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Lengthening osteotomy at the intertrochanteric level with simultaneous correction of angular deformities

Accepted: 6 June 2001 / Published online: 1 August 2001
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Abstract Fixed multiplane deformities around the hip representing a combination of rotational, angular, and leg-length discrepancies are disabling for the patient and pose a challenge for the orthopaedic surgeon. We describe a joint-preserving, one-stage procedure to address these complex problems using an intertrochanteric osteotomy with a step-cut to allow for corrective lengthening, angulation, and rotation. We present our results in nine patients. The aim of this paper is to provide the orthopaedic surgeon with a detailed approach to treating these deformities with reproducible results.

Résumé Les déformations fixées fixées au niveau de la hanche, intéressant plusieurs plans avec une composante de modification de longueur sont invalidantes pour le patient et posent de difficiles problèmes au chirurgien. Nous décrivons une technique d'ostéotomie intertrochantérienne en un temps avec correction des angulations, des rotations et des différences de longueur. Nous présentons nos résultats chez neuf patients. Le but de cette présentation est de fournir une approche détaillée au chirurgien orthopédiste pour traiter ces déformations avec des résultats reproductibles.

Introduction

Leg-length discrepancies with associated rotational or angular deformities can be caused by severe trauma or developmental disorders around the hip, with consequences not only for the patient's gait and function of the hip, but also for adjacent joints. Although each patient should be considered individually, length differences

over 2–2.5 cm are usually symptomatic and can lead to an unacceptable limp or backache [2, 4, 8, 15, 16]. A shortening procedure of the opposite side is an obvious choice for a straightforward leg length-difference of modest (2.5–5 cm) severity [8, 15, 17]. However, associated rotational or angular deformity can only be addressed by operating on the involved leg. We developed a joint-preserving technique to address a complex deformity in multiple planes around the hip in association with a moderate leg-length discrepancy in a single procedure. The main goals of the procedure are correction of the deformities, equalization of leg length, decreased pain, and improved function in a highly motivated patient.

Material and methods

Patients

We performed a one-stage lengthening intertrochanteric osteotomy with simultaneous correction of associated rotational and/or angular deformities in nine patients (Table 1). Prior to the procedure main complaints were pain, decreased functional hip motion, and a limp. Five patients had a positive Trendelenburg sign. The apparent leg-length discrepancy in these patients averaged 3.3 cm (range 2–5.5 cm) as assessed by placing blocks under the short extremity. For multiplane deformities with combined effects of contractures, angular deformities and true leg-length discrepancies, this is considered the best approach to determining the necessary amount of correction [11]. An alternative would be to measure the distance from the anterior superior iliac spine to the medial malleolus of the involved extremity and to compare this with the other leg that has to be placed in a mirror-image to the involved leg (i.e., with the same type and amount of contracture). We also obtained full-length films with both extremities on one film to measure leg-length discrepancy. Angular deformity (valgus/varus) was measured radiologically, and rotational deformity was determined clinically (the use of CT for evaluating rotational and true leg-length deformities had not been established in our institution at the time of initial evaluation of these patients). We did not use mathematical equations [6, 14] to plan our corrective osteotomy, as is often done in diaphyseal femoral or tibial deformities, but relied on clinical evaluation and plain radiographs. Such an approach is important with these deformities, given that complex deformities around the hip are often caused, at least partly, by contractures.

For this study P. Kloen was supported by a Maurice E. Müller Foundation Fellowship and an AO fellowship.

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Table 1 Results of corrective osteotomy. *DDH* developmental dysplasia of the hip, *SCFE* slipped capital femoral epiphysis, *LLD* leg length discrepancy, *fl-ctr* flexion contracture, *add-ctr* adduction contracture, *ext-rot ctr* external rotation contracture, *len* lengthening, *vlg* valgus, *var* varus, *int-rot* internal rotation, *ext* extension, *n.a.* not available

Age	Sex	Cause	Preoperative		Angular deformity	Rotational deformity	Trendelenburg	Osteotomy types	Postoperative ^a		Time to Union (Months)	Merle d'Aubigné Score	
			Functional LLD	Neck-shaft angle					Neck-shaft Angle	Functional LLD		Pre-operative	Post-operative
56	F	Trauma	2 cm	120°	Varus	25° ext-rot ctr	+	len, vlg, int-rot	135°	0	2	10	18
24	F	Trauma	2 cm	125°	Varus	20° ext-rot.ctr	-	len, vlg, int-rot	135°	0	3	16	17
32	F	DDH	3.8 cm	120°	Varus	None	+	len, vlg	140°	0.5 cm	3	12	17
17	M	Trauma	2.5 cm	135°	20° fl-ctr, 20° add-ctr	10° ext-rot ctr	+	len, var, int-rot, ext	115°	0	2,5	n.a. ^b	15
44	M	Trauma	5.5 cm	150°	10° fl-ctr, 25° add-ctr	None	+	len, vlg, ext	170°	1.5 cm	4	7	15
60	F	Trauma	3 cm	110°	Varus	None	-	len, vlg	140°	0	3	11	15
31	M	SCFE	3 cm	135°	None	25° ext-rot ctr	+	len, int-rot	135°	0	6	14	16
26	M	M. Perthes	5 cm	105°	Varus	None	-	len, vlg, int-rot	125°	1.5 cm	3	15	15
16	M	SCFE	3 cm	110°	Varus	35° ext-rot ctr	+	len, vlg, int-rot	130°	0	4	13	16

^a Amount of angular/rotational correction obtained based on intraoperative evaluation (position of blade plate insertion and rotational K-wires) and postoperative evaluation (radiographs)
^b This patient was nonambulatory because of other injuries at the time of his initial presentation to us. No preoperative Merle d'Aubigné was thus obtained

Fig. 1 K-wire placement prior to osteotomy as shown on anteroposterior and lateral schematic view. The dotted line represents the anticipated osteotomy. A anteverision K-wire, B summation K-wire, C and D rotational control K-wires, E osteotomy site. See text for further details

Fig. 2 Schematic illustration of osteotomy and corrections in various planes. See text for detail

These contractures need to be taken into account in conjunction with the bony deformity revealed by the radiographs. The increase in length that would be obtained by valgisation could easily be anticipated, as based on the preoperative planning.

We determined outcome for all nine patients based on radiographs and the Merle d'Aubigné score [9] at the latest follow-up.

Surgical technique

The patient is positioned supine with the extremity draped free with access to the iliac crest. The proximal femur is exposed through a standard lateral approach. The linea aspera is decorticated with an osteotome on each side of the anticipated osteotomy to facilitate incorporation of cancellous bone graft. An anteverision K-wire is placed along the anterior aspect of the neck, with additional K-wires proximally and distally of the anticipated level of osteotomy to control for rotational correction. One K-wire (summation-wire) is placed at a preoperatively calculated angle for correction of valgus or varus deformity and parallel to the anteverision

Fig. 3A–F Illustrative case. Anteroposterior (A) and lateral (B) radiograph showing posttraumatic arthritis of the hip after a mal-united acetabular fracture, with a 25° adduction and 10° flexion contracture. An intertrochanteric osteotomy had been performed previously at an outside hospital. Anteroposterior (C) and lateral (D) radiographs 5 weeks after our lengthening and valgus-extension

intertrochanteric osteotomy. The *arrow* depicts the lengthening obtained. The *thin black lines* show the angular corrections (*dotted line* preoperative; *solid line* postoperative). Anteroposterior (E) and lateral (F) radiographs at 6-year follow-up. Hardware has been removed

wire in the axial plane (Fig. 1). The chisel is placed parallel to the summation-wire. The placement of the chisel in the sagittal plane is determined by the needed extension or flexion correction (Fig. 2A). Once the chisel is in place the osteotomy is made using an oscillating saw, and thermal necrosis is prevented by saline cooling. Care should be given not to extend the horizontal part of the osteotomy to medial to prevent fracture of the trochanter minor fragment. The chisel is then exchanged for a six- or seven-hole 95° condylar blade plate (Fig. 2B) and a correction in the valgus-varus is done (Fig. 2C). Next, correction of a rotational deformity can be done by internally or externally rotating the distal fragment, after which a Verbrugge clamp is applied (Fig. 2D). Once adequate correction in the coronal, sagittal, and axial planes is obtained, a laminar bone spreader is used to obtain the predetermined increase in length after gently loosening the Verbrugge bone clamp (Fig. 2E). This is the most difficult part of the procedure since the surrounding soft tissues cause enormous resisting forces and it is essential that the correction is maintained in all planes.

For the lengthening we relied on manual traction and a laminar spreader; however, it might be helpful to use the AO femoral distractor at this stage. Multiple corticocancellous grafts from the iliac crest are placed in the gap, with additional cancellous graft along the decorticated linea aspera. It is important to remember that correction of angular deformities will effect length, and to take this into consideration before placing the graft [5].

Finally, the plate is transfixed with 4.5-mm cortical screws. One or two of the proximal screws should be aimed cephalad in order to obtain purchase in the proximal fragment, and can be placed in lag-fashion (Fig. 2F). Gentle passive range-of-motion exercises of the hip are started on the first postoperative day, when the patient can also begin partial weight bearing.

Results

Table 1 summarizes our results with a series of nine patients. Eight of the nine osteotomies healed within four months, while one patient demonstrated a radiographic delayed union without symptoms that showed consolidation at six months without further intervention. The patients were followed for an average of 49 months. The average preoperative Merle d'Aubigné score was 12.2 points (fair), while the average postoperative Merle d'Aubigné score was 16.1 (good). Three patients had a relatively small increase (less than three points) in their Merle d'Aubigné score. However, they had significant correction of preoperative contractures, which is not accounted for in this score. The Trendelenburg sign that was present in five patients preoperatively had disappeared in all but one.

Illustrative case

A 32-year-old man sustained a posterior wall/posterior column acetabular fracture on his right side in a motor vehicle accident. He underwent osteosynthesis of the acetabular fracture at an outside hospital, which led to a malunion and early posttraumatic hip arthritis. A valgus intertrochanteric osteotomy was done 9 years later, without significant improvement. He was referred to us two years after this osteotomy. At that time he walked with a limp and used a crutch as a result of an apparent leg-length discrepancy of 5.5 cm. His hip was painful day and night, and he could only walk for 15 min at a time. Radiographs indicated posttraumatic hip arthritis after a malunited acetabular fracture and a 25° adduction contracture, despite the previous intertrochanteric osteotomy (Fig. 3A,B).

We performed a multiplane corrective osteotomy, consisting of 3.5-cm lengthening, 20° valgization, and 10° extension (Fig. 3C,D). Six years later the patient has no complaints. He

wears a 1.5-cm insert in his right shoe and his walking time has increased to 2.5 h without assistive devices or limp (Merle d'Aubigne score 15). Radiographs show sclerosis and osteophyte formation, but a joint space that has sufficiently reconstituted (Fig. 3E,F).

Discussion

Deformities of the proximal femur following severe fractures or developmental disorders can range from a single-plane malalignment to a multiplanar deformity with a rotational and/or angular component with or without a leg-length discrepancy. These patients often present at a relatively young age, making a total hip arthroplasty undesirable. Few reports describe joint-preserving procedures for these complex problems [7, 12, 18].

The technique described here is applicable for the treatment of the deformities associated with modest leg-length discrepancies of up to 5 cm. Although small-length discrepancies could arguably be left alone, all patients in our group insisted on correcting the length discrepancy.

While we have achieved reproducible results with the procedure as described, there are several challenging aspects of which surgeons should be aware. First, proficiency with proximal femoral osteotomies and blade plate fixation is required, as is preoperative planning and careful execution. Second, in order to overcome the large resistive forces encountered when lengthening while simultaneously maintaining the reduction in other planes, one has the option of using either manual traction with a laminar spreader or the AO femoral distractor. An additional challenge could be the need for varization, which would imply abutment and possible subsequent fracturing of the trochanter minor fragment when transfixing the blade plate. Although our experience with varization using this type of osteotomy is rather small (one out of nine), the recommended approach to such correction is to contour the proximal fragment with a chisel to prevent fracturing of the trochanter minor fragment.

The main advantages of our technique versus others are the stable osteosynthesis obtained, the range and amount of multidimensional correction allowed, the large, well-vascularized metaphyseal surface leading to rapid osseous union, and a low rate of complications [1, 3, 10, 12, 13].

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