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RESEARCH ARTICLE

Ultrasound-guided Dextrose Prolotherapy for Refractory Piriformis Syndrome: A Retrospective Study

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ABSTRACT

Objective: Piriformis syndrome is a neuromuscular condition characterized by sciatic nerve compression by the piriformis muscle, resulting in buttock pain radiating to the posterior thigh. While physical therapy and corticosteroid injections are commonly used, treatment-refractory cases remain challenging. Dextrose prolotherapy is a regenerative technique gaining interest, but its efficacy in piriformis syndrome is not well established.

Materials and Methods: This retrospective study included 43 patients diagnosed with piriformis syndrome based on clinical criteria, including a positive FAIR test and at least one additional provocative maneuver. Patients received three sessions of ultrasound-guided injections of 5% dextrose (1 mL per site, 5 mL total) targeting the piriformis musculotendinous junction at 3-week intervals. Pain and functional status were assessed at baseline, 1-month, and 3-month follow-ups using the visual analog scale (VAS) and oswestry disability index (ODI). Patient satisfaction and adverse events were also recorded.

Results: Mean VAS scores decreased from 7.6 to 2.3 ($p<0.001$), and median ODI scores improved from 48 to 20 over three months ($p<0.001$). Eighty-eight percent of patients reported satisfaction with the treatment. No major complications were observed; minor adverse events were mild and self-limiting.

Conclusion: Ultrasound-guided dextrose prolotherapy significantly reduced pain and improved function in patients with refractory piriformis syndrome. These findings support its role as a minimally invasive treatment option, warranting further prospective studies.

Keywords: Dextrose, piriformis syndrome, prolotherapy, ultrasound-guided injections, sciatic pain

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INTRODUCTION

Piriformis syndrome is a neuromuscular disorder caused by compression or irritation of the sciatic nerve by the piriformis muscle, leading to buttock pain radiating to the posterior thigh, often mimicking sciatica. While the exact mechanisms are still unclear, inflammation, muscle spasm, and hypertrophy of the piriformis muscle are thought to contribute to sciatic nerve entrapment.[1,2] The piriformis muscle originates from the anterior sacrum (S2–S4) near the sacroiliac joint and inserts on the greater trochanter of the femur.[1]

Essentials for the diagnosis are tenderness over the muscle, positive provocative tests like Lasègue's and FAIR (flexion, adduction, internal rotation) tests, and buttock pain extending along the sciatic nerve route that worsens with hip flexion. The FAIR test, which reproduces pain through hip positioning, is highly sensitive for detecting sciatic nerve irritation by the piriformis muscle.[3] Advanced cases may present with gluteal muscle atrophy.[4,5]

Standard treatments include nonsteroidal anti-inflammatory drugs (NSAIDs), physical therapy, and corticosteroid injections. However, regenerative and proliferative injection therapies, such as dextrose prolotherapy, are gaining attention. Prolotherapy involves injecting proliferant agents, like dextrose, to stimulate controlled inflammation and promote repair of damaged connective tissues.[6,7]

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Prolotherapy has shown efficacy in musculoskeletal conditions like tendinopathies and various spinal conditions—sacroiliac joint dysfunction and instability in particular—where a satisfactory proportion of the patients achieved clinically meaningful functional gains.[6,8] Despite these findings, the efficacy of prolotherapy in piriformis syndrome is underexplored. Prolotherapy may offer a cost-effective, minimally invasive option for chronic pain management targeting the piriformis musculotendinous junction, which has limited vascular supply.[9] This study evaluates the efficacy of dextrose prolotherapy in patients with piriformis syndrome refractory to conservative treatments.

MATERIALS and METHODS

Study Design

This retrospective study analyzed hospital records of patients treated between April 1, 2022, and April 1, 2025, at a single tertiary physical medicine and rehabilitation center. University of Health Sciences, Istanbul Kanuni Sultan Suleyman Training and Research Hospital Ethic Commitment approved the protocol (ID: 2022.03.78) on 28/03/2022, and informed consent was waived due to the retrospective design, with all data de-identified to protect patient confidentiality. The study was conducted in accordance with the Declaration of Helsinki.

Participants

Forty-three patients with chronic piriformis syndrome were included, based on prior studies of injection therapies, to achieve sufficient statistical power to detect meaningful changes in pain and function (3). Inclusion criteria were: (1) age 18–65 years; (2) physiatrist-diagnosed piriformis syndrome via clinical findings, including a positive FAIR test, tenderness at the piriformis muscle, and at least one additional provocative test (one of Lasègue's, Freiberg's, Beatty's, or Pace's maneuver);[10,11] (3) symptoms persisting for more than 3 months despite conservative treatments; and (4) complete records for ultrasound-guided dextrose prolotherapy with pre-treatment, 1-month, and 3-month follow-up evaluations.

Baseline data included age, sex, body mass index (BMI), symptom duration, and functional status. To minimize selection bias, patients were systematically selected by sorting records chronologically by treatment date and including every third eligible patient. Exclusion criteria included lumbar disc herniation (confirmed by magnetic resonance imaging), prior lower back or hip surgery, trauma to the lumbar/gluteal region, recent injection therapy applied to the piriformis region (within 6 months), cognitive impairment, lumbosacral radiculopathy, or significant systemic metabolic diseases (uncontrolled diabetes, hypertension, cardiac failure, active inflammatory conditions).

Intervention

Patients received ultrasound-guided dextrose prolotherapy targeting the piriformis musculotendinous junction and enthesis, using a low-frequency curvilinear transducer (1–7 MHz) operated by a physiatrist trained in musculoskeletal ultrasound. The treatment solution consisted of 5% dextrose, with 1 mL injected per point across 5 sites (total 5 mL per session), targeting areas of maximum tenderness around the musculotendinous junction. Injections were administered at 3-week intervals for three sessions (9 weeks total). Patients continued standard exercises (piriformis stretching, core stabilization) post-injection to support recovery.

Outcome Measures

Pain levels were measured using the Visual Analog Scale (VAS), a widely recognized tool for quantifying pain intensity.[12] This scale ranges from 0 to 10, where 0 represents no pain and 10 signifies the worst imaginable pain. Patients were asked to rate their pain based on their subjective experience, providing a straightforward and reliable metric for assessing pain severity.

Functional disability was assessed using the oswestry disability index (ODI), a validated questionnaire designed to evaluate the impact of pain on daily functioning.[13] The ODI consists of 10 domains—pain intensity, lifting, self-care, walking, sitting, sexual function, standing, social life, sleep quality, and travel—each scored on a 0–5 scale. The total score is expressed as a percentage (0–100%), with higher scores indicating greater disability. This comprehensive tool captures the multidimensional impact of pain on patients' lives.

Assessments occurred at baseline, 1-month, and 3-month follow-ups. Patient satisfaction was recorded once at the 3-month follow-up as a secondary outcome, rated as "satisfied" or "not satisfied" based on self-reported symptom relief.

Data Collection and Analysis

Data were extracted by the principal investigator, blinded to outcomes during extraction to reduce bias. Descriptive statistics included means±standard deviations for normally distributed variables and medians (interquartile range) for non-normal variables, assessed via the Shapiro–Wilk test. Repeated measures ANOVA with post-hoc Bonferroni tests analyzed normally distributed data, while the Friedman test with Wilcoxon signed-rank tests evaluated non-parametric data. Missing data were addressed using listwise deletion, with sen-

Table 1. Baseline characteristics of participants

Characteristic	Value
Age (years, mean±SD)	47.6±9.2
Sex (female/male, n)	28/15
BMI (kg/m², mean±SD)	26.3±3.4
Symptom duration (months, median [IQR])	6 [4–12]
Baseline VAS (mean±SD)	7.6±1.1
Baseline ODI (%, median [IQR])	48 [44–54]

SD: Standard deviation; BMI: Body mass index; IQR: Interquartile range; VAS: Visual analog scale; ODI: Oswestry disability index

sitivity analyses to assess impact. Statistical significance was set at p<0.05, and analyses were conducted using IBM SPSS Statistics version 25.0 (Armonk, New York, IBM Corp.).

RESULTS

Of the 67 patients initially screened for eligibility, 43 patients met the inclusion criteria and were included in the final analysis. The participants included 28 females (65%) and 15 males (35%), with a mean age of 47.6±9.2 years (range: 28–62 years). The mean body mass index was 26.3±3.4 kg/m², with 49% classified as overweight and 14% as obese. The right side was more commonly affected than the left (58% vs. 42%). The median symptom duration before prolotherapy treatment was 6 months (IQR: 4–12 months, range: 3–24 months). At baseline, participants reported severe pain with a mean VAS score of 7.6±1.1 (range: 5–10) and significant functional disability with a median ODI score of 48% (IQR: 44–54%, range: 38–62%). Complete baseline characteristics are presented in Table 1.

Pain severity demonstrated statistically significant improvement over the study period (p<0.001). Mean VAS scores decreased from 7.6±1.1 at baseline to 2.5±1.0 at the 1-month follow-up, representing a mean reduction of 5.1 points (67% improvement). This improvement was sustained at the 3-month follow-up, with mean VAS scores of 2.3±0.9, corresponding to a total mean reduction of 5.3 points (70% improvement) from baseline. Pain reduction was statistically significant from baseline to both 1-month (p<0.001) and 3-month (p<0.001) follow-up points. No statistically significant change was observed between the 1-month and 3-month assessments (p=0.12), indicating sustained therapeutic benefit.

Functional status showed parallel improvements to pain scores. ODI scores improved significantly over time (p<0.001), decreasing from a median of 48 (IQR: 44–54) at baseline to 22 (IQR: 18–26) at the 1-month follow-up, representing a median improvement of 26 points (54%). At the 3-month follow-up, the median ODI score was 20 (IQR: 16–24), corresponding to a total median improvement of 28 points (58%) from baseline. Similar to pain outcomes, post-hoc analyses revealed significant functional improvements from baseline to both 1-month (p<0.001) and 3-month (p <0.001) follow-up, with no statistically significant change between the two follow-up time points, confirming sustained functional recovery. The complete pain and disability outcome data are presented in Table 2.

Patient satisfaction rates were high, with 38 of 43 patients (88%) reporting satisfaction with the treatment outcome at the 3-month follow-up. The 5 patients (12%) who reported dissatisfaction had poor improvements in both pain and functional outcomes.

Pairwise comparisons between time points demonstrated that the majority of improvement occurred between baseline and the 1-month assessments, with smaller additional gains observed between the 1-month and 3-month follow-up that did not reach statistical significance. This pattern suggests that maximal therapeutic benefit is achieved relatively early in the treatment course and is subsequently maintained. Detailed statistical comparisons with confidence intervals are provided in Table 3.

The treatment was well tolerated, with an excellent safety profile. No major complications, infections, or serious adverse events were reported during the study period. Minor adverse events were documented in 25 patients (58%), all of which were mild and self-limiting. The most common adverse event was mild injection site pain, occurring in 12 patients (28%) and resolving within 24–48 hours. Temporary

Table 2. Primary outcome measures over time

Outcome measure	Baseline (mean±SD / median [IQR])	1-month (mean±SD / median [IQR])	3-month (mean±SD / median [IQR])	p
VAS pain score (0–10)	7.6±1.1	2.5±1.0	2.3±0.9	<0.001
ODI score	48 [44–54]	22 [18–26]	20 [16–24]	<0.001

SD: Standard deviation; IQR: Interquartile range; VAS: Visual analog scale; ODI: Oswestry disability index

Table 3. Pairwise comparison (post-hoc analysis of changes between time points)

Comparison	VAS pain score (mean difference %95 CI)	ODI score (mean difference %95 CI)
Baseline vs 1-month	-5.1 (-5.6 to -4.6)***	-26 (-30 to -22)***
Baseline vs 3-month	-5.3 (-5.8 to -4.8)***	-28 (-32 to -24)***
1-month vs 3-month	-0.2 (-0.5 to 0.1)NS	-2 (-4 to 0)NS

Statistical significance: ***: p<0.001. VAS: Visual analog scale; ODI: Oswestry disability index; CI: Confidence interval; NS: Not significant (p>0.05)

Table 4. Reported adverse events during treatment period

Adverse event	n	%	Severity	Resolution time
Mild injection site pain	12	28	Mild	24–48 hours
Temporary stiffness	8	19	Mild	2–3 days
Minor bruising	5	12	Mild	5–7 days
No adverse events	18	42	N/A	N/A
Major complications	0	0	None	N/A

N/A: Not applicable

stiffness was reported by 8 patients (19%) and resolved within 2–3 days. Minor bruising at injection sites occurred in 5 patients (12%) and resolved within 5–7 days. Importantly, no patients discontinued treatment due to adverse events. Complete safety data are presented in Table 4.

DISCUSSION

Results of this study indicate that ultrasound-guided dextrose prolotherapy in refractory piriformis syndrome considerably improves function and reduces pain. The sustained improvements in VAS and ODI scores at 3 months suggest prolotherapy as a potential, minimally invasive treatment option.

These findings align with past studies that reported significant pain reduction with ultrasound-guided local anesthetic injections for piriformis syndrome, though our study uses dextrose to promote regenerative repair rather than temporary analgesia.[3,14,15] The sustained ODI improvements mirror benefits seen in other enthesopathies, such as lateral epicondylitis.[16] Prolotherapy likely stimulates fibroblast proliferation and collagen deposition, strengthening the piriformis musculotendinous junction and alleviating sciatic nerve irritation.[6,16] The precise injection protocol (5% dextrose, 1 mL per site, 3 sessions) and ultrasound guidance enhance reproducibility, similar to structured regimens in low back pain studies.[17]

The significant pain reduction observed (VAS improvement of 5.3 points) can be attributed to dextrose prolotherapy's well-established cellular mechanisms. Dextrose solutions act by dehydrating cells at the injection site, leading to local tissue trauma, which in turn attracts granulocytes and macrophages and promotes healing.[18] This cellular response is particularly relevant for piriformis syndrome, where chronic inflammation and tissue degeneration at the musculotendinous junction contribute to sciatic nerve compression.[19] The observed sustained improvement at 3 months in our cohort supports the hypothesis that dextrose-induced tissue regeneration provides long-lasting structural benefits rather than merely symptomatic relief.

The cost-effectiveness profile of dextrose prolotherapy also merits consideration in the current healthcare landscape. Unlike botulinum toxin injections, which require specialized storage and handling,[20,21] platelet-rich plasma injections, which are challenging to standardize and prepare,[22] or repeated corticosteroid injections that carry cumulative risks,[21] dextrose prolotherapy offers a simple, affordable intervention with minimal infrastructure requirements. The comprehensive safety profile, with no major complications among 43 patients, adds to the growing body of evidence supporting prolotherapy's safety in clinical practice.

While the diagnostic criteria for piriformis syndrome continue to evolve in the literature, our study employed well-established clinical diagnostic criteria, including the highly sensitive FAIR test and multiple provocative maneuvers, which have been validated in previous piriformis syndrome research.[1,2,4] The reliance on comprehensive clinical examina-

tion by experienced physiatrists, combined with our rigorous exclusion criteria that eliminated patients with lumbar disc herniation, lumbosacral radiculopathy, and other differential diagnoses, enhanced diagnostic specificity and strengthened the internal validity of our findings.[3] The consistency of treatment response across our cohort (91% achieving significant improvement) further supports the accuracy of our diagnostic approach and suggests that the clinical criteria used were sufficiently robust to identify patients who would benefit from this intervention.

Several limitations must be acknowledged in interpreting our findings. The retrospective design naturally limits causal inference and introduces potential selection bias, despite the pseudo-randomization process. The single-center design also limits generalizability, as treatment protocols and patient populations may vary across different healthcare settings. The absence of a control group prevents definitive attribution of improvements to prolotherapy versus natural history or concurrent exercises, and the lack of blinding may have influenced patient-reported outcomes, particularly satisfaction ratings. In addition, while the 3-month follow-up period demonstrates sustained improvement, a longer period may be necessary to assess the long-term durability of treatment effects or identify delayed complications.

An additional limitation of this study is the reliance on clinical diagnostic criteria without routine imaging for all patients. While our diagnostic approach employed well-established clinical tests, including the FAIR test and multiple provocative maneuvers, and we excluded patients with lumbar disc herniation confirmed by MRI, we did not perform routine imaging (such as MRI or ultrasound) for all patients to visualize piriformis muscle abnormalities directly. Future studies incorporating standardized imaging protocols could enhance diagnostic precision and provide additional morphological data to complement clinical findings.

This study represents the first systematic evaluation of dextrose prolotherapy specifically for piriformis syndrome, addressing a significant gap in regenerative medicine applications for peripheral nerve entrapment syndromes. The standardized ultrasound-guided injection protocol provides a reproducible framework that can be adopted by other practitioners and may serve as a foundation for future controlled trials. This provides a foundation for future research directions, including prospective randomized controlled trials comparing dextrose prolotherapy to established treatments, dose-response studies to optimize injection protocols, and long-term follow-up studies to assess the durability of treatment effects.

CONCLUSION

Ultrasound-guided dextrose prolotherapy appears to be a safe and effective treatment for refractory piriformis syndrome, significantly reducing pain and improving function. These results support its role as a minimally invasive alternative, with a structured injection protocol enhancing clinical outcomes. Prospective, controlled trials are needed to compare prolotherapy with other interventions and to refine treatment protocols.

Disclosures

Ethics Committee Approval: The study was approved by the University of Health Sciences, Istanbul Kanuni Sultan Suleyman Training and Research Hospital Clinical Research Ethics Committee (No: 2022.03.78, Date: 28/03/2022).

Informed Consent: Informed consent was waived due to the retrospective design, with all data de-identified to protect patient confidentiality.

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