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Editorial

Orthoses: Basic science, myths and future direction

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Abstract. The mechanisms by which orthoses work has been poorly understood despite the widespread use of orthoses in the physiotherapy and podiatry professions. This lack of clarity has been largely fuelled by methodological flaws in the literature, namely, approaching orthoses in a comparative manner to itself and/or other interventions. Future research would be best served by returning to physics first principles. The 'kinetic dose' concept is an approach worthy of further exploration.

Keywords: Orthoses, orthotics, ankle/foot, kinetics, kinematics

1. Introduction

Orthoses are a well-established and accepted tool in physiotherapy practice for a range of foot and ankle pathologies [1–4]. Despite the common utilization of orthoses by our profession (and our podiatry colleagues), the exact mechanisms by which orthoses work, remains under appreciated [5]. Deep rooted flaws in the literature base have influenced some clinicians to disregard orthoses entirely due to a perceived lack of efficacy. The literature base of the last twenty to thirty years has done orthoses a disservice by approaching orthoses in a comparative manner against itself and other interventions such as physiotherapy or corticosteroids [1, 6–8].

2. Basic science: Normal movement of the human foot

Our understanding of the human foot has come a considerable distance since the beginning of the podiatry profession in the 1950's and 60's. At that time, the father of modern podiatry, Merton L. Root proposed his subtalar neutral theory [9, 10]. Root hypothesised that in order for a foot to function optimally, it must be aligned in subtalar neutral [9]. This theory underpinned the podiatry and physiotherapy profession's approach to orthoses for decades despite its poor reliability and limited external validity [9].

As modern technology allowed researchers to delve deeper, we learned that simple one joint theories are insufficient to explain movement of the human foot. The bone pin studies in the late 2000's are as yet, our best attempt to quantify how the foot moves [11–13]. These studies involved inserting pins into all bones in the foot and also the tibia and fibula. Participants were then asked to walk and run while kinematic data was collected from each joint. The results questioned traditional thought with regard to the magnitude of individual kinematic variation and the contributions of each joint to movement. For example, the talocrural joint traditionally thought to be a sagittal plane joint displayed up to 10–15 degrees of frontal and transverse plane motion. Similarly, the variation between subjects for frontal plane motion at the talocrural joint was as little as 5.5 degrees in some individuals while others displayed larger ranges of up

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to 14 degrees. These results give clinicians an appreciation of the large variation in healthy movement between individuals.

3. Myth: Placebo orthoses

Many publications will compare a custom orthoses versus a placebo/sham orthoses for a given pathology [7, 8, 14]. This may seem logical at first reading. One may compare this approach to a pharmaceutical study where the placebo drug given is inert. However, this is simply not the case with orthoses. Newton's third law states every action has an equal and opposite reaction. When the foot hits the ground, there will be an equal and opposite ground reaction force on the tissues. Therefore orthoses can only influence the ground reaction force to the tissues in two possible ways, namely, kinetically and/or kinematically. Thus, any orthoses introduced to the foot will alter the kinetics and kinematics to some degree [15, 16]. Consequently, we cannot claim that a sham orthoses is inert [5]. Furthermore, given our knowledge of the bone pin studies, one can appreciate the variable, individual kinetic responses possible when using orthoses.

4. Myth: Kinematics must change for orthoses to be effective

Many clinicians may have experienced some kinematic changes in rearfoot alignment after introducing an orthoses, for example. Conversely, many other patients will not display any kinematic changes but still report a reduction in symptoms and improvement in function. Why is this the case?

When orthoses are introduced to a patient population, a proportion of them will exhibit kinematic change but not all [7, 17, 18]. On the other hand, it seems likely that kinetics changes occur consistently irrespective of the type of orthoses [15, 16, 19, 20]. For this reason, it seems probable that the dominant mechanism for clinical improvement is kinetic change, not kinematic change.

5. Future direction

Perhaps now, one can understand the this issues surrounding placebo orthoses or comparing different types of orthoses. What options are available for researchers moving forward to mitigate these issues? The 'kinetic dosage' concept offers the best hope of accurate quantification of the kinetic effect [5]. For example, if the intended goal of the orthoses treatment was to reduce plantarflexion moment in two individuals by 20%, two individual orthoses could be designed and tested to deliver that reduction instead of providing two identical orthoses with an unknown kinetic effect. Paracelsus once said 'Solely the dose determines that a thing is not a poison'. At present we are comparing unknown kinetic dosages to each other in the form of placebo orthoses versus custom orthoses. While the kinetic dosage concept is simple in principle, applying it to the complexity of the human foot is much more difficult in practice. Despite these difficulties, clinicians would be best served if research trended in this direction.

Similarly research comparing orthoses alone to physiotherapy or corticosteroid injections for example offers limited value [3, 6]. Orthoses were not designed to be used in isolation. A skilled clinician will utilise orthoses at the right time in the rehabilitation process and adjust accordingly throughout.

6. Conclusion

Decades of orthoses research has been misguided without giving appropriate thought to the physical principles underpinning their use, namely kinetics and kinematics. The reality of research in this area is that it is undeniably complex, but necessarily so. The human foot is a dynamic structure involving 26 bones and 33 joints that move with a high degree of individual variation. Consequently, treating pathology of the foot with orthoses is a challenging task. To achieve an optimal outcome with orthoses clinicians should have a detailed knowledge of the pathology and consider the current load on the pathological tissue. Thereafter, one may use orthoses to manipulate the kinetic load on the compromised tissues. If one applies orthoses in this manner, orthoses can be an invaluable tool to clinicians as part of the rehabilitation process.

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