International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Brace Based Mechanical Axis Deviation (MAD) of Lower Limb Correction in a Pediatric Patient With Severe Femoral and Tibial Bowing: A Case Based Description

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Abstract
Genu varum is a Latin term used to describe bow legs. It is a common finding in the pediatric population with a large differential spectrum which includes but not limited to Blount's disease, rickets, Post infective & post traumatic physeal injuries and physiologic bowing of the legs. The femoral intercondylar distance between the two knees is increased in this condition and it can have a unilateral or bilateral involvement. In the case of genu varum, the mechanical axis falls more inside beyondthe middle ofthe knee joint and the joint undergoes an increased non-physiological stress which can affect both the articular cartilage of the knee and its ligaments. Here we present a case of a 3 year old girl with severe varus deformity of both lower legs which was successfully managed with Brace based correction technique in the lower limbs.

Keywords: Genu varum; Mechanical axis deviation; Mermaids splint

Introduction:

Genu Varum (or Bow legs) is an alteration of the axis of the lower limbs such that it falls more towards the central body axis beyond the middle of the knee. The apparent look of the bilateral deformity is akin tothe round brackets or the most commonly termed bowed appearance. The mechanical axis of the lower limb (the line that connects the centre of the hip with the centre of the ankle), in normal situations passes through the centre of the knee thus distributing the load symmetrically across both the medial and lateral tibiofemoral compartments of the knee joint. In the case of genu varum, the mechanical axis falls more inside and the joint is subjected to (both in an upright position and during walking) an increased non-physiological stress affecting the articular cartilage and ligaments supporting the knee.

Genu varum is a relatively common finding in children. Physiological bowing is seen most commonly and has a benign course, which usually resolves spontaneously with growth. However, different causes of tibia vara need to be ruled out. Idiopathic tibia vara (Blount's disease) is the most frequently encountered pathological condition and treatment depends upon the age of the child and severity of the deformity at presentation.

Systemic disorders associated with this deformity includes achondroplasia, rickets, renal osteodystrophy and osteogenesis imperfecta. Children normally are born with knee varus, which gradually decreases with age, at around 12–18 months with knees straightening, then progress to marked valgus during the second and third years. The valgus then normalizes to adult levels by the age of 6 years.

In older children, varus axis should no longer be present and the physician should distinguish an idiopathic genu varum which is constitutional with a familial basis and without underlying pathologies, which falls in the category of secondary genu varum, where there is an associated pathology that causes the axial deviation. The causes of secondary genu varum include achondroplasia, rickets, renal osteodystrophy, osteogenesis imperfecta, multiple hereditary exostosis, consequences of infection or trauma on the growth cartilage.[1] The resulting short stature can also add to the genu varum in these conditions.

The hallmark of this condition is symmetrical and painless bowing, usually associated with in-toeing and often with a propensity for increased tripping on walking and running.

There are various interventions available for treatment of this condition, ranging from attempted bracing, osteotomy to guided growth (temporary hemiepiphysiodesis) based correction.

We are presenting a case of a 3-1/2 years old girl with varus deformity of both lower legs which was successfully mananged with Brace based deformity correction technique.

Case Presentation-

A 3-1/2years old girl presented with her mother and gave a history of severe bowing (varus deformity) of both lower legs. The mother realized the deformity when her child was 3 years old and according to her it has been gradually progressing since then. There was no history suggestive of any trauma and other significant medical or family history. She started walking at around 15 months of age and motor and cognitive development of the child was appropriate for her age in all aspects. Considering all these aspects, the case was considered to be having Idiopathic severe bilateral genu vara, which was not developmental as itstarted well beyond the spontaneous age of correction within 2 -3 years and had shown a progressive trend in worsening.

Clinical examination showed gross bowing of both the lower limbs with an increased intercondylar distance when asked to stand with her feet together in weight bearingstance. (Fig 1)The patient had a normal shaped head with no signs of facial dysmorphism & with no other chest or abdomino-pelvic deformity. Rest of the systemic examinations were within the normal limits.

The patient's biochemical blood parameters likeSerum Calcium, Phosphate, Vitamin D, alkaline phosphatase (ALP) and Bone specific ALP, Liver function tests, Kidney function tests were within normal limits.

Radiographs of the patient showed gross femorotibial bowing of the legs on weight bearing as shown in these radiographs. The mechanical axis drawn is found passing medial to the knee joint. (Figure 1, 2, 3; *Blue Line*: Mechanical Axis of lower limbs, *Red line*: Mechanical Axis of Femur and Tibia) After clinical and radiological diagnosis,the patient was decided for a trial of conservative management and proceed further based on response.The Conservative management was done with Mermaid splint/brace for both the lower limbs with timely follow up at 3 months intervals.

On 1st follow up at 3 months, deformity started showing improvement, so it was decided to continue with the same treatment. On continued 3 monthly follow up, the patient's deformity improved significantly with the varus deformity completely corrected as shown in the figure 3, 4, 5 & 6

Discussion

Physiological genu vara in children is known to correct spontaneously during the course of normal development and achieve normal adult valgus alignment of the knee at the age of 7 years. Any residual genu varum after the expected correction by the age of 2-3 years or beyond this age, without any underlying diseases, is called "idiopathic genu vara[2.]All patients with idiopathic genu vara without any deformity at the tibia had markedly increased femoral ante version with genu recurvatum.

According to Alvik et al, increased femoral ante version causes internal rotation of the femur in order to make the hip abductor muscles function more effectively, followed by internal rotation of the knee joint during movement and consequent loosening of the posterolateral aspect of the knee joint capsule[3.]

Bracing was widely used until the mid-1900s, but it was associated with problems of brace design and cost, patient non-compliance, and unproven efficacy.

Osteotomy, involves cutting the femur, the tibia/fibula, or both, depending upon the level or levels of bony deformity[4, 5]

Osteotomy is an invasive procedure and is often associated with complications like failure of fixation, physeal damage, infection, joint stiffness, compartment syndrome, neurovascular injury, overor undercorrection, and recurrence of deformity and it is a permanent method.[6, 7]

Guided growth is a minimally invasive and another newer method of correcting genu varum in the pediatric patient with some physeal growth remaining. Its advantage is that it is temporary procedure and reversible in nature[8.]

Guided growth (temporary hemiepiphysiodesis) is usually treatment of choice for most children with progressive genu varum. Here the lateral distal femoral or lateral proximal tibial physes may be temporarily restrained with an eight-Plate. The goal of this method is to restore the mechanical axis to neutral, mitigating the cumulative effects of gravity on the overloaded structures, alleviating the pain and gait disturbance, and helping to protect the knee throughout the growing years.[9] This epiphysiodesis is a temporary procedure. When the mechanical axis has been restored to neutral, the implants can be removed in order to restart the growth of cartilage. Therefore it is theoretically a reversible procedure. Subsequent growth should be monitored. This method comes with two risk, which are the risk of damageto the growth cartilage produced at the time of surgery & by the plate itself andalso when the plate have been removed, if there is still growth of the cartilage remaining on the opposite side, the knee may continue to deviate in the direction of correction, leading to hypercorrection (valgus knee) and even the “rebound” effect after the plates have been removed, the area of cartilage that has been slowed begins to regrow excessively, leading to a recurrence of the varus knee deformity. Hence, it should be performed using correct technique with and to perform the intervention near the end of the growth, so as to obtain the correct axis to prevent such complications.

Corrective braces for genus arum have been used for many years but have gone into oblivion since quite some time now. Braces had better advantages of holding devices than other corrective appliances. Corrective pressure over a long period of time is required to have any effect upon the deformities. The pressure must be moderately severe and constant to be effective and also without making the appliance uncomfortable and difficult to tolerate. Various types of corrective leg braces are available nowadays, but practically all types utilize the same basic three-point principle of pressure application and growth modification.

Various types of splints can be used for correcting genus arum, these include mermaid splint, lateral single bar knee ankle foot orthotic, shoe modification with elevating inner border of shoe from 3/16th to 1/4thinches.

In our case, we corrected the deformity conservatively using a mermaid splint and we were able to get a good outcome in 9 months and the mechanical axis deviation improved significantly towards normal during the course of treatment.

Conclusion-

When considering corrective intervention for idiopathic genu, the exact anatomical position of the actual deformity is required. It is very important to know whether the problem is due to a distal femur &/or proximal tibial varus alone or whether there is any accompanying rotational deformity of the femur &/or tibia, which are required to be addressed too. We need to assess the actual causes in order to perform an appropriate treatment, in order to get a satisfactory functional outcome. And although gone in oblivion, our case establishes a renewed interest in the correction of Mechanical axis of the lower limb with a principle linked brace based correction and clinician can keep such a treatment modality as an option.

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PICTURES etc.

Radiographs of the patient showed gross femorotibial bowing of the legs on weight bearing as shown in these radiographs. The mechanical axis drawn is found passing medial to the knee joint. (Figure 1, 2, 3; *Blue Line*: Mechanical Axis of lower limbs, *Red line*: Mechanical Axis of Femur and Tibia)

Fig: 1

Fig: 2

Fig 3: 3 months Post brace

Fig 4: 6 months Post brace

Fig 5: Clinical Picture 6 months Post brace

Fig 6: Clinical Picture post 9 months on brace

Fig 7: X ray Post 9 months on brace

X-RAY BILATERAL LOWER LIMBS (AP & LATERAL VIEWS)

- Bones in view appear normal without any lytic or sclerotic lesions.
- Joints in view appear normal with smooth articular margins and normal joint space.
- Soft tissue shadow appears normal.

Impression:

➢ ***The FS-TS (Femoral Shaft- Tibial Shaft angle) of left lower limb ~ 6 degree and of right lower limb is ~ 7 degree. The HKA (Hip Knee Angle) of left lower limb is 5 degree and of right lower limb is 2 degree.***