Section: Orthopaedics and Traumatology

Original Research Article

ANALYSIS OF USES AND INDICATION OF FIGURE OF 8 PLATE HEMIEPIPHYSIODESIS IN CORRECTION OF ANGULAR DEFORMITIES OF KNEE IN PAEDIATRIC POPULATION -A PROSPECTIVE STUDY

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Abstract

Background: Pathological genu varum and genu valgum in children are one of the most common reasons that an anxious parent consults an orthopaedic surgeon presentation varies with the age and degree of the deformity. **Aim:** The study aims to analyse the indication and use of hemiepiphysiodesis by a figure of 8 plate in treating angular deformities of the knee in paediatric population. **Materials and Methods:** This was a prospective study conducted at the Orthopaedics and Traumatology department, Madurai Medical College, Madurai, from 2019 to 2021. Non-operative: Observation - Initial mode of treatment genu valgum of <15° in a child of <7 years of age. Bracing is rarely used nowadays and it had shown to fail in pathologic genu valgum and it is unnecessary in physiologic genu valgum. **Result:** By the 14th month in Tibio femoral angle - Valgus, the average tibiofemoral angle has reduced from 19.5` to 5.8`. The deformity correction mean was found to be 13° ± 3° (range 10°–20°), and the average rate of correction of the deformity was found to be 1° ± 0.2° per month. By the 14th month in Tibio femoral angle - Vargus, the average tibiofemoral angle has reduced from 14.5` to -3.3`. The deformity correction mean was found to be 17° ± 2°, and the average rate of correction of the deformity was found to be 1.2° ± 0.2° per month—wound infection in one case which, was managed completely by intravenous antibiotics. **Conclusion:** Temporary hemiepiphysiodesis using 8-plates is a procedure with effective outcome for coronal angular deformity in paediatric population.

INTRODUCTION

Coronal plane deformities of the knee, a frequent problem encountered in paediatric orthopaedics, may usually managed successfully, requiring only parental reassurance.[1] The physiological deformities are usually seen between the age 1 and 3 years (varus) or between 3 and 6 years (valgus) and they usually resolve without any intervention. Some Coronal & sagittal plane deformities encountered in paediatric orthopaedics may need surgical treatment when they are associated with progressive deformities causing functional and cosmetic issues compounded by pain.[2] Pathological coronal and sagittal knee deformities can be either idiopathic or due to trauma or congenital syndromes or associated with malnutrition. Physiological deformities resolves by itself but pathological deformities gets worse as the underlying disease progresses, resulting in a gradual mechanical axis displacement.[3]

Genu valgum more than 10° can cause circumduction gait, anterior knee pain and sometimes patellofemoral instability. Genu varum may result in waddling gait, ligamentous laxity a lateral thrust.[4] Whatever may be the cause , either dysplastic, idiopathic or related to an endocrinopathy, the main aim of surgical treatment is to maintain and restore a neutral mechanical axis. Methods for epiphysiodesis (permanent and temporary) are numerous.[5] An accurate timing of surgical intervention is necessary in permanent methods to prevent under-correction or overcorrection6. Bone age determining is unreliable with current methods. So permanent epiphysiodesis

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methods are not used currently and temporary epiphysiodesis have become the main mode of treatment. It involves mainly transphyseal screws, staples etc and few years before an eight-plate has been introduced.

Staples produce problems like pin breakage, migration and implant bending, growth arrest and rebound deformity.[5] Transphyseal screws had an issue of crossing the the physis. The use of 8 plates has shown good results with few complications, reversible growth and faster correction in patients with idiopathic deformities.[6] In literature there is sparse data on the use of this device for pathological physis. When Stevens first highlighted this device, he described the use of this device for idiopathic and pathological physeal deformities. He stated that the eight plates are the best device for both types.[7] This study analyses the efficacy of hemiepiphysiodesis using 8-plate in correcting genu varum and genu valgum in pathological physis.

MATERIALS AND METHODS

This is a prospective study, conducted at the Orthopaedics and Traumatology department, Madurai Medical College, Madurai, from 2019 to 2021.

Non-operative: Observation - Initial mode of treatment genu valgum of <15° in a child of <7 years of age. Bracing is rarely used nowadays and it had shown to fail in pathologic genu valgum and it is unnecessary in physiologic genu valgum.

Operative methods: Osteotomies for deformity correction can provide desired outcome immediately but this procedures were associated with neurovascular injury, increased blood loss, risk of compartment syndrome and growth disturbance. Prolonged period of immobilization may be needed following corrective osteotomy which may also cause joint stiffness.

Permanent hemiepiphysiodesis: Timing of the procedure is the overall problem with performing a permanent physeal arrest. Permanent fusion of the growth plate was first introduced by Phemister in 1933. He described a technique of rectangular resection of bone containing epiphysis, physis and metaphysis. The resected area then reinserted with the ends reversed. Phemister claimed that by this procedure, both leg length equalization and frontal plane deformity correction such genu valgum correction could be achieved. Disadvantages of this procedure was prolonged post-operative care. A minimally invasive technique was introduced by Canale et al. using power drills and to destroy the growth plate permanently.

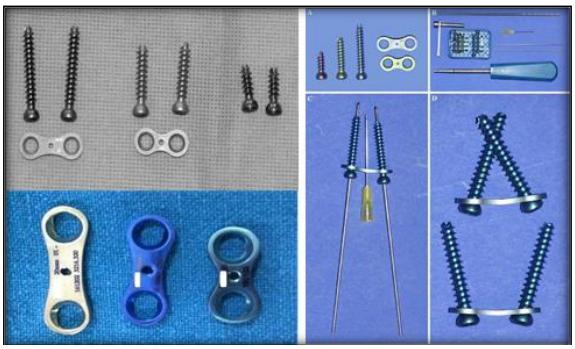
Temporary Hemiepiphysiodesis: Staples: Staples make a rigid construct providing compression to the physis throughout its length, but staples have a higher risk of breakage and extrusion.

Transphyseal screws: Especially in Europe, Transphyseal screws were used for partial or total growth arrest. Although the physiognomy is not directly disrupted by tibial screws, this technique is actually considered irreversible growth plate fusion, requiring the timing of the procedure.

Guided growth technique using 8-plate hemiepiphysiodesis: This new technology was developed to eliminate some of the complications associated with using staples. It was first described by Stevens, who developed the 8-plate implant. These implants are recommended to avoid compression of the growth zone and reduce mechanical damage. The Tension Tape Cover System consists of a plate fixed with one screw on each side of the growth plate. The screws are not securely fastened to the plate and may gradually bend as the deformity is corrected. The plate is fixed over the convex side of the knee over the physis. Growth is temporarily arrested over the convex side, and growth is allowed to continue over the concave side of the knee till the knee deformity is corrected.

Eight-plate: The 8-plate implant is a minimally invasive and safe implant that provides fast post-surgical recovery with an immediate load. The eight plates use two holes and divergent screws to act as loops and prevent compression of the growth plates. The 8 plate kit includes three sizes of cannula screws: 16, 24 and 32 mm, 3.2 mm cannula drill, 21 gauge needle, 1.2 mm threaded tip, screwdriver, and 4 plates with 8 plates.

The new instrument kit includes a 3.2 mm cannulated step drill and a guide for limited penetration to 5 mm. A cannular screw is inserted over the guide.



Surgical technique: Patient positioning: Supine position, Anaesthesia: General anaesthesia/Spinal anaesthesia, Tourniquet used: Tourniquet time was 45 minutes, and inflation pressure was 220 to 240 mmHg.

Surgical steps: Position of the patient is supine with a tourniquet (optimal); Use X-ray imaging (c-arm). Locate the lateral physeal (femoral, tibial, or both) with the C-arm and make a 2-3cm incision, preserving the periosteum. Insert a Keith needle or similar needle into the physis. Check the anterior-posterior (AP) and lateral projections. Insert the needle in the mid-sagittal direction (optimal). Do not position too far anteriorly (due to risk of recurvatum). Insert a 8- plate (12 or 16 mm in

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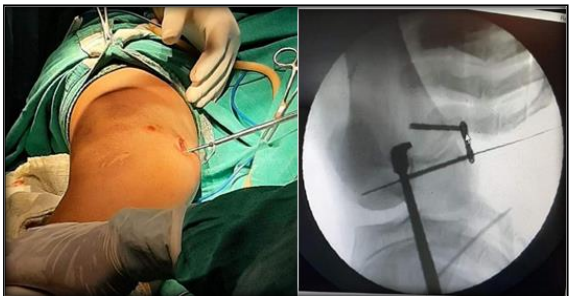
height) with a needle through the central hole. Insert the 1.6 mm epiphyseal smooth guide first, then the epiphyseal guide. The guide pins do not have to be parallel, but contact with the joint must be avoided. After drilling with cannular drill 3, insert a 4.5 mm cannular self-tapping screw (24 mm or 32 mm, doctor's choice).size 2mm. You can mix lengths and colors of screws. After hemostasis is complete, the wound is sutured in layers. It is important to keep in mind that this titanium plates are non-locking. Strength is based on the screw's ability to act as a flexible tension band that can bend when it reaches its maximum extension (~30°). At maximum divergence, the flexible plate gradually begins to bend in the opposite direction. The length of the screw is not critical, but it should not be long enough to reach the distant cortex.



Post-operative protocol: POP not applied, mobilization started 2nd post-operative day, range of movement of knee encouraged, weight baring started from day one of the post-operative period, IV antibiotics given for first 5 PODs, discharged on 3rd POD, wound dressing done on 3rd, 6th and 9th POD, and sutures removed on 12th POD.

RESULTS

Table 1: Tibiofemoral angle improvement and mechanical axis follow-up

	Tibiofemoral angle improvement		Mechanical axis	
	Valgus	Varus	Valgus	Varus
At admission	19.2`	14.5`	34.6	33
Three weeks follow up	18.8`	13.5`	32.3	30.5
Five weeks follow up	17.2`	12.2`	30.9	28
Seven weeks follow up	15.6`	11`	29	27
Four months follow up	11.6`	6.75`	21.2	17
Eight months follow up	8.6`	0.92`	14.5	9.25
One-year follow-up	6.9`	-2.45`	10	7.25
14 months follow up	5.8`	-3.3`	7.1	6
Final value	5.3`±	18`± 2	7 ± 1.2	6 ± 1.2

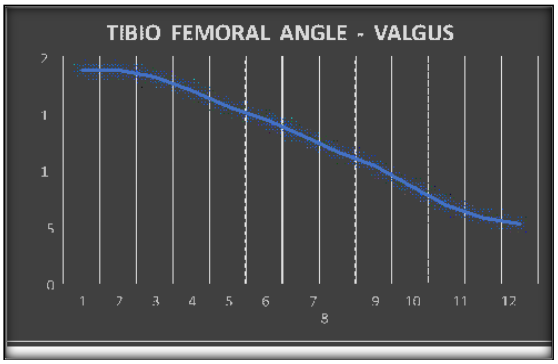


Figure 1: Tibiofemoral angle - Valgus

The preoperative measurement of the tibiofemoral angle ranges from 15` to 28` with an average degree of 19.2`. On subsequent follow-ups of patients, the angle is found to be on a decreasing trend. By the 14th month, the average tibiofemoral angle has reduced from 19.5` to 5.8`. The mean amount of deformity corrected is found to be 13° ± 3° (range 10°– 20°), and the overall rate of correction of the deformity is recorded to be 1° ± 0.2° per month.

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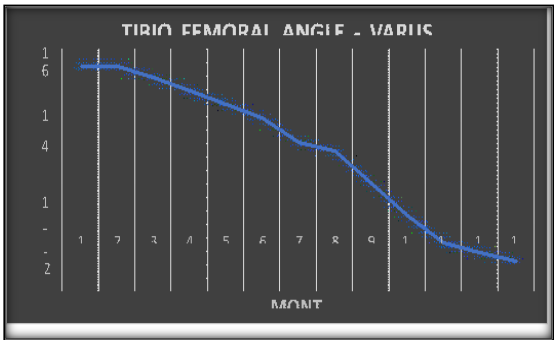

Figure 2: Tibiofemoral angle – Vargus

The preoperative measurement of the tibiofemoral angle ranges from 12` to 18` with an average degree of 14.5`. On subsequent follow-up of patients, the angle is found on a decreasing trend. By the 14th month, the average tibiofemoral angle has reduced from 14.5` to -3.3`. The mean deformity correction is 17° ± 2°. The rate of correction of the deformity is recorded to be 1.2° ± 0.2° per month.

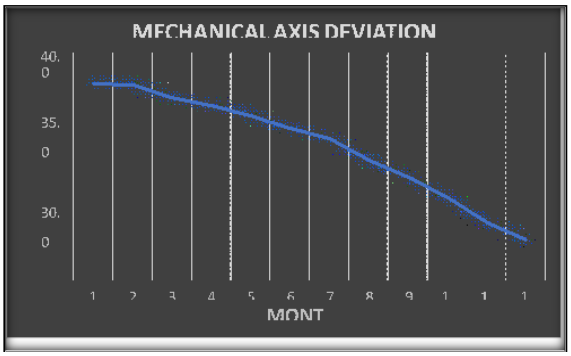

Figure 3: Mechanical axis deviation –Valgus

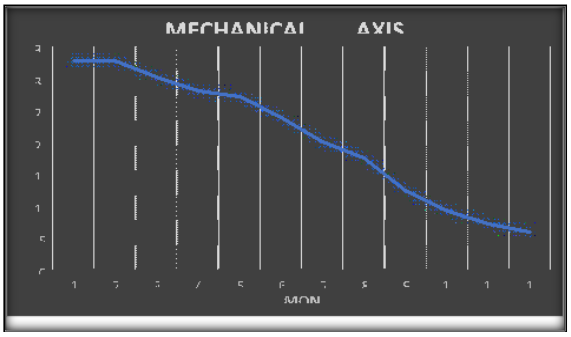

Figure 4: Mechanical axis deviation –Valgus

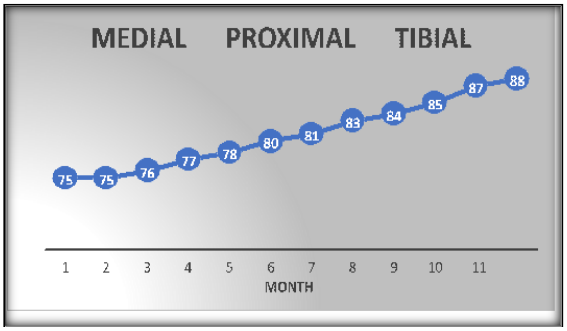

Figure 5: Medial proximal tibial angle- Genu varus deformity

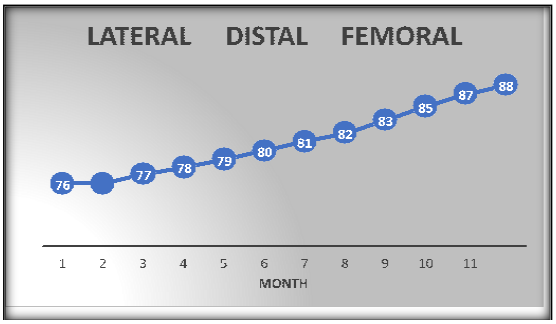

Figure 6: Lateral distal femoral angle- Genu valgus deformity

Complications: In one case, intravenous antibiotics managed wound infection completely. Implant failure in one case presented with implant loosening and protrusion beneath the skin, managed by implant removal and revision fixation.

DISCUSSION

Genu varum and genu valgum alter the biomechanics of the knee and causes distorted stress distribution on the weight-bearing surface of the knee joint. Various methods have been proposed to address this problem. Osteotomy is associated with frequent and sometimes severe complications like extensive soft tissue dissection, infection, delayed union, malunion, prolonged immobilization and complication associated with immobilization. So, many have resorted to a less invasive method of hemiepiphysiodesis to restore alignment with lower cost and the fewest complications. The most recent technique involves guided growth with an eight-Plate. Biomechanical, hormonal and genetic factors affect physeal growth in children. Growth modulation using eight-plate hemiepiphysiodesis depends on the biomechanical factor of growth modification based on the Hueter- Volkmann principle, which states that compression and tension forces at the physis can cause physeal growth inhibition and acceleration respectively.[8] plate is a flexible device with sustained compression at physis. The compression is not constant because the screws diverge with correction, and with maximum divergence, the plate bends, hence also known as a tension band plate. In contrast, the eight-plate with a non-rigid implant and a lateralized fulcrum ensures faster correction of deformities. In comparison, staples and trans physeal screws have a rigid implant with a centralized fulcrum, causing constant compression in the physis. Therefore, more time is needed to correct the deformity. Staples and transphyseal screws are rigid implants that may stop growing if deformity correction takes a long time. In contrast, the 8 plates are relatively flexible implants that allow screw removal. This is one of the reasons it lowers the incidence of growth retardation and is safer for young children than staples.

In our patient study, the median time to growth managed on the plate was 11 months (range 8–12

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months), similar to Ballal.et.al.[9] reported 13 patients with median growth time in plates of 10 months (range 8–14 months). Correction was faster if the child was less than ten years old. In our series, there was no difference in correction frequency by gender, as in Boero.et.al. During the 14-month study period, the mean anatomical tibiofemoral angle recovered by an average of 13' (10-16)°. These results are similar to those reported in the literature for aTFA 7–12° by Burghardt et.al. and Wiemann et.al. In a study by Boero et al. of 58 patients treated with 8 plates showed an improvement in TFA within physiological limits with a mean correction of 11° (range 6 - 16').

The median rate of femoro-tibia axis correction in our study was 0.9°/month, similar to Boero et al.[10] In a multicenter study, a large physical therapy series of 967 treated with 8 plates showed a success rate of 75-80%, with a correction rate of 0.79°/month. Ballal et al.[9] showed that the average correction rate of the tibial femoral axis was 0.7°/month. The mechanical axis deviation improved from an average of 3.6 cm to 0.7 cm in our study at a rate of 0.2 cm per month.

In the study by Rolf et al.[13] the total correction was 3.88 cm each at a rate of 0.18 cm per month. Burghard et al and others showed a mechanical axis correction of 0.17 cm/month. The average rate of mechanical axis correction in our study was 0.2 cm/month. In another study by Bhagel et al., MAD improved from 3.63 ± 0.35 cm to 0.73 ± 0.43 cm at the rate of 0.135 cm per month. The lateral distal femoral angle (LDFA) for hallux valgus was adjusted from 76 ± 1.02 to 88 ± 1.9 at a rate of 0.9 per month.

In the study by Rolf et al.[13] total correction of hallux valgus and varus deformity ranged from 82 to 91 degrees at a rate of 0.8 per month. The medial proximal tibial angle (MPTA) for varus deformity improved from 75 to 88 at a rate of 0.9 per month.

Similar results were reported by Burghardt et al. The MRI correction rate in their study was 0.85 per month.

There was only one implant failure in our study. They were also removed and hemiepiphysiodesis surgery was performed. Many of the screw fractures reported in the literature may be caused by convergence of the screw during insertion or over-tightening of the screw (cold welding), but there is no evidence of this in the recent literature. The literature reports more complications related to pathology (dysplasia, Mb. Blount, etc.) than children with normal physiology. Ballal et al.[9] encountered one case of both screw and plate migration which was revised. Such a complication didn't occur in our series. Several series encounter rebound growth after plate removal. We have not seen a rebound of deformity in our patient, with the longest follow-up of 6 months after plate removal. Complications related to the implant, like migration, breakage, bending of implants etc., seen with staples are rare with eight -plates. In our study, correction failure is seen in one patient and is on regular follow-up with the implant in situ.

CONCLUSION

Temporary hemiepiphysiodesis using 8-plates is an effective procedure with a low complication rate and a low recurrence rate for treatment of angular deformity of the knee joint in patients younger than 12 years of age. If the deformity does not improve after conservative treatment, this should be considered. Our study of 15 children with angular deformity around the knee demonstrated superior correction of the knee deformity by temporary hemiepiphysiodesis using an 8-plate.

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