

Editorial

How do eccentric exercises work in tendinopathy?

Painful tendon disorders are a major problem in competitive and recreational sports [1, 2]. Tendon injuries are difficult to manage, and current conservative and surgical management options have shown limited and often unpredictable success [3, 4]. Even when early diagnosis of Achilles tendinopathy is combined with appropriate and intensive management, rehabilitation can take several months.

Conservative management options for tendinopathy of the main body of the Achilles tendon include modified rest, exercise, analgesics, injections, electrotherapy, identification and correction of possible intrinsic and extrinsic causes [4]. This abundance of management modalities has arisen from the lack of consensus as to the cause of tendinopathy [5–8].

The lack of suitable evidence in support of a given management method does not necessarily imply that it is ineffective. Rather, there may be a lack of adequately powered studies to demonstrate its effectiveness [9].

Mechanical conditioning can be used as a treatment for enhancing tendon healing [10]. Mechanotransduction is the process of a cell converting mechanical stimuli into biochemical signals. Cells able to sense the mechanical signals are described as being mechanosensitive. Tendon responds to mechanical forces by adapting its metabolism and structural and mechanical properties [11]. Tendons adapt to alterations in the mechanical load being applied by changing their structure and composition. The tenocytes in the tendon are responsible for its adaptive response, and respond to mechanical forces by altering their gene expression patterns, protein synthesis and cell phenotype [12], which can be used to aid the healing process.

However, the duration, frequency, magnitude and type of mechanical stimulation applied to a tendon greatly affect the outcome of the loading regime. Therefore, the amount of loading necessary to improve and/or accelerate the healing process without causing damage to the healing tissue remains unclear [13, 14].

There is some evidence that eccentric strengthening programmes may be effective in the management of tendinopathy of the main body of the Achilles tendon [15, 16]. Graded eccentric exercises regimen was proven to be effective in case-control studies and in prospective randomized control trials [15–19]. Stanish *et al.* [20] introduced the concept of eccentric training in the rehabilitation of tendon injuries in the mid-1980s, and Scandinavian authors popularized it [19] more than a decade later, with some important differences. Stanish *et al.* [20], for example, recommend that patients should perform the eccentric exercises with no pain, while Scandinavian authors [19] recommend pushing through pain. Though effective in Scandinavian population [17, 18], the results of eccentric exercises observed from other study groups [16, 21] are less convincing than those reported from Scandinavia, with only around 60% of good outcome after a regime of eccentric training both in athletic [15] and sedentary patients [16].

The best evidence to date does demonstrate that eccentric exercise is likely a useful management for tendinopathy, but this evidence is currently insufficient to suggest it is superior or inferior to other forms of therapeutic exercise [21, 22].

There is little consensus regarding which variables may influence the outcome of eccentric training, including whether training should be painful, home- vs clinic-based training, the speed of the exercise, the duration of eccentric training and the

method of progression. Large randomized controlled trials that consider these parameters and include blinded assessors and extended follow-up periods are required. Three basic principles in an eccentric loading regime have been proposed:

- (i) Length of tendon: if the tendon is pre-stretched, its resting length is increased, and there will be less strain on that tendon during movement.
- (ii) Load: by progressively increasing the load exerted on the tendon, there should be a resultant increase in inherent strength of the tendon.
- (iii) Speed: by increasing the speed of contraction, a greater force will be developed.

However, the use of these modalities in the context of an eccentric rehabilitation programme requires confirmation.

In this issue, Rees *et al.* [23] examine why eccentric loading should be successful as a therapeutic option for tendinopathy of the main body of the Achilles tendon. They propose that the pattern of tendon loading, with its force fluctuations, rather than the magnitude of the force, is responsible for the therapeutic benefit seen. This parallels evidence from bone remodelling. Although Rees and colleagues propose a potential mechanism for the mechanism for efficacy of eccentric loading [23], they do not provide a definitive explanation to the mechanisms of function of the eccentric exercises. A main problem in the field of tendinopathy is that we do not know where the pain originates from. Four types of nerve endings can normally be identified in tendons: Ruffini corpuscles; free nerve endings; Pacini corpuscles mainly at the tendon site; and the Golgi tendon organs mainly at the muscular site [24]. Classically, pain in tendinopathy has been attributed to inflammatory processes, but, as it has become evident that tendinopathies are not inflammatory conditions, that they present histological evidence of a failed healing response and that even the degenerative paradigm is not really applicable, recently the combination of mechanical and biochemical causes has become more attractive [25]. Microscopic tendon disruption with mechanical breakdown of collagen could theoretically explain the pain mechanism, but clinical and surgical observations challenge this view [25]. The biochemical model has become appealing, as many chemical irritants and neurotransmitters may generate pain in tendinopathy. High concentrations of the neurotransmitter glutamate have been found in patients with Achilles tendinopathy [26]. The tendons in these patients showed no signs of inflammation, as indicated by the normal prostaglandin E2 levels [26]. Substance P and chondroitin sulphate may also be involved in producing pain in tendinopathy [25].

The commonest form of tendon healing is by scarring, which is inferior to healing by regeneration [27]. Tendons heal by going through inflammatory (1–7 days of injury), proliferative (7–21 days) and remodelling (3 weeks to 1 yr) phases. Despite collagen maturation and remodelling, tendons are biochemically and metabolically less active than bone and muscle [27, 28]. Fibroblasts synthesize collagen type III in the proliferative phase. This will be replaced gradually by collagen type I from day 12–14 with progressive increase in tensile strength [28]. It is still unclear how eccentric exercise may influence this process.

In conclusion, Rees *et al.* [23] shed further light on the complex process of the mechanism of eccentric training. Musculoskeletal physicians should be aware of tendon healing processes to optimize their management options. Future research should aim

to resolve optimal approaches to conservative management of Achilles tendinopathy. Even though the relevance of eccentric training to the conservative management of Achilles tendinopathy is understood, with accepted and well-recognized less convincing results than those reported from Scandinavia, studies regarding its mechanism are needed as a first step to understand and improve the current management regimens.

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