Original Research Article

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Evaluation of correction of genu varum and genu valgum deformities by temporary hemiepiphysiodesis using an eight-plate in children

Md. Sohel Rana[1], Md. Minhaz Uddin[2], Md Golam Forhad[3], Md Mahmudul Hassan[2], Sarwar Ibne Salam[4], Quazi Shahid-Ul-Alam[5]

[1]Department of Orthopedic Specialist and Trauma Surgeon, 250 Bedded General Hospital, Joypurhat, Bangladesh, [2]Department of Orthopedic Surgery, Dhaka Medical College Hospital, Dhaka, Bangladesh, [3]Department of Paediatric Orthopedics, Dhaka Medical College Hospital, Dhaka, Bangladesh, [4]Department of Paediatric Orthopaedics, National Institute of Traumatology and Orthopaedic Rehabilitation, Dhaka, Bangladesh, [5]Department of Paediatric Orthopedics, Sir Salimullah Medical College Mitford Hospital, Dhaka, Bangladesh

Address for correspondence: Dr. Md. Sohel Rana, Department of Orthopedic Specialist and Trauma Surgeon, 250 Bedded General Hospital, Joypurhat, Bangladesh. E-mail: ranarpmc34@gmail.com

Abstract

Background: Genu varum and genu valgum are common angular deformities in children, which may affect gait, joint alignment, and long-term musculoskeletal health if left untreated. Temporary hemiepiphysiodesis using an eight-plate provides a minimally invasive method for guided correction. This study aimed to evaluate the efficacy and outcomes of eight-plate hemiepiphysiodesis in correcting these deformities.

Materials and Methods: This quasi-experimental prospective interventional study was conducted from January 2020 to December 2021 at Dhaka Medical College Hospital and selected private hospitals in Dhaka, Bangladesh. The study included 20 children with clinically and radiologically confirmed genu varum ($n = 4$) or genu valgum ($n = 16$) undergoing temporary hemiepiphysiodesis with an eight-plate. Clinical and radiographic follow-up was performed every 3 months, and implants were removed after achieving correction. Data on demographics, deformity type, side and bone involvement, radiological parameters, and outcomes were analyzed using the Statistical Package for the Social Sciences version 26.0.

Results: Mean age was 7.9 ± 3.8 years; 75% were male. In genu varum, intercondylar distance improved from 13.25 ± 2.37 cm to 8.5 ± 0.33 cm. In genu valgum, inter-malleolar distance decreased from 13.19 ± 1.60 cm to 9.44 ± 1.01 cm, with mechanical lateral distal femoral angle improving from 78.75° to 84.85° and medial proximal tibial angle from 89.25° to 88°. Overall, 95% of patients achieved satisfactory outcomes.

Conclusion: Temporary hemiepiphysiodesis using an eight-plate is a safe and effective method for correcting genu varum and genu valgum in children, enabling controlled gradual correction while preserving normal growth.

Keywords: Eight-plate, Genu valgum, Genu varum, Hemiepiphysiodesis

Introduction

Angular deformities around the knee, particularly genu varum (bow-leggedness) and genu valgum (knock-knees), are among the most frequent orthopedic abnormalities encountered in children. While physiological bowing or valgus alignment often resolves spontaneously during growth, persistent or progressive deformities beyond early childhood may alter the mechanical axis

of the lower limb, leading to abnormal gait, joint malalignment, and early degenerative changes if left uncorrected.[1,2] The evaluation and timely correction of these deformities are therefore crucial for restoring normal limb function and esthetics. Temporary hemiepiphysiodesis has emerged as a reliable, minimally invasive method for guided growth correction in skeletally immature children. The technique involves temporarily tethering one side of the physis to modulate asymmetric growth, allowing for the gradual realignment of the limb while preserving normal physeal physiology.[3,4] Compared with osteotomy, which carries risks such as infection, delayed union, and neurovascular injury, temporary hemiepiphysiodesis offers gradual correction, less morbidity, and faster recovery. Among the available guided-growth implants, the eight-plate tension-band system, introduced by Stevens, has become the most preferred device. It acts as a dynamic tension band across the convex side of the deformity, allowing for controlled correction without causing permanent arrest of the growth plate. The technique is simple, reversible, and highly effective in restoring coronal plane alignment. Once the desired correction is achieved, the plate is removed, allowing symmetrical growth to resume.[5,6] The method provides consistent outcomes and applies to both idiopathic and pathological deformities. Evaluation of correction following eight-plate guided growth relies on clinical and radiological parameters such as mechanical axis deviation, intermalleolar distance (IMD), intercondylar distance (ICD), mechanical lateral distal femoral angle (mLDFA), and medial proximal tibial angle (mMPTA). Improvement of these measurements toward normative values indicates successful correction of genu varum or genu valgum deformities.[7] Radiographic monitoring also ensures accurate timing of implant removal, preventing overcorrection or rebound deformity. Recent studies have demonstrated predictable and satisfactory results using the eight-plate system. Jamil *et al*.[2] observed significant improvements in mechanical axis alignment and limb geometry following temporary hemiepiphysiodesis. Lohith *et al*.[3] found uniform and reproducible correction rates, especially when the procedure was performed early. Park *et al*.[4] demonstrated that the eight-plate system achieved more controlled correction compared with transphyseal screws. Similarly, Tawfik *et al*.[5] and Said *et al*.[6] confirmed that guided growth using the eight-plate ensures near-complete correction while maintaining physeal integrity. A meta-analysis by Ragheb *et al*.[7] further validated the technique's reliability and reproducibility, while Heisinger *et al*.[8] described a minimally invasive modification of the procedure that produced excellent alignment and cosmetic outcomes. This study aims to evaluate the results of correction of genu varum and genu valgum deformities in children through temporary hemiepiphysiodesis using the eight-plate technique.

Materials and Methods

This quasi-experimental prospective interventional study was conducted over a period of 2 years, from January 2020 to December 2021, in the Department of Orthopaedic Surgery, Dhaka Medical College Hospital and several affiliated private hospitals in Dhaka, Bangladesh. A total of 20 pediatric patients were selected through purposive (non-randomized) sampling, following strict inclusion and exclusion criteria. Inclusion criteria comprised patients over 2 years of age with at least 2 years of growth remaining, presenting with clinically and radiologically confirmed genu varum or genu valgum deformities. Exclusion criteria included sagittal plane deformities, systemic illnesses (such as bronchial asthma, congenital heart disease, and diabetes mellitus), and physeal bars involving more than 30% of the growth plate. Temporary hemiepiphysiodesis was performed under general anesthesia using an eightplate, placed laterally for genu varum and medially for genu valgum. Early mobilization without casting, radiographic followup every 3 months, and implant removal once clinical and radiological correction is achieved. Informed written consent was obtained from parents or legal guardians, and ethical approval was granted by the Ethical Review Committee of Dhaka Medical College. Statistical analysis was performed using the Statistical Package for the Social Sciences version 26.0. Continuous variables

were expressed as mean ± standard deviation (SD) and categorical data as frequency and percentage. Pre- and post-correction values were compared using the paired t-test for continuous variables and the Z-test for proportions. A $P < 0.05$ was considered statistically significant.

Results

Among 20 patients, the mean age was 7.9 years with a standard deviation of 3.8. The majority were within the age range of 8–13 years. Among 20 patients, 15 (75%) were male and 5 (25%) were female with a male–female ratio of 3:1 [Table 1].

Out of 20 patients, 16 (80%) had genu valgum and the remaining 4 (20%) patients had genu varum [Table 2].

The right side was most commonly affected (55%), followed by both sides (30%) and the left side (15%) [Table 3].

The femur was the most commonly affected site (72%), while the tibia accounted for 28%, indicating a higher susceptibility of femoral involvement in the study population [Table 4].

Table 1: Age and sex distribution among the participants (*n*=20)

Age (years)	Male	Female	Total	Standard deviation
2–4	5	1	6	3.8
5–7	1	0	1	
8–10	3	3	6	
11–13	6	1	7	
Total	15	5	20	

Table 2: Distribution of the knee deformity/type of deformity (*n*=20)

Deformity	Frequency	%
Genu varum	4	20
Genu valgum	16	80
Total	20	100

Among 4 genu varum patients, 50% patients were rickets and 50% were idiopathic cause [Table 5].

Among 16 genu valgum patients, idiopathic genu valgum were 50%, 37.5% were post traumatic, 6.25% were obesity, and rest 6.25% were due to hypophosphatemic rickets [Table 6].

Out of 4 genu varum patients, all (100%) were satisfactory outcome. Among 4 patients, their initial ICD was 13.25 cm with a SD of 2.37 and their final ICD was 8.5 cm with a SD of 0.33. The

Table 3: Distribution of patients according to side involvement (*n*=20)

Side	Frequency	%
Right	11	55
Left	3	15
Both	6	30
Total	20	100

Table 4: Distribution of patients according to bone involvement (*n*=20)

Site	Frequency	%
Femur	23	72
Tibia	9	28
Total	32	100

Table 5: Distribution of patients according to cause [genu varum] (*n*=4)

Cause	Frequency	%
Rickets	2	50
Idiopathic	2	50
Total	4	100

Table 6: Distribution of patients according to cause [genu valgum] (*n*=16)

Cause	Frequency	%
Idiopathic	8	50
Trauma	6	37.50
Obesity	1	6.25
Hypophosphatemic rickets	1	6.25
Total	16	100

mean mLDFA values improved from 101.12° to 92.9°, suggesting adaptation of the distal femoral physis to the progressive tibial valgus. The mean mMPTA values improved from 83.88° to 87°, suggesting adaptation of the distal femoral physis to the progressive tibial valgus. The correction occurs over a period of 12 months [Table 7].

Among 16 genu valgum patients, initial IMD was 13.19 ± 1.60 cm, improving to 9.44 ± 1.01 cm at 12 months. Mean mLDFA increased from 78.75° to 84.85°, and mean mMPTA slightly improved from 89.25° to 88°, indicating distal femoral physis adaptation to progressive tibial varus. The correction occurred over 12 months. Out of 20 patients, 19 (95%) had satisfactory outcomes; one patient had a poor outcome due to infection and hardware failure [Table 8].

Radiology: Pre-operative, immediate post-operative, and 18-month post-operative follow-up os a bilateral genu varum patient.

Photograph of a genu varum patient before and after correction by temporary hemiepiphysiodesis.

The final outcome shows a high success rate, with 95% of cases achieving satisfactory results and

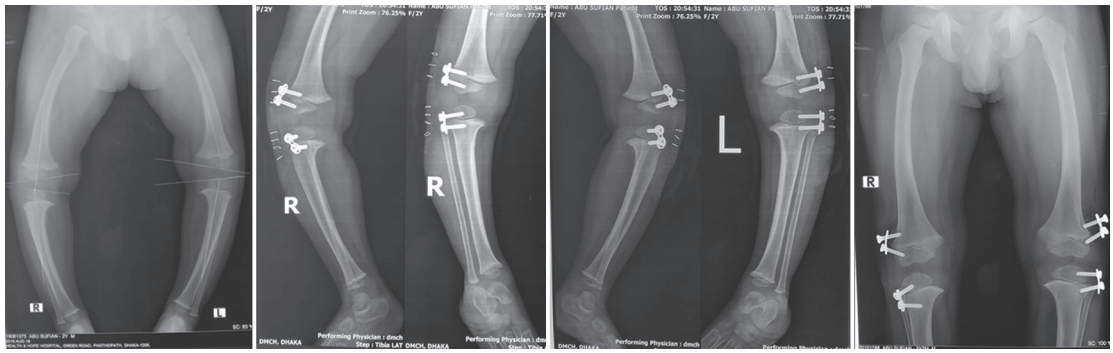

Table 7: Results of genu varum deformity correction (*n*=20)

Patient	Pre-operative					Post-operative 4th follow-up (12 months)				
	ICD	LDFAR	LDFAL	MPTAR	MPTAL	ICD	LDFAR	LDFAL	MPTAR	MPTAL
1	15	96°	97°	82°	83°	9	90°	91°	86°	86°
2	15	115°	105°	75°	78°	9	100°	96°	86°	85°
3	12	115°	87°	90°	91°	8	97°	87°	90°	91°
4	11	106°	88°	85°	87°	8	94°	88°	85°	87°
Mean	13.25	108°	94.25°	83°	84.75°	8.5	95.3°	90.5°	86.75°	87.25°
SD	2.37	9.06	8.46	6.27	5.56	0.33	4.27	4.04	2.22	2.63

ICD: Intercondylar distance, SD: Standard deviation, LDFAR: Lateral distal femoral angle right, MPTAL: Medial proximal tibial angle left

Table 8: Results of genu valgum deformity correction (*n*=20)

Patient	Pre-operative					Post-operative 4th follow-up at 12 months				
	IMD	LDFAR	LDFAL	MPTAR	MPTAL	IMD	LDFAR	LDFAL	MPTAR	MPTAL
1	12	76°	80°	89°	88°	9	84°	86°	89°	88°
2	13	68°	87°	88°	89°	11	76°	87°	88°	89°
3	12	87°	69°	89°	102°	10.5	87°	76°	89°	98°
4	11	72°	87°	88°	90°	8.5	84°	87°	89°	90°
5	15	69°	74°	88°	89°	10	84°	85°	88°	89°
6	14	87°	73°	89°	69°	9	87°	83°	89°	82°
7	16	86°	88°	100°	102°	11	87°	88°	94°	95°
8	12	71°	89°	88°	89°	9	85°	89°	88°	89°
9	14	65°	86°	90°	89°	10	80°	86°	90°	89°
10	14	67°	86°	89°	90°	11	82°	87°	89°	90°
11	16	67°	68°	90°	91°	9	82°	83°	90°	91°
12	13	87°	89°	97°	88°	8	87°	89°	91°	88°
13	14	66°	86°	90°	89°	9	81°	87°	90°	89°
14	12	67°	89°	91°	88°	9	84°	89°	91°	88°
15	12	88°	87°	68°	90°	9	88°	87°	83°	90°
16	11	70°	88°	90°	89°	8	85°	88°	90°	89°
Mean	13.19	74.6°	82.9°	89°	89.5°	9.44	83.9°	86°	89.25°	89.63°
SD	1.6	9.14	7.7	6.21	7.04	1.01	3.18	3.26	2.24	3.36

IMD: Intermalleolar distance, SD: Standard deviation

only 5% unsatisfactory, indicating overall effective management and positive prognosis in the studied population [Figure 1].

Discussion

This study evaluated the correction of genu varum and genu valgum deformities in children using temporary hemiepiphysiodesis with an eight-plate. The majority of participants were male (75%) with a mean age of 7.9 ± 3.8 years, consistent with previous studies reporting a higher prevalence of angular deformities requiring surgical intervention in boys aged 6–12 years.[9,10] Early intervention allows optimal correction potential, as younger children exhibit faster growth velocity, leading to more rapid improvement in alignment. The predominance of

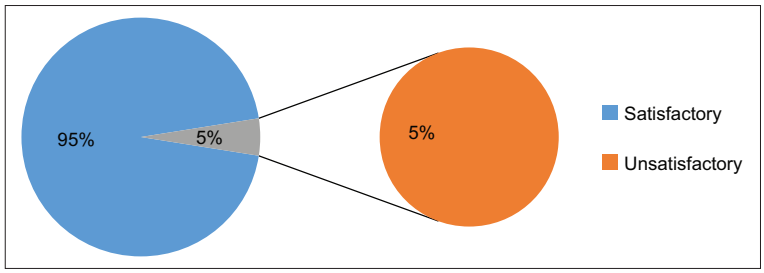

Figure 1: Pie chart showing final outcome of the patients

males could be attributed to increased physical activity and earlier clinical presentation of gait abnormalities in boys, which aligns with findings by Ballal *et al*.[9] In this study, genu valgum accounted for 80% of cases, while genu varum represented 20%, paralleling reports that valgus deformities are more common during growth due to physiological alignment changes in the coronal plane.[10,11] This observation agrees with Kaspiris *et al*.,[10] who demonstrated that genu valgum peaks between ages 3 and 9, often correcting spontaneously unless progressive or pathological. The greater number of valgus deformities in the present study may also reflect increased parental concern regarding cosmetic appearance and gait deviation. Bilateral involvement was more frequent than unilateral deformities, which corresponds with the findings of Dai *et al*.,[12] who reported symmetrical involvement in idiopathic deformities. This emphasizes the importance of evaluating both limbs, even if one appears clinically less affected. The distal femur was the most common site for eight-plate application, followed by the proximal tibia, consistent with the results of Venkataramana *et al*.,[13] who identified the distal femoral physis as the most responsive growth site for guided correction. Idiopathic etiology predominated, aligning with previous studies that identified idiopathic causes as the most common indication for guided growth.[14,15] The outcomes reinforce the versatility of eight-plate hemiepiphysiodesis in managing both idiopathic and pathological deformities, ensuring effective correction without growth arrest. In genu varum cases, ICD improved significantly from 13.25 ± 2.37 cm to 8.5 ± 0.33 cm, with corresponding improvements in mLDFA and mMPTA. These results are comparable to those reported by Burghardt and Herzenberg[16], who observed substantial correction within 12 months with minimal complications. Jelinek *et al*.[17] also reported similar outcomes, supporting the reliability of the eight-plate over traditional stapling methods. Among genu valgum patients, the IMD improved from 13.19 ± 1.60 cm to 9.44 ± 1.01 cm, while mLDFA increased from 78.75° to 84.85° and mMPTA from 89.25° to 88°. These findings are consistent with those of Joeris *et al*.[18] and Dai *et al*.,[12] who observed gradual and predictable correction without rebound in most patients. Overall, 95% of cases achieved satisfactory outcomes, and 5% showed poor results due to infection and hardware failure, comparable to the complication rates reported by Gaboura *et al*.[15] These findings reaffirm that eight-plate hemiepiphysiodesis provides an effective method for the correction of genu varum and genu valgum deformities in growing children.

Limitations of the study

The study's limitations include a small sample size, short follow-up duration, and lack of a control group, which may restrict generalization of outcomes to broader pediatric populations.

Conclusion

Eight-plate hemiepiphysiodesis provides a reliable and minimally invasive method for correcting genu varum and genu valgum in children. It allows gradual and controlled realignment of the knee, minimizes complications, and preserves normal

growth. The technique is effective for achieving functional and cosmetic improvement.

Recommendation

Early implementation of eight-plate guided growth is recommended for children with angular knee deformities. Regular follow-up is essential to monitor progress and detect complications. This approach ensures gradual, controlled correction, optimal limb alignment, and preservation of long-term joint health.

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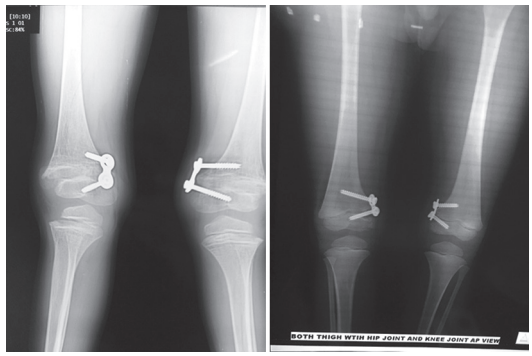
Appendix



Appendix – Post-operative X-rays after 12 months