Foot & Ankle: Studies

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Perspective

New Perspective: Comprehensive Outcome Measurements for Chronic Ankle Instability

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Perspective

Chronic Ankle Instability (CAI) is one of the most common musculoskeletal injuries. Seventy-three percent of individuals who suffered from ankle sprain injuries may sustain recurrent episodes, of which 59% will report long-term disability [1,2]. The foot and ankle complex is important in providing more effective clinical and research perspectives. There are several considerations regarding the foot and ankle complex needed to enhance the quality of evidence-based practice for clinicians.

First, a comprehensive functional approach needs to be enhanced. The human ankle joint is stabilized passively by restraints of ligaments, articulated surfaces, and other connective soft tissues as well as stabilized actively by muscle and tendon units [3]. These restraints are mechanical properties, which determine the effectiveness of loading forces delivered to the skeletal system and absorbed or transmitted (or both) to the articular soft tissues [4]. It is evident that increased stiffness is beneficial to injury-free performance. However, there is a lack of investigation quantifying the passive ankle joint, which would provide practitioners with a scientific rationale for clinical applications.

Other studies indicated that gender and ankle position differences with different loading patterns could produce different pain-generating pathways when considering the mechanical mechanisms of reducing the risk of injury [5,6]. One of the major neuromuscular causes of chronic ankle problems is proprioceptive deficits, which may occur because of direct trauma to mechanoreceptors and can cause inadequate foot position awareness [7]. The muscle tissues play an important role in ankle proprioception because of the high density of cutaneous receptors [8].

It is clinically imperative for healthcare practitioners to assess and treat the ankle-foot complex as a whole before the symptoms manifest themselves. For example, the effects of CAI on gait parameters were emphasized with muscle activity as well as kinematic and kinetic parameters [9]. However, the methodological quality of the studies assessing kinetics during walking was found to be poor. It was encouraged to use standardized selection criteria when assessing participants with CAI compared with a control group to increase the external validity of the results.

Secondly, the source of foot ankle instability needs to be stressed. The primary mechanism for lower limb mobility might be affected by ankle stiffness, which is more important than that of knee and hip stiffness [10,11]. However, clinicians habitually focused on the pain itself on the ankle-foot complex rather than understanding the specific nature of the ankle-foot complex dysfunction. Likewise, it is obvious to pay too much attention to details in foot mechanics and not understand the general ankle-foot complex as a whole. We lack a comprehensive understanding of postural reactions and balance deficits, especially in the elderly population. There is growing scientific evidence supporting a musculoskeletal and neurological link. For example, older adults possess altered sensory and musculoskeletal systems, leading to altered control of movement and posture [12,13]. However, these results were not consistent due to the lack of matched samples and invalid measures in a controlled study design, which need to be further investigated with valid and reliable assessment tools for the ankle-foot complex. The clinical outcome studies are still not convincing, and the morphological and functional implications in the neuro-musculo-skeletal system need to be further investigated for the source of foot and ankle dysfunctions.

Thirdly, the quantification of an evidence-based approach for the ankle-foot complex is needed. A recent systematic review summarized that only a few studies quantified the kinetic parameters and the muscle activity of walking and running to draw sound conclusions [9]. It was suggested that the methodological scores may not entirely capture the methodological quality of the assessed studies, which might be used to assess risk of bias of laboratory-based studies [14]. Although there is no universally standardized measure of ankle joint stiffness [15-17], a loss of functional integrity may affect ankle joint stiffness in the ankle-foot complex. The results of our previous studies, which utilized the Intel stretch device, are reproducible; and the measurements may help to identify ankle stiffness factors that will lead to more efficient rehabilitation programs and injury prevention strategies [18,19].

A variety of etiological factors might be related to ankle and foot dysfunction, but a concrete understanding of the determinant factors that affect clinical applications for ankle stiffness and CAI are still lacking. One of the causes of CAI is ankle joint stiffness, which has been attributed to the functional consequences of abnormal kinematics, abnormal kinetics, and altered muscle activation [20-22]. There are conflicting results regarding lower limb stiffness and association with the incidence of bony injuries [23,24]. For example, a history of tibial stress fractures in runners was shown to be increased in response to dynamic loading. Other studies reported that decreased stiffness results in soft tissue injuries due to the allotment of excessive joint motion [25,26]. In terms of walking performance, some level of stiffness is required for optimal utilization of the stored elastic energy in the musculoskeletal system during the loading portion of

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movement [24]. Further research is needed to investigate functional tasks during weight bearing for ankle stiffness measurements.

Passive joint stiffness, which is defined as the slope of the joint angle–passive joint torque curve, is an important measure of flexibility [27]. All the structures located within and over the joint, including the muscles, tendons, skin, subcutaneous tissue, fascia, ligaments, joint capsule, and cartilage, contribute to passive joint stiffness [28]. The muscle volume and other non-muscular anatomical structures result in the difference in passive joint stiffness [29]. Therefore, the measurement of ankle flexibility, independent of the confounding influences of a matched group for the large sample size, would help us to further understand ankle-foot complex stiffness mechanisms.

It is important to quantify stiffness according to ankle position so that clinicians can determine where the muscle is sufficiently lengthened. However, accurate measurements of ankle stiffness require eliminating various factors of orthopedic and neuromuscular dysfunctions. Ankle stiffness has an important role in lower limb movement because if the mechanics of the ankle and foot are changed, function of the lower limb will be directly affected. Individuals with increased ankle stiffness might develop continuous pain, muscle weakness, limited range of motion, functional contracture, and impaired balance and postural control. Therefore, it is crucial to understand how those factors affect stiffness and to determine the characteristics of passive stiffness for joint stabilization.

Fourthly, the characteristics of ankle-foot complex research relate to the understanding of human movement systems. The four systems of movement science include the neuromuscular, musculoskeletal, cardiopulmonary, and integumentary systems. The physiological organ systems interact to produce and support movement of the entire body. It is important to select physical assessments and manual therapeutic techniques that will assist the clinician in both the examination and treatment of the ankle-foot complex.

A one leg standing task has been extensively investigated for kinematic and kinetic analyses; and these analyses are clinically important in order to enhance evidence-based practice and to compare outcomes by integrating the best quantitative evidence for the foot-ankle complex [30-33]. The postural compensation strategies used by the subjects and based on the kinetic and kinematic data as well as visual input may lead to a better understanding of spinal movement patterns to clarify the comprehensive changes. The measurements were able to determine balance performance related to the ankle-foot complex since subjects stand on one leg with the contra lateral hip flexed 90 degrees to maintain body stability [30,31,34]. These studies reported valuable findings for movement patterns as well as kinematic and kinetic differences. Therefore, the kinematic pattern of postural reactions, as well as kinetic information from force plate data, may help to understand the results of functional outcome studies.

Therefore, the increased muscle strength, proprioception, and balance following the intervention could be objectively measured by the single leg standing test for kinetic and kinematic changes [32].

Non-surgical foot and ankle research, as well as other fields of clinical outcome research, requires an extensive endeavor to enhance the quality of clinical intervention with a developed theory of musculoskeletal and neuromuscular interactions. Sensitive kinetic, kinematic, and electromyography measures need to be compared following specific interventions for CAI while considering postural control. The potential factors based on individual variations and pain/level of disability also need to be examined for CAI in order to develop effective evaluation and rehabilitation strategies for evidence-based practice.

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