Original Article

Superior Gluteal Reconstruction Results in Promising Outcomes for Massive Abductor Tendon Tears

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Purpose: To evaluate the 1-year outcomes of a small patient series following open gluteus medius/minimus repair with human dermal allograft incorporated into the repair construct using a double-row repair. **Methods:** Data from consecutive patients undergoing a superior gluteal reconstruction for massive, irreparable abductor tendon tears with severe tendon loss and atrophy by a single fellowship trained surgeon from January 2018 to May 2019 were collected and analyzed. Baseline demographic data and magnetic resonance imaging were collected preoperatively. Clinical outcomes including Hip Outcome Score—Activities of Daily Living (HOS-ADL), HOS—Sports Subscale (HOS-SS), modified Harris hip score (mHHS), international Hip Outcome Score-12 (iHOT-12), visual analog scale (VAS) pain, and VAS satisfaction were recorded at 1-year postoperatively. **Results:** A total of 8 patients underwent open superior gluteal reconstruction for severe hip abductor deficiency. The mean age and body mass index were 62.6 ± 7.3 years and 29.6 ± 5.3 kg/m^2, respectively. The majority of patients were female (N = 7, 87.5%). Three (37.5%) patients had undergone previous endoscopic gluteus medius repair and presented for revision surgery. All patients had full-thickness tears with gluteus medius and gluteus minimus involvement. Patients were evaluated at an average of 11.5 ± 1.7 months from the initial surgical intervention and reported a mean HOS-ADL of 82.9 ± 24.3, HOS-SS of 73.2 ± 37.3, mHHS of 83.6 ± 17.1, iHOT-12 of 63.9 ± 27.4, VAS Pain of 30.0 ± 23.1, and VAS Satisfaction of 87.1 ± 17.0. There was no evidence of retears in this patient cohort as defined by physical examination findings and/or corroborating magnetic resonance imaging. **Conclusions:** Superior gluteal reconstruction for massive, irreparable abductor tendon tears with severe tendon loss and atrophy is a technique that demonstrates promising 1-year postoperative outcomes in both primary and revision patients. **Level of Evidence:** Level IV, therapeutic case series.

Abductor tendinopathy of the hip has become an increasingly recognized cause of lateral hip pain and dysfunction and a major contributor to greater trochanteric pain syndrome. Many patients who have been previously diagnosed with trochanteric bursitis are now recognized to have abductor tendinopathy, which can be refractory to nonsurgical treatment.[1] Gluteus medius and minimus tendinopathy of the hip encompasses a broad spectrum of degenerative tendinopathy ranging from interstitial, partial-thickness tears to retracted, full-thickness tears.[2] Abductor tendon tears have been referred to as "rotator cuff tears of the hip," due to similarities of the gluteus medius and the gluteus minimus tears to supraspinatus and infraspinatus tears, respectively.[3,4] Magnetic resonance imaging (MRI) has shown to be an accurate imaging modality with excellent interobserver reliability for the diagnosis of gluteus medius and minimus tendinopathy and is now

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commonly used in clinical practice for the workup of lateral hip pain and dysfunction.[5-9] Endoscopic repair of gluteus medius tears has been well-established within the literature, and outcomes have been excellent with medium- to long-term follow-up.[10-13]

Despite promising results with primary repair of torn gluteus tendons, patients with increased fatty infiltration or muscular delamination, specifically in grade 3 and 4 tears (modified Goutallier–Fuchs classification), have reported worse functional outcomes following endoscopic repair.[14,15] For this reason, alternative treatments have been proposed, including muscle transfers, Achilles allograft procedures, and primary repairs with allograft augmentation. Muscle transfers have reported good-to-excellent early outcomes[16-20]; however, this nonanatomic procedure may have increased morbidity leading to reduced functional benefit, relegating it to a salvage procedure.[21,22] A few case series reporting the use of synthetic, allograft, and autograft tissue for augmentation or reconstruction have provided positive early results.[23-28] Suppauksorn et al.[29] proposed a superior gluteal reconstruction (SGR), which uses an acellular dermal allograft matrix for reconstruction of the massive, irreparable hip abductor tendon tear and is the senior author's technique of choice for large, irreparable gluteus medius tears.

The purpose of this study was to evaluate the 1-year outcomes of a small patient series following open gluteus medius/minimus repair with human dermal allograft incorporated into the repair construct using a double-row repair. We hypothesized that patients undergoing SGR would have favorable patient-reported outcomes (PROs) without evidence of clinical retears at 1-year follow-up.

Methods

Preoperative Evaluation and Clinical Indications

After we obtained institutional review board approval, clinical data were retrospectively retrieved from a prospectively maintained institutional surgical repository. Patients who underwent gluteus medius and/or minimum tendon repair with the technique of SGR done by a single fellowship-trained surgeon (S.J.N.) between December 2018 and August 2019 were identified. All patients were assessed by the senior author (S.J.N.) diagnosed with abductor tendon tear had symptoms of lateral hip pain, tenderness on palpation of the greater trochanter, weakness with resisted hip abduction, and findings on MRI of gluteus medius and/or minimus tear. Patients indicated for operative repair had not responded to a trial of conservative management for a minimum of 3 months with a combination of activity modification, oral anti-inflammatory medications, and a focused physical therapy regimen. The exclusion criterion was patients undergoing endoscopic gluteus medius repair. In addition, no patients had a total hip arthroplasty in place.

Radiographic Measurements

All patients underwent preoperative MRIs. Imaging was analyzed by a fellowship-trained orthopaedic surgeon for gluteus medius and minimus involvement, tear type, retraction, presence of trochanteric bursitis, the Goutallier–Fuchs classification grade,[30] and tensor fascia latae hypertrophy.

Operative Technique

The SGR technique has been previously described in the literature. The indications for SGR include failure of primary gluteal repair, massive tears with fatty atrophy, or muscular delamination from gluteal tendons (Fig 1).[29] The procedure was performed using a direct lateral approach with the patient in the lateral decubitus position. The iliotibial band was incised in line with their fibers to allow entry into the peritrochanteric space, and a trochanteric bursectomy was performed. The greater trochanter was visualized and insertional anatomy of the abductor tendons defined. The torn edges of the gluteus medius and minimus tendons were identified and debrided while as much viable tendon as

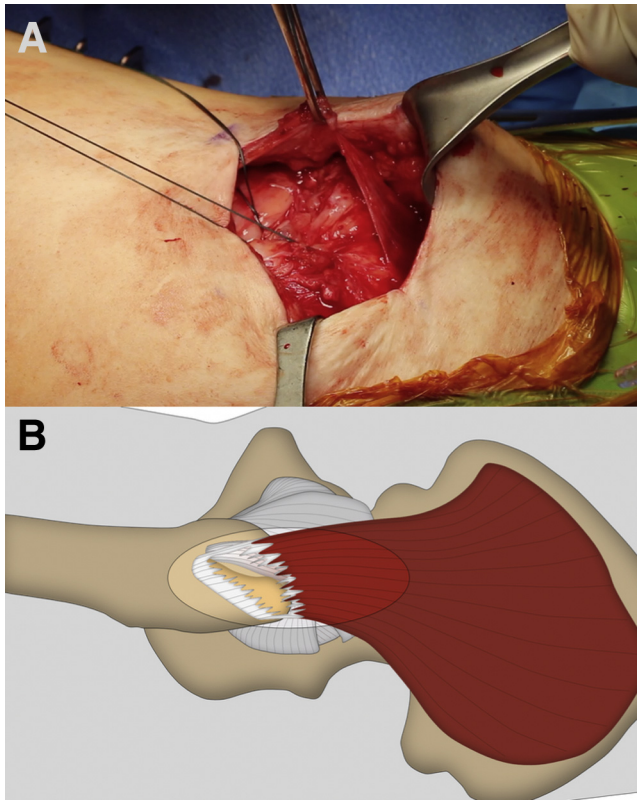

Fig 1. An image (A) and an illustration (B) of a massive gluteus medius/minimus tear of left hip with sutures placed on either side of the tear aiding in visualization before repair.

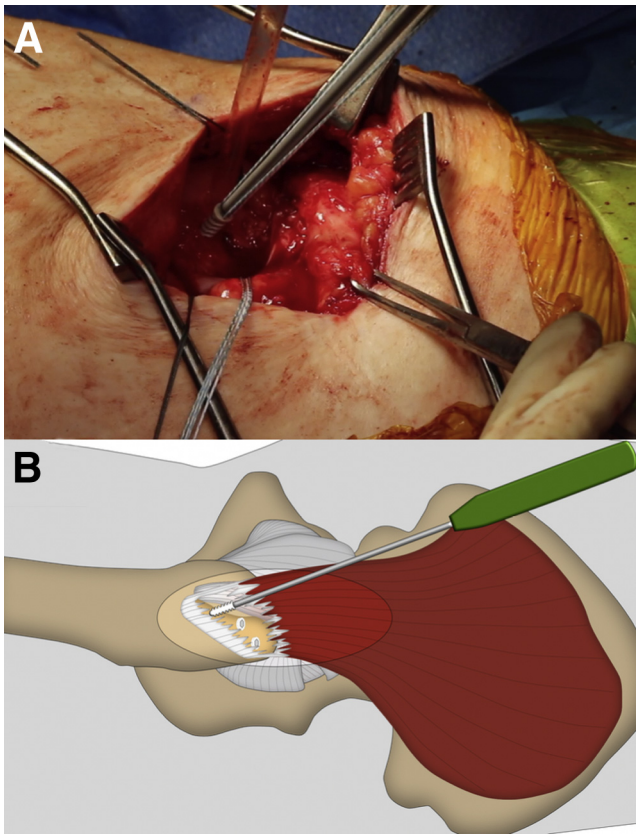

Fig 2. An image (A) and an illustration (B) of the placement of PEEK anchors in a left hip.

possible was preserved. The gluteus minimus was mobilized by freeing the tendon from the underlying capsule and overlying tensor fascia latae. The insertion site on the greater trochanter was then prepared. Anchor configuration for a double-row transosseous equivalent repair was planned based on the tear morphology to recreate the native tendon insertion. Two medial-row 4.75-mm fully threaded PEEK (polyether ether ketone) anchors (SwiveLock; Arthrex, Naples, FL) were first inserted in the lateral facet and superoposterior facet near the medial border of the footprint (Fig 2). The number of suture anchors depends on the size of the tear. The sutures and tapes were then passed through the proximal margin of the tendon in a horizontal mattress configuration with use of a free needle. The acellular human dermal allograft matrix patch (AlloMend; AlloSource, Centennial, CO) was trimmed to the appropriate dimensions and placed over the tendon defect and footprint. With the hip in 20° of abduction and neutral rotation, the medial-row sutures and tapes were then passed vertically through the graft and tied to compress the patch to the native tendons (Fig 3). One limb from each pair of sutures (4 pairs) was then incorporated into 2 lateral-row 4.75-mm PEEK anchors (SwiveLock; Arthrex). The sutures were sequentially tensioned before anchor insertion to compress the graft–tendon unit to the footprint and complete the double-row SGR (Fig 4). The integrity of the final reconstruction was assessed with gentle passive rotation of the hip, and following irrigation, the iliotibial band and superficial wound were closed in standard layered fashion.

Postoperative Rehabilitation

Following SGR, patients began a 4-phase rehabilitation protocol. For the first 8 weeks following surgery, patients were restricted to 20 lbs of foot flat weight-bearing to minimize joint reactive forces. During this period, patients ambulated with an assistive device. A continuous passive motion device was set at 30° to 70° of flexion, and was increased by 5° increments until 0° to 90° was achieved at 2 weeks following surgery. Patients were fitted with a postoperative hip brace and no active hip abduction or internal rotation and no passive hip adduction or external rotation was permitted for 6 to 8 weeks. Phase 2 began at 6 weeks and progressed the patient to full weight-bearing and initiated hip-strengthening exercises as the brace was discontinued. Phase 3 began at 12 weeks and allowed for ambulation without assist and return as tolerated to general activity. At 24 weeks patients entered phase 4,

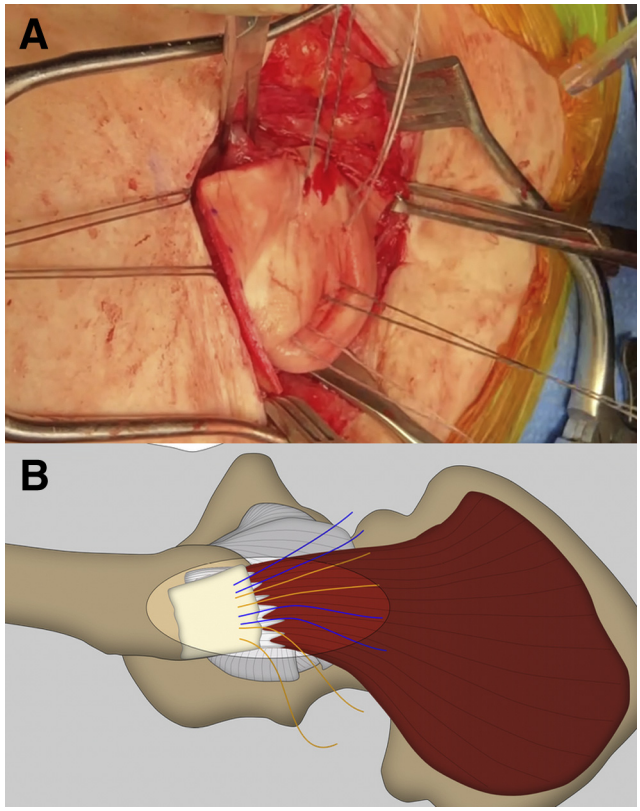

Fig 3. An image (A) and illustration (B) of the acellular human dermal allograft matrix patch (AlloMend; AlloSource) placed over the tendon defect and the greater trochanter of a left hip. The sutures are passed using free needle through the proximal tendon and the overlying graft in horizontal mattress fashion.

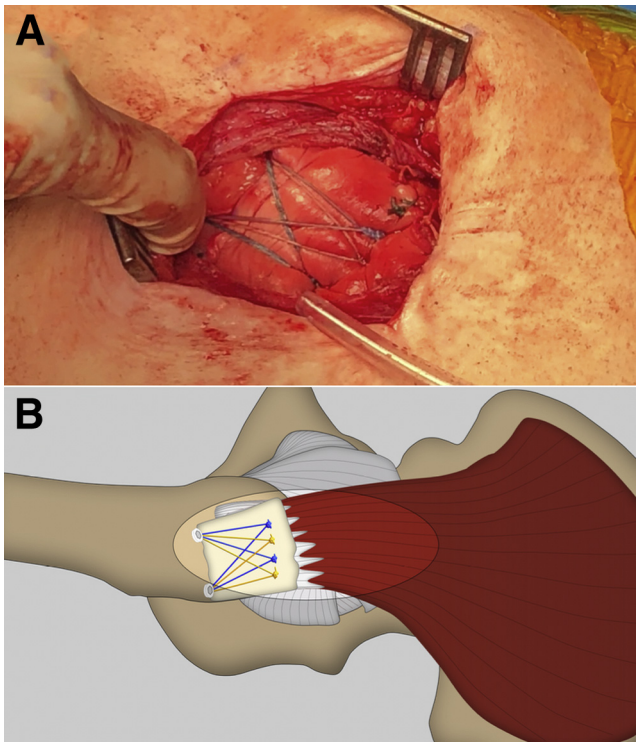

Fig 4. An image (A) and an illustration (B) of the complete double-row suture repair with superior gluteal reconstruction of a left hip using acellular human dermal allograft matrix patch (AlloMend; AlloSource).

which focused on strength, endurance, plyometric progression, initiation of a running program, and sport-specific drills. Patients were cleared to discontinue physical therapy and return to activity or sport at 4 to 6 months depending on progress.

Functional Outcome Measures

Preoperatively, demographic data were collected from all patients, including sex, age, operative extremity, body mass index, duration of symptoms, and comorbidities. Patients completed 1-year postoperative hip-specific PRO instruments including the Hip Outcome Score-Activities of Daily Living Subscale (HOS-ADL),[31] HOS-Sports Specific Subscale (HOS-SS), the modified Harris Hip Score (mHHS),[32] and the international Hip Outcome Tool-12.[33,34] Patients also received VAS satisfaction level and VAS pain at 2-years post-operatively. To determine whether patients achieved a clinically significant outcome, the patient acceptable symptomatic state (PASS) was used. Okoroha et al.[35] calculated PASS for patients undergoing endoscopic gluteus medius repair for the HOS-ADL, HOS-SS, and mHHS, and the threshold values were 77.9, 56.9, and 69.3, respectively.

Statistics Analysis

Noncontinuous variables are reported as frequency statistics, whereas descriptive statistics for all continuous variables are reported as mean and standard deviations (SDs). The percentage of patients achieving PASS for the HOS-ADL, HOS-SS, and mHHS was calculated.

Results

Demographics

A total of 8 patients underwent open SGR for severe hip abductor deficiency during the study period and were evaluated at an average of 11.5 ± 1.7 months from initial surgical intervention. The mean age and body mass index were 62.6 (SD ± 7.3) years and 29.6 (SD ± 5.3) respectively, and the majority of patients were female (N = 7, 87.5%). The characteristics of the patients are shown in Table 1. The patients' physical examination findings are shown in Table 2.The MRI characteristics are reported in Table 3. Eight (100%) patients had full-thickness tears with gluteus medius and minimus involvement with retraction present.

Intraoperative Data

All patients underwent open gluteus medius/minimus repair with allograft augmentation. One patient underwent a concomitant gluteus maximus transfer at time of surgery. Three patients (37.5%) had undergone previous primary endoscopic gluteus medius/minimus repair without augmentation and presented with evidence of retears and underwent revision surgery.

Clinical Outcomes

Postoperative PROs for the study population are reported in Table 4. Briefly, at 1-year follow-up, patients had an average HOS-ADL of 82.9 ± 24.3, HOS-SS of 73.2 ± 37.3, mHHS of 83.6 ± 17.1, international Hip Outcome Tool-12 of 63.9 ± 27.4, VAS Pain of 30.0 ± 23.1, and VAS Satisfaction of 87.1 ± 17.0. The percentage of patients achieving PASS for the HOS-ADL, HOS-SS, and mHHS were 62.5%, 50.0%, and 75.0%, respectively.

Postoperative Period

One patient underwent open repair of the contralateral gluteus medius during the follow-up period.

Table 1. Patient Demographics (n = 8)

Sex (% Female)	7 (87.5%)
Age, y	62.6 ± 7.3 (55-77)
BMI (kg/m^2)	29.6 ± 5.3 (20.8-33.7)
Laterality (right hip)	5 (62.5%)
Smoking status	0 (0.0%)
Duration of symptoms before surgery	
1 (<4 mo)	0 (0.0%)
2 (4-12 mo)	1 (12.5%)
3 (1-2 y)	3 (37.5%)
4 (>2 y)	4 (50.0%)

NOTE. Results reported as N (%) or mean ± standard deviation (range).

BMI, body mass index.

Table 2. Preoperative Physical Examination

Flexion	106.3 ± 10.6 (90-120)
IR at 90°	27.5 ± 7.1 (20-40)
ER at 90°	15.0 ± 8.7 (0-25)
FABER (positive)	5 (62.5%)
FADIR (positive)	3 (37.5%)
Painful arc from 1-3 o'clock (positive)	8 (100%)
Log roll (positive)	0 (0.0%)
Circumduction clunk (positive)	0 (0.0%)
Trochanteric pain (positive)	8 (100%)
Pain with abduction (positive)	8 (100%)
Abduction strength	4.0 ± 0.71 (4-5)
Limp (present)	4 (50%)

NOTE. Results reported as N (%) or mean ± standard deviation (range).

ER, external rotation; FABER, flexion abduction, external rotation. FADIR, flexion adduction internal rotation; IR, internal rotation.

Another patient continued to have a limp in the postoperative period. However, this patient developed back pain following postoperative physical therapy and was found to have L4-L5 herniated disk on MRI and underwent an ablation. There was no evidence of clinical retears in any patients as defined by physical examination findings (persistent or recently developed weakness of abductor strength against resistance and/or Trendelenburg sign) and/or corroborating MRI (gold standard for assessing retears), which was indicated with continued or newly acute pain and dysfunction in the postoperative time period.

Discussion

The most important findings of this study are that at 1-year follow-up SGR resulted in favorable outcome with 62.5%, 50.0%, and 75.0% of patients achieving PASS for the HOS-ADL, HOS-SS, and mHHS, respectively. Furthermore, there was no evidence of clinical retears at final follow-up. Currently, evidence for surgical intervention of abductor tendon tears using synthetic, allograft, and autograft tissue for augmentation of primary gluteus medius repairs is limited.

Table 3. Preoperative MRI Characteristics

Gluteus Medius Involvement	8 (100%)
Gluteus minimus involvement	8 (100%)
Full-thickness tear	8(100%)
Retraction (present)	8 (100%)
Greater trochanteric bursitis	
Mild	1 (12.5%)
Moderate	2 (25.0%)
Severe	5 (62.5%)
Goutallier–Fuchs classification gluteus medius	
0	1 (12.5%)
1	2 (25.0%)
2	3 (37.5%)
3	1 (12.5%)
4	1 (12.5%)
Goutallier–Fuchs classification gluteus minimus	
0	1 (12.5%)
1	0 (0.0%)
2	4 (50.0%)
3	1 (12.5%)
4	2 (25.0%)
Tensor fascia latae hypertrophy	4 (50.0%)

MRI, magnetic resonance imaging.

Table 4. 1-Year Postoperative Patient-Reported Outcomes

HOS-ADL	82.9 ± 24.3
HOS-SS	73.2 ± 37.3
mHHS	83.6 ± 17.1
iHOT-12	63.9 ± 27.4
VAS Pain	30.0 ± 23.1
VAS Satisfaction	87.1 ± 17.0

HOS-ADL, Hip Outcome Score–Activities of Daily Living; HOS-SS, Hip Outcome Score–Sports Subscale; iHOT-12, International Hip Outcome Tool; mHHS, modified Harris Hip score; VAS, visual analog scale.

In the present study, all 8 patients underwent SGR with dermal allograft for massive gluteus medius and minimus tears by the senior author. Patient outcomes at 1 year postoperatively were comparable with outcomes of patients with partial or full-thickness tears who had undergone endoscopic repair,[10,13,15] with no reported failures. Three (37.5%) of the patents in this study underwent SGR for failed endoscopic hip abductor repair. In addition, 7 (87.5%) of these patients had symptoms for greater than 1 year and all had massive gluteus medius and minimus tears. The tensor fascia latae was found to be hypertrophied in 4 (50%) of these patients. This is consistent with an article by Sutter et al.,[36] which explained that the tensor fascia latae is often hypertrophied in the setting of long-term gluteus medius and minimus insufficiency as it adopts a compensatory function in hip abduction.

The chronicity of these tears can lead to a wide separation from the femoral footprint or severe tendon loss. Retraction and the poor quality of the tendon may predispose these patients to retears following surgery, as the repair site may be under high tension. The authors believe that SGR with a acellular augment may strengthen the repair and increase the healing rate.[37]

Davies et al.[25] described the use of allograft acellular human dermal matrix to augment primary hip abductor tendon repair. In a series of 22 patients undergoing open hip abductor tendon repair, dermal allograft (Graft Jacket; Wright Medical, Memphis, TN) supplemented primary transosseous repair in the 9 patients with grade IV abductor tears (Milwaukee Classification). At 1-year follow-up, 3 (33.3%) of these patients obtained a poor outcome, with 2 requiring the use of ambulatory aids, compared with no patients with grade I-III tears.[25] According to the Harris Hip Score, 4 (50%) of the patients achieved an "excellent" outcome, which is slightly less than the 50% to 75% of patients achieving PASS in the current study. Rao et al.[26]

similarly used allograft dermal matrix to augment hip abductor tendon repairs in 12 patients with more promising results. The authors demonstrated significant improvement in pain, abductor strength, gait function, and outcome scores at a mean of 22 months without failure.[26] The mean Harris Hip Score was 81.26 at follow-up, which is comparable with the mean mHHS at final follow-up in the current cohort. Other authors have described gluteal medius repair with bioinductive patch augmentation using both open and endoscopic techniques.[27,28]

Fehm et al.[23] described the use of an Achilles tendon allograft with a calcaneal bone block in 7 patients with abductor deficiency following total hip arthroplasty. Patients had an average mHHS of 85.9 at 2-year follow-up, which is comparable with the average mHHS, 83.6, of the current study. Moreover, the patients demonstrated significant improvement in pain, gait, strength, and subjective outcomes at a minimum of 2-year follow-up.[23] In patients undergoing abductor tendon suture-anchor repair augmented with a transosseous synthetic scaffold (LARS; Corin Group, Cirencester Cloucestershire, UK), Ebert et al.[20,24] reported significant improvement in all mean patient PROs and clinical scores, including hip abductor strength and gait performance in 142 patients.

Limitations

This study has certain limitations that are worth noting. This is only a case series and due to the indication of the surgery, there are a limited number of patients. All patients were based on a single cohort of patients at a large, tertiary care institution who underwent surgery by a single, high-volume surgeon. Therefore, it is possible that these values may not be generalizable to a larger population. In addition, our study findings did not include preoperative PROs, so we are unable to compare pre- and postoperative PROs. However, we applied the principles of the PASS to calculate the percentage of patients achieving a clinically significant outcome. The PASS threshold values were defined in a population of patients undergoing endoscopic gluteus medius repair at 2-year follow-up, and it is possible that the threshold values are not a true representation for patients undergoing SGR at 1-year follow-up.

Conclusions

SGR for massive, irreparable abductor tendon tears with severe tendon loss and atrophy is a technique that demonstrates promising 1-year postoperative outcomes in both primary and revision patients.

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