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Original Article

Correction of Coronal Angular Deformity Around Knee Joint in Children Aged Less Than 10 Years by Temporary Epiphysiodesis Using Eight Plate

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Abstract

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Background: Coronal angular deformities in the lower limbs are frequently observed in childhood. Persistent lower limb valgus beyond the age of 8 is not considered physiologic. In skeletally immature children, temporary epiphysiodesis, a relatively minor and typically outpatient surgical procedure, where weight-bearing is usually not restricted, has become an appealing option in pediatric orthopedics.

Aim of Study: The purpose of this research was to assess the effectiveness and safety of epiphysiodesis in gradually correcting angular knee deformities by temporarily suppressing the physis in skeletally immature patients.

Patients and Methods: A prospective case series design study on twenty patients [21 affected limbs] who presented with angular deformities around their knee joints. These patients were selected from the outpatient clinic of the Faculty of Medicine at Al-Azhar University Hospital in Damietta underwent temporary epiphysiodesis with an eight-Plate implant to correct coronal angular deformities around knee joint. Related clinical and radiological findings were compared preoperatively and at follow up visits [from 6 to 21 months].

Results: The preoperative mean mechanical lateral distal femoral angle [mLDFA] was $84.4^\circ \pm 4.68^\circ$, increasing to $87.6^\circ \pm 3.21^\circ$ post-operative. The preoperative mean medial proximal tibial angle [MPTA] was $91.2^\circ \pm 9.75^\circ$, while it decreased to $89.3^\circ \pm 3.260^\circ$ post-operative. The rate of correction was approximately 0.46° per month in the femur and 0.61° per month in the tibia. Of the 20 cases, 19 were fully corrected [95%], 1 was partially corrected and still in progress [5%] with no instances of implant failure were reported.

Conclusion: The use of eight plates for temporary epiphysiodesis in correcting knee angular deformities, in children aged less than 10 years, presents promising results characterized by significant deformity correction and a low complication rate.

Keywords: Angular Deformity; Bone Plates; Orthopedic.



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INTRODUCTION

Coronal angular deformities of the lower limbs, such as bow legs and knock-knees, are frequently observed in childhood. While many cases are considered normal and resolve on their own, when these deformities become significant and progressive, they can disrupt the quality of life, leading to gait disturbances, pain, and in severe instances, joint instability. Additionally, these deformities may have indirect effects on other joints like the hip and ankle, and most importantly, they increase the risk of early osteoarthritis in the knee^[1].

Numerous options are available for correcting angular deformities. In the past, the standard approach was an osteotomy. However, due to the high rate of complications and the difficulty involved in performing an osteotomy and acute correction, orthopedic surgeons have been actively exploring alternative, less invasive treatment options. Physal manipulation offers a method for correcting angular deformities with significantly lower associated risks and complications compared to osteotomy^[2].

Blount performed the initial reversible epiphysiodesis using staples in 1949. Later, in 1984, Bowen and Johnson introduced a percutaneous total epiphysiodesis to address leg-length discrepancies, which they later modified by ablating specific portions of the growth plate, using it for correcting angular deformities [known as percutaneous hemiepiphysiodesis]^[3,4]. After gaining extensive experience with staples, Stevens proposed a different approach in 2007, utilizing an eight-plate with two non-locked screws. This implant acts as a flexible tension band that directs growth instead of applying compressive forces like previous techniques. However, a significant drawback of the 8-plate is its cost. Some patients might require multiple plates, such as two plates for the tibia and femur or even four plates for bilateral deformities. This cost consideration can hinder its use, particularly in developing countries^[5].

THE AIM OF THE WORK

The objective of this study is to assess the effectiveness and safety of epiphysiodesis in gradually correcting angular knee deformities by temporarily suppressing the physis in skeletally immature patients.

PATIENTS AND METHODS

Study Design: The study followed a prospective case series design.

Study Population: This study focused on twenty patients [21 affected limbs] who presented with angular deformities around their knee joints. These patients were selected from the outpatient clinic of the Faculty of Medicine at Al-Azhar University Hospital in Damietta.

Duration of the study: The data collection period spanned from march 2022 to January 2024, during which these patients underwent corrective percutaneous epiphysiodesis surgery.

Selection criteria:

- **Inclusion criteria:** Male or female children aged less than 10 years who has progressive knee at any side
- **Exclusion criteria:** Patients who had reached skeletal maturity and patients diagnosed with advanced Blount's disease where physal bar development had occurred.
-

Data collection before surgery included

1-Patient demographic and general characteristics: such as age, sex, onset and progression of deformity.

2-Clinical Examination: Assessments of weight, leg length, the presence of deformities in other joints, height, generalized ligamentous laxity, manifestations indicative of rickets or known dysplasias, and gait. Angular deformity of the lower extremities was quantified using a goniometer with the knees fully extended and the patellae oriented forward. In cases of genu varum, the intercondylar distance was measured, while for those with genu valgum, the intermalleolar distance was measured.

3-Radiological Assessment: Radiological evaluation involved acquiring standing full-length anteroposterior radiographs of both lower limbs with the patellae facing forward. The Mechanical Axis Deviation [MAD] of the limb was utilized to determine the type and extent of deformity. Furthermore, the origin of the deformity, whether in the femur, tibia, or both, was assessed by measuring the lateral distal femoral angle [LDFA] and the medial proximal tibial angle [MPTA]. Patients were photographed before the surgical procedure.

Surgical Technique: After the preoperative clinical and radiographic evaluations were finished. Temporary epiphysiodesis using an eight-Plate is implemented. the TH procedures were accomplished according to the methods of Stevens^[5] as follows: under fluoroscopic guidance, a 3.5-mm plate and two cannulated 3.5-mm cortical screws were introduced, parallel to the physis, into the metaphyseal and epiphyseal regions. The eight-Plates [length: 25 or 30 mm, thickness: 1 mm] were placed outside the periosteum along the guide pins, and fully threaded self-tapping cannulated screws [diameter: 3.0 or 4.5 mm, length being approximately half of the width of the physis] were implanted along the guide pins. After confirming the position of the plate and screws by fluoroscopy, we released the soft tissue compressed by the plate to ensure that the joint moved freely.

Postoperative Management and Patient Evaluation

Following the surgery, X-rays were performed. Patients were discharged on the day after the surgery along with instructions for full weight-bearing.

A follow-up clinic appointment was scheduled for 2 weeks after the procedure to assess the wound.. For children who had difficulty mobilizing, physical therapy was recommended.

Patients were regularly reassessed every 3 months, both clinically and through radiographs. Additionally, photographs were taken to assist in assessing the correction. **Clinical follow-up** included measuring intercondylar distances in cases of genu varum and intermalleolar distances in those with genu valgum. **Radiologically,** patients underwent regular follow-up with plain radiographs taken in the erect standing position every 3 months. The duration of follow up ranged from 6-22 months.

Outcome:

The final surgical outcome was assessed as either

- “Resolved” [achieving or maintaining neutral alignment],
- “Pending” [partial correction of deformity], or
- “Failed” [no effect or uncorrected].

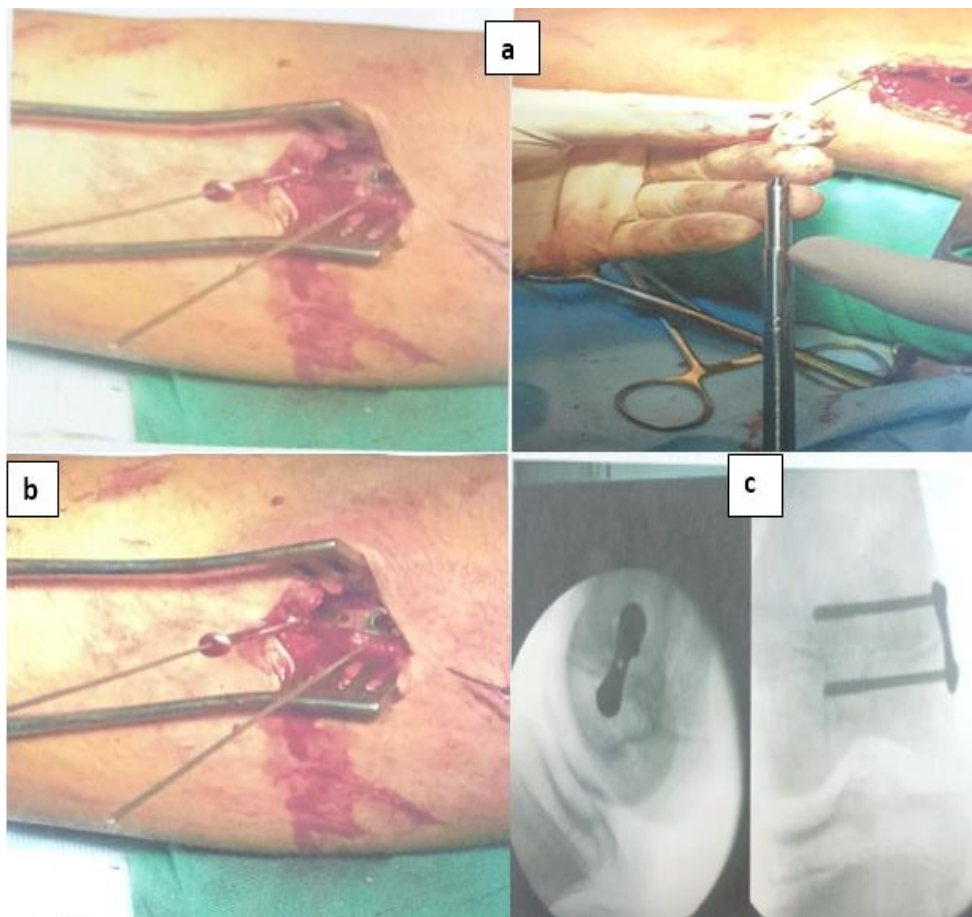


Figure [1]: Surgical technique [a] Insertion of cannulated screws; [b] Plate after fixation; [c] C arm image of the plate A-p view and lateral view.

Statistical analysis: The data were analyzed using IBM SPSS [Statistical Program for Social Science, version 27]. Quantitative variables were described using mean, standard deviation [SD], and range. Qualitative variables were described in terms of number and percentage. Shapiro-Wilk test was used to assess normality of quantitative variables. Paired t-test was employed for the comparison of quantitative normally distributed variables. A p-value <0.05 was considered significant.

RESULTS

Table 1. shows general characteristics of the studied patients. Out of the 20 patients, 16 [80.0%] were male and 4 [20.0%] were female. There were 10 patients [50.0%] with valgus deformity and 10 patients [50.0%] with varus deformity. In terms of the affected side, 9 patients [45.0%] had deformity on the right side, 10 patients [50.0%] had deformity on the left side, and 1 patient [5.0%] had deformity on both sides [right and left]. Regarding side of HE [Hip Extension, 9 [45.0%] had the deformity in the femur, 9 [45.0%] had the deformity in the tibia, 1 [5.0%] had the deformity on the same side in both the femur and tibia, and 1 [5.0%] had the deformity on both sides of the femur and tibia. It is also shown that 19 patients [90.0%] had resolved outcomes, while 1 patient [10.0%] had a pending outcome. Table 2 illustrates changes in radiological parameters among the studied participants. For LDFA, the mean value before the operation was 84.4° [± 4.68°], and after the operation, it increased to 87.6° [± 3.21°]. For MPTA, the mean value before the operation was 91.2° [± 9.75°], and after the operation, it decreased to 89.3° [± 3.260°]. These differences were statistically insignificant [P>0.05].

The mean gain of correction was 7.9° of mL DFA for 16 months and 10.5° of MPTA for the same duration. The mean rate of correction was 0.46° per month in the femur and 0.61 per month in the tibia.

Table [1]: General characteristics of the studied patients

Variables	N=20	%	
Sex	Male	16	80.0
	Female	4	20.0
Deformity	Valgus	10	50.0
	Varus	10	50.0
Side	Right	9	45.0
	Left	10	50.0
	Right and left	1	5.0
Side of [HE]	Femur	9	45.0
	Tibia	9	45.0
	Femur and Tibia same side	1	5.0
	Femur and Tibia both side	1	5.0
Outcome	Resolved	19	95.0
	Pending [still in progress]	1	5.0

N.B. All patients lie in the range of age less than 10 years

Table [2]: Changes in radiological parameters among the studied participants

	Pre-operative N=20	Post-operative N=20	P value*
LDFA ° [Mean±SD]	84.4± 4.68	87.6±3.21	0.597
MPTA ° [Mean±SD]	91.2±9.75	89.3±3.260	0.441

*Paired sample t test.



Figure [2]. Comparison of full-length anteroposterior standing radiographs in male patient 8 year 2 month old suffered from bilateral varus more on left side with past history of osteotomy bilateral distal femur and bilateral proximal tibia from four year. After bilateral temporary epiphysiodesis of proximal tibia physis and distal femur physis was performed, patient full correction to Rt side and still in progress to Lt side. **a**, pre-operation; **b**, Immediately postoperative; **c**, 2 months postoperative; **d**, 4 months postoperative; **e**, 21 months postoperative.



Figure [3]. Comparison of full-length anteroposterior standing radiographs in male patient 5 years old at time of presentation .Rt sided varus deformity. No previous surgical interventions. Correction by distal lateral femur and proximal lateral tibial hemiepiphyodesis. **a**, Immediately postoperative; **b**, 2 months postoperative; **c**, 16 months postoperative



Figure [4]. Comparison of full-length anteroposterior standing radiographs in male patient 9 years and 9 months of age upon presentation, exhibited a valgus deformity on the left side. There were no prior surgical interventions. The correction was achieved through proximal medial tibial hemiepiphyodesis. **a**, pre-operation; **b**, Immediately postoperative; **c**, 9 months postoperative; **d**, 15 months postoperative.

DISCUSSION

Coronal angular deformities in the lower limbs are frequently observed in childhood. However, majorities of these cases are considered physiologic and typically resolve spontaneously [1]. Normally, the alignment of the lower extremities undergoes a transition from varus to valgus during early childhood [6]. Children exhibiting bowlegs after the age of 2 are considered beyond the normal range and require a comprehensive evaluation [7]. Additionally, persistent lower limb valgus beyond the age of 8 is not considered physiologic. In cases of progressive pathological deformity, surgical intervention is often necessary. The decision on the site of deformity correction is guided by evaluating the mL DFA and MPTA.

Consequently, osteotomy or physal manipulation may be performed on the proximal tibia, the distal femur, or sometimes both [8]. Surgical interventions encompass immediate correction through osteotomy, progressive correction employing osteotomy with an external fixator, and growth plate hemiepiphyodesis for addressing moderate to severe deformities [6]. When an immediate correction of deformity is essential, osteotomy is recommended, especially for skeletally mature or nearly mature patients [9].

In skeletally immature children, osteotomy may be reserved for more severe deformities or situations where reliable follow-up is challenging. Temporary epiphysiodesis, a relatively minor and typically outpatient surgical procedure, where weight-bearing is usually not restricted, has become an appealing option in pediatric orthopedics [6].

After years of relying on staples, Stevens [5] proposed an alternative approach in 2007, introducing the use of an eight-plate with

two non-locked screws. This implant acts as a flexible 'tension band' that 'guides growth,' operating differently from previous techniques that exerted compressive forces. Stevens reported successful treatment in nearly all cases, with only two patients out of 34 [representing 63 of 65 limbs] not responding positively. The deformities addressed included those arising from various conditions such as posttraumatic, metabolic, dysplastic, or idiopathic factors, including Blount's disease [5]. The correction of angular deformities was observed to be faster than with staples, and no instances of growth arrest were noted. While one patient with Blount's disease experienced implant failure, it was successfully revised. Importantly, no immobilization was necessary, and patients were encouraged to resume early ambulation and normal activities as tolerated. This information aligns with findings from other studies, including those by *Delniotis et al.* [10] and *Coppa et al.* [11].

The present study constitutes a prospective case series involving 21 limbs of skeletally immature patients with knee deformities treated through temporary epiphysiodesis. The age at the time of presentation is less than 10 years. Follow-up duration varied from 6 to 21 months. The preoperative mean mechanical lateral distal femoral angle [mL DFA] was $84.4^{\circ} \pm 4.68^{\circ}$, increasing to $87.6^{\circ} \pm 3.21^{\circ}$ postoperative. The preoperative mean medial proximal tibial angle [MPTA] was $91.2^{\circ} \pm 9.75^{\circ}$, while it decreased to $89.3^{\circ} \pm 3.260^{\circ}$ postoperative. The rate of correction was approximately 0.46° per month in the femur and 0.61° per month in the tibia. Of the 20 cases, 19 were fully corrected [95%], 1 was partially corrected and still in progress [5%] with no instances of implant failure were reported.

When comparing the results of the current study and those of *Stevens* [5] who used the original 8-plate on 65 patients aged 20 months to 17 years. Stevens' study had a follow-up period ranging from 14 to 26 months. Stevens' study reported a correction rate of 97% [63 out of 65 cases], while the current study reported a correction rate of 95% [20

out of 21 cases]. Both studies showed high rates of correction, indicating that the treatment method used was generally effective. Regarding complications, both studies identified similar categories of complications, including insufficient correction, wound infection, recurrence, and implant failure.

In conclusion, the utilization of eight plates for temporary epiphysiodesis in the correction of knee angular deformities among children under the age of 10 exhibits encouraging outcomes marked by notable deformity correction and a minimal incidence of complications. Surgical intervention remains the preferred approach for managing progressive angular deformities around the knee, offering options such as osteotomy or epiphysiodesis. However, epiphysiodesis emerges as an attractive alternative for growing children, as it is a relatively minor outpatient procedure that typically does not require weight-bearing reduction. Despite epiphysiodesis attempts dating back over 65 years with Blount staples, the technique has experienced a resurgence in popularity with the introduction of Stevens' eight-plate, which has demonstrated favorable clinical results. The present study, which specifically investigates the use of eight plates for temporary epiphysiodesis in the correction of knee angular deformities, provides promising findings characterized by substantial deformity correction and a low occurrence of complications.

DECLARATIONS:

Ethical approval:

Approval was obtained from the Committee of the Damietta Faculty of Medicine IRB, Al Azhar University [DFM-IRB0001367-22-10-001] on 16-10-2022. The study was executed by the ethical standards laid down in the 1964 Declaration of Helsinki and its later modifications. The concept of the procedure was explained to the parents, and they were informed that the deformity would not be immediately corrected after the operation. Correction would occur "naturally" as the child grows, at which point the implant could be removed. Preoperative written consent for the surgery and for the child's participation in the study was obtained from the parents.

Consent for publication [consent statement regarding publishing an individual's data or image]: Not Applicable.

Data Availability: All data are available upon request.

Competing Interests: The authors declare no conflicts of interest.

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Authors' contributions: The first author was the main responsible for data collection; data analysis, and visualization. All authors contributed to conceptualization, methodology, data curation, writing original draft, review and editing. All the authors have read and agreed to the publication of the manuscript and all agreed to be accountable for all aspects of the work.

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REFERENCES

- Ghanem I, Karam JA, Widmann RF. Surgical epiphysiodesis indications and techniques: update. *Curr Opin Pediatr*. 2011 Feb; 23[1]:53-9. doi: 10.1097/MOP.0b013e32834231b3.
- Castaneda P, Urquhart B, Sullivan E. Hemiepiphysiodesis for the correction of angular deformity about the knee. *J Pediatr Orthop*. 2008 Mar; 28 [2]: 188-91. doi: 10.1097/BPO.0b013e3181653ade.
- Goyeneche RA, Primomo CE, Lambert N, Miscione H. Correction of bone angular deformities: experimental analysis of staples versus 8-plate. *J Pediatr Orthop*. 2009 Oct-Nov;29[7]:736-40. doi: 10.1097/BPO.0b013e3181b529fc.
- Inan M, Chan G, Bowen JR. Correction of angular deformities of the knee by percutaneous hemiepiphysiodesis. *Clin Orthop Relat Res*. 2007 Mar;456:164-9. doi: 10.1097/01.blo.0000246560.65714.c8.
- Stevens PM. Guided growth for angular correction: a preliminary series using a tension band plate. *J Pediatr Orthop*. 2007 Apr-May; 27[3]:253-9. doi: 10.1097/BPO.0b013e31803433a1.
- Moon SH, Kwon SS, Park MS, Kim NT, Sung KH. Change of limb alignment in Korean children and adolescents with idiopathic genu valgum. *Medicine [Baltimore]*. 2021 Nov 12;100 [45]: e27637. doi: 10.1097/MD.00000000000027637.
- Kolbe N, Haydon F, Kolbe J, Dreher T. Single-Stage Tibial Osteotomy for Correction of Genu Varum Deformity in Children. *Children [Basel]*. 2023 Feb 14;10[2]:377. doi: 10.3390/children10020377.
- Schoenecker PL, Rich MM, Gordon JE. The Lower Extremity. In Lovell and Winter's *Pediatric Orthopaedics*, edited by Weinstein SL and Flynn JN. Ed.7. Philadelphia: Lippincott; 2014. Pp.1261- 1340.
- Kow RY, Low CL, Yusof MN. Coronal Plane Screening of Lower Limb Deformity. *Malays Orthop J*. 2022 Jul;16[2]:159-161. doi: 10.5704/MOJ.2207.024.
- Delniotis I, Leidinger B, Kyriakou A, Galanis N. Blount's disease: The importance of early diagnosis and early treatment. *Clin Case Rep*. 2019;7[7]:1454-1455. doi: 10.1002/ccr3.2214.
- Coppa V, Marinelli M, Procaccini R, Falcioni D, Farinelli L, Gigante A. Coronal plane deformity around the knee in the skeletally immature population: A review of principles of evaluation and treatment. *World J Orthop*. 2022 May 18;13 [5]: 427-443. doi: 10.5312/wjo.v13.i5.427.

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