Is there a role for acupuncture in the treatment of tendinopathy?

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Abstract
Tendinopathy is a debilitating condition in athletic and sedentary populations for which a gold standard treatment strategy does not yet exist. While the pathophysiology of tendinopathy is well understood, a debate remains as to the nature of the pain mechanism in tendinopathy which makes treatment selection challenging. This clinical discussion presents evidence to suggest that acupuncture may have a role in the treatment of tendinopathy, through the facilitation of tendon blood flow and fibroblastic activity, making recommendations for further research.

INTRODUCTION
Tendinopathy is a clinical descriptor for pain and pathology in and around tendons.1 The term developed as a replacement for the historically used but now defunct ‘tendinitis’, as several authors describe the histological examination of tendinopathy as consistently showing either minimal or absent inflammatory markers.1–3 Tendon problems lead to significant morbidity in athletic and sedentary populations and may last for several months despite what is considered appropriate treatment.2–3 Conservative strategies that are common within current medical practice include pharmacological intervention, eccentric exercise, extracorporeal shockwave treatment and injection treatment, all of which are supported by promising but not definitive evidence from randomised controlled trials.1–4 The plethora of management strategies described in the literature demonstrate that gold standard treatment for tendinopathy remains under debate and the lack of consensus regarding the pathophysiology and pain mechanism in tendinopathy may be responsible.4

With best practice for the management of tendinopathy currently unclear, alternative methods of treatment are continually being explored. There is a growing acceptance towards acupuncture as a treatment for musculoskeletal conditions such as low back pain, arthritis and myofascial pain relief, among clinicians and patients alike in the Western world.5 Within tendinopathy, a multitude of injections appear to provide similar outcomes, thus some experts are starting to question whether it is the substance or the needle that provides the therapeutic effect.6 Acupuncture is already known to induce analgesia via (or through) several pain mechanisms. The insertion of an acupuncture needle stimulates A-delta and C fibres and can result in the release of several neuropeptides involved in pain modulation and local vasodilation such as ‘calcitonin gene related peptide’ (CGRP) and substance P.7,8 The early work of Janzen and colleagues is testament to the historic belief that acupuncture may have the potential to optimise the body’s own natural healing response via a homeostatic mechanism.9 Acupuncture has shown the potential to increase local blood flow within a target tissue and affect fibroblast migration through myofascial collagen manipulation,10,11 both of which could prove key in attempting to reverse tendinopathic change.

TENDINO PathOPATHOLOGY AND PAIN MECHANISM
With regards to the pathophysiology of tendinopathy, the current evidence base is uniform in describing a failed healing response.3,12 Specifically, a disruption of the hierarchical structure of collagen fibres is seen, with a significant increase in the immature type III collagen, due to the haphazard proliferation of tenocyte cells.12 There is a recurrent suggestion that apoptosis occurs at an accelerated rate within tendinopathy, leading to an imbalance in tendon remodelling.13,14 The result is an increase in non-collagenous matrix within the tendon, ultimately weakening the structure.14,15

The nature of the pain mechanism associated with tendinopathy is the main area of debate within the literature. Neovascularisation is a common feature of tendinopathy and a majority of authors indicate that neovessels are likely to be involved in tendinopathic pain.2,16,17 An increase in the neurotransmitter glutamate (consistently seen in painful tendons) is thought to further drive the pain process2,3,3 and this has lead to an increased interest in the role of the nervous system within the tendinopathic pain process. However, the counterargument is that neovascularisation may not be involved in tendin pain. Importantly, morphologically normal tendons can be painful and pathological tendons can be pain free prior to rupture.1

We would advocate the application of the pathology continuum (See figure 1) proposed by Cook and Purdam,14 which describes classifying tendinopathy into three distinct stages (reactive, dysrepair and degenerative). There are important clinical differences between the phases that will alter treatment selection if applied correctly. Reactive tendinopathy should demonstrate an alteration of the tendon matrix due to increased water content, with only minimal longitudinal collagen separation (if at all), all of which is a short-term homogenous thickening resultant from acute overload (see figure 2). As a contrast, dysrepair/degenerative tendinopathy differs significantly, with apoptosis, tenocyte exhaustion, collagen separation and neovascular in-growth all being present (See figure 3). The use of ultrasound scanning is recommended as a way of clinically differentiating between the phases, with neovessels and a hyperechoic appearance of collagen fibres being markers of degenerative pathology.14

Evidence for the use of acupuncture in the conservative management
of tendinopathy is currently limited. A recent review by Pfefer and colleagues\(^\text{18}\) identified short-term analgesia from acupuncture in the management of lateral epicondylar elbow pain. To highlight the dearth of evidence surrounding this area, only four studies met the inclusion criteria for the review of Green et al in 2002.\(^\text{20}\)

**ANGIOGENESIS**

A healthy tendon requires a balance between cell proliferation and cell death. It is thought that tendon hypovascularity and reduced oxygen supply, necessary to drive collagen production, is the precursor for the disruption of this balance.\(^\text{21}\) Angiogenesis (the growth of new blood vessels) is directly linked to a tendon’s capability to heal\(^\text{22}\) and thus it is thought that the hypoxic environment within tendinopathy is what triggers excessive apoptosis.\(^\text{21}\) It has suggested that neovascularisation as a process is a biological attempt to provide oxygen to a healing process that is in disarray but recent evidence suggests that as the vessels seem to grow from the ventral aspect of the tendon (from the Kager’s fat pad in the Achilles tendon as an example), they do not in fact assist with improving tendon vascularity.\(^\text{16}\)

Because of this, treatments that promote tendon blood flow are starting to be explored.

The development of treatments such as induced hyperthermia, ‘platelet rich plasma’ and ‘autologous blood’ injections, along with Alfredson’s surgical scraping\(^\text{16}\) all highlight an attempt to interfere with neovascularisation and stimulate angiogenesis, to provide an optimal environment for tendon healing.\(^\text{23}\) As an example, James and colleagues\(^\text{24}\) analysed the efficacy of autologous blood injection combined with dry needling in patella tendinopathy. A statistically significant improvement in subjective pain and function compared to baseline was identified following intervention, with a majority (22 out of 24) of patella tendons demonstrating a reduction of residual thickness on ultrasound. Acupuncture is known to induce local vasodilation within human tissue\(^\text{6}\) and there is new evidence that acupuncture may be able to facilitate tendon blood flow and thus

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**Figure 1** The tendinopathy pathology continuum as described by Cook and Purdham.\(^\text{14}\)

**Figure 2** A real-time ultrasound image depicting an enlarged patella tendon, often seen within reactive tendinopathy.
have a role in the treatment of tendinopathy.

**ACUPUNCTURE AND ANGIOGENESIS**

A recent study by Kubo and colleagues investigated the effects of acupuncture on blood volume and oxygen saturation in healthy human Achilles tendons. A single needle was inserted into the mid portion of the Achilles, penetrating the paratenon (the fascial interspace between a tendon and its sheath). During treatment, the needle was stimulated in a vertical plane (pecking). They identified a significant increase in total blood volume and oxygen saturation versus baseline for both treatment modalities, with no significant differences between the groups. However, during the 30 min recovery phase (after needle removal) total blood volume continued to increase and oxygen saturation was maintained in the acupuncture group, whereas both figures dropped swiftly in the heating group. Both of these differences were statistically significant. We theorise that the likely mechanism for the significantly superior blood flow with acupuncture is vasodilation induced by CGRP via the manipulation of sensory nerve endings. This result suggests that acupuncture may be able to contribute to tendon repair, but further research is required, particularly in tendinopathic tendons that may respond differently to healthy tendons.

Support for the above findings is seen in an earlier study conducted by Sandberg and colleagues, who investigated the effects of acupuncture on skin and muscular blood flow. They identified a significant increase in blood flow within the tibialis anterior muscle versus baseline (needing via ST36), with deep needle insertion superior to superficial needling. Stimulating the needle in a vertical plane further increased blood flow. We again suggest that vasodilation as a result of CGRP release is likely to responsible for the results identified. Additional support can be found among animal research, with a study by Shinbara and colleagues identifying increased muscular blood flow in a rat muscle model when penetrated by an acupuncture needle. Warden suggests that with careful selection and rigorous methodology, it is possible to draw appropriate conclusions regarding human tissue from animal research. Similar to previous results, this study found that effects on blood flow were maintained throughout a 60 min recovery period following treatment.

**FIBROBLAST MIGRATION VIA FASCIAL MANIPULATION**

Along with having the potential to facilitate increased tendon blood flow, acupuncture has also been shown to stimulate fibroblastic activity when collagen is wound around an acupuncture needle. Langevin and colleagues identified significantly increased fibroblastic activity in a mouse model with rotational needle manipulation, supporting the results from their previous work. This effect is attributed to a potential increase in the mechanical signalling through the extracellular matrix, thus leading to fibroblast migration. This is supported by the more recent work of Lee and colleagues, who identified significantly improved tissue healing in a mouse burn model when compared with a conventional dressing. They identified significantly greater basic fibroblast growth factor (bFGF) in the acupuncture group, with an additional reduction in leukocyte infiltration within the wound, suggesting an efficient inflammatory process. In our opinion, this has the potential to assist with reversing the apoptosis phenomenon consistently seen in tendinopathy, although further research in healthy and pathological human tendon tissue would be required to further support this theory.

**SUMMARY**

Regardless of the management strategy in question, further research is required in all aspects of tendinopathy treatment. As a result of the current lack of consensus seen among the evidence base, any addition to the dearth of evidence can only be positive. Further research into the source of pain in tendinopathy would be highly beneficial but at present the majority of literature suggests that neovascularisation is likely to be the primary cause, as there are several examples of clinical improvements coinciding with a decrease in neovascularisation. We would advocate the pathology model to allow clinicians to diagnose and also classify tendinopathy. This differentiation should (in time) allow for more appropriate treatment selection as the evidence base increases.

We would suggest that there is a small but high quality contingent of evidence supporting the theory that acupuncture may be able to influence tendon healing by increasing blood
flow via local vasodilation and increasing collagen proliferation. These effects are most likely a result of an increased release of the neuropeptide CGRP from sensory nerve endings and an increase in mechanical signalling through the extracellular matrix respectively. Further research in healthy and pathological human tendons is indicated, which may in time identify that acupuncture is effective in the management of tendinopathy through the mechanics proposed within this discussion.

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