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

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ABSTRACT

Introduction: Knee joint being crucial weight bearing region may be exposed to pathological mechanical load due to Mal-alignment causing early osteoarthrits of the knee joint. Correction by surgical treatment like hemiepiphysiodesis with eight plate is necessary and prove 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 osteoarthrits 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 90⁰ (i.e. implant angle should ≥ 90⁰) 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 plate⁵⁷. 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

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Variables | Time | TFA | MAD | PIA | DIA
--- | --- | --- | --- | --- | ---
Time<sup>†</sup> | 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

| Variables | Time | TFA | MAD | PIA | DIA
--- | --- | --- | --- | --- | ---
Pre Op | 13.7 ± 1.42 | 3.2 ± 0.36 | 93.7 ± 0.33 | 98.0 ± 1.03 | 91.3 ± 1.13
After 2 month | 9.33 ± 0.59 | 2.63 ± 0.26 | 105.0 ± 0.38 | 105.0 ± 0.38 | 105.0 ± 0.38
After 4 month | 5.83 ± 1.9 | 1.80 ± 0.05 | 113.0 ± 0.66 | 113.0 ± 0.66 | 113.0 ± 0.66
After 6 month | -2.33 ± 1.74 | 0.40 ± 0.19 | 117.6 ± 0.84 | 117.6 ± 0.84 | 117.6 ± 0.84
After 8 month | -6.00 ± 0.58*** | 0.00 ± 0.00*** | -0.97 ± 0.02*** | -0.97 ± 0.02*** | -0.97 ± 0.02***
After 10 month | -10.7 ± 0.98*** | 1.00 ± 0.00*** | 113.00 ± 1.97 | 113.00 ± 1.97 | 113.00 ± 1.97
After 12 month | -22.2 ± 2.39 | 1.66 ± 0.33 | 100.00 ± 0.00 | 100.00 ± 0.00 | 100.00 ± 0.00

We evaluated this system and mechanism by measuring change in implant angle, TFA, MAD and their interrelationship.<sup>9,10</sup> 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).
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).

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-4. 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-4).

DISCUSSION
Angular deformities of knee corrected by osteotomy can result in failure due to complications. Hemiepiphysiodesis 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 physical level or age using this treatment method. We found rates of correction were fast when the distal femoral and proximal tibial physees 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.

To evaluate 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± 1.42 to 6.00± 0.58. Study done by Guzman and Boero11 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. Burnhardt, John E. Herzenberg, Shawn C. Standard6 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 physis during surgery or post-operatively.

The PIA in our study increased for valgus and varus deformity from 97.93±0.99 and 99.67±0.61 to 117.71±0.99 and 117.67±4.84 respectively.
4. The TFA increased for valgus and varus deformity from 85.71±1.89 and 93.33±1.33 to 110.43±2.66 and 114.67±0.33 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 blunts staple in which there is migration of the staple leading to permanent damage to physis. 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 physis is growing and both plate and physis 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

<table>
<thead>
<tr>
<th>Variables</th>
<th>Time</th>
<th>TFA</th>
<th>MAD</th>
<th>LDFA</th>
<th>MPTA</th>
<th>PIA</th>
<th>DIA</th>
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<td></td>
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<td></td>
</tr>
<tr>
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<td></td>
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</tr>
<tr>
<td>MAD</td>
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<td>1.00</td>
<td></td>
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</tr>
<tr>
<td>PIA</td>
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<td>-0.97***</td>
<td>-0.97***</td>
<td>0.99***</td>
<td>-0.98***</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>DIA</td>
<td>1.00***</td>
<td>-0.98***</td>
<td>-0.98***</td>
<td>0.99***</td>
<td>-0.99***</td>
<td>1.00***</td>
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</tr>
</tbody>
</table>

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

**p<0.001, TFA: Tibio Femoral Angle, MAD: Mechanical Axis Deviation, PIA: Proximal Implant Angle, DIA: Distal Implant Angle, Time*: in months
other parameter also changes with the same pace.

REFERENCES


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