Systematic Review

Outcomes of Open Versus Endoscopic Repair of Abductor Muscle Tears of the Hip: A Systematic Review

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Purpose: To compare the outcome of open versus endoscopic gluteal tendon repair. **Methods:** An extensive review of PubMed was conducted by 2 independent reviewers for articles containing at least 1 of the following search terms: gluteus medius, gluteus medius tear, gluteus medius tendinopathy, gluteus medius repair, hip abductors, hip abductor tears, hip abductor repair, hip rotator cuff, hip rotator cuff repair, trochanteric bursa, trochanteric bursitis, trochanteric bursectomy, peritrochanteric procedures, peritrochanteric repair, and peritrochanteric arthroscopy. This yielded 313 articles. Of these articles, 7 satisfied the following inclusion criteria: description of an open or endoscopic gluteal repair with outcomes consisting of patient-reported outcome scores, patient satisfaction, strength scores, pain scores, and complications. **Results:** Three studies on open gluteal repairs and 4 on endoscopic gluteal repairs met the inclusion criteria. In total, there were 127 patients who underwent open procedures and 40 patients who underwent endoscopic procedures. Of the 40 patients who underwent endoscopic procedures, 15 had concomitant intra-articular procedures documented, as compared with 0 in the open group. The modified Harris Hip Score was common to 1 study on open repairs and 3 studies on endoscopic repairs. The scores were similar for follow-up periods of 1 and 2 years. Visual analog pain scale scores were reported in 1 study on open gluteal repairs and 1 study on endoscopic repairs and were similar between the 2 studies. Improvement in abductor strength was also similarly reported in selected studies between the 2 groups. The only difference between the 2 groups was the reported incidence of complications, which was higher in the open group. **Conclusions:** Open and endoscopic gluteal repairs have similar patient-reported outcome scores, pain scores, and improvement in abduction strength. Open techniques have a higher reported complication rate. Randomized studies of sufficient numbers of patients are required to ultimately determine if one technique produces superior patient outcomes over the other. **Level of Evidence:** Level IV, systematic review of Level IV studies.

Bunker[1] recognized gluteus medius and minimus tears as a cause of lateral thigh pain and abductor weakness, describing the pathology as "rotator cuff tears of the hip." Gluteal tears may be classified as either spontaneous or traumatic.[2] Spontaneous tears are associated with age, with the incidence peaking between the fourth and sixth decades.[3] They occur 4 times more frequently in women than in men, but the incidence increases at a similar rate in both groups. Most patients with spontaneous degenerative tears present with an insidious onset of lateral-sided hip pain that is aggravated by weight bearing.[4] In contrast, patients with traumatic tears can often pinpoint the exact time symptoms began to occur. On examination, there is often tenderness over the greater trochanter with a reduction in power on resisted hip abduction.[5] Peritrochanteric injections typically relieve the pain, but weakness still persists.[6]

Tears can be classified morphologically as intrasubstance (occurring in line with the tendon fibers), partial thickness, or full thickness.[7] Magnetic resonance imaging (MRI) can help differentiate between partial- and full-thickness tears and show fatty atrophy within the

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muscle.[4] Tendinosis is included in the differential diagnosis of gluteal tears and will appear on MRI as increased signal intensity on T2-weighted images. A partial-thickness tear is diagnosed when the tendon is thickened and there is increased signal intensity on T2-weighted and short inversion time recovery images. Focal discontinuity of the tendon with tendon retraction represents a complete tear.

In spontaneous tears, nonoperative management is often prescribed in the first instance. This consists of a combination of physical therapy, functional adjustment, and medications.[8] Medications may include nonsteroidal anti-inflammatories, steroid injections, and newer medical therapies, such as plasma rich in platelets, autologous blood, and high-volume saline solution injections. However, there is minimal high-level evidence to support the routine use of the latter therapies.[9]

Operative management is advocated for appropriate patients who have not achieved adequate pain relief with nonoperative management. The aim of surgical intervention is to restore the footprint and promote tendon-to-bone healing.[10,11] Traditionally, this was performed through an open approach because this allowed visualization of the footprint, preparation of bone surfaces, and fixation of tendon to bone.[12-14] However, with advancements in endoscopic instruments and techniques, there has been a recent increase in the prevalence of endoscopic repairs.[15-18] The aim of this systematic review was to compare the outcomes of open versus endoscopic gluteal repairs and provide an algorithm regarding the indications and benefits for each approach.

Methods

Two independent reviewers (S.C., P.L.) performed an extensive search of PubMed for articles that contained at least 1 of the following search terms: gluteus medius, gluteus medius tear, gluteus medius tendinopathy, gluteus medius repair, hip abductors, hip abductor tears, hip abductor repair, hip rotator cuff, hip rotator cuff repair, trochanteric bursa, trochanteric bursitis, trochanteric bursectomy, peritrochanteric procedures, peritrochanteric repair, and peritrochanteric arthroscopy. The search included articles published from January 1930 to September 2014. Reference lists from relevant articles were also reviewed to identify any additional studies of interest. The search revealed 313 articles. Of these, 251 were excluded after title and abstract review, whereas 62 full-text publications were reviewed. Seven of these articles met our inclusion criteria (Fig 1): human studies, articles written in English or abstracts in English, case series of more than 2 patients treated with either an open or endoscopic technique of gluteal tendon repair, and studies reporting on patient outcomes (Appendix Table 1, available at www.arthroscopyjournal.org). Articles were excluded if they were review articles, technique articles, case reports, or nonoperative studies or if they reported on the outcomes of repair in the setting of hip arthroplasty (Appendix Table 1, available at www.arthroscopyjournal.org).

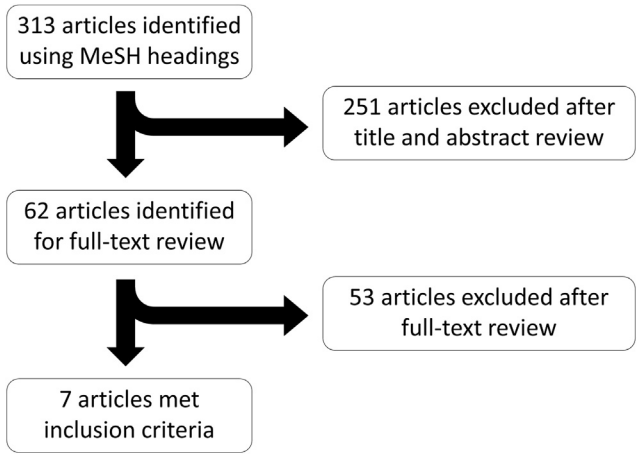

Fig 1. Selection procedure yielding 7 articles for review. (MeSH, Medical Subject Headings.)

Results

By use of the aforementioned search criteria, 7 articles ultimately met the appropriate criteria for inclusion in this review. There were 3 studies on outcomes of open gluteal repairs and 4 on endoscopic repairs. A meta-analysis could not be performed because of the heterogeneity of patient cohorts in each study and the outcomes reported. The review will analyze and discuss these articles in terms of patient demographic data and operative indications, repair techniques, classification of tears, outcomes, and complications.

Patient Demographic Data and Indications

Open Gluteal Repair. Table 1 summarizes the patient demographic data for the 3 outcome studies on open gluteal repairs. Walsh et al.[14] did not report on the male-to-female ratio, but the mean age of the female patients was slightly younger, at 62 years, compared with 65 years for male patients. Table 2 summarizes the clinical features of each of the cohorts that underwent an open gluteal repair. All 3 cohorts presented with lateral hip pain. Walsh et al. reported that in their cohort, 32 patients had a normal gait, 58 had a positive Trendelenburg sign, and 10 were immobile with pain. In contrast, Davies et al.[13] reported that 100% of their cohort had a positive Trendelenburg sign. A partial reduction in pain with a trochanteric injection was part of the diagnostic criteria in all 3 studies. MRI was used to image partial

Table 1. Demographic Data of Patients Undergoing Open and Endoscopic Gluteal Repairs

	Open			Endoscopic			
	Walsh et al.[14]	Davies et al.[13]	Davies et al.[12]	Thaunat et al.[17]	McCormick et al.[16]	Voos et al.[18]	Domb and Carreira[15]
No. of patients	89	22	16	4	11	10	15
No. of operations	89	23	16	4	11	10	15
Mean age (range), yr	62 (40-79)	67.7 (45-85)	63 (47-82)	68.5 (64-79)	65.9 (60-74)	50.4 (33-66)	58 (44-74)
Male-female ratio	NR	2:20	15:1		1:7	2:8	1:14
Concomitant procedures							
Labral						0	0
FAI						1	11
Tendon release						1	8
Cartilage						3	1
Capsule						0	0
GT exostectomy						0	0

FAI, femoroacetabular impingement; GT, greater tuberosity; NR, not reported.

or complete detachment of the gluteal tendons. The study by Walsh et al. was the only study to report normal MRI findings in 2 patients who were subsequently diagnosed with an abductor tear at surgery. In 1 patient a tear was found on post hoc analysis of the images. The discrepancy in the other patient was not discussed, but a diagnosis of gluteal separation was made based on a positive response to a local anesthetic injection. All operated tears were chronic. Although Davies et al.[13] did not include the duration of symptoms until surgery, they involved patients in whom nonoperative management had failed.

Endoscopic Gluteal Repair. Table 1 summarizes the patient demographic data for the 4 studies that reported on the outcomes of endoscopic gluteal repairs. Domb and Carreira[15] had the largest cohort of patients, totaling 15, and Thaunat et al.[17] had the smallest series, at 4 patients. Voos et al.[18] had the youngest cohort, with a mean age of 50.4 years, and Thaunat et al. had the oldest cohort, with a mean age of 68.5 years. There were a greater number of female patients in all case series that reported male-to-female ratios. Table 2 summarizes the clinical features of each of the cohorts that underwent an endoscopic gluteal repair. Domb and Carreira and McCormick et al.[16] defined their inclusion and exclusion criteria. Domb and Carreira used the following inclusion criteria: peritrochanteric pain, tenderness, reduced abduction power, failure of physical therapy for 3 months, and a tear shown on MRI (full or partial thickness) without retraction that was amenable to repair on endoscopic evaluation. The cohort also included patients with intra-articular pathologies that were concomitantly treated at the time of repair. These included labral tears, loose bodies, and femoroacetabular impingement. McCormick et al. included patients with lateral hip pain, trochanteric tenderness, and reduced power of abduction in whom a minimum of 3 months of nonoperative management had failed but excluded patients with partial-thickness tears on MRI and no concomitant intra-articular pathology. Voos et al. and Thaunat et al. did not specify their inclusion and exclusion criteria, but their cohorts consisted of patients with gluteal tears confirmed on MRI. The case series by Voos et al. included acute traumatic tears in 60% of cases and spontaneous and insidious tears in only 40%. Their study also included patients who had undergone concomitant procedures.

Table 2. Clinical Features of Patients Undergoing Open and Endoscopic Gluteal Repairs

	Open			Endoscopic			
Clinical Features	Walsh et al.[14]	Davies et al.[13]	Davies et al.[12]	Thaunat et al.[17]	McCormick et al.[16]	Voos et al.[18]	Domb and Carreira[15]
Mean BMI (range), kg/m^2	NR	30 (21-38)	NR	NR	NR	NR	26.17 (19.93-32.61)
Positive Trendelenburg sign	65%	100%	NR	NR	NR	NR	NR
Duration of symptoms, mean (range)	22.4 mo (6-144 mo)	NR	23 mo (6-48 mo)	3.2 yr (1-10 yr)	NR	Acute injuries in 6 of 10, insidious onset in 4 of 10	38.73 mo (1-240 mo)
Tear identified on MRI	98%	100%	100%				

BMI, body mass index; MRI, magnetic resonance imaging; NR, not reported.

Intraoperative Classification of Gluteal Tears

Open Gluteal Repair. Walsh et al.[14] and Davies et al.[13] used different 4-tier systems for grading gluteal tears intraoperatively (Table 3). Davies et al.[12] did not specify any grading system. Davies et al.[13] used the Milwaukee classification, in which the trochanter is represented by a clock face and grade 1, 2, 3, and 4 tears correspond to 1 hour, 2 hours, 3 hours, and a bald trochanter, respectively. Walsh et al. devised a classification in which type 1 tears had a normal bursa, normal appearance of the gluteus medius tendon, deep surface detachment anteriorly only, and a normal gluteus minimus; type 2 tears had a normal bursa, thickening of the tendon, grayish discoloration, loss of normal striations, detachment that may extend posteriorly, and a stretched gluteus minimus; type 3 tears had a scarred bursa and may have free fluid and tendon changes as in type 2 but a small disruption exposing the underlying trochanter with a partial tear or detachment of the gluteus minimus; and type 4 tears had total disruption of the gluteus medius and minimus tendons exposing the entire trochanter front and back with ulceration of the fascia lata.

Endoscopic Gluteal Repair. Domb and Carreira[15] intraoperatively graded gluteal tears based on the percentage of the tendon involved (Table 3). Grade 2 tears were repaired using a transtendinous technique, and grade 4 tears with a full-thickness repair technique. Grade 3 tears were repaired with either technique depending on how near the tear was to full thickness. McCormick et al.[16] only included full-thickness tears in their study cohort and did not comment on an intraoperative grading system. Thaunat et al.[17] did not comment on a classification system but commented that, in patients who did not have a full-thickness tear, a transtendinous window was used to debride the greater trochanter. Voos et al.[18] had 5 patients with full-thickness tears and 5 patients with high-grade partial-thickness tears that were completed to full-thickness tears intraoperatively.

Operative Technique

Open Gluteal Repair. Table 4 summarizes the salient points on the operative technique for all 3 studies on open gluteal repairs. In all 3 studies, patients were positioned in the lateral decubitus position with a direct approach to the greater trochanter. Davies et al.[13] and Davies et al.[12] performed a bursectomy, whereas Walsh et al.[14] performed a bursectomy if the tissue was pathologic. The gluteus medius and minimus tendons were identified, and the ends were debrided. The trochanter was decorticated with either instruments or a burr. Walsh et al. sutured the tendons to bone with transosseous tunnels, Davies

Table 3. Intraoperative Grading of Gluteal Tears for Open and Endoscopic Gluteal Repairs

	Open						Endoscopic					
	Walsh et al.[14]		Davies et al.[13]		Davies et al.[12]		Thaunat et al.[17]	McCormick et al.[16]	Voos et al.[18]	Domb and Carreira[15]		
	Description	%	Description	%	Description	%				Description	%	
Grade 1: mild	Deep surface detachment of GMe	12%	1 hour of trochanteric clock face exposed	4%	Less than one-third detachment of GMe	25%	NR	NR	NR	0%-25% tear	0%	
Grade 2: moderate	Partial detachment of GMe and stretching of GMi	66%	2 hours of trochanteric clock face exposed	17%	One-third to two-thirds detachment of GMe	50%				26%-50% tear	27%	
Grade 3: severe	Scarred bursa and partial exposure of trochanter	15%	3 hours of trochanteric clock face exposed	39%	Both GMe and GMi; greater than two-thirds detachment of GMe	25%				51%-99% tear	40%	
Grade 4: severe	Total separation of GMe and GMi with exposure of entire trochanter	7%	Bald trochanter	39%						Full-thickness tear	33%	

GMe, gluteus medius; GMi, gluteus minimus; NR, not reported.

Table 4. Operative Techniques of Open and Endoscopic Gluteal Repairs

	Open			Endoscopic			
	Walsh et al.[14]	Davies et al.[13]	Davies et al.[12]	Thaunat et al.[17]	McCormick et al.[16]	Voos et al.[18]	Domb and Carreira[15]
Position and approach	Lateral decubitus; incision centered over GT	Lateral decubitus; posterolateral	Lateral decubitus; incision centered over GT	Lateral decubitus with hip in 20° of abduction; 30° endoscope; pump pressure at 50 mm Hg	Lateral with leg in neutral rotation and slight abduction; 30° endoscope; pump pressures of 35 to 45 mm Hg	See technique article	Supine on well-padded traction table
Portal placement				Distal direct lateral	Distal direct lateral under fluoroscopy to locate vastus ridge; proximal direct lateral; accessory anterolateral; accessory posterolateral at 45° to gluteal footprint to facilitate anchor placement		
Bursectomy	Type 3 and 4 tears	Yes	Yes	Yes	Yes		Yes
Tendon preparation	GMe tendon split and tagged at anterior mobile portion; GMe and GMi debrided	GMe and GMi identified and ends debrided	GMe and GMi identified and ends debrided	Transtendinous window created in partial-thickness tears	Resection of adhesions and mobilization of tendon to establish tension-free repair		Transtendinous repair for partial-thickness undersurface tears; transtendinous window in line with GMe fibers
Preparation of trochanter	Decortication with instruments	Burr	High-speed burr	Burr	Light debridement with 4.5-mm full-radius resector		Lateral facet decorticated to bleeding bone with burr
Suture configuration	No. 5 Ethibond; vertical mattress	Anchors on anterior facet for GMi and lateral facet for anterior and central fibers of GMe; transosseous for posterior fibers of GMe	Double-row configuration with anchor sutures securing avulsed edge and heavy absorbable sutures to over-sew free edge	2 to 4 horizontal mattress sutures using BirdBeak device (Arthrex) or suture passer	Horizontal mattress sutures from each limb of anchor securing tendon to bone; for larger tears, limbs of tied repair are placed in bone through PushLock anchors (Arthrex) distally		Horizontal mattress sutures, one anterior and one posterior; close longitudinal split; anchor tendon to lateral facet; for full-thickness tears, distal-row fixation added by criss-crossing all sutures to two 4.75-mm SwiveLock anchors (Arthrex)
Fixation to bone	Transosseous fixation	Anchors and transosseous tunnels	Anchors	Resorbable 6.5-mm screw anchors	5.5-mm composite Corkscrew anchors (Arthrex) at 45° to footprint		5.5-mm BioComposite Corkscrew in lateral facet under fluoroscopy
Restoration of footprint	Tunnels axial for GMi and oblique for GMe	Curvilinear drill to create transosseous tunnels	Anchors inserted to footprint		Double-row repair for large tears		Double-row repair for full-thickness tears

GMe, gluteus medius; GMi, gluteus minimus; GT, greater tuberosity.

et al.[12] used anchors, and Davies et al.[13] used a combination of anchors and transosseous tunnels depending on the configuration of the tear. Walsh et al. used No. 5 Ethibond sutures (Smith & Nephew Endoscopy, Andover, MA) in a vertical mattress configuration in the tendon, whereas Davies et al.[12] used a double-row configuration with anchor sutures securing the avulsed edge and heavy absorbable sutures to over-sew the free edge to create a watertight seal. Davies et al.[13] used 6.5-mm anchors with No. 2 FiberWire (Arthrex, Naples, FL) to secure the gluteus minimus and medius tendons to the anterior and lateral facets of the trochanter, respectively. If the posterior fibers of the gluteus medius were involved, these were secured to the trochanter through a set of medial and lateral transosseous tunnels with No. 5 FiberWire using a Krackow cross-stitch 7 to 10 mm medial to the underedge of the tendon, with simple vertical stitches over the free flap to simulate a double-row repair. In addition, for retracted tears with an exposed trochanter, Davies et al.[13] supplemented the repair with a 5- to 7-cm allograft human fascial supplement. Walsh et al. restored the footprint through axial orientation of tunnels for the gluteus minimus repair and oblique orientation of tunnels for the gluteus medius repair. Davies et al.[13] used a curvilinear drill to create transosseous tunnels to restore the correct orientation of the tendon fibers.

Endoscopic Gluteal Repair. Table 4 summarizes the endoscopic technique of gluteal repair for each of the studies. Thaunat et al.[17] and McCormick et al.[16] placed the patient in the lateral position with the leg slightly abducted and used a 30° endoscope. Domb and Carreira[15] and Voos et al.[18] placed the patient in the supine position. A combination of direct distal-lateral and proximal portals and accessory portals were used to view the peritrochanteric space and facilitate instrumentation. A trochanteric bursectomy was performed by all to aid visualization. For partial tears, a longitudinal split was made in the gluteal tendon to create a trochanteric window for bone preparation. McCormick et al. specified light debridement with a burr, whereas Domb and Carreira performed debridement until bleeding bone was present. The gluteal tendons were mobilized by removing scar tissue and adhesions. Bioabsorbable anchors were placed in the greater trochanter, and horizontal mattress sutures were placed in the tendons. All studies used a double-row technique for full-thickness tears to provide added compression of tendon to bone.

Postoperative Rehabilitation

Open Gluteal Repair. All 3 open gluteal repair studies followed similar postoperative protocols (Appendix Table 2, available at www.arthroscopyjournal.org). The protocols had a period of restricted weight bearing followed by an exercise regimen. Davies et al.[13] used an abduction brace to protect grade 3 and 4 tears.

Endoscopic Gluteal Repair. Apart from McCormick et al.,[16] the other authors of the endoscopic gluteal repair studies restricted weight bearing for 6 weeks. McCormick et al. allowed flat-foot weight bearing on the basis that it balanced the pelvis without causing lurching and compromising the repair. All authors then followed a progressive rehabilitation protocol. Apart from McCormick et al., all others used an abduction brace.

Outcomes

Open Gluteal Repair. All 3 open gluteal repair studies reported on patients lost to follow-up and excluded patients (Table 5). In the study by Walsh et al.,[14] 7 of 89 patients were lost to follow-up and 11 patients were excluded, allowing the authors to report on the 6- and 12-month outcomes of 72 patients. In the study by Davies et al.,[13] none of the 22 patients were lost to follow-up or excluded from the 1-year analysis but 1 patient was excluded from the 5-year analysis. Davies et al.[12] excluded 5 of 16 patients from their report on 1-year outcomes. These patients had retears or infection after their primary procedure.

As part of the inclusion criteria of the review, all studies reported on patient outcome scores (Table 6). Davies et al.[13] reported the longest follow-up, at 5 years, whereas the other 2 studies had 12-month follow-up scores. Davies et al.[13] showed a significant

Table 5. Postoperative Follow-up for Open Gluteal Repairs

	Walsh et al.[14]	Davies et al.[13]	Davies et al.[12]
Lost to follow-up	7 of 89	0 of 23 at 1 yr 3 of 23 at 5 yr	0 of 16
Excluded	11 of 89 • 4 deaths (unrelated) • 4 interstate or overseas • 3 pathology-impairing assessment	0 of 23 at 1 yr 1 of 23 at 5 yr • 1 death	5 of 16 could not complete full follow-up • 4 retears • 1 deep wound infection

Table 6. Patient-Reported Outcome Scores for Open and Endoscopic Gluteal Repairs

	Open								Endoscopic					
	Walsh et al.[14]			Davies et al.[13]			Davies et al.[12]		Thaunat et al.[17]		McCormick et al.[16]	Voos et al.[18]	Domb and Carreira[15]	
	Preoperative	0.5 yr	1 yr	Preoperative	1 yr	5 yr	Preoperative	1 yr	Preoperative	6 mo	Mean, 23 mo (Range, 13-38 mo)	1 yr	Preoperative	2 yr
HHS				53	87	88								
mHHS									35.7 (20-54)	74 (46-84)	84.7 (SD, 14.5)	94 (84-100)	49.95	84.6
HOS-ADL									38.3 (21-52)	83 (64-95)	89.1 (SD, 11.3)	93 (85-100)	47.47	88.1
HOS-SSS													28.18	78.83
LEAS				6.7	8.9	8.8								
Merle d'Aubergine—Postel hip score	10.85 ± 0.30 (2-12)	16.66 ± 0.33 (9-18)	16.66 ± 0.33 (9-18)				10.5	15						
Merle d'Aubergine—Postel pain component	0.83 ± 0.06		5.22 ± 0.18											
NAHS													46.02	84.6
Oxford Hip Score							21.4	38.9						
SF-36 PCS							28.4	40.2						
SF-36 MCS							54.9	59.4						

NOTE. Data are presented as mean, mean (range), or mean ± standard deviation (range) unless otherwise indicated.

HHS, Harris Hip Score; HOS-ADL, Hip Outcome Score—Activities of Daily Living; HOS-SSS, Hip Outcome Score—Sport-Specific Subscale; LEAS, lower extremity activity scale; MCS, Mental Component Summary; mHHS, modified Harris Hip Score; NAHS, Non-Arthritic Hip Score; PCS, Physical Component Summary; SF-36, Short Form 12.

improvement in mean Harris Hip Scores and mean lower extremity activity scale scores for both the 1-year and 5-year follow-up compared with preoperative results. There was no significant difference between 1-year and 5-year scores, and there was no statistically significant difference in improvement according to the grade of the tear. Walsh et al.[14] reported a significant improvement in Merle d'Aubergine–Postel hip scores at the 6-month and 12-month follow-up compared with preoperatively. There was no significant difference between the 6-month and 12-month scores. The largest improvement was in the pain component of the Merle d'Aubergine–Postel hip score. This improved from 0.83 ± 0.06 preoperatively to 5.22 ± 0.18 at 6 months. There was also a significant improvement in the ability-to-walk component of the score (4.66 ± 0.15 to 5.61 ± 0.12), but the magnitude of improvement was not as great. Davies et al.[12] also reported a significant improvement in the Merle d'Aubergine–Postel hip score at 12 months compared with preoperatively in their patients. The patients had a similar mean baseline score to those of Walsh et al. and a similar magnitude of improvement at 12 months. Davies et al.[12] also reported a significant improvement in the Oxford Hip Score and Short Form 36 Physical Component Summary score at 12 months but not the Short Form 36 Mental Component Summary score.

In addition, the studies compared various other clinical parameters at follow-up (Appendix Table 3, available at www.arthroscopyjournal.org). Davies et al.[13] reported a significant improvement in resisted abduction at the 1-year follow-up, from a mean grade of 3.1 to 4.7. In terms of improvement in mobility, Walsh et al.[14] reported that 78% of their cohort had a normal gait compared with 5% preoperatively. In the cohort of Davies et al.,[13] 3 of 22 patients required walking aids at the 5-year follow-up. With respect to a positive Trendelenburg sign, Davies et al.[13] reported that all 22 patients had a positive sign preoperatively whereas only 4 of 19 had a positive sign at 5 years. Davies et al.[12] reported that 6 of 11 patients had a normal Trendelenburg sign at the 1-year follow-up compared with 5 of 15 preoperatively. Davies et al.[13] reported an improvement in pain in 90% of patients, and there was a significant improvement in the mean visual analog pain scale score reported by Davies et al.,[12] from 7 preoperatively to 2 at the 1-year follow-up. Davies et al.[13] reported that 78% of their patients had a subjective improvement in function and 16 of 19 were satisfied with their results at 5 years.

All studies on open gluteal repairs reported on their complications (Table 7). Walsh et al.[14] had 17 complications in their cohort of 89 patients. Procedure-specific complications included 4 retears, 3 hematomas, and 1 deep infection. Of the 4 patients with retears, 2 did not comply with non–weight bearing in the postoperative period and 2 incurred a tear after a fall. Davies et al.[13] reported 2 retears after a fall. Davies et al.[12] reported 4 retears and 1 deep infection. The tears did not correlate with the duration of symptoms or age. Two of the retears occurred in patients with a severe classification of their tears, reflecting a higher percentage of tendon involvement.

Endoscopic Gluteal Repair. All endoscopic gluteal repair studies had a 100% follow-up rate, with no patients lost to follow-up or excluded. In terms of patient outcome scores, Domb and Carreira[15] and Thaunat et al.[17] reported an improvement from preoperative to postoperative scores (Table 6). In 14 of 15 patients included by Domb and Carreira, there was an average improvement of more than 30 points for all scores. All 4 reported hip scores showed a significant improvement at final follow-up compared with preoperatively. McCormick et al.[16] and Voos et al.[18] did not report any comparative preoperative scores but their mean postoperative scores were comparable with those of Domb and Carreira.

In terms of other clinical parameters measured, Domb and Carreira[15] and McCormick et al.[16] reported a significant improvement in mean abduction power in their cohorts (Appendix Table 3, available at www.arthroscopyjournal.org). Voos et al.[18] reported that all patients had grade 5 power postoperatively in their cohort, in which grade 4 abduction power was part of the inclusion criteria for surgery. Domb and Carreira showed a significant improvement in mean visual analog pain scale scores postoperatively, and Voos et al. reported that no patients complained of pain on postoperative review. No endoscopic gluteal repair studies reported on complications, in particular, retears or surgical-site infections.

Comparison of Outcomes Between Open and Endoscopic Gluteal Repair Techniques

All studies reported patient-reported outcome scores. All studies on open gluteal repairs documented a significant improvement in postoperative scores. The results of Davies et al.,[13] however, only allow comparison between open and endoscopic results due to the commonality of the Harris Hip Score. They showed a mean improvement

Table 7. Complications of Open Gluteal Repair

	Walsh et al.[14]	Davies et al.[13]	Davies et al.[12]
Retears	4 of 89	2	4 of 16
Infection/hematoma	1 of 89/3 of 89		1 of 16
DVT/PE	6 of 89/1 of 89		
Other	1 pressure sore and 1 GT fracture		
Total	17 of 89	2 of 23	5 of 16

DVT, deep venous thrombosis; GT, greater tuberosity; PE, pulmonary embolism.

in the Harris Hip Score of 34 points at 1 year after surgery and 35 points at 5 years in their cohort of 22 patients. In comparison, Domb and Carreira[15] showed a mean improvement of 34 points in their cohort of 15 patients with endoscopic gluteal repairs (Fig 2). McCormick et al.[16] and Voos et al.[18] did not report preoperative scores, but the mean postoperative scores of 87.4 points and 94 points, respectively, at greater than 1 year of follow-up were similar to the absolute mean score reported by Davies et al.[13] Other commonly reported outcome measures between open and endoscopic gluteal repairs were the power of resisted abduction and visual analog pain scale. Davies et al.[13] reported a significant improvement in abduction power from 3.1 to 4.7 in their cohort compared with 3.3 to 4.6 and 4.2 to 4.73 for McCormick et al. and Domb and Carreira, respectively (Fig 3). Davies et al.[12] showed an improvement in the visual analog scale score from 7 to 2 in their cohort, which was similar to that reported by Domb and Carreira, from 6.8 to 1.4 (Fig 4).

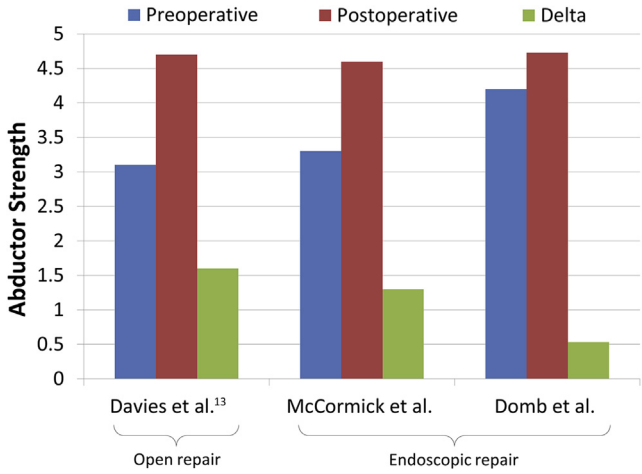

Fig 3. Comparison of mean abductor strength, preoperatively and postoperatively, among 3 studies. Postoperative data were collected at 1 year (Davies et al.[13] and McCormick et al.[16]) and 2 years (Domb and Carreira[15]) after surgery.

Discussion

The main difference in outcome that may be inferred from this review between the 2 techniques relates to the lower complication rates with endoscopic surgery. Specifically, open procedures had a combined retear rate of 10 of 128 patients compared with 0 reported in the endoscopic articles. Furthermore, open techniques appear to have a higher incidence of wound complications, such as infection and hematoma, compared with endoscopic techniques (4 of 128 *v* 0). Open and endoscopic gluteal repair techniques result in equivalent improvement in patient scores, abduction power, and pain reduction.

All studies reviewed had similar epidemiologic data on gluteal tears but differed in their exclusion criteria. The mean age in each study was 50 to 60 years, and there was a predominance of female patients within the cohorts. This age range and female predominance are consistent with the literature.[1,5,6,19-21] All studies had similar diagnostic criteria. These included a combination of lateral hip pain, peritrochanteric tenderness, reduced power on resisted abduction, and a positive response to peritrochanteric injections. All patients except one in the cohort of Walsh et al.[14] had a gluteal tear confirmed on MRI. Davies et al.[12] excluded their patients with complications from postoperative

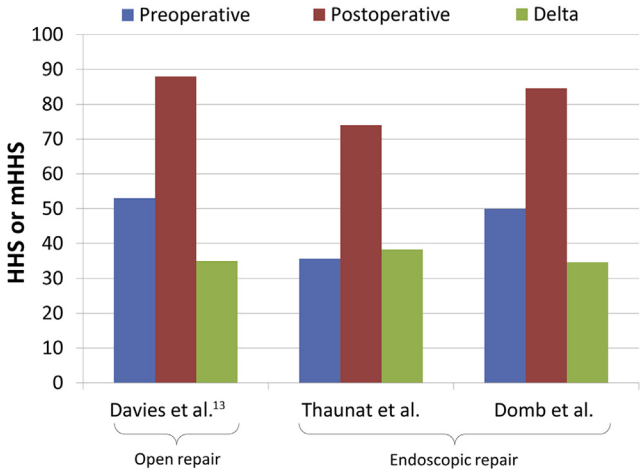

Fig 2. Comparison of Harris Hip Score, preoperatively and postoperatively, among 3 studies. Postoperative data were collected at 5 years (Davies et al.[13]), 6 months (Thaunat et al.[17]), and 2 years (Domb and Carreira[15]) after surgery. It should be noted that Davies et al. used the Harris Hip Score (HHS) whereas Thaunat et al. and Domb and Carreira used the modified Harris Hip Score (mHHS).

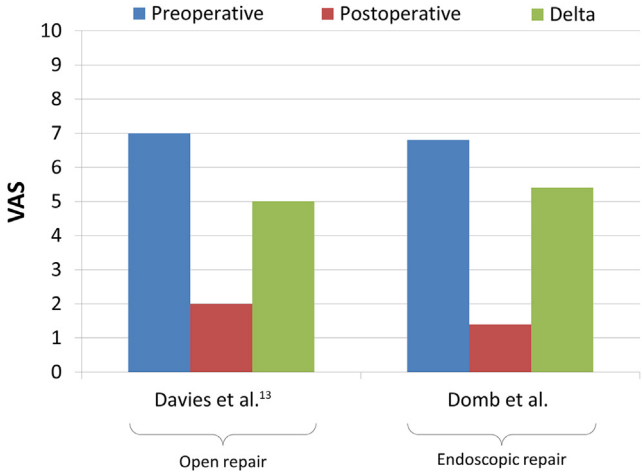

Fig 4. Comparison of mean visual analog scale (VAS) scores, preoperatively and postoperatively, between 2 studies. Postoperative data were collected at 1 year (Davies et al.[13]) and 2 years (Domb and Carreira[15]) after surgery.

evaluation. This totaled to 5 of 15 patients being excluded, which could have potentially influenced the significance of their patient-reported outcomes. Domb and Carreira[15] and Voos et al.[18] included patients who had undergone concomitant intra-articular procedures. This may have potentially led to heterogeneity between the 2 groups but highlights one of the potential advantages of the endoscopic approach: the ability to address intra-articular pathology in the same operative setting. Interestingly, the cohort of Domb and Carreira had similar baseline Harris Hip Scores to the cohort of Davies et al.[13] despite gluteal tears being associated with various other hip pathologies. Furthermore, the postoperative improvement in the scores was similar.

The operative techniques for open and endoscopic gluteal repairs followed similar principles—specifically, preparing the trochanteric bed, separating the gluteus medius and minimus, mobilizing the tendons and debriding the ends to accommodate holding sutures, and restoring the footprint through the placement of anchors or drill tunnels to restore the appropriate orientation of the tendon fibers. The morphology of the footprint has largely come from anatomic and biomechanical studies of the hip.[10,11] These studies have shown that the gluteus medius tendon inserts into the greater trochanter by 2 distinct attachment sites, the superoposterior and lateral facets.[22,23] The central and anterior thirds of the tendon insert into the larger rectangular lateral facet (surface area, 438 mm^2), whereas the posterior third inserts into the smaller circular superoposterior facet (surface area, 196.5 mm^2). The gluteus minimus tendon has a capsular head that inserts into the hip capsule and a long head that inserts into the lateral facet beneath the gluteus medius tendon. The trochanteric bald spot is found anterior to the lateral facet and separates the gluteus medius from the capsular insertion of the gluteus minimus.

With respect to complications, one of the potential advantages of endoscopic techniques is less tissue dissection. This may have contributed to the lower incidence of wound complications, such as hematomas and infections. It is difficult to stipulate why there were more retears in the open group. This finding may relate to the higher number of procedures in the open studies, patient factors such as postoperative falls, or the potential ability for endoscopic procedures to allow greater mobilization of retracted tendons and adhesiolysis of scar tissue.

There have been several reviews that have commented on surgical management of abductor tears and reviewed operative techniques.[2,6-8] However, many techniques have been accompanied by case reports and have not reported objective outcomes. This has made it difficult to compare techniques. In contrast, we have focused this review on objective outcomes reported in the literature that enabled comparisons between open and endoscopic techniques.

Limitations

One of the limitations of this review is that after an extensive literature search, there were no Level I randomized studies that compared open and endoscopic gluteal tendon repairs. Furthermore, there were only 7 studies that satisfied the inclusion criteria, with a resultant small number of patients, particularly in the endoscopic group. Among the 7 studies, all the articles on open gluteal repairs were prospective, reporting on preoperative and postoperative scores, whereas 2 of the endoscopic studies were prospective and 2 were retrospective. The retrospective studies did not include any preoperative patient outcome scores. Thaunat et al.[17] only reported on a small series of patients, making the study by Domb and Carreira[15] the only study that could be compared with the studies of open techniques. The other obvious limitation of this study, which follows from the first limitation, is the heterogeneity of the studies reviewed—specifically, the heterogeneity within patient populations and concomitant pathologies, grading of gluteal tears, and reported outcome measures. The heterogeneity of patient populations and outcome measures in addition to the small patient numbers within each technique arm made it difficult to draw decisive conclusions about the comparative outcomes of open versus endoscopic gluteal repairs. Ideally, a randomized controlled study of sufficient magnitude and follow-up is required to answer this question.

Conclusions

Open and endoscopic gluteal repairs have similar patient-reported outcome scores, pain scores, and improvement in abduction strength. Open techniques have a higher reported complication rate. Randomized studies of sufficient numbers of patients are required to ultimately determine if one technique produces superior patient outcomes over the other.

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Appendix Table 1. Inclusion and Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
Human studies	Review articles
Articles in English or abstracts in English	Technique articles
Case series with >2 patients	Case reports
Open or endoscopic gluteus medius or minimus repair	Nonoperative studies
Reporting of patient outcomes	Studies performed in setting of hip arthroplasty

Appendix Table 2. Postoperative Rehabilitation for Open and Endoscopic Gluteal Repairs

	Open			Endoscopic			
	Walsh et al.[14]	Davies et al.[13]	Davies et al.[12]	Thaunat et al.[17]	McCormick et al.[16]	Voos et al.[18]	Domb and Carreira[15]
WB status	NWB for 6 wk	25% WB for 6 wk for grade 1 and 2 tears or 12 wk for grade 4 tears	TWB for 6 wk	NWB for 6 wk	Flat-foot WB for 6 wk	6 wk of protected WB with crutches for 20 lb of pressure	6 wk of protected WB with crutches for 20 lb
Exercises	Abduction and hydrotherapy after 6 wk	When fully WB	ROM at 6 wk and resistance at 12 wk	Immediate exercises avoiding passive lateral rotation and adduction and active internal rotation and abduction for 6 wk	Passive ROM for first 6 wk and then ROM, resistance, and sport-specific exercises	CPM in recovery; passive ROM for first 6 wk followed by progression to active strengthening and sport-specific exercises	Avoid passive external rotation and adduction and active hip abduction and internal rotation for 6 wk
Brace	No	Yes—abduction brace for grade 3 and 4 tears	No	Yes—abduction brace	No	Yes—abduction brace	Yes—abduction brace

CPM, continuous passive motion; NWB, non−weight bearing; ROM, range of motion; TWB, toe weight bearing; WB, weight bearing.

Appendix Table 3. Other Clinical Outcomes Measured for Open and Endoscopic Gluteal Repairs

	Open							Endoscopic				
	Walsh et al.[14]		Davies et al.[13]			Davies et al.[12]		Thaunat et al.[17]	McCormick et al.[16]		Voos et al.[18]	Domb and Carreira[15]	
	Preoperative	Postoperative	Preoperative	1 yr	5 yr	Preoperative	1 yr		Preoperative	Minimum, 1 yr	Mean 2 yr	Preoperative	Minimum, 2 yr
Abductor strength grade, mean			3.1	4.7					3.3	4.6	10 of 10 had grade 5 power	4.2	4.73
Mobility	5% normal	78% normal 22% limp but no stick use		2 of 22 required aids	3 of 22 required aids 4 used cane for long walks								
Trendelenburg sign					4 of 19	5 of 16 normal, 4 of 16 mild, 4 of 16 moderate, 3 of 16 severe	6 of 16 normal, 4 of 16 mild, 1 of 16 moderate						
Pain relief					90% (40%-100%)						10 of 10 had complete resolution		
VAS score, mean						7	2					6.8	1.4
Satisfaction					16 of 19 patients satisfied					90% of patients satisfied			Mean score, 9.1 (0, lowest, to 10, highest)
Functional improvement					79.6% (20%-100%)								

VAS, visual analog scale.