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Neuroplasticity in Chronic Ankle Instability-Implications in Rehabilitation

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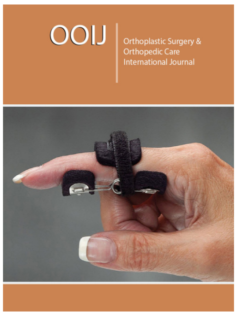

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Abstract

Ankle injuries are common injuries in athletic as well as non-athletic populations and a vast majority of these injuries become chronic ankle instability. However, rehabilitation is either conservative or post perative and is focused on improving muscle strength, balance and stability. However, the neuroplastic changes occurring remain overlooked which eventually leads to reoccurrence. Therefore, the focus of this article is to discuss the neuroplastic changes associated with chronic ankle instability and rehabilitation strategies to address these changes for better clinical outcomes and to reduce the risk of reoccurrence.

Keywords: Neuroplasticity; Ankle injuries; Chronic ankle instability; Proprioceptive exercises

Introduction

Ankle sprains are commonly encountered injuries in general as well as athletic population, about 70% of the general encounters ankle sprain at least once in their lifetime [1]. Following an acute ankle sprain about 32 to 74% of the population encounter a chronic sequela of recurrent ankle sprain and instability with a typical feeling of "giving away" which is termed as "Chronic Ankle Instability (CAI)" [2]. CAI is characterized by pain, significant instability and dysfunctional ankle movement. Injury to the ankle leads to impairment in mechanoreceptors, inflammation, joint effusion and chronic pain leading to cortical neuroplasticity. There occurs cortical reorganization in sensory and functional changes [3]. Neuroplastic changes are associated with chronic ankle instability.

Neuroplastic changes in the periphery

Patients with CAI demonstrate sensorimotor changes which include alteration in proprioceptive sense, postural control and muscular reflection. Mechano receptors and peripheral joint structures such as ligaments, muscles, tendons and skin provide proprioceptive input [3]. Following injury to the ankle there are deficits in these input pathways which lead to the development of maladaptive neuroplasticity within the central nervous system which eventually causes impaired processing of joint position perception. This impairment increases the reliance on visual and vestibular inputs in order to compensate for reduced proprioceptive inputs [4,5].

Neuroplastic changes in the central nervous system

The parahippocampal region consists of the post-central area, which is known to consist of the primary somatosensory cortex. This primary sensory cortex plays a vital role in joint proprioception. Following the injury to the ankle there is a reduction in the volume of para hippocampal region [6,7]. Patients with CAI showed greater activation of the ipsilateral motor cortex which is attributed to compensation of the unaffected ankle. Therefore, the unaffected ankle performs a greater role in balance control [8,9]. Patients with CAI tend to compensate for their posture and gait, which leads to redistribution of cerebral function. Under normal physiological circumstances, both cerebral hemispheres are mutually inhibited [10]. However, post-ankle injury the is a disturbance in this inhibition and increase in cerebral metrics which is due to an increased compensation from the unaffected side. In simpler terms the ankle instability, higher the activation of ipsilateral cortex as a compensatory mechanism for greater utility of unaffected ankle [11].

Neuroplastic changes in insula and cingulate motor area

Insula is one of the most important regions in processing pain and it is known to affect somatosensory, nociceptive and affective functions. The integration of information inputs provides the prediction of a combination of pain and perceptual errors. As the insula functions to integrate emotional and somatosensory signals, sensitization of chronic pain is associated with the overlapping of chronic pain in insula [12,13]. The Cingulate Motor Area (CMA) is significantly active during lower limb movements, even before voluntary activity [14]. Patients with chronic ankle instability demonstrate poor functional connectivity between the insula and CMA which leads to a conflict in these areas of the brain while processing information during exercise [15]. These processing difficulties eventually lead to an incomplete recovery of motor function, followed by the risk of reoccurrence. During rehabilitation when the patient becomes aware of the motor needs in order to recover, the hyperactivation in the CMA leads to a conflict between the unrealized fear of movement and the motivation to perform for a full recovery [16].

Management

The conservative management and post-surgical rehabilitation should focus on including proprioceptive exercises and cognitive loading exercises for better clinical outcomes along with a reduced risk of reoccurrence. The individual passes from cognitive to associative phase of learning and thereafter autonomous phase of learning, where the changes according to the need become automatic. Additionally proprioceptive exercises help in improving focus in the return to sport phase. Biomechanical ankle platform system, wobble boards and even surfaces are commonly used for training proprioception. The exercises begin in non-weight bearing and progress to weight bearing (with and without weight), from eyes open to eyes close, static to dynamic such as running, jumping, cutting, twisting, pivoting, lateral and backward movements. Slower to faster speed, bilateral stance to unilateral stance. Tai-chi, which includes slow, continuous graceful circular movement patterns is recently included in proprioceptive exercises [17]. Evidence suggests that patients with CAI depend of visual sources with an increased planning to execute a motor task, therefore they perform quite well in clinical set up but are poor performers and are prone to injury reoccurrence in the real world owing to increased distractions and increased cognitive demands. Therefore, it is important to train the patient with cognitive loading exercises in the clinical set-up. Cognitive loading exercises subjects the patient to engaging into a cognitive task while executing a motor function. Therefore, the patient engages in a motor task such as ankle exercises along with cognitive tasks such as serial sevens where the patient keeps on subtracting 7 from a give number. Cognitive tasks include counting forward, counting backwards, repeating numbers etc [18].

Conclusion

On a closing note, it is evidence that there are several neuroplastic changes developing after the acute stage of an ankle injury which remain consistent in chronic stages and even after surgical intervention. Therefore, it becomes mandatory to incorporate cognition and proprioception-based interventional strategies for better clinical outcomes and reduce the risk of reoccurrence.

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