Percutaneous osteotomy and simple monolateral frame for treatment of developmental coxa vara

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Objectives
Although subtrochanteric valgus osteotomy is considered the standard surgical management of developmental coxa vara, the method of fixation of the osteotomy is still a debate. This study aimed to assess the results and to evaluate the efficacy of percutaneous osteotomy and fixation by monolateral external fixator for the treatment of developmental coxa vara.
Patients and methods
Between December 2017 and February 2020, we conducted a prospective study that involved 10 cases (four females and six males). The patients' ages at the time of presentation ranged from 4.5 to 12 years with a mean of 6.7 years. All patients underwent percutaneous osteotomy and fixation by a monolateral external fixator. The mean follow-up period was 21 months (range, 14–28 months). Radiological evaluation depended on epiphyseal Hilgenreiner angle and neck-shaft angle, clinical evaluation depended on the IOWA score (it is the hip score of University of IOWA in USA).
Results
There was a significant improvement of the mean values of epiphyseal Hilgenreiner angle (80.6–29.1°), neck-shaft angle (86.9–129°), and IWOA score (58.4–92.2), there was one case of postoperative abductor tightening treated by abductor release and two cases of superficial pin-tract discharge treated by oral antibiotics and all three cases had excellent IOWA score at the last follow-up.
Conclusion
Using percutaneous valgus osteotomy and fixation by monolateral frame provides a reliable, less-invasive, low-cost option for the treatment of developmental coxa vara.

Keywords:
coxa vara, fixator, subtrochanteric osteotomy

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Introduction

Coxa vara can be defined as a femoral neck-shaft angle (NSA) less than 110°. It is more or less uncommon with a prevalence of one in every 25 000 children [1]. According to Herring, coxa vara can be classified into developmental, acquired, and coxa vara associated with femoral deficiency. The causes of acquired coxa vara are variable, it may be caused by trauma, slipped femoral epiphysis, infection, or rickets [2].

On the other hand, developmental coxa vara is characterized by a defect in ossification, which affects the medial part of the neck femur, although rarely it can affect the lateral part. The progressive changes that are associated with developmental coxa vara affect the proximal femur and can significantly alter the developing hip, causing early degenerative arthritis [3].

When the proximal femur is deformed, the hip joint is progressively exposed to bending and shear stresses causing a gradual decrease in the NSA. The bending stresses lead to the further vertical orientation of the physeal plate of the proximal femoral together with overgrowth of the greater trochanter and neck shortening [4].

The surgical management of developmental coxa vara aims to restore the neck-shaft alignment to normal to change the force across physics from shear to compression force, this can enhance ossification and healing of the neck. Valgus osteotomy of the proximal femoral is the standard management for coxa vara. There are several techniques for performing the osteotomy together with a variety of methods for fixation, such as internal fixation by plates and screws, external fixators, and fixation by pins [5].

This study aims to evaluate the outcome of the management of developmental coxa vara by percutaneous osteotomy and external fixation as a less-invasive and low-cost method.

Patients and methods

In the period between December 2017 and February 2020 and after getting the approval of ethical committee and the consents of all patients, we conducted a prospective case- series study that involved 10 cases (four females and six males). The patients' ages at the time of presentation ranged from 4.5 to 12 years with a mean of 6.7 years. The right hip was affected in seven patients, while the left hip was affected by three patients. The main presentation in all the patients was limping. The mean follow-up period was 21 months (range, 14–28 months).

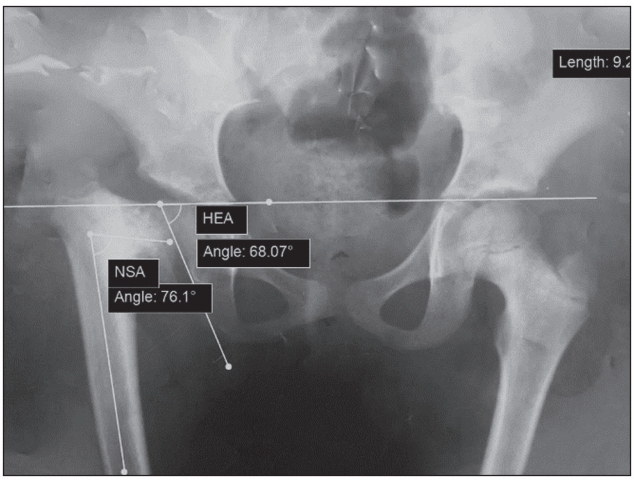
Inclusion criteria were pediatric patients with developmental coxa vara with epiphyseal Hilgenreiner angle (HEA) exceeding 45° and a head-shaft angle less than 110°. The chief complaint in all patients was limping.

Exclusion criteria were patients having coxa vara due to other etiologies, also patients with previous surgical management to the affected hip.

Clinical examination was done for all the patients to assess the patient's general condition, gait disturbances, limb-length discrepancy, affected the hip-joint range of motion, as well as the contralateral hip, full spine, and knee examination. We used the IOWA hip-scoring system (it is the hip score of University of IOWA in USA) to assess the patients preoperatively and postoperatively, IOWA score is out of 100 points, 40 for pain, 30 for function, 15 for gait, and 15 for anatomical assessment [6].

The preoperative radiological assessment included plain radiograph of the pelvis showing both hip joints' anteroposterior view, frog lateral positions, and limb scanograms. NSA and HEA were measured (Fig. 1).

Figure 1



Preoperative measuring of HEA and NSA. HEA, epiphyseal Hilgenreiner angle; NSA, neck-shaft angle.

The amount of deformity is calculated preoperatively to determine the amount of correction required. This was done by drawing a line parallel to the Hilgenreiner line below the lesser trochanter, another line was drawn parallel to the physeal plate. We measured the angle between the two lines and we subtracted 16 from it to get the degree of correction required.

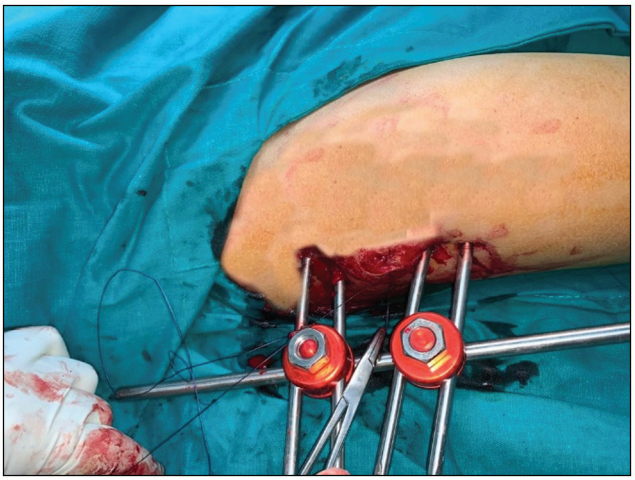
We took informed consent from each one of the patients' parents after explaining the procedure's steps, possible complications, the expected outcomes, and the follow-up plan.

Surgical technique

General anesthesia was used in all patients. A radiolucent operating table was used to enable the use of an image intensifier. The limb is disinfected and draped. Under the image-intensifier guide, two percutaneous parallel guide wires were applied to the proximal segment directed from proximal–lateral to distal–medial position. After checking the guide-wire positions by the image intensifier, we used a cannulated drill bit to make the proper track and then we applied two half-pins.

Distal to the planned osteotomy site, we used the same technique to apply another two half-pins perpendiculars to the femoral shaft. A small later incision was made at the osteotomy site at the subtrochanteric area, after dissection, we used a power-oscillating saw to osteomatize the femur. The femur is angulated by the degree of plane preoperatively. The monolateral frame is applied and the degree of correction was checked by the image intensifier and any needed corrections were made before tightening the fixator. The wound was closed and any further release around the half-pins was done (Fig. 2).

Figure 2

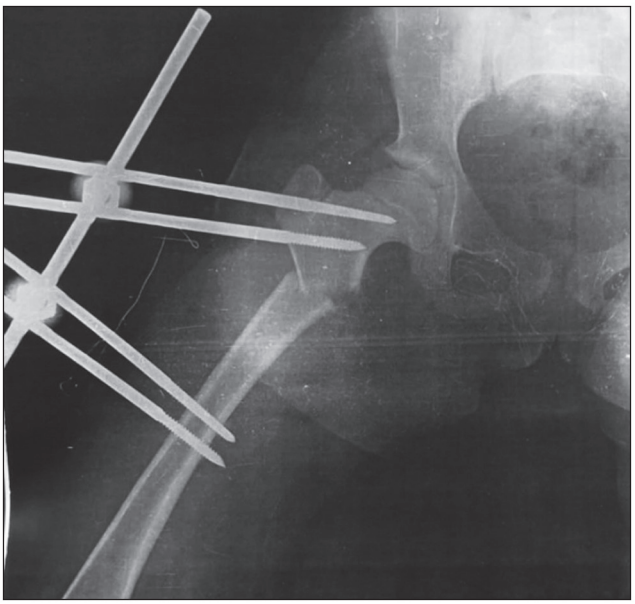


Closure of the osteotomy wound after application of the fixator.

Postoperative management

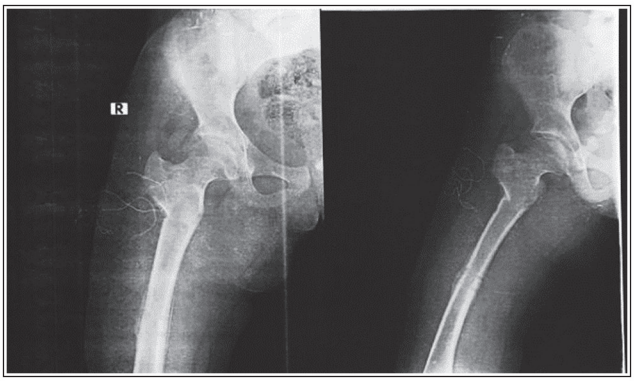
Postoperative radiograph were done on the first day to assess the degree of correction, HEA, and NSA (Fig. 3). Before discharge, we had to be sure that the parents were well informed on how to care about the fixator. Regular follow-up at the outpatient clinic included wound care, an inspection of the fixator, radiograph to assess maintenance of correction, and bone union (Fig. 4). The hip function is reassessed using the IOWA score after removal of the fixator and repeatedly till the last follow-up.

Figure 3



Immediate postoperative radiograph.

Figure 4



Radiograph after removal of the fixator.

Results

The average operative time was 32.5 min, ranging from 25 to 44 min. None of the patients needed blood transfusion intraoperatively or postoperatively. The average hospital stay was 1.4 days ranging from 1 to 3 days.

The improvement of the mean values of the HEA and NSA was statistically significant (both with $P<0.001$). The mean preoperative HEA improved from 80.6 to 29.1° postoperatively, as such, the mean preoperative NSA improved from 86.9 to 129° postoperatively (Table 1).

The osteotomies were fully united by an average of 10.6 weeks (ranging from 8 to 13 weeks), one case showed medialization of the distal fragment, but after the full union, there were no clinical complications, and no further management was needed. Fortunately, the rest of our cases maintained correction till a complete union was achieved. Comparing the mean preoperative IOWA score of 58.4 to the mean IOWA score at the last follow-up of 92.2, there was statistically significant improvement ($P<0.001$).

There was one case of postoperative abductor tightness, this was detected by decreased adduction range, and while the patient stood with their ankles together, the contralateral pelvis elevated. This was dealt with by abductor-muscle release. The range of motion improved and the last follow-up IOWA score for this patient was satisfactory.

Table 1 Patients' ages, preoperative and postoperative radiological data, and clinical scores

Patients number	Age (years)	Preoperative HEA	Postoperative HEA	Preoperative NSA	Postoperative NSA	Preoperative IOWA score	Last follow-up IOWA
1	12	68	26	76	122	55	93
2	6.5	80	28	88	130	61	95
3	4.5	65	26	94	132	68	90
4	8	95	34	80	129	52	88
5	5	74	31	77	126	59	94
6	7	82	27	98	135	54	92
7	5.5	88	28	102	136	64	96
8	6	78	29	84	125	60	94
9	7	90	32	91	132	53	89
10	5.5	86	30	79	123	58	91
Mean	6.7	80.6	29.1	86.9	129	58.4	92.2

HEA, epiphyseal Hilgenreiner angle; IOWA, it is the hip score of University of IOWA in USA; NSA, neck-shaft angle.

Two of our patients had superficial pin-tract discharge, there was no evidence of pin loosening and the discharge stopped after receiving oral antibiotics with no further complications.

We did not encounter any cases of deformity recurrence till the final follow-up. None of the studied cases suffered from avascular necrosis of the head femur.

Discussion

The use of trochanteric or subtrochanteric valgus osteotomy has been agreed on as the standard surgical management to achieve correction in cases suffering from developmental coxa vara, yet there is no unanimous agreement on the osteotomy technique or the method of fixation [2,7–9].

Methods of fixation commonly used include internal fixation by angled blade plate, pediatric hip screw, contoured small dynamic compression screw (DCP), Kirshner wires, external fixators, and the use of hip spica alone or with one of the former methods.

In fixation by a pediatric hip screw or by angled plate pate, the screw or the blade ends distal to the physis in the medulla not providing sufficient bone purchase. Fixation by contoured small DCP can provide rigid fixation, but it requires more operative time and more tissue dissection than fixation by an external fixator, also, the plate and screws need to be removed in another operation [9].

Using transfixing Kirshner wires for fixation offers an easy, low-cost, less-invasive, and less time-consuming alternative, but it is worth saying that the lack of rigid fixation dictates the use of hip spica postoperatively [3]. The mandatory use of hip spica makes it harder for the parents to care for the child and maintain proper hygiene, also, it may expose the child to several complications such as skin ulcerations, cast soiling, and breakage, which may necessitate spica removal and reapplication. Rarely seen complications are superior mesenteric-artery syndrome, tight cast, and compartment syndrome [10].

In this study, we used percutaneous osteotomy and fixation by monolateral external fixator, this provided a rigid enough fixation to preclude the need of postoperative hip spica, thus avoiding its potential hazards, and at the same time, this technique was cost-effective, needed relatively short operative time, and spared the patient a larger incision and tissue dissection.

Regarding the outcome of this technique, we had a postoperative HEA of an average of 29.1° (range, 26–34°). These results agree with many authors in the literature, who denoted that a HEA angle of less than 45° is crucial to prevent the recurrence of deformity [5,11–14].

Elzohairy and Khairy [15] performed a study where they used T-plate for internal fixation of intertrochanteric valgus osteotomy, the study included 18 children suffering from developmental coxa vara, the average postoperative improvement of the NSA was 129.9° and for the HEA, it was 27.8°. In a study done by Desai and Johnson [13] in which they treated twenty children suffering from coxa vara by valgus subtrochanteric osteotomy, they had an average postoperative NSA of 136° and an average HEA of 30°, they had excellent long-term functional results. These results are comparable with our own, which makes us optimistic about our long-term results, although in this study, we did not have long-term follow-up.

We had significant improvement in the average IOWA score at the last follow-up compared with the average preoperative score. This was greatly influenced by the correction of limb-length discrepancy, improvement of gait, and decrease of pain.

The best fixation method for a trochanteric femoral osteotomy is one that permits the performance of adequate correction, applied easily, provides rigid-enough fixation, allows the early motion of the hip and early postoperative mobilization, and does not need another operation to remove the implant [16]. We think that the external fixator fulfills these criteria. Hefny *et al.* [17] came to the same conclusion in their study in 2013, in which they treated nine children suffering from developmental coxa vara by subtrochanteric osteotomy and fixation by external fixator.

There is still a need for studies, including a larger number of patients and to be followed up for a longer duration.

Conclusion

Using percutaneous valgus osteotomy and fixation by monolateral frame provides a reliable, less-invasive, low-cost option for the treatment of developmental coxa vara.

Acknowledgments

The paper has been read and approved by all authors.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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