Section: Orthopaedics

Original Research Article

SUBTROCHANTERIC FEMORAL DEROTATION OSTEOTOMY – AN EXCELLENT CHOICE FOR CORRECTING IDIOPATHIC EXCESSIVE FEMORAL ANTEVERSION WITH INTOEING GAIT

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ABSTRACT

Background: Intoeing gait is a prevalent pediatric condition characterized by an inward rotation of the feet during ambulation. Primary causes include metatarsus adductus, internal tibial torsion, and increased femoral anteversion. The purpose of this study is to assess the outcomes of subtrochanteric femoral derotation osteotomy in idiopathic excessive femoral anteversion. **Materials and Methods:** A prospective interventional study was conducted over a duration of five years. All adolescent patients >8 years of age and symptomatic patients with inteoing were taken in the study. Degree of femoral anteversion was confirmed on computed tomography (CT) scan. Patient-related outcome measures (PROMs) were calculated using persistence of intoeing gait, persistence of hip pain, persistence of frequent fall post-operatively. Foot Progression angle and hip rotational range of motion were noted both pre-operatively and post-operatively and compared statistically. **Result:** In total, 10 extremities were operated in 6 patients with an average age of 12 (+/-3) years. Mean follow-up was 12 months (+/- 6months). All the patients had inteoing, 80% also complained of frequent falls and 60% had associated hip pain. Mean femoral anteversion was 40.1 degree (+/-8.5 degree). Post-operatively mean foot progression angle improves from 14.5 degree internally to 8.1 degree externally ($p<0.0001$). Mean hip internal rotation decreased from 75 degree to 45 degree ($p<0.05$). Mean hip external rotation improved significantly, from 30 degree to 55 degree ($p<0.05$). All the patients had their intoeing resolved post-operatively. **Conclusion:** Excessive femoral anteversion is a frequent cause of intoeing gait in children and can also present with unexplained hip, thigh and knee pain. Subtrochanteric femoral derotational corrective osteotomy can certainly be a procedure of choice in carefully selected cases and it also comes with a very favourable outcome.

INTRODUCTION

Intoeing gait, medically referred to as "pigeon-toeing," is a prevalent pediatric condition characterized by an inward rotation of the feet during ambulation.[1] It is defined as a gait with internally rotated foot progression angle.[2] Frequently observed in toddlers and young children, this gait pattern often raises parental concern, particularly when it contributes to recurrent tripping or impairs motor coordination.[3] However, intoeing is typically benign, with a natural tendency to resolve spontaneously as the child matures4.

The etiology of intoeing generally stems from anatomical variations during skeletal and muscular development. Primary causes include metatarsus adductus, internal tibial torsion, and increased femoral anteversion.[4,5] However, excessive femoral anteversion remains the most common cause of persistent intoeing gait in adolescent children and may disrupt the gait function.[5] These developmental conditions are typically identified through comprehensive physical examination and, in select cases, corroborated by radiographic imaging.

While the majority of intoeing cases do not necessitate intervention and demonstrate

improvement with growth, persistent or severe presentations may benefit from targeted therapeutic measures, such as orthotic management or physical therapy. A thorough understanding of the pathophysiology, natural course, and therapeutic options for intoeing gait can empower clinicians and parents alike to support optimal musculoskeletal development in affected children.

Derotation femoral osteotomy at various degrees can be used for surgical correction in individuals whose symptoms have not gone away after intensive physiotherapy and rehabilitation6. There is little research on the results of idiopathic cases,[3] so the purpose of this study is to assess the outcomes of subtrochanteric femoral derotation osteotomy in idiopathic excessive femoral anteversion.

Here we have described six cases with complain of intoeing and increased femoral anteversion managed with femoral derotation osteotomy.

MATERIALS AND METHODS

A prospective interventional study was conducted over a duration of five years between 2018-2023 at a tertiary care hospital. Total number of patients were 6 with a mean age of 12 years.

Materials

All adolescent patients >8 years of age and symptomatic patients with inteoing were taken in the study. Patients whose age were <8 years and inteoing without any clinical problem were excluded from the study.

Patient complaints; such as hip, thigh, or knee pain, clumsiness in stride or frequent falls were noted in the patient's notes. The cause of intoeing gait was determined by carefully evaluating the lower limbs' rotational profile using Staheli's approach5. Clinical suspicion of excessive femoral anteversion was raised when the internal rotation of the hips in extension was noticeably higher than the external rotation. Femoral anteversion was clinically noted using Craigs test. Only if symptoms persisted after intensive physiotherapy and no other compelling reason for pain was identified with excessive femoral anteversion, patients were considered for corrective derotation osteotomy.

Patient-related outcome measures (PROMs) were calculated using persistence of intoeing gait, persistence of hip pain, persistence of frequent fall post-operatively. Foot Progression angle and hip rotational range of motion were noted both pre-operatively and post-operatively and compared statistically. Preoperative plain radiographs of Pelvis with bilateral hip joint (AP view in 15 degree internal rotation, true lateral view) with bilateral full length of femur were taken. Preoperative NCCT scan of pelvis and with bilateral full length of femur upto proximal tibia were also taken. Femoral anteversion were measured using DICOM viewer (RadiAntR DICOM viewer, Medixant Inc. Poland), by measuring an angle between the axis of femoral neck and a line drawn along the posterior aspects of both femoral condyles (Fig 1).

Surgical Technique3,7 and follow-up

All the patients were set up in the supine position and preop fluoroscopy were taken for correct positioning of incision. Lateral sub-vastus approach was used. A 7 to 8 cm incision is placed approximately 3 finger-widths proximal and approximately 1 cm posterior to the tip of the greater trochanter. The skin is incised down to the abductor fascia. This fascia is then longitudinally incised as distal as possible to allow easy placement of future soft tissue protection guides with minimal soft tissue damage. Also the vastus lateralis is elevated off the fascia lata; it is then elevated of the lateral intermuscular septum and the femur is identified. Two k-wires were inserted parallel to each other, one proximally in the greater trochanter and the other in femoral shaft distal to the proposed location of osteotomy and plate fixation (Fig 2a). The approximate angle of correction was determined preoperatively by the operating surgeon, taking into account the measured anteversion angle and the difference in internal and external rotation of hips in extension. Jig wires were placed in the femoral neck for proximal screws, avoiding the trochanteric apophysis and femoral capital epiphysis. A transverse subtrochanteric osteotomy was performed with an oscillating saw just below the lesser trochanter and fixed with a proximal femoral plate after externally rotating the distal femur according to a previously decided correction angle. Locking Compression plate (LCP) and fixed angle blade plate were only used for fixation of derotated femoral osteotomy. Correction of rotation was determined by final position of k-wires (Fig 2b, 2c). Inter k-wire angle was measured digitally after correction of proximal and distal fragments of femur. Finally incision was closed after thorough wash without any application of drain.

Patients were allowed to partially weight bear as tolerated initially and were followed in clinic at three weeks, three months, six months and 1 year on average. Radiographs (Fig 3), hip rotational range of motion and foot progression angle were noted at follow-up.

Statistical Analysis

Data was tabulated in Microsoft Excel v23 and analysed using IBM SPPS v25. Student's t-test were used to analyse our results. Chi-Square test was used to analyse nominal and qualitative data. P-value < 0.05 was considered significant.

RESULTS

Patient demographics

Total number of patients taken were 6 after consideration of inclusion and exclusion criteria. Total number of limbs operated were 10. The mean age of presentation was 12 years (+/- 3 years) with a female: male ratio of 80:20. Mean follow-up was 12 months (+/- 6 months)

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Demography has been depicted in the Table 1

Table 1: Demography of patients

Parameters	Absolute value	Percentage
Mean age at presentation	12 (+/- 3)	
Sex (Male:Female)	1:5	20% : 80%
No of limbs operated	10	
Clinical symptoms		
Inteoing	6	100%
Hip pain	4	60%
Knee pain	2	40%
Frequent falls	5	80%

Clinical and Radiological examination

Pre-operative rotational profile of lower limbs have been summarized in Table-2. Average preoperative femoral anteversion was found 40.1 degree (+/- 8.5 degree).

Table 2: Clinical and radiological examination of patients

Parameters	Value (+/- SD)
Average Hip ROM	
Internal rotation (in degrees)	75 (+/- 12)
External rotation (in degrees)	30 (+/- 5)
Average Foot progression angle (in degrees)	-14.5 (+/- 8)
Average femoral anteversion on CT (in degrees)	40.1 (+/- 8.5)

Post-operative outcome

Patient-related outcome measures (PROMs) were improved significantly postoperatively. Only one patient have continuation of hip pain after 1 year of follow-up. Foot progression angle improved from 14.5 degree internally to 8.1 degree externally. Hip internal and external rotation was also improved significantly.
All outcomes and its statistical significance has been summarized in Table-3.

Table 3: Post-operative outcome of patients

Parameters	Pre-operative	Post-operative	P value
PROM			
Inteoing	6	0	<0.0001
Hip pain	4	1	<0.05
Frequent falls	5	0	<0.0001
Clinical examination			
Foot progression angle (in degrees)	-14.5 (+/- 8)	8.1 (+/- 4.5)	<0.0001
Hip internal rotation (in degrees)	75 (+/- 12)	45 (+/- 5)	<0.05
Hip external rotation (in degrees)	30 (+/- 5)	55(+/-7)	<0.05

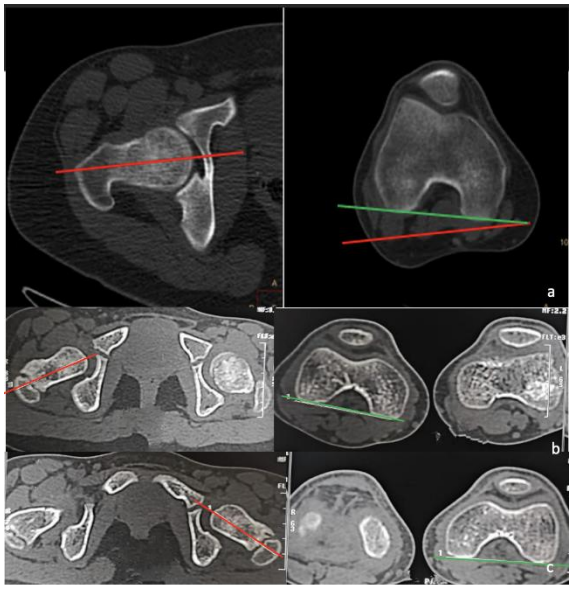

Fig 1 – 1a: Method for calculating femoral anteversion (angle between green and red line), 1b: Right femoral anteversion 40 degree, 1c: Left femoral anteversion 42 degree

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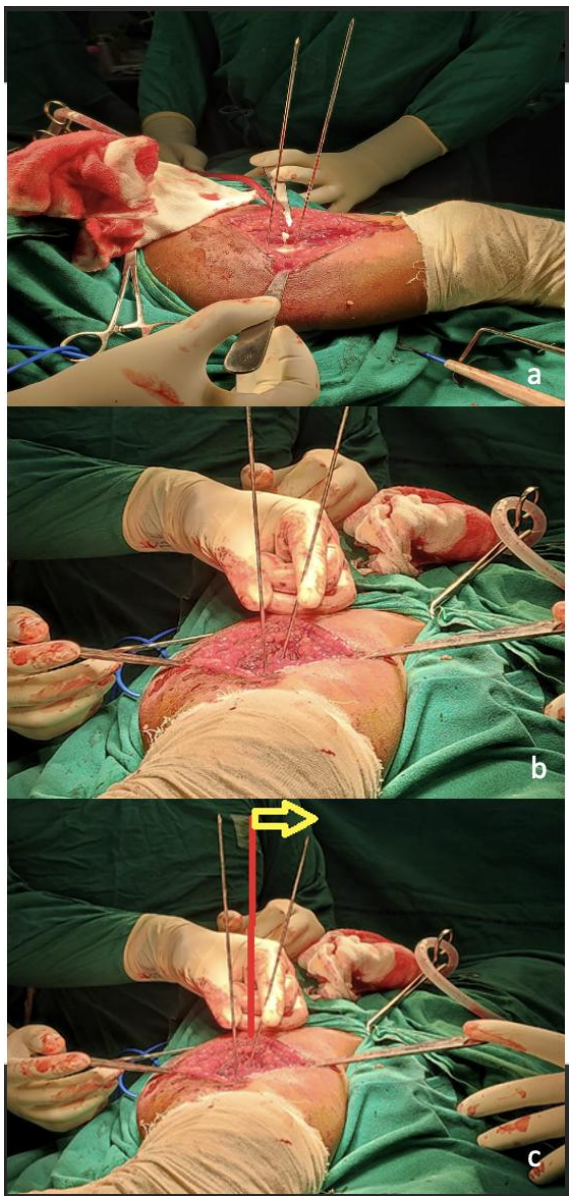

Fig 2 – 2a: Pins were put parallelly at proximal and distal fragment before subtrochanteric osteotomy, 2b: Post osteotomy required angular correction done by rotating distal pin, 2c: depicting angular correction achieved (angle between red line and final position of pin marked by yellow arrow)

Fig 3 – Post-operative radiographs; 3a: LCP, 3b: fixed angle blade plate

Fig 4 – 4a: Pre-operative image showing intoeing and negative foot progression angle, 4b, 4c: Post-operative image showing externally rotated foot and patella with positive foot progression angle

DISCUSSION

Intoeing gait is a common reason for attendance to Orthopaedic clinic and parental anxiety due to its cosmetic as well as functional reasons.[3] It may be manifested clinically as hip, thigh or knee pain, frequent falls and clumsiness of gait. It is defined as a gait with internally rotated foot progression angle.[2] Primary causes include metatarsus adductus, internal tibial torsion, and increased femoral anteversion.[4,5] The most frequent cause in children aged three to six is internal tibial torsion, but excessive femoral anteversion is more common in children aged six to ten3. Thackeray et al,[8] in their study demonstrated that the prevalence of intoeing is up to 30% in kids under the age of six, which drops to 7% in kids nine and higher, indicating the growth-related spontaneous correction. Now in terms of the progression of individual component of rotational malalignment, there are only few studies performed. As demonstrated by Staheli et al,[5] and Fabry et al,[9] femoral anteversion shows regression during childhood but following 8 years of age the change becomes minimal. On contrary, Without a change in femoral anteversion, intoeing can occasionally continue to improve after the age of eight, primarily as a result of compensating external tibial torsion.[10]

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This can result in rotational malalignment of the lower limb, commonly known as "miserable malalignment syndrome," in which increased external tibial torsion is used to compensate for increased femoral anteversion. Even though the foot progression angle is improved in these situations, the elevated Q angle causes anterior knee discomfort, instability, patellar maltracking, even habituated patellar dislocation.[3]

While the majority of intoeing cases do not necessitate intervention and demonstrate improvement with growth, persistence of intoeing can have implications like frequent falls, hip, thigh and knee pain, which have detrimental effect on the normal psychological and physical growth of the child. Targeted therapeutic measures, such as orthotic management or physical therapy may improve the quality of life of these children. However, some children still remain symptomatic after conservative management. In these cases, comes the role of corrective derotational surgeries. Gohar Naqvi et al,[3] described 35 extremities managed with proximal femoral derotation osteotomy, where mean foot progressing angle improved from 15.2° internally rotated preoperatively to 7.7° externally rotated. Intoeing was completely resolved in all except two patients. In their study, Peter M Steven et al,[11] collected a group of 16 consecutive patients (23 knees), with mean age of 17, who had undergone knee surgery before torsion was recognized and subsequently treated by means of rotational osteotomy of the tibia and/or femur. They demonstrated Knee pain was significantly improved after torsional treatment (mean 8.6 pre-op vs. 3.3 post-op, $p < 0.001$) at mean 59 months follow-up.

Even children with unexplained hip thigh and anterior knee pain should include a rotational profile assessment of the lower limb irrespective of gait pattern. The standard of assessment that is most frequently mentioned is Staheli's rotational profile.[5] It compares the internal and exterior rotation of extended hips and includes the foot progression angle and the thigh foot angle. Its purpose is to clinically distinguish between metatarsus adductus, tibial torsion, and femoral anteversion. A CT scan can be used to determine the angle of tibial torsion and femoral anteversion in suspected cases of increased anteversion.

All the patients in our series were more than 9 years old. We advise not to operate on a child less than 8 years old, as frequently femoral anteversion regresses spontaneously up to 8 years of age. All the 6 kids presented to us with inteoing had serious clinical manifestation associated with rotational malalignment of lower limb. They had undergone extensive physical therapy, gait training. Despite that, symptoms improved minimally; and for that reason, derotational osteotomy was advised. After performing a proximal femoral corrective derotational osteotomy, their symptoms improved drastically. Mean foot progression angle improves from 14.5 degree internally to 8.1 degree externally (Fig 4). Mean hip internal rotation decreased from 75 degree to 45 degree. Mean hip external rotation improved from 30 degree to 55 degree.

Limitations and complications

Despite the fact that it demonstrates positive clinical outcomes of subtrochanteric femoral derotation osteotomy, This study's limitations include the absence of a validated grading method to address the issue and objective measures of postoperative femoral anteversion angles using CT scans. Also, Gait lab analysis before and after corrective osteotomy would have been a helpful adjunct, and it should be taken into account for future research3. One out of 6 children developed surgical site related complications which was addressed using debridement and antibiotics.

CONCLUSION

Intoeing is common problem of school going and adolescent age group of children, which usually resolves spontaneously by the age of 8 years. Excessive femoral anteversion is a common cause of inteoing in this age group, which should be addressed if symptomatic. Physical therapy and gait training can be a valuable tool for management in these cases. Surgery should only be limited to patients above eight years of age with increased femoral anteversion and symptoms that persist despite extensive physiotherapy. Children with unexplained hip, thigh or knee pain should also have rotational profile assessment in their list of check-up, which may necessitate corrective surgeries. Subtrochanteric femoral derotational corrective osteotomy can certainly be a procedure of choice in carefully selected cases and it also comes with a very favourable outcome.

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