Case Report:

Growth Modulation With Reconstruction Plate for Genu Valgum Deformity in Twins: A Case Report and Literature Review

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ABSTRACT

Genu valgum is an angular deformity caused by several reasons, such as congenital syndromes, post-traumatic bone dysplasia, or an idiopathic form. It generates cosmetic problems, difficulties in function, and pain. Manipulating the growth plate by hemiepiphysiodesis with implants helps to achieve the correct alignment.

We presented twin girls diagnosed with genu valgum deformity who were suffering from cosmetic problems and pain. We used growth modulation to temporarily arrest the growth plate. This procedure was followed by photographs and after 8 months, the implants were removed without having overcorrection. A brief literature review was also performed concerning the reported cases in the international databases, such as PubMed and Google Scholar on growth modulation for genu valgum deformity in twins.

Twin girls with genu valgum deformities underwent hemiepiphysiodesis surgeries. We used reconstruction plates and 3.5 mm non-cannulated screws to fix both the distal femur and proximal tibia to temporarily arrest the growth plate. When we achieved the correct alignment the devices were removed.

1. Introduction

Genu valgum is a coronal angular deformity of the knee, i.e., frequent in the pediatric group (1-4). Coronal deformities cause cosmetic problems, pain, functional difficulties in gait patterns, and soft tissue changes (4, 5). Genu valgum reasons vary from an idiopathic form and post-traumatic to congenital syndromes and bone dysplasia, like arthrogryposis/vitamin D resistance rickets, and so on (1, 6, 7). Many of these deformities are physiological and could spontaneously subside without interventions. When not improved by age, surgical interventions either by osteotomy and internal fixation or correction by external fixator or growth modulation are recommended (1, 2, 8). Growth modulation manipulates the growth plate to correct the limb alignment (9). There exist different techniques for the gradual correction of lower limb deformities. One of them is temporary hemiepiphysiodesis; it is de-

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fined as arrest in one side of the growth plate to correct alignment and cause secondary angular modifications (2, 4). Temporary hemiepiphysiodesis is an effective and accepted method for children. It is performed in genu valgum deformities using various devices, such as tension band plates, reconstruction plates, staples, and so on. It requires removal without damaging the physis after ensuring that the correction has been attained (1, 9, 10, 11).

This study aimed to report the case of twin girls with genu valgum. We also reported the result of the provided intervention by growth modulation with reconstruction plates and non-cannulated screws.

2. Case report

Eight-year and 3-month-old homozygote twin girls with 135 cm height that weighed 38 kg, with the Body Mass Index (BMI) of 20.85 kg/m^2 were presented with bilateral genu valgum deformities. They demonstrated some problems, such as cosmetic issues and walking-induced pain because of knee contact. Their last hospitalization was two years ago due to tonsillectomy. They reported no history of trauma; however, their family history was positive for genu valgum deformity. Their paternal grandmother also had genu valgum. In their physical examinations, bilateral genu valgum was revealed and other characteristics were healthy. Both cases had a full range of motion and there was no instability and ligament laxity. Both knees of both patients were stable to stress tests and neurovascular examination results were normal. There was no history of pharmacotherapy and metabolic diseases. We measured the mechanical femoral axis and mechanical tibial axis in Hip-Knee-Ankle (HKA) standing radiographic view in both legs of the studied patients. They indicated 8 degrees bilateral genu valgum deformities without previous surgical interventions.

Under general anesthesia, the tourniquet was applied. With a medial midline incision over the right knee, without periosteal exposure; a three-hole reconstruction plate was implanted on the medial aspect of the distal femur under C-arm radiographic control. Then, we implanted two non-cannulated screws; one proximal and one distal to the physis. We also implanted a four-hole reconstruction plate on the medial proximal tibia under C-arm radiographic control. We placed one screw proximal to the physis and two screws distal to the physis. Checking under C-arm radiographic was appropriate (Figures 1 and 2).

The same procedures were conducted for the left knee of both subjects (distal femur and proximal tibia). Every 2 months, we controlled x-rays for plates and screws position and possible screws breakage or pull-out. The standing photographs of the reported twins were obtained monthly by parents to monitor deformity correction until reaching their desired beautiful alignments. Eight months later, we took the HKA radiographic alignment view; it revealed that we achieved a neutral mechanical axis. We rehospitalized the patients to remove plates and screws. One of the girls was 142 cm in height

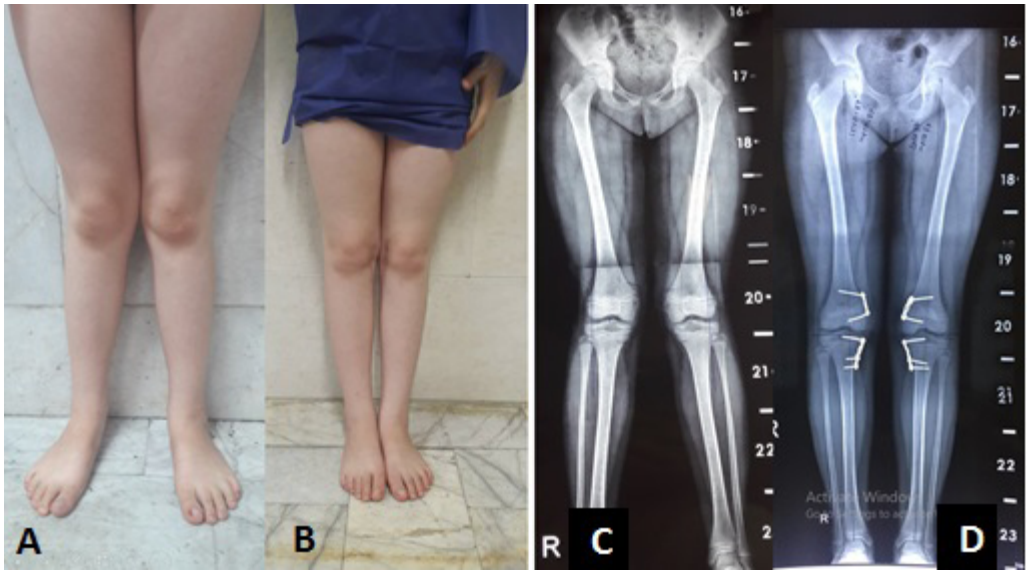

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Figure 1. Photographs of twin1 before hemiepiphysiodesis (A) photography before removal surgery (B) radiographic alignment view before growth modulation (C) last radiographic alignment view before performing removal surgery (D)

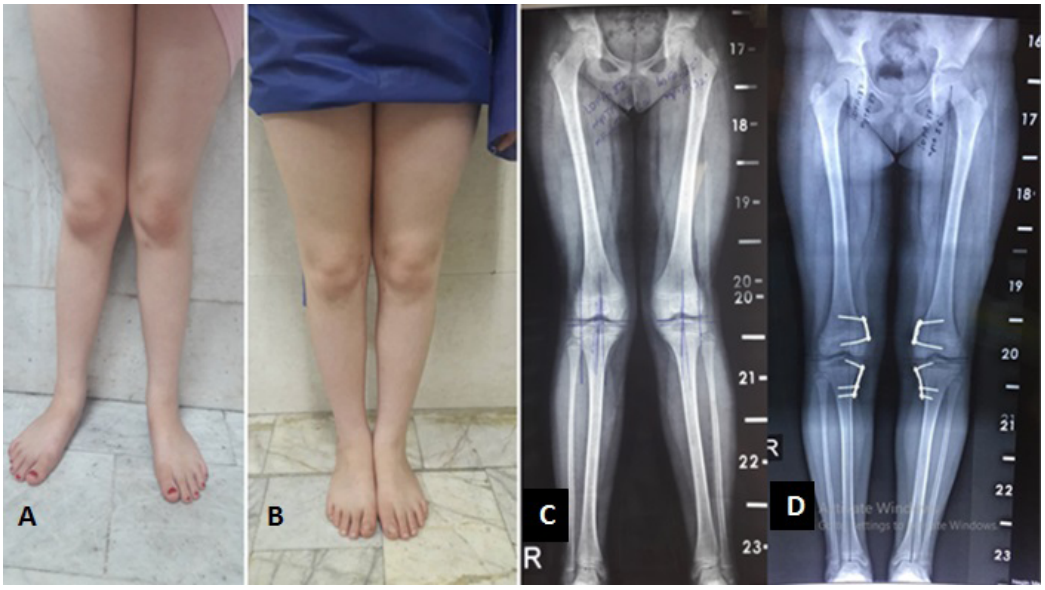

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Figure 2. Photographs of twin2 before growth modulation (A) photography before removal surgery (B) radiographic alignment view before growth modulation (C) last radiographic alignment view before conducting removal procedure (D)

and weighted 45 kg (BMI: 22.31 kg/m^2) and the other was 142 cm in height and weighted 43 kg (BMI: 21.32 kg/m^2). The surgeries were conducted well and postoperative radiographs presented no complications.

3. Discussion

To the best of our knowledge, there were no articles for growth modulation in twins; thus, this case report is the first study about modulation for genu valgum deformity in twins. In this study, we used 3.5mm noncannulated screws with reconstruction plates. This is because the result of reconstruction plates is as desirable as staples and 8-plates. It is more cost-effective, accessible, and appropriate for young ages.

In 1933, Phemister described a procedure that made premature physeal closure and arrested the growth plates on both medial and lateral sides of the bone to treat deformity (12, 13). Genu valgum is an angular deformity in which the mechanical axis is shifted laterally and commonly presents in children (1, 5). Growth modulation is an attractive and accepted method to use in skeletally-immature patients. Besides, it should be employed when failing to reach adequate correction (4, 5, 14). Temporary hemiepiphysiodesis is an invasive method and the basis of treatments for lower extremity angular deformities (15, 16). Using growth modulation for physis depends on the patient's age, nutrition, and disease. Moreover, it varies from person to person based on bone size and geometry, i.e., also unpredictable (2, 3). In contrast, Danino et al. argued that the growth modulation for genu valgum in the distal femur and proximal tibia is highly predictable. They also believed the femur's correction rate is faster than that of the tibia. Furthermore, after ensuring that the deformities were corrected and normal alignments were achieved, removing the device and keeping intact the periosteum is recommended to facilitate the physis to continue to grow (10, 15). This technique proved to be an effective and safe manner to correct genu valgum in pediatric patients (2, 4, 17). Factors influencing the success and correction rates are age and the direction of deformity (10). Age at the plate implantation is an essential factor that affects the success of treatment. has Accordingly, individuals with 3 years of growth remaining at the implantation time have higher chances to attain the surgical targets (10, 18). To make a precise and careful decision on the timing of surgery, bone age, which depends on skeletal development, is critical; it is preferred due to the provided criteria as the endpoint of growth. The current study overlooked evaluating the bone age. Complete correction is achieving a neutral mechanical axis deviation (19).

A concern about implant removal is the rebound phenomenon, i.e., why surgeons use slight overcorrection (19-21). Perfect timing is necessary to avoid and prevent overcorrection or under correction (18). Risk factors for rebound effects are younger age at plate insertion, increased BMI, and larger initial deformity (21-23).

Farr et al. explored the rebound of tension band plates. They suggested that each 1kg/m² increase in BMI indicates a 12% growth in the recurrence rate (21). The patient's age at the time of removal seems to be more crucial; each year of growth remaining until complete skeletal maturity increases rebound risk for 54%. The obtained data revealed that the chronological age of 12.5 years for males and 13 years for females at implantation time decreased such risks (21). Levielle et al. reported that patients with an initial deformity of >20 degrees are more prone to experience rebound, compared to those with less severe deformities. There were two groups of rebounder and non-rebounder in this study. At the time of implant removal and growth modulation, they recognized that the rebounders group were younger (females: <10 y; males: <12 y), compared to the non-rebounders. The presence of fibular hemimelia is also a risk factor for the rebound. To avoid overcorrection, they need to obtain complete correction of deformity and implant removal before skeletal maturity (22). It is recommended to remove both staples and transphyseal screws until 8-10 years of age within 24 months after surgeries; such a measure helps to avoid physeal damage and rebound phenomenon (3). In our study, to evaluate the rebound phenomenon, further follow-up is required.

Aslani et al. suggested that hemiepiphysiodesis with reconstruction plates is an effective method for correcting the deformities in growing children (24). They highlight the low cost of it, i.e., affordable by limited budgets. It is also easily accessible and applicable in developing countries. In a study, 42 limbs of 21 patients were examined with the Mean±SD age of 10 years and 3 months, and 2 years and 10 months. They obtained a result of 86% complete correction, 9% partial correction, and 5% without correction. Partial correction occurred in older children, i.e., because of limited remaining growth. They only had 6 screw failures of 58 plates and screw constructs. Two were distal femoral and epiphyseal were attached. Moreover, 4 were proximal tibial and metaphyseal (24). Shabtai et al. reported that idiopathic deformities in pediatrics have faster correction rates as well as higher success rates and fewer complications, compared to pathologic deformities (7).

Both staples and plates are really popular, safe, and invasive and gradually correct angular deformities in pediatrics (25). Stapling could cause problems in young children, while 8-plate is free of these disadvantages. This technique hardly grasps the bone and reduces the risk of extrusion and makes it usable in younger children (19). Park et al. reported that the strength of non-cannulated screws is higher than cannulated ones. Besides, 3.5mm non-cannulated and cortical screws have similar strength. They also reported that due to the thickness of reconstruction plates, some issues, like skin irritations might occur (26). The rate of correction in Tension Band Plates (TBP) is faster than percutaneous epiphysiodesis transphyseal screws (25). The time required for the implantation and explantation of staples is more than that of the TBPs. Besides, staples require a bigger incision; however, they are more effective than TBP to longitudinally block the physis (14, 20). TBP at a younger age may increase malalignment recurrence risks; even using TBP close to the age of skeletal maturity has a risk of not achieving the complete correction (21). Faster correction occurs in younger patients (10, 17). TBP has some consequences, such as overcorrection, under-correction, and rebound (21). Screws move freely at plate-screw junctions, i.e., because of the non-locking nature of TBP constructs. It also decreases the bone bar formation of the growth plate. TBP has fewer complications than staples and has a similar success rate (14). Eight-plates and reconstruction plates have the same efficacy. Due to the extraperiostal position of 8-plate, it could be easily removed in children of all ages (24).

Martinez et al. compared screws and non-absorbable filaments with 8-plate techniques in pediatrics. They reported no significant difference between them; however, the advantage of screws and non-absorbable filament technique is being a cost-effective model (4).

Concerns about compressive forces and injuries to growth plates when using plates and screws are minimized. Additionally, because of the low risk of premature physeal closure, they could be used for younger patients (17). The complications of growth modulation could be screw migration and infection, overcorrection and permanent physeal arrest, knee stiffness, fracture, and the failure of growth inhibition (7, 8, 18, 27). The associated risk factors include BMI, age, and underlying etiologies (7, 28). Bodyweight is an essential factor in breakage (29). Zajonz et al. found that the rate and potential of correction of femorotibial treatments are higher than that of each femoral or tibial interventions (30).

We recommend approaching to treat genu valgum to have better alignment and solve walking challenges in the pediatric group. We also suggest using reconstruction plates due to their low cost and availability. We could use photographs to observe if the correction of the mechanical axis is achieved or not. When reaching the desired correction, taking a radiographic alignment

view is recommended to estimate the time of removal surgery.

4. Conclusion

We presented a case of 8-year and 3-month-old twin girls with genu valgum deformity who underwent hemiepiphysiodesis surgeries. We used reconstruction plates and 3.5mm non-cannulated screws to fix both the distal femur and proximal tibia to temporarily arrest the growth plate. During 8 months, we observed and followed the patients by several photographs; after eight months, we obtained just one HKA radiographic alignment view that demonstrated complete correction. Then, we removed the implants.

Ethical Considerations

Compliance with ethical guidelines

All ethical principles are considered in this article. The participants were informed about the purpose of the research and its implementation stages; they were also assured about the confidentiality of their information; moreover, they were free to leave the study whenever they wished, and if desired, the research results would be available to them.

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Authors contributions

Both authors contributed in designing, running, and writing all parts of the research.

Conflicts of interest

The authors declared no conflicts of interest.

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