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Masterclass

New approach to the diagnosis and classification of chronic foot and ankle disorders: Identifying motor control and movement impairments

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ABSTRACT

The prevalence of foot and ankle (F&A) disorders is high. While chronic and recurrent F&A disorders are broadly documented in the literature, their underlying mechanisms have not been well defined. Currently, patho-anatomical, biomechanical and signs and symptoms (Si&Sy) models are widely used to diagnose and classify musculoskeletal F&A disorders. Within a multi-factorial bio-psychosocial framework, these models have limitations in identifying the underlying mechanisms that maintain chronic pain and disability. Therefore, a new approach to the diagnosis and classification of chronic F&A disorders is suggested in this Masterclass. This new approach is based on identifying the underlying mechanisms of the F&A disorder. This Masterclass aims to define and describe patterns of directional motor control and movement impairment of the F&A region based on the principal author's clinical observations. Such definition and description should lead to improved identification of consistent patterns. The basis of directional motor control and movement impairment patterns is proposed. As an example, one motor control and one movement impairment pattern is described in more detail. This Masterclass can be regarded as a prerequisite for future validation studies investigating the clinical applicability of adapting and implementing this novel classification system.

1. Musculoskeletal foot and ankle disorders and current diagnostic models

The prevalence of foot and ankle (F&A) disorders is high. In a European study population of 70,497 subjects with foot diseases, the prevalence of orthopaedic conditions was 20.4% (Burzykowski et al., 2003).

Ankle ligament injuries occur frequently, with over two million individuals suffering trauma each year in the United States (Beynnon et al., 2001). Residual symptoms and recurrence are common (Kannus and Renström, 1991; Konradsen et al., 2002).

Despite the information on chronic and recurrent F&A disorders (Orava, 1994; Cooper, 1995; Renström and Konradsen, 1997; Konradsen et al., 2002; De Vera Barredo et al., 2007; Lentz et al., 2010), processes responsible for recurrence or chronicity have not been well defined.

For most chronic musculoskeletal disorders, a specific diagnosis is rarely achieved, frequently leading to a "non-specific" or "syndrome" classification. Therefore, the identification of underlying mechanisms is of particular importance. The tendency for pain and disability to persist in the absence of obvious, ongoing primary peripheral pathology is challenging (Zusman, 2002). The classification of chronic disorders into homogeneous groups and the application of specific interventions tailored to these groups may enhance treatment efficacy, as has been documented for other body regions (e.g., chronic low back pain (CLBP)) (O'Sullivan, 2005). This approach has not yet been applied to the F&A region. Therefore, the development of a new classification system for chronic F&A disorders, leading to more specifically targeted interventions, is justified.

The typical and commonly used diagnostic models for musculoskeletal F&A disorders are patho-anatomical, biomechanical and signs and symptoms (Si&Sy) models. Following is a description of these models and a discussion of their limitations with regards to the identification of possible underlying mechanisms for F&A disorders.

1.1. Patho-anatomical model

The patho-anatomical model is based on a traditional medical approach and aims to identify the structural pathology and/or pathophysiological processes responsible for the disorder. Within this model, examples of typical chronic F&A diagnoses are Achilles tendinopathy, plantar fasciitis and metatarsalgia. The aetiology of

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these disorders is often described as being multi-factorial (Järvinen et al., 2005; De Vera Barredo et al., 2007; Espinosa et al., 2010). Management within this approach often targets only the symptomatic structure(s). The evidence for the effectiveness of this approach when applied to the F&A region is often conflicting (Crawford and Thomson, 2003; De Vera Barredo et al., 2007; Kingma et al., 2007; Woodley et al., 2007).

Management targeting the symptomatic tissue in isolation does not consider the multi-factorial nature of the disorder and all underlying mechanisms, or the consequences of the chronic F&A pain condition. This might explain why no single treatment has been found to be superiorly effective in treating these common F&A disorders. It is therefore reasonable to argue that different mechanisms may lead to F&A pain, and it is crucial to identify a cluster of all underlying factors that maintain the patient's F&A disorder.

1.2. Biomechanical model

The biomechanical model has played a prominent role in the functional diagnosis of F&A disorders. Biomechanical variations of the F&A serve to explain different structural pathologies, overuse syndromes and tissue irritation or sensitivity in chronic disorders. Typically, biomechanical variations are related to structural characteristics of the foot, movement abnormalities of the F&A and the kinetic chain of the lower extremity.

1.2.1. Structural characteristics of the foot and their correlation with pathologies and overuse syndromes

Conflicting evidence exists on the relationship between structural characteristics of the foot and pathologies or overuse syndromes, as is demonstrated by the examples below.

Giladi et al. (1985) demonstrated that a low arch of the foot was a protective factor against stress fractures, while Cowan et al. (1993) demonstrated a significant linear trend between increased arch height and increased risk of lower extremity overuse injury. Kaufman et al. (1999) found that men with either pes planus or pes cavus had an increased risk of stress fractures in the lower extremity.

This conflicting evidence could originate from the use of only non-weight-bearing (Giladi et al., 1985) or weight-bearing measurements (Cowan et al., 1993; Kaufman et al., 1999). None of the above-mentioned studies compared both conditions before determining the arch height. However, a patient with a flexible flatfoot will have a normal arch under non-weight-bearing conditions, but a substantial loss of arch height under weight-bearing conditions (Young et al., 2005). Weight-bearing position deficits of the foot do not necessarily correlate with structural characteristics in non-weight-bearing conditions.

1.2.2. Movement abnormalities of the foot and ankle and their correlation with pathologies and overuse syndromes

A forefoot varus beyond 7° is associated with overpronation, potentially leading to Achilles paratendonitis (Kvist, 1991). Donatelli et al. (1999) found that forefoot varus angles above 12° lead to excessive pronation throughout the stance phase of gait. However, abnormal pronation was not found to be a significant contributing factor in the development of overuse injuries (Donatelli et al., 1999).

Research evidence suggests that decreased ankle dorsiflexion is a risk factor for Achilles tendon pain (Kvist, 1991; Kaufman et al., 1999; Cook et al., 2002). Markedly limited passive ankle joint dorsiflexion was found in 58% of athletes with Achilles tendon paratenosis and in 70% of athletes with pain at the Achilles tendon insertion (Kvist, 1991). Reduced ankle dorsiflexion is related to ankle sprains, both as a predictive factor and as a persistent post-traumatic impairment (Kannus and Renström, 1991; de Noronha et al., 2006; Pacey et al., 2010). Restricted dorsiflexion is also found in the symptom-free population. Kvist's study (1991) highlighted that 44% of the asymptomatic control athletes had markedly limited dorsiflexion of the ankle.

1.2.3. Lower extremity kinetic chain principles and their correlation with pathologies and overuse syndromes

A biomechanical explanation for the association between movement abnormalities, consequent tissue strain and symptoms is often based on closed kinetic chain principles (Vogelbach and Combs, 1987; Ahonen, 1998). Based on these principles, within a closed kinetic chain, movement in one joint can result in movement in remote joints (Ahonen, 1998). For example, overuse injuries, such as patellofemoral pain or iliotibial band syndrome, can be related to biomechanical abnormalities remote from the specific symptom site (Wilder and Sethi, 2004; Souza et al., 2009). Some evidence exists for the inter-dependence of various alignment faults along the lower kinetic chain (Nguyen and Shultz, 2009). There is also emerging evidence of the coupling between F&A motion and lower limb transverse rotations (Souza et al., 2009). However, a relationship between static alignment, dynamic lower extremity function and injury risk remains rather theoretical (Nguyen and Shultz, 2009). Furthermore, within a kinetic chain model, human motion is considered a mechanical phenomenon, and other mechanisms regulating movement, motor control and pain mechanisms are ignored.

1.3. Signs and symptoms model

The signs and symptoms model is widely used within manual therapy. This model is often based on identifying movements that reproduce or reduce patient's symptoms, or identifying movement dysfunctions around the symptomatic region. Further differentiation between different musculoskeletal structures is accomplished with provocation testing. Any abnormal movement finding or symptom provocation can be considered a comparable sign (Maitland, 1986; Hengeveld and Banks, 2005). This model is further illustrated for the example of postero-medial ankle pain (Fig. 1) associated with sensitisation of the tibial nerve and excessive pronation of the F&A. These findings could be labelled comparable signs. However, identifying a sensitised structure does not explain the mechanism leading to sensitisation. Similarly, many different mechanisms may lead to excessive pronation of the F&A.

Within the Si&Sy approach, movement-based interventions will target the modification of symptoms by changing tissue response and/or normalising dysfunctional movements (Fig. 1). Evaluating possible underlying mechanisms for tibial nerve sensitisation and excessive pronation might demonstrate deficiencies in other contributing parameters (Fig. 1). The new classification system presented in this Masterclass paper proposes a targeted intervention approach to the underlying mechanisms that drive the disorder. It has been suggested that such an approach (versus interventions based on a Si&Sy approach) could change outcomes substantially (Elvey and O'Sullivan, 2004).

The Si&Sy model has been criticised before for its shortcomings (Elvey and O'Sullivan, 2004). While the model can be useful in identifying sensitised structures and movement dysfunctions, the underlying mechanisms of the F&A disorder might be overlooked. From this perspective, single tests and findings are not sufficient to identify the underlying mechanisms of the F&A disorders. Instead, a thorough examination process is recommended in combination with a clinical reasoning process that considers the interrelationship of all findings (Table 1).