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ORIGINAL ARTICLE

Correction of Genu Valgum Deformity by Temporary Hemiepiphysiodesis Using 8-Plate: Is It a Good Option for Genu Valgum Deformity Correction?

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ABSTRACT

Background: The rationale behind temporary hemiepiphysiodesis is to tether growth on the convex side of the deformity to allow the concave side of the physis to continue growing, leading to deformity correction. Tension band plating in the form of an 8-plate had been introduced by Stevens in 2007 to allow for temporary hemiepiphysiodesis. It is an easy, minimally invasive procedure that allows for early weight-bearing.

Methods: This study included 38 patients. The genu-valgum deformity was bilateral in 24 patients (a total of 62 knees). The patients were 25 females (65.8%) and 13 males (34.2%). The cause of deformity was idiopathic in 29 patients (76.3%), post-traumatic in 5 patients (13%), and chronic renal failure in 4 patients (10.7%). Mechanical axis deviation (MAD), lateral distal femoral angle (LDFA), and medial proximal tibial angle (MPTA) were recorded for all patients at presentation and on follow up for monitoring of deformity correction.

Result : MAD corrected from lateral to medial from 34.3±14.3 mm to 7.9±5.3 mm. LDFA corrected from 77.9±3.18° to 90.5±2.55°. This was found to be statistically significant (p-value <0.001). MPTA was corrected from 91.2±3.64° to 88.7±1.56°. This was found to be statistically insignificant (p value = 0.34).

Conclusion : The procedure is a minimally invasive approach with easy application and extraction. The procedure allows continued growth after plate removal and early postoperative mobilization.

Key Words: Genu valgum; hemiepiphysiodesis; 8-plate; mechanical axis deviation.

INTRODUCTION

The angular alignment of the lower extremities passes through different changes of normal variations, starting as a varus angulation of about 15 degrees that gradually changes to a valgus at 2 years, reaching a normal degree of alignment at 6-7 degrees valgus at the age of 5-6 years. [1-3] Pathological valgus alignment of the lower extremities in childhood has different etiologies, including trauma, dysplasia, metabolic, inflammatory, endocrine, neoplastic, developmental, and idiopathic. [4–7]

Patellar maltracking, overload of the lateral compartment of the knee, medial collateral ligament stress, pathological gait, and activity related pain may result from valgus deformity of the lower extremity. [8] There is a high tendency for progression in severe angular malalignment according to the Hueter-Volkman law, stating that growth is delayed when mechanical loading is increased and vice versa. [9] Genu valgum can be corrected surgically in an acute manner using osteotomies or in a gradual way using an extensor fixator or guided growth. [10] The gold standard method for the treatment of severe angular deformities is corrective osteotomies. However, it is a major surgery that has significant complications such as compartment syndrome, injury to the neurovascular bundle, inaccurate correction, and delayed or non-union. [1]

Guided growth can be achieved either temporarily or permanently by tethering one side of the physis, allowing for differential growth. [12] Guided growth using an 8-plate, first described by Stevens (2007), uses a non-locked plate with two screws to achieve temporary hemiepiphysiodesis. Using this technique avoids the drawbacks of using staples, such as implant failure, extrusion, and permanent closure of the physis. [13] The aim of the study is to evaluate the 8-plate as a tool for temporary hemiepiphysiodesis in patients with genu-valgum

deformity and report on its effectiveness and complications.

METHODS

Thirty-eight patients with genu valgum deformity (a total of 62 knees) underwent gradual correction using an 8-plate as a tool for temporary epiphysiodesis. Patients with genu valgum deformities without associated axial, sagittal, or intraarticular pathology were included. Patients with intra-articular pathology, a partially closed epiphyseal plate, or concomitant deformities in the axial and/or sagittal planes were excluded. Written informed consent was obtained from all participants, and the study was approved by the research ethics committee of the Faculty of Medicine, Zagazig University. The study was done according to the Code of Ethics of the World Medical Association (Declaration of Helsinki) for studies involving humans.

Patients were 13 males (34.2%) and 25 females (65.8%). The mean age and standard deviation of the patients were 10.2 ± 1.6 years (ranging from 8 years and 7 months to 11 years and 10 months). The deformity was bilateral in 24 patients (63.2%) and unilateral in 14 patients (36.8%) for a total of 62 knees. The etiology of deformity was idiopathic in 29 patients (76.3%), post-traumatic in 5 patients (13%) and chronic renal failure in 4 patients (10.7%).

The child was observed walking, with attention paid to his gait pattern, angular and rotational deformities of the knees. The degree of genu valgum is measured with a goniometer with the knees extended and the patellae facing forward. Intermalleolar distance (the distance between the ankles) is measured. Assessment of medial ligament laxity is important, especially in long-standing cases. Erect long-standing anteroposterior radiographs of the entire lower extremity were obtained (A-P scanogram) for best judgement and planning for the deformity before surgery, during follow-up, and after plate removal.

Angular deformities on the radiographs were evaluated by measuring the mechanical axis deviation (MAD), lateral distal femoral angle (LDFA), and medial proximal tibial angle (MPTA) of the affected side. MAD is the perpendicular distance from the mechanical axis line of the lower limb (from the center of the femoral head to the center of the ankle plafond) to the center of the knee joint line. The normal mechanical axis line passes 8±7 mm (1–15 mm) medially to the center of the knee joint line. So, if the mechanical axis passes lateral to the center of the knee joint, it is considered genu valgum. [14] The normal LDFA range is (85–90) degrees, if the LDFA is outside this normal range, the femur is contributing to the MAD. The normal MPTA range is (85–90) degrees, if the MPTA is outside this normal range, the tibia is contributing to the MAD. [14]

Surgical technique:

General anesthesia was given to all patients. Patients were placed supine on a radio-translucent table, and a thigh tourniquet was applied. The operated knee is put in 30 degrees of flexion, then the physis is determined under image guidance, and a guide wire (K-wire 1.6mm) is inserted along the line of the physis. The perfect position of the wire is confirmed radiologically in AP and lateral views. The incision was made medially over the femoral condyle for about 3–5 cm in length. The dissection was done down to the periosteum, which must be kept intact, then the plate is threaded along the K-wire to be held in place, and two guide wires are inserted in the holes of the 8-plate proximal and distal to the physis. A cannulated drill bit (3.2 mm) is used to drill the screw holes along the guide wires, and then the 8-plate is secured to the bone with two small, cannulated screws. The wound is closed after the removal of guide wires using absorbable sutures. Then, the wound was covered with a small op-site dressing and a bandage only.

Follow up: No cast or back slab were applied after surgery, only a simple bandage. I.V. antibiotics are given for 48 hours after surgery. Full weight-bearing was started as soon as possible after surgery, usually on the second or third day. All patients came in 2 weeks post-operatively to check the wound and have an X-ray taken to check the position of the plate and screws. Gait had to be checked for any problems. Then, 3–6 months of follow-up were recommended for the clinical assessment of deformity correction. Once the deformity was corrected clinically, an A-P scanogram for the lower limb was requested for radiological assessment of deformity correction.

STATISTICAL ANALYSIS

The results were presented as mean ± standard deviation. Comparisons between measures of multiple values (preoperative and one year after surgery) were done. All statistical analyses were performed with SPSS version 24.0, and $p < 0.05$ was considered statistically significant.

RESULTS

All patients were available for follow-up. Patients were followed up for 2 years postoperatively. The average correction time was 17.2 ± 3.4 months (range 14–22 months). Operative time was 30–50 minutes with minimal blood loss. Figures 1 and 2 illustrate cases before and after correction.

Mechanical axis deviation MAD was corrected from (mean ± SD) 34.3 ± 14.3 mm to 7.9 ± 5.3 mm. This was found to be statistically significant. The p-value is 0.0001. The LDFA was corrected from (mean ± SD) 77.9 ± 3.18 degrees to 90.5 ± 2.55 degrees. This was found to be statistically

significant. The p-value is 0.005.MPTA was corrected from (mean ± SD) 91.2 ± 3.64 degrees to 88.7 ± 1.56 degrees. This was found to be statistically insignificant. A p-value of 0.34 was detected (Table 1). The complications were rare; they included superficial wound infection in 4 patients and knee effusion in 3 patients.

Table 1: Radiological parameters corrections

	Before correction	After correction	p-value
MAD	34.3 ± 14.3	7.9 ± 5.3	<0.001*
LDFA	77.9 ± 3.18	90.5 ± 2.55	<0.001*
MPTA	91.2 ± 3.64	88.7 ± 1.56	0.34

*MAD: mechanical axis deviation; LDFA: lateral distal femoral angle; MPTA: medial proximal tibial angle. *: Significant.*

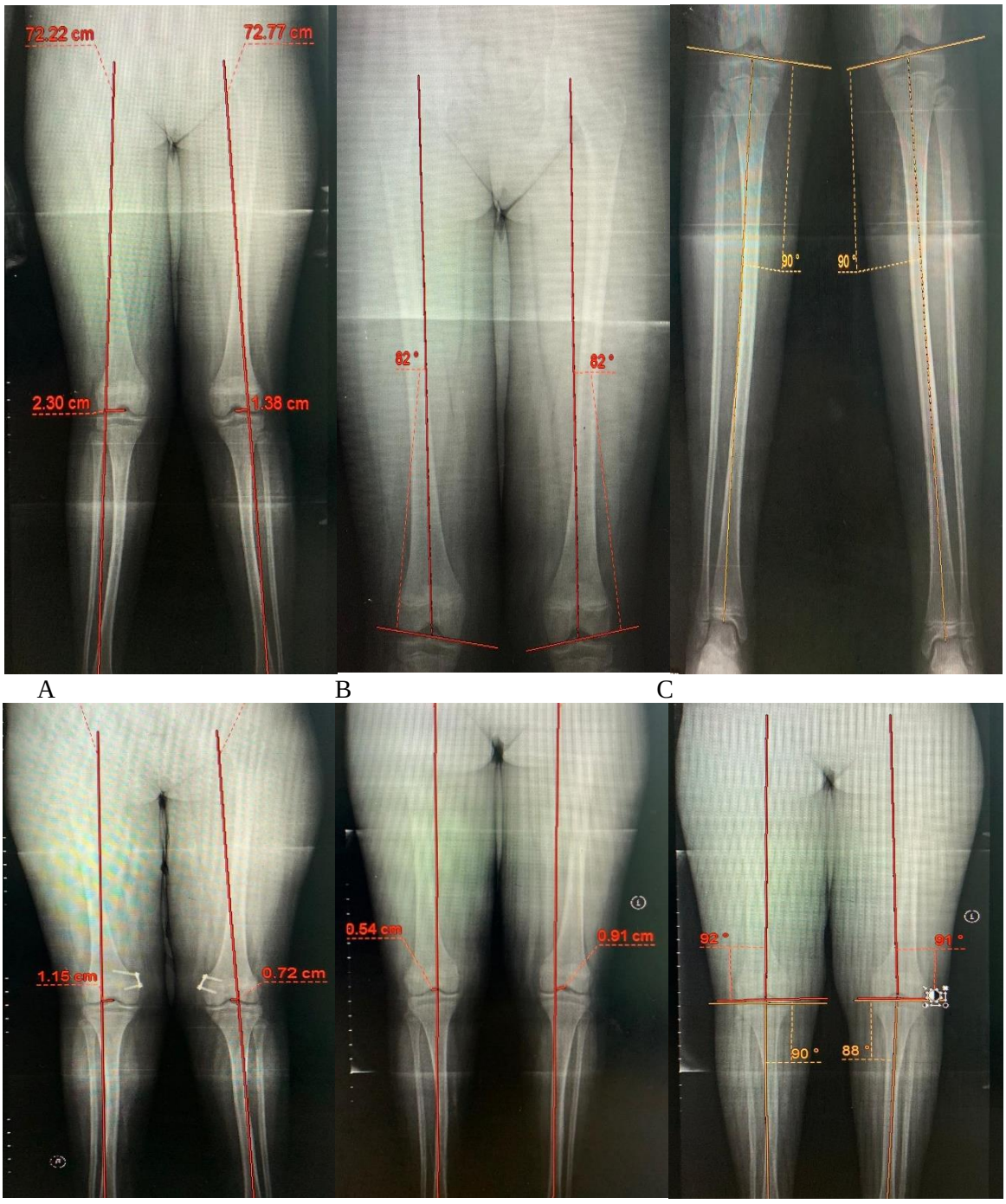
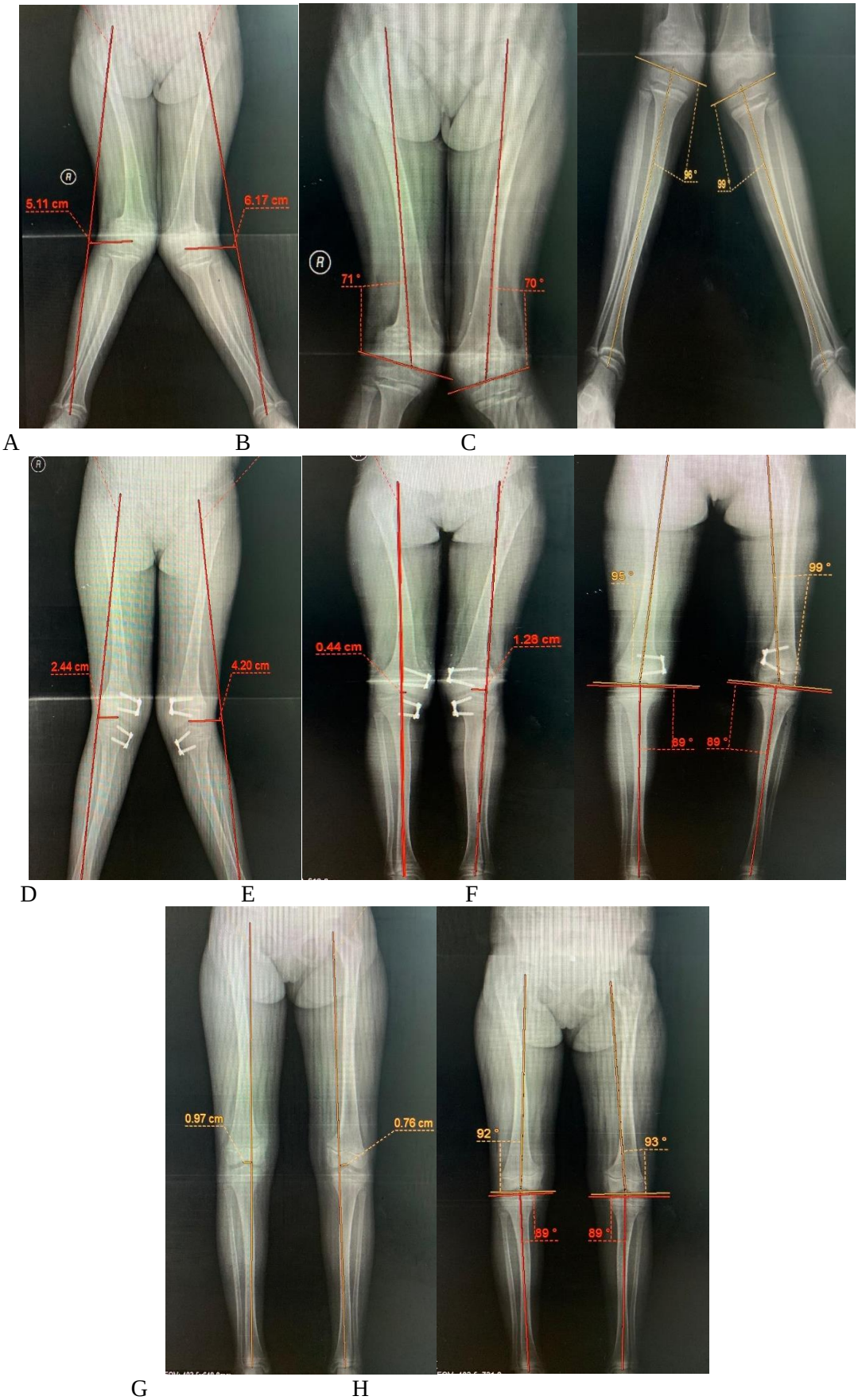


Figure 1: (A, B, C) Male patient with idiopathic bilateral genu valgum of femoral origin, MAD of 2.3 and 1.38 cm, LDFA of 82 degrees bilaterally. (D) Correction with bilateral 8- plate. (**E**) Correction of MAD to 0.54 and 0.91 cm (F) Correction of LDFA to 92 and 91 degrees.



A B C

D E F

G H

Figure 2: (A, B, C) Male patient with chronic renal failure, MAD of 5.11 and 6.17 cm, LDFA of 71 and 70 degrees, MPTA of 96 and 99 degrees. (**D, E**) Correction by bilateral femoral and tibial 8 plates (**F**) After removal of tibial plates (**G, H**) Final correction with MAD 0.97 and 0.76 CM**,** LDFA 92 and 93 degrees, MTPA 89 degrees bilaterally.

DISCUSSION

Immediate correction techniques are associated with frequent and sometimes severe complications, including injury to the neurovascular bundle, compartment syndrome, infection, growth-plate injury, improper correction, and deformity recurrence. [15, 16] Gradual correction with external fixation has some disadvantages, such as delayed healing, patient intolerance, and pin-site complications. [17] **Stevens** introduced a 2-screw-and-2-hole-plate system (8-Plate) for temporary hemiepiphysiodesis with many advantages over staples. The eight-plate holds one side of the growth plate, leaving the opposite side of the physis to continue growth, the screws diverge within the plate, effectively serving as a hinge. This hinge action also prevents compression of the growth plate that is being guided. The chances of the plate or screws bending or breaking under the forces of bone growth are virtually eliminated because of plate and screw flexibility. [13]

This study aims to assess the 8-plate as a tool for temporary hemiepiphysiodesis and report on its effectiveness and complications. With the following results, MAD was corrected from (mean ± SD) 34.3 ± 14.3 mm to 7.9 ± 5.3 mm. The p-value is 0.0001. LDFA was corrected from (mean ± SD) 77.9 ± 3.18 degrees to 90.5 ± 2.55 degrees. The p-value is 0.005. MPTA was corrected from (mean ± SD) 91.2 ± 3.64 degrees to 88.7 ± 1.56 degrees. The p-value is 0.34.

Stevens reported the results of 34 patients (65 knee deformities), average age 10.5 years, range of follow-up 14–26 months. The preoperative deformities of the femur and tibia ranged from 7 to 30 degrees as measured by the LDFA and the MTPA. Except for 2 patients with adolescent Blount disease, all patients corrected their deformities, neutralizing the mechanical axis while preserving a horizontal knee to within 3 degrees on a standing AP radiograph, and had their plates removed at a mean of 11 months after implantation. [13] **Burghardt et al.** studied 8-plate in 39 genu valgum and 4 genu varum patients (a total of 54 physes and 51 limbs). The average age was 10.2 years. They reported a correction of LDFA by 10 degrees (range 1–18) and a correction of MPTA by 7.78 degrees (range 0–14) [18]. **Guzman et al.** reported the results of 25 patients (47 legs) with idiopathic genu valgum, average age 12.5 years (range 10–16 years) and follow up for 12.3 months. They reported a preoperative LDFA of 78.7 (range 74–84) that corrected to 83.7 (range 75–91) degrees. Tibiofemoral angle corrected from 11.2 to 6 degrees. [19]

Oner et al. reported significant differences in MAD, MPTA, LDFA, and TFA values before and after surgery in both groups of genu valgum and genu varum patients. A neutral mechanical axis was achieved in 9 deformities (81.8%) in the genu varum group and in 31 deformities (79.5%) in the genu valgum group. In terms of treatment efficiency, no significant differences were found in radiographic values between the two groups. [20]

Zajonz et al. reported results on 134 patients with a total of 198 plates. They reported a correction of LDFA by 7±7.2 degrees. The correction of the MPTA by 4±6.02 degrees and the tibiofemoral angle by 9±2.7 degrees. [21]

In our study, age at the time of correction was 10.2±1.6 years. This was comparable to Stevens' [13] average of 10.5 years, Burghardt et al.'s [18] average of 10.2 years. But age was less than Guzman et al.'s [19] average of 12.5 years. It has been noticed that more correction can be achieved if it is started at a younger age. Reported complications in the literature are few, including rebound deformity [13, 19, 21], revision of fixation [13], plate and screw migration [22], superficial or deep infection [13, 23], and mild knee effusion [23].

The correction of all parameters of angular deformities, including MAD, LDFA, MPTA, and tibiofemoral angle TFA, in all these studies is consistent with the results obtained in our study. Our study has some limitations, including the small number of patients, the absence of a control group, and the lack of long-term follow-up.

CONCLUSIONS

Guided growth by temporary epiphysiodesis is the procedure of choice for the correction of angular deformities around the knee. An 8-plate provides an excellent tool for correction of the genu valgum deformity of the knee with a minimally invasive approach, easy application and extraction, continued growth after plate removal, and early postoperative mobilization.

Conflicts of interest :no conflicts of interest.

Financial Disclosures : Non

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