Greater Trochanteric Pain Syndrome

Percutaneous Tendon Fenestration Versus Platelet-Rich Plasma Injection for Treatment of Gluteal Tendinosis

Jon A. Jacobson, MD, Corrie M. Yablon, MD, P. Troy Henning, DO, Irene S. Kazmers, MD, Andrew Urquhart, MD, Brian Hallstrom, MD, Asheesh Bedi, MD, Aishwarya Parameswaran, MS

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Objectives—The purpose of this study was to compare ultrasound-guided percutaneous tendon fenestration to platelet-rich plasma (PRP) injection for treatment of greater trochanteric pain syndrome.

Methods—After Institutional Review Board approval was obtained, patients with symptoms of greater trochanteric pain syndrome and ultrasound findings of gluteal tendinosis or a partial tear (<50% depth) were blinded and treated with ultrasound-guided fenestration or autologous PRP injection of the abnormal tendon. Pain scores were recorded at baseline, week 1, and week 2 after treatment. Retrospective clinic record review assessed patient symptoms.

Results—The study group consisted of 30 patients (24 female), of whom 50% were treated with fenestration and 50% were treated with PRP. The gluteus medius was treated in 73% and 67% in the fenestration and PRP groups, respectively. Tendinosis was present in all patients. In the fenestration group, mean pain scores were 32.4 at baseline, 16.8 at time point 1, and 15.2 at time point 2. In the PRP group, mean pain scores were 31.4 at baseline, 25.5 at time point 1, and 19.4 at time point 2. Retrospective follow-up showed significant pain score improvement from baseline to time points 1 and 2 ($P < .0001$) but no difference between treatment groups ($P = .1623$). There was 71% and 79% improvement at 92 days (mean) in the fenestration and PRP groups, respectively, with no significant difference between the treatments ($P > .99$).

Conclusions—Our study shows that both ultrasound-guided tendon fenestration and PRP injection are effective for treatment of gluteal tendinosis, showing symptom improvement in both treatment groups.

Key Words—fenestration; gluteal; musculoskeletal ultrasound; platelet-rich plasma; tendinosis; tenotomy; trochanter

Greater trochanteric pain syndrome is a common condition that most commonly affects middle-aged and elderly women and potentially younger active male and female individuals.[1] Symptoms include pain referable to the lateral hip as well as point tenderness that often interferes with activity and sleeping.[2,3] Contrary to prior misconceptions that symptoms were due to underlying bursitis, it has been shown that the underlying etiology for greater trochanteric pain syndrome is most commonly tendinosis or a tendon tear of the gluteus medius, gluteus minimus, or both at the greater trochanter and that tendon inflammation (or tendinitis) is not a major feature.[4–7] In addition, adjacent bursal distention is uncommon, and the bursa is neither inflamed nor a cause of patient symptoms in most situations.[7,8] Treatment of greater trochanteric

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Address correspondence to Jon A. Jacobson, MD, Department of Radiology, University of Michigan, 1500 E Medical Center Dr, TC2910L, Ann Arbor, MI 48109-0326 USA.

E-mail: jjacobsn@umich.edu

Abbreviations
PRP, platelet-rich plasma

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pain syndrome should therefore be directed to treatment of the underlying tendon condition.

Ultrasound-guided percutaneous needle fenestration (or tenotomy) has been used to effectively treat underlying tendinosis and tendon tears, including tendons about the hip and pelvis.[9–13] The rationale behind tendon fenestration is that a chronic degenerative tendon process is converted to an acute process, and inherent growth factors are introduced with bleeding, thereby promoting tendon healing.[10] Similarly, autologous platelet-rich plasma (PRP), often combined with tendon fenestration, has been used throughout the body to treat tendinosis and tendon tears, as injection into a tendon promotes healing via the introduction of growth factors concentrated in and released from platelets.[14] Although studies have shown patient improvement with PRP treatment, the true effectiveness of this treatment compared to other treatments remains uncertain.[15–17]

Although percutaneous ultrasound-guided tendon fenestration has been shown to be effective about the hip and pelvis, there are no data describing the use of PRP for treatment of gluteal tendons, and there is no study comparing the effectiveness of each treatment for gluteal tendinopathy.[9] The purpose of this blinded prospective clinical trial was to compare ultrasound-guided tendon fenestration and PRP for treatment of gluteus tendinosis or partial-thickness tears in greater trochanteric pain syndrome.

Materials and Methods

Institutional Review Board approval was obtained before initiation of this study. Patients were recruited from referring physicians of various departments, including internal medicine, family medicine, rheumatology, sports medicine, physical medicine and rehabilitation, and orthopedic surgery. If a patient had signs and symptoms consistent with the clinical diagnosis of greater trochanteric pain syndrome, which included pain referable to the greater trochanter, and had failed conservative management, including physical therapy and nonsteroidal anti-inflammatory drugs, the patient would be considered for the clinical trial. If the patient was interested in enrolling, the patient would then be referred for an ultrasound examination to evaluate for a gluteal tendon abnormality and to exclude other types of hip disorders as part of patient care.

Ultrasound examinations of the hip were performed by 1 of 10 fellowship-trained musculoskeletal radiologists with musculoskeletal ultrasound experience using commercially available ultrasound equipment (iU22 and EPIQ; Philips Healthcare, Bothell, WA; and LOGIQ 9 and E9; GE Healthcare, Milwaukee, WI) and transducers (linear and curvilinear transducers with variable frequencies ranging from 5 to 15 MHz). The hip ultrasound protocol included imaging the gluteus minimus and medius tendons in short and long axes, as well as imaging the greater trochanteric area for the presence of bursal distention. Tendinosis was characterized as abnormal hypoechogenicity of the tendon with possible enlargement. A tendon tear was characterized as an anechoic tendon defect. In contrast to a partial-thickness tear, a full-thickness tear shows an anechoic defect extending to both tendon surfaces with possible tendon retraction.

The principal investigator reviewed the sonograms of the potential participant. Initial inclusion criteria included the presence of tendinosis or a partial-thickness tendon tear (<50% depth) of the gluteus minimus or gluteus medius tendon. If inclusion criteria were met, the primary investigator then contacted the potential participant via phone to explain the study and to assess for exclusion criteria, which included age younger than 18 years, pregnancy, risk of bleeding due to anticoagulant medication, presence of malignancy, and steroid injection less than 3 months before enrollment. Patients were then informed to discontinue aspirin and other nonsteroidal anti-inflammatory drugs for 2 weeks before the procedure.

At the time of the procedure, the patient signed the Institutional Review Board–approved research consent form. The patient was informed of the procedure risks (bleeding, infection, tendon rupture, allergy to medication, and pain), and the procedure consent form was also signed by the patient and primary investigator. An ultrasound examination of the affected hip was performed to document the presence of gluteus minimus or medius tendinosis or a partial-thickness tear (<50% depth), and the skin was marked at the planned puncture site. If both tendons were abnormal, the most sonographically abnormal tendon that was also symptomatic with transducer pressure was chosen for treatment. The patient also answered a series of questions with regard to hip symptoms (Table 1).

Patients were placed into either the tendon fenestration or PRP treatment arm based on the previous patient's treatment so that fenestration and PRP treatments would alternate between each subsequent patient. If there was an error in the PRP process (inadequate venous blood draw or failed PRP preparation), then that patient would be converted to the fenestration treatment arm. Patients were blinded with respect to their treatment arm.

In each patient, venous blood was drawn from one of the antecubital veins at the elbow. If the patient was in the tendon fenestration arm, 10 mL of venous blood was

drawn and discretely discarded, although the centrifuge lid was opened and closed regardless. If in the PRP treatment arm, 60 mL of blood was drawn into a syringe with the anticoagulant citrate dextrose, placed into a centrifuge (Harvest Technologies, Lakewood, CO), and centrifuged at up to 2650 rpm for approximately 14 minutes. This PRP preparation kit is commercially available and is reported to produce a leukocyte-rich sample (primarily mononuclear) with a platelet concentration 4 to 6 times that in whole blood. A successful PRP preparation resulted in approximately 10 mL of PRP. If the PRP sample was less than 7 mL, the sample was discretely discarded, and the patient was switched to the tendon fenestration arm.

For the ultrasound-guided percutaneous procedure, the transducer (linear or curvilinear, >7 MHz) was positioned either long or short axis to the involved gluteal tendon. With a sterile technique, a transducer cover, and sterile drapes, a 20-gauge, 3.5-in spinal needle with trocar was inserted in plane with the ultrasound transducer and sound beam. Less than 1 mL of local anesthetic (1% lidocaine) was initially injected with a 25-gauge needle at the skin surface. Subsequently, less than 1 mL of lidocaine was then injected over the surface of the tendon via the 20-gauge spinal needle. In the tendon fenestration arm, the 20-gauge needle with trocar removed was passed approximately 20 to 30 times at various angles through the abnormal tendon until the abnormal area was covered and the tendon softened (Figure 1). In the PRP treatment arm, the needle was inserted into the deepest aspect of the ten-

Table 1. Patient-Reported Outcomes

Outcome	Score
Level of pain	0 (no pain) to 10 (pain as bad as could imagine)
Pain interfering with general activity	0 (does not interfere) to 10 (completely interferes)
Pain interfering with walking	0 (does not interfere) to 10 (completely interferes)
Pain interfering with climbing stairs	0 (does not interfere) to 10 (completely interferes)
Pain interfering with sleeping	0 (does not interfere) to 10 (completely interferes)

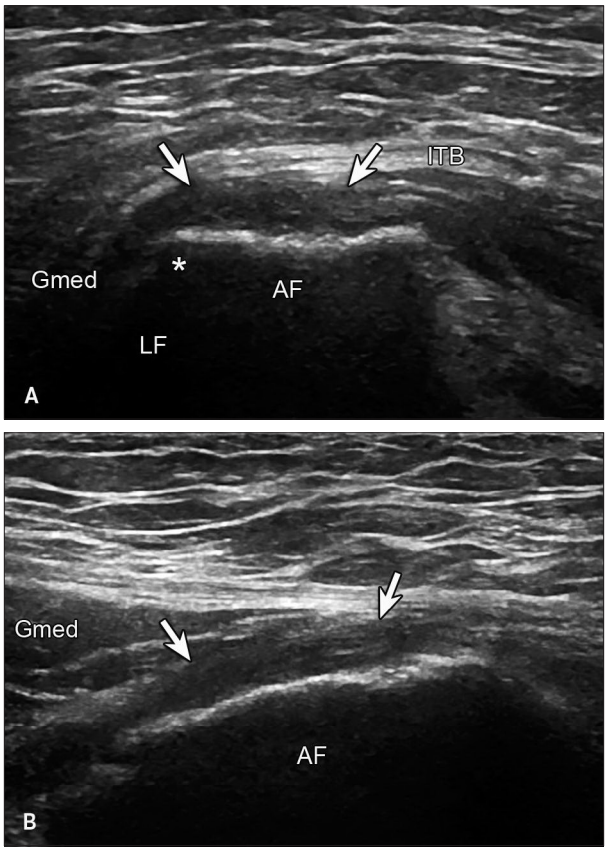


Figure 1. Images from a 55-year-old man with gluteus minimus tendinosis treated with fenestration. **A** and **B**, Sonograms short axis (**A**) and long axis (**B**) to the gluteus minimus showing a hypoechoic and thickened gluteus minimus tendon (arrows). Note the apex of the greater trochanter (asterisk) separating the anterior facet (AF) and lateral facet (LF) seen short axis to the femur in **A**, gluteus medius (Gmed), and iliotibial tract (ITB). **C**, Sonogram long axis to the gluteus minimus showing a 20-gauge spinal needle (arrowheads) with the distal tip in the area of tendinosis (arrow). Right side of **A** is anterior, and right side of **B** and **C** is distal.

don abnormality, and the PRP was injected as the needle was withdrawn through the abnormal tendon segment (Figures 2 and 3). This process was repeated until the entire abnormal tendon segment was treated. In contrast to the tendon fenestration arm, the number of times the needle was passed through the tendon was minimized and estimated as less than 10. During the procedure, the patient was instructed to look away from the procedure area to remain blinded to the treatment arm.

After the procedure, the patient was instructed to avoid nonsteroidal anti-inflammatory drugs for 2 weeks. For the first week, the patient was also instructed to avoid strenuous activity with regard to the hip. Activity was gradually increased during the second week as tolerated. Patients were contacted via phone or e-mail by the primary investigator at weeks 1 and 2 to assess hip symptoms by asking the same series of questions that was completed before the procedure (Table 1). The patient was instructed to follow-up with the referring clinician to reassess the hip between 4 and 6 weeks. Patients were subsequently e-mailed, and clinical records were reviewed by the primary investigator to determine whether patient symptoms referable to the greater trochanter were improved, similar, or worse compared to before the procedure beyond the initial 2-week data collection.

Baseline patient demographics and summated pain scores were compared between the treatment groups (fenestration versus PRP) to determine whether any significant difference existed, using the Fisher exact test for categorical variables and an independent-group t test for continuous variables. Summated patient pain scores were analyzed by repeated-measures 1-way analysis of variance over time adjusted for the treatment group. A paired comparison of different time points was performed by post hoc Tukey correction for multiple comparisons. In addition, the percentages of patients who showed improvement over time based on retrospective clinical chart review were compared between the treatment arms for any significant difference by the Fisher exact test. $P < .05$ was considered statistically significant.

Results

Of the 30 patients, 50% were treated with tendon fenestration (Figure 1), and 50% were treated with PRP (Figures 2 and 3). The mean patient age was 57 years (range, 24 to 81 years), with no significant age difference between the treatment groups (Table 2). The patients consisted of 6 men and 24 women, with no significant difference between the treatment groups. The left side was affected in 12 patients

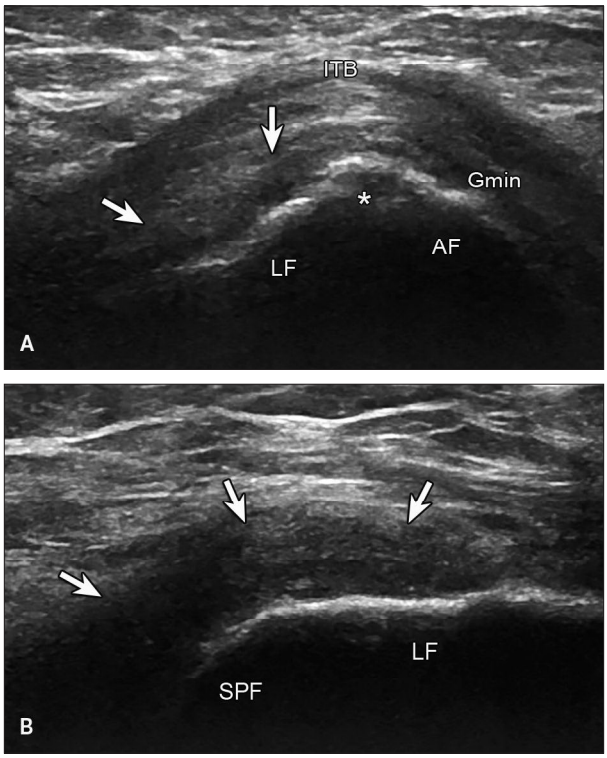


Figure 2. Images from a 69-year-old woman with gluteus medius tendinosis treated with PRP injection. **A** and **B**, Sonograms short axis (**A**) and long axis (**B**) to the gluteus medius showing a hypoechoic and thickened gluteus medius tendon (arrows) at the attachment on the lateral facet (LF) and superoposterior facet (SPF) of the greater trochanter. Note the apex of the greater trochanter (asterisk) separating the anterior facet (AF) and lateral facet seen short axis to the femur in **A**, gluteus minimus (Gmin), and iliotibial tract (ITB). **C**, Sonogram long axis to the gluteus medius showing a 20-gauge spinal needle (arrowheads) with the distal tip in the area of tendinosis (arrow). Right side of **A** is anterior, and right side of **B** and **C** is distal.

and the right side in 18, with no significant difference between the treatment groups. The gluteus medius was treated in 73% and 67% in the fenestration and PRP groups, respectively, with no significant difference between the treatment groups, with the gluteus minimus treated in the remaining patients. Tendinosis was present in all patients, with no patients having a tendon tear. In no patient was a distended bursa identified in the region of the greater trochanter, and similarly, in no cases were tendon calcifications seen at the ultrasound examination. Two patients initially assigned to the PRP group were moved to the fenestration group because of an error in the PRP preparation process. There were no immediate complications after the procedures.

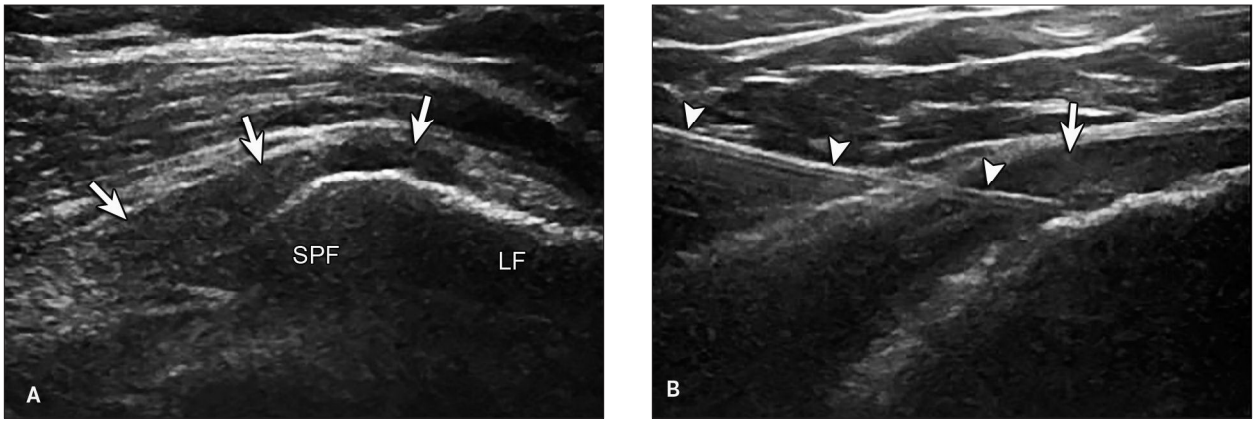
Regarding follow-up intervals after tendon procedures, the mean time from the procedure to symptom assessment at time point 1 in the fenestration group was 7.9 (range, 7 to 13) days, and in the PRP group, it was 8.0 (range, 7 to 10) days, with no significant difference between the groups ($P = .8996$). At time point 2, the mean time from the procedure to symptom assessment in the fenestration group was 17.6 (range, 14 to 23) days, and in the PRP group, it was 15.3 (range, 14 to 20) days, which was significantly different between the groups ($P = .0425$). Retrospective clinical follow-up was available in 93% (14 of 15) and 93% (14 of 15) of the fenestration and PRP treatment groups, respectively, with mean intervals of 128 (SD, 141.1; range, 15 to 555) and 55.7 (SD, 27.7; range, 21 to 108) days from baseline, respectively (mean for both groups combined was 92 days), with no significant difference between the treatment groups ($P = .0815$).

When comparing the pain scores between the treatment groups at each time point, at baseline the mean pain score in the fenestration group was 32.4 (SD, 10.2; range, 8 to 49), and in the PRP group, it was 31.4 (SD, 7.3; range, 11 to 41). At time point 1, the mean pain score after fenestration was 16.8 (SD, 11.46; range, 0 to 34), which was lower than the PRP group pain score of 25.5 (SD, 8.77; range, 9 to 40.5). At time point 2, the mean pain score after fenestration was 15.2 (SD, 10.8; range, 0 to 34), and after PRP treatment, it was 19.4 (SD, 10.26; range, 4 to 42).

Regarding changes in summated pain scores in each treatment group from baseline, at time point 1, 93% of patients (13 of 14) after fenestration showed improvement (mean improvement, 15; range, 46 to –4), compared with 79% (11 of 14) after PRP treatment (mean improvement, 5.6; range, 21 to –15). At time point 2 compared to baseline, 93% of patients (14 of 15) after fenestration showed improvement (mean improvement, 17; range, 46 to 0), compared with 80% (12 of 15) after PRP treatment (mean improvement, 12; range, 28 to –5).

Analysis of summated pain scores showed that overall, there was a significant time effect on the summated pain score (Table 3). The type of treatment had no significant effect on the summated pain score. Pair-wise comparison showed a significant change in summated pain scores between baseline and time point 1, as well as baseline and time point 2. There was no significant change in summated pain scores between time points 1 and 2. At final retrospective clinical follow-up, 71% (10 of 14) of fenestration patients and 79% (11 of 14) of PRP patients showed improvement, with no significant difference between the groups ($P > .99$).

Figure 3. Images from a 61-year-old woman with gluteus medius tendinosis treated with PRP injection. **A**, Sonogram long axis to the gluteus medius showing hypoechoic tendinosis (arrows) of the gluteus medius tendon predominantly at the attachment on the superoposterior facet (SPF) with less involvement at the lateral facet (LF) and the greater trochanter. **B**, Sonogram long axis to the gluteus medius showing a 20-gauge spinal needle (arrowheads) with the distal tip in the area of tendinosis (arrow). Right side of images is distal.



Discussion

Symptoms from greater trochanteric pain syndrome can be quite substantial and markedly decrease quality of life. The underlying conditions producing such symptoms in most cases are tendinosis and tears of the gluteal tendons at the greater trochanter.[5–7] An effective percutaneous treatment directed at these conditions would therefore be important. Our study has shown that both ultrasound-guided tendon fenestration and PRP injection are effective for treatment of greater trochanteric pain syndrome secondary to tendinosis, with improvement in pain scores from baseline to weeks 1 and 2 and 71% and 79% improvement at 92 days (mean) in the fenestration and PRP groups, respectively, with no significant difference between the treatments.

The greater trochanter of the proximal femur serves as the insertion of gluteus minimus and medius tendons. The footprints or bony insertions of the gluteus minimus and medius tendons on the greater trochanter are geographically related to the facets of the greater trochanter, where the gluteus minimus tendon inserts onto the anterior facet, and the gluteus medius inserts onto the lateral and superoposterior facets.[18] The gluteus maximus passes superficial to the posterior facet to insert onto the linea aspera of the proximal femur and iliotibial band. Respective bursae are located deep to each gluteal muscle and tendons.

Greater trochanteric pain syndrome most commonly involves middle-aged and elderly women. Pain is characteristically referred to the lateral hip over the greater trochanter with point tenderness. Symptoms are exacerbated by walking; pain interfering with sleeping often occurs when patients lie on the lateral affected hip.[2] The underlying condition in the setting of greater trochanteric pain syndrome in most cases has been shown to be tendinosis or a tendon tear of the gluteus medius and, less commonly, the gluteus minimus tendon, with an absence of acute inflammation.[4–6] Bursitis is not a common cause of symptoms. In patients with greater trochanteric pain syndrome, only 20% will have a distended trochanteric bursa on ultrasound imaging.[7] In addition, it has been shown that a distended bursa in this setting is typically not inflamed.[8] The distended bursa is not believed to be the primary cause of symptoms but may be simply a finding associated with the underlying gluteal tendon abnormality. Treatment for trochanteric pain syndrome should therefore be directed to treatment of the underlying tendon disorder.

A historic treatment for greater trochanteric pain syndrome has been percutaneous corticosteroid injection, largely because of the misconception that inflammation was present. The use of corticosteroids in this setting is counterintuitive, as true tendinitis is not present, and true bursitis is uncommon. When corticosteroids are injected superficial to tendinosis, pain levels have been shown to improve, with one study reporting that 72% of patients were improved 1 month after injection.[1] However, the pain relief is typically short lived, and there is a risk of tendon rupture if corticosteroids are injected into a tendon.[10]

Percutaneous tendon fenestration (also called dry needling or tenotomy) has been used to directly treat tendinosis and partial-thickness tendon tears.[1] The theory behind this treatment is that a chronic degenerative process is converted to an acute process. Bleeding introduces growth factors to induce inflammation and promote healing. The use of ultrasound guidance is important for accurately directing the tendon treatment to the abnormal area. Although studies have shown patient improvement after ultrasound-guided tendon fenestration, there are only limited studies evaluating fenestration of gluteal tendons, and

Table 2. Patient Demographics

Characteristic	Fenestration	PRP	*P*
n	15	15	
Age, y			.1611
Mean	60	53	
SD	13.06	12.60	
Minimum	31	23	
Maximum	81	72	
Side, n (%)			.2635
Left	8 (53.33)	4 (26.67)	
Right	7 (46.67)	11 (73.33)	
Sex, n (%)			.1686
Female	10 (66.67)	14 (93.33)	
Male	5 (33.33)	1 (6.67)	
Tendon, n (%)			>.99
Gluteus minimus	4 (26.67)	5 (33.33)	
Gluteus medius	11 (73.33)	10 (66.67)	

Table 3. Repeated Measures of Analysis of Pain Score Total Over Time Adjusted for Treatment Type

Parameter	Mean Pain Score Estimate (SE)	*P*[a]
Visit		<.0001
Treatment	25.42 (1.91) vs 21.56 (1.91)	0.1623
Pair-wise comparison for visits		
Time point 1 vs baseline (n = 28)	21.27 (1.87) vs 31.92 (1.82)	<.0001
Time point 2 vs baseline (n = 30)	17.28 (1.82) vs 31.92 (1.82)	<.0001
Time point 2 vs 1 (n = 28)	17.28 (1.82) vs 21.27 (1.87)	.0569

[a]One-way repeated measures analysis of variance for outcome of total pain score over time adjusted for treatment with post hoc Tukey correction to adjust for multiple comparisons.

there are no studies comparing gluteal tendon fenestration to other tendon treatments such as PRP injection.[9–13,19–21]

Although a comprehensive review of PRP treatment is beyond the scope of this discussion and has previously been described in the literature, PRP involves centrifuging autologous venous blood to separate the platelet-rich layer, which can then be injected into an abnormal tendon to promote healing.[14,22,23] Similar to tendon fenestration but in a higher concentration, growth factors are released from α granules in platelets to promote tendon healing. When PRP is injected, the tendon is typically fenestrated as well, and the use of ultrasound guidance ensures accurate localization of the tendon abnormality and targeted injection. There are intrinsic variations in PRP preparations with regard to platelet count and whether PRP preparations are leukocyte rich or leukocyte poor depending on which preparation kit is used. Nonetheless, studies have shown that patients improve after PRP tendon injection. However, most meta-analyses are inconclusive with regard to the effectiveness of PRP compared to other percutaneous tendon treatments, such as fenestration.[15,16]

The results of our study show that both ultrasound-guided percutaneous tendon fenestration and PRP injection are effective for treatment of gluteus medius and minimus tendinosis. In 2-week follow-up of patients, improvement in pain scores was seen in 93% (14 of 15) in the fenestration group and 80% (12 of 15) in the PRP group. The lower improvement rate in the PRP group at this time may be explained by the inflammation induced by the PRP injection, which in this study was leukocyte rich; however, there was a significant improvement in summated pain scores between baseline and time points 1 and 2 but no significant difference in pain scores between the treatment types. Subsequent retrospective assessment of symptoms at 92 days after the procedures showed improvement in 71% and 79% of patients in the fenestration and PRP groups, respectively, with no significant difference between the treatments. This finding was also consistent with PRP results from the literature at different tendon injection sites, where symptom improvement continues over time. These results show that the symptom improvement is present early after treatment and is sustained over time.

With regard to the PRP procedure, in this study, the tendon fenestration component was intentionally minimized compared to the dedicated tendon fenestration treatment group. In clinical practice, tendon fenestration is commonly performed either before or during the autologous PRP injection. It is not known whether increasing the fenestration component of the procedure would have any effect on patient symptom outcomes after PRP treatment.

There were a number of study limitations that need to be addressed. First, long-term symptom improvement was limited by retrospective assessment, with a somewhat short interval and a wide range of follow-up durations. The sample size was limited because of budgetary constraints, and it remains possible that the effect size was not large enough to detect a difference between the treatment groups. Nonetheless, the results do show symptom improvement in the short term and months after treatment. The limited retrospective follow-up could be interpreted as a potential positive outcome if asymptomatic patients did not seek further treatment for their greater trochanter symptoms. Another limitation was that the PRP samples were not individually assessed for platelet count; however, the PRP preparation kit used is commercially available and is reported to concentrate platelets to 4 to 6 times that in whole blood. An additional limitation was that all patients had tendinosis, so it is unclear whether patients with tendon tears would respond in a different manner. One last limitation was that patient care after treatment was not controlled, which may affect longer-term clinical outcomes. Future prospective studies to include more long-term and objective clinical assessment are required.

In conclusion, this single-blinded prospective study shows that both ultrasound-guided tendon fenestration and PRP injection are effective for treatment of greater trochanteric pain syndrome, showing improvement in pain scores at 1 and 2 weeks, with no significant difference between the treatments. Improvement was also seen at 92 days (mean) in 71% and 79% of the fenestration and PRP groups, respectively. Future randomized controlled trials are needed to determine more long-term clinical outcomes.

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