Trochanteric Osteotomy for Total Hip Arthroplasty: Six Variations and Indications for Their Use

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Abstract

Trochanteric osteotomy of the femur in total hip replacement used to be a simple, stereotyped technique and was declining in frequency of use. Many variations in the technique have evolved recently, including the trochanteric slide and the extended trochanteric osteotomy, which have increased the flexibility and utility of trochanteric osteotomy and the frequency of its application. The authors describe six trochanteric osteotomies and discuss the indications for their use.

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Most primary total hip arthroplasties and many revisions are done without osteotomy of the greater trochanter. The advantages of not doing a trochanteric osteotomy are many. The blood loss and operating time are usually less, nonunion is eliminated, and wires or cables are not needed. In selected cases involving difficult primary or revision procedures, osteotomy of the greater trochanter has distinct advantages, and in a few situations it is mandatory. For example, osteotomy and advancement of the greater trochanter is essential if the femur must be shortened. Failure to advance the trochanter leaves the abductors lax, leading to an increased risk of limp and dislocation. Some complex primary or revision cases also require trochanteric osteotomy for enhanced exposure of the acetabulum and the proximal femur; wider access to the hip means the risk of technical errors will be diminished.

It is valuable for the hip surgeon to know the various options and techniques of trochanteric osteotomy that can be used in the wide range of clinical situations that arise in hip surgery. In this article, we review and describe six techniques—namely, standard, trochanteric slide, oblique, horizontal, vertical, and extended—and outline our current indications for their use in primary total hip replacement (Table 1) and in revision procedures (Table 2).[1-9]

Standard Trochanteric Osteotomy

In the infrequent primary total hip replacements that require wider exposure than usual, we use the standard trochanteric osteotomy (Fig. 1). Examples are cases in which a very complex acetabular reconstruction is associated with severe developmental dysplasia or in which it is necessary to correct unacceptable laxity of the abductors for any reason, such as an offset problem that cannot be corrected by other means. It is also useful in cases of mandatory trochanteric osteotomy in which the femur is shortened or the hip is lax because of a high hip center.

After exposure of the hip, a Cushing elevator is inserted from anterior to posterior in the interval between the tendon of the gluteus minimus and the superior part of the hip capsule, craniad to the femoral neck at the junction of the greater trochanter with the superior part of the femoral neck. The osteotomy cut traverses the sulcus between the lateral portion of the origin of the vastus intermedius muscle and the insertions of the gluteus medius and minimus. To make this cut, it is necessary to release the origin of the vastus lateralis from the vastus tubercle and begin the osteotomy cut approximately 1 cm distal to the vastus tubercle. The osteotomy is performed with an osteotome or oscillating saw, which is aimed at the Cushing elevator.

Once the trochanter has been osteotomized, it is retracted proxi-

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Table 1
Indications for Trochanteric Osteotomies in Primary Total Hip Replacement

Indication	Type of Osteotomy
Wide exposure is needed for complex acetabular or femoral reconstruction	Standard or slide
Femur needs to be shortened	Standard or slide
Excessive laxity after reconstruction, because femoral offset cannot be restored	Standard or slide
Noncompliant patient (e.g., elderly or with Parkinson's disease) at risk for posterior dislocation	Oblique
Desire to leave posterior capsule and short external rotators intact	Oblique

mally, and the short external rotators are released from the trochanteric fragment. This enhances the mobilization of the trochanter proximally. Heavy grasping forceps are used to grip the trochanter during the remaining surgery.

The trochanter is reattached using the four-wire technique (Fig. 2). If advancement of the trochanter is not required, two vertical wires are passed, each through its own hole in the lateral femoral cortex; one is passed anterior to the midline and one posterior to the midline, about 2 cm distal to the cut edge of the trochanteric bed. If the trochanter is to be advanced distally, these holes must be made farther down the femoral shaft. The two vertical wires cross the medullary canal diagonally and proximally to emerge from the cut surface of the femoral neck near the calcar. A small piece of the anterior portion of the femoral neck is removed with a rongeur, so that the wires can exit the neck without interfering with contact of the collar against the calcar.

After the femoral component has been cemented, one wire is passed anterior to the neck of the femoral component, and the other wire posterior to it. Next, two transverse wires are placed through two separate drill holes in the lesser trochanter from anterior to posterior. One of a pair of matched color-coded wire-holding clamps is attached to the end of each wire. This facilitates identification, so that each wire can be tied to itself.

Once the femoral component is in place and the hip has been reduced, six holes are drilled through the trochanter from the cut surface. The two holes for the anterior and posterior vertical wires are placed as far craniad as is feasible. Four more holes, for the two ends of the proximal and distal transverse wires, are drilled distal to the first two holes but still in the proximal portion of the trochanter; two are placed close to the anterior edge of the bone and two close to the posterior edge.

The wires are threaded through the appropriate holes in the greater trochanter. If the trochanter is not to be advanced, it is placed against its original bed of cancellous bone. In a preliminary maneuver to determine which wire to tie initially, tension is

Table 2
Indications for Trochanteric Osteotomies in Revision Total Hip Replacement

Indication	Type of Osteotomy
Wide exposure is needed for complex acetabular reconstruction	Standard, horizontal, or slide
Femur needs to be shortened	Standard, horizontal, or slide
Excessive laxity in cases in which there is sufficient bone stock in the proximal lateral femur to leave a virgin trochanteric bed	Standard or slide
Excessive laxity in cases in which there is a compromised trochanteric bed	Horizontal or slide
Similar indications in hips in which a previous trochanteric advancement has moved the trochanter distally, to the lateral femoral cortex	Vertical or slide
Well-fixed cemented or cementless stem requires revision (e.g., because of sepsis or malpositioning)	Extended
Loose femoral components necessitate wide exposure (e.g., for cement removal)	Extended

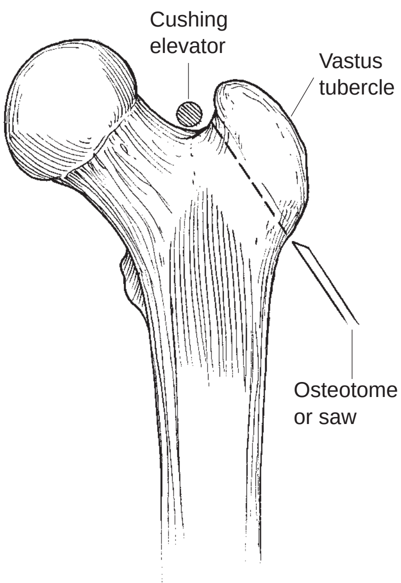


Fig. 1 Standard trochanteric osteotomy. The osteotomy cut traverses the sulcus between the lateral portion of the origin of the vastus intermedius muscle and the anterior portion of the insertions of the gluteus medius and maximus, beginning distal to the vastus tubercle and extending to the junction of the greater trochanter and the lateral portion of the femoral neck.

applied sequentially, first on the posterior vertical wire and then on the anterior vertical wire, to ascertain which produces better approximation of the trochanter to its bed. That wire is tied first with use of the R. I. Harris wire tightener (Life Instrument Corp, Braintree, Mass) (Fig. 3). To maintain tension on the wires while tying the knot, the first throw is held taut with fine-nose pliers while the second half of the square knot is being drawn tight.

After the first wire has been tied, the placement and fixation of the trochanter are again checked to be sure that broad, firm contact has been achieved. The other vertical wire is then tied in a similar manner. Next, the transverse wires are tied over the vertical ones. The ends of each wire are cut short, folded over, and buried in the tissue over the trochanter. If possible, the vastus lateralis is brought over the wires during closure.

In a study of 804 cases (725 primary and 79 revision cases) in which this technique was applied, 8 osteotomies (1%) did not heal.[4] Interestingly, all nonunions occurred in primary cases. Delayed union of the osteotomized trochanter (defined as that occurring more than 6 months after the procedure) was noted in 17 (2.3%) of the primary cases and 6 (7.6%) of the revision cases.

In the same study by Jensen and Harris,[4] osteoporotic bone, inadequately tightened vertical wires, and placement of the trochanter partially on cement were associated with nonunion. Other studies identified additional patient characteristics or technical points that may be related to failure (nonunion with or without migration), such as osteoporosis,[5] excessive body weight, interoperative trochanteric fracture, inability of the patient to protect the hip after surgery because of a spinal disability or contralateral weight-bearing joints,[6] inadvertent kinking or scoring of a wire,[7] and fixation of the trochanter in a tilted position.[8]

Wire mesh is recommended for trochanteric reattachment in most revision cases and most complex reconstructions, as well as in the treatment of many rheumatoid patients and patients who have been receiving corticosteroids.[10] The mesh is placed over the lateral surface of the trochanter, extending proximally onto the fibers of the gluteus medius. The wires are brought through the trochanter and then through corresponding holes in the mesh before being tied. In the 200 cases of trochanteric attachment reported by Jensen and Harris[4] in which trochanteric mesh was utilized, only 1 proceeded to nonunion. The mesh allows the wires to be tightened under considerable tension without the risk of the wires cutting through a weakened, small, or osteoporotic trochanter. Late fatigue failure of

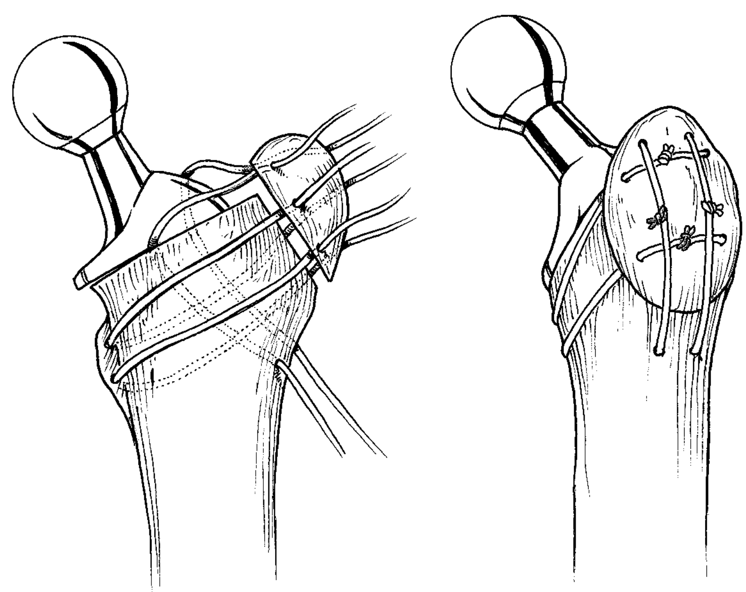


Fig. 2 The four-wire technique of fixation of the trochanteric osteotomy.

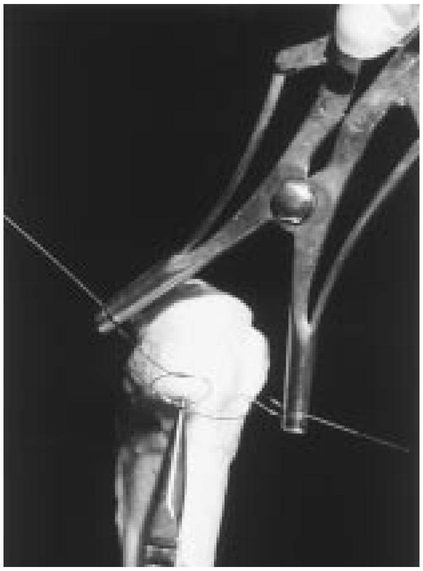


Fig. 3 The R. I. Harris wire tightener is used to tighten both throws of the square knot. A pair of thin-nosed pliers holds the wire after the first throw.

the mesh occurred in 26 cases (13%), but no reoperations were necessary.

Trochanteric Slide

The anterior trochanteric slide technique, or sliding trochanteric osteotomy, is a widely used alternative to the standard trochanteric osteotomy[1-3] (Fig. 4). This technique was described in detail in 1987 by Glassman et al,[3] along with the results in 89 revision cases, but variations had been presented previously by others. Indications for its use are the same as for the standard trochanteric osteotomy, namely, in primary or revision total hip replacements that require wider exposure than usual and in cases in which it is necessary to correct unacceptable laxity of the abductors. Many believe that the major advantage of this osteotomy over the standard trochanteric osteotomy is that the distal attachment of the vastus lateralis is left intact. This provides both a safeguard against proximal migration of the trochanteric fragment and continuity of the abductor-lateralis myofascial sleeve, with consequent preservation of some abductor function even if union of the osteotomy does not occur. The blood supply of the trochanteric fragment may be greater than in a standard osteotomy.

The skin incision used with this osteotomy diverges anteriorly from the course usually taken with a posterior approach. It parallels the anterior border of the greater trochanter before proceeding posteriorly parallel to the fibers of the gluteus maximus. Alternatively, a straight lateral incision can be used. The fascia lata is divided, and the anterior and posterior fascial flaps are raised. The gluteus medius muscle is then isolated anteriorly and posteriorly. The fascia overlying the vastus lateralis is incised for 15 cm distal to the vastus ridge, parallel to its muscle fibers, and 1 cm anterior to the intermuscular septum. The vastus lateralis is then elevated subperiosteally from the lateral and anterior femoral shaft and is retracted anteriorly with a Bennett retractor.

The osteotomy cut, usually performed with an oscillating saw, is oriented in the sagittal plane and begins just medial to the tendinous insertion of the gluteus medius into the greater trochanter. It may be preferable to leave the anterior tubercle and the minimus insertion attached to the proximal femur. The osteotomy exits distal to the vastus ridge, so that the origin of the vastus lateralis is preserved in continuity with the wafer of osteotomized bone. The osteotomized fragment is considerably thinner than that created by the standard trochanteric osteotomy.

Once the trochanter has been osteotomized, it is retracted with its muscular sleeve anteriorly. It is commonly held with a self-retaining retractor. The external rotators and gluteus minimus insertion are then sharply detached, and as much capsule or pseudocapsule as necessary is excised. Dislocation is usually accomplished with the hip in adduction and external rotation, and the leg is placed anteriorly in a sterile bag.

Reattachment of the trochanter is usually done with two wires (Fig. 4, C and D). Two trochanteric wires are passed through drill holes placed in the medial femoral cortex, proximal to the lesser trochanter. These wires are passed through two anterior and two posterior drill holes in the proximal femur and then through corresponding proximal and distal drill holes in the greater trochanter. The gluteus minimus tendon is sutured to the undersurface of the gluteus medius just proximal to the medius insertion into the greater trochanter. The wires are then tightened over the lateral aspect of the greater trochanter.

In a study of 90 cases (1 primary and 89 revision cases) in which this technique was applied, Glassman et al,[3] found that nine osteotomies (10%) had not healed at the time of follow-up 1 to 3 years after surgery (mean, 21 months). All nonunions occurred in the revision cases. In seven of the nine patients with a nonunion, the trochanteric fragment had migrated cephalad 2 to 26 mm (mean, 7.1 mm). Two of the nine patients with a nonunion underwent re-revision (one for infection and one for component migration). Of the remaining seven patients with trochanteric nonunion who were treated nonoperatively, only one had clinically evident abductor insufficiency (defined on the basis of a positive Trendelenburg sign or an abductor lurch). Of the remaining 82 hips appropriate for follow-up (six patients were excluded from abductor evaluation because of a significant associated orthopaedic problem adversely affecting gait), 23 (28%) demonstrated abductor insufficiency.

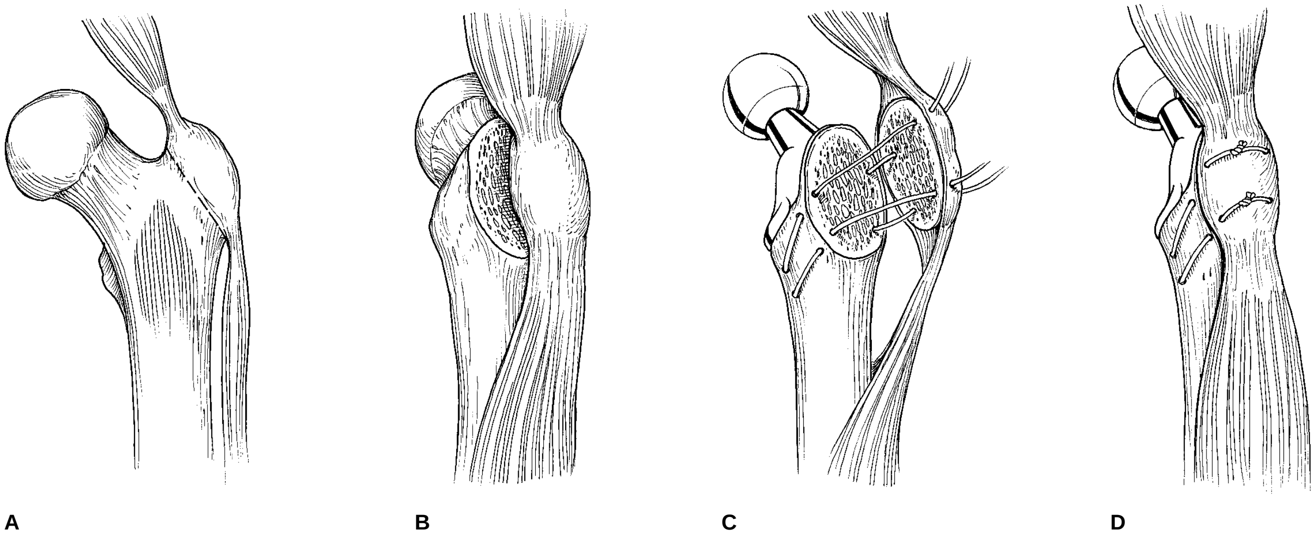


Fig. 4 Anterior trochanteric slide performed with use of the two-wire technique. **A,** Anteroposterior view. The osteotomy cut is oriented in the sagittal plane. It begins just medial to the tendinous insertion of the gluteus medius into the greater trochanter and includes the origin of the vastus lateralis. **B,** Lateral view with trochanteric fragment offset. **C,** Two trochanteric wires are passed through drill holes in the medial femoral cortex, proximal to the lesser trochanter. These wires are then passed through two anterior and two posterior drill holes in the proximal femur and then through corresponding proximal and distal drill holes in the greater trochanter. **D,** The wires are tightened over the lateral aspect of the greater trochanter.

Oblique Trochanteric Osteotomy

The oblique trochanteric osteotomy (Fig. 5) was devised for increasing the somewhat limited exposure that is sometimes obtained with a direct lateral approach for primary total hip replacement while minimizing the risk of posterior dislocation. The approach is similar to that used for the preceding techniques. The gluteus medius and minimus are isolated and protected by inserting a Cushing elevator. The anterior portion of the osteotomy begins over the palpable sharp ridge that is the limiting structure of the anterior aspect of the insertion of the abductors, lying along the most craniad aspect of the sulcus between the abductor insertions and the lateral half of the cathedral roof–shaped origin of the vastus intermedius. The anterior portion of the osteotomy is similar to, but slightly craniad to, that used for the standard trochanteric osteotomy, but the posterior bone cut remains superficial to the intertrochanteric ridge and the insertion of the short external rotators, which are left attached to the femur. Thus, the osteotomy fragment is wider anteriorly than posteriorly, but contains all of the insertion of both the gluteus medius and minimus. The greater trochanter is reflected craniad, and an anterior capsulotomy is done. The hip is dislocated anteriorly.

Reattachment of the trochanter is performed with two horizontal and three vertical wires. The vertical wires are placed as previously described, with the exception of the addition of a third vertical wire, which is placed in the midline of the lateral aspect of the femur. Both horizontal wires are placed through the lesser trochanter and are then grasped from behind the femur blindly in a heavy clamp, which crosses from lateral to medial posterior to the femur. Once grasped, the wires are drawn out laterally to surround the femur.

We analyzed 26 consecutive cases performed with this technique. The minimum follow-up period was 3 months. No dislocations occurred. Twenty-two unions, three probable unions, and one nonunion occurred. Four single-wire fractures (three vertical wires in three patients and one horizontal wire in one patient) and two two-wire fractures (two vertical wires in two patients) were observed. Although three trochanteric fragments migrated (1.0, 1.5, and 2.5 cm), two united, and one progressed to a nonunion. Brooker class III heterotopic ossification[10] was present in 3 cases, but flexion range of motion was not compromised.

Horizontal Trochanteric Osteotomy

A special problem exists when a trochanteric osteotomy is indicated in revision surgery when the proximal femoral anatomy is such that no cancellous bed would be available for reattachment if a standard osteotomy were to be done (Fig. 6, A). In these cases, a “horizontal” osteotomy is done (Fig. 6, B and C). The surgical technique involves isolating and protecting the gluteus minimus and medius as previously described. A horizontal (or, more accurately, a short oblique or nearly horizontal) bone cut is performed with a saw or osteotome as far proximal as possible without compromising the abductor muscle insertions. The resultant fragment must be advanced to reach the remaining intact lateral femoral cortex in order to find a satisfactory bed for reattachment. Therefore, the fragment must be of sufficient size to reattach, but the surgeon must bear in mind that the larger the fragment, the farther the trochanter must be advanced to be reattached. The lower extremity usually must be abducted maximally for the reattachment. We usually use two horizontal and two vertical wires in these cases, adding mesh to distribute force evenly on the trochanteric fragment. A third horizontal wire can be placed proximally as an “anti-escape” wire.

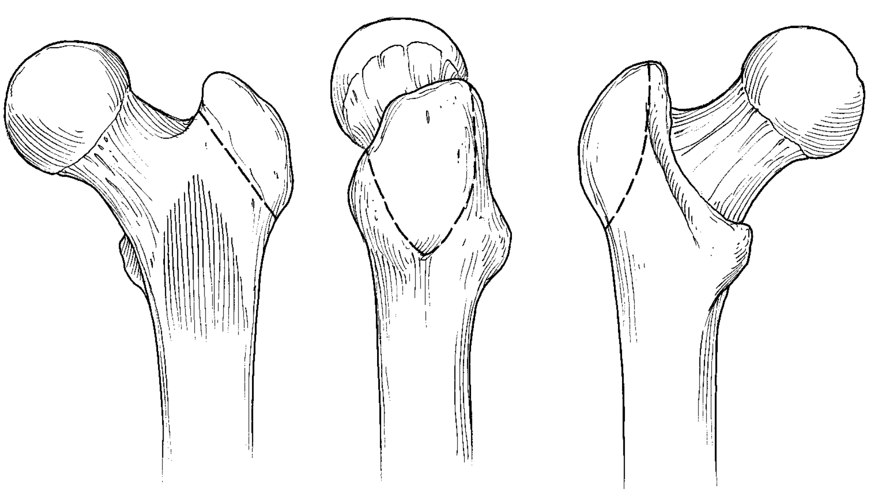
In one study in which horizontal trochanteric osteotomy was used in revision hip surgery, 25 of 28 osteotomies (89%) had healed at the time of follow-up examination (mean, 81 months; range, 60 to 111 months).[11] The patients were part of a larger group of 92 patients who underwent 99 revision total hip replacements that required trochanteric osteotomy. The differences between rates of union after horizontal, vertical, and standard osteotomy in these cases were not statistically significant.

Vertical Trochanteric Osteotomy

The vertical trochanteric osteotomy (Fig. 7) is indicated in revision hip replacements in which the trochanter has already been advanced to the lateral femoral cortex during a previous trochanteric advancement. In these circumstances, a standard, oblique, or horizontal osteotomy would not be appropriate. Wide exposure is necessary with full release of the vastus intermedius and lateralis well down the femur, distal to the greater trochanter. This is required so that the trajectory of the saw or osteotome can be made parallel to the shaft of the femur. The vertical bone cut is performed 3 to 5 mm lateral to the lateral femoral cortex, in order to leave a sufficient lateral bed of cancellous bone for reattachment.

Three horizontal or cerclage wires are usually used for this reattachment. Mesh is commonly utilized to distribute force evenly on the trochanteric fragment. Because of the distal location of the trochanter, vertical wires are usually ineffective in this situation.

In the previously cited study by Bal et al,[11] 10 of 10 osteotomies performed with this technique had healed at an average follow-up of 89 months (range, 64 to 115 months). The patients were part of the same larger group of 92 patients who underwent 99 revision total hip replacements that required trochanteric osteotomy, with no statistical difference between the rates of union for vertical osteotomy, horizontal osteotomy, and standard osteotomy.

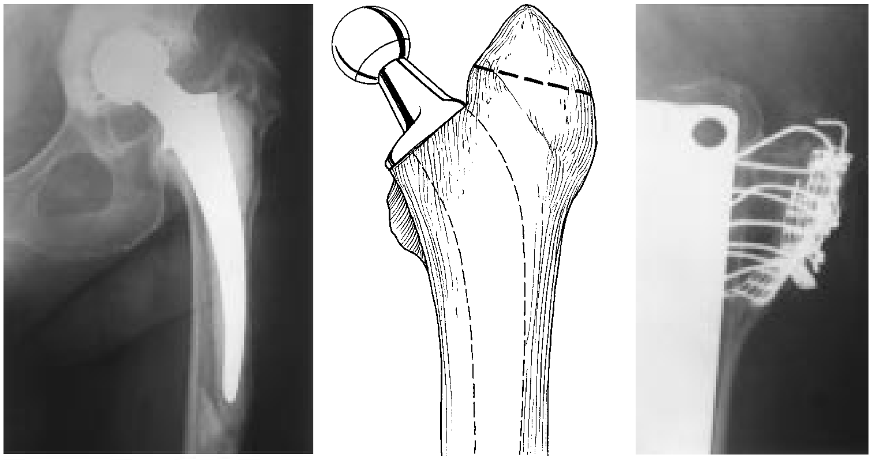


A B C

Fig. 5 Oblique trochanteric osteotomy. **A,** Anteriorly, the cut is parallel to the standard trochanteric osteotomy but slightly more craniad. The bone landmark used for the anterior portion of the cut is the shallow but sharp bone ridge denoting the anterior insertion of the abductor muscles. **B,** Orientation of osteotomy in lateral plane. **C,** The posterior portion of this osteotomy exits anterior to the intertrochanteric ridge. The entire insertions of the gluteus medius and minimus are on the osteotomized fragment, but the short external rotators and capsule remain uninterrupted.

Extended Trochanteric Osteotomy

The extended trochanteric osteotomy is indicated for removal of well-fixed cemented or cementless femoral components, as well as for cement removal in some patients with a loose femoral component in a well-fixed cement mantle (Fig. 8). The need to remove well-fixed stems



A B C

Fig. 6 Horizontal trochanteric osteotomy. **A,** Prerevision anteroposterior radiograph of the left hip of a 46-year-old woman with developmental dysplasia of the hip who required a revision total hip arthroplasty. Because the cement from the previous femoral component insertion extended deep into the trochanteric bed, the remaining thin rim of bone of the trochanteric bed would have been totally inadequate for reattachment of a standard trochanteric osteotomy. Anterior and posterior capsulectomies were performed initially, but the exposure was inadequate to safely remove and replace the femoral component. **B,** Plane of horizontal trochanteric osteotomy. The cut starts as far proximal as possible on the lateral surface of the greater trochanter without dividing the fibers of the abductors inserting into the trochanter. It is important to ensure that the entire insertions of the gluteus medius and minimus are on the osteotomized fragment. **C,** Ten-year follow-up radiograph demonstrates healed osteotomy.

is rare but occurs in cases of infection, osteolysis without loosening of the prosthesis, and malpositioning with recurrent dislocation without the possibility of obtaining a remedy by changing the attitude of the acetabular component or liner. Although this osteotomy has been described as being primarily for use in conjunction with cementless fixation,[6,12,13] we have developed a technique for its use in revision when a cemented stem is to be implanted.

It must be emphasized that to insert a cemented stem, the trochanter must be reattached before the use of the cement and stem insertion. Therefore, the exposure must be adequate to insert the stem as if the trochanter had been left on. This necessitates wide exposure, in contrast to the use of an extended trochanteric osteotomy for a cementless stem reinsertion, in which the femoral component can be inserted before trochanteric reattachment.

The vastus lateralis and vastus intermedius are detached anterior to the linea aspera and elevated from the femur. The osteotomy is planned preoperatively based on the radiographic appearance and the use of templates and radiographic landmarks. The proposed osteotomy is drawn on the bone with a sterile marking pen (Fig. 8, A and C). Before making the distal cut, a cerclage wire is placed distal to the osteotomy to reduce the risk of fracture. This wire is removed after reattachment of the osteotomized fragment.

The distal cut is made obliquely, from proximal to distal, perpendicular to the long axis of the femur and approximately a third or a fourth of the way through the femur. A circular, diamond-coated reciprocating saw is used to cut the two longitudinal arms of the osteotomy, one just anterior to the linea aspera and one parallel to that, measuring about a third of the circumference of the femur anterior to the linea aspera. The angle of these cuts is important. The bone is cut in an oblique plane so that, even with the inevitable bone loss encountered when cutting through the bone, a tight seal and intimate bone apposition can be achieved when the osteotomized fragment is replaced. Proximally, the osteotomy must be angled medially at the level of the vastus tubercle of the greater trochanter to incorporate all of the greater trochanter with the osteotomy fragment.

Next, the osteotomy fragment is carefully freed from the cement or the prosthesis by using a combination of osteotomes, both straight and curved, rigid and flexible. Care must be taken to protect this fragment, as it is often very fragile. The existing stem (and cement, if pres-

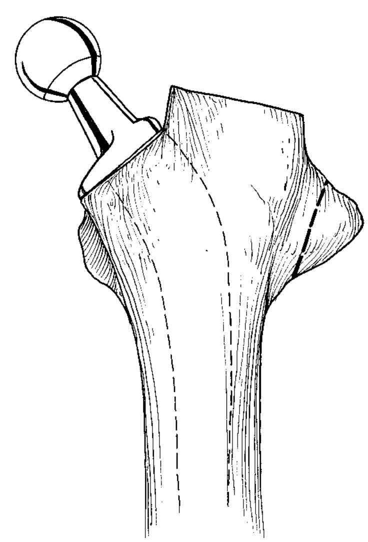


Fig. 7 Vertical osteotomy on a femur in which the greater trochanter was advanced to the lateral femoral cortex in a previous procedure. The insertions of the gluteus medius and minimus remain on the osteotomized fragment.

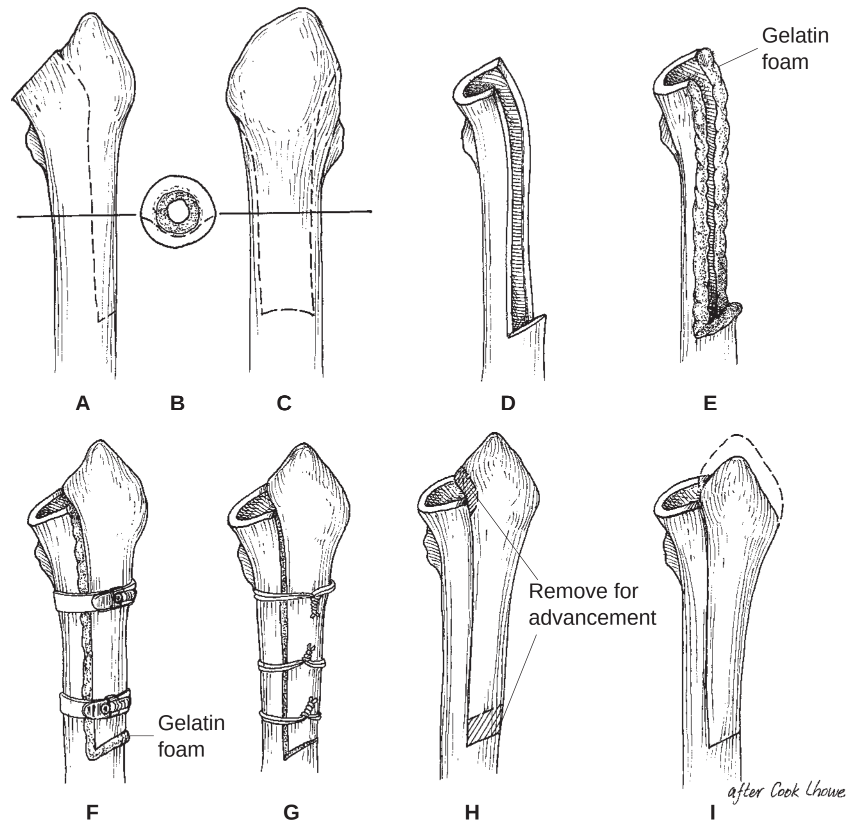


Fig. 8 Extended trochanteric osteotomy. **A,** Anteroposterior view of proximal femur shows outline of the anterior and distal limbs of the osteotomy. Distally, the osteotomy is cut obliquely so that the fragment can be dovetailed into the femur when it is replaced. **B,** Cross section illustrates that the vertical, or axial, arms of the extended trochanteric osteotomy are cut obliquely, allowing intimate reapproximation of the bone surfaces for reattachment even though inevitably some bone will be lost in the process of making the cuts. This tight reapproximation increases the coaptation of the osteotomy and, in cases in which cement is used, limits cement extrusion. **C,** Lateral view shows outline of osteotomy. **D,** Main fragment of the femur after osteotomy has been performed. **E,** Dry gelatin foam serves as a gasket throughout the osteotomy site. The gelatin foam is eventually resorbed and does not interfere with new bone formation. **F,** Two 0.5-inch hose clamps are used to obtain and maintain compression of the osteotomy while the femoral component is being inserted with use of contemporary cementing techniques, including pressurization. The gelatin foam keeps cement from intruding into the cut interface of the osteotomy. **G,** Because the hose clamps cannot be implanted, they are replaced with doubled monofilament cerclage wires after the cement has hardened. **H,** To facilitate advancement of the trochanter, the distal portion of the fragment is excised by making a cut parallel to the oblique distal cut in the osteotomy. The proximal portion is then appropriately fashioned in a similar way. **I,** After advancing the trochanteric fragment and closing the extended trochanteric osteotomy, the trochanteric fragment is reattached to the femur.

ent) is removed, and the femur is prepared for reinsertion of the femoral component.

If a cementless revision prosthesis with an extensively porous coating is to be used, the canal is prepared, and the prosthesis is inserted. The osteotomy fragment is shaped with a high-speed burr to fit well and to provide intimate contact of the fragment with the prosthesis once the osteotomy fixation has been secured.[13] The extended trochanteric fragment is rapidly and effectively repositioned anatomically with two hose clamps, which are subsequently replaced with multiple monofilament circumferential wires. These hose clamps are more effective than wires or cables for temporary fixation and can be obtained from the local hardware store for about $1. However, it must be emphasized that they cannot be left in the body or reused.

If the new femoral component is to be cemented, 1-cm-wide strips of dry gelatin foam are placed before reattachment, to act as a gasket throughout the osteotomy site (Fig. 8, E and F). The gelatin foam prevents cement from being forced into the interface of the osteotomy. The osteotomized fragment is dovetailed into the distal notch and compressed. Two or three sterile 0.5-inch hose clamps are placed proximally and distally and then tightened.

The leg is internally rotated to permit insertion of the cemented revision prosthesis as if from a standard posterior approach with the trochanter left on. The canal is prepared, and a plug is inserted.[14] We recommend that the stem be cemented with the use of contemporary techniques, including porosity reduction, pressurization, and centralization of the stem. This technique leads to minimal cement extrusion through the osteotomy site despite its extent and despite the high pressurization. The dry gelatin foam is resorbed and does not interfere with bone healing.[15] After the cement has polymerized, cerclage wires are placed proximal and distal to each hose clamp along the length of the osteotomy, and the hose clamps are removed (Fig. 8, G). Bone grafting may be used along the entire osteotomy site.

Results of a similar technique used for insertion of noncemented revision stems have been encouraging. Younger et al[13] found healing in all 20 of their patients at an average of 18.2 months (range, 15 to 25 months). Healing was present at 3 months in all patients, and no instance of trochanter migration greater than 2 mm was noted.

Complications of the extended trochanteric osteotomy include nonunion, migration, and intraoperative or postoperative fracture. If advancement of the trochanter is necessary, this must be determined before cementing the femoral component. In some cases, advancement can be achieved to a limited extent by resecting a portion of bone at the distal end of the osteotomized fragment. This can be accomplished by using an oblique cut parallel to the existing cut and fashioning the anterior and posterior sides proximally (Fig. 8, H and I). No long-term results of cemented reconstructions after an extended trochanteric osteotomy have been published.

Postoperative Care

Most patients who have had a trochanteric osteotomy of any type are able to stand the day after surgery and can proceed to walking with the aid of a walker or crutches immediately. However, they must be limited to only partial weight bearing until the trochanter is healed; this generally takes about 3 months, but the surgeon must be guided by the radiographic appearance. The patient should not start abduction exercises against gravity until the radiographs confirm that the trochanter has united. The patient can then begin to use one crutch for walking. Support is reduced progressively, first to a cane, which can be discarded when the patient can walk well for long distances without a limp. If any doubt exists about the security of the union of the trochanter, however, the patient should continue to use two crutches until radiographic evidence of union is demonstrated.

Summary

While most total hip surgery is done without osteotomy of the greater trochanter, greater trochanteric osteotomy is essential in certain situations and advantageous in others. This once-stereotyped technique may now be viewed as six unique variations, each with specific indications.

A standard trochanteric osteotomy can be used in selected cases in which there is severe deformity due to congenital dysplasia, as well as when the femur must be shortened or when wide acetabular exposure is desirable for any other reason. Another application is for tensioning of the abductors if, after the components have been placed and the length of the reconstruction is acceptable, the hip is still unacceptably lax. Conventionally, the osteotomy cut will traverse the sulcus between the lateral portion of the origin of the vastus intermedius muscle and the insertions of the gluteus medius and minimus. Reattachment is performed with a four-wire technique.

The anterior trochanteric-slide technique is a widely used alternative to the standard trochanteric osteotomy. The major advantage of this osteotomy is that the distal attachment of the vastus lateralis is left intact.

The oblique trochanteric osteotomy is applicable in primary hip arthroplasty when the objectives are optimal exposure and minimal risk of dislocation. This osteotomy is performed in an anterior-to-posterior direction and exits superficial to the insertion of the short external rotators.

The horizontal trochanteric osteotomy is applicable in selected revision cases in which the femoral component cannot be removed without danger of fracturing the trochanter, as well as in cases in which osteotomy is necessary for other reasons and no cancellous bed is available for reattachment. A horizontal bone cut is performed as high as possible and is advanced to cortical lateral femoral bone.

The vertical trochanteric osteotomy is applicable in revision hip replacement when a previous trochanteric osteotomy was performed and the healed trochanter lies on the lateral cortex. A standard, oblique, or horizontal osteotomy would not be appropriate in this setting.

An extended trochanteric osteotomy is used to remove well-fixed cemented and uncemented stems and to achieve wide exposure for cement removal. For cemented revision, the osteotomy is replaced with pipe clamps and a gelatin-foam gasket before cementing. The pipe clamps are replaced by cerclage wires before closure.

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