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Research Article

Two-Holes Reconstruction Plate for Correction of Coronal Plane Deformities of the Knee in Children, Khartoum, 2020

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Abstract

Objectives:

The aim of this study is to assess the radiological outcomes of guided growth techniques using two whole reconstruction plate for the treatment of coronal plan deformities around the knee.

Methods:

This is across sectional descriptive hospital-based study of 22 patients (30 limbs) gathered and treated during a period from 2018 to 2020 by a single surgeon employing standardized technique. The inclusion criteria were all patients with coronal plane deformities around the knee with an open physis, regardless of pathological background. Patients with physiological genuvarum or genuvalgum or who had previous or concurrent surgeries for the same problem were excluded from the study. Patient's age and gender were recorded. Mechanical axis deviation (MAD) distance, tibio-femoral angle (TFA), mechanical lateral distal femoral angle, and mechanical medial proximal tibia angle were measured from a long-standing anteroposterior radiograph, including the hip, knee and ankle joints.

Results:

The average age was 7.0± 3.5 years, and the mean duration of treatment was 10.4 months, with "sick physis" requiring longer durations. The mean rate of correction of TFA was 1.4°/month. The MAD distance improved from 34.1± 18.0 to 9.8± 6.4.

Conclusion:

This study confirms that success rate by guided growth technique using two-hole reconstruction plate in management of coronal plane deformity around the knee is high. Younger patients had better and faster out comes.

Introduction

Angular deformities of lower limb in Pediatric age group present very commonly to orthopedic and pediatric clinics, and it may be physiological or may be true deformities. (1)

While physiological deformities usually correct with growth, pathological deformities can cause functional impairment in the form of abnormal gait, painful joint, and a potential risk of developing osteoarthritis of the knee. (2) Guided growth is useful in correcting pediatric angular deformities, although growth manipulation has been applied to various deformities, it is most commonly used to correct coronal plane deformity about the knee. (3) Temporary hemi epiphysiodesis, timed permanent hemi epiphysiodesis, corrective Osteotomies, and Ilizarov ring fixator application are the various surgical modalities for the correction of angular deformities around the knee joint. (2)

Osteotomies have traditionally been the main stay of treating deformities not only in adults but also in children, these involve extensive soft-tissue dissection, complications of wound closure, infection, delayed union, malunion and prolonged immobilization which increase the morbidity of the patients. (4)

Guided growth hemi epiphysiodesis is widely used as a method for gradual correction of angular deformities in skeletally immature patients, and the rate of angular correction with hemi epiphysiodesis is an area of interest for many researchers. (5)

Guided growth saddles the plastic nature of physics to bring about the desired correction required. (6)

Staples, percutaneous screws, or figure of eight plate (tension band plate) can be used for temporary hemi epiphysiodesis. It is less invasive technique compared to Osteotomies, and the results are more predictable and the process is reversible. (7)

Complications related to the use of staples include breakage, extrusion, and permanent physical damage. (7)

Eight plates' temporary hemi epiphysiodesis considered a new idea as a better alternative to staples and other procedures yielding good results with fewer complications. (8)

Management of coronal plane angular deformities around the knee:

Untreated coronal plane angular deformities generally results in a non-resolving and sometimes progressive varus or valgu deformity that produces joint deformity and growth retardation, which can then be corrected

only with complex surgical procedures. Even when such surgery is performed, substantial articular disruption of both compartments of the knee may have already occurred. Thus, once the radiographic diagnosis of infantile tibia vara is certain, the orthopedist should recommend treatment immediately because patients treated in the early stages of the disease have a better prognosis. (9)

Treatment choices and prognosis depend greatly on the age of the patient at the time of diagnosis, which should be the same age at which treatment is recommended. (9)

Statement of the problem:

There are multiple surgical options for treatment of coronal plan angular deformities around the knee. Using Osteotomies involve extensive soft-tissue dissection, complications of wound closure, infection, delayed union, malunion and prolonged immobilization which increases the morbidity of the patients. Hence, there is a trend toward using less invasive techniques such as guided growth techniques. (4)

Justification:

In the past, Osteotomies have been the mainstays of treating deformities even in children. Recently, guided growth techniques become widely used in management of coronal plan angular deformities around the knees. It is a less invasive technique compared to osteotomies. The results are more predictable and the process is reversible. The implants can be removed after the desired correction is achieved. The standard implants used, 8-plates, are not available in Sudan. Here by we are using a two-hole reconstruction plate.

Objective

General objective:

Assess the radiological outcomes of guided growth techniques using two hole reconstruction plate for the treatment of coronal plane deformities around the knee.

Specific objectives:

Evaluate the rate of correction of coronal plan deformities around the knee by hemi epiphysiodesis using two-hole reconstruction plates, identify the causes of coronal plane deformities around the knee, correlate

between the rate of correction and the age and gender of the patient, correlate between the radiological outcome and the type of deformity and identify the post-operative complications: Screw cut out, Breakage, Failure of correction and Overcorrection.

Methodology

This was cross-sectional descriptive hospital-based study conducted between 2018 to 2020 in specialized orthopedics hospitals in Khartoum, Sudan. Skeletally immature patients, with open physis, 2 years before skeletal maturity and patient diagnosed with coronal plan angular deformities around the knee (genuvarum and genuvalgum) were included in the study, then patient's radiographic outcomes have been assessed pre and post-surgery using check list developed for the purpose of the current research.

Ethical approval obtained from EDC then verbal and written approval obtained from patients parents.

Data then were entered into the Statistical Package for Social Sciences (SPSS) version 23 (IBM SPSS Inc., Chicago, IL, USA), and descriptive analysis was conducted to determine the degree of comparability using simple descriptive statistics: Mean ±SD values and percentages. For the categorical data the chi-squared test was used and for the numeric variables the Paired t-test. The difference at value of $P<0.05$ will be considered significant.

Results

Twenty-two patients (30 lower limbs) with mean age (7.0±3.5) years were included in this study to determine the outcome of guided growth technique using two-hole reconstruction plate for correction of coronal plane deformities of their knees.

50% were male and 50% were female, 13 (43.3%) with right side knee and 17 (56.7%) with left side knee deformity. 21(70%) with genuvalgum and 9(30%) with genuvarum.

14 (46.7%) with idiopathic causes of disease, 9 (30%) with skeletal dysplasia (SD), 4 (13.3%) with mucopolysaccharidoses (MPS), 2 (6.7) with Blount disease and1(3.3%) with Osteochondrodysplasias causes.

The mean rate of correction of the tibiofemoral angle was 1.4 ± 0.52 angle per month (table1).

Mean, standard deviation of age and duration of correction among study participants were 7± 3.5 years and 10.4 ± 4.9 months respectively.

Paired t test was used to determine the outcome of guided growth technique using two-holes reconstruction plate pre and post the technique and found that, significant decrease in MAD and TFA after the use of guided growth technique with p.value 0.000 with mean rate of correction 1.4 angle per month, and insignificant differences in mLDFA and mMPTA with p.value 0.155 and 0.067 respectively. (Table 2).

Significant negative correlation with p.value 0.005 was found when age by years of children with coronal plane deformity around the knees correlated with rate of correction after guided growth technique. Table 3.

Significant association was found when types of deformity was associated with gender with p. value 0.003 which found that, majority of genu varum deformity found in females and genu valgum found in males. (Table 4).

Rate of correction was compared with gender group (male and female) and found that, insignificant differences among gender with p. value 0.801.(Table 5)

Insignificant difference was found when age of study participants was compared between two different types of deformity (genu varum and genu valgum) with p. value 0.649. (Table 6).

	Rate of correction
Mean	1.4017
Std. Deviation	0.52135
Minimum	0.25
Maximum	3

Table 1: Rate of correction of tibiofemoral angle per month

Variables	Pre (mean±SD)	Post (mean±SD)	P value
MAD	34.1±18.0	9.8± 6.4	0.000
TFA	17.9±6.5	5.8 ± 0.57	0.000
mLDFA	85.0±11.2	87 ±3.9	0.155
mMPTA	93.2±10.5	89.6±5.6	0.067

MAD= mechanical axis deviation, TFA= tibiofemoral angle, mLDFA= mechanical lateral distal femoral angel, mMPTA=mechanical medial proximal tibial angel.

Table 2: Mean of MAD, TFA, m.LDFA and m.MPTA pre and post use of guided growth technique

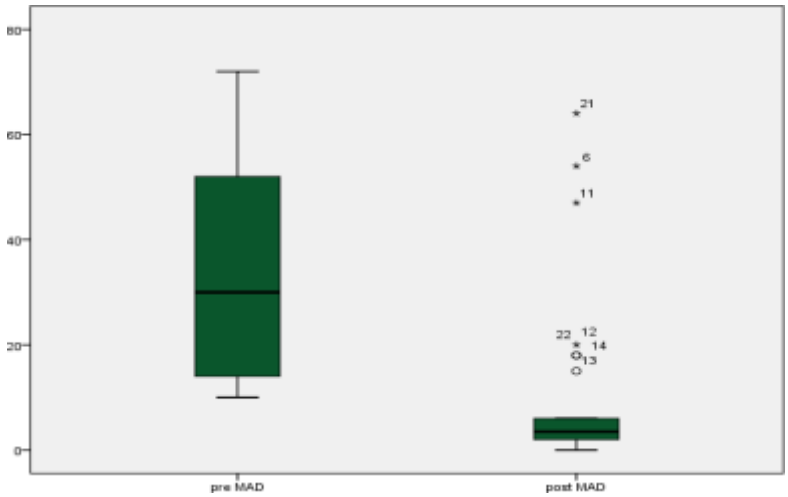

Figure 1: Mean difference in MAD pre and post guided growth technique

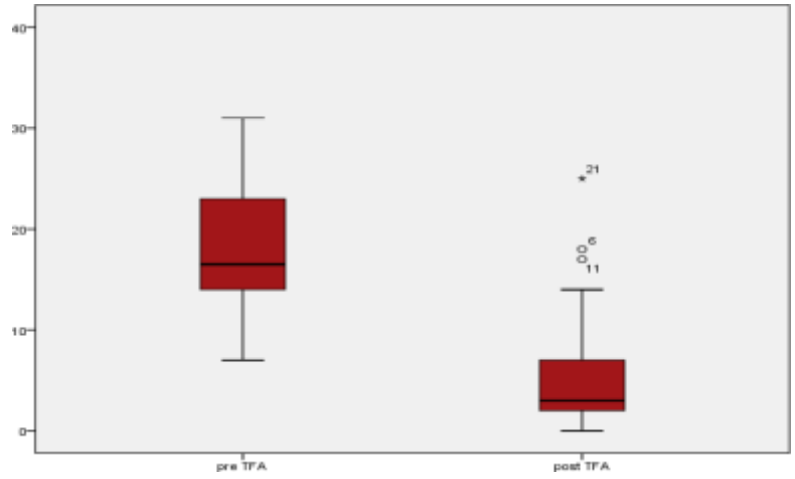

Figure 2: Mean difference in TFA pre and post guided growth technique

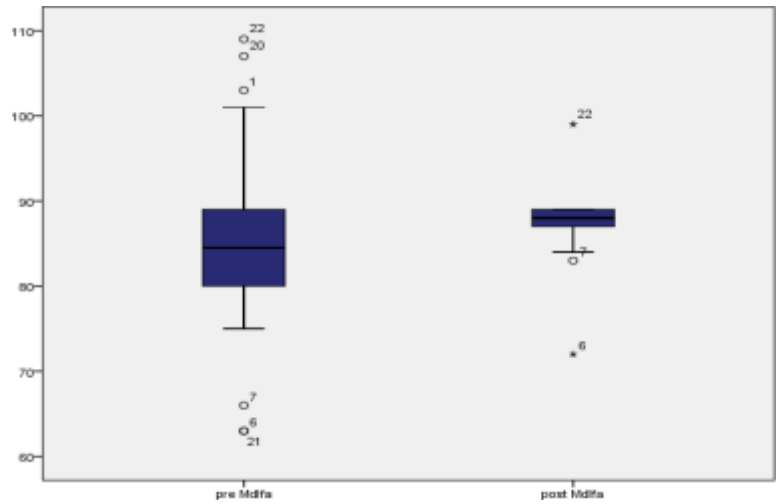

Figure 3: Mean difference in m.LDFA pre and post guided growth technique

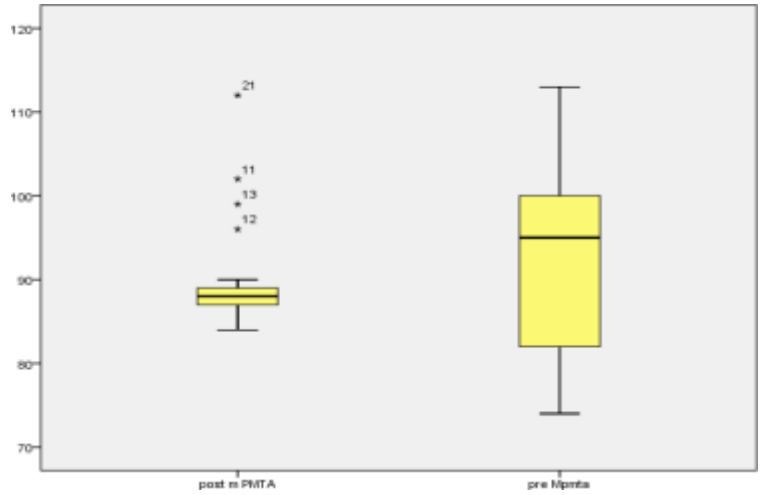

Figure 4: Mean difference in m.MPTA pre and post guided growth technique

Rate of correction	R	P value
Age/years	0.358-	**0.005**

Table 3: Correlation between age and rate of correction among study participants (n=30)

		Gender		Total	*P.* value
		Male	Female		
Types of deformity	**G. varum**	1	8	9	0.003
	G. valgum	14	7	21	
Total		15	15	30	

Table 4: Association between Types of deformity and gender among study participants (n=30)

	Gender	N	Mean±SD	*P.Value*
Rate of correction	**Male**	15	1.4±0.4	0.801
	Female	15	1.3±0.6	

Table 5: Comparison between rate of correction and gender among study participants (n=30)

	Types of deformity	N	Mean±SD	*p.value*
Age	G.varum	9	6.5±3.5	0.649
	G.valgum	21	7.1±3.6	

Table 6: Mean comparison between types of deformity and age among study participants (n=30)

Lower Limb Scanogram Showing BilateralGenuvalgum

Lower Limb Scanogram Showing Corrected BilateralGenuvalgum Using 2 HoleReconstruction Plate

Discussion

The demographics of the study population were comparable to those of the literature. The male and female ration was equal of 15 each. The mean age of Genu varum was 6.56 and Genuvalgum patients was 7.19. Comparable demographics were found by Kulkarni RM et al with a total of 24 children under the age of 10, thirteen of them suffered from genu valgum, while the remaining 11 had a genuvarum deformity. (4)

Most of the patients were of idiopathic etiology, however, the rest causes were bone disorders such as skeletal dysplasia, Blount's disease, mucopolysaccharidosis and osteochondrodysplasias. These finding are in contrast to that reported by Kulkarni RM et al who found a seven cases of nutritional Rickets, five cases of vitamin D resistant Rickets, four cases of metaphyseal chondrodysplasia, two cases of posttraumatic tibia valga and one each of congenital short femur syndrome, idiopathic genu valgum, achondroplasia, distal femur valgus secondary to proximal tibia chronic osteomyelitis, arthrogryposis with bilateral genuvalgum and developmental dysplasia of the hip (DDH)with a unilateral left genuvalgum.(4)

Furuhashi et al also reported findings which are different, in their retrospective review of 27 patients who underwent temporary epiphysiodesis. Nineteen cases of Idiopathic cause, two cases of Asymmetric neurologic disorders, two cases of Developmental dysplasia of the hip, and one each of congenital pseudarthrosis of the tibia, and multiple exostosis. (10)

These differences can be related to the difference in the populations and the different ages of presentation of reported etiologies.

Assessment of the radiological outcome revealed good results in most of the patients. A part from one case of failure of correction, there were no reported complications like screw cut out, breakage or overcorrection. These results reinforce Vaishya et al study (Growth modulation by hemi epiphysiodesis using eight- plate) who reviewed retrospectively a total of 24 patients with 11 bilateral and 13 unilateral knees affected with genuvalgum deformity. They achieved excellent results in 91.67%. One case had a partial correction of the deformity. And one case had reported with a superficial infection which was taken care. There were 2 cases of over-correction, which were gradually self-corrected during follow-up. There were no cases of implant specific complications such as a plate or screw break age or backing out of the screws or migration of plate. No rebound deformity was observed, in any of the corrected cases. (11)

A matching finding was demonstrated by Leveille et al who performed a retrospective review of all patients undergoing growth modulation with a tension band plate for coronal plane deformity about the knee in total

of 67 limbs, with Seventeen limbs underwent revision surgery for recurrent deformity and one limb of persistent deformity. (17)

Another study reported similar findings to our study by Boero et al studied patients with knee an gular deformities who were managed with eight- Plate guided growth. They did not observe complications such as hardware failure over the duration of treatment, as is observed with other techniques. There was no need for repeat surgery other than routine planned hardware removal. The deformity remained uncorrected in only1 patient in the pathological group. (12)

In our current study we investigated the rate of correction in relation to age; males (15) had a mean rate of 1.42 degrees per months in TFA. For females (15) the mean was 1.37 degrees permonthsin TFA.

On assessment of the rate of correction along with different type of deformities; in both the genuvalgum and genuvalgus groups, the MAD, TFA improved from a preoperative measurement to a lower one at last follow up both of which were highly significant. These findings are in line with that of Baghel et al who studied the rate of correction of knee angular deformities (Genu Varum and Genu Valgus) in 15 patients managed with eight-Plate guided growth (Reversible hemi epiphysiodesis using eight plate).Follow-up was done clinically and radiologically every second month till deformity was completely corrected and 8 plate was removed only when MAD came 0˚.The mean age of Genu varum and Genu valgum patients ranged from 3-10 and 2-13years, respectively. Baghel A et al findings were as follows; Regarding Genu Varus, the rate of change a sex pressed by the regression coefficient showed remarkable decrease (improvement)of1.92 degree per month in TFA, 0.34 cm/month in MAD and 0.83 degree/month in LDFA while significant ($p<0.01$) increase (improvement) of 1.10 degree/month in MPTA, 1.99 degree/month was seen. (13)

In the Genu Valgum group Baghel A et al reported that the rate of change, revealed significant decrease (improvement) of 1.29 degree/month in TFA0.27cm/month in MAD and 0.87 degree/month in MPTA while significant increase (improvement) of 1.18 degree/month in MPTA was observed. (13)

A significant improvement on rate of correction with the mean of 1.4 ± 0.52 angle per month, similar to our reported findings was demonstrated by Kulkarni RM et al, in their study for the Correction of coronal plane deformities around the knee using a tension band plate in children younger than 10 years in a total of 24 children.(4)

When assessing correlations, the type of deformity being valgum or varum was not found to have a significant impact on the radiological outcome. In contrary to our findings, post-operative correction as

assessed by the change in MAD and TFA was affected significantly by the age. This is contrasting the results of Gaboura et al., which concluded that generally, genuvalgum had a better and faster correction thangenu varus. (14)

Another contrasting evidence supporting the effect of type of deformity on rate of correction was reported by EL-Sobky TA et al in their prospective series on growth modulation for knee coronal plane deformities in children with nutritional rickets, found that valgus knees demonstrated a significantly high speed of correction of TFA in contrast to varus knees. These radiographic improvements correlated positively with the clinical outcomes. (15)

In line with these findings are the outcomes demonstrated by Danino Betal, who conducted a multicenter retrospective study on 372 physis in 206 patients to evaluate the temporal sequence of events following temporal hemi epiphysiodesis in idiopathic knee varus/valgus. They concluded that factors significantly influencing success and rate of correction were age, direction and magnitude of deformity. They concluded that value Rate of correction was significantly faster than varus rate of correction: 0.90° versus 0.77°/ month, respectively. (16)

These heterogeneous findings related to correlation between age and type of deformity on the one side and the rate of correction on the other site can be explained in part due to deformity severity, the various patient and disease characteristics and the different rates of follow up.

Conclusion

Knowledge of the natural history of the development of the tibiofemoral angle is necessary to distinguish between the physiological and pathological deformities. The study confirms that success rate using guided growth technique in management of coronal plane deformity around the knee is high. Hemi epiphysiodesis with two-hole reconstruction plate still stands to be a valid procedure for coronal plane deformities correction around the knee. Younger patients had better and faster outcomes.

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