Clin Orthop Relat Res
DOI 10.1007/s11999-008-0292-6

MULTIMEDIA ARTICLE

Femoral Shortening During Hip Arthroplasty Through a Modified Lateral Approach

Domagoj Delimar MD, PhD, Goran Bicanic MD, Kresimir Korzinek MD, PhD

Received: 18 September 2007 / Accepted: 23 April 2008

Abstract We describe a modification of the direct lateral approach to the hip that provides excellent femoral and acetabular exposure and an easy way to shorten the proximal femur and equalize leg length. The approach also is useful for lower extremity elongation while preserving muscle continuity and minimizing postoperative complications. The exact amount of shortening can be calculated and planned preoperatively and measured and corrected intraoperatively if necessary. It avoids the necessity for osteotomies of the trochanter and transverse cuts or detachment of abductor muscles.

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

Kresimir Korzinek—retired.

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.

Electronic supplementary material The online version of this article (doi:10.1007/s11999-008-0292-6) contains supplementary material, which is available to authorized users.

D. Delimar, G. Bicanic (✉), K. Korzinek
Department of Orthopaedic Surgery, School of Medicine, University of Zagreb, Clinical Hospital Centre Zagreb, Salata 7, 10000 Zagreb, Croatia
e-mail: gbic@mef.hr

Introduction

Numerous surgical approaches to the hip have been described [2, 14]. For patients with high dislocation from developmental dysplasia, for revision hip surgery, and for patients with proximal femoral deformities, special procedures and approaches must be used [2, 3, 14, 15]. These approaches must provide good exposure while allowing extremity length equalization, proximal femoral shortening, anatomic cup placement, and soft tissue balance [3, 4, 12, 14, 17].

We present an approach allowing these requirements that is a variation of a direct lateral [1, 10] and the Stracathro approach [13]. Although a modified lateral approach, it allows for excellent anterior and posterior acetabular and femoral exposure and provides a simple method of proximal femoral shortening and leg-length equalization, all while preserving abductor muscle continuity.

Materials and Methods

The key advantages of our approach are: (1) preservation of continuity of the abductor and vastus lateralis muscles while allowing extensive femoral shortening; (2) easy conversion to an extended approach; and if necessary, (3) an unlimited amount of femoral shortening. In the described approach, there are two main steps, the first of which is the same as a Hardinge approach [10] or that of Bauer et al. [1], and the second, which is an addition to the approach of Hardinge and Bauer et al. and could be described as an inverted or dorsally mirrored Hardinge or Bauer approach. The abductor muscles are stripped from the greater trochanter and there is no trochanteric osteotomy during the approach which differs from the Stracathro approach [13]. Unlimited femoral shortening

at the proximal end of the femur makes our approach different from other approaches and techniques because other approaches divide the femur in two parts (either at the subtrochanteric level or trochanteric level) [2, 3, 12, 13, 15]. The patient can be placed in either the supine or lateral decubitus position. A straight skin incision is performed over the greater trochanter, extending proximally 4 to 5 cm and distally as far as necessary (usually 6 to 7 cm). The fascia lata is incised distally in line with the fibers, parallel to the femur, and proximally between the gluteus maximus and the fascia lata muscle, also in line with the fibers. The gluteus medius is split exactly in the middle of the greater trochanter, extending distally in line with the fibers of the vastus lateralis muscle as far as necessary and proximally in line with the fibers of the gluteus medius, proximally up to 4 cm to protect the transverse branch of the superior gluteal nerve. The anterior half of the continuous tendon is detached either by cautery or with a chisel. If the chisel is used, a thin layer of bone from the greater trochanter remains attached to the continuous tendon of the gluteus medius and the vastus lateralis (Fig. 1A). The posterior half of the continuous tendon of the gluteus medius and the vastus lateralis is always detached with the chisel leaving a bone flake of at least 2 to 3 mm thickness attached to tendons (Fig. 1B). The

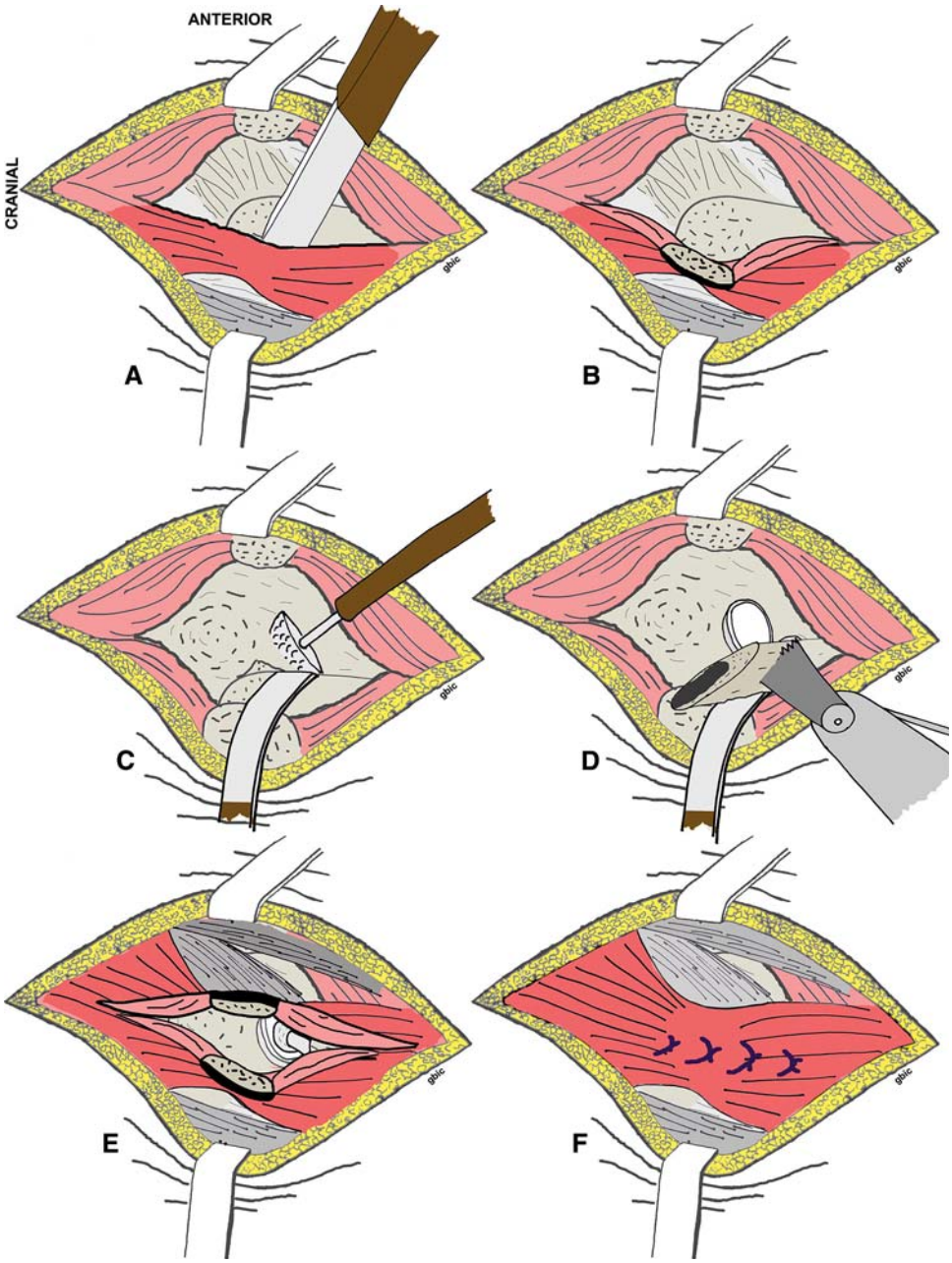

Fig. 1A–F A lateral view of the right hip is shown. The (**A**) anterior half of the continuous tendon of the gluteus medius and vastus lateralis is detached. The chisel is on the posterior half of the continuous tendon. (**B**) Anterior and posterior halves of the continuous tendon are detached with a chisel. (**C**) After femoral neck resection, the proximal femoral stump is moved posteriorly and exposure is continued to the level of the true acetabulum by removing fibrous tissue. (**D**) The acetabular cup is placed in the desired position in the level of the true acetabulum and additional proximal femoral shortening is performed. (**E**) The femoral head of the endoprosthesis is relocated distally into the acetabulum. The original tendinous attachment of the abductor muscles (with the flake of bone) remains proximal to its original insertion (which is moved distally). Raw surfaces of two flakes of bone are sutured together and are not reattached to its original position so the proximal part of the vastus lateralis will be proximal to the original attachment on the femur. (**F**) For closure, tendon suturing is performed. If there is any overlapping between the bone flakes and femoral stump, an additional one or two transosseous sutures are recommended.

extracapsular exposure is continued anteriorly and posteriorly up to the acetabulum. After capsulotomy and resection of the femoral neck (as for any standard THR), the proximal femoral stump can be moved anteriorly or more often posteriorly for better observation of the anterior and posterior columns. Easy access to the true level of the acetabulum is gained and the cup can be placed in the desired position (Fig. 1C) [16]. If the cup is for any reason placed more proximally than desired, resection of the proximal femur must be adjusted accordingly. During femoral broaching and trial repositioning, additional proximal femoral shortening can be performed (Fig. 1D) and the desired leg length achieved (Fig. 1E). With distal relocation of the femoral head into the original acetabulum and shortening, the original tendinous attachment of the abductor muscles (with the flake of bone) will be proximal to its original insertion (which is moved distally). We do not reattach this flake to its original position so the proximal part of the vastus lateralis will be proximal to the original attachment on the femur and it becomes a functional part of the abductor muscles. For closure, we recommend tendon suturing with the addition of one or two transosseous sutures (Fig. 1F). In this way, abductor muscle continuity is preserved and the basic principles of minimally invasive surgery are followed.

We used this approach in 12 patients with developmental dysplasia undergoing THA from January 2003 to December 2004 (Fig. 2). All patients were females with high hip dislocation (Crowe Type IV [5]). The average age of the patients was 46 years (range, 38–59 years). The mean body mass index was 25.6 kg/m^2 (range, 19–28 kg/m^2; median, 26.3 $\pm$ 3.2 kg/m^2).

The operating surgeon (DD) evaluated all patients 6 weeks postoperatively, every 3 to 4 months during the first year, 12 months postoperatively, and then at least once a year. Improvement of abductor muscle strength in the majority of patients was observed subjectively (DD) between the third and sixth months postoperatively; however, some patients had improvement of abductor muscle strength after 12 months postoperative. All patients with a minimum followup of 24 months (mean, 36 months; range, 25–48 months) were invited for a final and independent evaluation, which was performed by the second author (GB).

Results

The average postoperative Harris hip score at a mean of 36 months was 96.7 (range, 92.2–100; median, 96.7 $\pm$ 3.1). All patients were evaluated clinically for range of motion and muscle strength (Chatillon MSC-500 dynamometer, Ametek S.A.S., Elancourt, France) (Table 1). All measurements and evaluations were performed by the second author (GB).

Limb lengths were measured preoperatively and postoperatively on standing whole limb anteroposterior view radiographs by one of us (GB). All radiographs were digitized and standardized for magnification. The femur on the postoperative radiograph was superimposed on the preoperative radiographs and medial and lateral femoral shortening were measured. The average extremity elongation measured clinically was 4.5 cm (range, 3–7 cm;

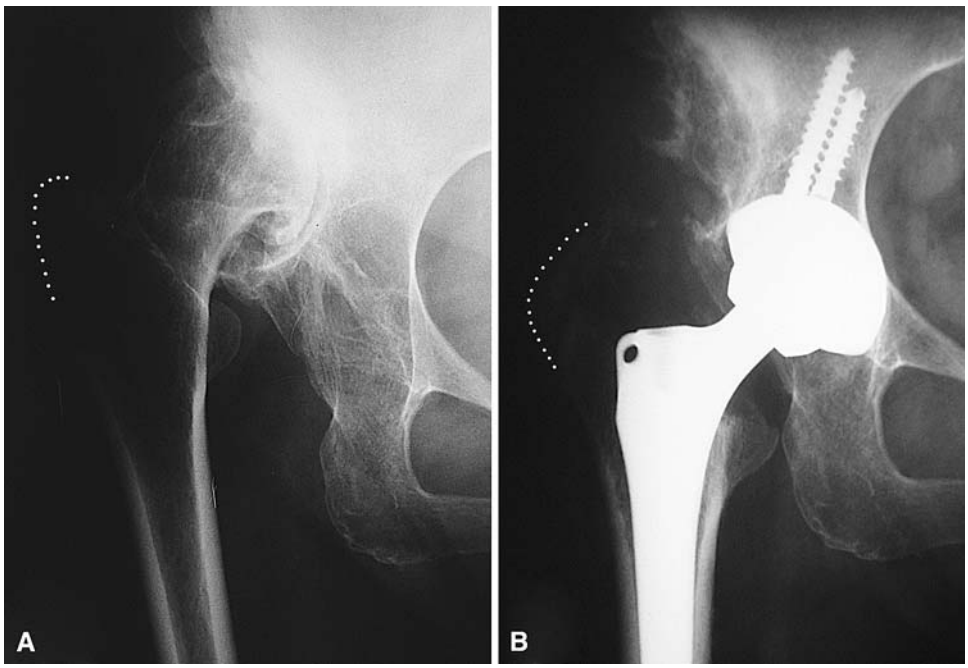

Fig. 2A–B (**A**) Preoperative and (**B**) postoperative radiographs are shown. The white dots outline the greater trochanter.

Table 1. Functional results after minimum followup of 2 years

Type of testing	Type of movement	Values for operated extremity	Values for nonoperated extremity	p Value
Range of motion (degrees)	Flexion	90 (74–110)	102 (70–120)	< 0.01
		90 ± 11	110 ± 18	
	Extension	10 (5–15)	12 (10–15)	< 0.01
		10 ± 2	11 ± 2	
	Abduction	25 (15–36)	31 (20–37)	< 0.01
		27 ± 6	32 ± 5	
	Adduction	22 (12–30)	30 (24–35)	< 0.01
		23 ± 7	30 ± 4	
	Internal rotation	33 (20–46)	36 (20–43)	0.22
		35 ± 9	39 ± 7	
	External rotation	22 (15–25)	31 (20–43)	< 0.01
		21 ± 3	31 ± 8	
Strength (Newtons)	Flexion	79 (48–123)	99 (70–121)	< 0.01
		75 ± 22	106 ± 20	
	Extension	96 (61–166)	123 (97–190)	< 0.01
		90 ± 32	115 ± 27	
	Abduction	74 (65–110)	81 (59–113)	0.045
		67 ± 16	75 ± 18	
	Adduction	73 (49–115)	69 (55–110)	0.11
		69 ± 21	62 ± 19	
	Internal rotation	51 (22–95)	83 (30–137)	< 0.01
		47 ± 25	89 ± 31	
	External rotation	63 (43–78)	72 (57–85)	0.13
		63 ± 11	72 ± 9	

median, 4.0 ± 1.1 cm), whereas the average proximal femoral shortening measured on the anteroposterior view on the medial side was 1.9 cm (range, 0.5–3.0 cm; median, 2.0 ± 0.8 cm) and 2.3 cm on the lateral side of the femur (range, 0.5–3.5 cm; median, 2.3 ± 1 cm). In all patients, the acetabular cup was placed in the true acetabulum. Postoperatively, the leg-length discrepancy was less than 0.5 cm in 11 of the 12 patients. In one patient, the surgically treated leg was 1.5 cm shorter.

The average relative distance in millimeters between the ideal center of rotation using the postoperative center of rotation was measured according to the method of Ranawat et al. [18]. The mean difference was 8 mm (range, 1–14 mm; median, 8 ± 4 mm).

None of the patients limped or had a positive Trendelenburg sign at final followup (Video 1. Supplemental materials are available with the online version of CORR). No patients had a peroneal nerve palsy. We observed no instances of heterotopic ossification in these 12 patients, but one patient who had more recent surgery and less than the 24 months minimum followup underwent reoperation for heterotopic ossification.

Discussion

This extension of the direct lateral approach is easy and quick to perform. It can be performed following basic principles of minimally invasive surgery (muscles are never cut transversely), and the approach can be extended distally when necessary. Indications for this approach include THA in patients with high hip dislocation (Crowe Type IV [5]). The technique also addresses common pitfalls, especially those occurring during THA for patients with acetabular dysplasia, high dislocation, gross leg-length discrepancies [12, 17], and in difficult revision cases; specifically we believe the approach will (1) reduce the nonunions or malunions which may occur after trochanteric or subtrochanteric osteotomy, (2) avoid the use of long femoral stems for bridging osteotomy sites in cases of subtrochanteric osteotomies, (3) reduce the possibility of development of irritation of tractus iliotibialis because no hardware is used for fixation of the greater trochanter, and (4) allow virtually unlimited distalization of the center of rotation without excessive tension of the gluteus medius which is markedly shortened in high hip dislocations or long-standing resection arthroplasties of the hip. It allows superior acetabular exposure and proper cup placement. Several additional techniques can be used for cup placement in the true acetabulum such as cotyloplasty or acetabular roof reconstruction [7, 8, 11]. This approach also enables substantial lower extremity elongation [11] while preserving muscle continuity. However, changes in the postoperative position of anterior and posterior structures (rotator muscles) may occur because these muscles remain attached to the bone detached from the anterior and posterior half of the greater trochanter. Sciatic nerve palsies are possible in extreme elongations (although we have had no such occurrences). Nerve palsy, however, usually develops because the nerve is injured with posterior retractors or after large hematomas [6, 9]. We do not advise proximal extension greater than 4 cm because of the possibility for superior gluteal nerve lesion, but this disadvantage is common to all lateral approaches. It is crucial to always split the abductor muscles (gluteus medius and vastus lateralis) in line with the muscle fibers and avoid transverse cuts. The important technical step in this approach is to detach the posterior half of the continuous tendon of the gluteus medius and vastus lateralis with a chisel. At least 2 to 3 mm of underlying bone should be chiseled because the tendon tissue in this area is thinner than in the anterior part leading to a high risk of ruptures and tendon tears. Owing to the bony flake of the greater trochanter, ectopic ossification may occur in some cases. The rehabilitation protocol is the same as in any primary THA because continuity of the abductor muscles is preserved. We recommend that patients continue muscle strengthening because some patients

experienced improvement in abductor muscle strength even after 12 months postoperatively.

When performing THA through the direct lateral approach and proximal femoral shortening is needed, the surgeon can easily extend the incision. The amount to be shortened can be calculated and planned preoperatively, subsequently measured, and finally corrected intraoperatively if necessary. The approach also enables full exposure while preserving continuity of the abductor muscles. It eliminates the necessity for osteotomies of the trochanter and transverse cuts or detachment of the abductor muscles.

References

1. Bauer R, Kerschbaumer F, Poisel S, Oberthaler W. The transgluteal approach to the hip joint. *Arch Orthop Trauma Surg*. 1979;95:47–49.
2. Blackley HR, Rorabeck CH. Extensile exposures for revision hip arthroplasty. *Clin Orthop Relat Res*. 2000;381:77–87.
3. Bruce WJ, Rizkallah SM, Kwon YM, Goldberg JA, Walsh WR. A new technique of subtrochanteric shortening in total hip arthroplasty: surgical technique and results of 9 cases. *J Arthroplasty*. 2000;15:617–626.
4. Charles MN, Bourne RB, Davey JR, Greenwald AS, Morrey BF, Rorabeck CH. Soft-tissue balancing of the hip: the role of femoral offset restoration. *Instr Course Lect*. 2005;54:131–141.
5. Crowe JF, Mani VJ, Ranawat CS. Total hip replacement in congenital dislocation and dysplasia of the hip. *J Bone Joint Surg Am*. 1979;61:15–23.
6. DeHart MM, Riley LH Jr. Nerve injuries in total hip arthroplasty. *J Am Acad Orthop Surg*. 1999;7:101–111.
7. Delimar D, Bicanic G, Pecina M, Korzinek K. Acetabular roof reconstruction with pedicled iliac graft. *Int Orthop*. 2004;28:319–320.
8. Delimar D, Cicak N, Klobucar H, Pecina M, Korzinek K. Acetabular roof reconstruction with pedicled iliac graft: early clinical experience. *Int Orthop*. 2002;26:344–348.
9. Edwards BN, Tullos HS, Noble PC. Contributory factors and etiology of sciatic nerve palsy in total hip arthroplasty. *Clin Orthop Relat Res*. 1987;218:136–141.
10. Hardinge K. The direct lateral approach to the hip. *J Bone Joint Surg Br*. 1982;64:17–19.
11. Hartofilakidis G, Stamos K, Karachalios T. Treatment of high dislocation of the hip in adults with total hip arthroplasty: operative technique and long-term clinical results. *J Bone Joint Surg Am*. 1998;80:510–517.
12. Maloney WJ, Keeney JA. Leg length discrepancy after total hip arthroplasty. *J Arthroplasty*. 2004;19(4 suppl 1):108–110.
13. McLauchlan J. The Stracathro approach to the hip. *J Bone Joint Surg Br*. 1984;66:30–31.
14. Mulliken BD, Rorabeck CH, Bourne RB, Nayak N. A modified direct lateral approach in total hip arthroplasty: a comprehensive review. *J Arthroplasty*. 1998;13:737–747.
15. Paavilainen T, Hoikka V, Paavolainen P. Cementless total hip arthroplasty for congenitally dislocated or dysplastic hips: technique for replacement with a straight femoral component. *Clin Orthop Relat Res*. 1993;297:71–81.
16. Pagnano W, Hanssen AD, Lewallen DG, Shaughnessy WJ. The effect of superior placement of the acetabular component on the rate of loosening after total hip arthroplasty. *J Bone Joint Surg Am*. 1996;78:1004–1014.
17. Parvizi J, Sharkey PF, Bissett GA, Rothman RH, Hozack WJ. Surgical treatment of limb-length discrepancy following total hip arthroplasty. *J Bone Joint Surg Am*. 2003;85:2310–2317.
18. Ranawat CS, Dorr LD, Inglis AE. Total hip arthroplasty in protrusio acetabuli of rheumatoid arthritis. *J Bone Joint Surg Am*. 1980;62:1059–1065.