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Treatment of pediatric genu varum by temporary hemiepiphysiodesis using 8-shaped plate

Abdalla. A.Eliwa, Adel.H.Adawy and Mohamed.A.Meselhy
Orthopedic Surgery Dept., Faculty of Medicine, Benha University
E-mail: eliwa255@gmail.com

Abstract

Background: Genu varum, a common juvenile orthopaedic disease, may cause gait problems and functional difficulties. Hemiepiphysiodesis using an 8-shaped plate is a new technique, although its clinical and radiological results need study. This research examined the clinical and radiological outcomes of hemiepiphysiodesis with 8-shaped plate for juvenile genu varum. Methods: Thirty children aged 3–15 with genu varum were investigated antegrade and retrogradely. The patients had clinical, radiological, and laboratory tests before surgery. Under general anaesthesia, patients were examined for operation time, intraoperative and postoperative problems, radiological follow-up, and hospital stay. Final follow-up was six months following surgery. Results: The research group had a mean age of 6.6 years and 43 percent females and 57 percent men. Correction was done bilaterally (7%), left (10%), and right (13%), targeting femur and tibia (50%) or femur just (10%) or tibia only (40 percent). Mean hospitalisation was 0.8 days, and average correction was 10.6 months. Surface infections (7%), LIMITED ROM (10%), and damaged screws (3%) were the only difficulties, with 80% with no issues. Rebound correlates with complications. Intercondylar distance, mechanical axis deviation, proximal tibial angle, and distal femoral angle improved significantly. Logistic regression did not find rebound or complications risk variables. Conclusions: 8-plate insertion is a successful therapy for genu varum in children, although rebound and complications must be monitored.ssary.

Keywords: Genu Varum; Pediatric Orthopedics; Hemiepiphysiodesis; 8-Shaped Plate; Clinical Outcomes; Radiological Outcomes.

1. Introduction

It It is well known that infants may bend their lower extremities till age 2. The condition is characterised by symmetrical, painless bowing, in-toeing, and tripping. Natural growth will cure this problem [1].

Physiologic genu varum is safe and self-limiting in kids under 2. The mechanical axis lies in the inner quadrant or does not intersect the knee in older children with pathologic genu varum because the knee travels laterally [2].

Braces, osteotomy, and other interventions are available. Intrusive osteotomies may induce fixation failure, physeal damage, infection, joint stiffness, compartment syndrome, neurovascular injury, over- or undercorrection, and reoccurring deformity [3].

Child genu varum correction is minimally invasive and modular with guided growth (temporary hemiepiphysiodesis). Intervention is temporary and reversible, its principal advantage. The percutaneous transphyseal screw and eight-Plate (Orthofix, Verona, Italy) replaced this procedure due to staple migration, breakage, and premature revision surgery [4]. Finding eight-Plate alternatives with comparable efficacy and lower cost. Follow-ups occur every three months. Radiographs are repeated as required. Plate removal happens when the mechanical axis is neutral or slightly lateral overcorrected [5].

Follow-ups occur every three months. Radiographs are repeated as required. Plate removal lasts 6–12 months until hardware removal when the mechanical axis is neutral or modestly overcorrected [6].

This study studied the clinical and radiological effects of 8-shaped hemiepiphysiodesis for juvenile genu varum..plate.

2. Methods

Patients:

This A prospective research examined the clinical and radiological outcomes of hemiepiphysiodesis with 8-shaped plate for juvenile genu varum.

The research comprised 30 infants who had genu varum repair at Benha University's orthopaedic department from January 2022 to January 2023. The Benha University Faculty of Medicine Orthopedic Department and Ethics Committee approved the work before it. Parents gave informed written permission, were told the study's goal, and issued a secret code number.

Both genders and children without response to conservative genu varum therapy till age 3 were included.

Age above 15, active rickets, and involvement in another clinical trial or experimental product within 30 days were exclusion criteria.

Methodology:

Collection of Data: The research included all patients who met the inclusion criteria and consented to a comprehensive history and clinical evaluation. The lower leg will also be examined for length, deformity (unilateral or bilateral), origin (tibial or femoral or both), and concomitant abnormalities such external tibial torsion.

All patients had a complete history, clinical, and lower limb exam: Check limb length, deformity (unilateral or bilateral), origin (tibial or femoral) and accompanying deformity (external tibial torsion).

Laboratory investigations: all patients will have regular hepatic, renal, complete blood picture, coagulation profile, and random blood sugar tests to rule out rickets and evaluate preoperatively.

Preoperative evaluation: CT scanogram and long film x-ray demonstrating angles and mechanical axis deviation from hips to ankles. The mechanical axis of the limb is aberrant if it crosses the knee joint outside the inner two quadrants of a six-quadrant zone. All patients had their bone ages taken to assess whether directed growth might rectify the growth.

Operative procedure: Surgery is conducted under general anaesthesia. Patient lies supine; tourniquet reduces bleeding. The target side and segment (distal femur or proximal tibia) physis level is determined by intraoperative radiograph. Palpating the anterior and posterior borders of the femur or tibia and creating a 2 cm skin incision at this area estimates the physis centre. Incised fascia lengthwise. Avoid damaging the perichondrial ring and periosteum by bluntly dissecting it.

The epiphyseal plate is put in the middle and temporarily fastened with a tiny wire or needle via a small central hole. Excellent positioning was verified by radiograph. The cortices were drilled and equipped with self-tapping titanium screws that should not cross the segment's anatomical axis. After that, wound closure is proper. Safely moved partly weight-bearing patients released. Three or four days later, the compression bandage was removed and knee mobility encouraged. Two weeks were typical for full weight-bearing.

Follow-up: Weight-bearing AP full-length radiographs and standardised AP and lateral knee radiographs were taken. ICD, MDA, MPTA, and LDFA were measured preoperatively and 3,6,9, and 12 months postoperatively.

Statistical analysis:

The Data was revised, coded, and tabulated using IBM SPSS Statistics (Version 25.0, IBM Corp., Released 2017, Armonk, NY). Normality was tested using the Shapiro-Wilk test. Data descriptive statistics comprised means, standard deviations (± SD) for numerical data and frequency/percentage estimates for non-numerical data. The Chi-Square test, Mann Whitney Test, and Repeated ANOVA were used to analyse qualitative variable relationships, non-parametric variable differences across study groups, and dependent variable measures. Logistic regression used odds ratios (OR) and 95 percent confidence intervals (CI) to estimate risk for categorical dependent variables. Significant results were determined with a p-value < 0.05 at 95%. CI.

3. Results

The In this research, 30 children with genu varum had 8 plate implantation. They averaged 6.6 years old. The gender split was 43% female and 57% male. The mean BMI was 21.27 kg/m2. The side of correction was 7 percent bilateral, 10 percent left, and 13 percent right. 50% of individuals received femur and tibia correction, 10% had femur correction, and 40% had tibia correction. Mean hospitalisation was 0.8 days (0-2 days) and mean deformity correction duration was 10.6 months.

Mean plate removal time was 12.57 months. 7 percent had superficial infections, 10 percent LIMITED ROM, 3 percent damaged screws, and 80 percent had no complications.tions. **Table 1**

Table (1) Outcome of the studied subjects

		Total subjects n=30
Time to remove plates, month	M±SD (12.67±1.58)	Range (9-15)
Correction success rate, n (%)	Distal femur	3(100%)
	Proximal tibia	11(91.7%)
	Both	14(93.3%)
	Total	28(93%)
Complications	Superficial infections	2(7%)
	LIMITED ROM	3(10%)
	Broken screws	1(3%)
	No complications	24(80%)

Rebound phenomenon, n (%)	1(3%)

The studied parameters were compared according to rebound phenomenon, a significant p value detected when we compared rebound and non-rebound cases according to complications. All rebound cases (n=1) were associated with complications while 13.8% of non rebound cases were associated with complications. No significant difference between the studied groups in other parameters. **Table 2**

Table (2) Differences in studied parameters according to rebound phenomenon

	Non Rebound n=29	Rebound n=1	Test	p
Age	6.6±3.46	3	Z=0.283	0.985
BMI	21.35±1.61	19	Z=1.144	0.253
Side				
Bilateral	22(78.5%)	1(100%)	X2=0.315	0.854
Left	3(10.7%)	0(0%)		
Right	3(10.7%)	0(0%)		
Correction implementation site				
Both	15(53.5%)	0(0%)	X2=1.552	0.460
Femur	2(7.1%)	0(0%)		
Tibia	11(39.2%)	1(100%)		
Time of removal	6.6±3.46	1.61	Z=0.535	0.865
Hospital stay	6.6±3.46	1	Z=0.629	0.254
Correction success rate				
Inproperly corrected	2(7.1%)	0(0%)	X2=0.074	0.786
Corrected successfully	26(92.8%)	1(100%)		
Complication				
No complications	25(87.2%)	0(0%)	X2=4.138	0.042*
With complications	4(13.8%)	1(100%)		
Correction time	6.6±3.46	13	Z=0.556	0.259

Z= Mann Whitney, X^2=Chi-Square, * Significant p value <0.05,

The metrics were compared by complications. Significant variations were found in deformity side, 8 plates implementation location, and rebound phenomena between complex and non-complicated participants. Non-complex group had 88% bilateral deformity, complicated group 33.3% right and left deformity. 17 percent of difficult cases experienced rebound phenomena, compared to none in non-complicated cases. Table 3

Table (3) Differences in studied parameters according to complications

	No complications n=24	Complication n=6	Test	p
Age	6.12±2.33	9±6.78	Z=0.729	0.466
BMI	21.36±1.65	20.8±1.48	Z=0.624	0.533
Side				
Bilateral	21(88%)	2(33.3%)	X2=8.170	0.017
Left	1(4%)	2(33.3%)		
Right	2(8%)	2(33.3%)		
Correction implementation site				
Both	14(60%)	1(17%)	X2=18.00	0.001
Femur	0(0%)	3(50%)		
Tibia	10(40%)	2(33%)		
Time of removal	6.6±3.46	11.2±1.64	Z=1.936	0.054
Hospital stay	6.6±3.46	1.2±0.44	Z=1.402	0.161
Correction success rate				
Inproperly corrected	1(4%)	0(0%)	X2=0.429	0.513
Corrected successfully	23(96%)	6(100%)		
Rebound phenomenon				
Non rebound	24(100%)	5(83%)	X2=4.138	0.042
Rebound	0(0%)	1(17%)		

Correction time	6.6±3.46	12.4±1.81	Z=1.376	0.169

Z= Mann Whitney, X^2=Chi-Square, * Significant p value <0.05

A significant p value (<0.001*) was seen in ICD after adjustment at 0, 3, 6, 9, 12, and 15 months. The mean measurement at the start was 10.3 cm and 0.78 cm at the end. Figure 1

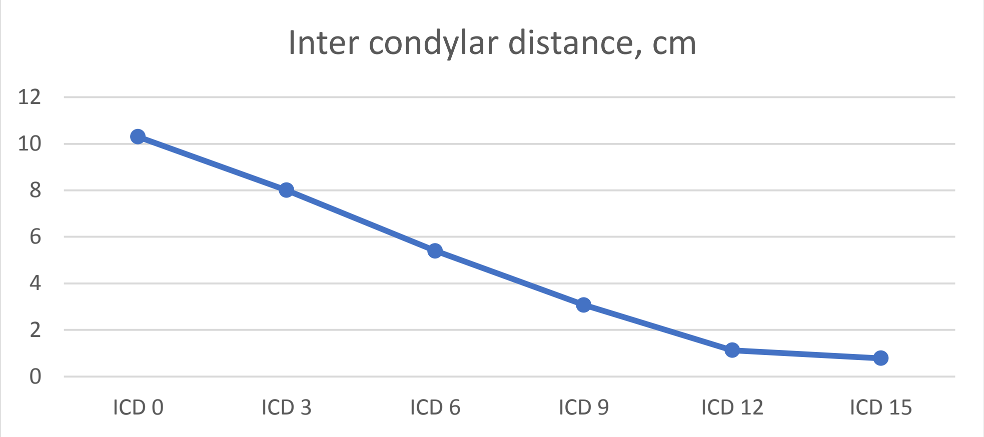

Fig. (1) ICD measurement throughout study time

Mechanical axis deviation on right side adjusted genu varum demonstrated statistically significant difference across repeated ANOVA experiments. Left side corrected genu varum exhibited significant ANOVA difference between repeated readings. Table 4 and Figure 2

Table (4) MAD right side and MAD left side serial measurements throughout study time

MAD at right side	M±SD	Range	Test Repeated ANOVA	p
Base	2.87±0.5	1-3	335.217	<0.001*
3 months	2.87±0.5	1-3		
6 months	1.94±0.25	1-2		
9 months	1.94±0.25	1-2		
12 months	1±0	1-1		
15 months	0.68±0.48	0-1		
MAD at left side				
Base	2.81±0.6	1-3	426.621	<0.001*
3 months	2.81±0.6	1-3		
6 months	1.9±0.3	1-2		
9 months	1.9±0.3	1-2		
12 months	1±0	1-1		
15 months	0.52±0.51	0-1		

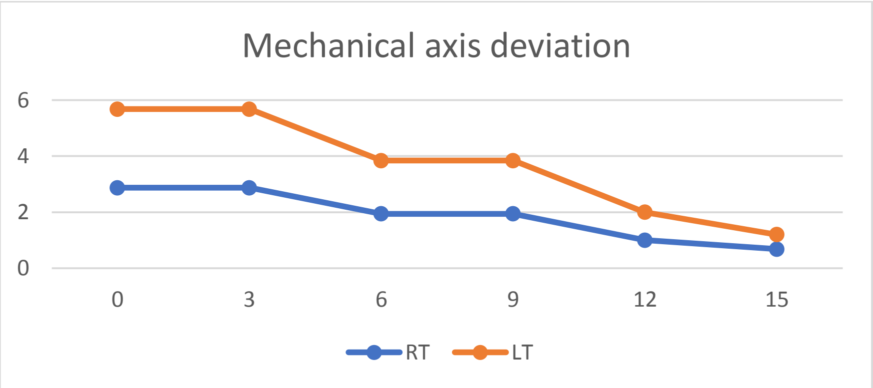

Fig. (2) Right and left MAD measurements throughout study time

Lateral distant femur angle repeated measurements showed a significant p value when assessed at 0,3,6,9,12 and 15 months in both right and left sides. **Figure 2**

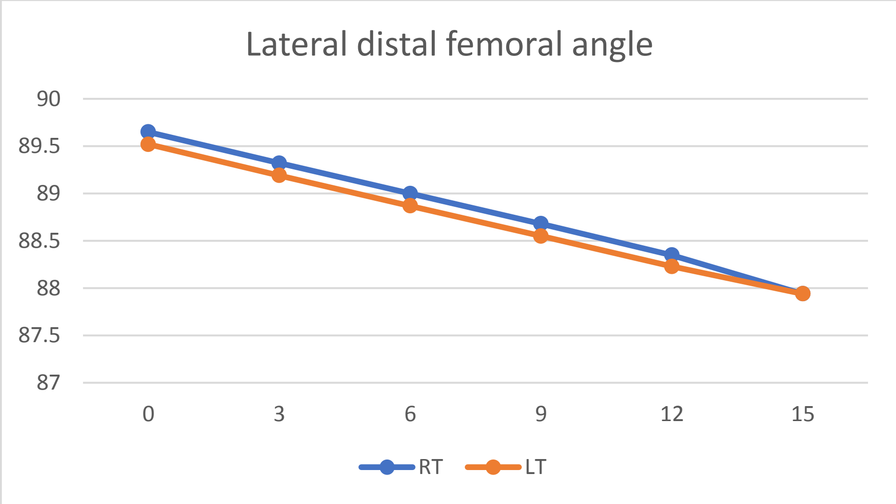

Fig. (2) LDFA serial measurements throughout study time

Medial proximal tibial angle repeated measurements showed a significant p value when assessed at 0,3,6,9,12 and 15 months in both right and left sides. **Figure 3**

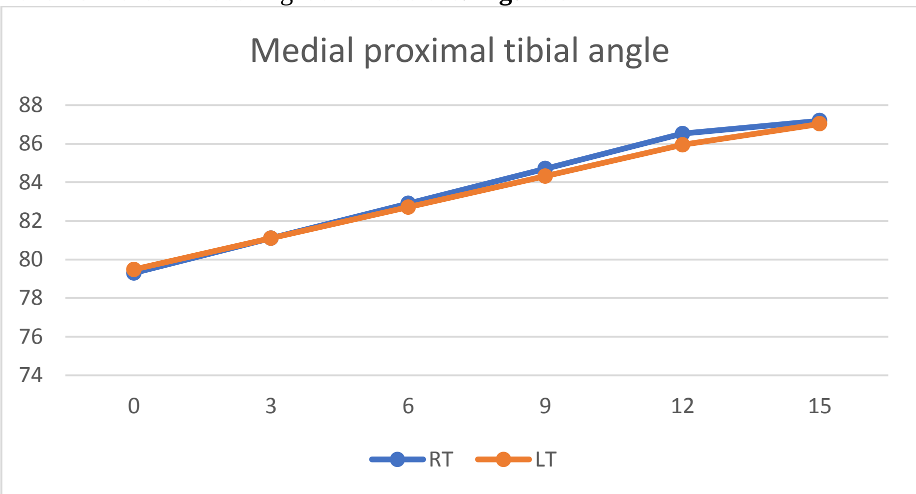

Fig. (3) MPTA serial measurements throughout study time

Logistic regression analysis was conducted for the prediction of rebound phenomenon using age, BMI, Correction side, plates time of removal, hospital stay and correction time. All parameters used in regression analysis were not shown as a significant risk factor for rebound phenomenon. **Table 5**

Table (5) Logistic regression analysis for prediction of rebound phenomenon

	B	CI	p
Age	1.009	0.655-1.554	0.966
BMI	2.089	0.543-8.029	0.283
Side (Right)	0.136	0.006-2.802	0.196
Time of removal	1.077	0.428-2.707	0.875
Hospital stay	0.717	0.121-4.24	0.714
Correction time	0.831	0.482-1.428	0.502

OR: odds ratio; CI: confidence interval, *: Significant ≤0.05.

Logistic regression analysis was conducted for the prediction of complications using age, BMI, Correction side, plates time of removal, hospital stay and correction time. Left deformity side and time of plates removal were associated with the risk of complications in univariate analysis. **Table 6**

Table (6) Logistic regression analysis for prediction of complications

	B	CI	p

Age	0.815	0.619-1.072	0.143
BMI	0.271	0.026-2.777	0.271
Side (Left)	0.23	0.001-0.518	0.018
Time of removal	2.582	1.019-6.542	0.046
Hospital stay	0.468	0.135-1.622	0.231
Correction time	0.753	0.50-1.120	0.161

OR: odds ratio; CI: confidence interval, *: Significant ≤0.05.

4. Discussion

Hemi-Epiphysiodesis treats paediatric genu varum surgically. It partially stops development on one side of the growth plate to rectify the malformation on the other. Staplers, screws, and plates may be used for hemi-epiphysiodesis. Newer implants for this technique include the 8-shaped plate. The 8-shaped plate implant treatment for paediatric genu varum is new and successful. The implant presses on the growth plate to halt development and repair the abnormality.

The present research corrected 30 genu varum youngsters with 8 plates. They averaged 6.6 years old. The gender split was 43% female and 57% male. The mean BMI was 21.27 kg/m2. The side of correction was 7 percent bilateral, 10 percent left, and 13 percent right. 50% of individuals received femur and tibia correction, 10% had femur correction, and 40% had tibia correction.

A retrospective research by Dai et al. found a mean age of 4.69 years and a comparable gender distribution in 66 genu varum patients who had 8 plate implantation [7]. Another systematic study by Rodrigues et al. found a mean age of 7.2 years in 6830 papers, supporting your results [8].

Park et al. treated 20 genu varum patients with 39 physes (24 distal femoral, 15 proximal tibial) using 8-shaped plate hemi-epiphysiodesis. The mean patient age was 9.5 years, with 24 females and 22 men. The 8-shaped plate corrected genu varum deformity with a mean correction angle of 7.2 degrees. Complications included two implant breakages and one delayed union. Hemi-epiphysiodesis with an 8-shaped plate is safe and effective for genu varum, however implant breakage is infrequent [9].

The present hospital research included 0.8 days of hospitalisation from zero to 2 days and 10.6 months of deformity repair.

According to Gyr et al., patients who had hemi-epiphyseal stapling for genu varum correction had a mean hospital stay of 3.8 days, greater than the present research. The research indicated a mean correction time of 12.4 months, somewhat longer than the present study [10].

Mean plate removal time was 12.57 months. Outcomes included 7 percent superficial infections, 10 percent LIMITED ROM, 3 percent damaged screws, and 80 percent no sequelae.

Wiemann et al. found that 8-plate implantation patients had a mean correction time of 7.8 months and a mean hospital stay of 1.2 days [11]. In contrast, the present research found a longer mean correction time of 10.6 months and a shorter mean hospital stay of 0.8 days.

Dai et al. found a 12% complication rate in 8-plate implantation patients, with implant migration and failure being the most prevalent [7]. In contrast, the present research found a 20% total complication rate, with superficial infections and reduced range of motion being the most prevalent.

A significant p value was found when we compared rebound and non-rebound patients by complications in this research. All rebound instances (n=1) had difficulties, whereas 13.8% of non-rebound patients did. No significant differences between groups in other metrics.

Hemi-epiphysiodesis with 8 plates for genu varum correction might cause rebound. Stevens et al. found rebound in 10% of patients, which was related with deformity recurrence and revision surgery [12].

One rebound instance was identified in this investigation, which is minimal compared to the literature. However, this solitary instance had difficulties, supporting Stevens et alresults .'s on rebound and recurrence/complications.

In other problems, Stevens et al. (2007) reported more superficial infections than the present study (7%) did (16 percent). However, the present research found 10% restricted range of motion, which is greater than Stevens et al (4 percent). Differences in patient groups, surgical procedures, and follow-up durations may explain these incidence rates [12].

Park et al. (2016) discovered that deformity location greatly impacts complications. They found that tibial varus deformity patients had more problems than femoral varus individuals. According to the present research, complex cases had a greater rate of tibial varus deformity (66.7%) than non-complicated cases (12%) [13].

Park et al. (2017) found more difficulties when 8 plates were placed in the tibia than the femur [9].

The present investigation also identified a strong association between rebound and problems. Zajonz et al. found that rebound phenomenon patients had more problems than non-rebound individuals [14].

After rectification, Vaishya et al. found a considerable decrease in mechanical axis deviation and intercondylar distance, which lasted up to 2 years [15]. Also, Schagemann et al. found substantial improvements in mechanical axis deviation and intercondylar distance following 8 plate implantation for genu varum correction in 44 patients [16].

Both right and left lateral distant femur angle repeated assessments at 0,3,6,9,12, and 15 months indicated a significant p value. Both right and left medial proximal tibial angle repeated assessments at 0,3,6,9,12, and 15 months revealed a significant p value.

Like the present research, Ghaznavi et al. found that 8-plate correction improved the lateral remote femur angle and medial proximal tibial angle in 109 skeletally immature patients (212 physes) with genu varum. The angles improved significantly after 3, 6, and 12 months following surgery, with no significant differences between the right and left sides [17].

The current research used logistic regression analysis to predict rebound utilising age, BMI, Correction side, plate removal time, hospital stay, and correction time. All regression parameters were not rebound risk factors.

Park et al. discovered that rebound phenomena following genu varum correction surgery was associated with younger age and bigger preoperative mechanical axis deviation [13]. Another research by Ulusaloglu et al. indicated that rebound risk increased with longer corrective time and higher preoperative medial proximal tibial angle [18].

Similar to the present investigation, Ko et al. found no significant rebound phenomenon risk factors [19].

The present study used logistic regression analysis to predict problems using age, BMI, corrective side, plate removal time, hospital stay, and correction time. In univariate analysis, left deformity side and plate removal time were linked with problems.

Lee et al. (2020) found that age, BMI, and amount of correction were independent risk factors for problems [20]. In another research, Park et al. (2016) examined genu varum corrective osteotomy problems. They employed logistic regression using age, sex, BMI, deformity angle, and correction extent as predictors. BMI (OR=1.27, p=0.025) and amount of correction (OR=1.06, p=0.011) were independent risk factors for problems. [13].

5. Conclusion

The 8-plate insertion improves intercondylar distance, lateral distant femur angle, and medial proximal tibial angle in juvenile genu varum therapy. Bilateral deformities have less consequences than right/left deformities, however rebound phenomena does. Left-side deformity and plate removal timing enhance complications.sks.

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