Surgical Technique

Gluteus Maximus and Tensor Fascia Lata Transfer for Primary Deficiency of the Abductors of the Hip

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Published online: 18 August 2013
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Abstract

Background Avulsion of the abductor muscles of the hip may cause severe limp and pain. Limited literature is available on treatment approaches for this problem, and each has shortcomings. This study describes a muscle transfer technique to treat complete irreparable avulsion of the hip abductor muscles and tendons.

Description of Technique Ten adult cadaver specimens were dissected to determine nerve and blood supply point of entry in the gluteus maximus and tensor fascia lata (TFL) and evaluate the feasibility and safety of transferring these muscles to substitute for the gluteus medius and minimus. In this technique, the anterior portion of the gluteus maximus and the entire TFL are mobilized and transferred to the greater trochanter such that the muscle fiber direction of the transferred muscles closely matches that of the gluteus medius and minimus.

Methods Five patients (five hips) were treated for primary irreparable disruption of the hip abductor muscles using

this technique between January 2008 and April 2011. All patients had severe or moderate pain, severe abductor limp, and positive Trendelenburg sign. Patients were evaluated for pain and function at a mean of 28 months (range, 18–60 months) after surgery.

Results All patients could actively abduct 3 months postoperatively. At 1 year postoperatively, three patients had no hip pain, two had mild pain that did not limit their activity, three had no limp, and one had mild limp. One patient fell, fractured his greater trochanter, and has persistent limp and abduction weakness.

Conclusions The anterior portion of the gluteus maximus and the TFL can be transferred to the greater trochanter to substitute for abductor deficiency. In this small series, the surgical procedure was reproducible and effective; further studies with more patients and longer followup are needed to confirm this.

Level of Evidence Level IV, therapeutic study. See Instructions for Authors for a complete description of levels of evidence.

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Introduction

Spontaneous complete avulsion of the abductor muscles of the hip or avulsion as a complication of chronic trochanteric bursitis may cause severe limp and often is accompanied by pain [3, 5]. Simple repair of the abductor tendons and muscle often is successful [4, 9, 14], but the failure rate is high [5, 11, 16], leaving deficiencies in the muscle and tendon that cannot be repaired with direct suturing. Augmented repair using Achilles tendon allograft has been used with some success in a small series of patients [6]. Even in patients with successful repair of the muscle and tendon, fatty degeneration remains detectable on MRI [13]. Complete avulsion of the abductor

tendon associated with THA has been treated by transfer of the vastus lateralis in patients with intact abductor muscles that have been irreparably separated from the greater trochanter [1, 10]. Anterior gluteus maximus flap transfer has been used when the abductor muscles are completely missing or deficient, and this occasionally has been done with the addition of the tensor fascia lata (TFL) [17]. The TFL also has been used to substitute for deficient gluteus medius and minimus muscles after conversion of a prior fusion to a THA [2]. A recent online report describes using a long strip of the fascia lata and gluteus maximus transferred under the vastus lateralis but not transferred directly into the greater trochanter [15].

Substitution for deficient abductors requires muscle transfer to the greater trochanter. The anterior portion of the gluteus maximus takes origin from the posterior portion of the iliac crest and sacrum and passes over the greater trochanter to insert in the fascia lata [8]. The gluteus maximus is positioned to be a strong extensor of the hip, but because it does not attach to the bone surface of the greater trochanter, it is not an effective abductor. The TFL takes origin from the anterior superior iliac spine and inserts distally in the anterior portion of the fascia lata. The TFL is positioned well to function as a hip flexor but, in the absence of the gluteus medius and minimus, is not an effective hip abductor [7]. In a previous study, we confirmed that both of these muscles are positioned conveniently for transfer to the greater trochanter to allow them to function as abductors of the hip [17]. That study involved hips with THA and deficient capsule and described a two-limb technique of gluteus maximus transfer to fill the deficiency in the posterior and superior hip.

This report describes a surgical technique to transfer the anterior portion of the gluteus maximus and the entire TFL to the greater trochanter to treat chronic, irreparable deficiency of the abductor muscles of the hip associated with chronic trochanteric bursitis and spontaneous avulsion of the gluteus medius and minimus. Because hips with this condition do not have capsular deficiency, the gluteus maximus transfer was done as a single flap without the capsular portion being transferred through the posterior and superior portion of the joint. A cadaver study first was performed to map the innervation and blood supply of the gluteus maximus and TFL, to establish the feasibility of transferring them to the greater trochanter to substitute for the gluteus medius and minimus, and to determine whether direction of muscle fibers in the transferred muscles matched those of the deficient gluteus medius and minimus. Five patients who had irreparable damage to the abductor tendon, including the entire attachment of the gluteus medius and minimus, were treated with this muscle transfer technique and evaluated to assess its effectiveness in restoring abductor power and eliminating pain.

Materials and Methods

Cadaver Study

Ten human cadaver specimens (six male, four female) were dissected to expose the posterior and lateral portions of the hip. The skin and subcutaneous tissues were removed to clearly delineate the surfaces of the gluteus maximus, gluteus medius, gluteus minimus, and TFL. The insertions of the gluteus maximus and TFL into the fascia lata were exposed completely. The anterior $\frac{1}{3}$ of the gluteus maximus was elevated with a triangular strip of the fascia lata, completely released from its anterior attachment to the fascia lata, and then dissected superiorly while observing its nerve and blood supply. Next the TFL was released from its anterior attachment to the fascia lata and sartorius and detached distally, leaving it with a cuff of fascia lata attached. To determine the safe zone for dissecting the TFL, the posterior edge of the TFL was freed from the edge of the gluteus medius and dissected proximally along its undersurface to expose the terminal branches of the superior gluteal nerve at their entry into the undersurface of the muscle at its posterior edge. The entire length of the TFL and the distance from the proximal end of the muscle to the point of entry of the terminal branches of the superior gluteal nerve into the muscle were measured with a ruler. The most distal point of entry, expressed as a percentage of the length of the muscle from its proximal end, was calculated by dividing the distance from the proximal end to the point of entry of the nerve by the entire length of the muscle.

The two muscle flaps were aligned to overlap the greater trochanter, and their relationship to the muscle fibers of the gluteus medius and minimus that lay immediately deep to the transferred muscle was observed. A goniometer was used to measure the angular difference in alignment of the posterior muscle fibers of the gluteus medius and those of the transferred gluteus maximus, and a similar measurement was made to assess the angular difference between the transferred TFL and gluteus minimus.

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The anterior $\frac{1}{3}$ of the gluteus maximus was released from its distal attachment to the fascia lata so that a triangular tip of fascia lata remained attached to its distal end. This flap was released from its attachment anteriorly to the fascia lata and from its attachment posteriorly to the remaining portion of the gluteus maximus approximately $\frac{1}{2}$ of the length of the muscle. The anterior fascial edge was incised transversely to expose the muscle fibers of the gluteus maximus. The TFL was released from its attachment to the

Fig. 1 A standard posterior approach to the hip is made with a skin incision that parallels the midsubstance of the gluteus maximus, crosses the greater trochanter, and extends distally at least 10 cm distal to the inferior edge of the greater trochanter to ensure that the TFL will be fully accessible. The gluteus maximus is split in line with its fibers about $\frac{1}{2}$ the length of the muscle, and the fascia lata is split distally to a point well below the distal end of the TFL (a). The gluteus maximus flap is released from the fascia lata leaving a slip of fascia attached to the distal end of the flap (b). The anterior edge of the gluteus maximus flap is released from the fascia lata proximally as far as the iliac crest. A transverse incision is made in the fascia still attached to the gluteus maximus flap (c) to allow the muscle fibers to be stretched when the muscle is pulled longitudinally. The gluteus maximus flap is elevated, exposing the gluteus medius and minimus and their avulsed attachment to the greater trochanter (d). Distally the anterior portion of the fascia lata is incised transversely to the lateral edge of the sartorius (e), leaving a cuff of fascia lata at least 1 cm wide attached to the distal end of the TFL.

fascia lata distally, leaving a cuff of fascia lata approximately 1 cm wide (Fig. 1). The muscle was released from its attachment to the fascia lata anteriorly as far as its attachment to the anterior superior iliac spine. The ascending branch of the lateral femoral circumflex artery was clamped and cauterized. The posterior edge of the TFL was released from the fascia lata as far proximally as the junction of the muscle with the gluteus medius (Fig. 2). This dissection was done superficially to avoid damaging the terminal branches of the superior gluteal nerve as they entered the TFL. The distal $\frac{1}{2}$ of the TFL was elevated

Fig. 2 The fascia lata is incised transversely to the lateral edge of the sartorius (a), leaving a cuff of fascia lata at least 1 cm wide attached to the distal end of the TFL (b), and then the TFL is separated from the sartorius proximally to the anterior superior iliac spine (c). The posterior edge of the TFL, still with a cuff of fascia lata attached, is released proximally to the inferior edge of the gluteus minimus (d). The TFL is *not* separated from the abductor muscles.

from distally as care was taken to avoid damage to its nerve and blood supply where it entered the muscle posteriorly from the undersurface of the gluteus medius. The fascia lata between the posterior edge of the TFL and anterior edge of the gluteus maximus was excised.

The greater trochanter was exposed and a 4- × 4-cm concave trough was fashioned on its lateral surface using a $\frac{1}{2}$ -inch osteotome, exposing the cancellous bone. The vastus lateralis was split in a T-shaped fashion to expose the underlying bone just distal to the greater trochanter (Fig. 3). Holes were drilled in the edges of the greater trochanter for placement of heavy nonabsorbable sutures (Fig. 4). The hip was placed in neutral abduction and the anterior gluteus maximus flap was tensioned firmly over the greater trochanter and sutured with a combination of simple and mattress sutures to the trough with heavy nonabsorbable sutures (Number 5 Ethibond[®]; Ethicon, Inc, Somerville, NJ, USA) passed through the holes drilled in

Fig. 3 The vastus lateralis is split in a T-shaped fashion and elevated from the underlying femoral cortex (a). A sharp osteotome is used to decorticate the lateral surface of the greater trochanter (b).

Fig. 4 The edges of the decorticated surface are perforated with a drill.

the cortical edges (Fig. 5). These sutures were angled distally from the transferred flap approximately 45° to minimize slipping in response to tension in the flap. Next the distal tip of the gluteus maximus flap and its fascia lata extension were sutured under the vastus lateralis with heavy absorbable sutures (Number 3 Vicryl®; Ethicon, Inc). Interrupted mattress sutures and figure-of-eight sutures were used to attach the tip of the flap to the undersurface of the fascia of the vastus lateralis. The hip was adducted slightly to ensure that the flap was tensioned, and then it was returned to neutral abduction. With the hip in neutral abduction, the TFL flap was tensioned firmly and approximated to the posterior suture line of the gluteus maximus flap where it attached to the greater trochanter and was sutured under the vastus lateralis flap and on to the transferred portion of the gluteus maximus with a combination of heavy absorbable sutures (Number 3 Vicryl®) and heavy nonabsorbable sutures (Number 5 TI-CRON™; Covidien, Mansfield, MA, USA). Approximately one of every three sutures was nonabsorbable. The adjoining edges of the transferred flaps were sutured together with Number 3 Vicryl® suture and the vastus lateralis edges were closed over the transferred flaps with heavy absorbable suture (Number 3 Vicryl®) (Fig. 6). As each muscle

flap was sutured in place, its tension was tested by bringing the hip to slight adduction and ensuring that the tissue was tight in this position. In three of the five hips, the TFL developed a gray, dusky appearance as it was being sutured into its new position. Normal color was rapidly regained when the overlying fascia was pie-crusting with multiple 1-cm incisions. The muscle flap closure was finished by suturing with Number 3 Vicryl® the inferior edges of the transferred gluteus maximus and TFL together and by suturing the lower portion of the gluteus maximus to the posterior edge of the TFL and further proximally to the surface of the transferred anterior portion of the gluteus maximus (Fig. 7).

Postoperative management and rehabilitation included ambulation with touch-down weightbearing with two-handed support from either crutches or walker on the first postoperative day. Gentle abduction exercises done in the standing position were initiated with physical therapy supervision after 6 weeks and gradually increased for 2 weeks. Full weightbearing was allowed after 6 weeks, but two-handed support was continued with crutches or a walker. After the eighth postoperative week, abduction exercises were advanced to include abduction against gravity while lying on the opposite side. At this time, a

Fig. 5 The gluteus maximus flap (a) is sutured to the edges of the decorticated greater trochanter with heavy nonabsorbable sutures angled to pull the flap distally. The fascia lata extension (b) is placed on the cortical bone under the elevated vastus lateralis (c).

single crutch on the opposite side was used for ambulation, and a cane was substituted for the crutch after 2 weeks. The use of a cane was encouraged for a full year after surgery. Gait training and abductor strengthening were supervised by an experienced physiotherapist beginning at 3 months postoperatively.

Patients and Methods

Inclusion criteria in the study included patient consent and willingness to return for followup and have results presented and published. The clinical criteria were primary avulsion of the abductor tendon attachment to the greater trochanter, marked weakness of abductors, positive Trendelenburg sign, noticeable limp, and palpable strong contraction of the TFL with hip abduction and of the gluteus maximus with hip extension. Five patients (four women, one man; five hips) were treated for primary disruption of the gluteus medius attachment to the greater trochanter between January 2008 and April 2011. None of the patients reported significant trauma, but three reported feeling the tendon tear while lifting or swinging a golf club. Minimum followup was 18 months (mean, 28 months; range, 18–60 months). Mean age was 67 years (range,

Fig. 6 The TFL (a) is transferred over the greater trochanter and gluteus maximus flap (b). Its inferior edge is sutured under the vastus lateralis flaps (c), which are closed securely with absorbable sutures. The distal end may be overlapped posteriorly to reconstruct a capsular defect.

56–72 years). Mean weight was 79 kg (range, 48–97 kg). Preoperatively, all patients reported moderate or severe pain, and all had severe abductor deficiency limp and strongly positive Trendelenburg sign with one-leg stance. None could actively abduct the hip while lying on the contralateral side, but when lying on the opposite side, all had palpable contraction of the gluteus maximus during hip extension and TFL during abduction effort. Three hips had chronic trochanteric bursitis treated with multiple cortisone injections for more than 2 years. At surgery, all patients were found to have complete avulsion of the entire gluteus medius attachment to the greater trochanter with muscle atrophy. Two patients had complete avulsion of the greater trochanteric attachment of the gluteus medius and gluteus minimus, and the other three had thinning and attenuation of the posterior 1/2 of the gluteus minimus and complete avulsion of the gluteus medius attachment. Although definite cause of the tendon disruption could not be determined, all the hips had hypertrophic trochanteric bursa tissue and fibrillated tendon edges, suggesting attrition of the tendons and spontaneous rupture. Two hips had had attempted repair of the abductor tendons at another institution, one using Achilles tendon allograft and one using

Fig. 7 The anterior (a) and posterior (b) portions of the fascia lata are repaired with absorbable sutures, and the posterior portion of the gluteus maximus (c) is overlapped over the anterior flap (d) and TFL flap (e).

suture anchors for direct repair. All patients had intact gluteus maximus and TFL muscles.

The patients were seen for followup at 1 month, 2 months, 3 months, and yearly thereafter. The ability to abduct while standing was tested at 1 month, and abduction strength while lying was tested at 3 months. Gait and one-legged stance were evaluated at the 3-month postoperative visit and at yearly intervals thereafter. Pain was assessed at each postoperative visit.

Results

In the cadaver specimens, the anterior portion of the gluteus maximus and the entire TFL could be released and transferred to the greater trochanter without excessive tension on the muscle fibers. In all cases, the angle of the muscle fibers in the transferred gluteus maximus was within 10° of the angle of the posterior fibers of the gluteus medius, and the angle of the fibers of the transferred TFL was within 5° of the anterior fibers of the gluteus minimus (Table 1).

Entry of the nerves and vessels into the gluteus maximus was consistently proximal, within 2 cm of their exit from

Table 1. Angular deviation of transferred flap

Cadaver	Gluteus maximus to the posterior fibers of the gluteus medius ($^\circ$)	TFL to the anterior fibers of the gluteus minimus ($^\circ$)
1	0	5
2	3	4
3	7	2
4	2	0
5	4	3
6	6	3
7	5	2
8	7	4
9	9	5
10	2	4

TFL = tensor fasciae lata.

Fig. 8 The fascia lata (a) has been divided up to the iliac crest, and the anterior gluteus maximus flap (b) has been elevated, exposing the gluteus medius (c). The inferior gluteal nerve and accompanying vessels (d) enter the muscle proximally and run along the undersurface of the muscle (e).

the sciatic notch of the pelvis, and the neurovascular structures were not disturbed by separating the anterior $\frac{1}{3}$ of the muscle from the posterior $\frac{1}{3}$ (Fig. 8). The terminal branches of the inferior division of the superior gluteal nerve and its accompanying vessels entered the TFL in its proximal $\frac{1}{2}$ in all cases (Fig. 9). The mean point of entry was 0.38 (range, 0.3–0.4) of the muscle's length from its proximal attachment to the iliac crest, and the point of entry was always on the posterior edge of the muscle so that the anterior edge of the muscle could be released from the sartorius without endangering its innervation (Fig. 10). Once released from its anterior and deep attachments, the distal end of the TFL readily could be transferred posteriorly to the greater trochanter. Posterior dissection of the muscle above the midpoint of the muscle was not necessary

Fig. 9 The interval between the gluteus minimus (a) and TFL (b) has been dissected to expose the branches of the superior gluteal nerve (c, d) that cross between the two muscles.

Fig. 10 Dissection of the interval between the TFL (a) and sartorius (b) extended to the anterior superior iliac spine (c) without encountering visible nerve branches.

to allow it to be transferred to the greater trochanter. In all specimens, the muscle overlapped the greater trochanter and could be attached to the posterior edge without excessive tension. Likewise, the anterior $\frac{1}{3}$ of the gluteus maximus easily overlapped the greater trochanter, and its distal fascial tip could be placed under the vastus lateralis attachment into the femur.

All five patients healed primarily and were discharged from the hospital within 5 days. At 1 month postoperatively, all could abduct the operated hip gently while standing. By 3 months postoperatively, all could abduct against gravity while lying on the opposite side with the knee flexed, but all walked with a limp and had positive Trendelenburg sign. All were able to begin cane use by 3 months. One patient fell during the 10th month postoperatively and avulsed the proximal tip of the greater trochanter.

At the 1-year postoperative visit, all patients except the patient who avulsed his greater trochanter were able to walk without a cane and could abduct the hip strongly against gravity in neutral rotation with the knee extended while lying on the opposite side. The patient who fell and fractured his greater trochanter could not abduct the affected hip while lying on the opposite side. He continued to walk with a moderate limp and had a positive Trendelenburg sign. Three patients had no limp and one had a mild limp but negative Trendelenburg sign. None had lateral hip pain. The two patients with more than 2 years of followup could walk with no detectable limp and had maintained strong hip abduction.

Discussion

Abductor tendon avulsion, although relatively uncommon, is probably underdiagnosed. It can cause gait dysfunction and pain. The described treatments for this condition are inconsistently successful [4, 5, 9, 11, 14, 16]. The current study demonstrated, in both the laboratory and clinical setting, the TFL and anterior portion of the gluteus maximus were conveniently positioned for transfer to the greater trochanter to substitute for deficient gluteus medius and minimus muscles. The muscle fibers of the transferred gluteus maximus and TFL were found to closely align in direction and could substitute for those of the deficient abductor muscles. The surgical procedure was reproducible and effective at short-term followup, with four of the five patients reporting pain relief, improved function, and improved gait.

The small size of the study, both in the 10 cadaver specimens and five patients, is a limitation of this study. It is possible that the muscles in some patients would be less amenable to transfer to the greater trochanter than is suggested in this study. A larger study might reveal problems

with the surgical technique intraoperatively or with complications postoperatively that were not encountered in this small series. Whereas the present study focuses on treatment of primary avulsion of the hip abductors, it is likely that similar procedures could be used to correct the deficiencies caused by abductor muscle damage of minimally invasive surgical techniques [12]. However, addition of the TFL to the transfer would be ineffective if superior gluteal nerve damage were involved. Testing the muscle for response to electrocautery at the time of surgery can help determine whether the muscle is functional.

Simple repair of spontaneous avulsion of the gluteus medius and minimus has a high failure rate [5, 11, 16]. Direct repair of the abductor tendons is the mainstay of treatment for repairable lesions [4, 9, 14], but reconstruction in cases of irreparable damage to the tendons or complete loss of the muscles has not been described in the orthopaedic literature for primary rupture of the abductor tendons. However, use of a long strip of the fascia lata including the TFL and gluteus maximus recently has been reported online [15]. The reported technique seems to transfer the muscle flaps anterior and posterior to the greater trochanter and does not secure the muscles to the prominence of the bone surface. Treatment of complete deficiency of the abductor muscles has been described for cases involving THA [1, 10, 17, 18]. Transfer of a portion of the posterior gluteus maximus has been successful in most cases when the greater trochanter is present but is widely separated from the lateral femoral cortex [18]. Transfer of the anterior portion of the gluteus maximus to the greater trochanter has been successful in cases with revision THA and complete deficiency of the abductor muscles [17]. In cases involving THA, capsular deficiency is a common finding and predisposes to dislocation. In such cases, an additional gluteus maximus flap taken from the posterior portion of the muscle and transferred through the joint above the femoral neck and into the anterior capsule fills the superior and posterior joint cavity to stabilize the hip. Since primary avulsion of the abductor tendons does not result in capsular deficiency, this posterior gluteus maximus flap is not necessary. The posterior gluteus maximus muscle fibers do not align accurately with the intact muscles fibers of the gluteus medius and minimus, so the hip requires external rotation to achieve abduction and the patient often is left with a limp [17]. Transfer of the vastus lateralis also has been effective as treatment for deficiency of the abductor muscles [1, 10], but the exposure is extensive and requires extension of the incision to the knee, separation of the vastus lateralis from the other members of the quadriceps, and dissection of the neurovascular structures of the vastus lateralis. It is not clear from reported cases whether this procedure would be useful in cases of total absence of the abductor muscles.

The gluteus maximus is innervated by the inferior gluteal nerve very close to the point of exit of the nerve from the sciatic notch [8, 17], so the anterior portion of the muscle can safely be separated from the rest of the muscle. The insertion of the gluteus maximus into the fascia lata can be transferred readily to the greater trochanter, allowing the upper portion of the gluteus maximus to act as an abductor of the hip [17]. The TFL is innervated by the superior gluteal nerve [8], so the muscle can be detached safely from its anterior fascial covering and its anterior surface completely freed to allow its distal end to be transferred posteriorly to the greater trochanter. Our cadaver dissection suggests that dissection of the posterior edge of the TFL above the midpoint of the muscle would endanger its nerve supply from the superior gluteal nerve, but that more proximal dissection is not necessary to achieve effective transfer of the muscle to the greater trochanter. This muscle has dense tendinous attachments into the fascia lata, and when transferred with an attached cuff of iliotibial band, it can be secured with sutures to the transferred gluteus maximus and over the top of the greater trochanter to reinforce the posterior capsule and short external rotator muscles. Combined transfer of the anterior portion of the gluteus maximus and TFL provides much more muscle mass than the gluteus maximus alone and also aligns the muscle fibers in a position of greater advantage in abduction. Furthermore, the dissection is subcutaneous and does not require extensive dissection and exposure of the neurovascular structures of the transferred muscles. It also can be done effectively when the abductor muscles are completely absent.

Deficiency of the hip abductor muscles remains a difficult and unsolved problem. The muscle transfer technique described in this study may benefit some patients, but the surgery is technically difficult, and the effectiveness of the procedure is not sufficiently established by the data in this brief report to recommend widespread use as yet. With more experience, this information may improve surgical treatment of this difficult problem.

Acknowledgments The author thanks William C. Andrea MS, CMI for preparation of the illustrations and Diane J. Morton MS for assistance with manuscript preparation.

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