Use of Locking Plates for Fixation of the Greater Trochanter in Patients With Hip Replacement

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Summary: Trochanteric fixation is infrequently needed in total hip replacement, but when necessary, both short-term and long-term complications can occur with traditionally used techniques. Locking plate technology can now be used for fixation of the greater trochanter without the use of multifilament metallic cables, and has potential for a high rate of clinical success. This manuscript reviews the rationale for and implementation of a contemporary technique for the management of peritrochanteric osteotomies, fractures, and nonunions in total hip arthroplasty patients.

Key Words: total hip replacement—internal fixation—nonunion—fracture—trochanteric osteotomy.

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Fixation of the greater trochanter in total hip arthroplasty (THA) is desirable not only after osteotomy, but also in many cases of acute fracture or nonunion. There are a plethora of specific trochanteric fixation methods described in the literature, but no one method has been conclusively shown to be advantageous. A complete review is beyond the scope of this manuscript, but can be found in Berry and Lieberman’s Surgery of The Hip, 1st edition.1

Suffice it to say, the method chosen should achieve the surgical goal of allowing the greatest chance of healing, and at the same time be easiest for both the surgeon and the patient. Stable, reliable fixation should be attained with earliest possible full weight-bearing and active abduction. It is my opinion that the surgeon should avoid multistrand metallic cables if possible, or to remove these immediately after healing.

I have found that the most challenging fixation is in trochanteric bone with associated osteolysis, usually caused by polyethylene debris. Periprosthetic greater trochanteric fracture (Vancouver Classification Type A6) associated with a significant osteolytic lesion may occur as a late complication of THA, and when treated nonsurgically almost always goes on to nonunion. In addition, osteotomy may be indicated at the time of THA dislocation, or may lead to dislocation. Another set of potential indications for internal fixation is in trochanteric nonunion, where there is associated pain, Trendelenburg lurch, or hip instability.

INDICATIONS FOR GREATER TROCHANTERIC FIXATION IN PATIENTS WITH THA

The primary indications for internal fixation of the greater trochanter in THA are repair of an osteotomy, fracture or nonunion; although not all fractures and nonunions of the trochanter need to be treated surgically. Current indications for trochanteric osteotomy are limited to cases of difficult surgical exposure and soft-tissue tensioning, and fixation is needed in all cases. Indications for treatment of trochanteric fractures and nonunions are less definite. I prefer nonsurgical management with temporary limitations in weight-bearing and active abduction if the fracture is minimally displaced (< 1 cm), does not progressively displace over time (I recheck anteroposterior and lateral radiographs after 1 and 2 weeks of touch-down weight-bearing), and is not associated with THA subluxation or dislocation. One exception is in patients with significant polyethylene wear (for polyethylene bearing surfaces) or known or suspected adverse reaction to metal debris (for metal on metal bearing surfaces), where revision THA is indicated irrespective of the trochanteric fracture or nonunion. In such cases, I strongly consider trochanteric fixation at the time of the revision. There are some clinical situations that are somewhat unique, where fixation should also be considered. A trochanteric fracture may be associated with a larger than usual portion of the proximal femur, for example. A fracture may occur at the time of THA dislocation, or may lead to dislocation.

RATIONALE FOR USAGE OF LOCKING PLATES

There are a number of short-term and long-term complications associated with traditional greater trochanteric fixation including trochanteric pain syndrome, nonunion, THA instability, generation of third body debris in the joint and secondary bone loss from metallic debris. This latter finding may be quite severe, and compromises the integrity of the proximal femur (Fig. 1). Polymer “wire” or metallic monofilament fixation alone may be appropriate for extended trochanteric osteotomy fixation, where long surface areas of viable bone, in conjunction with buttressing of the bone to the femoral prosthesis, make union likely. Some surgeons use limited fixation with 2 screws for thin wafers used in the trochanteric flip technique although nonunion can be seen with this approach (Fig. 2). For standard length osteotomies, fractures, and nonunions, it seems that the most reliable fixation with avoidance of multifilament wire is appropriate in almost every case. Although plates are available that use monofilament wires, and limited screw fixation can achieve satisfactory results, failure to heal has been reported in both techniques. I therefore have used trochanteric fixation with the use...
of a locking plate over the last 9 years, and feel that this is most reliable. The most challenging cases are those with chronic non-union, as these usually demonstrate osteoporotic and osteolytic bone with limited vascularity of the proximal (trochanteric) fragment. Even in these cases, over 90% union has been achieved in my experience (Table 1). It should be noted, however, that biomechanical and peer reviewed clinical studies comparing locking fixation with other methods of fixation are lacking at this time.

**SURGICAL TECHNIQUE**

**Osteotomy**

After primary or revision hip replacement has been completed with the patient in the lateral decubitus position, and the hip range of motion tested, the ipsilateral knee and foot are abducted on a sterile Mayo stand. The proximal femur exposure, initiated at the time of the osteotomy, is extended if necessary to accommodate the length of the locking plate. Without excessive soft tissue stripping, the vastus lateralis is reflected anteriorly for the length of the plate. I prefer a Zimmer NCB periprosthetic trochanteric plate (Warsaw, IN) that is available in 2 proximal widths, narrow and wide, for the left and right sides. It requires assembly to the NCB periprosthetic femoral plate, and I prefer the short plate for trochanteric fixation (Fig. 3). Connection screw holes at the distal trochanteric plate are used, and screws are tightened to 6 N using the corresponding torque screwdriver. This plate construct is wider in the area of the prosthesis and has offset holes that may allow bicortical screw placement in the area of the prosthesis. With the appropriate plate, a pointed reduction forceps is used to apply compression over the osteotomy site. Next a pin is placed through the plate distally, to make sure that the plate is aligned appropriately with the anterior curve of the femur. Proximally, the plate slides over the fascial plane of the abductor muscles, and should fit so as not to ride higher than the tip of the trochanter. The plate does not usually need to be contoured, and a “best fit” scenario is attained using the tip of the trochanter, anterior and posterior trochanteric margins, and central femur at the tip of the plate as boundaries.

As the proximal fragment is usually small, attaining fixation with 2 to 3 separated locking screws that achieve bicortical fixation is the next step. These should be spread anteriorly and posteriorly so as not to tighten the plate to bone on just 1 side. Fixation angles are fixed in the proximal, trochanteric portion of the plate. Distal fixation is next performed. The NCB system allows for polyaxial screw placement with screw locking achieved through the use of locking caps that are threaded into the plate holes, which is said to improve stability in osteoporotic bone. Compression across the osteotomy site,

| Diagnosis                  | Average Follow-up (Range) (mo) | Number Healed (% Union) |
|----------------------------|---------------------------------|-------------------------|
| Fracture, intraoperative    | 3 16 (22-38)                    | 3 (100)                 |
| Fracture, postoperative     | 2 8 (5-13)                      | 2 (100)                 |
| Nonunion, fracture          | 16 35 (1-96)                    | 14 (87.5)               |
| Nonunion, osteotomy         | 1 3 (NA)                        | 1 (100)                 |
| Trochanteric osteotomy      | 3 24 (6-33)                     | 3 (100)                 |
| Total                      | 25 28 (1-96)                    | 23 (92)                 |

NA indicates not applicable.
initiated with the reduction forceps, can be augmented with the use of a nonlocking screw used in compression mode distally or lag screw technique across the osteotomy site itself. Anterior and posterior placement of the plate screw holes allows fixation anterior and posterior to the femoral component of the hip replacement (Fig. 4). One technique uses fluoroscopy to determine whether there is enough clearance for a 5 mm screw (and using a 4 mm screw or nonlocking screw if there is not); I prefer starting with the smaller drill, and redrilling if there is no impediment so as to use the largest screw possible. My preference is for maximal fixation in the trochanteric fragment (usually 5 to 7 bicortical locking screws), and distal fixation of a minimum of 3 bicortical and 1 unicortical screws. Note that the locking screws must have an angle of no > 15 degrees, but nonlocking screws can be used at greater angles of divergence. There are theoretical concerns that drilling through the cement mantle may cause stress risers that could lead to cement fracture and femoral prosthesis loosening. We have not found this to be an issue to date; in fact, with this system there are special drills to be used in cases of a cemented stem.

Fracture

In the lateral decubitus position, after confirmation that the femoral component of the hip replacement is stable, the knee and foot are abducted and supported on a sterile Mayo stand. The proximal femur exposure is performed by reflecting the vastus lateralis origin from the vastus tubercle and incising the fascia 1 cm anterior to the intermuscular septum for the length of the plate. The vastus lateralis is reflected anteriorly without excessive soft tissue stripping. After the fracture hematoma is removed and fragments aligned, a Zimmer NCB periprosthetic trochanteric plate and short femur plate are assembled and used using the same technique described above for osteotomy (Fig. 5). After fixation, the vastus is draped over the plate and the muscular fascia (epimysium) closed with a running 2.0 absorbable suture.

When trochanteric fracture is encountered in conjunction with an unstable or loose femoral component, fixation can be performed before cementing a new stem or after placement of a stable cementless stem. Some contouring of the fracture fragment in the intramedullary portion is often needed after placement of a cementless component. The bone removed can be used as onlay graft after fixation.

Nonunion

After revision hip replacement has been completed with the patient in the lateral decubitus position, and the hip range of motion tested, the ipsilateral knee and foot are abducted on a Mayo stand. The soft tissues attaching the trochanter to the pelvis (usually a combination of abductor muscles, pseudo-capsule, and scar tissue) are mobilized so that the trochanter can be advanced to the lateral femur. In some cases, a shorter or lower offset femoral head and neck are used to permit advancement. The proximal femur is then exposed by reflecting the vastus lateralis origin from the vastus tubercle or lateral proximal femur and incising the fascia 1 cm anterior to the intermuscular septum for the length of the plate. The vastus lateralis is reflected anteriorly without excessive soft tissue stripping. After the fracture hematoma is removed and fragments aligned, a Zimmer NCB periprosthetic trochanteric plate and short femur plate are assembled and used using the same technique described above for osteotomy (Fig. 5). After fixation, the vastus is draped over the plate and the muscular fascia (epimysium) closed with a running 2.0 absorbable suture.

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lateral is reflected anteriorly without excessive soft tissue stripping. The bony surfaces of the underside of the trochanter and proximal lateral femur are gently debrided of granulation tissue and fashioned to attain maximal contact. Again a Zimmer NCB periprosthetic trochanteric plate and short femur plate are assembled and used. With the appropriate plate, a pointed reduction forceps is used to apply compression over the osteotomy site. If mechanical advantage is needed to advance the trochanter, the proximal fixation can be placed, and then the bone/plate construct can be advanced to the lateral femur. Next a pin is placed through the plate distally, to make sure that the plate is aligned appropriately with the anterior curve of the femur. Proximally, the plate slides over the fascial plane of the abductor muscles, and should fit so as not to ride higher than the tip of the trochanter.

In cases where the proximal fragment is paper thin from osteolysis, a portion of an allogeneic femoral head can be used as a structural graft for screw fixation. Although this bone is unlikely to incorporate, it may act as a biologically inert structural foundation for proximal fixation.

**POSTOPERATIVE CARE**

Clinical judgment is used to guide postoperative care. In cases of osteotomy and simple fracture, where excellent fixation and maximal bony congruity are achieved, I prefer protected weight-bearing for 4 weeks, and avoidance of active hip abduction exercises for 6 weeks. In cases of nonunion or limited bony congruity at the junction site, I am conservative: touch-down weight-bearing for 6 weeks, followed by protected (partial) weight-bearing for another 6 weeks, no active abduction for 10 weeks, and an abduction hip orthosis in some cases.

If a patient is having trochanteric pain associated with the hardware, I will pursue nonsurgical management for the first year. This may include oral and/or topical analgesics and/or nonsteroidal anti-inflammatory medications, use of a gait aid, physical therapy modalities, and if these fail to control symptoms, therapeutic corticosteroid injection. After 1 year, hardware removal may be considered, but is not mandatory. In instances of failed fixation, hardware removal and salvage procedures such as trochanteric excision and tendon transfer may be considered.

**FIGURE 5.** A, Preoperative anteroposterior radiograph of a 59-year-old man with fracture dislocation of his left total hip arthroplasty (THA), after reduction of the dislocated THA. B and C, Three-month postoperative anteroposterior and lateral radiographs showing healed osteotomy, fixed with Zimmer NCB periprosthetic trochanteric plate assembled with short femur plate (Warsaw, IN).

**FIGURE 6.** A and B, Preoperative anteroposterior radiograph of a 74-year-old woman with painful nonunion and aseptic acetabular loosening of her right total hip arthroplasty. She had 2 prior attempts at trochanteric fixation after osteotomy 16 years earlier. C, Nine month postoperative anteroposterior radiograph showing healed osteotomy, fixed with Zimmer NCB periprosthetic trochanteric plate assembled with short femur plate (Warsaw, IN).
**DISCUSSION**

Fixation of the greater trochanter in THA is imperative after osteotomy and in cases of displaced or symptomatic fractures or nonunions. Of these indications, nonunions are most difficult to treat because of bone loss, soft tissue scarring and retraction, and poor bone viability.

Locking plate technology has revolutionized fracture care, but has only recently been suggested for fixation of the trochanter in THA.\(^1,2\) Difficulties noted in the literature\(^5–8\) in conjunction with my own experience with complications from various traditional treatments (Fig. 1) led me to seek an alternative treatment. Since 2004, I have used locking plate technology (Table 1), and since their availability last year I have utilized a specialized trochanteric fixation plate that maximizes fixation without the use of multifilament metallic cables (Zimmer NCB periprosthetic trochanteric plate and short femur plate assembly). The technique described in this manuscript seems to be the best choice to obtain stable, reliable fixation in these uncommon but difficult situations. Allogeneic structural bone graft augmentation may be used in selected instances of severe trochanteric osteolysis. The reader should exercise caution interpreting these preliminary results in a small cohort of patients from a single surgeon; future work should include multicenter studies with standardized follow-up and peer review.

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