UEL

Sport Rehabilitation: Injury to Optimal Performance

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The role of eccentric training in the management of Achilles Tendinopathy

Analysing and discussing Herrington L. and McCulloch R. (2007) article

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Sports injuries can be caused by intrinsic or extrinsic factors, either alone or in combination (Paavola, et al, 2002). In chronic tendon disorders, an interaction between these two types of factors is common. Achilles tendon injury is a common sequel to sporting participation. Similar to other tendons, pain classically appears with an increase in training load, or in elite athletes, sustained high training loads (Cook et al, 2002). Achilles tendinopathy appears more prevalent in sports that have a large running component, but occurs in all sports and at all levels of participation.

Prevalent occurrence of Achilles tendinopathy amongst the athletes, slow rehabilitation progress and reoccurrence of the injury in some occasion has made Achilles tendinopathy an appropriate subject for this essay.

The aim of this essay is to critically evaluate and analyse a few key points of the above study in depth and scrutinize the implications of the outcomes within practice in relation to sport injuries rehabilitation to optimal performance. In addition, the robustness and benefits of the study's outcomes for athletes will be analysed. The key features that will be discussed include pathology of Achilles tendon, eccentric training and ultrasound application. Finally, the implication of the study's outcome in practice will be evaluated and some relevant features for further research will be recommended.

Achilles tendon problems are very common among athletes as well as the general population. The terminology used to describe the painful condition of the Achilles tendon is superfluous, confusing and most often does not reflect the underlying abnormality (Paavola, et al, 2002). Additional terms such as Achilles tendinopathy, tenopathy, tendinosis, partial rupture and paratenonitis, have been used to describe the problems of noninsertional pain associated with this tendon (Paavola, et al, 2002). Two-thirds of Achilles tendon injuries in competitive athletes are paratenonitis and one-fifth are insertional complaints (bursitis and insertion tendinitis). The remaining afflictions consist of pain syndromes of the myotendineal junction and tendinopathies (Kvist, 1994). Occasionally, Achilles tendon pain is found in inactive individuals (Paavola, et al, 2002) and interestingly aging is not specifically associated with tendinopathy. However, active older individuals may also present with Achilles tendon problems, often with symptoms for the first time. Occasionally, they can recall a previous episode or previous symptoms, or report asymptomatic tendon swelling for an extended period (Cook et al, 2002). Achilles tendon overuse injuries are thought to account for 11% of all running injuries (Kvist, 1994). In addition, Kvist (1994) have demonstrated that limited mobility of the subtalar joint and limited range of motion of the ankle joint were more frequent in athletes with Achilles tendinopathy than in those with other symptoms. In addition to hyper-pronation of foot and varus deformity of the forefoot (Paavola et al, 2002), leg-length discrepancy is one of the more controversial potential contributing factors to Achilles tendinopathy (Kvist, 1994, Cook et al, 2002). The Achilles tendon is the single tendon of the soleus and gastrocnemius muscles, inserting into the calcaneum. It has a highly structured peritendinous tissue with no synovial membrane and is hypovascular. The blood supply to the tendon enters on the deep (anterior) surface, and appears to be similar in volume throughout its length (Cook et al, 2002). However, the chronic form of Achilles tendinopathy is not an inflammatory condition (Paavola, et al, 2002) which is an important aspect in rehabilitation. The evidence confirms that the histopathological findings in athletes with overuse tendinopathies are consistent with those in tendinosis - a degenerative condition of unknown aetiology. This may have implications for the prognosis and timing of a return to sport after experiencing tendon symptoms. The literature indicates that healthy tendons appear glistening white to the naked eye and microscopy reveals a hierarchical arrangement of tightly packed, parallel bundles of collagen fibers that have a characteristic reflectivity under polarized light. Stainable ground substance (extracellular matrix) is absent and vasculature is inconspicuous. Tenocytes are generally inconspicuous and fibroblasts and myofibroblasts absent (Khan et al, 1999). In stark contrast, symptomatic tendons in athletes appear grey and amorphous to the naked eye and microscopy reveals discontinuous and disorganised collagen fibers that lack reflectivity under polarized light (Khan et al, 1999). However, Khan et al, (1999) conclude that effective treatment of athletes with tendinopathies must target the most common underlying histopathology, tendinosis, a non-inflammatory condition.

Alfredson et al, (1998) indicate that conservative treatment should be applied prior to surgical approach. “Nevertheless, the management of Achilles tendinopathy is varied. Traditionally conservative treatment is often passive with little emphasis placed on activities to modify the tendons’ structure and its ability to withstand the stresses placed on it, often leading to a recurrence of the problem” (Herrington & McCullochb, 2007; Croisier et al, 2001). As Achilles tendinopathy may cause disability (Kader et al., 2002), therefore an adequate management is essential to return the athlete to the desired level of performance. Herrington & McCullochb, (2007) confirm that all subjects returned to full functional ability based on VISA-A questionnaire tool, yet the robustness and validity of their outcomes for a large population and beyond one year is unknown. Herrington & McCulloch (2007) have carried out a pilot study in which their repeated measures trial compared two interventions outcome. “The objective of their study was to investigate the effect of different types of treatment on Achilles tendinopathy. One proposed to increase tensile strength of the tendon by eccentric training, the other a more traditional treatment used in a clinical setting using Ultra Sound (US) and Deep Frictional Massage (DFM)” (Herrington & McCulloch, 2007, p191). They had randomly allocated twenty-five participants to the eccentric group (n ¼ 13) or the control group (n ¼ 12). Herrington & McCullochb, (2007) had measured the outcomes by using the VISA-A questionnaire (Robinson et al., 2001). They assessed overall functional changes of the participants after 12 weeks and the changes occurring in function at four-weekly intervals throughout the study. They used the VISA-A questionnaire to measure the functional improvement of the participants. The VISA-A questionnaire has been previously established by Robinson et al., (2001), which measure the functional improvement in patients with Achilles tendinopathy. Although the authors back up the reliability and validity of this tool, yet none of the other studies that have been reviewed for this essay had used the VISA-A questionnaire.

Conventional interventions especially ultrasound application have been used regularly for treatment of Achilles tendinopathy. Herrington & McCulloch (2007) have applied ultrasound in combination with DFM in both control group and experimental group. In this review, only the US application that has been used will be evaluated. They applied six sessions of ultrasound with 1-week interval, while using the same machine (EMS Combination 850; Model 90) for all applicants. The ultrasound frequency, which they applied over painful part of the Achilles tendon, was 1 MHz, on a continuous setting at 1.0W/cm² for a period of 5 minutes (Enwemeka, 1989). However, they did not explain why they used this particular US setting or why they had not tried a different modality for instance lower or higher intensity. There is strong supporting evidence from literature on the positive effects of ultrasound on tendon healing. In a similar study Chestera et al, (2007) have compared the effectiveness of eccentric loading exercises with therapeutic ultrasound in the management of chronic Achilles tendon pain whereby they used 3MHz at 0.5w/cm² for 2 minutes. The results of Chestera et al, (2007) study demonstrated that there was no statistically significant difference in the effectiveness of both procedures. This was the only study that examined the effect of two applications, which have been discussed in this essay, nevertheless because their subjects were not athletes; it made it difficult to compare their result with Herrington & McCulloch (2007) study. In addition, Enwemeka et al (1990) has proven that the effect of 1 MHz therapeutic ultrasound with intensity of 1W/cm² for 5 minutes, on the healing strength of rabbit tendons induced a significant increase in both the tensile strength and the energy absorption capacity of the tendons. In another study, Chukuka et al, (1990) have indicated that the effect of low-intensity ultrasound on the healing strength of tendons in continuous waves at a intensity of 0.5 W/cm² for 5 minutes every day increases tensile stress and energy absorption capacity. They appeared to demonstrate that the same effect is not produced when sonication intensity is raised to 1.5 W/cm². Enwemeka (1989) showed that sonication at 0.5 W/cm² augments both tensile strength and tensile stress without increasing the relative sizes of the tendons. Hence, all of the above studies suggest that the beneficial effects of ultrasound may be enhanced by sonicating at continuous and lower intensities rather than high intensity. Therefore, It has been suggested that, high-intensity ultrasound may hinder fibroplasia and collagen synthesis and hence impair the healing process of tendons Enwemeka (1989).

Accordingly, the US setting 1.0W/cm² continuous intensity with one-week intervals used by Herrington & McCulloch (2007) may not be the best option. However, this does not undermine their results. In addition, because the authors have applied the US to both control and eccentric group, it is difficult to conclude that the improvements of the subjects in the eccentric group was related only to the exercise, and this is one of the possible biases of this study.

A number of studies have indicated that eccentric calf muscle training has beneficial effects in the management of Achilles tendon pain for recreational athletes (Chestera et al, 2007). Remarkable study by Stanish et al (1986) led to the proposed theory of eccentric loading and since then this method become a popular choice for managing Achilles tendinopathy. Calf muscle strength has been measured after rehabilitation in patients with surgically treated complete Achilles tendon ruptures and in patients with complete Achilles tendon ruptures treated either surgically or nonsurgically (Alfredson et al, 1998). "Although there is evidence that eccentric, exercise shows beneficial short-term effects in treating Achilles tendinopathy, the literature is still limited" (Herrington & McCullochb, 2007; Mafi et al, 2001). However, a few studies indicate that the eccentric training of ruptured Achilles tendon show promising results and benefits (Mafi et al, 2001; Vertommen et al, 1992; Silbernagel et al, 2001). Nevertheless, the specific results of eccentric exercise at tendon properties are yet unknown. In addition, Vertommen et al, (1992) found that the subjective pain measure favours the use of eccentric exercise for the rehabilitation of Achilles tendonitis. In another study, Chestera et al, (2007) indicate that the eccentric exercise increases the muscle-tendon length, which gradually enhance the tendon's tensile strength.

In (Herrington & McCulloch, 2007) study, both the experimental group and the control group participants have received the similar DFM, US, and stretches. In addition, the experimental group received a 12-week eccentric training, including the DFM and US in the first 6 weeks of the study. The authors did not explain why the eccentric group also received the conventional treatment (US and DFM). In addition, all participants were performing an exercise programme twice a day, 7 days a week, based on their exercise sheet. Furthermore, a report by Alfredson et al (1998), later supported by randomised controlled trials (Mafi et al, 2001; Silbernageletal, 2001) have identified heavy-load eccentric calf muscle training as an effective treatment in the management of Achilles tendon pain. Alfredson et al (1998) carried out a 12-week eccentric training period; all 15 patients were back at their preinjury levels with full running activity. They (Alfredson et al, 1998) indicate that there was a significant decrease in pain during activity and the calf muscle strength on the injured side had increased significantly. Whereas, a 12-week eccentric exercise programme by Herrington & McCulloch (2007) appears to produce a superior functional outcome when used in addition to US and DTF rather than US and DTF alone, with none of the control group returning to their previous activity levels. Vertommen et al, (1992) compared the eccentric and concentric exercise and found no significant differences between the eccentric and concentric groups with respect to the return-to-activity measures. They concluded that the eccentric group had a significantly greater decrease in pain and the subjective pain measure favours the use of eccentric exercise for the rehabilitation of Achilles tendonitis. A randomised controlled trial (Silbernagel et al, 2001) indicated that eccentric overload training for patients with chronic Achilles tendon have significant improvements in plantar flexion and pain reduction even in the long-term and the participants were satisfied with their present physical activity level. They considered themselves fully recovered and had no pain during or after physical activity. Mafi et al, (2001) have demonstrated that after the eccentric training regimen 82% of the patients were satisfied and had resumed their previous activity level, compared to 36% of the patients (8/22) who were treated with the concentric training regimen. The results of eccentric training was significantly better (P<0.002) than concentric training. There is sufficient evidence in support of heavy loading eccentric training and the recovery of Achilles tendinopathy (Herringtona & McCullochb, 2007, Alfredson et al, 1998). For instance, Alfredson et al, (1998) has demonstrated that after a 12-week eccentric training, all 15 patients with chronic Achilles tendinosis (degenerative changes) were back to their pre-injury levels with full running activity. There was a great decrease in pain during activity, and the calf muscle strength on the injured side had increased substantially and did not differ particularly from that of the non-injured side. Finally, isokinetic eccentric exercises (Croisier et al, 2001) have also presented a very satisfactory short-term effect for treatment of recurrent Achilles tendinitis. After comparing the above evidence with Herrington & McCulloch (2007) study the robustness of eccentric exercise, appears even more reliable than before. The result of the eccentric group is in consensus with all above reviewed studies, which indicates that eccentric exercise is an efficient intervention for treatment of Achilles tendinopathy amongst athletes, especially in addition to passive treatments. However, since Herrington & McCulloch (2007) had no eccentric exercise only group in their research, and no other evidence was found in the reviewed literature with this specific modality, which compares the effectiveness of eccentric exercise and conventional treatment in athletes with Achilles tendinopathy, therefore it is not possible to have an unambiguous conclusion to this issue. Although (Chestera et al, 2007) have compared the effectiveness of US with eccentric exercise, their subjects were non-athletes, and therefore the question remains unanswered. Patients selected in this study (Chestera et al, 2007) were characterized by a long duration of symptoms and ineffectiveness of conventional treatment. It shows that eccentric training programmes proposed with the intention to adapt tendons to increased loads, had a positive effect on the painful Achilles tendon condition. It appears that the nature of this strength programme should be strongly biased towards eccentric muscle contraction. Most forms of treatment remain "passive" as to tissue structure adaptations and there is only limited evidence yet to support satisfactory results with these classical techniques. Ideally, future studies should undertake a prospective randomised trial to investigate the effectiveness of eccentric loading exercises, compared with therapeutic ultrasound in the management of Achilles tendon pain in athletes.

By analysing the methodology of Herrington & McCulloch (2007) and comparing their results with other similar study, the following features have considerable implications for their evidence in practice. Foremost, their study has not carried out a new hypothesis; they have combined and examined existing methods for conventional ultrasound settings (Enwemeka, 1989) and eccentric exercise (Alfredson et al, 1998; Mafi et al, 2001) treatment. In addition, their prescribed exercises included combined aspect of Alfredson et al (1998) and Stanish et al (1986) programmes. However, since the eccentric group (experimental group) was receiving the conventional treatment (US and DFM) and eccentric training and there was no group with eccentric exercise only, the outcome of the above study is not reliable enough to be applied in practice unless carried out as combination of those interventions. Yet there is no evidence in literature, which confirms the use of conventional and eccentric exercise independently. In addition, the eccentric exercises were performed every day, which is extremely time-consuming for most patients considering the busy lifestyles of many of the athletes.

The results show that the eccentric group demonstrated considerably higher (F ¼ 5.21, p ¼ 0.014) VISA-A scores in their function than the control group over the 12-week period. “In addition, the main effect of the type of treatment (eccentric or DFM/US) was also significant (F ¼ 7.57, p ¼ 0.022)” Herrington & McCulloch (2007). Nine participants in the eccentric group scored the highest number on the VISA-A questionnaire tool at 12 weeks and 4 of them achieved this score at 8 weeks. However, the maximum score that the control group achieved was 84/100. It appears that the eccentric group achieved the greatest overall increase in mean VISA-A score over the 12 weeks (51.8%). The best recovery in eccentric group was from 0 to 4 weeks (30.4%) with less improvement between 8 and 12 weeks (5.6%). Whereas the control group had an overall 31.9% raise in mean VISA-A scores over the 12 weeks, with the best improvement from 4 to 8 weeks (12.8%). In addition, the Post-hoc paired t-tests showed that the eccentric group had considerable increases in VISA-A scores between 0 and 4 weeks and 4–8 weeks (p ¼ 0.01) but no improve was found between 8 and 12 weeks. Therefore, no major progress founded between each time interval for the control group. This study has no relevancy for acute Achilles tendinopathy, because all participants were involved in different activities and Achilles-loading sports. In addition, participants had a long duration of symptoms (mean ¼ 24.5 months) and were vigorous in their Activity of Daily Living

(ADL). The outcomes of this study indicate that the conservative management has to be tried first with Achilles tendinopathy (Alfredson & Lorentzon, 2000) as both eccentric and control groups improved significantly (p ¼ 0.001) after a 12-week treatment programme. However, the eccentric group scored much higher (p ¼ 0.014) than the control group, which is in consensus with previous evidence (Alfredson et al., 1998; Mafi et al., 2001). Since the eccentric group had received additional DFM, US and stretching, therefore it is difficult to relate the improvement in experimental group only to eccentric exercise training. It appears that two of the eight participants in the eccentric group did not return to the full activity; however, their performance had increased over the 12 weeks. The results indicate that none of the participants in the control group returned to their previous activity levels. Consequently, returning to functional activities and preinjury running level is in accordance with all of the above studies, yet most of those studies used different types of measurement tools for the functional ability of their participant. Khan et al (1999) indicate that Achilles tendon recover slowly and therefore a prognosis of 3–6 months is relatively normal. Hence, any rehabilitation programmes should be as long as possible to allow for full structural repair of the tendon and reduce the risk of reoccurrence. Herrington & McCulloch (2007) suggested that the management of Achilles tendinopathy have to be long enough with a minimum 12-weeks treatment programme. "Herrington & McCulloch (2007) study suggests that the addition of a 12-week eccentric exercise programme to conventional treatment of ultrasound and deep transverse frictions is more effective in treating Achilles tendinopathy than conventional treatment alone".

The study reviewed and other evidence suggests that Achilles tendinopathy should be treated first by conservative methods like US, DFM and eccentric exercise prior to any surgical approach. In addition, this study demonstrated that an additional 12-weeks eccentric training to DFM and US significantly improved (p ¼ 0.001) the functional ability of all participants. This study demonstrated that there are some indications as to the positive effects of eccentric exercise on Achilles tendinopathy; yet, their results are not sufficient to implement in practice as single modality because they had not an eccentric only group. Therefore, further research is required to investigate whether eccentric exercise alone will make such significant functional improvement in athletes with Achilles tendinopathy. In addition, the future studies may investigate how the full recovery of Achilles tendinopathy can be achieved in short period rather than the proposed 3-month prognosis. In conclusion, physiotherapists apply a wide variety of modalities in treating Achilles tendinopathy. The final goal is a safe and painless return to sports or occupational activity with the maximal restoration of physical fitness components affected by the injury. Thus, further studies have to explore the effects of varying treatment parameters and clinical aspects, to develop therapeutic protocols that may optimize the healing process of repaired tendons in athletes.

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