

Management of post-traumatic genu valgus deformity in adolescent by proximal tibial corticotomy with bone lengthening by Ilizarov method: a case report

Abstract

Introduction: Genu Valgus and Varus are the most common lower limb deformities at knee level, seen in childhood. Genu valgus is more common about 10%, where knee/knees turn inward, causing the appearance of the knees to be touching each other while the ankles remain apart. Genu Valgus is a normal physiological process in children's; it may be pathological due to various causes. Physiological genu valgus is greatest at the age of 3-4 years and spontaneously resolves by the age of 7 years. When valgus deformity is persistent or worsening after 7 years of age is called pathological genu valgus. Cosmetic abnormality is common complaint. Abnormal circumduction gait, knees touching on medial aspect and LLD found on examination. Plan x-ray A/P view in standing position of full both lower limbs with pelvis provides diagnosis and treatment plan information.

Case presentation: A 15 years old girl came with the complaints of abnormal walking due to right knee bending inwards, also during standing position. She was perceived pain in right knee during walking and longtime standing position. She has H/O- fractured proximal tibia (Rt.) more than 6 months ago due to trauma and treated by plaster. Plaster removed after 3 months. One month later she developed pain in knee joint during walking and right knee gradually bend inwards. O/E- Bil genu valgus right > left. Clinically, right knee -30° and left knee -10° valgus. There was 1.5 cm shortening of right lower limb than left. Both right and left lower limb with pelvis full radiograph was done. In x-ray both femurs and knee joints were normal. In radiograph, the medial and lateral surface of right tibia with fibula bends medially. Left tibial surfaces and fibula appears almost normal. The right tibia at the point of 14 cm from upper end there was maximum angulation point. The degree of genu valgus was evaluated by CORA method and treatment plan set accordingly. There was 30° medial bending of right tibial shaft and about 10° of left tibial shaft. The patient was diagnosed as post traumatic unilateral right tibial genu valgus following proximal tibia fracture. The patient was treated by proximal tibial corticotomy with Ilizarov frame.

Aim: The aim of the treatment is restoration of normal mechanical axis.

Objective: To assess the effectiveness and outcomes of the treatment method.

Result: After complete union and consolidation, substantial evidence was checked and confirmed by both clinical and radiological. There was no abnormal gait and pain during walking. Mechanical axis of right lower limb was restored as normal. The final outcome is excellent.

Abbreviations: A/P, antero-posterior; CORA, Center of Rotation of Angulation; F/U, follow up; H/O, history of; LLD, limb length discrepancy; O/E, on examination; POD, post-operative day; ROM, range of motion.

Introduction

Genu Valgus and Varus are the most common lower limb deformities at knee level, seen in childhood (Toddler, preschool and early school age children). Genu valgus (Knock - Knee) is more common about 10%, where knee/knees turn inward, causing the appearance of the knees to be touching each other while the ankles

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Chowdhury Foyzur Rob,¹ Md. Jahangir Hossain,² Prof. Xu Sheng Kang³

¹Chief Consultant, Department of Orthopedics, Al-Haramain Hospital, Sylhet, Bangladesh

²Consultant, Department of Orthopedics and Trauma, Care Medical Services, Nabigonj, Sylhet, Bangladesh

³Associate Professor, Department of Orthopedics, Unit -IV (Trauma), Taihe hospital (Number one affiliated hospital of Hubei university of medicine), Shiyan city, Hubei province, P. R. China

Correspondence: Chowdhury Foyzur, Department of Orthopaedics, Al-Haramain Hospital, Kazi Tower, Samata-30, Subhani Ghat, Sylhet-3100, Bangladesh, Tel +880 1715250800, Email foyzurro@gmail.com j.hossain1@gmail.com

Co-correspondence: Md. Jahangir Hossain, Department of Orthopaedics, Department of Orthopedics and Trauma, Care Medical Services, Nabigonj, Sylhet, Bangladesh, Tel +880 1534524371, Email j.hossain1@gmail.com

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Conclusion: Genu valgus is common in children and observation is the first line of treatment. Physiological variant treated conservatively. Pathological genu valgus needs management according the cause. When surgical correction is indicated, corrective osteotomy usually done but there is so many complications and needed repeated surgery. In post-traumatic proximal tibial genu valgus effectively corrected by Ilizarov with corticotomy, which minimize complications, Due to early mobilization and decrease hospital stay time, resulting cost effective and found excellent final outcome.

Message of the case report

CORA method analysis of deformity and corticotomy with Ilizarov circular external fixator is an excellent promising method for correcting limb deformities.

Keywords: post-traumatic genu valgus, ilizarov, cora, corticotomy, limb deformity

remain apart. Genu Varus 8.6%, where one or both lower limbs curve outward at knees.

Genu Valgus is a normal physiological process in children's; it may be pathological if associated with skeletal dysplasia, physal injury, tumors or rickets. Physiological genu valgus is greatest at the age of 3-4 years and spontaneously resolves by the age of 7 years.¹⁻³ When valgus deformity is persistent or worsening after 7 years of age is called pathological genu valgus. Medical and family history can help to differentiate between physiological and pathological causes. Cosmetic abnormality is common complaint. Abnormal circumduction gait, medial side knee pain, adducted hip, knees

touching on medial aspect and LLD found on examination. Plan x-ray A/P view in standing position of full both lower limbs with pelvis provides diagnosis and treatment plan information.

Pathological deformity most commonly occurs in distal femur. Genu valgus also caused by innocent appearing fractures of the proximal tibia in children. The deformity is usually absent or minimal at the time of the first radiograph but becomes appear later after removal of cast, many explanations had been proposed but pathogenesis remains uncertain.⁴ Surgical treatment is indicated if deformity is $>15^{\circ}$ in a child of >7 years old.³ Ilizarov external fixator work through compression-distraction neo-histogenesis that help in bone lengthening. It provides adequate fracture stability and maintains anatomical alignment. Also Ilizarov control infection through neo-angiogenesis and tissue stress.⁵

Presentation of the case

A 15 years old adolescent girl came with the complaints of abnormal walking due to right knee bending inwards, also during standing position. She was perceived pain in right knee during walking and longtime standing position. She has H/O- fractured proximal tibia (Rt.) more than 6 months ago due to trauma and treated conservatively by long leg full plaster. Plaster removed after 3 months. One month later she developed pain in knee joint during walking and right knee gradually bend inwards. After more than 6 months of her primary fracture, when the problems worsening she was came to us with above complaints. O/E- Bil genu valgus right $>$ left. Clinically, right knee -30° and left knee -10° valgus. There was 1.5 cm shortening of right lower limb than left. Previous fractured x-ray was not found. Both right and left lower limb with pelvis full radiograph was done. In x-ray both femurs and knee joints were normal. In radiograph, the medial and lateral surfaces of right tibia with fibula bend medially. Left tibial surfaces and fibula appears almost normal. The right tibia at the point of 14 cm from upper end there was maximum angulation point. The degree of genu valgus was evaluated by CORA method and treatment plan set accordingly. There was 30° medial bending of right tibial shaft and about 10° of left tibial shaft. The patient was diagnosed as post traumatic unilateral right tibial genu valgus following proximal tibia fracture.

Treatment procedure: We were taken decision to perform corticotomy with apparently closed system because there was a H/O-fracture, so chance of latent quiescent type infection may be persist.

Upper tibial corticotomy was done at obvious apex (at the point of maximum angulation) by giving least incision on medial surface of right upper leg. Fibulectomy (Rt. fibula) also done. Bony fragments were fixed by Ilizarov frame with two cross k-wire for stability and maintain alignment. Four Ilizarov circular rings were used. One ring placed in distal femur and another in proximal tibia above corticotomy line to maintain joint space. Other two rings placed in tibia below the corticotomy. All rings were fixed by k-wire with bone and 2 olive wires used in middle 2 rings. Rings were connected by threaded rods to each other, in addition middle 2 rings (Rings are set above and below the corticotomy) are connected by two telescopic rods on medial and lateral side of leg parallel to medial and lateral surface of tibia. The Ilizarov frame provides stability and maintains alignment.

Surgery duration 1 hour and 30 minutes (90 minutes), total blood loss about 120 ml. Tourniquet was not used during surgery. Bony fragments were in anatomical alignment and adequate fixation stability maintained. Partial weight bearing walking started on 3rd POD with walker. Hospital stays 5 days. Stitch off done on 12th POD. After 3 weeks when callus appeared k-wires were removed and bone

lengthening with angulation correction was started at a rate of 0.25 mm x 4 times (6 hourly) in a day by loosening of lateral telescopic rod for 10 days. Total one (1) cm bone lengthening was done of lateral tibial surface. Angulation and length were corrected to our desire and restoration of normal mechanical axis.

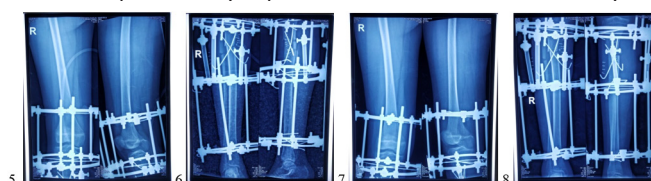
Patient and relatives were trained up to clean and proper maintained Ilizarov frame to avoid pin track infection. Also encourage the patient to regular walking with hip and ankle joint movement by exercise. Patient came in F/U weekly for 1 month, 2 weekly for next month and finally once in a month until full recovery. After 3 months, when callus became consolidate, Ilizarov frame removed and apply long leg full plaster for another 6 weeks. After plaster removal knee joint mobilization was done and within 5 months of corticotomy, full recovery was regain with full ROM of all joint of right lower limb. There was 0.5 cm shortening of right lower limb which was corrected by high heel shoe.

Illustration

X-rays



1, 2 & 3 Pre-operative x-ray of pelvis & both lower limbs. 4. CORA analysis



5 & 6 Post-operative x-ray 7 & 8 Follow up x-ray

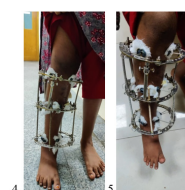


9. Final x-ray

Pictures:



1, 2 & 3 post-operative pictures



4 & 5 Follow up pictures



6, 7 & 8 Final pictures after correction

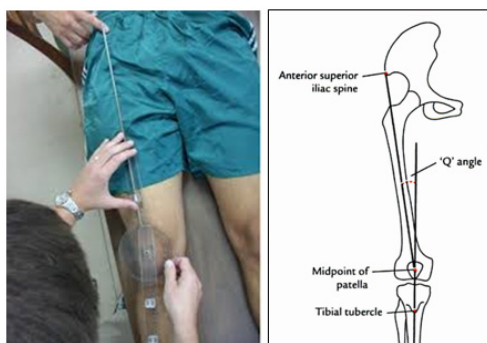
Discursion

Genu valgus is more noticeable cosmetic deformity in childhood, usually 3-5 years age. The deformity is more common at femoral distal end than to proximal tibia.⁶ Majority of the cases are physiological and resolve normally. There are pathological existence due to both focal and systemic processes where the deformity often progresses and need to treatment.⁷ In children, the Physiological coronal changes around knee, at first there is a varus then decline till it is reversed to valgus, then valgus enhance 10-15° at 4 years, then it starts to decrease over another 2 years till it reaches adult level (7° valgus) usually bilateral.^{7,8} The proximal metaphyseal fractures are usually occur in children at the age of 3-6 years and significantly progress to late valgus deformity, known as “Cozen`s phenomenon” (First describe by Lewis Cozen in 1953), the incidence is 50-90%, occurs 5-15 months after injury.^{9,10}

Pathological genu valgus may be unilateral or bi-lateral. Unilateral genu valgus may be idiopathic or due to trauma, infection, vascular

Q angle (Quadriceps angle)

The direction and magnitude of force produced by the quadriceps muscle has great influence on patella-femoral joint bio-mechanics. Q angle can be measure in standing or supine state of the body.



The Q angle is formed between two lines, one is representing by connecting the anterior superior iliac spine to the mid-point of the patella (the resultant line of force of the quadriceps) and another from the center of the patella to the center of the tibial tubercle.

A typical Q angle is 12° for men and 17° for female. Q angle increase in genu valgus.¹⁸

Tibio-femoral angle

It is the angle between mechanical axes of femur and tibia, done in

damage, tumors and Ellis-van Creveld syndrome (EVC) is a very rare genetic disorder involving a severe, relentlessly progressive genu valgus deformity of the knee and it is usually difficult to correct all of the deformities by elevation of the depressed lateral tibial plateau alone, whereas bi-lateral may be idiopathic or caused by rickets and skeletal dysplasia.^{6,7,11,12}

Asymmetry or unilateral genu valgus is suggestive of pathologic. The valgus is >15° of >7 years age is also pathological.¹³ Trauma with minor fracture (i.e. -Proximal tibial Green-stick fracture at medial part) is the main cause of unilateral genu valgus.¹⁷ Trauma in young patients often leads to physis injury and ground arrest which can eventually result into deformity. It may result in both limb length discrepancy (LLD) and angular deformity. Physeal injuries complicate 18-30% of pediatric fractures. Growth arrest occurs in 5-10% of cases in those with physeal fractures.¹⁴

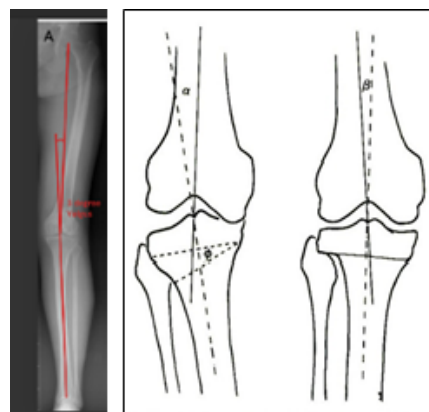
Pathophysiology of post-traumatic genu valgus

1. Excessive overgrowth of proximal tibial growth plate due to fracture hyperemia and metaphysis injury, 2. Imbalanced relaxation of ligaments and external rotation of tibia due to gravity while leg in cast, 3. Uninterrupted instability with valgus knee after conservative management of medial collateral ligament injury, 4. Early weight bearing on tibia before consolidation of fracture site, Structural changes caused by bowing, perhaps micro-fractures not visible radiographically, may account for a recurrence of the bowing deformity when stress is applied during healing, 5. Excessive lateral tibio-fibular torsion.^{4,9,15,16}

Clinical and radiological evaluation of genu valgus

Lower limbs deformity can be evaluated by long film x-ray of both lower limbs with pelvis A/P view, Q angle (Quadriceps angle), tibio-femoral angle and CORA (Center of Rotation of Angulation) method.^{6,7,17}

weight bearing, full length lower limb (LL) x-ray A/P view. The angle can't measure accurately until a child is able to stand by self. The first line is illustrated from the center of femoral head to tip of the femoral intercondylar notch and another from midpoint of tibial inter-spinous line to the tibial mid-plafond. The tibio-femoral angle is useful to quantify the degree of valgus or varus alignment at knee, also after total knee replacement. Varus knee is physiological from birth to 24 months of age and then valgus until 7 years is normal. 1-1.5° varus is normal in adult and in healthy person it can be 1° valgus and 3.2° varus.¹⁹



Tibio-femoral angle 30 valgus in normal knee

Tibio-femoral angle before & after deformity correction

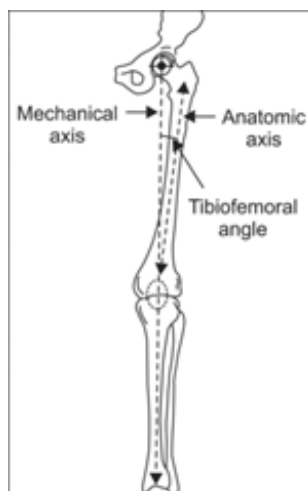
CORA (center of rotation of angulation)

It is a method of both mechanical and anatomical axis planning based on joint orientation and a system of deformity analysis for the purpose of corrective osteotomy and hardware fixation.

Each long bone has, it's given anatomical and mechanical axis.

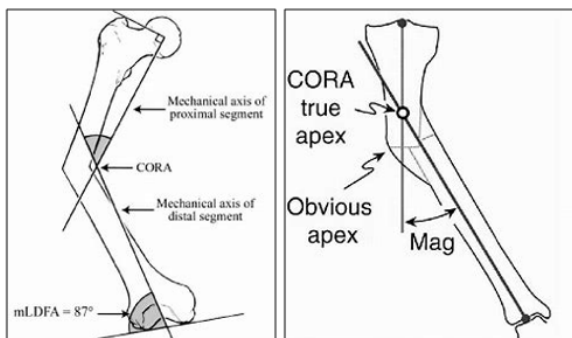
Anatomical axis: It is the line that passes through the midpoint of diaphysis. Every segment of a deformed bone has a separated particular anatomical axis and those lines are intersect each other.

Mechanical axis: It is the straight line that connects the center points of upper and lower joints in frontal or sagittal plane, through which the force of axial mechanical load pass of during in static weight bearing.



On anteroposterior (A/P) evaluation, in case of tibia the mechanical and anatomical axis coincides each other, but in femur those are separate. The mechanical axis in femur goes from the center of femoral head to knee joint center. Concerning for the lower limb, it extends from the center of femoral head to the center of ankle joint and normally pass through the center of knee joint. The mechanical axis is always a straight line in both frontal and sagittal plane, but the anatomical axis may be straight in frontal plane but curved in sagittal plane as in femur.¹⁷

In deformed tibia, CORA determination is so simple, because both mechanical and anatomical axes are amalgamate and goes through center of tibial diaphysis. The anatomical axis of each segment of deformed tibia drawn on x-ray, the lines will intersect and the acute angle between the lines is CORA.



In deformed femur, the mechanical axis of proximal segment is illustrated by a line drawn from the center of femoral head to the tip of greater trochanter and another line drawn at right angle of the

line from the center of femoral head. The distal segment axis can be found by drawn the tibial axis as retrograde direction, unless there is no deformity at knee joint or a line drawn connecting the tip of both femoral condyle then distal segment axis drawn which passes through midpoint of intercondylar line and tip of inter condylar fossa.

Recently CORA method has been incorporated into the latest computer planning software, but the mathematical modeling of six axis deformity correction is first dependent on the surgeon's competence to understand, analyze and quantify the radiographic deformity. Till now CORA method apply worldwide for deformity analysis, limb lengthening, deformity correction and the concept used both design with functionality of the last generation of external devices.²⁰

In case of below knee traumatic valgus deformity, tibia was bowed medially and more manifest along medial than later wall.⁴

Treatment protocol: i) Physiological genu valgus deformity managed conservatively. Surgical correction of angular deformity are consider, growth modulation and corrective osteotomy. ii) Hemiepiphysiodesis is done for pathologic genu valgus in a skeletally immature patient and iii) Osteotomy is the treatment of choice for immediate correction or in a skeletally mature patient.^{6,8,9}

In traumatic proximal tibial genu valgus, a medial wedge osteotomy can be done for rapid healing and short recovery time.^{13,21} The CORA method of deformity analysis, the Ilizarov circular external fixator rings applies after corticotomy to correct deformity, lengthening and also to detect the causes and prevent the secondary deformity.^{17,22}

Most common complications of surgery are infection, secondary deformity like medial proximal tibial angle, Multiple and repeated osteotomies may be required, which associated with pain, stiffness, risk of non-union, mal-union and prolonged period of immobilization.^{8,13}

In our case, there is post traumatic proximal tibial unilateral genu valgus deformity. We correct the deformity and limb lengthening by proximal tibial corticotomy with Ilizarov frame. So, we minimize and control infection, maintain knee joint space, provide bony stability and prevent secondary deformity very nicely with early mobilization and decrease hospital stay time, as well as reduce treatment cost.

Result

After complete union and consolidation, substantial evidence was checked and confirmed by both clinical and radiological. There was no abnormal gait and pain during walking. All joints of right lower limb are free and regain full ROM with in normal position. Mechanical axis of right lower limb was restored as normal. The final outcome is excellent.

Conclusion

Genu valgus is common in children and observation is the first line of treatment. The goal of the treatment is restoration of normal mechanical axis. Physiological variant treated conservatively. Pathological genu valgus needs management according the cause. When surgical correction is indicated, corrective osteotomy usually done but there is so many complications – infection, secondary angulation etc, and needed repeated surgery. CORA method apply worldwide for deformity analysis, limb lengthening, deformity correction and the concept used both design with functionality of the last generation of external devices. Ilizarov method is a promising method for correcting limbs deformities. In post-traumatic proximal tibial genu valgus effectively corrected by Ilizarov with corticotomy,

which minimize complications, facilitate limb lengthening by controlled tissue neo-genesis, prevent and manage secondary angulation deformity. Due to early mobilization and decrease hospital stay time, resulting cost effective and found excellent final outcome.

Consent

We have taken patient's and guardian consent in oral and written form, to use pictures, radiographs and clinical data in publication of all mediums.

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The official logo of our organization z & j fellows (Zubayer & Jahangir fellows).



Conflict of interests

The authors declare no conflicts of interest

Author's contributions

C. F. Rob was contribution in writing and editing the manuscript, J. Hossain was contribution in writing and editing the manuscript, literature reviews, analyzed and interpreted data regarding the case, Professor Kang review and editing the manuscript.

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