Treatment of Gluteal Tendinopathy

A Systematic Review and Stage-Adjusted Treatment Recommendation

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Background: Gluteal tendinopathy is the most common lower limb tendinopathy. It presents with varying severity but may cause debilitating lateral hip pain.

Purpose: To review the therapeutic options for different stages of gluteal tendinopathy, to highlight gaps within the existing evidence, and to provide guidelines for a stage-adjusted therapy for gluteal tendinopathy.

Study Design: Systematic review; Level of evidence, 4.

Methods: We screened Scopus, Embase, Web of Science, PubMed, PubMed Central, Ovid MEDLINE, CINAHL, UpToDate, and Google Scholar databases and databases for grey literature. Patient selection, diagnostic criteria, type and effect of a therapeutic intervention, details regarding aftercare, outcome assessments, complications of the treatment, follow-up, and conclusion of the authors were recorded. An assessment of study methodological quality (type of study, level of evidence) was also performed. Statistical analysis was descriptive. Data from multiple studies were combined if they were obtained from a single patient population. Weighted mean and range calculations were performed.

Results: A total of 27 studies (6 randomized controlled trials) with 1103 patients (1106 hips) were included. The mean age was 53.7 years (range, 17-88 years), and the mean body mass index was 28.3. The ratio of female to male patients was 7:1. Radiological confirmation of the diagnosis was most commonly obtained using magnetic resonance imaging. Reported treatment methods were physical therapy/exercise; injections (corticosteroids, platelet-rich plasma, autologous tenocytes) with or without needle tenotomy/tendon fenestration; shockwave therapy; therapeutic ultrasound; and surgical procedures such as bursectomy, iliotibial band release, and endoscopic or open tendon repair (with or without tendon augmentation).

Conclusion: There was good evidence for using platelet-rich plasma in grades 1 and 2 tendinopathy. Shockwave therapy, exercise, and corticosteroids showed good outcomes, but the effect of corticosteroids was short term. Bursectomy with or without iliotibial band release was a valuable treatment option in grades 1 and 2 tendinopathy. Insufficient evidence was available to provide guidelines for the treatment of partial-thickness tears. There was low-level evidence to support surgical repair for grades 3 (partial-thickness tears) and 4 (full-thickness tears) tendinopathy. Fatty degeneration, atrophy, and retraction can impair surgical repair, while their effect on patient outcomes remains controversial.

Keywords: gluteal tendinopathy; lateral hip pain; treatment; systematic review

Tendinopathy of the gluteus medius or minimus tendon (including tears) is recognized as the primary cause of symptoms in patients with greater trochanteric pain syndrome.[43,47,48,54] Gluteal tendinopathy typically affects women in their fourth to sixth decades of life and manifests as chronic lateral hip pain and tenderness.[45,47] The degenerative progression of tendinopathy is common.[3,13] The cellular mechanism of tendon degeneration has been described by Bhabra et al,[2] distinguishing 4 grades of tendinopathy (Table 1). Tendinosis can progress to partial-thickness tears, while full-thickness tears occur with more advanced degeneration and can lead to tendon retraction and atrophic changes in the muscle belly.[34,35]

Modern imaging techniques are capable of depicting morphological changes that reflect the histopathological findings described. Both ultrasound and magnetic resonance imaging (MRI) have shown a reasonable ability to identify tendon abnormalities and may, at most, be limited in identifying and differentiating between tendinosis and partial-thickness tears.[19,56] Ultrasound has been reported to have a high sensitivity of 79% to 100% and a positive predictive value of 95% to 100% for gluteal tendon tears but requires a skilled practitioner.[23,56] MRI has been shown to be an accurate means of diagnosing gluteal tendon tears,

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TABLE 1
Grades of Progressive Tendon Degeneration[a]

	Description	MRI Findings	Histopathological Findings[b]
Grade 1	Bursitis	No or minimal changes within gluteal tendons	Wavy pattern of collagen fibers
Grade 2	Tendinopathy	Increased tendon signal on T1-weighted images and normal appearance on T2-weighted images	Tendinosis, angiofibroblastic hyperplasia, and disorganization and fragmentation of collagen fibers
Grade 3	Partial-thickness tear	Increased signal intensity on T2-weighted images	Depletion of functional tendon cells and breakdown of collagen and extracellular matrix
Grade 4	Full-thickness tear	Discontinuity of 1 or both gluteal tendons	Gross structural disruption and mechanical failure

[a]MRI, magnetic resonance imaging.
[b]From Bhabra et al.[2]

with a reported sensitivity of 73% and specificity of 95% for the presence of tears.[16] Grade 1 tendinopathy, associated with bursitis, displays no changes or only minimal changes within the gluteal tendons. Grade 2 tendinopathy is characterized by an increased signal of the tendon on T1-weighted MRI scans, while the fluid-sensitive image appears largely normal.[30] Grade 3 tendinopathy (partial-thickness tears) is diagnosed via increased signal intensity on T2-weighted MRI scans, and grade 4 tendinopathy (full-thickness tears) has discontinuity of one or both gluteal tendons[30] (Table 1).

As the abnormality is thought to have been previously underdiagnosed, greater recognition of the injury combined with an aging population will result in a higher incidence of gluteal tendinopathy and gluteal tendon tears requiring treatment.[1] A battery of treatment regimens has been described for the management of gluteal tendinopathy including topical or systemic analgesics, physical therapy and exercise programs, shockwave therapy (SWT), and injections (corticosteroids and platelet-rich plasma [PRP]). Surgical management is typically referred to as being "reserved for recalcitrant cases."[28]

Previous systematic reviews have not differentiated treatment outcomes based on the grade of tendinopathy, which may account for the broad range of treatment methods described.[11,20,28] The aim of this article was to review the current evidence for therapeutic options for each stage of gluteal tendinopathy, to highlight gaps within the existing evidence, and to provide guidelines for a stage-adjusted therapy for gluteal tendinopathy.

METHODS

Information Sources and Eligibility Criteria

A literature search including the databases of Scopus, Embase, Web of Science, PubMed, PubMed Central, Ovid MEDLINE, CINAHL, UpToDate, and Google Scholar was undertaken. The Joanna Briggs Institute Evidence-Based Practice Database and Trip Medical Database were assessed for current and unpublished trials (gray literature). Eligible articles contained at least 1 of the following search terms: "lateral hip pain" or "greater trochanteric pain syndrome" or "gluteus (gluteal) tendinosis (tendinopathy, tendinitis, tendon injury, tendon tear)" or "hip abductor (abductor, abductor tendon, hip abductor tendon) tendinosis (tendinopathy, tendinitis, tendon injury, tendon tear)" and "treatment" or "therapy" or "surgery" or "repair." We limited the results to studies on humans published in the English language. As we attempted to provide a contemporary framework for the treatment of this abnormality, we only considered research published between January 2000 and January 2020. The final search was performed on January 31, 2020. The full electronic search strategy is provided in Appendix Figure A1.

Study Selection

All records identified through the search of the databases were considered, and all abstracts were screened. Overall, 2 authors (A.L. and J.F.) were involved in the study selection. A third author (J.M.O.) was available to consider inclusion in the event of a dispute. Duplicates were removed.

Retrospective and prospective study designs were accepted. Case series and case reports with <10 participants were dismissed from further analysis. Review articles were not considered, but reference lists from identified review articles were screened manually for additional records not revealed via the database search. Only full-text articles were included. For cases in which only the abstract had been published, we contacted the study authors to retrieve a full-text version of the research.

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TABLE 2
Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
• Articles reporting treatment options for gluteal tendinopathy • Human studies • Original research • Published between January 2000 and January 2020 • Minimum sample size of 10 participants	• Non–English language studies • Full text not available • Animal studies and in vitro experiments • Single-case reports • Case series with <10 participants • Review articles • Trial registrations • Prior total hip replacement on affected side • Concomitant surgical interventions

Studies that used the terms "greater trochanteric pain syndrome" or "lateral hip pain" were accepted for review to identify all articles that address the aims of this review. As this review focused on treatment options for primary gluteal tendon injuries, full-text articles reporting treatment options for greater trochanteric pain syndrome without specifying the underlying abnormality were removed from further analysis. Gluteal tendon abnormalities after total hip replacement were not considered in this analysis. Articles on surgical treatment options were discarded if participants underwent any additional surgical interventions at the same time, as this would impede an assessment of the treatment effect of the intervention on the primary injury (eg, studies in which abductor tendon repair was always accompanied by arthroscopic surgery of the ipsilateral hip). A thorough list of the inclusion and exclusion criteria is provided in Table 2.

Data Items and Data Collection

Data extraction was performed by one of the authors (A.L.). Descriptive data (sample size, sex, age, body mass index, laterality), stage of the tendon disease (grades 1-4 tendinopathy), patient selection (inclusion and exclusion criteria), diagnostic criteria (clinical, radiological), duration of symptoms, previous treatment, type and effect of the therapeutic intervention, details about aftercare, mode and time points of outcome assessments, complications of the treatment, follow-up, and conclusion of the authors were recorded. The study type, level of evidence (LoE; according to the Oxford Centre for Evidence-Based Medicine), performance of a power analysis, treatment allocation, and blinding were also assessed to evaluate the quality of the research.

Statistical Analysis

To minimize the risk of bias, the underlying LoE was considered when a synthesis of the results was carried out. Frequency-weighted means were assigned to patient age, preoperative duration of symptoms, and postoperative follow-up. Data from multiple studies were combined if they were obtained from a single patient population (eg, reporting of 2 different follow-up times of a single patient population). Studies were excluded from weighted mean and range calculations in the case of missing values. The remainder of the statistical analysis was descriptive.

RESULTS

Study Selection

A total of 659 results were obtained via the electronic search strategy. Reference screening of the review articles revealed 3 additional articles that met our inclusion criteria. In 5 studies, full-text versions of eligible abstracts were not available. Our attempt to liaise with the abstract authors failed in 3 cases, while the 2 remaining abstracts were conference papers/abstracts with no full-text version published.

A full-text review was conducted for 57 articles. Of these, 6 were removed because they reported additional arthroscopic procedures on the hip. Moreover, 2 articles were removed for an inadequate number of participants not evident on the abstract review. There were 22 studies reporting treatment options for greater trochanter pain syndrome without specifying the underlying abnormality, disqualifying them from this analysis. Thus, 27 articles were considered for this review.[¶] A PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram outlining the systematic search process is shown in Figure 1.

Study Characteristics

The 27 studies included 6 randomized controlled trials[4,10,25,26,33,42] (LoE 1b); the remaining 21 studies consisted of case-control studies (LoE 3),[50] and case series (LoE 4).[#]

Descriptive Data

The total sample size was 1103 patients (1106 hips). The individual studies had 11 to 204 participants. The overall mean age (sample size adjusted) was 53.7 years (range, 17-88 years), and the mean body mass index (14 studies[**]) was 28.3 (range, 19.4-40.2). One study excluded male participants[22]; for the remaining studies, the female-to-male sex ratio was calculated as 7:1. Information on laterality was provided in 7 studies,[9,10,29,33,38,50,53] with 54.3% of left hips treated. Table 3 shows a summary of the descriptive data.

Patient Selection (Inclusion and Exclusion Criteria)

Within the studies, the inclusion criteria most commonly consisted of a clinical diagnosis of the disease (see Diagnosis section), with a duration of symptoms of >12 weeks. All

[¶]References 4, 8-10, 14, 17, 18, 21-23, 25, 26, 29, 31-33, 36-42, 50, 51, 53, 55.
[#]References 8, 9, 14, 17, 18, 21-23, 29, 31, 32, 36-41, 51, 53, 55.
[**]References 4, 10, 18, 21, 22, 25, 26, 29, 31, 36, 38, 40, 42, 53.

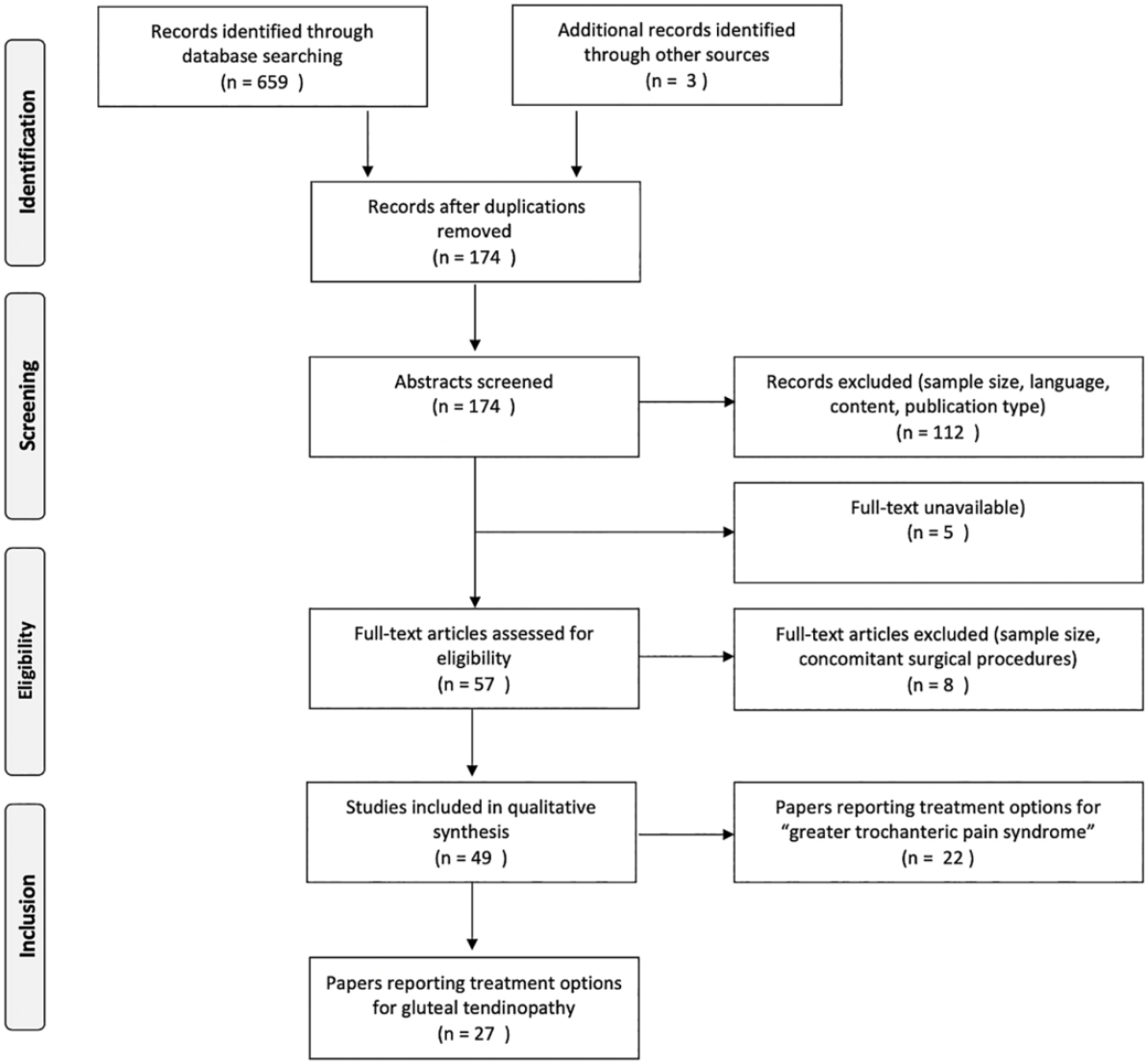

Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram.

studies reported that radiological confirmation of the clinical diagnosis was performed using ultrasound and/or MRI. All surgical intervention studies required "failed nonoperative treatment" for study inclusion, with failure being assumed if symptoms were not controlled after rest, analgesics/nonsteroidal anti-inflammatory drugs, physical therapy, and single or multiple injections (typically corticosteroids or occasionally PRP) over a time period of typically 3 to 6 months.

Hip osteoarthritis and history of trauma or previous surgery to the ipsilateral hip joint were among the common exclusion criteria, together with concomitant lower back pain and/or sciatica as well as systemic inflammatory or neurological disorders. Local corticosteroid injections (CSIs) within the previous 3 months or a certain tear size (full-thickness tears) were exclusion criteria found in articles reporting nonoperative treatment measures.

Duration of Symptoms and Previous Treatment

The overall mean duration of symptoms (20 studies[††]) for all treatment groups was 26.2 months, while patients undergoing surgery experienced symptoms for a mean of 32.0 months before their surgical treatment. Previous treatment (20 studies[‡‡]) consisted of analgetics alone in 1 study,[4] nonoperative treatment not further specified in 4 studies,[18,32,38,55] nonoperative treatment including physical therapy in 3 studies,[33,36,41] and nonoperative treatment including physical therapy and CSIs in 12 studies.[§§] The absence of previous treatment was stated in 1 study.[42]

[††]References 8-10, 14, 17, 18, 21-23, 25, 26, 31, 38-40, 42, 50, 51, 53, 55.

[‡‡]References 4, 9, 10, 14, 17, 18, 21-23, 29, 31-33, 36, 38, 40-42, 50, 53, 55.

[§§]References 4, 9, 14, 17, 21-23, 29, 31, 40, 50, 53.

TABLE 3
Patient Characteristics[a]

	Value
No. of patients/hips (range per study) (27 studies/1103 patients)	1103/1106 (11-204)
Age, y (27 studies/1103 patients)	53.7 (17-88)
Body mass index (14 studies/863 patients)	28.3 (19.4-40.2)
Sex ratio, female:male, n (24 studies/989 patients)	7:1
Laterality, right/left, % (7 studies/256 patients)	45.7/54.3
Symptom duration, mo	
Overall (20 studies/1039 patients)	26.2 (6-49)
Surgical studies only (12 studies/573 patients)	32.0 (11.7-49)

[a]Data are shown as mean (range) unless otherwise indicated.

Diagnosis

The clinical diagnosis was established with the presence of lateral hip pain (pain with walking, stair climbing, or lying on the affected side) combined with tenderness on palpation over the greater trochanter in almost every study. Additional clinical signs or provocative tests such as the Trendelenburg sign, resisted hip abduction, or the flexion–abduction–external rotation test were also frequently applied, while a confirmatory local injection was rarely performed for establishing the diagnosis. Radiological examinations were consistently carried out in all studies, with MRI being the diagnostic tool most commonly used (16 studies[|||]). Sonography was the preferred imaging technique in 6 studies,[10,23,32,33,36,39] MRI and sonography were used in 3 studies,[25,26,37] and MRI or sonography was used in 2 studies.[4,14]

Outcome Measures

A variety of outcome measures was used across the included studies to assess treatment success. Pain was most commonly assessed using a visual analog scale (VAS; 16 studies[¶¶]) or numeric rating scale (NRS; 2 studies[10,42,51]). Common patient-reported outcome measures (PROMs) were the modified Harris Hip Score (mHHS; 9 studies[##]), Harris Hip Score (HHS; 8 studies[14,18,21,22,31,38,41,50]), Oxford Hip Score (6 studies[8,9,17,21,22,31]), 12-Item Short Form Health Survey (SF-12; 5 studies[4,21,22,31,50]), Hip Outcome Score (HOS; 4 studies[29,37,40,50]), global rating of change scale (4 studies[21,22,31,42]), 36-Item Short Form Health Survey (SF-36; 3 studies[8,9,17]), and Patient Acceptable Symptom State (3 studies[4,25,26]). Rarely used measures for the determination of outcomes were the Lower Extremity Functional Scale,[10,18] Nonarthritic Hip Score,[29,53] and Merle D'Aubigné–Postel score[17,55] in 2 studies each. The Oswestry Disability Index,[23] EuroQol-5 Dimensions,[42] Victorian Institute of Sport Assessment–Gluteal Tendon,[42] International Hip Outcome Tool (iHOT-33[37]/iHOT-12[50]), lateral hip pain questionnaire,[42] Lequesne index,[38] University of California Los Angeles activity scale,[14] or Western Ontario and McMaster Universities Arthritis Index[4] was used in 1 study each.

Patient satisfaction was reported in 12 studies[a] and was commonly determined using a Likert scale. Common functional outcome assessments were resisted hip abduction in 7 studies,[14,21,22,29,31,40,42] a 30-second single-leg stance test (3 studies[14,21,31]), a 6-minute walk test (2 studies[21,22]), or an evaluation of range of motion or gait abnormalities (Trendelenburg sign, limping; 6 studies[18,23,29,38,40,41]). The follow-up period ranged from 1.5 weeks to 100 months.

Treatment Options and Outcomes

Among the 27 studies considered in this review, the reported treatment options were physical therapy, injections (corticosteroids, PRP, autologous tenocytes) with or without needle tenotomy/tendon fenestration, SWT, therapeutic ultrasound, or surgical procedures such as endoscopic or open tendon repair (with or without tendon augmentation). Most of the studies reported a mixture of different grades of tendinopathy.[b] Few publications allowed for separate outcome assessments according to the stage of the disease in their results.[33,40,42] A summary of the studies and their results is provided in the Appendix Table A1 (available as Supplemental Material).

Physical Therapy. Physical therapy had been performed in 3 of 11 studies[9,33,36] reporting nonoperative treatment measures before the treatment of interest was initiated, while this was routinely the case in studies reporting surgical treatment modalities.[c] Mellor et al[42] (LoE 1b) investigated the effect of an exercise program (initial educating session, followed by 14 individual sessions over 8 weeks with a registered physical therapist) on hip pain intensity and patient satisfaction measured using the global rating of change scale. Greater total improvement and lower pain intensity were found 8 weeks after initial treatment for gluteal tendinopathy compared with a single CSI at baseline or a wait-and-see approach. No difference in pain intensity could be detected at any other time points. The patient-perceived success rate of the exercise program at 12 months from baseline was 78.6%. This was significantly higher than was the patient-rated success rate for a CSI or the wait-and-see approach. Interestingly, pain data showed a different effect profile at 52 weeks, with no difference seen between the exercise group and the CSI group.

Injections (With or Without Needle Tenotomy/Tendon Fenestration). Mellor et al[42] (LoE 1b) found clinically important (change in NRS score <2) pain relief after a single CSI lasted up to 52 weeks compared with baseline values. Patient outcomes measured using the mHHS peaked at 6 weeks after a single CSI according to data published by Fitzpatrick et al[25,26] (LoE 1b) and thereafter declined. However, the mHHS scores obtained from this

[|||]References 8, 9, 17, 18, 21, 22, 29, 31, 38, 40-42, 50, 51, 53, 55.
[¶¶]References 4, 8, 9, 14, 17, 22, 23, 29, 31, 33, 36, 38, 39, 42, 50, 53.
[##]References 4, 23, 25, 26, 29, 37, 40, 50, 53.

[a]References 8, 9, 14, 18, 21, 22, 29, 36, 40, 41, 50, 53.
[b]References 4, 8-10, 14, 17, 18, 21-23, 25, 26, 29, 31-33, 36-39, 41, 50, 51, 53, 55.
[c]References 4, 14, 17, 21-23, 29, 31, 40, 50, 53.

population at 52 and 104 weeks from baseline were at the same level as those at the 6-week mark and were significantly higher than were baseline values.

There were 2 studies by Fitzpatrick et al[25,26] (data obtained from a single patient population) that compared the outcomes (mHHS, Patient Acceptable Symptom State) of a single leukocyte-rich PRP (LR-PRP) injection to those of a single CSI (LoE 1b). They reported favorable 2-year outcomes of a single LR-PRP injection for patients with grades 1, 2, and 3 tendinopathy. While an equal effect size for LR-PRP and corticosteroids was seen up to the 6-week follow-up, the mHHS score was significantly higher in the LR-PRP group at 12 weeks and thereafter from baseline. An ongoing benefit was observed over a period of 2 years. The effect of a single CSI declined at 24 weeks.

Lee et al[37] reported favorable results for a single PRP injection with concomitant needle tenotomy of the gluteal tendons. Statistically significant and clinically important (greater than the minimal clinically important difference) improvements in mHHS, HOS, and iHOT-33 scores were shown over a mean follow-up time of 19.7 months.

All the aforementioned studies reported a single ultrasound-guided application of nonactivated LR-PRP with a preparation centrifugal force of 1050*g* to 1250*g* and a spin time of 14 to 17 minutes. Unfortunately, an isolated review of the results in patients with higher grade tendinopathy (grade 3/partial-thickness tears) could not be conducted from these publications.

According to Jacobson et al[33] (LoE 4), a PRP injection or sonography-guided tendon fenestration led to an alleviation of pain in patients with grades 1 and 2 tendinopathy. No statistical difference between the 2 treatment methods was seen. However, owing to the short follow-up of only 2 weeks and the long time frame required to reach the full effect of PRP, the results of this study were not deemed sufficient to support its use. A retrospective cohort analysis by the same group concluded that 54% of patients treated using tendon fenestration for grade 2 or 3 tendinopathy of the gluteus medius or minimus tendon reported marked improvement of their symptoms.[32] The treatment effect (improvement of mHHS scores) of a single PRP injection plus tendon fenestration reported by Lee et al[37] was not superior to the effect of a single PRP injection alone shown by Fitzpatrick et al.[26]

Bucher et al[9] investigated the effect of autologous tenocyte injections on clinical outcomes in patients with grade 1, 2, or 3 tendinopathy of the gluteal tendons. They showed significantly improved Oxford Hip Score, VAS, and SF-36 scores at 12 months from baseline, and clinical outcomes were sustained to 24 months. Of 12 patients, 3 reported donor-site discomfort at the patellar tendon, while no other complications were reported with this technique.

SWT and Therapeutic Ultrasound. SWT was reported as effective in reducing lateral hip pain from grades 1 to 3 gluteal tendinopathy in studies published by Carlisi et al[10] (LoE 1b) and Seo et al[51] (LoE 4). Pain levels were significantly lower at 1 week compared with baseline, and significant improvement was maintained over 27 months in the latter study, even though patient-reported success was rated as "good" or "excellent" in only 56% after that period of time. Carlisi et al showed that SWT achieved better pain reduction compared with therapeutic ultrasound at short-term and midterm follow-up. However, no significant benefit in functional scores between the groups could be detected. Seo et al assessed the tendon abnormality and outcome for each patient. Of 12 patients, 2 were diagnosed with a partial tear (grade 3) of the gluteus medius. One of them was regarded as having treatment failure at intermediate-term follow-up, and the second patient achieved a fair outcome at a mean follow-up of 27 months with an NRS score of 4 (baseline NRS score, 6; overall mean ± standard deviation NRS score at final follow-up, 3.3 ± 3.0). Even though the small numbers do not allow for generalization, there are concerns as to whether this treatment option is suitable for partial-thickness tears. No standard protocol for SWT in gluteal tendinopathy has been established according to the literature screened in this review.

Surgery. Overall, 16 studies reported on outcomes after a surgical intervention for gluteal tendinopathy (LoE 1b[4] and LoE 3[50] in 1 study each; LoE 4 in 14 studies).[d] Endoscopic or open bursectomy with or without iliotibial band (ITB) release showed promising results in the treatment of recalcitrant trochanteric bursitis.[4,12,15,46] Blakey et al[4] analyzed the effect of radiofrequency microdebridement as an adjunct to arthroscopic gluteal bursectomy and ITB release for grades 1 to 3 tendinopathy. Even though the treatment led to significant improvements in patients with recalcitrant gluteal tendinopathy, the addition of radiofrequency microdebridement showed no statistically significant additional benefit to arthroscopic bursectomy and ITB release in this small randomized controlled trial. Coulomb et al[14] found that debridement without repair only provided modest clinical results in patients with partial-thickness tears of the gluteal tendons and therefore recommended repair be considered in every case. Makridis et al[38] reported significantly improved outcomes (Lequesne index, HHS, disability) after open repair of grade 3 or 4 gluteal tendinopathy using suture anchors via a double-row technique and an average follow-up of 4.6 years. Patients with muscle atrophy had significantly lower functional scores. Good results for open repair of partial- and full-thickness tears were also found by Fearon et al[23] and Walsh et al.[55] Davies et al[18] reported overall high satisfaction after open repair, with postoperative improvements maintained over 5 years. The authors recommended the use of suture anchors be limited to the repair of small tears only, while they recommended transosseous fixation of larger tears, together with allograft augmentation, in severe cases.

Open tendon repair using synthetic augmentation was proposed for high-grade partial- and full-thickness tears by Ebert et al.[21] The synthetic ligament (ligament augmentation and reconstruction system [LARS]) was thought to provide additional mechanical strength and support to healing tissue, thereby minimizing retears. The reported results were encouraging, with good clinical and functional outcomes and meaningful improvements in PROM scores (96% patient satisfaction) at 12 months. The retear rate was 2.7%, and the overall complication rate was 6.3% (revision surgery in 1.8%). Bucher et al[8] and Huxtable et al[31]

[d] References 8, 14, 17, 18, 21-23, 29, 31, 38, 40, 41, 53, 55.

achieved excellent results using the same technique. No failure of tendon repair was reported with this technique, but 1 patient underwent revision for removal of the LARS interference screw, which caused local irritation.[8]

Endoscopic gluteal tendon repair was reported by Thaunat et al[53] and Hartigan et al.[29] Both achieved significant improvements in pain (VAS) and function (mHHS, HOS, Nonarthritic Hip Score). The follow-up time was 32 and 38 months, respectively. The reported failure rate of repair was 4.5%.[53] According to Saltzman et al,[50] no improvement in clinical retear rates, patient-reported outcomes, or pain was seen when a platelet-rich fibrin matrix (PRFM) was added to tendon repair, but improvements in iHOT-12 and SF-12 scores suggest that the PRFM might have a role in improving subjective outcomes of hip-specific and overall physical function (LoE 3).

Complication rates varied. Makridis et al[38] reported a surgical failure rate of 16%, while Walsh et al[55] reported a rate of only 5.6%. A thorough list of the complications reported in each study is provided in Appendix Table A1 (available as Supplemental Material).

Aftercare and Mean Follow-up Times

Overall, 24 studies[e] reported the type of aftercare. As for the nonoperative treatment options, rest or the avoidance of provoking activities was occasionally recommended in the first 2 weeks, but most patients were not given any restrictions during aftercare. Surgical intervention studies commonly recommended partial weightbearing in the first 6 weeks after open or endoscopic tendon repair.[14,17,18,21,29,31,40,50] Resisted exercises were mostly not allowed before 12 weeks postoperatively. Follow-up times were provided in all but 1 study.[10] The overall mean follow-up was 21.3 months (mean follow-up for surgical vs nonsurgical intervention studies, 26.0 vs 15.0 months, respectively).

DISCUSSION

This systematic review summarized the results of 27 articles that evaluated treatment options and outcome effects for gluteal tendinopathy. This review reflects the outcomes of 1103 patients (1106 hips) and aimed to provide a framework for the treatment of gluteal tendinopathy throughout the different stages of this disease. The evidence has been synthesized into a staged treatment recommendation (Table 4). Further scientific work is needed to enhance the evidence base supporting this proposed framework.

Body of Evidence for Low- to Moderate-Grade Gluteal Tendon Disease (Grades 1-2 Tendinopathy)

Only 1 study investigated the effectiveness of physical therapy for the treatment of low- to moderate-grade gluteal tendinopathy.[42] The therapeutic effect (pain, patient-reported success) of an 8-week exercise program was better than that of a wait-and-see approach over a 12-month period and showed better outcomes than did a single CSI. Patient satisfaction was significantly higher in the exercise group at 8 weeks as well as at 6 and 12 months from baseline. Pain levels showed a tendency toward better outcomes, in favor of exercise after 8 weeks. Even though a combined treatment regimen of physical therapy and corticosteroids seems commonly applied in daily practice, the available literature did not show any evidence for or against this treatment method.

CSIs allow for remarkable improvement in pain in the first 4 to 8 weeks (grades 1-3 tendinopathy; LoE 1b,[25,26,42] LoE 4[36]). Several studies agreed on a positive short-term effect of CSIs in GTPS papers,[6,44,49,57] but the therapeutic benefit was shown to usually last no longer than 3 to 6 months.[6,7,49] However, different articles reported significantly improved outcomes up to 104 weeks from baseline,[25,26,42] confirming a treatment effect for a single CSI after that time as well. Of note, the therapeutic response was less successful after structural abnormalities within the gluteal tendons had developed.[57] Outcome scores for a single CSI were significantly worse compared with a single PRP injection.[26] In addition, the potential deleterious effects of CSIs need to be taken into consideration. The available evidence therefore supports the use of a CSI for low- to moderate-grade tendinopathy only for short-term pain relief, while an LR-PRP injection achieves a good outcome up to 2 years.

Autologous tenocyte injections are supported by LoE 4 for low- and moderate-grade tendinopathy.[9] In addition, there is LoE 1b supporting the use of PRP for the treatment of low- to moderate-grade gluteal tendinopathy (grades 1 and 2).[25,26,33] The existing literature did not allow for the assessment of effect variability in different stages of the tendon disease. Especially in higher grade tendinopathy (grade 3), an isolated review of the results could not be conducted. There was no evidence supporting the use of PRP in grade 4 tendinopathy. The type of preparation, platelet concentration, activity of PRP (activated vs nonactivated), and frequency of applications have been acknowledged as contributing to the variability of the treatment effect.[24] Based on the available literature, a single ultrasound-guided application of nonactivated LR-PRP with a preparation centrifugal force of 1050*g* to 1250*g* and a spin time of 14 to 17 minutes should be used.

Needle tenotomy is often performed in conjunction with injections such as PRP, but data on the effect of percutaneous needle tenotomy (tendon fenestration) as a stand-alone treatment option are limited. Tendon fenestration showed similar effects on pain improvement compared to PRP (LoE 1b) within the first 2 weeks of application,[33] while the effect of a single PRP injection plus tendon fenestration was not superior to that of a single PRP injection alone over a longer follow-up period.[26,37] Therefore, well-designed studies evaluating the long-term efficacy of needle tenotomy versus PRP are needed to support its use in gluteal tendinopathy.

The use of SWT in gluteal tendinopathy is supported by LoE 1b. As with PRP treatment, the given literature did not allow a differentiation of its efficacy with different grades of

[e]References 8-10, 14, 17, 18, 21-23, 25, 26, 29, 31-33, 36-38, 40-42, 50, 53, 55.

TABLE 4
Treatment Recommendations[a]

Treatment	Recommendation[b]	LoE	Comments
Grades 1-2 tendinopathy			
PRP	+++	1b	• Large number of publications • Good intermediate-term results (2-y follow-up) • Clear instructions on preparation
SWT	++	1b	• High LoE • No standard protocol regarding total energy, energy per session, or No. of sessions available
Exercise	++	1b	• Higher patient satisfaction than single CSI after 12 mo (pain levels comparable with CSI) • Type and mode of exercising still need to be defined
CSI	++	1b	• Good short-term results • Effects usually do not last >3-6 mo • Therapeutic effect inferior to PRP
Endoscopic or open bursectomy with or without ITB release	++	4	• Good results in function and pain improvement • Long follow-up times shown • Complication rate of 8% • Low LoE
Autologous tenocyte injection	+	4	• Small numbers • Low LoE
Tendon fenestration	+/–	4	• Short-term data only (2 wk) • No long-term outcomes as stand-alone procedure • PRP plus tendon fenestration not superior to PRP alone
Trochanteric reduction osteotomy	–	4	High complication rate
Grade 3 tendinopathy			
Open or endoscopic tendon repair	++	4	• Large improvements in PROM scores • High patient satisfaction at long-term follow-up (5-y results) • Mean complication rate of 10% (4.5% revision surgery) • Endoscopic repair appears to have lower complication rates • Low LoE
PRP	+/–	1b	Uncertain, as no differentiation in outcome assessments performed
SWT	+/–	1b	Results inferior compared with grades 1-2 tendinopathy
Grade 4 tendinopathy			
Open tendon repair	+++	4	• Good clinical and patient-reported outcomes • Long follow-up times (up to 5-y results) • Transosseous fixation for large tears recommended and suture anchors for small tears • Complication rate of 10% (4.5% revision surgery)
Endoscopic tendon repair	+++	4	• Similar improvements in functional outcomes and patient satisfaction to open repair • Appears to result in fewer postoperative complications
Tendon augmentation	+++	4	• Good clinical and functional outcomes up to 24 mo • Comparative trials to unaugmented repair lacking

[a]CSI, corticosteroid injection; ITB, iliotibial band; LoE, level of evidence; PROM, patient-reported outcome measure; PRP, platelet-rich plasma; SWT, shockwave therapy.

[b]+++, treatment strongly supported by evidence; ++, treatment supported by evidence; +, some evidence supporting treatment but not recommended as first-line treatment; +/–, evidence not sufficient to support treatment; –, evidence suggesting avoidance of treatment.

degeneration. Overall, 2 articles[10,51] (LoE 1b and LoE 4, respectively) found good long-term results for grades 2 and 3 tendinopathy, but concerns arise as to whether this treatment option is suitable for grade 3 tendinopathy, as the only 2 patients reported with this stage of disease achieved a fair outcome or were regarded as having treatment failure. In addition, the lack of a standardized treatment protocol limits even further the applicability of SWT in the treatment of gluteal tendinopathy.

Evidence for surgical interventions in low-stage disease (grades 1 and 2 tendinopathy) consists mainly of LoE 4 studies. While overwhelming evidence supports nonoperative treatment in these stages of gluteal tendon disease, surgery in cases recalcitrant to other treatment methods appears to be a valuable management option. Soft tissue interventions such as endoscopic or open bursectomy with or without ITB release have shown promising results. Longitudinal or cross-shape splitting of the ITB did not have inferior outcomes when compared to Z-lengthening procedures at the level of the greater trochanter or at the supracondylar level.[12,15,46] The adjunct of radiofrequency microdebridement to arthroscopic bursectomy and ITB release did not enhance patient-reported outcomes (LoE 1b).[4]

Complication rates up to 8% have been reported for these soft tissue procedures,[50] while a series of trochanteric reduction osteotomy was found to have a 30% complication rate at 2-year follow-up.[27] Therefore, the surgical approach of trochanteric reduction osteotomy should not be encouraged.

Body of Evidence for Moderate- to High-Grade Gluteal Tendon Disease (Grades 3-4 Tendinopathy)

Several studies have supported the efficacy of surgery in treating gluteal tendinosis as well as partial- and full-thickness tears.[f] Surgical interventions are often referred to as "reserved for recalcitrant cases." This is reflected in a longer duration of symptoms before undergoing surgery, which averaged 32.0 months compared with 26.2 months across all treatment options. Because there is good evidence supporting the effectiveness of nonoperative measures in low-grade tendon disease (grades 1 and 2), surgery for "recalcitrant cases" may be a reasonable choice. There were 6 studies reporting on nonoperative therapy that included patients with partial-thickness tears in their analysis.[9,10,25,26,33,51] In 5 of these studies, outcome reporting did not allow for a differentiation of their results according to the disease stage, while 1 study[51] reported inferior outcomes for patients with grade 3 tendinopathy. Because none of the studies on nonoperative treatment results included patients with full-thickness tears, there is no evidence for the efficacy of nonoperative treatment measures in this stage of the tendon disease. Hence, surgery can be considered early in the course of grade 3 tendinopathy and should be recommended for symptomatic grade 4 tendinopathy.

[f]References 8, 17, 18, 22, 23, 31, 38, 40, 41, 50, 53, 55.

Recommendations for a surgical intervention were derived mostly from LoE 4 studies. Both open and endoscopic techniques are viable surgical approaches to repairing partial- or full-thickness abductor tendon tears in the hip. Open repair techniques resulted in large and clinically meaningful improvements in PROM scores and correspondingly high patient satisfaction at medium- to long-term follow-up.[8,17,21] Improvement was maintained over a 5-year period of time.[18] Transosseous fixation of larger tears was suggested, while suture anchors for small tears provided good outcomes.[18] Augmented hip abductor tendon repair demonstrated good clinical and functional outcomes up to 12 months.[8,21,22] Augmentation devices may provide a mechanism to protect the repair site while the tendon heals, similar to an abduction sling employed after rotator cuff repair,[21] but comparative trials involving validated PROMs and radiological scoring systems are lacking to date.

Endoscopic gluteal tendon repair achieved similar improved functional outcomes and patient satisfaction to that of open repair.[29,40,53] The mean complication rate of all surgical studies considered in this review was 10%, and revision surgery was performed in 4.5% of cases (mean follow-up, 27 months). Endoscopic repair appears to result in fewer postoperative complications including tendon repair. PROM scores, pain or clinical retears, and patient satisfaction did not improve by adding a PRFM to tendon repair.[50]

There has been conflicting evidence regarding the effect of fatty degeneration or gluteal muscle atrophy on patient outcomes. Thaunat et al[53] described a correlation between poor clinical results and the extent of fatty degeneration in gluteal tendon injuries. By contrast, fatty degeneration did not affect postoperative functional abilities in a study by Makridis et al.[38] However, patients with muscle atrophy had significantly lower functional scores. Ebert et al[22] found that the degree of fatty degeneration at the time of surgery was not associated with PROM scores or functional capacity before surgery or at 2 years after surgery. Bogunovic et al[5] reported that both a greater preoperative level of fatty degeneration and gluteal muscle atrophy were correlated with increased pain and decreased patient-reported function and satisfaction scores after endoscopic hip abductor tendon repair. A statistical link between full-thickness tears and muscle atrophy or fatty degeneration could not be confirmed in the literature.[52]

Treatment Recommendations

Table 4 summarizes the evidence and provides evidence-based treatment recommendations for the different stages of tendinopathy.

Our Preferred Treatment Method

In line with the recommendations in Table 4, our preferred treatment approach consists of a single LR-PRP injection for grades 1 and 2 tendinopathy, while endoscopic tendon repair (with or without augmentation) is our treatment method of choice for grade 4 tendinopathy. As for partial-

thickness tears (grade 3 tendinopathy), we lean toward a single PRP injection before opting for endoscopic tendon repair. Most importantly, we recommend that available treatment options be discussed in detail with patients and that decisions be made in conjunction with informed patients.

Limitations

The limitations of English-language literature and the time frame for publication (2000-2020) introduce a publication bias at the study level. The former was accepted given the costs associated with translation, and we adhered to research published over the past 2 decades to provide a contemporary framework. Of note, recognition and understanding of the disease have largely evolved in the past 20 years, and the number of publications before the time frame analyzed in this review is very limited. At the outcome level, bias could result in the form of reporting bias, as studies reporting unfavorable or indifferent outcomes are difficult to publish. The LoE of the eligible studies was limited. There were 6 randomized controlled trials (LoE 1b) included, while the remaining literature consisted of case series, case-control studies, or cohort studies (LoE 4). Unfortunately, all but 1 surgical intervention study belonged to the latter group. In addition to the low LoE, the output of this systematic review is impaired by the heterogeneity of the literature reviewed. This includes heterogeneity in the patient population, grading of tendinopathy, and reported outcome measures, impeding a direct comparison of the studies in the form of a meta-analysis.

Future Research

As for low-grade tendon disease (grades 1 and 2 tendinopathy), future research should address the lack of standardization in SWT and provide recommendations on, for example, total energy, energy per session, or number of sessions. High-quality research comparing SWT with PRP injections should also be encouraged. The role of physical therapy needs to be clarified, as there is evidence for the positive effect of exercise, while there are no treatment protocols that have proven its effectiveness.

Treatment options for partial-thickness gluteal tendon tears require further research. Established treatment methods for grades 1 and 2 tendinopathy need to confirm their efficacy in grade 3 tendinopathy, and higher level research is required for surgical interventions for this disease.

CONCLUSION

Gluteal tendinopathy is a degenerative process with major implications on patients' quality of life. Overall, 10% to 40% of patients with gluteal tendinopathy have unsuccessful nonoperative treatment.[55] As the treatment method of choice may change with deterioration of the tendon, early diagnosis of the stage of the disease and the initiation of a stage-adjusted therapy are crucial.

Nonoperative measures should be applied to treat grades 1 and 2 tendinopathy. According to the existing evidence, a single LR-PRP injection is a reasonable option. SWT shows promising results. Exercise improves patient satisfaction, while specific treatment protocols for SWT and physical therapy are lacking. Corticosteroids show good short-term outcomes, while the long-term effect is inferior to results obtained using PRP. Endoscopic or open bursectomy with or without ITB release is a valuable option in low-grade tendinopathy refractory to nonoperative treatment. The reported complication rates for these soft tissue interventions are low. Bone-remodeling procedures (trochanteric reduction osteotomy) should be discouraged.

Surgical interventions show favorable outcomes for the treatment of partial-thickness tears. The LoE across surgical intervention studies is low. The existing literature lacks sufficient evidence to provide strict guidelines for the nonoperative treatment of grade 3 tendon tears. Grade 4 tendinopathy (full-thickness tears) is suited to early surgical interventions. Fatty degeneration, atrophy, and retraction can impair reparability, but their effect on patient outcomes is controversial.

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APPENDIX

# ▲	Searches	Results
1	(gluteus or gluteal).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	8810
2	(tendinosis or tendinopathy or tendinitis or tendon injury or tendon tear).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	10835
3	lateral hip pain.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	122
4	greater trochanteric pain syndrome.mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	184
5	(hip abductor or hip abductor tendon).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	732
6	(treatment or therapy or surgery or repair).mp. [mp=title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	8983616
7	1 and 2	207
8	3 or 4 or 5 or 7	1081
9	6 and 8	550
10	limit 9 to (english language and full text)	91

Figure A1. Electronic search strategy for eligible studies.