8-11-2021

What Treatment and Prevention Options are the Most Effective for Elbow, Knee, and Plantar Tendinopathies?

Cody Lawson

What Treatment and Prevention Options are the Most Effective for Elbow, Knee, and Plantar Tendinopathies?

By,

Cody Lawson PA-S2

Advised by Ryane Lester

Paper Submitted in Partial Fulfillment

Of the Requirements for the Degree

of Master of Science

Physician Assistant Studies

Augsburg University

08/11/2021

Table of Contents

Abstract

Objective*:* Tendinopathies of the upper and lower extremity are one of the most common injuries in athletes and non-athletes in the United States. This literature review aimed to determine the most effective preventions and treatments for patients with tendinopathies.

Methods*:* A literature search was conducted primarily through Google Scholar and PubMed, for articles related to effective preventions and treatments for tendinopathies.

Discussion*:* Based on the literature review, there were multiple effective treatments and preventative measures for tendinopathies in the upper and lower extremity. The most effective preventative measures consisted of risk factors, dynamic warmups, and prevention programs. Treatments were broken down into three categories: elbow, patella, and plantar tendinopathies. The diamond tape job and counterforce brace improved symptoms in patients with elbow tendinopathies, and improved function throughout the body. Corticosteroids improved symptoms short term in the UE and LE, while PRP improved symptoms and promoted long term tissue healing. Physical therapy (eccentric exercises) appeared to show abundant benefit on tendinopathies regardless of the location.

Conclusion: For tendinopathies that fail conservative treatments, preventative measures can help avert tendinopathies. Corticosteroids, PRP, and physical therapy can be used for treatment. Specific prevention programs can inhibit elbow tendinopathies and improve function throughout the whole body, while a reduction in risk factors could prevent elbow, patella, and plantar tendinopathies. Regarding the elbow and plantar fascia, the best long-term results were PRP or physical therapy (eccentric exercises). For the knee, eccentric exercises were the most effective treatment, while PRP had mixed results. Despite an increase in research on these topics, more RCT's are needed in upper/lower tendinopathies, and standard protocols for PRP.

Introduction

Tendinopathies are among the most common orthopedic injuries in the United States, estimated to affect nearly 30% of patients with musculoskeletal pain[1]. Not all adults who experience a tendinopathy seek treatment, leading to a slightly lower prevalence. The most recent assessment of total expenditure for those with tendon and ligament conditions, have increased from US $367 billion in 1996-1998 to $796 billion in 2009-2011[1].

A tendinopathy is an umbrella term used to describe tendonitis, characterized by inflammation and tendinosis, depicted by degradation of the tendon. Tendinopathies are prevalent, and affect a wide range of populations including: athletes, weekend warriors, and the common workforce. An injury to the tendon can prolong your everyday activities for days to months if left untreated. The most common structure of the tendon that becomes pathological is the mid tendon, or tendon-bone junction. These locations become inflamed by repetitive stress, elongation, and loading of the tendon. The physiology of why the tendon becomes injured is not fully understood. Three conceptual models have been studied to explain how injury occurs. 1. Tendon cell response 2. Collagen disruption and 3. Inflammation. All three in combination are expected to play a role in tendon injury. The most recent models studied tendon injury or pathology, and showed it was directly affected by tendon overload. Pain is a central feature in tendinopathies, and is initiated by tendon overload, and repetitive stress. Pain is an important factor, due to the tendon in the reactive or degenerative phase during injury. Not all tendinopathies have pain, but when pain surfaces, the tendon cells are at the stage of aggravation[2].

The goal of this paper is to determine what are the most effective preventive measures and treatments for tendinopathies in the upper extremity and lower extremity. Preventative

measures that will be discussed are dynamic warmups and how they prepare the body for strenuous, and non-strenuous activity. Preventative programs that focus on specific exercises, and stretches to protect the tendon from injury, and risk factors. Bracing/taping techniques were also evaluated for effectiveness in injury prevention and pain control. Treatments of tendinopathies is the main focus, and the paper will assess what is most effective treatment for common/prevalent tendinopathies in the elbow, knee, and foot. This literature review will further assess the treatment modalities of platelet rich plasma (PRP), corticosteroids, and physical therapy. The specific anatomic locations to be discussed are the elbow, the knee, and the plantar aspect of the foot.

Platelet rich plasma is a bioactive component of whole blood with a platelet concentration above baseline that contains various growth factors[1,3]. The increased growth factors are responsible for healing through cell proliferation, chemotaxis, cell differentiation, and angiogenesis. It is thought the platelets act like a rally point for modulation of collagen synthesis, release of cytokines and chemoattractants. Early pain relief is hypothesized to conduct anti-inflammatory activity via the inhibition of Cox-2 enzymes, whereas the long-term effects are due to boosted natural healing responses through cell proliferation neoangiogenesis, and collagen production[3]. The process is as follows: blood is drawn from the body and by centrifuge, the plasma is separated, then injected into the tendon.

Corticosteroids are an anti-inflammatory drug that decreases inflammation and reduces the activity of the immune system. Steroids have been used for short term use in tendinopathies for decades. Evidence shows that corticosteroids produce negative side effects on tendon cells over time which reduces cell viability, cell proliferation, and collagen synthesis[2].

Background: Literature Review

Overview of elbow tendinopathy

The elbow is a very complex joint, consisting of muscles, tendons, bones, ligaments, and articular cartilage. The elbow musculature assists in elbow flexion, elbow extension, forearm pronation, and forearm supination. Three tendinopathies will be discussed further in the elbow: lateral tendinopathy (tennis elbow), medial tendinopathy (golfers elbow), distal bicep tendinopathy, and distal triceps tendinopathy. For this paper, the elbow will be grouped as elbow tendinopathy at times.

The lateral epicondyle is the common origin of the extensor forearm muscles. The most common extensor tendon that is affected with lateral elbow tendinopathy is the extensor carpi radialis brevis (ECRB). Lateral epicondylitis is usually seen in populations 18-25 year old athletes, or 30-65 year old non-athlete adults[4]. This tendinopathy most commonly arises from repetitive trauma to the lateral portion of the elbow, or high tensile load of the tendon. When tendons transmit forces between the muscle and the connecting bone in a repetitive manner, microtrauma affects the tendon. This process usually is followed by the inflammatory response.

The medial elbow is very similar to the lateral side, as most of the flexor tendons attach at the medial epicondyle of the humerus. The most common flexor tendons affected are the flexor carpi radialis and the pronator teres. Medial epicondylitis is due to a valgus force, combined with eccentric and concentric forces. This kind of force is seen in throwers, due to the high velocity of the wind-up phase, progressing to the follow through phase[5]. Kherian et al. reports, when comparing medial epicondylitis to the lower extremity, the prevalence of medial epicondylitis effect 4% of the working class aged 40-60 years old[5]. Repetitive movements, obesity, and smoking are poor prognostic factors.

The anterior portion of the elbow affected is the distal bicep tendon. Distal bicep tendinopathy is rare; thus, little has been reported on the pathological process. Case reports and retrospective studies concluded that the incidence of complete bicep rupture is approximately 1.2/100,000, with nearly eight times that number for smokers. 80% of cases are males, between the ages of 50-60 years old[5]. The bicep tendon attaches on the medial aspect of the radial tuberosity[4]. The bicep functions as a supinator and assists in elbow flexion.

Tricep tendinopathy is the rarest of the elbow tendinopathies. It attaches to the posterior portion of the olecranon. In a report of 1,014 tendon injuries, the tricep was affected in eight cases. The specific etiology is unknown, but just like the other tendinopathies, is thought to be caused by repetitive stress to the distal third of the tendon. It is often found in weightlifters, anabolic steroid users, chronic steroid injection sites, and olecranon bursitis. In the work or sport related environment, contracting the triceps, with an eccentric load is also found to be a culprit[5].

Overview of Patella Tendinopathy

Patella tendinopathy, also known as “jumpers knee”, is common in the athletic population. The tendon is attached to the quadricep muscle, extending from the inferior pole of the patella to the tibial tuberosity[6]. Common factors include excessive training volume, specific sports activity, quick acceleration, deceleration, cutting movements and training surfaces. This condition is more common in males than females. It is estimated that 40-50% of volleyball players and basketball players will suffer from this condition at some point int their careers. It also affects sedentary people and has a prevalence of 14% in general populations. The exact etiology and risk factors are unknown, but it is thought to be due to quadricep flexibility/ strength, leg length discrepancy, and impaired hamstring flexibility[6].

Overview of Plantar Tendinopathy

The plantar fascia attaches from the medial calcaneus to the proximal phalanges of the toes. The fascia provides support for the foot and assists during toe extension. This process allows the longitudinal arch to be elevated, and inversion of the hindfoot. Plantar fasciitis is the most common cause of heel pain in adults ranging 40-60 years of age. No specific etiology is known but is hypothesized to be due to a degenerative tear of the calcaneal portion of fascia. Studies show plantar fasciitis is more common in women, and twice as likely in people who are overweight. A common complaint is that the patient feels like their foot is tight and describes a stabbing pain with their first few steps in the morning[7,4].

Preventative measures of Tendinopathies:

When discussing how to prevent tendinopathies, it is important to understand what modifiable, or non-modifiable risk factors exist. Risk factors in the upper and lower extremities directly affect preventions and treatments for these tendinopathies. A systematic review for modifiable risk factors for the elbow, patella and foot were conducted. Six prospective and twenty-five cross sectional studies were analyzed to determine the evidence on potential risk factors. The meta-analysis results showed that people with greater activity volume, higher body weight, and greater counter movement jump height, were modifiable risk factors. These factors could prevent elbow, patella and plantar tendinopathies[8]. Observational studies showed a clear association between load and tendinopathies in patella, and plantar tendinopathies. Studies showed a spike in loads, deconditioning, and gait abnormalities directly affected tendinopathies. Intrinsic risk factors such as inflammatory, autoimmune conditions, diabetes, hyperlipidemia, and gout were found in patients with upper/lower tendinopathies. The above risk factors that affect elbow, patella and plantar tendinopathies can be potentially prevented by reducing loads,

proper deconditioning/joint position, proper diet, and exercise[2]. Intrinsic biomechanical risk factors affect every tendon differently. Similarly, Cardoso et al. also reports risk factors like flexibility, foot posture, and neuromuscular capacity in the lower limb, have mixed evidence.

Keir et al. performed a narrative review on the relationship between occupational risk factors and upper extremity disorders. Exposure to workplace risk factors found force, repetition, posture, and vibration to be directly correlated. In three studies, an increase in epicondylitis was shown in labored workers with prolonged gripping or use of heavy tools. During the 3-year longitudinal study, medial epicondylitis was found in workers who performed handgrip tasks for at least 4 hours a day, compared to 1 hour per day. Results showed a lack of association between force and epicondylitis with workers who lifted loads more than 5kg vs those who lifted lighter loads. Further studies showed prolonged repetitive tasks that involved the elbow, wrist and fingers linked to a risk of epicondylitis. Workers who performed repetitive wrist flexion/extension for at least 2hrs per day for 9-19 years were 2.4 times more likely to have a tendinopathy. The relationship between the workers who used vibration tools on a daily basis and epicondylitis was inconsistent. The interaction between force and posture showed that awkward forearm posture combined with a forceful task were associated with increased risk of lateral epicondylitis. Clinically, this article shows a direct correlation between occupational risks to elbow and wrist tendinopathies[9].

Preventative measures: Dynamic Warm-up

If known risk factors exist and/or are acknowledged, the goal would be to prevent or minimize symptoms. A specific type of prevention measure was evaluated to see the effects it had on upper and lower tendinopathies. A dynamic warm-up was studied to see how effective it would be to prevent tendinopathies. Dynamic stretching exercises are completed in the beginning

of workouts or planned repetitive movements. This allows the body to warm up and prepare for the load it is about to receive. It consists of continuous muscle contractions while the joint moves into full range of motion. Some dynamic exercises encompass sport specific movements to better prepare the person for activity. Opplert reports that dynamic stretching/exercises may provide an acute increase in muscular contractility[10].

Kapooka health researchers studied 1,538 army recruits for three years. The researchers evaluated the efficacy of static stretching vs dynamic stretching on performance and injury prevention. Over the period of three years, results showed that static stretching at the beginning of a workout session may harm muscles, tendons, ligaments, joints, and performance, especially in the knees (patella) and feet (plantar). Evidence showed that static stretching reduced the force output by 8-15% for up to one hour. This reduction in performance may contribute to your body working harder to achieve the normal results, and injury can occur. The results showed a reduction in injuries, which included tendinopathies in the elbow and knee. Although, throughout the dissection of their research, no specific relationship was found that dynamic warm-ups would reduce the occurrence of tendinopathies. In dynamic warm-ups the soldiers performed active stretches in both the upper and lower body. Exercises moved from slow movements to 70-80% maximum speed in 2-3 sets of 10 repetitions. The soldier's dynamic warm-up consisted of the following exercises: jog/stride/sprints, butt kickers, shoulder twirls, cycling, pull throughs down and offs, and an African dance[11].

Prevention programs were evaluated to address the effectiveness of avoiding tendinopathies. The study by Day et.al conducted a clinical commentary on comprehensive rehabilitation strategies for elbow tendinopathies. The program used highlighted phased therapeutics that addressed dysfunction along the kinetic chain[12]. Their research identified

shoulder weakness as one part of the multifaceted problem in patients with lateral epicondylitis. A comprehensive approach included addressing shoulder girdle weakness with scapular muscle exercises, based on the Kinetic Chain Theory. KTC hypothesizes that during functional arm motions, kinetic energy is transferred from proximal to distal segments of the arm. When proximal weakness occurs, the demand overloads the distal segment[12]. The authors created a dual rehabilitation program to address the proximal (scapula) through the distal (wrist) segments to further prevent lateral epicondylitis. A multicentered randomized control trial is currently being conducted to compare with a standard localized treatment of elbow tendinopathies.

The dual rehabilitation program starts with an active warm up for ten minutes to increase blood flow and pliability of the soft tissues. **Phase 1** consisted of neuromuscular education of scapular stabilizing muscles. **Phase 2** utilized light to moderate controlled resisted strengthening of the proximal scapular stabilizing muscles. **Phase 3** utilized moderate to heavy loads with increased weight and resistance. The wrist and elbow were also broken down into three phases. **Phase 1** consisted of neuromuscular reeducation of primary wrist extensors and radial deviators. **Phase 2** consisted of light to moderate progressive resisted strengthening of elbow and wrist musculature. **Phase 3** used moderate to heavy resisted exercises that focused on the same muscle groups. The goals were to establish independence with advanced strengthening without pain or substitution of exercises. The second step of the preventative program focused on patient education and ergonomics. The authors conclude, through correct progressions with the elbow/shoulder musculature, this specific prevention program prevented tendinopathies in the upper extremity, predominantly elbow tendinopathies. This article based their prevention program to deter elbow tendinopathies by focusing on proper motor recruitment and improving muscular strength/endurance[12]. What is the future of injury prevention?

A non-randomized control trial evaluated the effectiveness of a prevention program to minimize medial elbow injuries in baseball athletes. Both the intervention and control group were measured at baseline, 3 months and at 1 year follow up. The following assessments were evaluated: clinical assessment of the elbow/shoulder, ultrasonography of the elbow, physical function of shoulder/hip/elbow, strength of shoulder, strength of scapular muscles, and measurements of the kyphosis angle. 136 baseball athletes aged 8-11 years old conducted the dynamic prevention program at a minimum of once per week with results of 0.8/1000 athlete exposures versus the control group 1.7/1000 athlete exposures. Hazard ratio 50.8%, 95% Cl, 0.292-0.882; P= .016. The program improved the intervention group's total range of shoulder motion, hip IR, shoulder IR, lower trapezius strength, kyphosis angle, and improved physical function. The authors concluded the prevention program would prevent medial elbow injury and improve physical function in the shoulder, hip and knee[13].

A prospective cluster randomized control trial tested a prevention program which also found a reduction in medial elbow and shoulder injury in baseball athletes. This study evaluated 237 baseball players aged 8-11 years old. The intervention group consisted of 117 players and the control group consisted of 120 players. Similarly to Sakata's previously mentioned research, this study shortened the exercises for the intervention group compared to Sakata et al. to further improve compliance. The intervention group performed 5 stretches, 2 dynamic mobilities, and 2 balance training exercises during their warm-up[14]. Both groups were assessed at baseline, every 4 months, and at 1 year follow up. Ball speed during pitches, physical function of the shoulder/elbow/hip, dynamic balances, and kyphosis angles were also evaluated. The incidence of shoulder and elbow injuries for the intervention group were 1.7/1000 athlete exposures versus control group of 3.1/1000 athlete exposures (hazard ratio, 1.940; 95% Cl, 1.175-3.205; P= .010.

The intervention group showed a decrease in medial elbow injuries, an increase in ball speed, shoulder horizontal adduction, hip IR, kyphosis angle, and foot posture[14]. The results were similar to Sakata et al., that a prevention program decreases medial elbow/shoulder injuries and improves performance in the upper and lower body. The use of nonspecific external rotator strength exercises, core stability, and thoracic spine mobilities, seemed effective to prevent injuries/tendinopathies rather than specific exercises in each category.

Treatments of Tendinopathies: Taping/bracing

Prevention is a critical piece, but once there is injury, one of the following treatments will be needed. There are multiple treatments for the elbow, patella, and plantar. Some treatments discussed will benefit certain anatomy, while others may not benefit at all. This paper examines the effectiveness of Diamond Taping to reduce symptoms of tendinopathies. Diamond Taping is a technique first introduced by McConnell to alleviate symptoms of upper and lower body tendinopathies. This taping technique unloads the tendons, which reduces symptoms and improves functionality to the patient. This taping method also can be used to keep the patella tract in place while exercises are performed.

Previous studies of Diamond Taping have been shown to improve grip strength both immediately and 30 minutes after use. This experimental study was carried out in a physiotherapy outpatient clinic focusing primarily on deskbound workers. The authors selected 16 desk workers aged 30-50 years old who were diagnosed with lateral epicondylitis by an Orthopedician, with pain for more than one week. Subject demographics were included, and anyone who had past skin reactions, acute trauma, fractures, elbow dislocations/subluxations, or recent steroid injections (<6weeks) were excluded from the experiment. Each subject completed a baseline of grip strength using the dynamometer, tennis elbow function scale questionnaire,

and a visual analogue scale for pain prior to interventions. The intervention group used the Diamond Tape technique with 4 pieces of approximately 80 to 100mm long, 3.8cm wide, non-elastic, rigid tape (leukotape)[15]. Hypoallergenic tape was applied proximally in a diamond shape, while tractional force was applied on the soft tissue around the lateral epicondyle. The data showed that pain, grip strength, and functionality did not improve at the 0-minute mark post diamond taping (p value >0.01). The subsequent assessments at 30 minutes and 8 hours showed reduction in pain, improved grip strength, and functionality (p value <0.01) when compared to baseline. The results did not show significant pain reduction and grip strength between 30 minutes and 8 hours, but the functional status (TEFS score) improved at 8 hours when compared to outcomes at 30-minute post taping (p value<0.01)[15]. The conclusion of their results showed progressive improvement in functional performance and grip strength at 30 minutes to 8 hours after the Diamond Tape job.

Counterforce bracing has been used for tendinopathies, specifically lateral epicondylitis for over 40 years. The mechanism is still debated, but it is thought to unload the origin of the ECRB tendon, thus allowing the tendon to heal. A double-blinded prospective randomized control trial enrolled 31 participants with lateral epicondylitis to compare the efficacy of the counterforce brace versus a placebo brace. The study was further divided into two groups, one with the counterforce brace, and the other with the placebo brace. The outcomes measured were patient related pain, functional outcomes, epicondyle tenderness, and strength at 6 months and long term. The participants were followed up at 2, 6, 12, and 26 weeks, as well as 3 years[16]. The participants were similar in sex, age, hand dominance, and duration of symptoms. The intervention brace was the DonJoy ProCare universal surround elbow brace, while the placebo brace was the DonJoy ProCare clinic tennis elbow brace. Both groups showed improvement in

patient frequency, severity, difficulty in picking up objects, and elbow function at 6 months and 3 years. Both braces improved epicondyle tenderness and grip strength at 6 months. The counterforce brace provided significant reduction in pain, frequency, and severity of pain in the short term (2-12 weeks) compared to the placebo brace. The counterforce brace also showed dominance in level of pain during sleep, and pain level at rest, compared to the placebo brace from week 2-26 weeks[16]. In conclusion, both braces treat lateral epicondylitis, but the counterforce brace shows significant improvement in pain reduction at rest and during sleep in both the short and long term.

Treatments of Elbow Tendinopathies

For the purpose of this paper, only steroid and PRP therapy will be discussed. The treatments that will be examined are tendinopathies that do not alleviate on their own. 80% of most tendinopathies spontaneously resolve within 8-12 months[17]. Corticosteroids are still frequently used in orthopedics for short-term pain relief. The repetitive use causes weakness of the tendon and lack of pain control, since most tendinopathies are due to microtrauma rather than an inflammatory process. PRP is used for long term use due to growth factors, and increasing vascularity of the tendon to improve tendinous morphology[17].

For most patients with tendinopathies, conservative treatments like rest, ice, and non-steroidal anti-inflammatory drugs (NSAIDS) are used. Corticosteroids, PRP, physical therapy, and bracing will be the non-surgical treatments explored. Corticosteroids have been used as short-term relief for tendinopathies, despite the evidence of detrimental effects to the tendon. A systematic review of 50 investigations concluded that corticosteroids reduce cell viability, cell proliferation, and collagen synthesis[1]. Unlike corticosteroids, PRP has not been around the treatment index for a long period of time. PRP is currently being studied vigorously, and is

thought to promote healing through growth factors and cytokines[2]. Physical therapy (exercise-based therapy) is the cornerstone for treating tendinopathies for the past three decades. This treatment focuses on progressions and protocols to strengthen/educate the muscles and tendons in each stage of the healing process. The main downfall to physical therapy is that the process can take months to years. The question arises, what treatment is the most effective in managing tendinopathies in the upper and lower body?

A systematic review was conducted to evaluate the effect of corticosteroid injections versus PRP injections for lateral epicondylitis. Twelve databases were used to search for relevant primary randomized control trials. The databases used included, Web of Science, Scopus, PubMed, ScienceDirect, CINAHL, EMBASE, OVID, NICE, Physiotherapy Evidence Database, Cochrane Library and ClinicalTrials database. The author chose the most recent clinical trials which included 2005-2018. Out of 732 relevant studies, only 5 primary studies were included in the systematic review. The studies used had an end point assessment average of 1 year. Population details to assess the validity of the research varied among each study. Age and gender ratios of subjects were representative of the populations, although one study failed to provide demographic data[18]. Two studies did not report the randomization process, along with blinding outcome assessors. The use of different types and doses for PRP and steroids were also a common tactic. The PRP preparation protocol was a common issue in every study. The findings of the systematic review were as follows: corticosteroid injections provided rapid symptomatic improvement with maximum effect at 6-8 weeks, before symptoms reoccurred. PRP showed a slower onset of improvement at 24, 52, and 104 weeks in 3 studies. Corticosteroid showed a more rapid result compared to PRP at 3 months in 1 study. One study showed comparable results of PRP and corticosteroid at one month. Ultrasonographic findings showed doppler activity

decreased more significantly in the steroid group versus the PRP group. Also, the corticosteroid group showed cortical erosion at the lateral epicondyle, and reduced tendon thickness. The author concluded that corticosteroids provide a rapid therapeutic effect with reoccurrence of symptoms, while PRP showed slower but long-term therapeutic effect to the patient.

A systematic review and meta-analysis of seven randomized control trials were evaluated to further determine the efficacy of PRP vs corticosteroids for elbow tendinopathy. The literature search was performed in EMBASE, Medline, Cochrane Library, and PubMed. The Cochrane Collaboration's tool for assessing the risk of bias was used to evaluate the quality of the trials. Quality assessment seems to be an issue throughout some of the resources used in this paper. The author established quality by assessing random sequence generations, allocation concealment, blinding of participants, personnel, and outcome assessment as well as incomplete measures, selective reporting, and other biases[19]. The inclusion/exclusion criteria were that all trials had to be randomized, no additional agents could be compared, and the same dose of injections were given across all trials. The randomized blinded control trials from 2010-2018 conducted their research on patients with an average age of 42.2 years. The results showed the local steroid injection yielded greater results via the DASH score at 4 weeks (95% Cl: 7.72 to 16.08; P <.00001) and 8 weeks (95% Cl 2.98 to 9.60; P= 0.0002). PRP had significantly lower VAS score (95% Cl: -5.18 to -0.04; P= 0.05) and DASH score (95% Cl -9.99 to -5.46; P < 0.00001) compared to the steroid group at 24 week follow up. Local steroid treatments for lateral epicondylitis were the gold standard for management for decades, but the authors concluded that PRP shows greater improvement over steroids long term.

A retrospective review by Hastie et al. was conducted to see if PRP injections for patients with lateral epicondylitis would reduce the number of patients needing surgical intervention. Can

PRP hold its ground against surgery? The review of cases ranged from January 1, 2008-December 31, 2015. The number of patients undergoing arthroscopic release surgery and the number of PRP injections were recorded each year. Electronic patient records were used to quantify the number of patients requiring surgery. This data compared pre and post PRP injection to ascertain if PRP reduced surgical intervention[20]. Most patients' diagnoses were confirmed by MRI, to better understand the tissue quality. Prior to the 2012 retrospective study, PRP injections were not available and if conservative measures failed, patients were sent to surgery. After 2012, patients who failed conservative measures were offered a PRP injection at the same stage surgery was previously offered.

The technique of PRP injection is as follows: the PRP concentrate of 6ml was injected at three different sites. A single injection over the lateral epicondyle, and three separate stabs made into the common extensor tendons with approx. 2ml injected at each site[20]. Four years prior to the study (2008-2012), 52 patients underwent arthroscopic release surgery, with a mean of 12.75 patients a year. The four years after PRP introduction, (2012-2015) the number of arthroscopic surgeries reduced to 17, with a mean of 4.25 patients a year. Using the Pearsons chi squared test, this was a significant reduction in the number of surgeries required for lateral epicondylitis, $P<0.001$. MRI to confirm the diagnosis was performed in 60 out of 64 patients having PRP (94%) and 54 out of 69 (78%) patients undergoing surgical release. Since 2012, 64 patients who were treated with PRP had to receive arthroscopic release surgery. In summary, the author utilizes PRP injections as a mainstay treatment before arthroscopic release surgery, due to the high success rate. The author concluded PRP injections can give long term improvement in symptoms with lateral epicondylitis. The evidence of PRP injection to the extensor common

tendons for lateral epicondylitis show's improvement in symptoms in 56 out of 64 patients (87.5%)[20].

Comparably to Hastie et al., a retrospective review containing 33 patients with ages averaging 16-64 years old was performed to determine if PRP was an equal alternative to surgery. The patients were diagnosed with medial epicondylitis via MRI from 2006-2016, with a minimum follow up of one year who failed non operative treatment. The nonoperative treatments were performed for 3 months that included steroid injections, NSAIDS, topical creams, and physical therapy. 15 patients were treated with two series of PRP injections to the medial epicondyle, while 18 patients were treated with debridement surgery. The outcome measurements were time to full range of motion, time to pain free status, Mayo Elbow Performance Score (MEPS), and the Oxford Elbow Score (OES)[21]. The PRP group had an out-of-pocket cost of $650 for the two injections, while the surgery group price was not reported. The injections were performed 2-3 weeks a part while continuing a home exercise program. The surgical procedure was described as an open debridement of the damaged tendon using sutures. The surgery group was immobilized in a cast for 1 week and underwent a home exercise program for an additional 3-5 weeks. Each group was followed clinically for a minimum of 1 year, with returning visits at 2 weeks, 6 weeks, 3 months, and 1 year after intervention. The results were as follows: 55% (18/33) received surgery, 45% (15/33) received PRP. Overall, 80% (12/15) of the PRP group, and 94% of surgeries (17/18) achieved successful outcomes. A significant improvement to full ROM was 42.3 days for PRP vs 96.1 days for surgery; $P<.01$). The time to pain free status was 56.2 days for PRP vs 108 days for surgery; $P<.01$. No significant differences were found in return to activity rates, successful outcomes, MEPS scores, and OES scores[21].

Additionally, the study failed to report or document side effects of either treatment, or the ages of the patients. Despite the reportings, PRP showed similar outcomes to surgery, thus the authors considered it as an alternative to surgery.

Treatments of Knee Tendinopathies

Unlike elbow tendinopathies, patella related treatments differ slightly. Patellar tendinopathy is a condition characterized by anterior knee activity-related pain to the inferior pole of the patella. The pain is most localized to the patella tendon. The prevalence of patella tendinopathies is 44% in volleyball players, 32% in basketball players and 28% in track and field athletes[22, 23]. Patellar tendinopathy is also common in sedentary populations and work-related incidents. The prevalence in the working and sedentary populations are 17%. The acute cases of patella tendinopathies mostly heal without treatment, but up to 20% become chronic and need further attention[23]. The treatments for patella tendinopathies are very similar to the elbow and shoulder. Exercise based rehabilitation is the current state of the art treatment used in athletics.

A randomized control trial consisting of 57 athletes split into 3 groups, were assessed to evaluate the efficacy of leukocyte rich PRP(LR-PRP), leukocyte-poor PRP(LP-PRP), and saline on patella tendinopathy. Athletes who were chosen were diagnosed with patella tendinopathy less than 6 months in a multisite single-blinded control trial. Patients received a single ultrasound guided injection, followed by 6 weeks of supervised rehabilitation. Outcomes were measured by the Victorian institute of Sport Assessment (VISA-P), pain during activity, and global rating of change at 6 weeks, 6 months, and 12 months[22]. The athletes in the study were aged 18-50, and performed recreational sports including: basketball, volleyball, soccer, rowing, swimming, running, skiing, tennis, cycling, badminton, weight training, and handball. The study retention was 93% at 12 weeks, and 79% at one year. There was no significant change in pain, global

rating of change, and VISA-P among the 3 treatment groups at 12 weeks. Combined with exercise- based rehabilitation, a single injection of any of the two PRP concentrates versus the saline, did not improve patella tendinopathy symptoms. The author failed to report demographics, previous knee injuries, minus knee surgeries or the sport each participant played.

A systematic review and Meta-analysis were performed to further analyze the most effective treatment for patella tendinopathies. Two independent observers chose PubMed and Cochrane databases in 2017. The quality of each article was assessed using the Coleman score. A meta-analysis was performed on articles that reported the Victorian Institute of Sport Assessment scale for patella tendinopathies (VISA-P).

A total of 22 studies were included, and the best treatments found were eccentric exercises, extracorpeal shockwave therapy, single use PRP, and multiple use PRP. The short-term results of 470 patients less than 6 months of follow up were as follows. Eccentric exercise protocols in 150 patients showed a mean improvement of 25.6 points, with the pretreatment VISA-P score of 49.0 to a posttreatment score of 75.3. The ESWT in 175 patients showed a mean improvement of 13.4 points, with a pretreatment VISA-P score of 50.8 to a post treatment score of 64.4. A single dose of PRP in 45 patients showed a mean improvement of 21.8 points, with a pretreatment VISA-P score of 46.7 to a post treatment score of 68.9. The multiple injections of PRP in 100 patients showed a mean improvement 14.5 points, with a pretreatment VISA-P score of 50.1, to a posttreatment score 64.7. The short-term results showed that eccentric exercise obtained the best results ($P<.05$), followed by the single dose of PRP ($P<.05$), while the ESWT group finished last ($P<.05$)[23]. Long term results less than 6 months were reported for 501 patients. Eccentric exercise protocols in 122 patients showed a mean improvement of 28.3 points, with a pretreatment VISA-P score of 49.9, and post treatment score of 79.3. The ESWT

group of 140 patients showed a mean improvement of 27.4 points, with a pretreatment VISA-P score of 52.2 and posttreatment score of 77.3. The single use PRP in 97 patients showed a mean improvement of 24.3, with a pretreatment VISA-P score 42.6, and post treatment score of 68.0. The multiple injections of PRP in 142 patients showed a mean improvement of 38.7, with a pretreatment VISA-P score of 45.8, and a posttreatment score of 84.7. The conclusion of this study resulted in the multiple injections of PRP obtaining the best results ($P<.05$) at long term follow up, followed by ESWT and eccentric exercise[23]. Treatments of tendinopathies of the elbow and knee differ slightly. There is extensive research and results that show PRP is the most effective non-operative treatment for the elbow, while patella tendinopathies have mixed results.

Treatments of Plantar Tendinopathies

Plantar Fasciitis is the most common cause of heel pain. Military recruits, adult athletes, and laborer's aged 40-60 are the most common groups affected. Risk factors include decreased dorsiflexion of the ankle, obesity, and prolonged standing. It is estimated that the annual economic burden on patients with plantar fasciitis range from $192 and 376 million[24]. Most cases of plantar fasciitis are self-limited or can resolve with conservative treatment. The most common conservative treatments used are NSAIDS, stretching, physical therapy and night splints.

A randomized control study containing 90 participants with ages averaging 44.6 years old was performed to compare if PRP, corticosteroid, or a placebo would best treat chronic plantar fasciitis. Participants were divided into three groups, one group to PRP, one group to corticosteroid, and one group to a placebo. All participants were monitored at one week, 3 weeks, 3 months, 6 months, 12 months, and 18 months. Their symptoms were documented via visual analogue score (VAS). All groups were showed significant improvement on the VAS

between baseline and 18 months. Corticosteroid group showed better improvement over the PRP and placebo group short term (3 weeks). From the 3-18 month follow up, PRP showed significant improvement over the corticosteroid and placebo group. There were no limitations or confounding variables in this study significant enough to create bias between groups. There were no serious complications in any group. Repeat injections were required for 1.4 more patients in the corticosteroid group vs the PRP group. Both groups at a combined reinjection rate of 20%, thus 2 in 10 patients would require a repeat injection[23]. These results suggest that corticosteroids are a great short-term option for chronic plantar fasciitis, while PRP is a great long-term treatment. Cost and availability of treatment would potentially be a concern.

A prospective randomized comparative study containing 80 participants with ages ranging 26-61 was conducted to compare PRP vs corticosteroid in patients with plantar fasciitis. The study was conducted over a period of two years from 2015-2017. The patients were selected from the orthopedic outpatient office where the authors were affiliated. Two groups of 40 participants were randomly assigned to either PRP or corticosteroid group and treated with a single injection. They were evaluated by a physician at baseline, and monitored at 1 month, 3 months, and 6 months post injection. The participant's symptoms were documented using the VAS, modified Roles and Manley score and the functional outcome score by the American Orthopedic Foot & Ankle-hindfoot scale. An x-ray of the foot and ankle, along with ultrasonography of the plantar fascia was conducted at each visit. There were equal number of male/female participants in both groups, and the mean duration of pain between both groups were comparable (P=.654). There were improvements in VAS, modified Roles and Maudsley score. FAI core scale, AOFAS ankle hind-foot score, and plantar thickness in both groups[25]. No significant difference in improvement between the PRP and Corticosteroid group were noted at

any stage of the study. The author concluded that PRP and corticosteroids for plantar fasciitis are equally effective[25]. There were no documented complications in either group. Several limitations need to be discussed in this study as they possibly lead to bias or ambiguity. The authors of this study used patients that were currently being treated in an affiliated clinic, failed to document demographics, and failed to conduct the research to one year, unlike their resources that attributed to their research.

Lastly, a meta-analysis of randomized controlled trials was performed to compare the effects of platelet-rich plasma (PRP) and other treatments in patients with plantar fasciitis[26]. Two independent researchers used Medline, Web of Science, and Embase to identify relevant trials. The main outcomes used for this study were changes in the baseline of VAS, AOFAS, and RMS. The results were expressed as weight mean difference (WMD) with 95% confidence interval (95% Cl). Ten randomized control trials showed 445 patients had plantar fasciitis. Nine studies compared PRP with steroid, and one study compared PRP with whole blood. Out of the ten studies, four studies were categorized as low risk of bias while the other six were labeled unclear. Subgroup analysis for VAS and AOFAS shows that PRP had superior effect over corticosteroid at 12 months, but not 1, 3 and 6 months[26]. In conclusion, PRP was the most effective in treating pain and improving function in patients with plantar fasciitis. Like the other research depicted in this paper, PRP is the treatment of choice for long-term care of tendinopathies. Like the elbow, plantar tendinopathies react well to PRP therapy, but more RCT's are needed to further lay a solid foundation to the PRP protocol.

Physical therapy

Physical therapy is an individualized rehabilitative multifaceted plan that addresses the affected body part. For a patient with tendinopathies, the clinician focuses on pain relief,

musculoskeletal education, load monitoring/management, and an exercise-based rehabilitation program to restore function of the tendon. Goals are established at the beginning of the program, are unique to the patient, and progress through the protocol at each stage of the healing process. Exercise based rehabilitation is the most evidence-based intervention for tendinopathies for the past three decades[2,27]. Physical therapy for tendinopathies are broken down into four stages. Stage one is the isometric exercise phase, which relieves tendon pain by contracting the muscle without moving the limb. Stage two is the isotonic and heavy slow resistance phase, which focuses on full range of motion to improve strength and stiffness of the tendon. Stage three focuses on increasing speed with functional movements. This allows for proprioception in the joint. Stage four is the patient release stage that focuses on autonomy to the patient and sport specific movements.

A case study containing one 19-year-old collegiate baseball pitcher was performed to test the efficacy of a multifaceted exercise prescription for an overhead athlete with suspected elbow tendinopathy. The patient presented postinjury six weeks with left antecubital elbow pain with an auditory pop after a curveball pitch in a game. A thorough physical exam was performed to determine the likelihood of distal bicep tendinopathy. The patient was seen five times over 6 weeks. The patient had no history of elbow or shoulder pain, no use of opiates, corticosteroids, or had any history of injections to the elbow. The outcomes were measured by numeric pain rating scale (NPRS), Focus on Therapeutic Outcomes (FOTO), and the Global Rating of Change scale (GROC). Given the need for eccentric control of the biceps during pitching, eccentric exercises were the main focus[27]. The clinician opted to perform exercises that mimicked all phases of pitching which would provide better outcomes, and increase patient confidence. The interventions used entailed 4 visits. Visit one included soft tissue mobilization to the elbow,

eccentric exercises at low intensity in multiple forearm positions to replicate the stress of pitching, and strength improvement in elbow flexors. The second session consisted of shoulder/elbow exercises at the gym with supinated, neutral, and pronated grip using a moderate to heavy load as tolerated. Shoulder IR/ER exercises were performed to gain scapular control and endurance. The exercises started in the prone position to improve scapular control while voiding pulling motions[27]. Visit 3 and 4 consisted of eccentric/concentric exercises that progressed with the patient's needs, sport specific training, and return to throwing. The measurable outcomes previously discussed were performed after each session, and at the end of the 4 weeks. The patient had significant improvements in all measurable outcomes, global rate of change, strength, and endurance. The patient was able to return to pitching with no change in performance[27]. Additionally, a few limitations must be addressed in this study possibly leading to bias, or ambiguity. The clinician performed and documented the findings/outcomes, no imaging was done to solidify the diagnosis, and no randomization or blinding was performed.

A systematic review by Irby et al. with 25 systematic reviews assessed 228 RCT's and enrolled over 15,000 patients to find the most most effective treatments for elbow, patella, and plantar tendinopathies. All studies were required to include at least one control group treated with eccentric exercise, PRP, corticosteroids, ESWT, dry needling, or topical glyceryl trinitrate. Primary efficacy outcomes were measured using the VISA score, DASH, VIAA, pain scales, and physical function. Studies were excluded based on how the PRP was prepared. Overall physical therapy (eccentric exercises) appeared to be the most effective treatment no matter the location of tendinopathy. PRP provided the most conflicting evidence showing some benefits, while other reviews showed no benefit. However, Leukocyte rich PRP (LR-PRP) showed promising results on patella and plantar tendinopathies. Corticosteroids showed moderate benefit across all the

tendinopathies, previously discussed in the short term, while showing negative effects long term. Although, when paired with ultrasound lavage, corticosteroids showed positive outcomes. Dry needling and ESWT did not show benefits regardless the length of use[28].

Methods

The research topic presented was conducted using a search of PubMed and Google Scholar throughout the month of June 2021. The key search words utilized were: PRP, corticosteroid, physical therapy, eccentric exercises, lateral epicondylitis, medial epicondylitis, bicep tendinitis, tendinopathies, counterforce brace, patella tendinopathies, and plantar fasciitis. The goal of this study was to analyze the most recent data to determine the most effective preventative measures and treatments for tendinopathies in the upper/lower body. The search included only articles that used PRP, corticosteroids, braces, physical therapy, and preventative measures as the primary intervention. The search consisted of articles from 2015 to 2021, however the majority articles used were from last three years.

Discussion

Tendinopathies are among the most common orthopedic injuries in the US, which affect both athlete and non-athlete populations. The total expenditure for tendinopathies ellipse over $780 billion within the last ten years. A tendon injury can prolong normal activity for days or even months if left untreated. Most tendinopathies can be treated conservatively with rest, ice, and NSAIDS. In addition, the most effective preventative measures and treatments for the tendinopathies that cannot be managed conservatively were examined. What preventative measures and treatments are the most effective?

The preventative measures researched were risk factors, dynamic warmups, and specific prevention programs. Risk factors consisted of inflammatory, autoimmune conditions, diabetes,

hyperlipidemia, gout, joint posture, and loading. The risk factors that affect elbow, patella, and plantar tendinopathies can be potentially prevented by reducing loads, proper deconditioning/joint position, proper diet, and exercise. Future research should consider if there is a role for prevention/treatment for at-risk jobs. Dynamic warmups consisted of multifaceted exercises/stretches that allowed the body to warm up and prepare for the load. There was not a specific relationship found that dynamic warmups would reduce the occurrence of tendinopathies. The specific prevention programs researched focused on highlighting phased therapeutics that addressed dysfunction along the kinetic chain, throughout the whole body. Although there were fewer lower extremity RCT's compared to upper extremity, the prevention programs improved function no matter the location. The literature further showed that specific prevention programs prevented elbow tendinopathies and improved function in the whole body, while reducing risk factors could prevent elbow, patella, and plantar tendinopathies.

The treatments that focused on tendinopathies were further broken down into the elbow, knee, and plantar aspect of the foot. The most prevalent therapeutics researched were PRP injections, corticosteroid injections, taping/bracing, and physical therapy. The most effective tape job for tendinopathies only focused on lateral epicondylitis. The Diamond Tape job showed progressive improvement in functional performance and grip strength at 30 minutes to 8 hours post taping. The specific brace found to treat elbow tendinopathies was the counterforce brace which showed significant improvement in pain reduction at rest and during sleep for both short and long term, compared to the placebo. The pitfall in the research regarding bracing for tendinopathies was that braces were limited to only the elbow and more research needs to be conducted for patella and plantar tendinopathies.

In the elbow, corticosteroids helped reduce symptoms from 1 month to 6 months before symptoms reoccurred. PRP reduced symptoms and improved function slower on average from 6 weeks to 104 weeks. Furthermore, corticosteroids showed cortical erosions at the lateral epicondyle and tendon wasting. Tendinopathies in the knee had different results than the elbow. Short term results showed that eccentric exercises (physical therapy) as a treatment and prevention, showed the greatest improvement over PRP and corticosteroids. Corticosteroids and single dose PRP showed equal improvement in patella tendinopathies while multiple PRP injections showed extensive success in patella tendinopathies long term. Regarding plantar fascia injuries, PRP showed superior effect over corticosteroid at 12 months, but not 1, 3, or 6 months. Corticosteroids effectively treated plantar fasciitis in the acute phase, but not long term. Physical therapy, specifically eccentric exercises appeared to show great benefit on tendinopathies, no matter the location. Certain pitfalls and limitations need to be discussed regarding treatments and preventions. Overall, the upper extremity randomized control trials outweigh the lower extremities on PRP and prevention methods. Most tendon injuries noted are in the elbow and shoulder, versus the patella and plantar fascia. Athletes are the group most studied, due to the amount of funding that surrounds that population. More studies need to be completed for the patella and plantar fascia to further dissect the mixed results of PRP in the patella. The amount of athlete versus non athlete studies were not consistent, which raises the question; How do you create an equal treatment/prevention program for both athletes and non-athletes?

Conclusion

For tendinopathies that fail conservative managements, certain treatments and prevention programs can alleviate the symptoms and heal the tendon. The literature showed that specific prevention programs prevented elbow tendinopathies and improved function in the whole body,

while reducing risk factors could prevent elbow, patella, and plantar tendinopathies. More RCTS to evaluate if a prevention program can prevent upper extremity/lower extremity tendinopathies needs to be performed. The research shows that a series of treatments can alleviate symptoms of tendinopathies across the body, but certain treatments do outshine others when evaluating them at specific anatomical locations of the body. Physical therapy (eccentric exercises) is one of the best treatments when treating tendinopathies, no matter the location, but especially in the knee. PRP is the most effective treatment for elbow tendinopathies and plantar fasciitis. Although, PRP can be expensive (nearly $650 per injection) cost effectiveness is an issue. PRP also does not have a specific preparation technique. Corticosteroids showed slight improvement of symptoms across the body, primarily in the plantar fascia but with short term improvement only. Corticosteroids is cost effective but does break down tendons with extended use. Counterforce bracing, and Diamond Taping can alleviate elbow tendinopathies, but few RCTS were found for the lower extremity at this time. More studies are needed to look at upper and lower extremity tendinopathy treatments, PRP formulations, and injection protocols.

References

1. Lipman K, Wang C, Ting K, Soo C, Zheng Z. Tendinopathy: injury, repair, and current exploration. *Drug Des Devel Ther*. 2018;12:591-603. Published 2018 Mar 20. doi:10.2147/DDDT.S154660

2. Cardoso TB, Pizzari T, Kinsella R, Hope D, Cook JL. Current trends in tendinopathy management. *Best practice & research clinical rheumatology*. 2019;33(1):122-140. doi:10.1016/j.berh.2019.02.001

3. Shetty SH, Dhond A, Arora M, Deore S. Platelet-rich plasma has better long-term results than corticosteroids or placebo for chronic plantar fasciitis: randomized control trial. *The journal of foot and ankle surgery : official publication of the american college of foot and ankle surgeons*. 2019;58(1):42-46. doi:10.1053/j.jfas.2018.07.006

4. Armstrong A, Hubbard M. *Essentials Of Musculoskeletal Care*. 5th ed. AAOS; 2016.

5. Kheiran A, Pandey A, Pandey R. Common tendinopathies around the elbow; what does current evidence say? *Journal of clinical orthopaedics and trauma*. 2021;19:216-223. doi:10.1016/j.jcot.2021.05.021

6. Nayak M, Yadav R. *Patellar Tendinopathy: "Jumper's Knee"*. Intechopen; 2019.

7. Trojian T, Tucker AK. Plantar fasciitis. *American family physician*. 2019;99(12):744.

8. Sprague AL, Smith AH, Knox P, Pohlig RT, Grävare Silbernagel K. Modifiable risk factors for patellar tendinopathy in athletes: a systematic review and meta-analysis. *Br J Sports Med*. 2018;52(24):1575-1585. doi:10.1136/bjsports-2017-099000

9. Keir PJ, Farias Zuniga A, Mulla DM, Somasundram KG. Relationships and Mechanisms Between Occupational Risk Factors and Distal Upper Extremity Disorders. *Human Factors*. 2021;63(1):5-31. doi:10.1177/0018720819860683

10. Fernandez-Fernandez J, García-Tormo Vicente, Santos-Rosa FJ, et al. The effect of a neuromuscular vs. dynamic warm-up on physical performance in young tennis players. *Journal of strength & conditioning research*. 2020;34(10).

11. Dintiman G, Ward R. *Encyclopedia Of Sports Speed*. Mountain View, CA: Track & Field News; 2011.

12. Day JM, Lucado AM, Uhl TL. A COMPREHENSIVE REHABILITATION PROGRAM FOR TREATING LATERAL ELBOW TENDINOPATHY. *Int J Sports Phys Ther*. 2019;14(5):818-829.

13. Sakata J, Nakamura E, Suzuki T, et al. Efficacy of a Prevention Program for Medial Elbow Injuries in Youth Baseball Players. *The American Journal of Sports Medicine*. 2018;46(2):460-469.

14. Sakata J, Nakamura E, Suzuki T, et al. Throwing Injuries in Youth Baseball Players: Can a Prevention Program Help? A Randomized Controlled Trial. *The American Journal of Sports Medicine*. 2019;47(11):2709-2716.

15. Mehta J, Tilak M, Sundrasekaran A, Chalageri P, Yadav B. Effect of Taping on Pain, Grip Strength, and Function in Deskbound Workers with Lateral Epicondylalgia. *World Journal of Physical Medicine and Rehabilitation*. 2019;1(1007).

16. Kroslak M, Pirapakaran K, Murrell GAC. Counterforce bracing of lateral epicondylitis: a prospective, randomized, double-blinded, placebo-controlled clinical trial. *Journal of shoulder and elbow surgery*. 2019;28(2):288-295. doi:10.1016/j.jse.2018.10.002

17. Kim GM, Yoo SJ, Choi S, Park YG. Current Trends for Treating Lateral Epicondylitis. *Clin Shoulder Elb*. 2019;22(4):227-234. Published 2019 Dec 1. doi:10.5397/cise.2019.22.4.227

18. Ben-Nafa W, Munro W. The effect of corticosteroid versus platelet-rich plasma injection therapies for the management of lateral epicondylitis: A systematic review. *SICOT J*. 2018;4:11. doi:10.1051/sicotj/2017062

19. Li A, Wang H, Yu Z, et al. Platelet-rich plasma vs corticosteroids for elbow epicondylitis: A systematic review and meta-analysis. *Medicine (Baltimore)*. 2019;98(51):e18358. doi:10.1097/MD.0000000000018358

20. Hastie G, Soufi M, Wilson J, Roy B. Platelet rich plasma injections for lateral epicondylitis of the elbow reduce the need for surgical intervention. *J Orthop*. 2018;15(1):239-241. Published 2018 Jan 31. doi:10.1016/j.jor.2018.01.046

21. Bohlen HL, Schwartz ZE, Wu VJ, et al. Platelet-Rich Plasma Is an Equal Alternative to Surgery in the Treatment of Type 1 Medial Epicondylitis. *Orthopaedic Journal of Sports Medicine*. March 2020. doi:10.1177/2325967120908952

22. Scott A, LaPrade RF, Harmon KG, et al. Platelet-Rich Plasma for Patellar Tendinopathy: A Randomized Controlled Trial of Leukocyte-Rich PRP or Leukocyte-Poor PRP Versus Saline. *The American Journal of Sports Medicine*. 2019;47(7):1654-1661. doi:10.1177/0363546519837954

23. Andriolo L, Altamura SA, Reale D, Candrian C, Zaffagnini S, Filardo G. Nonsurgical treatments of patellar tendinopathy: multiple injections of platelet-rich plasma are a suitable option: a systematic review and meta-analysis. *The american journal of sports medicine*. 2019;47(4):1001-1018. doi:10.1177/0363546518759674

24. Shetty SH, Dhond A, Arora M, Deore S. Platelet-rich plasma has better long-term results than corticosteroids or placebo for chronic plantar fasciitis: randomized control trial. *The journal of foot and ankle surgery : official publication of the american college of foot and ankle surgeons*. 2019;58(1):42-46. doi:10.1053/j.jfas.2018.07.006

25. Jain SK, Suprashant K, Kumar S, Yadav A, Kearns SR. Comparison of plantar fasciitis injected with platelet-rich plasma vs corticosteroids. *Foot & ankle international*. 2018;39(7):780-786. doi:10.1177/1071100718762406

26. Ling Y, Wang S. Effects of platelet-rich plasma in the treatment of plantar fasciitis: A meta-analysis of randomized controlled trials. *Medicine (Baltimore)*. 2018;97(37):e12110. doi:10.1097/MD.0000000000012110

27. Holshouser C, Jayaseelan DJ. Multifaceted exercise prescription in the management of an overhead athlete with suspected distal biceps tendinopathy: a case report. *Journal of functional morphology and kinesiology*. 2020;5(3). doi:10.3390/jfmk5030056

28. Irby A, Gutierrez J, Chamberlin C, Thomas SJ, Rosen AB. Clinical management of tendinopathy: a systematic review of systematic reviews evaluating the effectiveness of tendinopathy treatments.(report). *Scandinavian journal of medicine and science in sports*. 2020;30(10):1810.

AUGSBURG UNIVERSITY

Augsburg University Institutional Repository Deposit Agreement

By depositing this Content ("Content") in the Augsburg University Institutional Repository known as Idun, I agree that I am solely responsible for any consequences of uploading this Content to Idun and making it publicly available, and I represent and warrant that:

- I am *either* the sole creator or the owner of the copyrights in the Content; or, without obtaining another's permission, I have the right to deposit the Content in an archive such as Idun.
- To the extent that any portions of the Content are not my own creation, they are used with the copyright holder's expressed permission or as permitted by law. Additionally, the Content does not infringe the copyrights or other intellectual property rights of another, nor does the Content violate any laws or another's right of privacy or publicity.
- The Content contains no restricted, private, confidential, or otherwise protected data or information that should not be publicly shared.

I understand that Augsburg University will do its best to provide perpetual access to my Content. To support these efforts, I grant the Board of Regents of Augsburg University, through its library, the following non-exclusive, perpetual, royalty free, worldwide rights and licenses:

- To access, reproduce, distribute and publicly display the Content, in whole or in part, to secure, preserve and make it publicly available
- To make derivative works based upon the Content in order to migrate to other media or formats, or to preserve its public access.

These terms do not transfer ownership of the copyright(s) in the Content. These terms only grant to Augsburg University the limited license outlined above.

Initial one:

X I agree and I wish this Content to be Open Access.

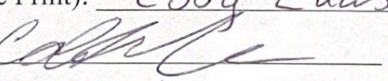
___ I agree, but I wish to restrict access of this Content to the Augsburg University network.

Work (s) to be deposited

Title: What Treatment and Prevention Options are the Most Effective for Elbow, Knee, and Plantar Tendinopathies

Author(s) of Work(s): Cody Lawson

Depositor's Name (Please Print): Cody Lawson

Author's Signature:  Date: 08-12-21

If the Deposit Agreement is executed by the Author's Representative, the Representative shall separately execute the Following representation.

I represent that I am authorized by the Author to execute this Deposit Agreement on the behalf of the Author.

Author's Representative Signature: _____ Date: _____