A Literature Review on Neuromuscular Control Training in Chronic Ankle Instability for the Prevention of Lower Limb Injuries

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Abstract: Chronic ankle instability (CAI) is the damage commonly to the lateral ankle ligaments by forced inversion or an outward snapping of the ankle joint relative to the foot. It is one of the most common injuries of lower limb seen in orthopaedic trauma. In most people, only the anterior talo-fibular ligament is affected but, in a minority, this is also can be seen with a combined rupture of the calcaneo-fibular ligament. In most of the cases, conservative treatment leads to fully functional recovery in the majority of people. The term chronic (lateral) ankle instability⁵ is used when the instability i.e., recurrent sprains or giving way persists for longer than six months. It can occur with or without increased mechanical laxity and initially treated conservatively and in most of the cases leads to fully functional recovery in the majority of people. Purpose: To review the literature for finding the effectiveness of neuromuscular control training on preventing lower leg injuries in subject with chronic ankle instability and to review the literature for finding the effectiveness of neuromuscular control on Range of motion, dynamic balance, postural stability, landing phase and on self-reported function in subject with chronic ankle instability. Search method: PubMed, google scholar, research gate, science direct, Cochrane from these databases the articles which fulfill the inclusion criteria were taken and reviewed to know the effectiveness of neuromuscular control training on preventing lower leg injuries. Results: Out of 14 articles, 9 articles shows that neuromuscular control training (NMT) is effective as preventive strategy, in that 5 articles show the improvement in landing phases after NMT, 4 article shows improvement in postural control and implementing NMT shows improvement in ROM, ankle joint position sense, earlier leg muscle activation, and self-reported function in subjects with chronic ankle instability. Conclusion: These reviews can be used to demonstrate that neuromuscular control training could exhibit a protective strategy for the previously injured ankle and in reduction of other lower limb injury and further injury through improved motor control.

Keywords: Neuromuscular control training, ankle, chronic ankle instability, previous ankle sprain, lower limb, injury prevention, dynamic and postural control, intervention, self-reported function, AND, OR, IN, WITH.

1. Introduction

Chronic ankle instability (CAI) is an encompassing term used to describe the presence of mechanical instability (MI) and functional instability (FI) or both following the occurrence of first ankle sprain⁶. FI is defined as the subjective feeling of instability and is in relation with a proprioceptive and neuromuscular dysfunction while MI is more objective and involves the movement of the ankle joint beyond the physiologic ROM, pathological laxity, arthrokineamtics restrictions and degenerative and synovial changes⁷. It is commonly develops following lateral ankle ligament trauma, is a pathological condition characterized by laxity of the lateral ligaments, repetitive bouts of ankle instability causing the ankle to give way leading to recurrent lateral ankle sprains and residual symptoms, such as pain and instability that last for at least 12 months and is associated with a variety of sensorimotor adaptations, including biomechanical alterations, anterior hypermobility of the talocrural joint and inversion hypermobility of the subtalar joint, decrease ROM (particularly ankle dorsiflexion ROM)⁸, decreased strength, altered functional movement patterns, their dynamic balance and gait contributed to recurrent injuries, and postural instability⁹. Individuals with CAI land in a more plantar flexed and inverted position⁴.

After the first acute ankle sprain, 40% of people may develop CAI. An updated model of CAI suggests that damaged to the mechanoreceptors located within the lateral ankle ligaments, and possibly the muscle spindles, can negatively alter signal inputs to the central nervous system and consequently influence proprioceptive and neuromuscular control⁴. As a result, reductions in neuromuscular control of the lateral ankle musculature, particularly in the peroneus longus and peroneus brevis, has been identified to be one causative factor that contributes to the recurrent lateral ankle sprain paradigm in individuals that develop CAI⁴. The prediction of eventual Chronic ankle instability is an inability to complete jumping or landing tasks within 2 weeks of a first-time ankle sprains and poorer dynamic postural control and lower self-reported function 6 months after a first-time ankle sprain⁸.

Neuromuscular control exercise (specific stabilization exercise) utilizes principles of neuromotor learning to retrain control of specific muscles and are designed aimed at improving the function of the affected muscles and control of posture and movement patterns, ultimately leading to a reduction in the level of dysfunction, deficits, instability and further injury⁸. It is used to describe a combination of functionally based exercises, including postural stability, proprioceptive, and strength training, as part of a
rehabilitation regimen. NMT programs are effective in improving motor control on tasks requiring dynamic balance and/or a biomechanically desirable movement strategy. Since poor movement quality has been considered a risk factor for lower limb injury can be an effective training method for modifying such risk factors. A key objective of NMT programs is to improve movement competency which can be considered important to the development of fundamental movement skills (FMS) related to motor control and represent the central nervous system’s ability to orchestrate coordinated and purposeful movement in relation to the body’s interaction with its environment and motor control in the execution of movement may be characterized by the maintenance of posture and balance in the presence of expected and unexpected perturbations

2. Methodology

**Study Selection Data extraction**

The data which was collected were tabulated based on the sample size, treatment given, outcome measures used, the results obtained were arranged in chronological order. Inclusion criteria (a) Studies published in English (b) Published between 2010-2022 (c) articles on Neuromuscular training for chronic ankle instability and its effectiveness. (d) Conservative management for chronic ankle instability.

<table>
<thead>
<tr>
<th>Sl. no</th>
<th>Authors</th>
<th>Years and Journal</th>
<th>Study design</th>
<th>Participants no.</th>
<th>Treatment</th>
<th>Outcome measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Chiao Lin, et al</td>
<td>2021, PLOS ONE Journal</td>
<td>Cross-sectional study</td>
<td>26</td>
<td>Muscle activations using EMG</td>
<td>Cumberland Ankle Instability Tool (CAIT) and Foot and Ankle Ability Measure (FAAM)</td>
<td>Leg muscles activated earlier and less bilaterally and Unilateral CAI alters the pattern of the motor control strategy around proximal joints bilaterally.</td>
</tr>
<tr>
<td>2.</td>
<td>Mark D. Williams, et al</td>
<td>2021, PLOS ONE Journal</td>
<td>Meta-analytical review.</td>
<td>9 studies</td>
<td>Neuromuscular training program, &gt;8 weeks</td>
<td>Y – Balance test, ROM &amp; Star Excursion Balance Test (SEBT)</td>
<td>Moderate, significant effect in favour of NM training programs on motor control, more effective in younger, shorter, and lighter individual and larger effect sizes in males.</td>
</tr>
<tr>
<td>3.</td>
<td>Pi-Yin Huang, et al</td>
<td>2021, International Journal of Environmen Research and Public</td>
<td>Randomized Controlled Study</td>
<td>30</td>
<td>Plyometric, plyometric integrated, balance training group, Ankle joint</td>
<td>CAIT questionnaire, electro goniometer</td>
<td>Improved ankle joint position sense and neuromuscular control of the ankle plantar flexors during pre-landing phase and single-leg drop landing, reduced adjusting time of the ankle plantar flexor</td>
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</table>

**Literature Evaluation:** The results of the research varied widely. 14 articles were eligible as per the inclusion criteria. The studies were grouped into 9 Randomized control trials, 2 Cross-sectional studies, 1 Comparative, 1 Meta-analytical review, and 1 Cochrane review.
<table>
<thead>
<tr>
<th>ID</th>
<th>Author(s)</th>
<th>Year</th>
<th>Journal</th>
<th>Design</th>
<th>Intervention</th>
<th>Outcomes</th>
<th>Keywords</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Jarugool Tretriuxana, et al</td>
<td>2021</td>
<td>Physical Therapy in Sports</td>
<td>Cross-sectional study</td>
<td>2021, Physical therapy in sports</td>
<td>Jump-landing task, muscle activation co-contraction</td>
<td>surface electromyography (EMG), CAIT questionnaire</td>
</tr>
<tr>
<td>7</td>
<td>C. Collin Herb, et al</td>
<td>2018</td>
<td>Journal of Athletic Training</td>
<td>Randomized controlled study</td>
<td>2018, Journal of Athletic Training</td>
<td>Dependent variables of the frontal-and sagittal-plane kinematics and kinetics of the ankle, knee, and hip and the EMG amplitude of 4 lower extremity muscles were assessed during a DVJ</td>
<td>Godin Leisure-Time Exercise Questionnaire score, FAAM-S, Identification of Functional Ankle Instability (IdFAI)</td>
</tr>
<tr>
<td>10</td>
<td>Shmuel Springer, et al</td>
<td>2015</td>
<td>Journal of Foot and Ankle Research</td>
<td>Comparative study</td>
<td>2015, Journal of Foot and Ankle Research</td>
<td>Postural control and upper limb position sense</td>
<td>Overall Stability Index (OSI), BESS</td>
</tr>
<tr>
<td>11</td>
<td>Mark A. Dundas, et al</td>
<td>2014</td>
<td>Journal of Sports Sciences</td>
<td>Randomized controlled trial study</td>
<td>2014, Journal of Sports Sciences</td>
<td>Single step-down during continuous gait</td>
<td>CAIT</td>
</tr>
<tr>
<td>12</td>
<td>Siavash Dastmanes</td>
<td>2012</td>
<td>Scholar</td>
<td>randomized controlled</td>
<td>2012, Scholar</td>
<td>33 males</td>
<td>Core Stabilization, SEBT</td>
</tr>
<tr>
<td>13.</td>
<td>Gregory M. Gutierrez, et al.</td>
<td>2012, The American Journal of Sports Medicine</td>
<td>Controlled laboratory study</td>
<td>45</td>
<td>Preparatory and reactive neuromuscular control when landing on a custom-designed ankle supinating device</td>
<td>CAIT</td>
<td>Can increase peroneal activation when necessary to dynamically stabilize the ankle, indicating the potential for training, may deploy a different control strategy after injury to protect the ankle from recurrent injuries, and minimize incidence of injury.</td>
</tr>
<tr>
<td>14.</td>
<td>Jasper S de Vries et al.</td>
<td>2011, The Cochrane Collaboration</td>
<td>Cochrane review</td>
<td>10 studies, in those 4 studies about neuromuscular control</td>
<td>Neuromuscular training (including wobble board and other balance exercises), bidirectional to unidirectional pedaling on a recumbent stationary bicycle for 4 weeks</td>
<td>Ankle Joint Functional Assessment Tool (AJFAT) questionnaire, Foot and Ankle Disability Index (FADI) and the FADI Sport, and modified Karlsson ankle score</td>
<td>Showed a better outcome for neuromuscular training, improve ankle function and short-term effectiveness for subject with chronic ankle instability</td>
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4. Results

Out of 14 articles, 9 articles shows that neuromuscular control training is effective as preventive strategy, in that 5 articles show the improvement in landing phases after NMT, 4 article shows improvement in postural control and implementing NMT shows improvement in ROM, ankle joint position sense, earlier leg muscle activation, and self-reported function in subjects with chronic ankle instability.

5. Discussion

In a cross-sectional study by Chiao-I Lin et al they found that motor control of proximal joints bilaterally was affected by CAI, and that there was altered muscle activation around proximal joints in people with CAI. Mark D. Williams, et al found that there is moderate, significant effect in favour of NM training programs on motor control, more effective in younger, shorter, and lighter individual and larger effect sizes in males. Pi-Yin Huang in their RCT they found that both isolated plyometric training and integrated balance training were helpful in improving the joint position sense and muscle activation of ankle flexors during the pre-landing phase in athletes with FAI and isolated plyometric training leads to a more rapid stabilization in the ankle plantar flexor during a medial single-leg drop-landing task. In a cross-sectional study by Jarugool Tretriluxana et al. they found that in athletes with CAI the muscles around the ankle joint appear to adapt in order to maintain joint stability via decreased activity of the TA, which is suggestive of muscle activity adaptation. In a RCT conducted by Mohammad Karimizadeh Ardakani and company they found that jump landing biomechanics in male basketball players in university changed after a 6 week hop-stabilization program which led them to conclude that the current hop-stabilization program to be an effective and sport specific program that can be used to reduce the risk of lower limb injury. Hatem Jaber and company in their Randomized control trial stated that people with CAI had significantly diminished postural control which may be attributed to alteration in the proximal and distal muscle activity such as diminished hip and ankle activity, which also had a negative impact in quality of movement and may lead to prolonged functional impairments. They suggested targeting hip muscles in the conditioning and rehabilitation program for people with CAI. In a RCT done by Colin Herb they found that there is a difference in landing strategies related to continued ankle instability. Kinematic and kinetic changes after ground contact and greater vGRF related to a faulty landing strategy. DVJ task vs gait should be considered for rehabilitation. Brent I. Smith et al in their RCT found that a 4-week hip strengthening protocol improved static and dynamic balance, hip strength and self-reported function related to sports activities in individuals with CAI and an overall improvement in the neuromuscular control of the lower extremity. They suggested that other aspects of the kinetic chain to be incorporated in CAI rehabilitation interventions. In a study by Joao Coito et al. found that the application of their 8-week exercise neuromotor program had a positive effect on the postural control and had a reduced incidence of injury in male amateur football players. In a comparative study done by Shmuel Springer to investigate the sensorimotor function of different body sites in participants with CAI found that they demonstrated lower
limb postural control and upper limb positions similar to those of healthy controls. In a RCT by Mark A. Dundas et al. found that in people with CAI, prior to touchdown there is an increased TA activation which resulted in less plantar flexion, suggestive of a protective strategy for the previously injured foot. Siavash Dastmanesh et al found that after 8 weeks of core stabilization training, there were changes in postural control in patients with CAI, which made progress in the neuromuscular function and kinetic chain movement in the lower limb. Their study illustrated the importance of proximal muscles training for the prevention and decreasing the incidence of CAI. Gregory M. Guerrero et al. in a study found that people with ankle instability can increase peroneal activation when necessary to dynamically stabilize the ankle, which may be a protective strategy. They also found that dorsiflexion strength is reduced in persons with ankle instability, which may limit their ability to dorsiflex before landing. Jasper S de Vries et al in 2011 found that Neuromuscular training showed a better outcome for neuromuscular training, improve ankle function and short-term effectiveness for subject with chronic ankle instability.

6. Conclusion

This literature review analysed the effects of Neuromuscular control on chronic ankle instability. These reviews can be used to demonstrate that Neuromuscular control could exhibit a protective strategy for the previously injured ankle and in reduction of other lower limb injury and further injury through improved motor control. The guidelines given in this review will help us to achieve higher quality results and to also determine the true effectiveness of neuromuscular control training as rehabilitation protocol for chronic ankle instability.

References


[3] Lin C-WC, Delahunt E, King E. Neuromuscular Training for Chronic Ankle Instability


[20] Dastmanesh S, Shojaedin SS, Eskandari E. ABR-2012-3-8-3926-3930 The Effects of Core Stabilization

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