Role of Implant Angles in Hemiepiphysiodesis using 8 Plate for Correction of Angular Deformity Around Knee

Anurag Baghel[1], Narendra Singh Kushwaha[2], Shailendra Singh[3], Raghav Pratap Singh[4], Santosh Kumar[5]

ABSTRACT

Introduction: Knee joint being crucial weight bearing region may be exposed to pathological mechanical load due to Mal-alignment causing early osteoarthritis of the knee joint. Correction by surgical treatment like hemiepiphysiodesis with eight plate is necessary and proves beneficial depending upon the degree of deformity. The aim of this study was to evaluate the total change of Tibiofemoral Angle (TFA), Mechanical Axis Deviation (MAD) and implant angles and the relationship between implant angles and TFA and MAD during the correction of deformity.

Material and methods: we carried out our study in 15 patients having knee angular deformities like genu varum and genu valgus. These patients were surgically managed using eight-plate guided growth. Correction of deformity was measured by radiological assessment. Certain growth and implant angles were measured radiographically like- tibio femoral angle, mechanical axis deviation and Implant angles. Every patient was properly under surgical, medical management and post operative follow up.

Results: Proximal and Distal implant angles showed negative correlation with Mechanical axis deviation in Genu varum and Genu valgum cases which was statistically significant ($p<0.001$). Tibio femoral angle improved for valgum deformity from 22.210± 2.390 to 6.340± 2.620. Mechanical axis deviation improved for valgum deformity from 3.63± 0.35 cm to 0.73± 0.43 cm (6%).

Conclusion: Implant angles increases in their values and their increment retards as the deformity comes near to correction values. These implant angles show that physes is growing and both plate and physes are working normal.

Keywords: genu varum, genu valgum, hemiepiphysiodesis, implant angle

INTRODUCTION

Knee joint being crucial weight bearing region may be exposed to pathological mechanical load due to Mal-alignment causing early osteoarthritis of the knee joint. Correction by surgical treatment is necessary depending upon the degree of deformity. Most physiological deformities peak between 1 and 3 years (varus) or between 3 and 6 years (valgus) and resolve spontaneously.[1]

Pathological angular deformities can be either idiopathic or due to congenital syndromes such as skeletal dysplasia. In contrast to physiological deformities, pathological deformities manifest as the underlying disease progresses and acts on skeletal growth, leading to a gradual mechanical axis displacement.[2] Correction of genu valgum and genu varum by eight plate application is safe and effective.[3]

There are two implant angles – proximal implant angle and distal implant angle.[4] Proximal implant angle is the angle subtended by proximal screw of eight plate with the long axis of shaft of plate (Figure-1). Distal implant angle is the angle subtended by distal screw with long axis of plate (Figure-1).

We placed the plate on convex side of deformity (Tension bend wiring). We put the screws at an angle of more than 90° (i.e. implant angle should ≥ 90°) so as to avoid the damage to physes. These screws put the resistance to growth of physes and so slows down the growth of physes of the side where plate is applied, but not on the opposite side. But these screws don't put permanent resistance to growth of physes as they are not locked in plate.[5] They are movable in the plate, so when physes grows the implant angle increases and thus these screws put partial resistance to growth. So these screws give guided growth arrest to physes attributed to thin non locking mechanism in plate[5,7]

The aim of this study was to evaluate the total change of Tibiofemoral Angle (TFA), Mechanical Axis Deviation (MAD) and implant angles and the relationship between implant angles and TFA and MAD during the correction of deformity.

MATERIAL AND METHODS

This study population composed of total 15 patients from the department of orthopaedic surgery, KGMU, Lucknow. 5 Patients had genu varum deformity with unilateral as well as bilateral limbs involvement irrespective of gender. 10 Patients had genu valgum deformity with randomly involved unilateral or bilateral limbs, irrespective of gender. Only patients with open physes of bone were included in the study with the age group of 2 to 14/16 years (14 for female and 16 for male).[6]

Patients with potential growth on opposite side of physes and Mechanical Axis Deviation (MAD) in zone 2 or 3 with gait disturbance, knee pain, medial or lateral thrust were included.[7]

Patients with mature bone having closed physes or suffering from any kind of physiological deformity were excluded. Correction of deformity was measured in terms of the following radiological criteria:

Tibiofemoral Angle (TFA) 2. Mechanical Axis Deviation (MAD) 3. Proximal Implant Angle (PIA) 4. Distal Implant Angle (DIA) were also measured.

PIA and DIA tells about functioning of the growth plate (Physes) and clinical Improvement in functional status and symptoms of patients.

Implant angles, MAD and tibio-femoral angle were measured

[1]Lecturer, Department of Orthopaedic Surgery, Government Medical College, Kannauj, [2]Associate Professor, [3]Assitant Professor, Department of Orthopaedic Surgery, [5]Professor, Department of Orthopaedic Surgery, KG Medical University, Lucknow, [4]Director, Ayushman Hospital, Dhampur, Uttar Pradesh, India

Corresponding author: Dr. Anurag Baghel, House no. MS-52, Sector D, Aliganj, Pin- 226024, Lucknow, Uttar Pradesh, India

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Variables	Pre Op	Post Op					% change	p value
	At 0 month	After 2 month	After 4 month	After 6 month	After 8 month	After 10 month		
TFA	13.17 ± 1.42	9.33 ± 1.50^{ns}	5.83 ± 1.89*	2.50 ± 1.75**	-2.33 ± 1.74***	-6.00 ± 0.58***	145.6%	p<0.001
MAD	3.22 ± 0.16	2.63 ± 0.25^{ns}	1.80 ± 0.35**	1.07 ± 0.29***	0.40 ± 0.19***	0.00 ± 0.00***	100.0%	p<0.001
PIA	99.67 ± 0.61	101.17 ± 0.65^{ns}	105.00 ± 0.86^{ns}	113.00 ± 1.65***	115.00 ± 1.97***	117.67 ± 4.84***	15.3%	p<0.001
DIA	93.33 ± 1.33	94.00 ± 1.15^{ns}	98.00 ± 1.03^{ns}	105.50 ± 1.59***	110.67 ± 1.02***	114.67 ± 0.33***	18.6%	p<0.001

^{ns}p>0.05 or *p<0.05 or **p<0.01 or ***p<0.001 - as compared to Pre Op

Table-1: Pre and post treatment changes in angular deformity around knee joint in patients with genu varum

Variables	Time	TFA	MAD	PIA	DIA
Time†	1.00				
TFA	-1.00***	1.00			
MAD	-1.00***	0.99***	1.00		
PIA	0.98***	-0.97***	-0.98***	1.00	
DIA	0.98***	-0.98***	-0.98***	0.99***	1.00

***- p<0.001, TFA: Tibio Femoral Angle, MAD: Mechanical Axis Deviation, PIA: Proximal Implant Angle, DIA: Distal Implant Angle

Table-2: Inter correlation between mean response of variables over the periods in patients with genu varum

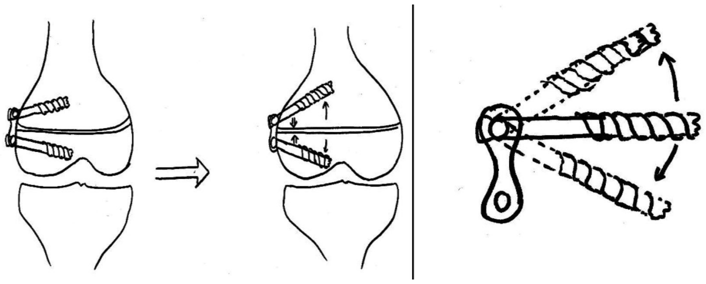

Figure-1: Showing varied degree of Implant Angle

by computer software. Patients were only allowed for movement after proper healing and when they got rid of post surgical pain. Clinico-radiological Follow-up was done every second month till deformity was fully corrected and 8 plate was removed when once MAD came 0^0. Radiographic imaging of patients was done by exposing patella forward with X ray beams parallel to the ground and towards the knee.[8] Due to unavailability of large X ray films we made the scanogram by joining 2 or 3 films together by computer software and then we measured different parameters on it.

We evaluated this system and mechanism by measuring change in implant angle, TFA, MAD and their interrelationship.[9,10]

All patients were evaluated clinico-radiologically pre-operatively. Implant angles were calculated at immediately after operative procedure. Subsequently patients were evaluated at every 2nd month till MAD ≈ 0 cm and then the plate was removed. For radiological evaluation scanogram was done. MAD and all angles were measured by computer software.

STATISTICAL ANALYSIS

Statistical analysis was done using ANOVA and post hoc tests. Data are summarized as Mean ± Standard Deviation. Comparison between Groups was carried out by one way repeated measures analysis of variance using general linear models. Bonferroni post hoc was used for contrasts and to analyze mean difference. Pearson correlation method was used to assess association between the variables. Simple linear regression was done to assess relative association between time and response of treatment. P<0.05 was considered statistically significant.

RESULTS

The mean age of patients in Genu Varum was between 3-10 yrs with mean (± SD) 6.50 ± 2.66. There were six limbs of five patients of Genu varum deformity (five males, one female, one bilateral, four unilateral) which were evaluated. After treatment TFA showed change of 145.6 % and MAD showed a change of 100%. PIA showed a change of 15.3% and DIA showed a change of 18.6% as Summarized in Table-1. ANOVA revealed significant improvement in all variables (p values < 0.01 or < 0.001).

Variables	Pre Op	Post Op						% change	p value
	At 0 month (n=14)	After 2 month (n=14)	After 4 month (n=14)	After 6 month (n=14)	After 8 month (n=14)	After 10 month (n=14)	After 12 month (n=7)		
TFA	22.21 ± 2.39	20.00 ± 2.19^{ns}	16.79 ± 1.96^{ns}	13.71 ± 1.89^{ns}	10.57 ± 1.65**	7.50 ± 1.58***	6.34 ± 2.62***	61.4%	p<0.001
MAD	3.63 ± 0.35	3.09 ± 0.37^{ns}	2.39 ± 0.37^{ns}	1.66 ± 0.33**	0.97 ± 0.32***	0.55 ± 0.29***	0.73 ± 0.43***	79.9%	p<0.001
PIA	97.93 ± 0.99	99.93 ± 0.99^{ns}	102.71 ± 1.01*	107.36 ± 1.14***	110.64 ± 1.04***	114.50 ± 0.95***	117.71 ± 0.99***	16.8%	p<0.001
DIA	85.71 ± 1.89	88.93 ± 1.49^{ns}	93.64 ± 1.54*	98.07 ± 1.76***	102.64 ± 1.53***	106.71 ± 1.50***	110.43 ± 2.66***	22.4%	p<0.001

^{ns}p>0.05 or *p<0.05 or **p<0.01 or ***p<0.001 - as compared to Pre Op, TFA: Tibio Femoral Angle, MAD: Mechanical Axis Deviation, PIA: Proximal Implant Angle, DIA: Distal Implant Angle

Table-3: Pre and post treatment changes in angular deformity around knee joint in patients with genu valgum

Variables	Time	TFA	MAD	LDFA	MPTA	PIA	DIA
Time†	1.00						
TFA	-0.98***	1.00					
MAD	-0.97***	1.00***	1.00				
PIA	1.00***	-0.97***	-0.97***	0.99***	-0.98***	1.00	
DIA	1.00***	-0.98***	-0.98***	0.99***	-0.99***	1.00***	1.00

***- p<0.001, TFA: Tibio Femoral Angle, MAD: Mechanical Axis Deviation, PIA: Proximal Implant Angle, DIA: Distal Implant Angle, Time†: in months

Table-4: Inter correlation between mean response of variables over the periods in patients with genu valgum

To see the association between the variables

The mean response of the variables over the periods (months) were correlated with each other and summarized in Table-2. Table-2 also showed significant (p<0.001) and negative (inverse) correlation of TFA and MAD with time while significant (p<0.001) and positive (direct) correlation of PIA and DIA with time. Further, PIA and DIA both showed significant (p<0.001) negative correlation with MAD (Table-2).

A total of 10 patients (7 males, 3 female) of Genu Valgum deformity were evaluated.

There were fourteen limbs (ten patients) of genu valgum deformity (five males, one female, one bilateral, four unilateral) which were evaluated. Mean age ranged from 3 – 10 years with the mean±SD 6.50±2.66 years. After treatment TFA showed change of 61.4 % and MAD showed a change of 79.9%, PIA showed a change of 16.8% and DIA showed a change of 22.4% (Table-3). ANOVA revealed significant improvement in all variables (p values < 0.01 or < 0.001).

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DISCUSSION

Angular deformities of knee corrected by osteotomy can result in failure due to complications. Hemipiphyseodesis for knee deformity correction using common 8-plate procedure is beneficial. This surgical method is thought to exhibit less hardware failure, easier to apply with lesser complications such as hardware breakage and migration. It is also seen in our study that this technique if used on adolescents have fairer and faster rate of correction. The age group of children in this study was below 16 years. Therefore, the majority were adolescents which correlates with the study by Stevens PM[5] In previous literature nobody estimated relation between rate of correction by physeal level or age using this treatment method. We found rates of correction were fast when the distal femoral and proximal tibial physes were treated concurrently, or when the technique was used in children under the age of 16 years. This age factor proved beneficial as it gave advantage to reduces the need for osteotomy for knee deformities.[3]

In this study all plates were applied to femoral side of deformity. After 8 plate application, deformity got corrected MAD came to center of the knee joint, pain was relieved, Child started to play with his peers as he could run or walk normally without any gait disturbance.

We evaluated role of angles for deformity correction by measuring them through radiographs.

1. TFA changed from 22.210± 2.390 to 6.340± 2.620 in valgum deformity. For varum deformity it changed from 13.17^0± 1.42^0 to 6.00^0± 0.58^0. Study done by Guzman and Boero[11] correlated with our findings.
2. MAD improved for valgum deformity from 3.63± 0.35 cm to 0.73± 0.43 cm. The total correction for varum deformity was from 3.22± 0.16 cm to 0 which was in contrast to the study done by Rolf D. Burghardt, John E. Herzenberg, Shawn C. Standard[4] since the total correction of valgus and varus deformity in their study was 3.07 cm and 3.88 cm respectively.

   We measured two other angles-proximal implant angle and distal implant angle which was based on the study done by Anastasios D. Kanellopoulos et al, in pigs. Proximal implant angle is angle subtended by proximal screw with the plate and similarly distal implant angle is angle between screw and plate. If both the angles increases it shows that physes is growing and is functional and no harm had been done to physes during surgery or post-operatively.
3. The PIA in our study increased for valgus and varus deformity from 97.93^0±0.99^0 and 99.67^0±0.61^0 To 117.71^0±0.99^0 and 117.67^0±4.84^0.
4. The DIA increased for valgus and varus deformity from 85.71^0±1.89^0And 93.33^0±1.33^0 To 110.43^0±2.66^0 and 114.67^0±0.33^0 respectively. The PIA and DIA correlated well with the time and other variables.

Eight plate was removed when MAD came to 0 and TFA was around 7 degree of valgus (adult value). We did not encounter complications related to implant as it occurs with blounts staple in which there is migration of the staple leading to permanent damage to physes.

Osteotomies were avoided since the deformity was corrected in short span of time. Patients were mobilized as soon as they became comfortable with post operative pain. No post operative POP cast was given.

CONCLUSION

During the study we concluded the role of implant angles in hemiepiphysiodesis using 8 plate. The implant angles increase in their values and their increment retards as the deformity comes near to correction values. These implant angles reveal that physes is growing and both plate and physes are working normal.

Their relation with deformity correction i.e. MAD and TFA is linear (more or less). Due to this collinear relation we can say that all parameters go hand in hand. If one parameter changes

other parameter also changes with the same pace.

REFERENCES

1. Brooks WC, Gross RH (1995) Genu varum in children: diagnosis and treatment. J Am Acad Orthop Surg. 3:326–335.
2. Boero S, Michelis MB, Riganti S. Use of the eight-plate for angular correction of knee deformities due to idiopathic and pathologic physis: initiating treatment according to etiology. Journal of Children's Orthopaedics. 2011;5:209–216.
3. Ballal MS, Bruce CE, Nayagam S. Correcting genu varum and genu valgum in children by guided growth: temporary hemiepiphysiodesis using tension band plates. J Bone Joint Surg Br [Br]. 2010;92:273-276.
4. Rolf D. Burghardt, John E. Herzenberg, Shawn C. Standard, Dror Paley. Temporary hemiepiphyseal arrest using a screw and plate device to treat knee and ankle deformities in children: a preliminary report J Child Orthop. 2008;2:187–197.
5. Stevens PM. Guided growth for angular correction. A preliminary series using a tension band plate. J Pediatr Orthop. 2007;27:253-259.
6. Narayan D,Bajaj ID. Ages of epiphyseal union in long bones of inferior extremity in U.P.subjects. Indian J Med Res. 1957;45:645–649.
7. Stevens PM, Pease F. Hemiepiphysiodesis for posttraumatic tibial valgus.J Pediatr Orthop. 2006;26:385–392.
8. Ramin Espandar et al. Angular Deformities of the Lower Limb in Children. Asian J Sports Med. 2010;1: 46–53.
9. Celestre PC, Bowen RE. Correction of angular deformities in children- Current Orthopaedic Practice. 2009;20:641-647.
10. Heath Ch, Staheli It. Normal limits of knee angle in white children: genu varum and genu valgum. J Pediatr Orthop. 1993;13:259-62.
11. Guzman H, Yaszay B, Scott VP, Bastrom TP, Mubarak SJ. Early experience with medial femoral tension band plating in idiopathic genu valgum. Journal of Children's Orthopaedics. 2011;5:11–17.

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