediately came to a positive result: the pain completely disappeared. At follow-up after 6 months, he noted that phantom pains bother him less; when they appear, he independently does mirror therapy or uses the method of imagining movements.

Discussion

The exact pathogenesis of the phantom limb phenomenon is still unknown. But it has been established that it is caused by several peripheral and central mechanisms. During the amputation procedure, nerves and surrounding tissues are damaged, which disrupts normal afferent and efferent signals [8]. After cutting the nerves during amputation, excitability increases in their axons, and nerve cells proliferate randomly, which leads to the formation of neurinomas. A large number of sodium channels appear in them, leading to excessive excitation. Increased pressure, e.g., from a prosthesis, can exacerbate this excitability. In the spinal ganglia, changes are also observed immediately a few minutes after a peripheral nerve injury. In addition to phenotypic changes in them, their bioelectrical features, such as excitability threshold and action potential duration, also change. Spontaneous electrical activity appears [1, 8]. All these changes in the peripheral nervous system may serve as one of the factors contributing to the reorganization of the cortex and the development of phantom pain. Central mechanisms begin with sensitization in the spinal cord. The combination of high activity and nociceptive signals, slowing down of the inhibitory activity of the supraspinal centers, is one of the main factors [11]. In recent years, it has been found that the reorganization of the cerebral cortex plays an important role. Parts of the primary somatosensory and motor cortex responsible for the amputated limb are occupied by neighboring regions [13, 17]. Psychoemotional factors, such as depression, anxiety, and high stress, can trigger phantom pain in amputees [9].

Drug therapy is usually the first to be prescribed for phantom pain, and it is treated as a neuropathic one [1, 14, 17]. Although the adverse events and high cost of medications interfere with long-term use, for example, acetaminophen has a negative effect on the liver; NSAIDs cause damage to the gastrointestinal tract and kidneys; opioids cause respiratory distress, constipation, nausea, and cognitive impairment. Therefore, rehabilitation methods (acupuncture, electrical nerve stimulation, mirror therapy, transcranial magnetic stimulation, etc.) are used as an adjunct or in person [14, 17, 25].

Pharmacological treatment is often initiated with antidepressants, usually amitriptyline, but findings regarding its efficacy are controversial. The study with 47 participants where positive outcomes were found is uncontrolled, so the results may not be reliable. Of the anticonvulsants, the drug of choice for neuropathic pain is gabapentin. In the studies conducted, gabapentin results in a significant reduction in phantom pain compared to placebo and has no serious side effects. Another widely used option, especially in acute settings, is oral opioids, for example, morphine sulfate or burpenofrine. As shown by the fMRI morphine not only relieves pain but also acts on central mechanisms, reducing cortical reorganization. However, its side effects, such as dependence and respiratory suppression, limit long-term administration [1, 15, 17]. Peripheral nerve blocks with local anesthetics are also effective. A 6-day course of perineural blockade with bupivacaine or ropivacaine not only reduces phantom pain significantly, but the analgesic effect lasts up to 6 months. Patients also report physical and emotional improvement afterward [17].

Among the non-invasive methods of neuromodulation, the most proven are percutaneous electrical nerve stimulation and repetitive transcranial magnetic stimulation of the contralateral primary motor cortex. Invasive methods such as spinal cord stimulation and deep brain stimulation can be advised in cases where conservative therapy has failed and chronic pain significantly impairs daily life [14, 15, 17].

In recent years, mirror therapy has shown positive results and been proven to be effective in many studies. It gives the illusion that a healthy limb looks in a mirror exactly like an amputated limb, creating the image of normal movement in a phantom arm or leg. Usually a normal-sized reflection of the intact limb is used, but lenses, virtual reality, etc. with zoomed-in or zoomed-out images may also be used [25]. This method was first invented by Ramachandran and Rogers-Ramachandran in 1996. The mirror image of the normal limb rearranges and reorganizes the mismatch between proprioceptive and visual responses from the amputated limb. As a result, phantom pain is reduced [20].

Mirror therapy has a positive effect irrespective of the cause of amputation, type of amputated limb, and age [6]. Its clinical effect is higher than that of other methods [16]. To study the effectiveness of mirror therapy, many randomized, controlled studies have been conducted. In their first meta-analysis, mirror therapy, when used in conjunction with motor imagery, reduced chronic pain to a large degree compared to conventional physiotherapy [4]. The latest systematic review of 12 studies from 2018 found that mirror therapy led to a significant reduction in the severity of phantom pain [10]. The strength of the effect may depend on the type of pain; it works better for deep neuropathic pain (e.g., a feeling of pressure) than for superficial pain (e.g., a feeling of heat). The explanation may be the fact that in the integration of sensory and motor systems, deep tissues are involved rather than superficial ones [15].

In addition to phantom limb pain, mirror therapy can reduce complex regional pain syndrome (CRPS) that occurs in an existing limb. Ramachandran in 1995 suggested that CRPS may be a type of learned pain and can be unlearned through mirror visual feedback. By now, there are plenty of works indicating the positive effect of

mirror therapy on CRPS [19, 21]. In a systematic review and meta-analyses conducted, mirror therapy reduced post-stroke pain to a greater extent compared to the control group [3, 22]. In addition, the analgesic effect was preserved for 2–6 months [3].

Excitingly, mirror therapy can be used for back pain. Wand et al. found in a randomized controlled study that patients' pain decreased immediately after exercises when performed with their backs seen in the mirror. According to the authors, mirror therapy also had a positive effect on the duration of pain [23].

Side effects of mirror therapy include increased pain, worsening movement disorders, dizziness, and depression [6, 25]. Technological innovations like virtual reality can be applied in cases where a patient has difficulty doing mirror therapy or does not have a healthy limb to be reflected [1].

Measures to prevent phantom pain include preoperative anesthesia (ketamine or epidural blockade before surgery) and targeted reinnervation of the muscle. The former may reduce residual limb pain in the perioperative period but probably has no role in preventing the development of phantom pain. A more effective method here is targeted muscle reinnervation surgery (TMR), where the proximal nerves of the amputated limb are connected to a donor muscle that is denervated from its own nerves. Impulses from the donor muscle provide proprioceptive feedback from the amputated limb and prevent phantom pain. In the case of phantom pain that has already developed, TMR can also completely relieve the patient's pain [1, 17].

Conclusion

Mirror therapy is a safe, easy-to-use, and highly effective method for the treatment of phantom pain. Its' price is low, and there are almost no contraindications or severe side effects. Such benefits allow it to be widely used in the treatment of various pain syndromes. In the clinical case we reported, mirror therapy very quickly and significantly reduced the phantom pain that bothered the patient for many years. Rehabilitation therapists and neurologists can use it in the initial treatment of phantom pain not only in inpatient but also in outpatient departments, with further continuation by amputees at home.

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