Trochanteric Slide Osteotomy on Previously Osteotomized Greater Trochanters

**Dror Lakstein MD, Yona Kosashvili MD, MHA,
David Backstein MD, MEd, FRCSC,
Oleg Safir MD, FRCSC, Allan E. Gross MD, FRCSC**

Received: 7 April 2009 / Accepted: 21 July 2009 / Published online: 4 August 2009
© The Association of Bone and Joint Surgeons® 2009

Abstract The sliding trochanteric osteotomy is a useful and safe technique facilitating exposure of the hip in a complex arthroplasty. The modified sliding trochanteric osteotomy preserves the posterior capsule and short external rotators, allows anterior dislocation of the hip, and is associated with a lower dislocation rate. With the increased incidence of failed THAs and need for revision, there is an increased need for better exposure of challenging hips. Therefore, trochanteric osteotomies in hips that previously had osteotomies are not uncommon and likely will become frequent in the future. We evaluated use of the modified trochanteric slide osteotomy on greater trochanters that previously had osteotomies and were healed. We reviewed 38 patients with repeated osteotomies and 38 matched control patients with osteotomies on greater trochanters that did not have previous osteotomies. The minimum followup was 13 months (mean, 37 months; range, 13–73 months). Thirty-three osteotomies (87%) healed with bony union, four (11%) had fibrous union, and one (3%) had nonunion. Two (5%) patients had a new onset abductor lurch develop. Two (5%) patients had

persistent trochanteric pain and two (5%) had dislocations. The bony union, fibrous union, and nonunion rates, and the abductor lurch, persistent trochanteric pain, and dislocation rates, were similar to those of the control patients. Repeated osteotomy on a previously healed greater trochanter osteotomy is a reliable procedure with similar clinical outcome and complication rates as a primary osteotomy.

Level of Evidence: Level III, therapeutic study. See Guidelines for Authors for a complete description of levels of evidence.

Introduction

The advantages of osteotomy of the greater trochanter (GT) for improved hip exposure in a complex hip arthroplasty have been well documented [5, 8, 9, 11, 15]. This osteotomy provides improved exposure of the acetabulum and proximal femur. Although the original standard transverse trochanteric osteotomy reportedly had high nonunion and migration rates (8%–14%) [3, 12, 14], the more recently introduced sliding trochanteric osteotomy preserves the continuity of the gluteus medius, GT, and vastus lateralis and has a lower nonunion rate (5%) [4, 11]. Additionally, the modified sliding trochanteric osteotomy (MTSO) [9, 11] preserves the posterior hip capsule and short external rotators to enhance stability [9]. Goodman et al. [9] reported a dislocation rate of 3.3% in patients who had the MTSO with a lateral approach to the hip, compared with a dislocation rate of 14.8% in patients who had a sliding trochanteric osteotomy with a posterior approach. The MTSO is commonly used for hip revision arthroplasty [1, 9, 11], femoroacetabular impingement [7], acetabular trauma [6], and sometimes for primary THAs [4]. We use the MTSO almost routinely for hip arthroplasty revisions

Each author certifies that he or she has no commercial associations (eg, consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

Each author certifies that his or her institution has 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.

D. Lakstein (✉), Y. Kosashvili, D. Backstein, O. Safir,
A. E. Gross
Orthopedic Department, Division of Arthroplasty, Mount Sinai
Hospital, 600 University Avenue, Suite 476A, Toronto, ON
M5G 1X5, Canada
e-mail: drorale@gmail.com

and complex primary THAs when exposure is expected to be difficult owing to distorted anatomy, scarring, and osteolysis.

Hip arthroplasty revisions and complex primary THAs are more technically challenging and have higher complication and failure rates than routine primary THAs [2]. Moreover, with increased life expectancy and THAs performed in younger patients, it is not unusual for patients to require more than one revision surgery in their lifetime. When treating such patients, it sometimes is desirable to perform an osteotomy on GTs that already have had an osteotomy in previous procedures.

We therefore determined the union and complication rates of MTSOs on previously osteotomized and healed GTs and compared these rates with those of MTSOs in hips without previous GT osteotomies.

Materials and Methods

We retrospectively reviewed all 197 patients with 204 MTSOs performed in our institution between August 1999 and April 2008. All data were collected prospectively in our clinical database. Sixty-nine patients had previous GT osteotomies performed in the same hip. We excluded 25 patients because the previous osteotomy had failed to unite, (as determined intraoperatively) and six patients died or were lost to followup before 1 year. Thus, 38 patients (38 osteotomies) were available for evaluation. There were 24 men and 15 women. The patients' average age was 63 ± 15 years (range, 19–86 years). The minimum followup was 13 months (mean, 37 months; range, 13–73 months). None of the 38 patients were lost to followup.

We identified 38 control patients from the 135 patients who had revision hip arthroplasties with a first-time MTSO between August 1999 and April 2008. Thirty-one of the control patients were included in a previous report [11]. Each control patient was matched blindly and individually with a study patient on the basis of age, gender, and length of followup. There were no differences between the two groups regarding length of followup, age, indication for surgery, and whether the femoral stem in situ was cemented or noncemented (Table 1). The study group had more ($p = 0.0093$) previous revisions than the control group.

The original GT osteotomy was a standard transverse osteotomy in 24 patients, a sliding trochanteric osteotomy in 10 patients, and an extended trochanteric osteotomy in four patients. Thirty-one patients had one previous osteotomy performed in the same hip, four patients had two previous osteotomies, and three patients had three previous osteotomies (Table 2). Thirty-seven osteotomies (97%) were performed for THA revisions. It was a first revision

Table 1. Comparison of demographic, clinical, and surgical factors

Factor	Repeated osteotomy	First-time osteotomy	p Value
Followup (months)*	37 ± 17	44 ± 25	0.158
Age (years)*	63 ± 15	63 ± 14	1
Number of previous revisions*	1.92 ± 0.85	1.39 ± 0.88	0.0093
Indication for surgery			
Aseptic loosening	28 (73.7%)	30 (78.9%)	0.787
Infection	7 (18.4%)	1 (2.6%)	0.056
Dislocation	2 (5.3%)	3 (7.9%)	1
Periprosthetic fracture	0	1 (2.6%)	1
Complex primary THA	1 (2.6%)	3 (7.9%)	0.61
Femoral stem in situ			0.73
Cemented	6 (15.8%)	4 (10.5%)	
Noncemented	32 (84.2%)	34 (89.5%)	

* Values are expressed as mean $\pm$ standard deviation.

Table 2. Previous osteotomies

Number/type of previous osteotomies	Number of patients
Number of previous osteotomies	
One	31
Two	4
Three	3
Type of previous osteotomy	
Standard (transverse) trochanteric	24
Sliding trochanteric	10
Extended trochanteric	4

in 10 patients (26%), a second revision in 20 patients (53%), and a third to fourth revision in seven patients (18%). Twenty osteotomies (53%) were performed for acetabular component revisions, five (13%) for femoral component revisions, and 12 (32%) for both component revisions. Indication for revision was aseptic loosening in 28 (74%) patients, infection in seven (18%) patients, and dislocation in two (5%) patients. One osteotomy was performed for a difficult primary THA in a patient who had a previous trochanteric osteotomy performed for fixation of an acetabular fracture. In 33 patients, the old osteotomy was fixed with cerclage wires; in four patients, it was a cable-grip system; and in one patient, it was a screw. In one patient, the wires were removed a few years earlier owing to local irritation.

The surgical technique was similar for both groups (Fig. 1) [11]. We consider preexisting trochanteric non-union, irradiated hips, and abductor rupture as relative contraindications for MTSO. After splitting the fascia lata, the trochanteric bursa was resected and the previous trochanteric fixation hardware was removed if present before performing the osteotomy. The sliding trochanteric

Fig. 1A–C Diagrams of the right hip illustrate the (A) planned plain of osteotomy, immediately anterior to the insertion of the short external rotators, exiting just distal to the origin of the vastus lateralis. (B) The osteotomy was performed and the hip is dislocated. (C) The osteotomy is fixed back to place with two cerclage wires. (Reprinted from Lakstein

D, Backstein D, Safir O, Kosashvili Y, Gross AE. Modified Trochanteric Slide for Complex Hip Arthroplasty Clinical Outcomes and Complication Rates. *J Arthroplasty*. 2009 March 19. [Epub ahead of print])

osteotomy is based on preservation of an intact musculo-osseous-muscular sleeve comprised of the gluteus medius, the GT, and the vastus lateralis, which allows physiologic reconstruction of the hip's soft tissue envelope [8, 15]. The MTSO also preserves the posterior capsule and the short external rotators and enhances posterior stability [9, 11]. The osteotomy was made from posterior to anterior, starting between the posterior border of the gluteus minimus and medius anteriorly and the piriformis and short external rotators posteriorly. The GT was osteotomized from its tip to just distal to the origin of the vastus lateralis, thus preserving the continuity of the abductors, the trochanter, and the vastus. The osteotomized trochanter then was retracted anteriorly, providing excellent exposure of the hip. Reattachment of the osteotomy at the end of the procedure was performed using two or three double-loop cerclage wires in all cases. During postoperative rehabilitation, patients were restricted from active abduction for at least 6 weeks.

Followups were done at 6 weeks, 12 weeks, 6 months, and 1 year after the procedure and then annually. We specifically recorded local pain that did not resolve by 6 months, new onset of an abduction weakness lurch, and postoperative dislocations.

Radiographic evaluation included routine hip radiographs (anteroposterior [AP] view of the pelvis, AP and lateral views of the affected hip) performed preoperatively, immediately postoperatively, and at 6 weeks, 6 months, and annually postsurgery. The initial 6-week postoperative series of radiographs served as the baseline to which all subsequent radiographs were compared. Two of us (OS, DL) evaluated radiographs for trochanteric migration or nonunion. The GT was considered to have healed if there

was continuity of the bone trabeculae between the trochanteric fragment and the site of reattachment. Migration was determined by measuring and comparing the distance between the tip of the GT and the shoulder of the femoral component on the AP radiograph on the day of the operation and after 1 year. Nonunion was diagnosed by the presence of a continuous radiolucent line between the osteotomized fragment and the proximal femur [4, 11]. If the GT did not migrate 15 mm or more from its original position, we considered it a fibrous union [4, 12]. Agreement between observers (92%) was quantified by the kappa statistic and was 0.736. Consensus regarding radiographs for which there was no agreement was obtained with the senior author (AEG).

After matching the control patients, we determined differences in length of followup, age, and number of previous revisions between study and control patients using the t test for independent samples, differences in indications for surgery, and whether the femoral stem was cemented or noncemented using Fisher's exact test. We determined differences in rates of bony union, fibrous union, nonunion, GT fragmentation, persistent trochanteric pain, new onset abductor lurch, and dislocation between study and control patients using Fisher's exact test. Data were analyzed using MedCalc® Version 9.2.0.1 (MedCalc Software, Mariakerke, Belgium).

Results

Thirty-three of the 38 osteotomies (87%) achieved bony union (Fig. 2). Four osteotomies (11%) formed a fibrous union. One patient (3%) had nonunion of the GT with

Fig. 2A–B The radiographs show a well-healed repeat MTSO. A 64-year-old man had the MTSO performed for revision of his loose cup, which healed well. **(A)** When the stem loosened, it was revised through a second MTSO. **(B)** A radiograph taken 4 years later showed a well-united osteotomy with local bone remodeling.

Table 3. Comparison of complications

Complication	Repeated osteotomy	First-time osteotomy	p Value
Bony union	33 (86.8%)	33 (86.8%)	1
Fibrous union	4 (10.5%)	4 (10.5%)	
Nonunion	1 (2.6%)	1 (2.6%)	
GT fragmentation	1 (2.6%)	3 (7.9%)	0.61
Persistent trochanteric pain	2 (5.2%)	3 (7.9%)	0.82
Abductor lurch	2 (5.2%)	2 (5.2%)	1
Dislocation	2 (5.2%)	4 (10.5%)	0.67

proximal migration. All five unhealed osteotomies were asymptomatic. The femoral stem in the patient with nonunion and three of the four patients with fibrous unions were noncemented. All five patients with fibrous unions or nonunion had only one previous GT osteotomy.

One patient (3%) had a fracture of the osteotomized GT, which was nondisplaced and asymptomatic. Four patients (11%), all with well-healed osteotomies, complained of trochanteric pain, but only in two (5%) patients did the pain persist beyond 6 months. The pain was mild and did not require additional surgical intervention. Two patients (5%) had an abductor lurch develop, which did not resolve with abduction strengthening exercises by 1 year after the osteotomy. Both of these patients had radiographic bony union of the osteotomy. Two (5%) patients with well-healed osteotomies had postoperative dislocation. One with component malposition was treated with another revision

and the second was treated successfully with closed reduction.

We found no differences between study and control patients regarding the percent with bony union, fibrous union, nonunion, GT fragmentation, persistent trochanteric pain, new onset abductor lurch, or dislocation (Table 3).

Discussion

The sliding trochanteric osteotomy is a useful and safe tool that facilitates exposure of the hip in complex arthroplasties [6, 7, 9]. The MSTO preserves the posterior capsule and short external rotators, allows safe anterior dislocation of the hip, and has a lower dislocation rate [9, 11]. With the steep increase in the prevalence of failed THAs and the revision burden of 13.1% to 18.3% [10], the need for better exposure of challenging hips is more common. It therefore follows the need to perform a trochanteric osteotomy in hips that previously had an osteotomy is not uncommon and will likely become frequent in the future. We asked whether there was any difference in union and complication rates when MTSTOs were performed on previously osteotomized and healed GTs compared with native GTs.

Our study has some limitations. We had a relatively small number of subjects. However, having a repeated trochanteric osteotomy is quite uncommon, and we suspect much larger groups of patients operated on in one institution would not be available for study of this situation.

We found a bony union rate for osteotomies performed for revision and complex primary THAs in hips with previously well-healed GT osteotomies of 87%, similar to the union rate of the control group. The rate of trochanteric nonunion with migration (3%) also was similar to that of the control group. Although comparable to the nonunion rate of 3.7% reported by Dupont and Charnley [5], it is lower than the 12% to 29% nonunion rates in more recent reports of the traditional trochanteric osteotomy [4, 14]. Nicholson et al. [12] reported a series of 69 patients undergoing repeated standard trochanteric osteotomy with a nonunion rate of 14%. The rates of GT fractures (3%), persistent trochanteric pain (5%), and new onset abductor lurch (5%) were low, not different from the complication rates in the control group, and not associated with fibrous union or nonunion. The postoperative dislocation rate was 5%, comparable to the rates of dislocations after primary THAs and much lower than the typical rates for revisions [13].

The presence of an old healed GT osteotomy did not influence the complication rates of the MTSTO and should not be a consideration against the use of MTSTO when it is

indicated for a complex hip arthroplasty. These patients have challenging multiply revised hips, and any effort to obtain excellent exposure is advisable.

References

1. Ackerman DB, Trousdale RT. Triplanar trochanteric osteotomy: a modified anterior trochanteric slide osteotomy. *J Arthroplasty*. 2008;23:459–461.
2. Ahnfeldt L, Herberts P, Malchau H, Andersson GB. Prognosis of total hip replacement: a Swedish multicenter study of 4,664 revisions. *Acta Orthop Scand Suppl*. 1990;238:1–26.
3. Amstutz HC, Maki S. Complications of trochanteric osteotomy in total hip replacement. *J Bone Joint Surg Am*. 1978;60:214–216.
4. Bal BS, Kazmier P, Burd T, Aleto T. Anterior trochanteric slide osteotomy for primary total hip arthroplasty: review of nonunion and complications. *J Arthroplasty*. 2006;21:59–63.
5. Dupont JA, Charnley J. Low-friction arthroplasty of the hip for the failures of previous operations. *J Bone Joint Surg Br*. 1972;54:77–87.
6. Ebraheim NA, Patil V, Liu J, Haman SP. Sliding trochanteric osteotomy in acetabular fractures: a review of 30 cases. *Injury*. 2007;38:1177–1182.
7. Ganz R, Gill TJ, Gautier E, Ganz K, Krügel N, Berlemann U. Surgical dislocation of the adult hip: a technique with full access to the femoral head and acetabulum without the risk of avascular necrosis. *J Bone Joint Surg Br*. 2001;83:1119–1124.
8. Glassman AH, Engh CA, Bobyn JD. A technique of extensile exposure for total hip arthroplasty. *J Arthroplasty*. 1987;2:11–21.
9. Goodman S, Pressman A, Saastamoinen H, Gross A. Modified sliding trochanteric osteotomy in revision total hip arthroplasty. *J Arthroplasty*. 2004;19:1039–1041.
10. Kurtz S, Mowat F, Ong K, Chan N, Lau E, Halpern M. Prevalence of primary and revision total hip and knee arthroplasty in the United States from 1990 through 2002. *J Bone Joint Surg Am*. 2005;87:1487–1497.
11. Lakstein D, Backstein D, Safir O, Kosashvili Y, Gross AE. Modified trochanteric slide for complex hip arthroplasty clinical outcomes and complication rates. *J Arthroplasty*. 2009 March 19. [Epub ahead of print]
12. Nicholson P, Mulcahy D, Fenelon G. Trochanteric union in revision hip arthroplasty. *J Arthroplasty*. 2001;16:65–69.
13. Phillips CB, Barrett JA, Losina E, Mahomed NN, Lingard EA, Guadagnoli E, Baron JA, Harris WH, Poss R, Katz JN. Incidence rates of dislocation, pulmonary embolism, and deep infection during the first six months after elective total hip replacement. *J Bone Joint Surg Am*. 2003;85:20–26.
14. Ritter MA, Gioe TJ, Stringer EA. Functional significance of nonunion of the greater trochanter. *Clin Orthop Relat Res*. 1981;159:177–182.
15. Romero AC, Imrie S, Goodman SB. Sliding trochanteric osteotomy preserves favorable abductor biomechanics in revision total hip arthroplasty. *J Arthroplasty*. 2001;16:55–64.