Surgical Technique

Transfer of the Anterior Portion of the Gluteus Maximus Muscle for Abductor Deficiency of the Hip

Leo A. Whiteside MD

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Abstract

Background Loss of the abductor portions of the gluteus medius and gluteus minimus muscles due to THA causes severe limp and often instability.

Description of Technique To minimize the symptoms of limp and instability, the anterior ½ of the gluteus maximus was transferred to the greater trochanter and sutured under the vastus lateralis. A separate posterior flap was transferred under the primary flap to substitute for the gluteus minimus and capsule. To ensure tight repair, the flaps were attached and tensioned in abduction.

Patients and Methods The technique was performed in 11 patients (11 hips) with complete loss of abductor attachment; the procedure was performed in nine patients during THA and in two later as a secondary procedure. Preoperatively, all patients had abductor lurch, positive Trendelenburg sign, and no abduction of the hip against gravity. Minimum followup was 16 months (mean, 33 months; range, 16–42 months).

Results Postoperatively, nine patients had strong abduction of the hip against gravity, no abductor lurch, and negative Trendelenburg sign. One patient had weak abduction against gravity, negative Trendelenburg sign,

and slight abductor lurch. One patient failed to achieve strong abduction, had severe limp after 6 months of protection and physical therapy, and was lost to followup.

Conclusions Gluteus maximus transfer can restore abductor function in THA with a high success rate.

Introduction

Disruption or total destruction of the abductor muscles of the hip almost always causes a noticeable limp and predisposes to dislocation after revision THA [1, 13, 14]. Abductor deficiency can be caused by primary disruption of the abductor mechanism, osteolytic destruction of the proximal femoral bone stock in association with failed THA, or destruction of the abductor muscles themselves by the inflammatory process sometimes associated with metal-on-metal THA [4, 6, 9, 11]. In most cases of avulsion of the tendon or greater trochanter associated with THA, surgeons cannot reattach the gluteus medius and minimus to the femur, even if a fragment of greater trochanter is still present. In cases of destructive inflammation associated with failed THA, the abductor muscles and capsule of the hip may be completely absent.

Restoring abductor function of the hip by simply closing the gluteus maximus and fascia lata tightly over the defect is not effective in restoring abductor function in cases of irreducible displacement of the greater trochanter in failed THA [14]. In cases with chronic detachment of the gluteus medius and wide separation from the femoral bone stock, abductor function can be restored by spanning the gap between the greater trochanter and the femur with a segment of gluteus maximus muscle transferred from the posterior portion of the muscle [14]. However, this muscle transfer technique is not effective when the abductor

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The author certifies that his institution approved the human protocol for this investigation, that all investigations were conducted in conformity with ethical principles of research, and that informed consent for participation in the study was obtained.

L. A. Whiteside (✉)
Missouri Bone and Joint Research Foundation, 1000 Des Peres
Road, Suite 150, St Louis, MO 63131, USA
e-mail: info@mobojo.org; whiteside@whitesidebio.com

muscles are missing or completely deficient due to osteolytic disintegration and prolonged displacement of the greater trochanter. Complete substitution of the abductor function of the gluteus medius is necessary in these cases to stabilize the pelvis and prevent limp. The anterior $\frac{1}{2}$ of the gluteus maximus is positioned favorably to abduct the hip. It attaches along the posterior $\frac{1}{2}$ of the iliac crest, and its anterior fibers are nearly parallel to the femoral shaft in full extension [7]. It is innervated by the inferior gluteal nerve, which enters posteriorly and proximally in the muscle [7]. Therefore, it can be detached anteriorly from the fascia lata as far proximally as the iliac crest and posteriorly from its attachment to the iliotibial band as far proximally as $\frac{1}{2}$ of the length of the muscle. When elevated as a triangular flap with a distal tongue of fascia lata, this muscle flap can be attached directly to the greater trochanter and vastus lateralis muscle. In situations involving capsular deficiency, posterior instability, or absence of the short external rotator muscles, an additional triangular flap can be raised from the posterior portion of the gluteus maximus muscle and transferred under the main anterior gluteus maximus flap and greater trochanter to attach to the anterior capsule. This flap substitutes for the gluteus minimus muscle and short external rotators and capsules and helps limit excessive internal rotation and adduction of the hip. The tensor fascia lata can be transferred to the greater trochanter, adding adduction and internal rotation strength to the hip.

Destruction of the greater trochanter and abductor muscle group of the hip continues to be a problem in revision THA, especially in patients with metal hypersensitivity [4, 6, 9, 11]. A technique to reconstruct the abductors has been used for the past 4 years to address these conditions that otherwise would be associated with major abductor deficiency and instability of the hip. This article describes the technique and reports its ability to restore abductor function and hip stability.

Surgical Technique

The indication for this approach is abductor deficiency caused by loss of the gluteus medius and minimus muscles in patients who have a normally functioning gluteus maximus muscle. It cannot be performed in cases with weakness or absence of the gluteus maximus muscle.

The surgical technique used a posterior exposure of the hip, in which the gluteus maximus muscle was split in line with its fibers, approximately $\frac{1}{2}$ of the length of the muscle. The fascia lata was split in line with its fibers, extending well below the greater trochanter (Fig. 1). After the procedure was completed on the hip, the gluteus maximus flaps were fashioned. The anterior portion of the gluteus maximus was exposed by deep subcutaneous

Fig. 1 The posterior approach splits the gluteus maximus in line with its fibers approximately $\frac{1}{2}$ of the length of the muscle and continues distally, splitting the fascia lata (A). The fascia just anterior to the gluteus maximus muscle is split in line with its fibers up to the iliac crest. The anterior incision is extended distally to form a long fascial tip for the anterior muscle flap (B). The anterior fascial portion of the flap is cut transversely to the edge of the muscle (C).

dissection, and the fascia lata was split in line with its fibers from the upper portion of the muscle to a point approximately 4 cm distal to the upper attachment of the gluteus maximus muscle into the fascia. This incision joined the fascial incision made for exposure, leaving a substantial distal fascial flap for attachment to the bone. The anterior $\frac{1}{2}$ of the gluteus maximus was elevated with blunt and sharp dissection to form a triangular proximally based flap. The anterior fascial edge of this flap was transected down to muscle tissue to allow the muscle fibers to be tensioned correctly (Fig. 2). Deficiency of the posterior capsule and short external rotators was addressed with an additional posterior gluteus maximus flap. Approximately 1.5 cm of the distal attachment of the posterior portion of the gluteus maximus muscle into the fascia lata was elevated sharply (Fig. 2) and dissected proximally about $\frac{1}{2}$ of the length of the muscle to fashion a triangular flap that was wider proximally than distally (Fig. 3). This exposes the sciatic nerve, which must be guarded carefully throughout the

Fig. 2 The anterior gluteus maximus flap has been elevated. The anterior incision may extend up to the iliac crest if necessary, and the posterior incision extends approximately $\frac{1}{2}$ of the length of the muscle. The distal portion of the flap is triangular-shaped and consists entirely of fascia lata. The anterior fibrous band, made up of the fascia lata, is transected with a knife (A) to allow the muscle fibers to be tensioned correctly when the flap is attached to the femur. The posterior flap is delineated (B).

procedure. A heavy nonabsorbable suture (Number 5 Ethibond[®]; Ethicon Inc, Somerville, NJ) was passed through the anterior capsular structures of the hip, and then the suture was passed through the tip of the posterior flap in a figure-eight and out through the anterior capsule of the hip. The posterior flap was pulled across the top of the femoral neck and the suture was tied to secure the posterior flap to the anterior edge of the greater trochanter and anterior capsule of the hip. This construct was reinforced with additional absorbable sutures (Number 3 Vicryl[®]; Ethicon) passed through the greater trochanter and through the anterior edge of the hip capsule (Fig. 4).

Next, the greater trochanter was prepared to allow attachment of the anterior muscle flap directly to the femur. A sharp osteotome was used to elevate the lateral cortex of the greater trochanter over an area of about 2 cm by 3 cm (Fig. 5). Multiple drill holes were made in the cortical

Fig. 3 The posterior flap (A) has been elevated approximately $\frac{1}{2}$ of the length of the muscle fibers. The sciatic nerve (B) is shown in the surgical field.

edges of the bone (Fig. 6). The vastus lateralis was split in line with its fibers (2 cm) and detached from its proximal attachment into the femur 1.5 cm anteriorly and posteriorly. Then, the hip was abducted 15° and the muscle flap was sutured under moderate tension into the greater trochanter with multiple heavy sutures (Number 5 Ethibond[®]), angled so as to pull the flap distally (Fig. 7). If a fragment of the greater trochanter still was present along with the retracted gluteus medius muscle, the upper edge of the posterior gluteus maximus flap was sutured to the bone fragment and the anterior gluteus maximus flap was applied over the top of this repair and also sutured to the edges of the bone fragment with Number 3 Vicryl[®] sutures.

The triangular fascial tongue of the gluteus maximus flap was placed under the vastus lateralis and held in place with multiple heavy absorbable sutures (Number 3 Vicryl[®]). The vastus lateralis was reattached to its original site with the same suture (Fig. 8). In cases where the greater trochanter was missing, the distal fascial tongue was fashioned long enough to attach to the lateral femoral

Fig. 4 The posterior gluteus maximus flap (A) has been passed over the top of the femoral neck, under the tip of the greater trochanter (B), and sutured into the anterior capsule and anterior edge of the greater trochanter.

cortex distally. A single cable passed around the femur allowed the fascial tongue to be passed under, folded back, and sutured to itself for attachment to bone (Fig. 9). The vastus lateralis covered this attachment and was sutured down proximally. Additional abductor muscle mass could be recruited by using the tensor fascia lata. After the gluteus maximus flap was attached, the fascia lata was cut transversely at the distal attachment of the tensor fascia lata and then the anterior edge of the tensor was dissected from its fascial attachments and elevated with sharp and blunt dissection. The posterior edge of the tensor was released sharply from its fascial attachments $\frac{1}{2}$ to $\frac{2}{3}$ of the length of the muscle, and the distal end of the muscle was attached to the gluteus maximus flap attachment with heavy absorbable sutures (Number 3 Vicryl®). This tensor fascia lata transfer was performed before the vastus lateralis was closed, and its distal attachment included suturing under the vastus lateralis flaps. After the transfers were completed and before closure was started, the hip was brought to

Fig. 5 A sharp osteotome is used to make a slot in the greater trochanter from near its tip to just above the attachment of the vastus lateralis muscle to the femur, removing only the cortex.

neutral abduction to ensure the transferred muscles were tight.

Closure was completed with the hip in 15° abduction. The posterior edge of the anterior flap was sutured snugly to the top of the posterior flap (Fig. 10). Next, the anterior and posterior portions of the fascia lata were brought together over the top of the transferred flaps and sutured snugly, extending proximally to form a Y shape. The anterior edge of the anterior flap was not closed so that the muscle pull would be exerted directly on the greater trochanter (Fig. 11). The upper edge of the lower $\frac{1}{2}$ of the gluteus maximus was sutured to the posterior edge of the anterior flap, leaving the posterior flap underneath (Fig. 11). This completed muscle and fascial closure applied the upper $\frac{1}{2}$ of the gluteus maximus to the greater trochanter to maximize its effectiveness for abducting the femur (Fig. 12).

Postoperative care included early partial weightbearing of 50 pounds with two-handed support, use of an abduction pillow for 3 days while in bed, and avoidance of abduction exercises for 6 weeks postoperatively. Patients then started

Fig. 6 Drill holes are made in the walls of the greater trochanter with a 1/8-inch drill bit.

gradual abduction strengthening exercise and gradually increased weightbearing for another 6 weeks. All patients were encouraged to use a cane for 6 months.

Patients and Materials

This procedure was performed in 11 patients (11 hips), four men and seven women, with total abductor deficit associated with THA. The patients' mean age was 67 years (range, 52–73 years). All patients had severe abductor lurch when walking, strongly positive pelvic sag with ipsilateral one-legged stance (Trendelenburg sign), no active hip abduction while lying on the opposite side, and no palpable abductor muscle contraction with attempted hip abduction. Three patients had previous metal-on-metal THA with massive soft tissue destruction, six had multiple revision THAs with osteolytic destruction of the greater trochanter and loss of the abductor muscles, and two patients had failed repairs of a greater trochanteric fracture after revision THA and wide irreducible displacement of the trochanteric fragment. Three patients had recurrent dislocation in association with this abductor deficiency.

Fig. 7 The vastus lateralis muscle has been detached from its attachment to the femur and split in line with its fibers (A). The anterior gluteus maximus flap has been sutured to the slot in the greater trochanter (B). These sutures are angled so as to pull the flap distally. The distal fibrous tip of the anterior flap lies on the bone under the elevated vastus lateralis muscle (C).

Fig. 8 The vastus lateralis muscle has been sutured to the distal fibrous tip of the anterior gluteus maximus muscle.

Nine of the 11 patients had failed components requiring revision. The gluteus maximus muscle was intact in all patients. Seven had at least a partially intact greater trochanter. Two patients had a totally absent greater trochanter and required attaching the gluteus maximus flap directly to

Fig. 9 In the absence of the greater trochanter, the posterior flap (A) is sutured to the anterior capsule of the hip and the anterior flap (B) is passed under a cable that encircles the femur and is sutured to itself under moderate tension with the hip abducted 15°. The vastus lateralis shown as split and elevated in this drawing (C) is sutured over this construct.

Fig. 10 The posterior edge of the anterior gluteus maximus flap (A) is sutured to the posterior gluteus maximus flap (B), which passes under it.

Fig. 11 The lower ½ of the gluteus maximus muscle (A) has been sutured to the fascia lata (B). The upper edge of this portion of the gluteus maximus muscle (C) will be attached to the lower edge of the anterior flap (D), as depicted by the arrow.

the lateral cortex of the femur. Two of the three patients with a history of recurrent dislocation had an additional posterior gluteus maximus flap to replace the deficient superior and posterior capsule and gluteus minimus muscle.

The revision THA was performed with fully porous-coated tapered Ti femoral components and porous-coated acetabular components. Four patients had custom augments to fill major acetabular bone deficits and to secure fixation.

One patient (one hip) was lost to followup after 6 months and the remaining 10 patients (10 hips) were followed for a minimum of 16 months (mean, 33 months; range, 16–42 months).

Results

At last followup, 10 patients regained adduction of the hip against gravity when lying horizontally in the lateral position. Nine had strong abduction and a negative Trendelenburg sign and walked without a limp. One had weak abduction and a slightly positive Trendelenburg sign (slight pelvic sag with ipsilateral one-legged stance) with mild limp. One patient failed to achieve strong abduction; this patient had a severe limp after 6 months of careful protection and physical therapy and was lost to followup. This

Fig. 12 The posterior flap (A) passes under the anterior flap (B). The anterior fascial edge of the anterior flap (C) has not been sutured to allow pull of the transferred muscles to be exerted on the greater trochanter. The transverse cut in the anterior fascial portion of the flap is pulled open (D) by the tension of the closure.

patient was 72 years old, female, and obese; had severe muscle and fibrous tissue atrophy; and was believed to have failed due to failure of the repair.

One of the three patients who had recurrent dislocation of the hip preoperatively continued to have recurrent dislocation after transfer of the anterior $\frac{1}{2}$ of the gluteus maximus. Seven months postoperatively, the patient had a second operation to transfer a posterior gluteus maximus flap under the greater trochanter to reconstruct the superior and posterior capsule. At 9 months postoperatively, this hip was stable.

Discussion

Loss of the abductor portions of the gluteus medius and gluteus minimus muscles due to THA causes severe limp and often instability. A technique to reconstruct the abductors has been used for the past 4 years to address these conditions that otherwise would be associated with major abductor deficiency and instability of the hip. This article described the technique and reported its ability to restore abductor function and hip stability.

The limitations of this study include the following. First, it is a small series. However, complete loss of abductor

function is uncommon, and therefore the indications would necessarily be limited. Second, the followup is relatively short, and while it is inadequate to ensure no late dislocations, it is long enough to assess restoration of abductor function and only one patient had a postoperative dislocation. Third, there is no comparative cohort of patients treated with alternative methods. Finally, a single surgeon performed all the procedures in this study, and the results of other surgeons may be substantially different.

Transfer of the anterior portion of the gluteus maximus muscle to the greater trochanter and lateral femur restored effective hip abduction in most (90%) patients with severe abductor deficiency before surgery. Addition of a smaller posterior flap of gluteus maximus muscle, transferred under the greater trochanter, seemed to prevent recurrent dislocation. An earlier report of transferring a portion of the gluteus maximus muscle to restore abductor function of the gluteus medius muscle in cases of displacement of the greater trochanter had a similar success rate [14]. The current study dealt with hips with more severe abductor deficiency than those reported in that series and achieved similar results. In other situations with loss of major muscle attachments to bone, muscle flap transfer is effective in restoring function. Surgeons have treated chronic avulsion of the patellar tendon and loss of extensor power of the knee effectively with gastrocnemius muscle transfer [3]. Chronic rotator cuff avulsion responds well to latissimus dorsi and deltoid muscle transfer [12]. The gluteus maximus muscle is convenient and effective when covering soft tissue defects about the pelvis [2, 8, 10]. Since the gluteus maximus muscle is active in abduction and extension of the hip [7], it is capable of actively abducting the hip if attached directly to the greater trochanter. In most patients, this abductor strength is sufficient to stabilize the pelvis and eliminate pelvic sag during walking.

Loss of the ligament and muscle control of the hip is likely responsible for the high rate of dislocation after revision THA [5, 13]. The large, patulous joint and poorly constrained ROM predispose the hip to dislocation [5, 13]. The series in this article is too small to establish the effect of this procedure on dislocation rate, but addition of a posterior muscle flap in cases of severe capsular deficiency probably stabilizes the hip and protects against instability. It is probably not coincidental that, of the three patients with preoperative instability, the one without the additional posterior muscle flap had recurrent dislocation postoperatively. Furthermore, addition of the posterior muscle flap later seems to have controlled recurrent dislocation in this hip.

It is fortunate that destruction of the abductor muscle group does not generally affect the gluteus maximus, thus leaving it available as a muscle transfer. Even in the face of

complete destruction of the abductor muscles, this convenient muscle flap transfer appears to be an effective remedy for much of the disability caused by loss of the abductor muscles.

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