Ultrasound-Guided Percutaneous Tenotomy for Gluteal Tendinopathy

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Background: Gluteal tendinopathy is a common cause of lateral hip pain. Percutaneous ultrasonic tenotomy (PUT) has been used successfully for the treatment of tendinopathy of the elbow, knee, and ankle, but its use in the hip has not been described.

Purpose: To evaluate the efficacy of PUT in patients who did not respond to nonsurgical management of gluteal tendinopathy.

Study Design: Case series; Level of evidence, 4.

Methods: A total of 29 patients with gluteal tendinopathy (mean age, 62 years) who did not respond to nonsurgical treatment were enrolled in this prospective study and underwent ultrasound-guided PUT in an outpatient setting. Patients with a history of ipsilateral hip surgery were excluded. All patients initially underwent magnetic resonance imaging or a computed tomography arthrogram demonstrating tendinopathy and/or partial tearing of the gluteus minimus or medius tendon or both tendons. Outcomes were assessed with a visual analog scale (VAS) for pain, the Harris Hip Score evaluation, and the 12-Item Short Form Health Survey (SF-12) before the procedure and at subsequent follow-up visits or by telephone interviews at 3 weeks, 3 months, 6 months, and final follow-up (range, 18-30 months).

Results: The mean final follow-up was at 22 months postoperatively. At final follow-up, VAS scores had improved from a preprocedural mean ± SD of 5.86 ± 1.73 to 2.82 ± 2.22 ($P < .01$). Harris Hip Scores improved from a preprocedural mean of 60.03 ± 10.86 to 77.47 ± 14.34 ($P < .01$). Total SF-12 scores improved from a mean of 29.93 ± 5.39 (51% optimal) to 34.41 ± 4.88 (64% optimal) ($P < .01$). No complications were reported. At final follow-up, when asked whether they would have the procedure again, 15 patients replied "yes definitely," 3 replied "yes probably," 3 replied "maybe," 1 replied "likely not," and 2 replied "definitely not." There were 3 patients who eventually had hip abductor tendon repair, and their PUT procedures were considered failures.

Conclusion: PUT is an effective treatment, with good results for patients with gluteal tendinopathy.

Keywords: tendinitis; ultrasound-guided; minimally invasive; gluteal tendinopathy; greater trochanteric pain syndrome

Gluteal tendinopathy and trochanteric bursitis both fall under the broader term *greater trochanteric pain syndrome*.[17,18,21,26] The problem is most often thought to be related to tendinosis of the gluteus medius or minimus tendon, or both, with or without bursal involvement. The gluteus medius and minimus tendons insert on the greater trochanter of the femur and together act as the hip abductors. A bursa lies between the 2 muscles and beneath the iliotibial band. Over time, friction over the greater trochanter and hip abductor tendons can lead to partial tears of the gluteal tendons and can present as lateral hip pain localized over the greater trochanter.[17] The patient's pain often radiates to the lateral aspect of the thigh and knee. Pain often increases when the patient is going up and down stairs and is often most pronounced while the patient is lying on the affected side. If tendinopathy or tearing of the gluteal tendons is suspected, a magnetic resonance imaging (MRI) scan or ultrasound study can confirm the diagnosis and further detail the pathologic features.[13,19]

Initially, the treatment regimen for gluteal tendinopathy consists of rest, activity modification, weight reduction, stretching, physical therapy, and nonsteroidal anti-inflammatory medication.[26] More invasive techniques include corticosteroid injections, platelet-rich plasma (PRP) injections,[10,11] and extracorporeal shock wave therapy.[12,22,27] If these measures are not successful, open
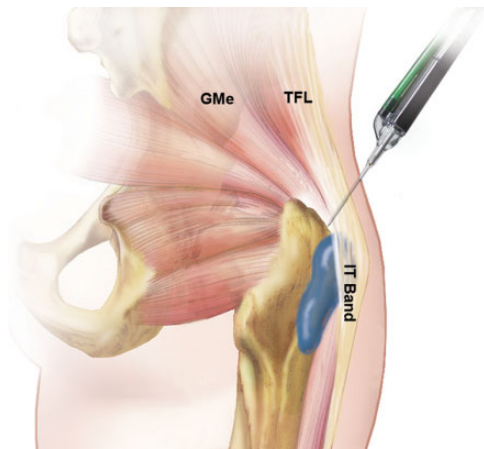
Figure 1. Ultrasound-guided percutaneous tenotomy of the hip abductor tendons. GMe, gluteus medius; IT, iliotibial; TFL, tensor fascia lata.

bursectomy and iliotibial band lengthening[5,6,30,33] and arthroscopic bursectomy[1] are available treatment options with good success rates.

Advanced ultrasound-guided interventions have been used for tendinopathy.[24] Percutaneous ultrasonic tenotomy (PUT) has been used successfully to treat lateral epicondylitis,[2,28] Achilles tendinitis,[7,20] patellar tendinitis,[23] and plantar fasciitis.[20] The technique uses high-frequency energy to debride pathologic tissue under continuous irrigation.[16] The rationale behind percutaneous tenotomy is that when the pathologic tissue is removed, a chronic degenerative process is converted to an acute process, introducing inflammatory growth factors and promoting tendon healing.[17]

In 2016, a system modification was made to lengthen the probe (Tenex TX System; Tenex Health) used to deliver ultrasonic energy and irrigation to the diseased tendon. The longer probe allowed this percutaneous technique to be used to treat tendinopathy in the shoulder and the hip (Figure 1).

We hypothesized that ultrasound-guided PUT would provide pain relief and functional improvement in patients with gluteal tendinopathy. We report our results in a prospective series of patients in whom the technique was used to treat recalcitrant gluteal tendinopathy after at least 4 months of nonoperative management.

METHODS

Study Design

After institutional review board approval was obtained, patients were enrolled in this prospective study if they (1) were 18 years or age or older; (2) had experienced symptoms of gluteal tendinopathy for a minimum of 4 months (ie, pain with gait, pain with activities of daily living, or inability to lie on the affected side at night); (3) had not responded to nonsurgical treatment modalities, including local injection for a minimum of 4 months; and (4) had a noncontrast MRI or computed tomography (CT) arthrogram read by a radiologist that showed either partial tearing or tendinosis

of the gluteus medius or minimus tendon, or both. Patients with complete tears were treated with open repair; they were not believed to be candidates for tenotomy. Patients with previous open surgery on the hip were also excluded.

After informed consent was obtained, 29 patients were enrolled in the study and underwent treatment. They completed pretreatment questionnaires for baseline measurement of symptoms. Outcomes were assessed with a visual analog scale (VAS) for pain,[25] Harris Hip Score (HHS),[14,31] and the 12-Item Short Form Health Survey (SF-12)[32] before the procedure and at subsequent follow-up visits or by telephone interviews at 3 weeks, 3 months, 6 months, and a final follow-up after a minimum of 18 months. (The SF-12, a generic measure of patients' self-reported health status, contains mental and physical domains and provides a total score. A higher score means that the respondent has optimal physical or mental health, or both.) At the final follow-up, a patient satisfaction questionnaire was administered.

The treatment group consisted of 26 females and 3 males, with an average age of 62 years (range, 32-83 years) (Table 1).

Technique and Postprocedural Care

For insurance reimbursement of the facility fee, the procedures are typically done in a hospital or surgery center. The patient was placed in the lateral decubitus position with the affected hip up. The point of maximum tenderness either proximal to or over the greater trochanter was identified. Next, a diagnostic ultrasound was performed to localize the area of diseased tissue, which is identified as a hypoechoic area of the insertion of the gluteus medius or minimus tendons over the greater trochanter. The area was then prepared and draped in a sterile fashion (Figure 2). The skin, subcutaneous tissue, and tendon were then anesthetized with a local anesthetic in the trajectory of the intended treatment. A No. 11 blade was used to make an incision through which the ultrasound needle (Tenex TX System) was placed. Under ultrasonic imaging, the needle was advanced to the diseased gluteal tendon insertion (Figure 3). A tenotomy was then performed by use of pulsed ultrasound energy under direct visualization with continuous irrigation and debridement of the pathologic tissue. The procedure, which usually took between 2 and 3 minutes, was complete when all visual evidence of damaged tendon was removed and confirmed by ultrasound visualization. After completion, a sterile dressing was applied, and the patient was allowed to leave the treatment area. Patients were instructed to bear weight as tolerated, perform stretching, and reduce their activities for 7 to 10 days before resuming their normal activities.

Statistical Analysis

We performed repeated-measures analysis of variance (ANOVA) for each of our outcome measures: VAS, HHS, and SF-12. We conducted the Mauchly test of sphericity on each to determine whether adjustments needed to be made to the degree of freedom. Last, we ran Bonferroni post hoc tests to

TABLE 1
Patient Demographics and MRI Results in 29 Patients[a]

Patient	Sex	Age, y	BMI	Length of Symptoms, mo	No. of Injections	MRI or CT Arthrogram Results
1	F	63	27.0	15	1	Moderate-grade tear of gluteus medius tendon with trochanteric bursitis
2	F	66	30.7	6	1	Moderate gluteal tendinosis with high-grade partial articular-sided tear involving gluteus minimus tendon; mild trochanteric bursitis
3	F	83	25.1	60	1	Gluteal tendinitis
4	F	52	38.5	24	1	Mild abductor tendinosis
5	F	71	24.5	42	4	Mild gluteus minimus tendinosis
6	F	61	30.5	10	1	CT arthrogram; mild gluteus medius tendinosis
7	F	53	28.6	10	0	Mild insertional gluteus medius/minimus tendinosis with mild trochanteric bursitis
8	F	70	29.6	24	1	Mild gluteus minimus tendinitis
9	F	76	31.1	180	3	Insertional tendinosis of gluteus minimus; greater trochanteric bursitis
10	F	62	24.4	6	1	Moderate-grade partial tearing of distal gluteus medius and minimus tendons
11	F	65	35.0	12	0	Moderate-grade partial tearing of distal gluteus medius and minimus tendons
12	M	63	20.8	24	4	Tendinosis and low- to moderate-grade partial tearing of posterior aspect of gluteus minimus and anterior aspect of gluteus medius tendons
13	F	71	25.0	36	1	Gluteus medius tendinitis; greater trochanteric bursitis
14	F	69	25.2	4	1	Gluteus medius and minimus tendinosis with moderate-grade partial-thickness tearing
15	F	39	21.9	24	2	Low-grade partial tearing of the gluteus medius and minimus tendons
16	F	37	27.0	10	3	Moderate gluteal tendinosis without tear; mild trochanteric bursitis
17	F	65	29.1	12	1	Moderate tendinosis with partial-thickness articular-sided tear of the gluteus medius; moderate greater trochanteric bursitis
18	F	71	34.5	60	1	Moderate-grade partial tearing of the gluteus medius tendon
19	F	60	26.5	24	1	Low-grade partial tearing of distal gluteus medius and minimus tendons
20	F	64	28.7	24	1	Gluteus medius tendinosis; trochanteric bursitis
21	F	32	30.6	14	1	Gluteus minimus tendinosis and low-grade partial tearing; mild greater trochanteric bursitis
22	F	63	23.5	6	1	Severe tendinosis of the gluteus minimus tendon
23	M	76	35.5	12	1	CT arthrogram; gluteus minimus tendinopathy
24	F	45	27.4	60	1	Mild abductor tendinosis
25	F	66	23.8	12	10	Gluteus minimus tendinosis with mild- to moderate-grade partial tearing; gluteus medius tendinosis
26	M	69	31.0	24	5	Gluteal tendinitis
27	F	59	26.4	204	6	Gluteus medius tendinitis with small partial-thickness tear of gluteus minimus; mild trochanteric bursitis
28	F	63	28.8	240	2	Moderate gluteal tendinosis with mild trochanteric bursitis
29	F	65	21.9	9	1	Tendinopathy with low-grade partial-thickness tears of the gluteus medius and minimus tendons

[a]BMI, body mass index; CT, computed tomography; F, female; M, male; MRI, magnetic resonance imaging.

Figure 2. The procedure is performed under ultrasound visualization.

apply the correction to adjust the confidence intervals and *P* values to take into account multiple comparisons.

RESULTS

Patients were evaluated for an average of 22 months (median, 20 months; range, 18-30 months); 3 patients (10%) had failed results and went on to have open abductor tendon repair.

Visual Analog Scale

The VAS descriptive analysis showed that pain scores declined gradually over time, with the lowest mean ± SD score at the 3-month interval (2.24 ± 1.97) (Figure 4 and Table 2). A slight increase was noted at 6 months (2.52 ±
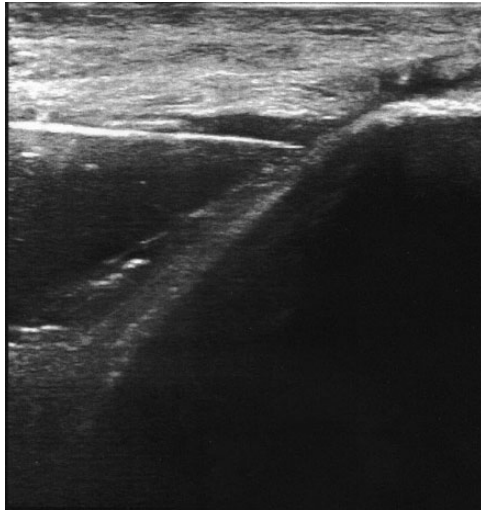
Figure 3. Coronal ultrasound image demonstrating the needle ultrasound probe at the gluteus medius tendon insertion site on the greater trochanter.
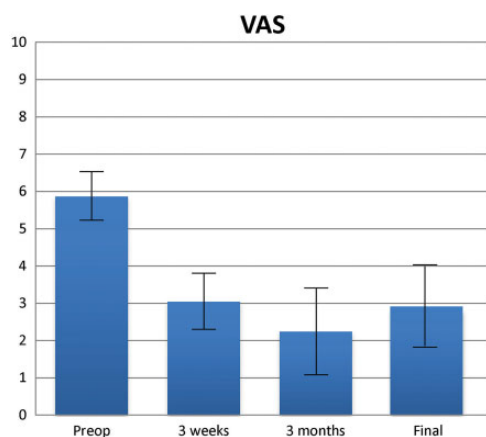

Figure 4. Visual analog scale (VAS) scores (with 95% CI) before and after the procedure.

TABLE 2
Visual Analog Scale Descriptive Statistics in 29 Patients

Time Point	Mean	SD	95% CI
Before procedure	5.86	1.73	5.21 to 6.52
3 wk	3.04	1.95	2.30 to 3.78
3 mo	2.24	1.97	1.49 to 2.99
6 mo	2.52	2.34	1.63 to 3.41
18 mo	2.82	2.22	1.98 to 3.67

2.34) and at 18 months (2.82 ± 2.22); however, mean scores remained below the preprocedural and 3-week postprocedural averages. Overall, pain scores decreased from a preprocedural mean of 5.86 ± 1.73 to 2.82 ± 2.22 at 18 months after the procedure.

The repeated-measures ANOVA measured the difference between the VAS mean scores over the course of 18 months after the procedure; the VAS pain score was significantly different at the 4 follow-up time points ($F_{3.22, 90.08} = 19.78$; $P < .01$; partial $\eta^2 = 0.41$). The sample effect size based on within-patient factor variability was 0.41 (Table 3).

Post hoc analysis with a Bonferroni adjustment showed that the VAS concentration significantly decreased from preprocedural average to each follow-up time point. A significant decrease was seen from preprocedural average to 3 months (mean difference, 2.82; 95% CI, 1.44 to 4.21; $P < .01$) and from preprocedural average to 18 months (mean difference, 3.04; 95% CI, 1.44 to 4.64; $P < .01$) (Table 4).

Harris Hip Score

The HHS results improved significantly at the 18-month follow-up (Figure 5). An increase in function was noted from 60.03 ± 10.86 before the procedure to 77.47 ± 14.34 at 18 months (Table 5).

The differences in HHS results were statistically significant at each time point ($F_{2.40, 67.17} = 13.10$; $P < .01$; partial $\eta^2 = 0.32$). The sample effect size for the within-patient factor variability was 0.32 (Table 6).

A post hoc analysis with Bonferroni adjustment showed that the HHS difference decreased from the preprocedural value to –14.12 (95% CI, –23.01 to –5.23; $P < .01$) at 3 weeks and –17.44 (95% CI, –25.96 to –8.91; $P < .01$) at 18 months of follow-up (Table 7).

Early and intermediate data showed improvement with no marked deterioration over time.

SF-12 Health Survey

The SF-12 is a quality-of-health survey. Composite measures assessed at follow-up included physical and mental health scores. An increase in total function from before the procedure was noted, with a mean score of 29.93 ± 5.39 to 34.41 ± 4.88 at 18 months after surgery (Figure 6 and Table 8).

Sphericity is assumed; therefore, the 1-way repeated-measures ANOVA made no adjustments (Table 9). A statistically significant difference was noted in composite SF-12 scores at the 5 time points (before the procedure and 3 weeks, 3 months, 6 months, and 18 months after the procedure) ($F_{4.00, 112.00} = 9.80$; $P < .01$; $\eta^2 = 0.26$) (Table 9). The sample effect size based on within-patient factor variability was 0.26.

A post hoc analysis with Bonferroni adjustment indicated that there was a significant mean difference in the SF-12 composite scores at each time point when compared with the preprocedural baseline. The mean difference in SF-12 composite scores at 18 months postoperatively was –4.483 ($P < .01$) (Table 10).

Patient Satisfaction

At final follow-up, when patients were asked whether they would have the procedure again, 15 (52%) responded, "yes definitely," 3 (10%) responded "yes probably," 3 (10%) responded "maybe," 1 (3%) responded "likely not," and 2 (7%) responded "definitely not." For 2 patients (7%), 6-month follow-up data were not available. A further

TABLE 3
Visual Analog Scale One-Way Repeated-Measures Analysis of Variance[a]

Source		Type 3 Sum of Squares	df	Mean Square	F	Significance	Partial η^2
Time	Greenhouse-Geisser	249.27	3.22	77.48	19.78	<.01	0.41
Error	Greenhouse-Geisser	362.87	90.08	3.92	—	—	—

[a]Dashes refer to no value given.

TABLE 4
Visual Analog Scale Pairwise Comparisons
With Preprocedural Scores (Based on
Estimated Marginal Means)

Time Point	Mean Difference[a]	SE	Significance[b]	95% CI
3 wk	2.82	0.45	<.01	1.44 to 4.21
3 mo	3.63	0.45	<.01	2.27 to 4.98
6 mo	3.34	0.54	<.01	1.71 to 4.97
18 mo	3.04	0.53	<.01	1.44 to 4.64

[a]Mean difference is significant at the .05 level.
[b]Adjustment for multiple comparisons: Bonferroni correction.
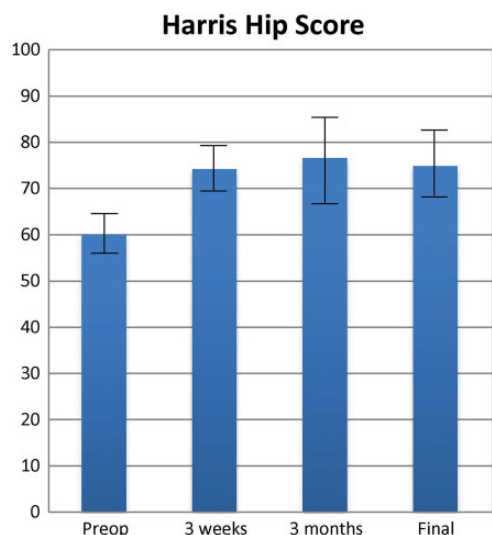

Figure 5. Harris Hip Scores (with 95% CI) before and after the procedure.

TABLE 5
Harris Hip Score Descriptive Statistics in 29 Patients

Time Point	Mean	SD	95% CI
Before procedure	60.03	10.86	55.90 to 64.17
3 wk	74.15	12.04	69.57 to 78.74
3 mo	76.58	15.25	70.78 to 82.38
6 mo	74.83	17.15	68.30 to 81.35
18 mo	77.47	14.34	72.02 to 82.93

3 patients (10%) in the study group who continued to have pain were considered to have experienced treatment failure and subsequently underwent open debridement and repair of the abductor tendons at 6 weeks, 5 months, and 14 months after their initial procedures. All had resolution of pain after surgery and improved function.

DISCUSSION

The chronic symptoms of greater trochanteric pain syndrome are now recognized to be due to tendon degeneration secondary to repetitive microtrauma rather than an inflammatory bursal condition alone.[26] Consequently, measures aimed at minimizing inflammation are unlikely to address the problem of tendinosis.[18] Although nonsurgical measures should be considered first for the treatment of gluteal tendinopathy, currently no evidence-based protocol is available for the management of greater trochanteric pain syndrome.[26]

All of our patients with symptomatic greater trochanteric pain syndrome had confirmed tendinosis or low-grade partial-thickness tears. Although an abnormal finding, this condition can be found in asymptomatic individuals. In a 2004 study,[8] investigators performed MRI on patients with and without greater trochanteric pain and demonstrated that 8% of asymptomatic patients had findings consistent with an abductor tear. In 2008, Blankenbaker et al[3] reviewed 131 consecutive MRI studies of the pelvis (256 hips). Only 16 of the 256 hips were described as painful. The authors found that 88% of the hips with trochanteric pain had MRI findings of gluteal tendinopathy, whereas 50% of those without symptoms had findings of tendinopathy. All of our patients had symptomatic tendinosis or partial tears confirmed by MRI or CT arthrogram.

Multiple percutaneous techniques have been described in recent literature that are specific to the hip. Jacobson et al[15] compared percutaneous tendon fenestration with PRP injection for gluteal tendinosis. They studied 15 patients in each group and found no significant difference in summated pain scores at final follow-up between the 2 groups. At an average final follow-up of 92 days, 71% of patients in the needle fenestration group reported improvement versus 79% of patients in the PRP group. Similarly, Brennan et al[4] demonstrated noninferiority of dry needling versus cortisone injection in a noninferiority randomized clinical trial comparing 50 hips in 43 patients evaluated for 6 weeks. Fitzpatrick et al[11] published the 2-year results of leucocyte-rich platelet-rich plasma (PRP) treatment for gluteus and medius tendinopathy. Those investigators found that a single injection of PRP performed under ultrasound guidance resulted in greater improvement in pain and function compared with a single corticosteroid injection.

TABLE 6
Harris Hip Score One-Way Repeated-Measures Analysis of Variance[a]

Source		Type 3 Sum of Squares	df	Mean Square	F	Significance	Partial η^2
Time	Greenhouse-Geisser	5939.66	2.40	2475.87	13.10	<.01	0.32
Error	Greenhouse-Geisser	362.87	90.08	3.92	—	—	—

[a]Dashes refer to no value given.

TABLE 7
Harris Hip Score Pairwise Comparisons
With Preprocedural Scores (Based on
Estimated Marginal Means)

Time Point	Mean Difference[a]	SE	Significance[b]	95% CI
3 wk	−14.12	2.92	<.01	−23.01 to −5.23
3 mo	−16.54	3.54	<.01	−27.34 to −5.75
6 mo	−14.79	3.69	<.01	−26.02 to −3.56
18 mo	−17.44	2.80	<.01	−25.96 to −8.91

[a]Mean difference is significant at the .05 level.
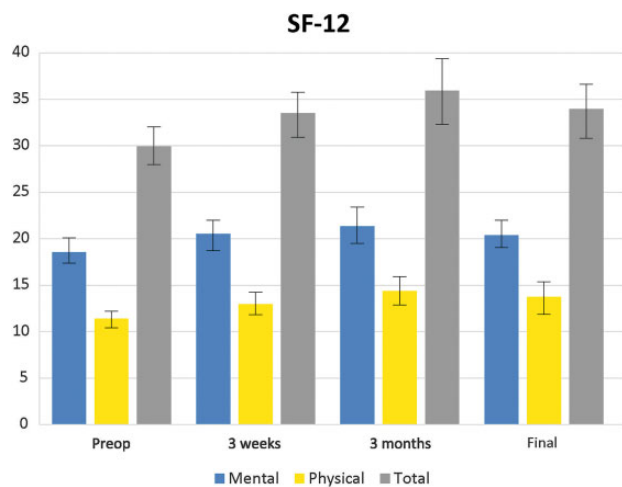[b]Adjustment for multiple comparisons: Bonferroni correction.

Figure 6. Mean scores for the 12-item Short Form Health Survey (SF-12) (with 95% CI) before and after the procedure.

TABLE 8
12-Item Short Form Health Survey
Descriptive Statistics in 29 Patients

Time Point	Mean	SD	95% CI
Before procedure	29.93	5.39	27.88 to 31.98
3 wk	33.50	5.68	31.34 to 35.66
3 mo	35.75	6.21	33.39 to 38.11
6 mo	34.09	6.47	31.62 to 36.55
18 mo	34.41	4.88	35.56 to 36.27

Recently, additional minimally invasive measures have become available to treat tendinopathy. PUT has been studied for chronic elbow tendinopathy.[2,28] It offers the benefit of precisely guided removal of tendinopathic tissue;

it can be done in a variety of practice settings; and it can be done under local anesthesia. PUT focuses on emulsification and debridement of angiofibroblastic tissues seen within tendinopathy or fasciopathy.

Surgical intervention for greater trochanteric pain syndrome has evolved from open surgery to endoscopic bursectomy and tendon repair. In a 2007 study,[1] patients with recalcitrant trochanteric bursitis underwent arthroscopic bursectomy. At final follow-up at an average of 26 months, the authors reported an improvement in mean VAS scores from 7.2 to 3.1 ($P = .0001$); further, HHS improved from a preoperative mean of 51 to 77 at final follow-up ($P = .022$). In our study, at final follow-up averaging 23 months (median, 20 months; range, 18-30 months), we saw an improvement in mean VAS scores from 5.86 to 2.82 ($P < .01$), HHS improved from a mean of 60.03 to 77.47 ($P < .01$), and total SF-12 scores improved from a mean of 29.93 to 34.41 ($P < .01$).

In our assessment of clinical outcomes in this study, we used the HHS primarily because it is a validated tool to measure hip symptoms.[31] Although the HHS is heavily weighted toward pain, it also measures function, activities, deformity, and range of motion. Our primary goal with this study was pain relief. The patients in this study had a mean score improvement of 17.44 points at final follow-up, which is greater than the minimal clinically important improvements of 16 points as reported by Singh et al.[29]

We also used a VAS to assess pain and found an overall mean difference of 3.04 points. According to Farrar et al,[9] a reduction of approximately 2 points represents a clinically important difference. The most marked difference in pain was seen in the first 12 weeks after treatment. Mean VAS scores slightly increased at final follow-up but were not significant.

Our last outcome measurement, the SF-12, is a subset of the SF-36 Health Survey, which is a generic measure of patients' self-reported health status; we found a statistically significant difference in pre- and postprocedural total SF-12 scores.

Limitations

This study was a case series, which inherently means there is a lack of a control group. We did not compare ultrasound-guided PUT with open or arthroscopic bursectomy, which is the standard of care for patients who are surgical candidates. Although 19 patients had physical therapy before the procedure at some point for greater trochanteric pain syndrome, none of our patients underwent formal physical therapy after the procedure, which possibly could have improved their results.

TABLE 9
12-Item Short Form Health Survey One-Way Repeated-Measures Analysis of Variance[a]

Source		Type 3 Sum of Squares	df	Mean Square	F	Significance	Partial η^2
Time	Greenhouse-Geisser	550.63	4.00	137.66	9.80	<.01	0.26
Error	Greenhouse-Geisser	1573.36	112.00	14.05	—	—	—

[a]Dashes refer to no value given.

TABLE 10
12-Item Short Form Health Survey Pairwise Comparisons
(Based on Estimated Marginal Means)

Time Point	Mean Difference[a]	SE	Significance[b]	95% CI
3 wk	−3.571	0.89	<.01	−6.28 to −0.86
3 mo	−5.821	1.03	<.01	−8.96 to −2.68
6 mo	−4.158	1.07	.01	−7.42 to −0.90
18 mo	−4.483	1.03	<.01	−7.63 to −1.33

[a]Mean difference is significant at the .05 level.
[b]Adjustment for multiple comparisons: Bonferroni correction.

Another limitation of this study was the relatively short-term follow-up. We saw a slight increase in pain scores and decrease in HHS scores after 3 months, and we cannot definitively say treatment outcomes will be sustained long term.

CONCLUSION

We believe that our study is the first prospective evaluation of ultrasound-guided PUT in the hip for the treatment of gluteal tendinopathy using validated outcomes questionnaires. Our patients showed an early improvement in pain and function, and no complications were noted.

This new procedure appears to be an effective and safe option for gluteal tendinopathy and is a valid option for patients who do not want to undergo surgical intervention. The procedure can be done in an outpatient setting under local anesthesia and is well tolerated. It is covered by insurance as a coded procedure, as opposed to PRP injection, which is usually a self-pay treatment, and the risks of open and arthroscopic surgery are avoided.

ACKNOWLEDGMENT

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