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ORIGINAL

EVALUATING THE IMPACT OF ACUPUNCTURE AND MOXIBUSTION ON PAIN MANAGEMENT AND ATHLETIC PERFORMANCE IN ATHLETES WITH CLUSTER HEADACHES

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ABSTRACT

Cluster headache is a debilitating condition characterized by intense pain with a distinct circadian and seasonal onset pattern, significantly impacting athletes' performance and training schedules. Standard treatments in Western medicine, such as high-flow oxygen therapy and triptans, offer only temporary symptom relief and are frequently associated with recurrence. Acupuncture, known for its broad mechanism pathways and notable efficacy, presents a promising alternative. This review explores the potential mechanisms through which acupuncture might alleviate cluster headaches in athletes, focusing on interactions with the hypothalamus, activation of the trigemino vascular system, and modulation of the central pain system. Additionally, we discuss how acupuncture and moxibustion could not only reduce headache frequency and intensity but also enhance overall recovery and athletic performance by improving pain management. This integrated approach could offer a significant advantage in the sports setting, where maintaining peak physical condition is crucial

KEYWORDS: Cluster Headache; Acupuncture; Moxibustion

1. INTRODUCTION

Cluster headaches are recognized as one of the most painful conditions,

characterized by excruciating, unilateral pain often described as having a piercing quality. While they are less common than migraines, their impact on individuals, especially athletes, can be profound, affecting their training, performance, and overall quality of life(Fan & Yu, 2018). The episodic nature of these headaches, along with their sudden onset, poses unique challenges in managing an athlete's schedule and physical condition(SUN et al., 2021). Traditional treatment methods, including high-flow oxygen and triptans, are primarily effective for acute management but do not prevent future episodes and often carry side effects that can further hinder athletic performance. As such, there is a pressing need to explore more holistic and sustainable treatment options(Courault, Demarquay, Zimmer, & Lancelot, 2021). Acupuncture and moxibustion, components of traditional Chinese medicine, have shown promise in treating various pain conditions and are increasingly considered viable options for managing complex pain disorders like cluster headaches(Robbins, Starling, Pringsheim, Becker, & Schwedt, 2016). The theoretical foundation for these treatments in the context of cluster headaches involves modulation of neurological pathways that are also crucial in pain perception and physical stress response. This includes potential effects on the hypothalamus, which is implicated in the circadian rhythm of these headaches, and the trigeminovascular system, a key player in the pathophysiology of headache disorders(W. LIU, YAN, & ZHAO, 2019). Given the limitations of current medical treatments for cluster headaches and the potential of acupuncture and moxibustion to provide relief while supporting continued athletic training and performance, this review aims to critically assess existing literature on the subject(Remahl, Ansjön, Lind, & Waldenlind, 2002). We will explore the mechanisms by which these treatments can benefit athletes, discuss clinical evidence, and highlight areas requiring further research. The ultimate goal is to provide a comprehensive overview that can guide future studies and help integrate these traditional methods into sports medicine practices effectively(Tfelt-Hansen, 2010).

2. Acupuncture for cluster headache treatment

In the clinical application of acupuncture for CH treatment, most doctors use local acupoint selection combined with limb acupoint selection, and penetrating acupuncture and scalp acupuncture have a good effect. Penetrating acupuncture can strengthen the communication between the epimeric meridian and its adjacent meridians, promote the flow of Qi and blood on meridians, and achieve curing of the disease. Scalp acupuncture is based on the theory of functional localization of the cerebral cortex as the primary basis of its selection of acupoints, and involves stimulation in specific head areas(Kaube, Hoskin, & Goadsby, 1993). After acupuncture, the scalp and subcutaneous sensory structures send out nerve impulses that excite and diffuse in the cortex. Through the nerve impulses, cerebral blood vessel tension is reduced, and blood flow and oxygen supply are increased, thus leading to

pain relief (YUAN, XING, & LI, 2017). The study of functional magnetic resonance imaging (fMRI) on the mechanism of acupuncture treatment of migraine shows that acupuncture treatment can improve a dysfunctional trigeminal nerve, and inhibit the descending pain mechanism and pain matrix or pain regulation-related brain areas of migraine patients, thus achieving therapeutic effect (Gan, Tsai, & Pei, 2018). Based on conventional acupuncture treatment, acupuncture targeted to the sphenopalatine ganglion (SPG) can more effectively relieve the degree, attack, frequency, and duration of the CH episode (Zai, Ji, Cheng, Chen, & Liu, 2022).

3. Mechanism of acupuncture treatment

3.1 Participation in the regulation of hypothalamic dysfunction

CH is characterized by a headache attack, which is accompanied by severe temporal, orbital, or periorbital pain, lasting from 15 minutes to 3 hours (Olesen, 2018). Positron emission tomography (PET) scanning and functional MRI studies have identified hypothalamus activation during spontaneous and triggered CH onsets (A May, Bahra, Büchel, Frackowiak, & Goadsby, 2000; Arne May, Bahra, Büchel, Frackowiak, & Goadsby, 1998) (Yin et al., 2021). CH has a fixed attack time and a strong seasonal rhythm. Often, it occurs at a fixed time every day in a specific month of the year, and the onset frequency peaks at night, suggesting that the circadian rhythm plays a crucial role in the pathogenesis of CH (Barloese et al., 2015). The suprachiasmatic nucleus cells in the anterior part of the hypothalamus produce a self-sustaining rhythm, which is carried by the light signal from the retina through the melatonin secreted by the retinal hypothalamus bundle and pineal gland (Rosenwasser & Turek, 2015). The suprachiasmatic nucleus in turn drives the body and brain, which have a circadian rhythm, including the secretion of pituitary hormones (Antle & Silver, 2005). Orexin-A and Orexin-B (also known as hypocretins) are neuropeptides produced exclusively by neurons in the posterior and lateral parts of the hypothalamus and are involved in regulating wakefulness and food intake. Some genetic studies found the polymorphism of the orexin receptor gene to increase CH risk (Rainero et al., 2008). Melatonin is a hormone that is naturally secreted by the pineal gland after the onset of darkness and participates in regulating the sleep-wake cycle. In a small, double-blind, placebo-controlled study, melatonin proved to be beneficial in CH treatment (Wei et al., 2017). Acupuncture can regulate the suprachiasmatic nucleus of the hypothalamus and induce metabolism changes in the nocturnal state (P. J. Goadsby, 2002). Abnormal melatonin levels secreted by the hypothalamus participate in the pathological process of CH, resulting in abnormal circadian rhythm activity (Moore MD, 1997). The secretion of melatonin has a strong circadian rhythm, which is regulated by the suprachiasmatic nucleus. The retina-hypothalamus connection provides light signals for the circadian rhythm (Hofman, Zhou, & Swaab, 1996). In the active phase of CH, the characteristic

nocturnal peak of melatonin secretion decreases, and its metabolite excretion is abnormal (Waldenlind, Gustafsson, Ekbom, & Wetterberg, 1987). Zheng Xue'na et al (Zheng et al., 2018) found that acupuncture could improve melatonin secretion and expression of melatonin receptors in the suprachiasmatic nucleus of rats with insomnia, thus improving their insomnia and restoring their circadian rhythm. Acupuncture at the acupoints of Shenmen, Neiguan, and Sanyinjiao can effectively improve 5-HATT levels, serotonin neuron excitability, and increase inhibitory neurotransmitter levels to regulate the dynamic balance between excitability and inhibition (L. LIU et al., 2022); the 5-HT receptor (5-HT1F) can prevent a headache attack through non-vascular central nervous inhibition (W.-h. WANG & Yan, 2019). Therefore, acupuncture can prevent or inhibit the occurrence of migraine by activating hypothalamic hormone receptors.

3.2 Inhibition of trigeminal neurovascular system activation

CH is characterized by severe unilateral pain and is accompanied by restlessness and parasympathetic autonomic symptoms, such as tears, nasal congestion, or runny nose. The individual attack onset may be related to trigeminal autonomic reflex activation (P. J. Goadsby, 2002). Its acute attack involves trigeminal vascular system activation and is mainly manifested by changes in the distribution of pain of ophthalmic branch of the trigeminal nerve and the brain neuropeptide concentrations; therefore, the acute onset of pain may be considered as a manifestation of trigeminal autonomic reflex. A combination of the autonomic nervous system (facial nerve and parasympathetic nerve output) and trigeminal nerve produces the trigeminal-autonomic nerve reflex, which is considered to be the basis of the characteristics of cranial nerve autonomic symptoms displayed by CH, including rhinorrhea, conjunctival infection, lacrimation, and nasal congestion (P. Goadsby, 2005). The trigeminal neurovascular system pain signals are transmitted to the ophthalmic branch of the trigeminal nerve, and then to the cranial vessels and dura mater. These synapses are located in the dorsal horn of the trigeminal cervical nerve complex, trigeminal nucleus caudalis, C1, and C2, and then projected to the thalamus, triggering activation of cortical areas, including the prefrontal cortex, insular cortex and cingulate knee, thus causing pain. Calcitonin gene-related peptide (CGRP) is a neuropeptide comprising 37 amino acids (Amara, Jonas, Rosenfeld, Ong, & Evans, 1982), which can be found in different regions of the peripheral and central nervous systems. Approximately one-fourth of the total CGRP is expressed in the trigeminal ganglion sensory neurons, especially in the neurons of the meningeal vascular system. Stimulation of the trigeminal ganglion and peripheral afferent nerves leads to increased CGRP levels in cerebral venous hematoma, and electrical stimulation of the dura mater leads to dural vasodilation, which is effectively inhibited by sumatriptan. The most important physiological function of CGRP in cerebral blood vessels is to prevent excessive vasoconstriction. During the

acute onset of CH, significantly increased CGRP levels are present in the ipsilateral external jugular vein. High-flow oxygen therapy and subcutaneous injection of sumatriptan can return CGRP levels to normal. Acupuncture treatment of trigeminal neurovascular system activation provides immediate and continuous analgesia. Compared with modern medical drug treatment, acupuncture can reduce the degree of pain, number of onsets, and frequency of recurrence. In addition to reducing serum CGRP levels and improving migraine symptoms, electroacupuncture for the acupoints "Waiguan" and "Fengchi" can up-regulate and down-regulate the expressions of CB1 and CGRP receptors, respectively, in the trigeminal ganglia of migraine rats. Acupuncture for the acupoints "Yangbai", "Sibai," and "Jiache" has shown to increase the pain threshold in migraine rat models and regulate the synthesis and release of substances moderated by CGRP-positive neurons of the trigeminal nerve. Additionally, acupuncture can also regulate vasoactive intestinal peptides and other neurotransmitters, which is an important mechanism of action of acupuncture for the regulation of the trigeminal neurovascular system.

3.3 The regulation or suppression of the pain system by acupuncture

3.3.1 The regulation of the pain system by electroacupuncture

5-hydroxytryptamine (5-HT) has long been the key neurotransmitter for headache treatment. 5-HT1B/1D/1F receptors are widely involved in the pathogenesis of migraine and are treatment targets for the same. 5-HT and its mRNA are distributed in the middle meningeal artery, trigeminal ganglion, trigeminal spinal tract nucleus, dorsal raphe nucleus, midbrain aqueductal gray matter, thalamus, and other meningeal tissues. Moreover, it is involved in the expansion of the meningeal artery, neuroinflammation, central sensitization, and activation of pain pathways, which are involved in the pathophysiological process of headache, and the 5-HT receptor may be involved in the release of trigeminal neurovascular neuropeptides and CGRP during a headache attack. Electroacupuncture at the acupoints "Yanglingquan" and "Taichong" can effectively reduce CGRP levels in rat plasma, which suggests an effective reduction in headache severity by acting on 5-HT1F receptors.

3.3.2 The regulation of multiple brain regions activities by acupuncture

Acupuncture has a significant impact on pain regulation and has a good therapeutic effect on various types of pain, such as inflammatory and neuropathic pain. Pain transmission mechanisms of the central nervous system include multiple brain structures and systems, mainly involving the upstream processing of pain information and the downstream regulation of pain networks. When the downward conduction of pain produces an uncomfortable response, it generates a primary headache by changing the processing of upward pain

information. The anterior cingulate cortex (ACC) is located in the medial frontal lobe of the brain, adjacent to the corpus callosum. During CH onset, ACC glucose metabolism increases, and pain regulation in the frontal lobe area is insufficient, which may participate in the pathophysiology of CH onset. Research shows that (Hamel, 2007) the acupuncture therapyof "soothing the liver and regulating the mins" can up-regulate the expression of opioid receptors in the ACC of migraine rats, thus increasing the pain threshold and relieving pain symptoms. When CH onset occurs, the hypothalamus on the side of the headache is activated, indicating that there is a functional abnormality in the hypothalamus and pain processing during CH onset. This may be related to the orexin secreted by the hypothalamus. Orexin A levels are significantly reduced in the cerebrospinal fluid of migraine patients, and orexin B receptor gene polymorphism is closely related to the occurrence of migraine. Activation of hypothalamic orexin release can inhibit mice's sensitivity to physiological and pathological pain, and patients may wake up from sleep during the CH onset, which may be related to orexin release. ACC activation and abnormal hypothalamic orexin secretion may suggest that acupuncture treatment of CH is achieved by regulating the connection between multiple brain regions.

4. Clinical study on acupuncture treatment of CH

4.1 Filiform needle acupuncture

Clinical acupuncture for CH is mainly filiform needle acupuncture. The filiform needle acupuncture treatment pays more attention to acupoint selection. It uses syndrome differentiation for treatment, and the acupoints are selected along the meridians. Zai Fenglei et al performed needling on the acupoints Touwei, Yintang, Yangbai, Hegu, Neiting, and Ashi and then performed lifting, inserting, leveling, reinforcing, and reducing techniques after getting the Qi (Zai et al., 2022). The needle was left for 30 minutes in combination with acupuncture of the sphenopalatine ganglion on the affected side and was released immediately after the acupuncture reached the established depth. The treatment course lasted 2 weeks. A total of three course treatments were performed and 57 cases were treated, with a total effective rate of 93.0%. Wang Cuicui et al. selected the acupoints Baihui (C. Wang & Zou, 2015), Sishencong, Shangxing, Pigu, Yintang, Yangbai, Sun, Touwei, and Fengchi by using the method of "soothing the Qi and calming the nerves" on the far end of the meridian;" the acupoints Houxi, Shenmai, and Kunlun were added when the pain was in the Taiyang meridian; the acupoints Hegu and Neiting were added when the pain was in the Yangming meridian; the acupoints Waiguan, Xiaxi, and Zulinqi were added when the pain was in the Shaoyang meridian; the acupoint of Taichong was added when the pain was in the Jueyin meridian. The needle was retained for 50 minutes after getting Qi. The frequency was once a day and a course comprised seven such sessions. The duration and frequency of episodes were significantly reduced by two courses of treatment in 20 cases.

Yan Yuqian et al. discriminately selected the acupoints Eshi (Yan & Yan, 2008), Touwei, Yangbai, and Hegu. The needle was retained for 30 minutes with the twisting and reducing method, and a course comprised of 10 days of such sessions. Thirty cases were treated for two courses, and the cure rate was 70%.

4.2 Electroacupuncture treatment

In the treatment of CH with electroacupuncture, different doctors choose different waveforms. Zhao Xiaodong treated 51 patients by selecting the acupoints Sizhukong (ZHAO, 2013), Toulinqi, Touwei, Xiayan, Xuanli, Xuanluxue, Qubin, Tianchong, Fengchi, Luoqi, and Yuzhen. After puncturing, lifting, inserting, twisting, and turning, the needle was retained after getting the Qi. The waveform comprised mainly of dense waves, and the intensity was considered suitable as long as the patients could tolerate the numbness and swelling. The efficacy rate was 94.12%. Zhou Guoying et al. selected the acupoint Yangbai for horizontal acupuncture towards the eyes (Zhou, Jin, & Chen, 2010), the acupoint Yintang for horizontal acupuncture toward the nasal tip, and the acupoints Taiyang, Touwei, and Shuaigu for horizontal acupuncture towards the ear. Vertical acupuncture was also performed at the acupoints Xiaguan, Jiache, Fengchi, Hegu, and Taiyang. After getting the Qi, the electroacupuncture therapeutic apparatus were connected, and the dilatational waves were used at the frequency of 40 minutes per session and one session was performed per day. Sessions for 10 days formed a course, and there was an interval of 2 days between courses. A total of three courses of treatment were applied, and 41 of 47 cases reported effectiveness.

4.3 Acupuncture combined with traditional Chinese medicine treatment

Kang Jinzhong treated CH patients with acupuncture and traditional Chinese medicine and selected the acupoints Chengqi (KANG, 2005), Tongziliao, Shangjingming (the midpoint of the line between Jingming and Zanzhu), Touwei, and a part of Eshi to conduct the reducing method. Bloodletting from the acupoints Zuqiaoyin, Zhiyin, and Lidui combined with the addition and reduction treatment of Bupleurum and Pueraria Flesh-Resolving Decoction was performed for 32 cases, and 25 patients reported complete cure. The cure rate was 78.1%.

5. Summary and prospect

Cluster headaches represent a significant challenge for athletes, not only due to the extreme pain experienced during episodes but also because of their unpredictable occurrence and the disruption they cause to training and competition schedules. While conventional treatments like oxygen therapy and triptans are effective for acute episodes, their short-term relief is a major limitation, necessitating the exploration of more sustainable, holistic treatment approaches(Pelissier, Pajot, & Dallel, 2002). Acupuncture and moxibustion

have emerged as potent alternatives, offering a multifaceted approach to pain management that could be particularly beneficial in a sports context. The mechanisms by which acupuncture affects cluster headaches appear to involve modulation of pathways in the hypothalamus, inhibition of the trigeminovascular system, and alterations in the central pain system. These actions not only address the pain itself but may also mitigate the frequency and intensity of headache episodes. For athletes, the implications of effective acupuncture treatment extend beyond mere symptom relief. By reducing the incidence and severity of cluster headaches, acupuncture can potentially improve athletes' overall well-being, mental focus, and physical readiness. This holistic improvement is crucial for athletes who need to remain in peak condition for performance. Moreover, the integration of moxibustion with acupuncture provides a complementary boost in treatment efficacy, potentially enhancing energy flow and muscle relaxation, which are critical in high-stress physical activities. This combined approach can help in maintaining a consistent training regimen by minimizing downtime and enhancing recovery processes, thus supporting athletes in achieving their performance goals. In conclusion, while further clinical trials are needed to fully elucidate the efficacy and mechanisms of acupuncture and moxibustion in treating athletes with cluster headaches, preliminary evidence suggests that this could be a groundbreaking approach in sports medicine. By expanding the scope of research to include more rigorous, sport-specific clinical studies, we can better understand how these traditional techniques can be optimized to support athletic health and performance, offering a viable, long-term strategy for managing this challenging condition.

5.1 Declaration of Competing Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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