MOJ Sports Medicine

Percutaneous Ultrasound Tenotomy using the Tenex System on the Adductor Longus Tendon: A Pilot Case Series

Abstract

Background: Tendinopathy is a large problem in sports causing substantial pain in active populations. Treatments focusing on removing the tendinopathic tissue and promoting the body’s natural healing response are desirable to get their patients back to full activity in a relatively short amount of time.

Purpose: The purpose of this investigation was to describe the ultrasound guided percutaneous tenotomy procedure on the adductor longus tendon, report patient NPS scores before and after the procedure and report recovery time.

Study design: Descriptive case series investigation.

Methods: Percutaneous ultrasound tenotomy using the Tenex system was used to treat patients who failed conservative treatment for adductor longus tendinopathy. A Numeric Pain Scale (NPS 0-10) was used to assess patient pain levels before and after the procedure. The patient’s self-reported recovery time in weeks was also recorded. Students paired t-test was used to analyze NPS data collected and basic descriptive statistics were reported for patient time to recovery.

Results: Twelve patients were included in this study and all eleven reported some level of improvement after the procedure. Average NPS scores before and after the procedure was as follows: Pre NPS M=7.33 ± 2.1, post NPS M=2.58 ± 2.23. Patients showed significant improvement in pain after Tenex procedure (P<0.001). Patient’s average time to recovery was M= 4.55± 2.92wks (M±SD wks); two patients reported very little relief and no recovery thus far.

Conclusion: Percutaneous ultrasound tenotomy using the Tenex system has shown good results in this preliminary case series. Our results suggest this procedure may be effective in reducing patient’s pain symptoms for adductor tendinopathy when conservative treatment fails.

Keywords: Tendinopathy; Tendinosis; Ultrasound; Percutaneous tenotomy

Clinical Relevance

Groin pain caused by tendinopathy is a significant problem in athletic populations; an accurate and effective treatment is required for minimal turnaround time for athletes. Ultrasound guided percutaneous tenotomy of the adductor longus tendon may be a good treatment option for patients who have failed conservative treatment. The procedure has a quick recovery time with no complications and patients report good relief after this procedure.

What is Known about the Subject

Percutaneous Tenotomy has been shown to be effective in treating other tendinopathies. These studies are discussed in the body of this paper; however no investigations to date have used this technique on the adductor longus tendinopathy to our knowledge.

What this Study Adds to Existing Knowledge

Because there have been very few descriptive studies published on this technique, we describe a novel approach to diagnosing and treating adductor longus tendon tendinopathy.

Introduction

Tendinopathy can be a painful and debilitating injury for active populations and is commonly seen in sports medicine practices [1,2]. Based on the pathological findings there are two main tendinopathy classifications: tendonitis, which is an acute inflammatory response or tendinosis which is a chronic type of overuse and degenerative injury [3]. The etiology of tendinopathy is still being elucidated, but it seems that tendinosis is the more prevalent type of tendinopathy [4]. It is suggested that clinicians treat any tendinopathy as tendinosis if they cannot distinguish between the two because tendinosis is much more difficult to
treat, while tendonitis may resolve with rest and conservative treatment [3]. Mistreatment of tendinopathy can cause lengthy recovery periods, increased pain symptoms and frustration for both the patient and the clinician [4]. This investigation will review and discuss the degenerative characteristics of tendinous as it seems more prevalent to the participants in this investigation.

Healthy tendon is primarily made up of Type I collagen but also contains small amounts of Type III collagen and other fibrillar proteins like elastin and laminin [5]. These fibrillar proteins are surrounded by a gelatinous mucosa containing proteoglycans and water that support and hydrate the fibrils [5-7]. Dispersed throughout the fibrillar matrix are tenocytes or tenoblasts; cells that are responsible in part for remodeling tendon placed under strain and repairing damaged tendon [8,9]. Tenocytes and tenoblasts synthesize pro-collagen fibrils to be incorporated into the fibrillar extracellular matrix. In tendinopathic tissue tenocytes are sometimes plump and chondroid in appearance instead of thin spindle like cells [10,11]. Still others have shown a significant amount of tendinocyte apoptosis in acute tendon tears in addition to chronic tenonopathies [12]. These findings have yet to show a causative relationship in tendinopathy, but future histological and cell culture investigations may provide answers.

Other transmission electron microscopic findings show smaller collagen fiber diameter and a lower collagen crimp angle in damaged tendon than normal healthy tendon. Smaller regional collagen fiber diameter is indicative of an imbalance in collagen synthesis and breakdown [13,14] and reduced crimp angle decreases the amount the tendon can deform before failure [14]. Both of these morphological properties will decrease the amount of maximal tensile load the tissue can withstand, increasing the likelihood of acute injury or rupture [13-15].

Tendons also have a unique metabolism showing seven and one half times lower oxygen consumption than skeletal muscles [16]. This is likely due to the low ratio of respiring cells to extracellular matrix. The low metabolic demand benefits human performance by reducing the Oxygen demand and consequently requiring little vascularization [17]. However, this is also thought to play a role in healing tendon after injury; lower vascularization in tendinopathy reduces the tendons ability to get nutrients to the tissue causing longer recovery periods than other soft tissue injuries [17,18].

The etiology of tendinosis is multifactorial and the intrinsic properties that make the tendon unique may also contribute to the lengthy recovery times after injury [17]. These biological and biochemical abnormalities described above can be seen as hypoechoic regions on diagnostic ultrasound (US) and are accurately identified with ultrasound visualization in damaged tendon tissue [11,19-22]. US provide another imaging technique that is responsible in part for remodeling tendon placed under strain and repairing damaged tendon [8,9]. Tenocytes and tenoblasts synthesize pro-collagen fibrils to be incorporated into the fibrillar extracellular matrix. In tendinopathic tissue tenocytes are sometimes plump and chondroid in appearance instead of thin spindle like cells [10,11]. Still others have shown a significant amount of tendinocyte apoptosis in acute tendon tears in addition to chronic tenonopathies [12]. These findings have yet to show a causative relationship in tendinopathy, but future histological and cell culture investigations may provide answers.

Diagnostic ultrasound is done after physical exam to corroborate physical exam findings. The adductor tendons are examined under ultrasound imaging as part of a more extensive standardized exam that checks for pelvic instability, hernias and hip pathology. This procedure follows some of the most current research guidelines in musculoskeletal diagnostic ultrasound [28-31]. The exam starts with the evaluation of the pubic symphysis, checking for bony abnormalities and pelvic instability using a flutter kick to assess dynamic stability. The ultrasound probe is moved laterally and slightly distally where the adductor longus muscle is visualized. All the musculature should be checked to rule out other pathologies although an adductor longus tear or tendinopathy is most common. If a hypoechoic region appears in the area of the tendon between the muscle and pubic tubercle the patient is positive for adductor longus tendinopathy. Figure 1 shows an example of the hypoechoic region found on diagnostic ultrasound.

All patients were diagnosed with adductor tendinopathy with these methods described above and some patients had hernias in addition (Patients 1-3 and 11-12 in Table 1). The presence of an adductor tendinopathy made them a candidate for the percutaneous ultrasound tenotomy treatment of the adductor longus tendon after failed conservative treatment. Therefore an adductor tendinopathy diagnosis was achieved by localized pain just below the pubic ramus on patient physical exam and identification of a hypoechoic region in the adductor tendon with diagnostic ultrasound.

Institutional review board was contacted for approval of this investigation; however review was not needed for this study design. A letter regarding exemption was received in lieu.

**Methods**

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**Physical exam and diagnostic ultrasound**

The pelvic region is an area predisposed to pelvic instability, hernias, hip pathology and other sports related injuries. In some cases hernias and adductor tears can occur simultaneously; this is especially prominent in European footballers [26]. The patient is first put through a physical exam to test for indications of adductor tendinopathies, hernias and other hip pathologies. The physical exam is designed to allow the physician to localize the patients pain using a combination of an adductor squeeze test and a partial sit up to see whether the pain may be coming from a hernia (above the pubic ramus) or an adductor tendinopathy (below the pubic ramus). The full physical exam is detailed in this article [27].

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**Procedure**

**Equipment:** Either Terason t3200 ultrasound machine was used with a linear high frequency 5-15 MHz probe or a Sonosite Xporte.
Patients were prepped and draped in a surgical fashion and sterile technique including sterile gloves and probe cover were used. The tendon insertion area was cleansed in preparation for the procedure using the antiseptic in the prepackaged TENEX kit. The probe was placed in the transverse and longitudinal position at first to find the most pathologic region then placed in a longitudinal position for the injection using the US guidance. 1% lidocaine was used to numb the skin and some of the deeper soft tissue structures at the point of maximal tenderness. Once this was done, a lateral to medial approach was taken but this was all done longitudinal to the probe. First, a 27-gauge needle infiltrated with 1% Ropivacaine and then a 22-gauge needle was used for infiltration of the adductor longus tendon; the needle point was visualized by ultrasound guidance. A small 1 cm incision was made over the site of the tendon using an 11 blade. The connective tissue superficial to the tendon is also incised for easier placement of the ultrasonic Tenex probe, being sure to avoid the spermatic cord. Figure 2 shows the Tenex needle point in the hypoechoic region. The Tenex probe emits ultrasound waves at a frequency that breaks up the pathologic tendon tissue but leaves the normal healthy tendon intact. The probe debrides the necrotic or damaged tissue leaving room for healing and tendon regeneration. The procedure takes between 1-3 minutes to complete. The patient often times reports immediate relief. A 5mm steri strip was used to dress the incision after completion of the procedure. The supplementary video file shows the procedure in detail (S1).

All patients were instructed not to do anything to stress the area for approximately two weeks to allow proper healing. They were instructed not to take anti-inflammatory medications as the theoretical inhibitory effect on the healing process [32]. They were instructed to take Tylenol for the pain. Physical therapy and progressive exercise program was prescribed for all patients after two weeks of rest and continued for four weeks, patients were also educated and highly encouraged to continue an exercise program at home after physical therapy.

**Patient Preparation:** Patients were prepped and draped in a surgical fashion and sterile.

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**Quantitative Analysis**

Patients were surveyed with a verbal Numeric Pain Scale (NPS, 0-10); this score was recorded as a Pre-NPS score to assess their baseline pain level before the procedure and a Post-NPS score after the patient was recovered (between 3-6 months) [33,34]. It should be noted that the patients were asked to report the maximum amount of pain felt during any activity for the pre and post NPS scores. Most patients reported values greater than zero for their post NPS scores based on their discomfort levels during activity. NPS scores are summarized in Table 1. Student’s paired t-test was used in statistical analysis of NPS scores. For patients self-reported recovery time they were asked to approximate how long it took them to become pain free during sedentary behavior and minimal physical activities. This investigation did not take into account the varying degrees of physical activity levels for these patients, although many reported to be physically active recreationally or competitively.

**Table 1:** Patient age, pre-procedure NPS scores, post-procedure NPS scores and approximate time to recovery. Mean, standard deviation (SD), standard error of the mean (SEM), T and P values for one tailed students paired t-test reported. Significance set at α < 0.05.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age</th>
<th>Pre NPS</th>
<th>Post NPS</th>
<th>Time to Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>*1</td>
<td>61</td>
<td>10</td>
<td>8</td>
<td>No Recovery</td>
</tr>
<tr>
<td>*2</td>
<td>36</td>
<td>5</td>
<td>4</td>
<td>No Recovery</td>
</tr>
<tr>
<td>*3</td>
<td>77</td>
<td>5</td>
<td>1</td>
<td>No Recovery</td>
</tr>
<tr>
<td>4</td>
<td>57</td>
<td>5</td>
<td>4</td>
<td>4 Weeks</td>
</tr>
<tr>
<td>5</td>
<td>28</td>
<td>6</td>
<td>4</td>
<td>1 Week</td>
</tr>
</tbody>
</table>

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Results

There were no complications reported by any patients in follow up. All patients showed improvement in self-reported pain scores, although some only minimally improved (Figure 3). Patient average baseline NPS score (0-10) before the percutaneous tenotomy was M=7.33 (SD±2.1) and after the procedure the average NPS score was M=2.58 (SD±2.23) (Figure 4). A student’s paired t-test showed the reduction in pain symptoms was significant (P<0.001). Significance for the one tailed paired t-test was set at α<0.05. Nine patients reported good results with significant decrease in pain, although only two reported complete relief during sedentary and high intensity activities (Patient 11 and 12 Table 1).

The average time to full recovery was approximately 4.5 weeks (Patients 4-12, Table 1). Most patients reported no pain except during physical activity. In the patients that reported significant pain relief and improved functionality after recovery still had some pain during moderate to intense physical activity. Two patients reported full recovery within one week based on their ability to perform every day activities including moderately intense physical activity; these patients were recorded as being fully recovered in approximately 1 week. Three patients reported no full recovery (Patients 1-3 in Table 1) but still showed some relief indicated by a lower NPS score. One of these three patients reported intermittent pain with no apparent pattern whatsoever. These patient outcomes will be examined further in the discussion section.

Discussion

The purpose of this investigation was to describe in detail the percutaneous ultrasound tenotomy procedure. The location of the adductor tendinopathy presents some clinical challenges for diagnosis as well as treatment. Studies have supported the efficacy of ultrasound to identify and locate tendonopathies [11,19-21]. Ultrasound diagnosis eliminates some of the disparity between possible pathologies in this location; mainly the differentiation between sports hernia and adductor tendinopathy [28-31]. In some cases, as shown by our data, these two injuries occur simultaneously and could potentially play a role in patient recovery.

All of the patients who reported no recovery or showed very little improvement in their pain symptoms were >55 years of age, or had a hernia surgery with the tenotomy, or both. Patients 1-3 who reported no recovery had hernia repairs previously and were referred to us by outside physicians regarding their recurring groin pain. These patients although positive for adductor longus tendinopathy still reported pain after the procedure. It is our belief that these patients were suffering from recurring nerve pain from their previous hernia repairs. These three patients were the first three patients this procedure was performed on in this case series. Due to the novelty of this procedure, we would like to suggest the possibility of our own personal improvement over time and that our refinement of the procedure may have contributed to our outcomes, especially with respect to the Tenex needle placement of these first three patients. Our two younger

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**Table 1: NPS Scores and Time to Recovery**

<table>
<thead>
<tr>
<th>Patient</th>
<th>Pre Procedure NPS</th>
<th>Post Procedure NPS</th>
<th>Time to Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
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<td>2</td>
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<td>0</td>
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</tr>
<tr>
<td>10</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>11</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

*Indicates patients who also had a hernia surgery.

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**Figure 3:** Individual pre and post NPS scores; dark grey is the pre procedure NPS score and light grey is the post procedure NPS score.

**Figure 4:** Average pre procedure NPS scores versus average post procedure NPS scores. Average ± standard error of the mean (SEM), T=5.875, P=7.81x10^-5.

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and healthier patients who had hernia repairs and a tenotomy procedure performed by our team had reported full recovery, these patients were also the last two patients to be included in this investigation. In addition, in our experience a large part of the patients full recovery depends on their physical activity level and adherence to the exercise protocols prescribed to them. Regardless of these previous reasons it seems that older individuals may not be the best population for the adductor tenotomy procedure based on our data.

Despite these three patients’ outcomes above, our data shows a good improvement in patient pain symptoms and a reasonable time to recovery. The patient’s exercise protocol and physical therapy focuses on strengthening exercises. It has been shown in the literature that acute non-damaging slow-speed resistance exercise has an anabolic effect on tendon and muscle protein synthesis and is good for rehabilitating tendinopathy [35,36]. This exercise prescription is employed approximately two weeks after the procedure with a progressive loading methodology to allow the patients a gradual increase in exercise intensity.

Limitations

We recognize that this type of investigation has some inherent limitations. This study employed a retrospective case series design using a subjective Numerical Pain Scale to quantify the patient’s pain. The patients were also required to estimate their amount of time it took them to recover from the procedure. These are considered limitations due to the patients’ individual differences and their relative pain tolerance. There was not a control group nor were there any blinded or double blinded protocols. We decided to included patients who also had hernias in conjunction with the adductor tenotomy because we felt that including these hernia patients was important to get the realistic picture of a sports medicine practice; therefore our sampling protocol is considered a limitation. Being a case series with relatively new technology there was a learning curve with this procedure and as this case series progressed we were generally more confident with the skill it took to perform this procedure; however this should be noted as a limitation that cannot be controlled for.

Recommendations for Research

Future investigations should employ a prospective case-control investigation using blinded groups, multiple treatment methods and other more objective data collection tools. In addition our investigation did not take into account patient adherence to the exercise protocol prescribed after the procedure; this could be a major determining factor of patient recovery. The data seemed to indicate younger more athletically motivated individuals recover quicker. For these reasons future investigations should take into account exercise adherence as part of the investigation.

Conclusion

If the pain is in fact from the changes in the biochemical milieu of the tissue, in theory, the percutaneous tenotomy should relieve pain and promote healing by removing the stimulus causing it. Our data seem to support other findings in part [1,9,27], however, until the full etiology is elucidated about the biochemical and structural factors involved with tendinopathy clinicians will still have to weigh the options for certain treatments of the pathology. These findings suggest a percutaneous ultrasound tenotomy using the Tenex system may be effective in reducing patient’s pain with adductor tendinopathy [37].

Acknowledgement

Anthony Joseph and Ethan Ostrom planned the study. Anthony performed the procedure with the Tenex system. Ethan and Anthony followed up with the patients for the numeric pain scale survey. Anthony spoke with them in person if they came into the office after 3 months post procedure. Ethan made phone calls to contact and survey the patients if they were not seen after 3 months post procedure. Ethan wrote the paper and analyzed the data. Anthony assisted with the literature review and edited the paper. Ethan submitted the study.

Conflict of Interest

None.

References

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