SURGICAL TECHNIQUES

TWO-STAGE SURGICAL TREATMENT OF
COMPLEX FEMORAL DEFORMITIES WITH
SEVERE COXA VARA IN POLYOSTOTIC
FIBROUS DYSPLASIA

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Introduction

For complex femoral deformities in patients affected by polyostotic fibrous dysplasia and coxa vara associated with shepherd's crook deformity of the femoral shaft¹⁻⁴, the correct treatment is stabilization with an interlocking cervicodiaphyseal nail after correction of all of the femoral deformities^{2,5-7}. However, a 1-stage correction of both severe coxa vara of $\leq 90^\circ$ and femoral shaft deformity with simultaneous stabilization of the osteotomies by a cervicodiaphyseal nail is not feasible for technical reasons⁸.

Therefore, since 2005, we have attempted to correct such complex femoral deformities with a 2-stage procedure. The first stage consists of a valgus intertrochanteric osteotomy, either linear or closing wedge, stabilized with a hip blade-plate. As soon as the valgus osteotomy has healed, to avoid possible complications caused by the hip plate, the second stage of the procedure is performed, usually 4 to 5 months later. The second procedure includes removal of the hip plate, 1 or 2 osteotomies performed distal to the lesser trochanter to correct the shepherd's crook deformity, and stabilization with a cervicodiaphyseal nail.

Since the 2 surgical procedures must be performed consecutively within a few months and both are physically demanding, the general condition of the patient must be good, especially for those with McCune-Albright syndrome as they are burdened by several comorbidities. Moreover, this procedure has scarce or no indications in very disabled patients who are not able to walk and in whom either restoration or improvement of the normal femoral anatomy does not guarantee a recovery of the ability to walk.

In children under the age of 9 years, a custom-modified humeral nail, which required reaming that started at 9 mm at the tip of the greater trochanter, was used^{8,9}. To obtain sufficient femoral neck stabilization, the proximal femoral physis may be violated in selected patients, and lower limb-length inequality addressed when present, with proper surgical techniques according to the age of the patient⁸.

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Indications and Contraindications

Indications

- Coxa vara of $\leq 90^\circ$ with diffuse femoral involvement by fibrous dysplasia without shepherd's crook deformity.
- Coxa vara of $\leq 90^\circ$ with diffuse femoral involvement by fibrous dysplasia with shepherd's crook deformity.

Contraindications

- Coxa vara of $\geq 100^\circ$. In such patients, a single-stage valgus osteotomy and immediate stabilization with a cervicodiaphyseal nail may be performed.

Step 1: The First-Stage Procedure—Intertrochanteric Valgus Osteotomy and Fixation with a Hip Blade-Plate: Preoperative Planning

Evaluate the patient radiographically and select the hardware.

- Obtain a preoperative photograph or video of the patient and make a standing anteroposterior radiograph of the pelvis and lower limbs as well as a frog-leg lateral radiograph of the femur (Video 1, Figs. 1-A, 1-B, and 1-C). All figures and videos are from the case of one of our patients.
- Use standardized radiographs and a software-based radiographic method (Carestream Health) to obtain measurements of the neck-shaft angle bilaterally, the length of the lower limbs, and the mechanical axis.
- Before the first-stage operation, evaluate the range of motion of the hips. In patients with a limitation of internal rotation with the hip extended, indicating proximal femoral retroversion, make a computed tomographic (CT) scan for an exact evaluation of the retroversion. Ensure that the deformity is adequately corrected during surgery by externally rotating the proximal osteotomy fragment.
- Roughly calculate the change in the femoral length, which increases from 0.65 to 0.98 cm for every 10° increase in the neck-shaft angle, according to the length of the femoral neck as measured from the center of the femoral head to the midshaft of the femur at the level of the lesser trochanter. This distance usually ranges from 4 to 6 cm, depending on the age of the patient¹⁰. In our patient, the neck-shaft angle measured 90° and the length of the neck measured 5 cm.
- Calculate the amount of valgus correction in relation to the degree of hip adduction. Our patient had a hip adduction of 40°, allowing a valgus correction of up to 130°. The femoral lengthening should be between 2.6 and 3.92 cm.
- Use a blade-plate instead of a screw-plate because, although the blade-plate is a relatively older type of implant, the blade is larger and flatter than a screw. Therefore, in the context of the weak fibrodysplastic bone of the femoral neck, we believe a blade offers more resistance than a screw to the distracting forces generated by the overtensioning of the gluteus medius⁴, and it preserves more bone stock. The blade angulation is selected according to the amount of correction desired.

Fig. 1-A

Fig. 1-B

Fig. 1-C

Video 1 The patient's ability to walk before surgery.

Figs. 1-A, 1-B, and 1-C A 19-year-old girl with McCune-Albright syndrome. **Fig. 1-A** Severe anterolateral bowing of the right thigh is present.

Fig. 1-B Anteroposterior radiograph of the pelvis and lower limbs showing coxa vara and shepherd's crook deformity of the right femur.

Fig. 1-C Lateral radiograph of the femur showing marked anterior bowing.

Step 2: Patient Preparation

Position the patient on the traction table.

- In children, general anesthesia is performed together with a caudal block to control postoperative pain. In adults, epidural, spinal, and lumbar plexus blocks may also be considered.
- Position the patient supine on a traction table and apply slight traction to the involved lower limb to keep it stable. The use of a traction table is advised to allow for an easy and quick axial view of the hip with the image intensifier and to enable correct positioning of the hip blade-plate as well as to increase traction at the time of valgus positioning of the proximal osteotomy fragment (Fig. 2).
- The contralateral lower limb is positioned with the hip flexed from 90° to 100° so as to obtain, with the fluoroscope, a lateral view of the hip undergoing surgery (Fig. 2). The accuracy of the preoperative radiographic planning compensates for the lack of the intraoperative clinical comparison with the contralateral limb.
- Clean, prepare, and drape the operative field from the iliac crest to the knee.

Fig. 2

Fig. 2 The patient is positioned supine on a traction table.

Step 3: Preparation of the Lateral Aspect of the Proximal Part of the Femur and Marking the Position for Both the Osteotomy and the Hip Blade-Plate

Expose the lateral aspect of the proximal part of the femur and mark the position of both the blade-plate and the osteotomy.

- Under fluoroscopic control, make a longitudinal incision starting at the level of the lateral aspect of the greater trochanter (Fig. 3-A).
- Perform a sharp dissection deep to the fascia lata so that it is split longitudinally and exposes the vastus lateralis, which is partially detached from the lateral aspect of the femur according to the length of the plate. Incise the vastus lateralis posterior to the fascia lata incision close to the linea aspera to preserve more innervated muscle fibers.
- After periosteal elevation, position 1 or 2 Hohmann retractors around the proximal part of the femur.
- Drill 2 Kirschner wires into the femur: insert the proximal Kirschner wire into the distal part of the femoral neck and parallel to it so as to mark the blade-plate position in the femoral neck, and insert the distal Kirschner wire just proximal to the lesser trochanter to mark the osteotomy line (Figs. 3-B and 3-C). Wedge resection is advisable in a patient with coxa vara associated with a very proximal shepherd's crook deformity, whereas a straight osteotomy is advised in a patient with either an absent or a more distally located shepherd's crook deformity. We recommend a minimum distance of 2.5 cm from the osteotomy site to the blade insertion point.

Fig. 3-A

Fig. 3-B

Fig. 3-C

Figs. 3-A, 3-B, and 3-C Preparation of the lateral aspect of the proximal part of the femur and marking the position for both the osteotomy and the hip blade-plate. **Fig. 3-A** A 12-cm-long longitudinal incision is made starting at the level of the greater trochanter. **Fig. 3-B** The lateral aspect of the proximal part of the femur is exposed, and 2 landmark Kirschner wires are drilled. **Fig. 3-C** Fluoroscopic view showing the proximal Kirschner wire marking the position of the blade of the plate while the distal wire marks the position of the osteotomy.

Step 4: Blade-Plate Positioning, Osteotomy, and Osteotomy Fixation

Prepare the slot for the blade, perform the osteotomy, and correct the valgus alignment of the proximal part of the femur.

- Introduce the slot-chisel for the blade-plate into the femoral neck, guided by the proximal Kirschner wire, and check its position on both planes under fluoroscopy (Figs. 4-A and 4-B).
- Partially insert a 130° angulated blade-plate into the prepared slot, and perform the osteotomy with an oscillating saw. With an osteotome, check that the medial cortex of the femur is completely interrupted (Figs. 5-A, 5-B, and 5-C).
- Insert the entire blade into the slot and start the valgus correction maneuvers by asking an assistant to abduct the leg in traction while slightly applying traction to the involved limb so as to open the osteotomy line (Figs. 6-A and 6-B). Push simultaneously both the plate and the proximal osteotomy fragment medially by inserting

Fig. 4-A

Fig. 4-B

Fig. 5-A

Fig. 5-B

Fig. 5-C

Fig. 6-A

Fig. 6-B

Figs. 4-A and 4-B Preparing the slot for the blade. **Fig. 4-A** The slot chisel is introduced into the femoral neck along the guide of the proximal Kirschner wire. **Fig. 4-B** Lateral fluoroscopic view of the femoral neck with the proximal Kirschner wire and the chisel.

Figs. 5-A, 5-B, and 5-C Insertion of a 130° angulated blade-plate into the prepared slot, and performance of the osteotomy with an oscillating saw. **Fig. 5-A** The blade-plate is partially introduced into the femoral neck. **Fig. 5-B** The osteotomy is performed with an oscillating saw. **Fig. 5-C** Fluoroscopic view of the blade-plate and the osteotomy.

Figs. 6-A and 6-B Start of the correction of the valgus alignment of the proximal part of the femur. **Fig. 6-A** After completing the osteotomy, the blade is completely introduced into the femoral neck under fluoroscopic control. **Fig. 6-B** The traction leg of the operating table is abducted (red arrow) and the plate is pushed medially at the same time.

the blade pusher into the lowest screw hole in the plate. The blade pusher is the same device used to hit the blade-plate into the neck of the femur.

- When the plate is close to the lateral aspect of the femur, grasp both the plate and the femur with 1 or 2 Lambotte bone holders. Be careful not to apply too much pressure to the weak fibrodysplastic bone so as to avoid bone crushing (Figs. 7-A and 7-B).
- Fix the plate to the femoral shaft by inserting all of the screws (Figs. 8-A and 8-B). We recommend that the plate be fixed with screws in at least 6 cortices. If the bone is too weak, to avoid secondary pullout of the screws, keep the thigh abducted at 35° to 40° by applying, immediately after surgery, a hip spica cast or a brace that is worn for 5 weeks postoperatively.

Fig. 7-A

Fig. 7-B

Fig. 8-A

Fig. 8-B

Figs. 7-A and 7-B Positioning the plate. **Fig. 7-A** The plate is held adherent to the lateral aspect of the femur with 2 Lambotte bone holders.

Fig. 7-B Fluoroscopic view showing correct positioning of the plate and medial opening of the osteotomy.

Figs. 8-A and 8-B Fixation of the plate to the femoral shaft. **Fig. 8-A** The blade-plate is screwed to the femoral shaft.

Fig. 8-B The final blade-plate position is checked by fluoroscopy. The neck-shaft angle has been corrected to 130°.

Step 5: Postoperative Management

Check postoperative bleeding, provide blood transfusions if needed, and have the patient resume walking.

- Maintain the suction drain for 2 to 3 days. Blood tests for hemoglobin and hematocrit control are done every 6 to 12 hours^{8,9}. The patient is managed with passive range-of-motion exercises as soon as they can be tolerated, and assisted walking with crutches is allowed for 5 weeks, with weight-bearing on the contralateral, noninvolved limb.
- If the patient is not able to walk, owing to the cumbersome spica cast or hip brace at 40° of abduction, a wheelchair can be used.
- The spica cast or the hip brace is worn for 5 weeks. After clinical and radiographic evaluation, have the patient start active range of motion of the hip and assisted partial weight-bearing after the osteotomy has healed, usually by the end of the third month postoperatively.

Step 6: The Second-Stage Procedure—Hip Plate Removal, Osteotomy of the Femoral Shaft to Correct the Shepherd's Crook Deformity, and Stabilization with a Cervicodiaphyseal Nail: Preoperative Planning

Study the patient radiographically, simulate the osteotomies, perform another assessment of lower-limb length, and select the hardware.

- Make standing anteroposterior radiographs of the pelvis and lower limbs and a lateral radiograph of the affected femur (Figs. 9-A and 9-B). In our patient, at 6 months after the first-stage procedure, there was a loss of correction of the neck-shaft angle of almost 5° because of proximal migration of the blade of the hip blade-plate.
- Make radiographs of the deformed femoral shaft on the computer and mark the center of rotational angulation of each deformity component on the coronal plane in order to calculate the number of osteotomies needed (Fig. 9-C).
- Perform mock osteotomies either on the radiographs or with a software-based radiographic method, realign the fragments to straighten the femoral shaft on the coronal plane, and measure the length of the fragments (Fig. 10-A). In patients with marked anterior bowing of the femoral shaft, some intraoperative adjustment may be done to achieve deformity correction in both coronal and sagittal planes.
- Measure the overall length of the straightened femur and check the new alignment of the whole lower limb. Calculate the length of the nail on the radiographs. The diameter of the nail must be approximately one-third of the femoral thickness measured on both coronal and sagittal planes to avoid stress-shielding.
- If overlengthening occurs, remove a bone cylinder from 1 of the osteotomy segments to equalize limb length.
- At this stage, nothing can be done if there is persistent shortening: it is well known that fibrodysplastic bone cannot be lengthened². In our patient, the correction of the shepherd's crook deformity led to a 20° valgus angulation of the knee because of hypoplasia of the lateral femoral condyle. The lowest femoral osteotomy fragment must be reamed in a mediolateral direction to improve knee valgus (Fig. 10-B).

Fig. 9-A

Fig. 9-B

Fig. 9-C

Fig. 10-A

Fig. 10-B

Figs. 9-A, 9-B, and 9-C Perform an assessment of lower-limb length. **Fig. 9-A** Standing anteroposterior radiograph of the pelvis and both femora, 6 months after the first-stage procedure. The neck-shaft angle measures 125° owing to some cranial migration of the blade of the plate.

Fig. 9-B Lateral radiograph of the femur showing marked anterior bowing. **Fig. 9-C** The center of rotational angulation of each deformity and the needed corrective osteotomies are marked on the radiograph.

Figs. 10-A and 10-B Mock osteotomies. **Fig. 10-A** Mock osteotomies are done on the anteroposterior radiograph. The osteotomy fragments are realigned and measured to calculate the length of the nail. In this patient, correction of the femoral shaft deformity on the coronal plane caused 20° of valgus knee angulation because of the hypoplasia of the lateral femoral condyle. **Fig. 10-B** The lowest fragment must be reamed in a mediolateral direction to improve knee valgus (yellow line).

- A cervicotrochanteric nail with a spiral cervical blade (PFN [proximal femoral nail]; Synthes, Johnson & Johnson) is used because the spiral blade is large and offers a better purchase into the soft fibrodysplastic bone of the femoral neck. A straight nail can have a custom modification in which it is bent 10° laterally to allow its introduction through the tip of the greater trochanter (Fig. 11). The bending process, as well as the evaluation of the length of the nail, is performed before the operation.

Fig. 11

Fig. 11 Photograph of the nail (PFN; Synthes, Johnson & Johnson) assembled with the spiral blade and the distal locking screws. A custom-made 10° lateral proximal angulation of the nail allows its insertion from the apex of the greater trochanter.

Step 7: Patient Preparation, Plate Removal, and Drilling of Kirschner Wires to Mark the Site of the Planned Osteotomies

Position the patient on the traction table and expose the lateral aspect of the femur from the tip of the greater trochanter to the level of the most distal planned osteotomy.

- Place the patient under general anesthesia and use a caudal block to control postoperative pain.
- Position the patient supine on a traction table with a slight traction applied and with the hip maintained in neutral rotation with the patella facing upward.
- Hold the contralateral lower limb in a flexed position so that the fluoroscope can be correctly positioned to obtain a lateral view of the hip (Fig. 2).
- Clean and prepare the operative field from the transumbilical line distally to the middle part of the leg.
- Drape the patient from the anterior superior iliac spine to the anterior tibial tuberosity
- Through the previous incision, expose and remove the plate (Fig. 12).
- Make a new incision spanning from 4 cm proximal to the tip of the greater trochanter to the level of the most distal osteotomy.
- Perform a sharp dissection deep to the fascia lata, which is split longitudinally and elevated together with the vastus lateralis. All osteotomy sites are marked with Kirschner wires according to the preoperative plan and are checked with fluoroscopy (Figs. 13-A, 13-B, and 13-C). Identify the tip of the greater trochanter through the gluteus medius, which is split by blunt dissection.
- The first osteotomy should be done at approximately 8 to 9 cm distal to the tip of the greater trochanter (at the level of the lateral bend of the cervicotrochanteric nail).

Fig. 12

Fig. 13-A

Fig. 13-B

Fig. 13-C

Fig. 12 The hip plate is exposed and removed.

Figs. 13-A, 13-B, and 13-C Marking the osteotomy sites with Kirschner wires. **Fig. 13-A** Through the new incision spanning from 4 cm proximal to the tip of the greater trochanter to 4 cm distal to the level of the most distal osteotomy, the lateral aspect of the femur is exposed and the osteotomy levels are marked with Kirschner wires. **Fig. 13-B** The level of the proximal osteotomy is marked with a Kirschner wire and checked under fluoroscopy.

Fig. 13-C The levels of both the middle and the most distal osteotomies are also checked under fluoroscopy.

Step 8: Perform All of the Osteotomies and Drill a Medullary Canal in the Osteotomy Fragments

All of the osteotomies are performed, and a medullary canal is drilled in each femoral fragment.

- After periosteal elevation is done and retractors are positioned, do the first (proximal) osteotomy. Afterward, position a custom-made compass guide to drill a pin from the lateral part of the osteotomy surface to the tip of the greater trochanter (Figs. 14-A and 14-B). In children and adolescents, the compass guide must be positioned at the lateral aspect of the greater trochanter to avoid injury to the retinacular vessels.
- Ream a canal along the pin up to a diameter of 15 mm to host the proximal part of the nail (Fig. 14-C).
- Elevate the periosteum only at the level of the osteotomy site to avoid devascularization of the osteotomy fragments, and perform the other osteotomies with an oscillating saw (Fig. 15).
- Grasp each osteotomy fragment with a Lambotte bone holder and ream a canal 1.5 mm wider than the diameter of the selected nail along the guide pin previously drilled into the fragment with the use of a compass guide (Fig. 16).
- According to the preoperative plan, the most distal fragment is reamed in a mediolateral direction. Position the most distal fragment in varus, as far as possible, as it will improve the valgus angulation of the knee caused by the hypoplasia of the lateral femoral condyle⁴. If needed, any residual knee valgus deformity will be corrected later.

Fig. 14-A

Fig. 14-B

Fig. 14-C

Fig. 15

Fig. 16

Figs. 14-A, 14-B, and 14-C Performing the proximal osteotomy. **Fig. 14-A** The proximal osteotomy is performed 8 cm distal to the tip of the greater trochanter to match the level of the lateral bend of the nail, and a guide pin is drilled from the surface of the osteotomy to the tip of the greater trochanter with a compass guide. **Fig. 14-B** Fluoroscopic view showing the correct position of the guide pin. **Fig. 14-C** The proximal fragment is reamed in a distal-proximal direction up to a diameter of 15 cm to host the proximal part of the nail.

Fig. 15 The 2 distal osteotomies are sequentially performed in a proximal-distal direction.

Fig. 16 A guide pin is positioned with a compass guide in each femoral fragment firmly grasped with a Lambotte bone holder. A medullary canal 1.5 mm wider than the nail is reamed afterward in each osteotomy fragment along the guide pin.

- To avoid maltracking of the reamer, check the position of the guide pin in the most distal osteotomy fragment on both anteroposterior and lateral radiographs with the fluoroscope before reaming the medullary canal (Fig. 17).

Fig. 17

Fig. 17 The correct position of the guide pin in the most distal femoral fragment is checked under fluoroscopy in anteroposterior and lateral radiographs.

Step 9: Nail and Spiral Blade Insertion, Stabilization of Osteotomies, and Closure

Introduce the nail into the osteotomy fragments and insert the spiral blade and distal locking screws.

- Release the traction and adduct the traction arm 20° to facilitate introduction of the nail.
- Introduce the nail through the femoral fragments with gentle rotation movements.
- Check the correct position of the nail driven into each femoral fragment under both direct and fluoroscopic vision (Figs. 18-A and 18-B).
- After nailing the most distal fragment, check the proper position of the nail with the fluoroscope.

Fig. 18-A

Fig. 18-B

Figs. 18-A and 18-B Nail insertion. **Fig. 18-A** The nail is introduced into the osteotomy fragments under direct vision.

Fig. 18-B Fluoroscopic control of the nail introduced through the osteotomy fragments.

- Position the guide pin for the spiral blade into the femoral neck with the guide arm connected to the nail holder (Fig. 19-A).
- Introduce a spiral blade of the correct length into the femoral neck (Figs. 19-B, 19-C, and 19-D) and screw a plug into the proximal part of the nail to lock the spiral blade. All of the femoral fragments should now be correctly realigned (Fig. 20).
- Position 1 or 2 distal locking screws under fluoroscopic control after bringing the traction arm into neutral position.
- Close the vastus lateralis, apply a suction drain, and then close the fascia lata. Perform standard subcutaneous and skin closure (Fig. 21).
- Make postoperative anteroposterior and lateral radiographs of the involved femur (Fig. 22).

Fig. 19-A

Fig. 19-B

Fig. 19-C

Fig. 19-D

Fig. 20

Fig. 21

Fig. 22

Figs. 19-A through 19-D Spiral blade insertion. **Fig. 19-A** The guide pin for the spiral blade is introduced into the femoral neck. **Fig. 19-B** The correct position of the pin is checked under fluoroscopy.

Figs. 19-C and 19-D The final position of the spiral blade is checked under fluoroscopy in both anteroposterior (**Fig. 19-C**) and lateral (**Fig. 19-D**) radiographs.

Fig. 20 All of the femoral fragments are correctly realigned along the intramedullary nail.

Fig. 21 Comparative clinical aspect of the thigh deformity before the first stage and after the second-stage procedure.

Fig. 22 Postoperative anteroposterior and lateral radiographs.

Step 10: Postoperative Management

Check postoperative bleeding, which is usually marked; administer blood transfusions as needed; and have the patient resume walking.

- Encourage active motion of the toes, ankle, knee, and hip as tolerated, as soon as the caudal block wears off.
- Leave the drain in for at least 3 days. Do blood tests for hemoglobin and hematocrit control every 6 to 12 hours as postoperative bleeding is usually marked and blood transfusions are needed.
- Have the patient start assisted walking with crutches without weight-bearing on the involved limb as soon as the pain subsides, usually by the fourth to fifth postoperative day (Fig. 23).
- Make control radiographs of the femur before discharging the patient.
- Make additional radiographs of the femur after the sixth postoperative week and have the patient start partial weight-bearing at that time.
- Have the patient increase weight-bearing progressively with the use of 1 crutch and have additional radiographs made by the end of the fourth month postoperatively. For patients with a lower limb-length discrepancy and/or deformity of the contralateral lower limb needing further surgery, protected walking with 2 crutches is advisable (Video 2).

Fig. 23

Fig. 23 Preoperative photograph of the patient and photograph made at the fifth postoperative day.

Video 2 The patient's ability to walk 4 months after surgery.

Results

We performed this surgery on 13 femora in 11 patients⁸. Seven patients, ranging in age from 5 to 10 years (mean, 8.4 years), still had open physes. Four patients were fully grown and ranged from 16 to 35 years old (mean, 26 years). The mean neck-shaft angle (and standard deviation) was $83^{\circ} \pm 15.1^{\circ}$ (range, 50° to 100°) before the first-stage procedure and $130^{\circ} \pm 6.9^{\circ}$ (range, 120° to 140°) after the procedure, with a mean improvement of 46.9° (range, 25° to 70°). Radiographic healing of the osteotomy occurred at 3 to 4 months. The second-stage procedure was performed at a mean interval of 6 months. However, we believe that 4 to 5 months is the ideal interval between the 2 stages because, by that time, the osteotomy is healed and the complication rate due to the hip plate is still low. At the end of the second-stage procedure, the correction of the neck-shaft angle obtained at the end of the first-stage operation in 13 hips was maintained in all but 2 hips that had a loss of correction averaging 4.5° . The femoral shaft osteotomies showed radiographic healing at a mean of 4 months. At the latest follow-up evaluation, at a mean of 4 years and 7 months, the mean loss of correction of the neck-shaft angle was 5° relative to the value immediately after the second-stage procedure. All patients had no pain; 7 patients walked without a limp, 3 patients had a substantial improvement of the previous limp, but 1 patient had no improvement.

Pitfalls and Challenges

- Insert the blade of the plate into the slot before completing the osteotomy; otherwise, it may be difficult to control the proximal femoral fragment, and a wrong direction might be taken by the blade owing to the soft bone of the femoral neck.
- If there is anterior or lateral bowing of the femur, or both, just distal to the lesser trochanter, the distal part of the plate will not be adherent to the femoral shaft. In those patients, the distal screws must be positioned in a slightly oblique direction, and some impingement of the plate against the fascia might be expected.
- Drill the medullary canal in the proximal osteotomy fragment in a distal to proximal direction using a guide pin: its position is critical.
- If bleeding is marked when the periosteum is elevated, applications of Tabotamp gauze (Ethicon, Johnson & Johnson) may reduce bleeding. In this regard, the periosteum must be elevated only at the site of the osteotomies.
- The medullary canal must be reamed in each osteotomy fragment under the guidance of a pin positioned with a compass guide: maltracking is likely to occur with freehand pin drilling.
- If a knee valgus develops at the end of the mock femoral osteotomies during the preoperative plan, drill the medullary canal in the distal femoral fragment in a mediolateral direction to either correct or reduce the valgus deformity that is due to the lateral femoral condylar hypoplasia⁴.
- In many patients, the distal end of the femur is bowed anteriorly. Be careful not to perforate the anterior femoral cortex when the medullary canal is drilled in the most distal osteotomy fragment.

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