Tendinopathy and Sports: Understanding the Problem and Options of Management-perspectives from Physiotherapy, Sports Medicine, and Orthopedics

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ABSTRACT

Tendinopathies are perhaps the leading cause of sports-related overuse injuries necessitating visit to an expert. Increased general public participation in sports and growing intensity of elite level sport had further warranted more attention and research into pathophysiology and management of tendinopathies. As a result, its management has seen enormous changes in the last few decades. The newer research methodologies applied to diagnostic and therapeutic aspects have generated a plethora of literature, which has helped sports medicine experts. However, these newer modalities have also added to the confusion among many. This review aims to present current understanding of pathophysiology of tendinopathies and evidence of success or failure of several modalities in current use.

Keywords: Exercise, Management, Orthobiologics, Sports, Tendinopathy.

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INTRODUCTION

Over the past few decades, advancements in technology and research methods have allowed researchers from various fields to answer questions that may have eluded their predecessors. The fields of sports medicine and

physiotherapy too have benefited, and through various computer programs and wearable equipment, we now have the means for efficient injury prevention and management. However, there are still a significant number of ailments that lack adequate understanding, and where clinicians and researchers have failed to reach a common consensus over fixed pathophysiological processes that may underpin them; tendinopathy is one such disorder, which even in the 21st century eludes a well-defined management protocol.

Tendinopathy has been used as an umbrella term to describe a spectrum of changes that occur in damaged or diseased tendons in the upper and lower limbs.¹ Tendinopathy or tendinosis is a common, yet highly debated disorder of the tendons, seen in individuals of all age groups, most frequently in the active adult population. The disorder is characterized by localized tenderness and pain, which is significantly exacerbated when the load on the tendon is increased, resulting in loss of function and performance.² Despite its frequent occurrence, the exact etiopathogenesis of the pathological process is still not crystal clear, and researchers and clinicians continue to debate the presence or absence of an inflammatory component in tendinopathy at all sites.³

Cook and Purdam⁴ proposed the occurrence of tendon pathology in a continuum, describing it as occurring in three overlapping phases. Their theory describes the first phase as reactive tendinopathy, a noninflammatory response to acute overload or unaccustomed activity in young individuals, who usually experience pain with increased tendon loading. Reactive tendinopathy is followed by tendon dysrepair/failed healing occurring as a result of chronic overloading of the tendon. The authors report collagen separation and matrix disorganization accompanied by neovascular ingrowth. The pathology progresses to degenerative tendinopathy, exhibiting areas of cell death, which, if severe enough, may evolve to tendon rupture. It is a well-documented fact that degenerative tendinopathy is more prevalent in the older population, where it has little capacity for reversibility. As a clinician, especially in a sports setting, it is important to understand that pathological tendons are not always painful and pain can occur anywhere on the tendon pathology spectrum.¹

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REVIEW OF LITERATURE

Tendon pain has the potential to be highly debilitating, especially in elite athletes, who tend to exhibit deterioration in their athletic function and performance.⁵ Evidence-based management encourages clinicians to treat patients with the best possible protocols and, therefore, it is extremely important for a sports physiotherapist to be aware of optimal treatments in order to ensure high-quality athletic performance.

To determine the optimal treatment protocols available, an extensive literature search was conducted in PubMed, Cochrane Library, Google Scholar, and Medline using the following key words: tendinopathy, tendinosis, conservative, management, physical therapy, sports, exercise. The search was restricted to randomized controlled trials (RCTs), systemic reviews, reviews, and meta-analysis between the years 2009 and 2016.

Tendon Loading

Literature search revealed that tendon loading through various forms of exercise is being employed as the favored management and is backed by strong evidence demonstrating significant improvements in pain, function, athletic performance, and patient satisfaction in patients suffering from chronic tendinopathy. Additionally, tendon loading through eccentric training has shown to have structural benefits including improved collagen production, which has positive short- and long-term effects of the tendon structure.⁴

Malliaras et al⁶ conducted a systemic review to determine the optimum loading programs for patients suffering from Achilles and patellar tendinopathy. Their review of 32 RCTs demonstrated improved clinical outcomes as a result of improved neuromuscular performance. However, they failed to observe any superior benefits of isolated eccentric training when compared with eccentric-concentric training and heavy-slow resistance (HSR) training. Although further research is warranted in various forms of tendon loading, a plethora of evidence exists regarding the benefits of eccentric training in tendinopathy. A randomized trial conducted by Beyer et al⁷ comparing HSR training to eccentric training demonstrated significant improvement in pain and function in patients with chronic midportion Achilles tendinopathy using both forms of training. However, there was a significant difference in patient satisfaction and exercise compliance in favor of HSR training. A meta-analysis regarding eccentric training on Achilles tendinopathy, patellar tendinopathy, and common wrist extensor tendinopathy exhibited beneficial outcomes regarding pain, function, and return to activity/sport.⁸ Another systemic review of 13 RCTs found that eccentric training yields

improvements in pain and function in the management of patellar tendinopathy.⁹ In a recent review of 11 RCTs reviewed, Ortega-Castillo and Medina-Porqueres¹⁰ concluded that there was moderate evidence in favor of eccentric training for reducing pain and improving strength in upper limb tendinopathies, recommending its inclusion in rehabilitation programs. In an RCT involving 120 patients suffering from chronic lateral elbow tendinopathy, Peterson et al¹¹ compared eccentric with concentric loading. They discovered that patients in the eccentric training group exhibited significantly superior results compared with the concentric group in terms of pain reduction and muscle strengthening after a 3-month intervention. Moreover, these improvements were maintained at a 1-year follow-up.

As evidence suggests, tendon loading has proven highly beneficial in managing chronic tendinopathies in the upper and lower limbs. On the contrary, tendon loading in acute or reactive tendinopathy should be avoided and management should aim to reduce tendon load.⁵ Isometric exercise is an emerging form of loading that has been experimented with in painful tendons, especially during in-season rehabilitation where eccentric training would potentially aggravate tendon pain and is not a viable option. An RCT of 29 athletes with patellar tendon pain concluded that both isometric and isotonic exercise programs were capable of significantly reducing tendon pain at a 4-week follow-up.¹² Rio et al¹³ assessed the immediate effects of isometric and isotonic training in six athletes with patellar tendon pain and their randomized cross-over study demonstrating significant reduction in pain immediately after one bout of exercise in favor of isometric training.¹³ Furthermore, these results were sustained even 45 minutes following the exercise bout. In another midseason clinical trial, Rio et al¹⁴ demonstrated isometric training to be significantly superior to isotonic training which exhibited immediate reduction in pain, which was sustained at 1-week and 4-week follow-up.

Electrotherapy Modalities

Shock Wave Therapy

Shock wave therapy is another area of interest and can potentially be a beneficial modality for conservative management of tendinopathy. In a recent meta-analysis of 13 studies, Mani-Babu et al¹⁵ examined the effectiveness of extracorporeal shock wave therapy (ESWT) in commonly occurring tendinopathies of the lower limb. They found moderate evidence in favor of ESWT over home-based exercises and corticosteroid injections when treating greater trochanteric pain syndrome and Achilles tendinopathy. Interestingly, they also discovered that ESWT was more effective in managing insertional Achilles

tendinopathy when compared with eccentric exercise. Additionally, combination of eccentric training with ESWT was shown to be more beneficial when compared with eccentric training alone. In an RCT consisting of 68 patients with chronic Achilles tendinopathy and a history of failed management, Rompe et al^{16,17} found that combining ESWT with eccentric training yielded significant improvements in pain and function at a 4-month follow-up in midportion Achilles tendinopathy and at 1 year in insertional Achilles tendinopathy. These results should encourage clinicians to administer ESWT as an adjunct to eccentric training. Despite the increasing interest in ESWT in the management of tendinopathy, there is very limited research of its effectiveness in the upper limb. Galasso et al¹⁸ conducted an RCT to determine its effectiveness in 20 patients with noncalcifying supraspinatus tendinopathy, demonstrating significant improvements in pain and range of movement compared with baseline and the placebo group. Although further research is warranted in the area, current management should incorporate ESWT as an adjunct to eccentric training, especially in the lower limb.

Laser Therapy and Therapeutic Ultrasound

Low-level laser therapy (LLLT) has been proposed as a management option for tendinopathy. A systemic review with meta-analysis analyzed 17 RCTs to determine the clinical effectiveness of LLLT on pain and function in shoulder tendinopathy.¹⁹ The authors concluded that LLLT produced clinically significant improvements in shoulder pain and function when used as an adjunct to exercise therapy and even as monotherapy. Tumilty et al²⁰ conducted a double-blind RCT including to study the effect of photomodulation and eccentric exercises in 80 participants with chronic Achilles tendinopathy. Their results demonstrated clinically significant improvements in pain and function at a 12-week follow-up in favor of photomodulation being used as an adjunct to eccentric training twice a week. These studies demonstrate the potential of laser therapy as a treatment option in the future as further research in this area is warranted.

Therapeutic ultrasound is commonly used for upper and lower limb tendinopathy. However, there is very low-quality evidence for its efficacy in improving pain and function as demonstrated by in a systemic review of 11 RCTs.²¹

Glyceryl Trinitrate

Although glyceryl trinitrate (GTN) patches are used in the management of tendinopathy by clinicians in managing acute and chronic patients, there is conflicting evidence regarding its long-term and short-term efficacy.

Its effectiveness in reducing pain in acute and chronic tendinopathies was demonstrated in a systemic review including 446 patients, over seven RCTs, and comparative clinical trials.²² The authors concluded that not only did topical GTN reduce pain in daily activities, it also enhanced tendon strength. Bokhari and Murrell²³ conducted three RCTs to assess the long-term benefits of GTN patches in noninsertional Achilles tendinopathy, lateral elbow tendinopathy, and supraspinatus tendinopathy. At a 3-year follow-up, only noninsertional Achilles tendinopathy showed significant improvement whereas no additional benefits were noted in any patient at a 5-year follow-up. Nonetheless, the authors demonstrated short-term benefits of GTN patches in reducing pain in lateral epicondylitis. Owing to the limited evidence and conflicting results, the treating clinician should make a decision on administering a GTN patch. Patients using GTN patches have also reported of significant incidences of headaches and need to be cautioned by the clinician prior to its use.^{22,24}

Manual Therapy

Soft-tissue mobilization has been a part of management protocols for tendinopathies. A systemic review and meta-analysis conducted by Desjardins-Charbonneau et al²⁵ demonstrated low-level evidence for efficacy of soft-tissue mobilization for patients with rotator cuff tendinopathy. Furthermore, an RCT comparing the efficacy of soft-tissue mobilization with a supervised exercise program concluded no significant benefits of soft-tissue mobilization in reducing pain in rotator cuff tendinopathy.²⁶

Emerging Concepts of Managing Tendinopathy

Tendon Neuroplastic Training

The exact source of tendon pain still eludes us, and this is touted as one of the prime reasons for failed tendon rehabilitation by some authors, as they debate over local and centrally mediated pain. In a recent narrative review, Rio et al²⁷ proposed a new approach to rehabilitation where they employed an exercise protocol using externally paced strength training. Their new approach aimed to restore corticospinal control of the muscle tendon complex by employing isometric and isotonic strengthening in nine athletes, administering external paced resistance using a metronome capable of inducing excitability and inhibition. Even though their results demonstrated significant pain reduction with both forms of exercise at a 4-week follow-up, isometric training had significant immediate reduction in pain. This trial is the first of its kind and gives direction to future studies in this area with larger patient groups.

Nutritional Intervention

Nutrition has been studied for many decades, and sports nutrition has gained significant importance when training and rehabilitating elite athletes. Additionally, as a team approach to rehabilitation in sports setting may not always be an option, it is beneficial for a sports physiotherapist to be aware of nutritional interventions available to aid the healing process of tendons. However, research in this area is extremely limited and a systematic review by Curtis²⁸ suggests that nutritionally supplementing whey protein, protein, glutamine, and amino acids to the diet could promote protein and collagen synthesis in the healing human tendon. Although the authors reviewed 110 studies, animal trials were also included. Nonetheless, only results relevant to human trials have been discussed in this essay.

Orthopedics and Sports Medicine Aspects

It is the opinion of the senior author (MSD) that sports-related tendinopathies in the acute phase respond well to a supervised rehabilitation protocol, with limited pharmacological interventions.²⁹ The current understanding is that the problem is not of an inflammatory nature, and hence there is a limited role of pharmacological agents; nevertheless, in the acute stage, the judicious use of nonsteroidal anti-inflammatory medication can help. The best suited under some circumstances could be Ibuprofen, probably best suited for the so-called "reactive tendinopathy" stage, as this can have an inhibitory effect on some ground substance proteins responsible for tendon swelling.

Modern understanding of the pathology has made it clear that a majority of the sports-related cases have issues with repetitive overload, and subsequent problems in healing. We now have a better understanding of the role of various growth factors and cells in the process of tendon

healing,³⁰ making Orthopods consider options in sports-related tendinopathies where the healing processes can be enhanced.³¹ The usage of platelet-rich plasma (PRP) has become relatively frequent, with well-selected indications, in cases that have failed all other physical therapy modalities plus a well-structured rehabilitation protocol. Our work on lateral epicondylitis,³² compared a single injection of leukocyte-poor (type-4) with bupivacaine injections, and it has shown good improvement in pain and function for recalcitrant lateral epicondylitis. This has also been corroborated by other research (Table 1),³²⁻³⁶ although larger multicentric studies are needed to recommend this as the best modality of management.

Another area of concern for sportspersons is the rotator cuff, and this is notorious for not healing in the distal part, which is the area involved in sports-related injuries. The distal part of the rotator tendon heals poorly, and PRP with its concentration of growth factors has the potential to stimulate tendon healing. Although PRP has been used to augment rotator cuff repairs, the evidence does not support its use in that scenario (Table 2).³⁷⁻³⁹ Nevertheless, there is some inconclusive evidence that PRP as a conservative option may help,⁴⁰ but it may be too early to advocate its routine use at this stage.

Patellar tendinopathy is commonly encountered in jumping athletes and PRP injections may help in cases of refractory pin unresponsive to standard physiotherapeutic measures. Many studies have been conducted and some are ongoing, and they are grouped in Table 3.^{41,42}

Although used extensively, PRP and other orthobiological products are still not proven to be effective beyond doubt. Nevertheless, the increasing use and dependence of sports physicians and orthopedicians on this modality to sort out what is essentially an overuse phenomenon reflects on the changing paradigms in modern sports medicine.

Table 1: Summary of studies using PRP for resistant lateral epicondylitis (modified from Dhillon et al^{30,31})

Authors	Study type	Patients studied	Control	PRP type	Outcome measure	Results
Mishra and Pavelko ³³	Cohort study	15 cases vs 5 controls	Bupivacaine	1A	VAS, Mayo elbow score	81% reduction in pain in PRP group at 6 months
Creaney et al ³⁴	Prospective randomized trial	80 cases vs 70 controls	Autologous blood	1B	PRTEE	Improvement in PRTEE at 6 months 35.8 in PRP and 46.8 in ABI group with higher conversion to surgery in ABI group
Thanasas et al ³⁵	RCT	14 cases vs 14 controls	Autologous blood	1A	VAS, Liverpool elbow score	70.8% improvement in PRP group and 57.8% in the autologous blood group at 6 months
Behera et al ³²	Prospective randomized trial	15 cases vs 10 controls	Bupivacaine	1A	VAS, modified Mayo clinic performance index for elbow, Nirschl score	Significant improvement at 6 months and 1 year for all scores

PRTEE: Patient-rated tennis elbow evaluation; ABI: Autologous blood injection

Table 2: Summary of studies using PRP for rotator cuff injury (modified from Dhillon et al^{30,31})

Authors	Study type	Patients studied	Control	Outcome measure	Results
Randelli et al ³⁷	RCT	26 cases vs 27 controls	Nonapplication of PRP	SST, UCLA score, Constant score	PRP positively affected cuff rotator healing of grade I and II tears
Rha et al ³⁸	RCT		Dry needling	Shoulder pain and disability index, passive ROM	Clinical effect of the PRP injection was superior to the dry needling from 6 weeks to 6 months after initial injection
Weber et al ³⁹	RCT	30 cases vs 30 controls	Nonapplication of PRP	UCLA score, VAS, SST, ASES score	No significant difference in VAS scores between groups and no statistically significant differences in recovery of motion, SST, or ASES scores

ROM: Range of motion; SST: Simple shoulder test; ASES: American shoulder and elbow surgery; UCLA: University of California, Los Angeles shoulder scale

Table 3: Studies using PRP for patellar tendinopathy (modified from Dhillon et al^{30,31})

Authors	Study type	Patients studied	Control	Outcome measure	Results
Filardo et al ⁴¹	Case-control study	15 cases vs 16 controls	Physical therapy	Tegner, EQ VAS, and pain level	Statistically significant improvement in all scores at the end of the PRP injections and a further improvement was noted at 6 months
Gosens et al ⁴²	Prospective case series	36 patients	–	VAS, VISA	Statistically significant improvement in VAS and VISA scores in patients receiving PRP injections

Table 4: Pain provocation tests for lower limb tendinopathy

Tendon	Low-load tests	High-load tests
Achilles tendon	Single leg heel raise	Hop
Patellar tendon	Decline squats	Single leg highjump, landing from height
Hamstring tendon	Single leg bent knee bridging	Single leg dead lift
Gluteal tendon	Single leg stance	Hop

Areas of Clinical Uncertainty

The Pathology of Tendinopathy

To make good clinical decisions regarding management, the understanding of the pathological process of a disorder is essential. The exact mechanisms underpinning tendinopathy have eluded medical professionals with some authors proposing an inflammatory component⁴ and others opposing this notion and claiming that acute tendinopathy is a noninflammatory response.⁴³ This debate has resulted in experimentation with various physiotherapy and medical interventions, majority of which have been successful in determining an effective concrete solution to the most effective management of tendinopathies (Table 4).

Pain in Tendinopathy

Pain is the primary limiting factor in regard to function and performance. Interestingly, a tendon can be pain-free even with the presence of pathology leading to speculation on whether the pain is a locally or centrally mediated response. Neovascular ingrowth following collagen disorganization is proposed to be locally responsible

for tendon-related pain.⁴⁴ On the contrary, Rio et al⁴⁵ have proposed a more centrally mediated response with multiple potential contributors to pain.

Optimum Tendon Loading

Although the pathology of tendinopathy is still elusive, it is known that unaccustomed tendon loading is responsible for development of tendinopathy. However, the amount of load that induces tendon pathology is still unknown.⁴ Therefore, sports physiotherapists need to develop exercise programs with sufficient rest intervals between bouts, especially during trainings in season. The sports physiotherapists need to construct programs that ensure systemic progression of load in order to achieve enhancement of the muscle-tendon unit capacity. Studies have shown type-1 collagen takes up to 3 days to respond to high-load training, and daily bouts of high-load training place excessive strain on the tendon, eventually leading to injury.⁴⁶ As per discussions during the lecture on management of tendinopathy by Mr David Spurrier, sports physiotherapists should consider employing an approach of high-load training, followed by days of low-load training followed by medium-load training to ensure optimum rest to allow tendons to accommodate to the loads.

Clinical Practice in Sports Physiotherapy

Quantification of Tendon Function and Symptoms

- *Victorian Institute of Sport Assessment (VISA)*: The questionnaire has shown to have good test-retest,

intrarater, and interrater reliability and is used as a tool for functional assessment and severity of symptoms in patients with tendinopathy.^{47,48}

- *Loading/pain provocation tests:* Tendon loading and pain provocation tests used with visual analog scale (VAS) to monitor pain summarized in Table 3 assist the sports physiotherapist to monitor the athlete's tendon response to training loads.⁵

Managing in-season acute tendinopathy and progressive loading in sports persons:

- Minimize tendon compression and tension at various sites in the tendon that have a potential to overload, especially the enthesis.²
- Progressive loading in the form of isometric exercises should be initiated as they have the potential to inhibit pain immediately and can be repeated several times a day.¹⁴
- Depending on availability, ESWT, laser therapy, and soft-tissue mobilization can be delivered for management of pain.¹⁵
- Modification of training in order to avoid heavy tendon-loading exercises on consecutive days.⁴⁶

Management of Chronic Tendinopathy

- From the physiotherapist's point of view, the literature review suggests that eccentric training should be the treatment of choice for managing chronic upper and lower limb tendinopathies and administering ESWT as an adjunct can potentially yield long-term clinically significant improvements in function and pain.
- As mentioned previously, the sports physiotherapist needs to monitor the tendon response to loading and training modifications should ensure that high-load training is not repeated on consecutive days.
- Interventions by sports physicians or orthopedic surgeons are limited to the use of injections. As stated previously, lateral epicondylitis reacts well to PRP injections when other noninterventional methods have failed. The debate still rages about the platelet concentration, leukocyte filtration, and frequency of injections. Nevertheless, this is a procedure more frequently incorporated by the sports physician in their management repertoire.

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