Treatment of coxa vara utilizing an external fixator

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Background

Valgus subtrochanteric osteotomy is the gold standard in the surgical treatment of coxa vara. Nevertheless, there has been no consensus on the method of fixation and osteotomy details. In the literature, there are few reports on using rigid internal fixation methods that preclude the need for postoperative immobilization.

Patients and methods

In this study, 15 hips of 13 patients with the diagnosis of developmental coxa vara underwent subtrochanteric osteotomy with stabilization using an external fixator.

Results

All osteotomies achieved the planned correction angle, and all osteotomies healed primarily except in one case. Radiographic analysis revealed an improvement in Hilgenreiner's epiphyseal angle and neck–shaft angle.

Conclusion

This technique proved to be safe and effective in the treatment of proximal femoral deformity associated with coxa vara and limb length discrepancy. It has potential advantages over commonly used open techniques and provides an available alternative to currently applied methods used for fixation of proximal femoral osteotomies.

Keywords:
coxa vara, external fixator, Ilizarov, osteotomy

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Introduction

Classically defined as a femoral neck–shaft angle of less than 110°, coxa vara is relatively uncommon, occurring in approximately one per 25 000 children [1]. This deformity results from a heterogeneous group of conditions that can be classified as congenital, developmental, dysplastic, and traumatic [1]. The natural history of coxa vara may be debilitating as the child develops progressive limb length discrepancy, a limp, pain, abductor weakness, and restricted motion. Secondary acetabular dysplasia and genu valgum may compound the situation. Because nonoperative management is ineffectual, a variety of surgical methods have evolved to deal with progressive coxa vara [1–5]. Historically, treatment has evolved from nonoperative (which was found to be ineffective) to surgical, with both subtrochanteric and intertrochanteric valgus osteotomies commonly utilized. Despite well-performed osteotomies, recurrence is cited in the literature ranging from 30 to 70% [1,3,4,6]. The high recurrence rate can be explained by the biomechanics of the underlying disorder. Coxa vara lends itself to progression as the physis assumes a more vertical position. Resultant forces across the hip then become shearing rather than compressive [7]. This bending moment is pathologic not only to the mechanical properties of stability of the epiphysis but also to normal continued physeal growth. Thus, unlike the normal hip in which these resultant forces are compressive, in coxa vara the shearing forces cause the deformity to recur unless osteotomy addresses the physeal position [8]. Adequate surgical correction of coxa vara is difficult and requires careful clinical and radiographic assessment, preoperative planning, proper implant selection, and meticulous surgical technique. Restoration of the femoral neck physis to a relatively horizontal position will – theoretically at least – normalize the biomechanical forces, converting them from shear, which is poorly tolerated, to compression, which is more physiologic. Correction of Hilgenreiner's epiphyseal (HE) angle to less than 38° is the goal of intraoperative correction. This will protect the physis and femoral neck, reducing the risk of recurrent coxa vara, regardless of the etiology of the deformity and the age of the patient [4,8]. Achieving corrections of limb deformities and length discrepancies through less invasive means is becoming increasingly popular [9]. Recently, good results using external fixator systems have been reported for the correction of proximal femoral deformities secondary to slipped capital femoral epiphysis, Perthes disease in children using open techniques, and percutaneous proximal femoral osteotomy in the treatment of coxa vara [10–12]. In this paper we describe the surgical technique and present the long-term results of a minimally invasive percutaneous approach with external fixators (Orthofix and Ilizarov) for correction of severe deformities secondary to coxa vara.

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Patients and methods

Between 2002 and 2010, 15 subtrochanteric femoral osteotomies were performed in 13 consecutive patients for treatment of coxa vara using external fixator systems for stabilization. Fifteen hips of 13 patients, two receiving bilateral and 11 receiving unilateral treatment, were included in this study. After obtaining detailed informed consent from all patients, monolateral limb reconstruction system fixator was used in three cases and Ilizarov fixator in 10 cases. The average age at initial surgery was 11.3 years (range 5–22 years). There were different etiologies of coxa vara in this group: 10 patients had infantile coxa vara, two patients had fibrous dysplasia, and one patient had proximal femoral focal deficiency. The indication for surgery in this group of patients included in the study was the chief complaint of a limp, with minimal or no pain. Physical examination revealed a short leg gait with an abductor lurch, a positive Trendelenburg's test, and limitation of abduction and internal rotation of the involved hip in all patients. Standard radiographs were taken before and 1, 3, 6, and 12 months after surgery, including an anteroposterior (AP) view of the pelvis and frog lateral of the affected hip. Scanograms were available preoperatively for all patients. HE angle and neck–shaft angle were measured before surgery, immediately after surgery, and at the latest follow-up on the AP pelvis radiograph. All patients had an HE angle of more than 60 and an FNS angle of less than 90. Seven cases had preoperative limb length discrepancy of an average of 4.2 cm (range 2–8 cm). In four cases, additional diaphyseal osteotomy was performed to correct limb length discrepancy. Minimum follow-up was 1 year because radiographic evidence of healing was required. The mean duration of follow-up was 3.7 years (range 1–7 years).

Operative technique

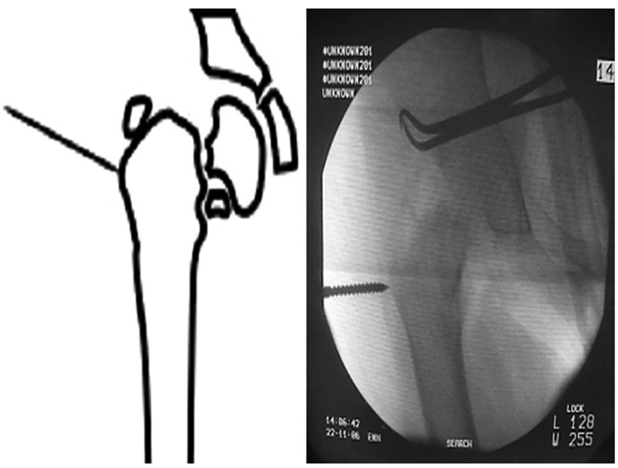
After induction of general anesthesia the patient is positioned in lateral decubitus. The involved lower extremity is prepared and draped. The affected limb is held in a hip neutral position and a true AP view of the involved hip is reproduced on the C-arm monitor. Placing the half pins in the proximal segment with the limb in the hip neutral position avoids the need of extensive skin release around the half pins after the corrective osteotomy. The proximal half pins are placed in the superolateral to inferomedial direction (Fig. 1). When using ilizarov fixator, the half pins are mounted on the femoral arch, and care is taken to allow at least two-finger breadth between the arch and the underlying skin.

Subsequently, with the limb in neutral alignment in the frontal, sagittal, and transverse planes (i.e. knee neutral position) half pins are placed at right angles to the femoral shaft mounted on one or more arches on the basis of the size of the limb (Fig. 2).

Thereafter, a 2-cm transverse incision is made at the level of the proposed osteotomy site at the subtrochanteric area and multiple drill holes are made by connecting the drill holes with an osteotome or using a gigli saw (Fig. 3).

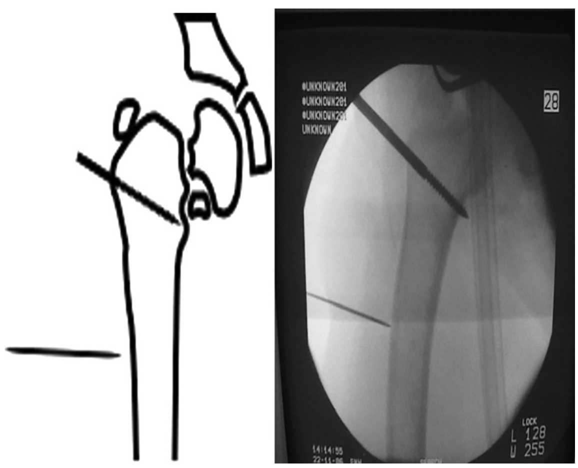
Acute correction is performed using conical washers mounted on three rods connecting the proximal and the distal arches (Fig. 4). Multiplanar clamps are applied for gradual correction when using the limb reconstruction system fixator. In four cases supracondylar femoral osteotomy was performed for lengthening and correction of the mechanical axis.

Figure 1



Application of proximal half pin in the superolateral to inferomedial direction.

Figure 2



Distal half pin inserted in a perpendicular angle with the anatomical axis of the proximal femur.

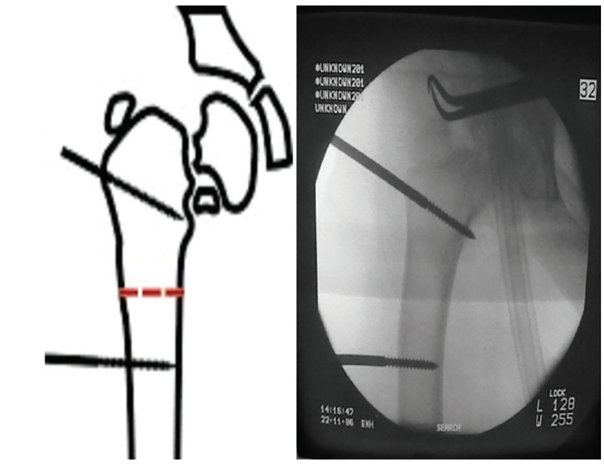
Results

A total of 15 subtrochanteric osteotomies were performed in 13 patients with coxa vara of diverse etiologies. Two cases had failed subtrochanteric osteotomies with plate and screws. The average age at surgery was 12.8 years (range 5–22 years), and the average follow-up was 3.7 years (range 1–7 years). All of the procedures had greater than 1-year follow-up. All osteotomies healed without need for revision except for one case. All osteotomies achieved the planned correction angle (Fig. 5). Radiographic analysis revealed an average improvement of 40° in HE angle (range 20–70°) from 62° (range 50–100°) before surgery to 34° (range 25–35°) after surgery (Fig. 6). The neck–shaft angle improved an average of 51° (range 35–75°) from 82° (range 60–95°) before surgery to 133° (range 125–140°) after surgery.

There were no intraoperative fractures or neurovascular injuries. Evaluation of follow-up radiographs showed that all osteotomies had healed by 4 months after surgery with no nonunions, malunions, device failures, or avascular necrosis, with only one case of delayed union healed by local compression distraction without bone graft.

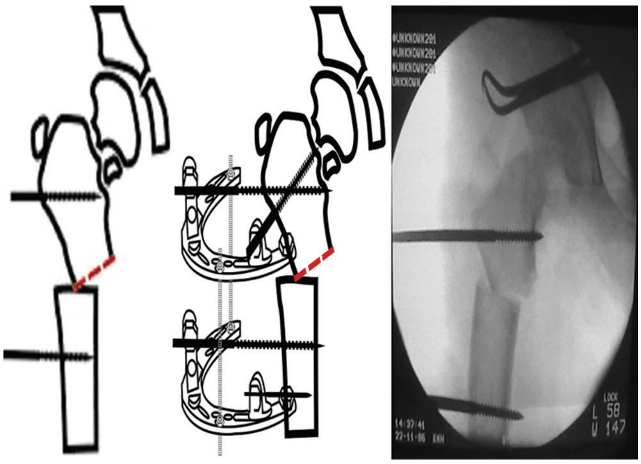
Positional changes of bony fragments were not noted in any patients after surgery. Complications occurred in eight (53%) of 15 hips. In one (6.6%) hip with fibrous dysplasia, osteotomy was performed twice because of fracture at osteotomy site after falling on her side; fracture occurred at the osteotomy site after an accidental fall 11 months after the primary operation. The patient's external fixator had been removed 6 months after surgery. Seven (46.6%) hips had postoperative pin tract infections; six (40%)

Figure 3



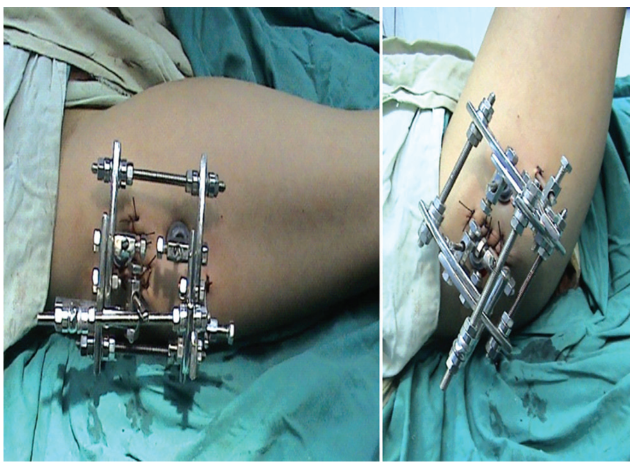
Osteotomy site at the subtrochanteric area.

Figure 4



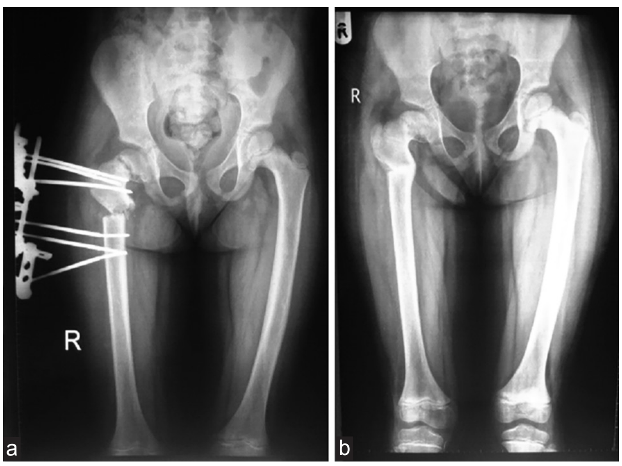
Acute correction through a subtrochanteric osteotomy.

Figure 5



Clinical photo showing the application of two arches and three connecting rods.

Figure 6



(a) Radiographs for postoperative follow-up of osteotomy after acute correction, (b) healed osteotomy with correction of neck shaft angle.

were superficial and one (6.6%) was deep. All five superficial infections were treated with an intravenous administration of antibiotics and frequent dressing changes and healed uneventfully. Removal of half-pin and debridement were performed for the one deep infection 2 months after the primary operation, which did not jeopardize the fixation of the frame. The osteotomy had healed without displacement of fragments 4 months after the primary operation.

Discussion

Multiple surgical techniques have been described for correction of coxa vara. These include Langenskiold intertrochanteric osteotomy, interlocking intertrochanteric osteotomy, valgus subtrochanteric osteotomy with blade plate fixation, and Pauwel Y-shaped intertrochanteric osteotomy [3,4,6,8,13,14]. Excellent long-term follow-up has been reported with both Pauwel osteotomy and valgus subtrochanteric osteotomy with a blade plate [4,6,8]. Desai and Johnson reported excellent long-term results of treatment of congenital coxa vara utilizing a valgus subtrochanteric osteotomy in 20 hips of 12 patients [6]. Their mean postoperative correction of the HSA to 136° and HEA to 30° is comparable to that in our series (133° and 34°, respectively). The recurrence rate was also quite similar to this series. The outstanding long-term results of Pauwel osteotomy were reported by Cordes *et al.* in a series of 14 children and 18 hips with coxa vara of multiple etiologies [6]. Their mean postoperative correction of the head–shaft angle to 141° and HEA to 29° was also similar to the results of this series.

Recurrence of deformity occurred in a single case in their series due to loss of fixation postoperatively, which did not occur in our series. There are several pitfalls with the current techniques described in those literatures for proximal femur osteotomies. These include the necessity of open procedures with removal of a trapezoidal fragment of bone from the subtrochanteric area, leading to increased blood loss as well as further shortening of an already shortened extremity. There are limited choices of implants to allow secure fixation of the underlying bone, which can be quite small. Moreover, the device needs to avoid the proximal femoral growth plate, providing a minimal amount of bone available for fixation. Typically, the implant is rigidly applied to the underlying bone, making appropriate lateral translation of the distal fragment and minor adjustments after fixation very difficult. On the basis of the stability achieved intraoperatively, some of these children need a body cast for several weeks after surgery to protect against displacement at the osteotomy site, and all of them needed a second operation for removal of internal fixation devices [3]. According to Colyer [10] the ideal fixation device for multiplanar femoral trochanteric osteotomy is one that allows the surgeon to perform an accurate correction, is easily applied, maintains rigid fixation, permits early joint motion and mobilization of the patient, and avoids another operation to remove the internal hardware. We believe that external fixator technique fits this description.

There are several potential benefits in our technique, which include avoidance of large open exposure and decreased potential for significant blood loss, while achieving an accurate and sustained correction of the triplanar deformity. With an opening wedge osteotomy, limb length discrepancy is improved without compromising the quality and time of bony union. By avoiding the need for any supplemental cast immobilization, early mobilization with a short hospital stay is possible. Complications associated with internal fixation, such as prominent hardware, implant failure, the possibility of violating the proximal femoral growth plate, the need for a second major surgical procedure for removing an internal implant, and the potential for deep infection are significantly decreased. However, there are potential obstacles to this technique. These include a need to be familiar with the use of the Ilizarov fixator and Orthofix external fixator; however, other external fixator systems can be used as long as the principles outlined above are followed. The inconvenience of the pin sites with the possibility of drainage around the pins is another drawback. After using hydroxyapatite-coated half-pins, using a proper technique for pin insertion [15], avoiding thermal necrosis while drilling, using oral antibiotics early for pin site drainage, and ensuring appropriate pin site releases and care, we have noted few deep pin-related complaints. With preoperative education and counseling, the patients seem to adapt reasonably well to the external fixator. Despite well-performed osteotomies, the literature cites recurrence rates as high as 30–70% [9,15]. In our series, one of the 13 hips had to be revised. This occurred with trauma to pathologic fracture in the femur with fibrous dysplasia. In a study of valgus osteotomies for coxa vara [6], Carroll and colleagues reported an overall recurrence rate of close to 50%. When HE angle was corrected to 38° or less, 95% of the children had no recurrence of their varus deformity. In our study the average Hilgenreiner's angle was 74° before surgery, and it was corrected to an average of 33° after surgery. Further follow-up will be necessary to assess the long-term impact of our technique on the incidence of recurrence. Even when a repeat osteotomy was required, this technique led to no increase in morbidity, given the lack of large incisions and retained hardware.

This technique may also have a role in the treatment of other pediatric proximal femoral deformities, such as those associated with slipped capital femoral epiphysis, Perthes disease, and developmental dysplasia of the hip. The most important factor in reducing the likelihood of recurrent varus is restoration of the femoral neck physis to an anatomic position (an HE angle of 38° or less), thereby normalizing the forces across the physis [4,8]. In our study, the average epiphyseal angle improved from 62° preoperatively to 34° postoperatively. The external fixator implant allowed us to achieve and maintain the desired correction in 13 cases. Although valgus osteotomy reduced the length discrepancy, four patients required distal osteotomy to address length discrepancies and angular deformities of the knee. Shim *et al.* [16] identified the latter problem, noting that patients with progressive coxa vara often develop ipsilateral compensatory genu valgum. This highlights the need to avoid medial displacement of the osteotomy, which will exacerbate loading of the lateral compartment and distal femoral physis. This problem has not been addressed in more recent articles on the subject, such as those by Skaggs *et al.* [17], Kim *et al.* [18], or Sabharwal *et al.* [12]. Once the coxa vara is corrected, the genu valgum may become obvious. For this reason, we recommend a full-length standing radiograph and CT-scanogram to document alignment length and complications preoperatively. In our study we addressed mechanical axis correction by means of subtrochanteric and distal femoral osteotomy, correcting coax vara mechanical axis deviation and limb length inequality.

Conclusion

Our technique proved to be safe and effective in the treatment of proximal femoral deformity associated with coxa vara and limb length discrepancy. It has potential advantage over the commonly used open techniques and is minimally invasive, easily reproducible, and provides available alternative to currently available methods used for the fixation of proximal femoral osteotomies.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

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