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Strength training for plantar fasciitis and the intrinsic foot musculature: A systematic review

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ABSTRACT

The aim was to critically evaluate the literature investigating strength training interventions in the treatment of plantar fasciitis and improving intrinsic foot musculature strength.

A search of PubMed, CINHAL, Web of Science, SPORTSDiscus, EBSCO Academic Search Complete and PEDRO using the search terms plantar fasciitis, strength, strengthening, resistance training, intrinsic flexor foot, resistance training.

Seven articles met the eligibility criteria. Methodological quality was assessed using the modified Downs and Black checklist. All articles showed moderate to high quality, however external validity was low.

A comparison of the interventions highlights significant differences in strength training approaches to treating plantar fasciitis and improving intrinsic strength. It was not possible to identify the extent to which strengthening interventions for intrinsic musculature may benefit symptomatic or at risk populations to plantar fasciitis. There is limited external validity that foot exercises, toe flexion against resistance and minimalist running shoes may contribute to improved intrinsic foot musculature function. Despite no plantar fascia thickness changes being observed through high-load plantar fascia resistance training there are indications that it may aid in a reduction of pain and improvements in function.

Further research should use standardised outcome measures to assess intrinsic foot musculature strength and plantar fasciitis symptoms.

1. Introduction

Plantar fasciitis is one of the most common musculoskeletal disorders of the foot (McPoil et al., 2008; Young, 2012) treated in primary care (Thing, Maruthappu, & Rogers, 2012). It is thought to result from chronic overload either from lifestyle or exercise and affects both elderly and athletic populations (Schwartz, 2014).

The plantar fascia is an aponeurosis that originates from the medial tubercle of the calcaneus and extends distally to the phalanges (Bolgla, & Malone, 2004). The Windlass Mechanism is a term used to describe how the plantar aponeurosis acts like a pulley (Hicks, 1954), developing tension during dorsiflexion of the great toe. This shortens the distance between the calcaneus and the metatarsals, as the aponeurosis winds around the metatarsal head resulting in elevation the medial longitudinal arch (Bolgla, & Malone, 2004). Together with the intrinsic foot muscles the plantar aponeurosis stabilises the arch and provides dynamic sensory and motor control to the foot (McKeon & Fourchet, 2015).

In addition to sedentary middle aged patients (Radford, Landorf, Buchbinder, & Cook, 2006), plantar fasciitis is particularly prevalent in running and dancing activities that require maximal plantarflexion of the ankle and dorsiflexion of the metatarsophalangeal joint (Brukner & Khan, 2012). Symptoms are characterised by pain radiating the medial aspect of the heel into the arch of foot. Pain is often most intense with the first steps of the day or after rest or warming up with activity (Thing et.al., 2012). As the condition progresses these symptoms can become more debilitating reducing

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the patient's ability to weight bear. Recent literature proposes that the condition should be termed a fasciosis as the pathology more closely resembles that of tendinosis (Brukner & Khan, 2012; Schwartz, 2014).

Brukner and Khan (2012) state that despite plantar fasciitis being the most common cause of rear foot (inferior heel pain) differential diagnosis should not overlook other common conditions such as fat pad contusion, and less common conditions such as calcaneal stress and traumatic fractures, medial calcaneal nerve entrapment, lateral plantar nerve entrapment, tarsal tunnel syndrome, talar stress fracture, retrocalcaneal bursitis, along with not to be missed pathologies such as spondyloarthropathies, osteoid osteoma and post knee or ankle injury complex pain syndrome (CRPS Type 1). McPoil et al. (2008) include a similar list of differentials, but with the addition of Sever's disease (calcaneal apophysitis) a common cause of heel pain in pediatric patients typically aged 7–14 years old (Marchick, Young, & Ryan, 2015).

Treatments for plantar fasciitis have been varied, with conflicting evidence (McPoil et al., 2008). Until recently exercise therapy reviews have highlighted the effectiveness of plantar fascia-specific stretching and have indicated it may have limited benefits (Almubarak, 2012; Schwartz, 2014). However, a recent a systematic review found that there is a significant association between intrinsic foot muscle weakness and painful foot pathologies such as plantar fasciitis (Latey, Burns, Hiller, & Nightingale, 2014). Therefore, the aim of this review is to critically evaluate the literature investigating strength training interventions in the treatment of plantar fasciitis and improving intrinsic foot musculature strength.

2. Methodology

2.1. Search strategy

The systematic review "Strength training for plantar fasciitis and the intrinsic foot musculature" was registered with PROSPERO (No. CRD42016036302). The following bibliographic databases were searched to identify potentially relevant articles: PubMed, CINHAL, Web of Science, SPORTSDiscus, EBSCO Academic Search Complete and PEDRO or all articles up until March 23, 2016.

The database search, literature screening and data extraction was completed by a single researcher (DH). The database search consisted of using the search terms: ("plantar fasciitis") AND ("strength" OR "strengthening" OR "resistance training") and then repeated with the search terms ("intrinsic foot muscle" OR

REPORTING: "Yes=1," "No=0"

1. Is the hypothesis / aim / objective of the study clearly described?
2. Are the main outcomes to be measured clearly described in the Introduction or Methods section
3. Are the characteristics of the patients / samples included in the study clearly described?
4. Are the interventions of interest clearly described?
5. Are the distributions of principal confounders in each group of subjects to be compared clearly described? "Yes=2," "Partially=1," "No=0"
6. Are the main findings of the study clearly described?
7. Does the study provide estimates of the random variability in the data for the main outcomes?
8. Have all important adverse events that may be a consequence of the intervention been reported?
9. Have the characteristics of patients lost to follow-up been described?
10. Have actual probability values been reported (e.g., 0.035 rather than <0.05) for the main outcomes except where the probability value is less than 0.001?
11. Were the subjects asked to participate in the study representative of the entire population from which they were recruited?

EXTERNAL VALIDITY: "Yes=1," "No=0," "Unable to determine=0"

12. Were those subjects who were prepared to participate representative of the entire population from which they were recruited?
13. Were the staff, places, and facilities where the patients were treated, representative of the treatment the majority of patients receive?

INTERNAL VALIDITY - BIAS: "Yes=1," "No=0," "Unable to determine=0"

14. Was an attempt made to blind study subjects to the intervention they have received?
15. Was an attempt made to blind those measuring the main outcomes of the intervention?
16. If any of the results of the study were based on "data dredging" was this made clear?
17. In trials and cohort studies, do the analyses adjust for different lengths of follow-up of patients, or in case-control studies, is the time period between the intervention and outcome the same for cases and controls?
18. Were the statistical tests used to assess the main outcomes appropriate?
19. Was compliance with the intervention/s reliable?
20. Were the main outcome measures used accurate (valid and reliable)?

INTERNAL VALIDITY - CONFOUNDING (Selection Bias): "Yes=1," "No=0," "Unable to determine=0"

21. Were the patients in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited from the same population?
22. Were study subjects in different intervention groups (trials and cohort studies) or were the cases and controls (case-control studies) recruited over the same period of time?
23. Were study subjects randomised to intervention groups?
24. Was the randomized intervention assignment concealed from both patients and health care staff until recruitment was complete and irrevocable?
25. Was there adequate adjustment for confounding in the analyses from which the main findings were drawn?
26. Were losses of patients to follow-up taken into account?

POWER

27. Did the study have sufficient power to detect a clinically important effect where the probability value for a difference being due to chance is less than 5%?

Fig. 1. Modified Downs & Black Checklist (Deschpande et al., 2008).