Is wedge less distal femoral osteotomy adequate for correction of genu valgum deformity?

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Abstract

Introduction: Coronal plane knee deformities are common disorders affecting adolescents. Valgus deformities (TFA >12-15 degree & IMD >10 cm) require corrective osteotomy and wedgeless "V" distal femoral osteotomy is a viable as treatment option.

Materials & Methods: Thirty adolescent patients (13-18 years), patients with valgus deformities were included. Patients with severe collateral ligament instability, subluxation and sagittal plane deformity>15 degrees or genu valgum due to tibial deformity were excluded. Preoperative clinical evaluation (Bostman’s et al. knee score, inter-malleolar distance, knee-flexion test) and radiological evaluation was done. Wedge less supracondylar V osteotomy was done and stabilized with two K wires. Post-operative clinical and radiological parameters were recorded including complications.

Results: The mean TF angle preoperative was 20.23±3.63 degrees which was 2.9 ± 0.92 degrees at 6 weeks and 5.5±0.73 degrees at 6 months. The mean IM distance preoperative was 12.45±2.2 cm which was 1.63±0.32 cm at 6 months. (p<0.0001) The mean MAD preoperative was 18.96±2.62 which was 2.8±0.39 at 6 months. The mean LDFA angle preoperative was 76.9±3.33 degrees which was 87.7±0.83 degrees at 6 months. (p<0.0001) The mean Bostman’s score preoperative was 30±0 which was 5.27±0.98 at 6 weeks, 29.47±0.9 at 3 months and 29.47±0.9 at 6 months. The complications reported included infection in 2 patients, hypertrophic scar in 1 patient, neuropraxia in one patient.

Conclusion: Wedgeless distal femoral osteotomy is a viable option for correction of genu valgum with potential advantages of minimal blood loss, no leg length discrepancy, non-rigid fixation and early union.

Keywords: Valgus deformity, Wedgeless 'V' osteotomy, Tibiofemoral angle (TFA), Intermalleolar distance (IMD), Bostman’s score

Introduction

Coronal plane knee deformities are common disorders affecting adolescents. Nutritional rickets is the leading cause of these deformities in developing countries. These deformities may originate from distal femur or proximal tibia (knee). However, genu valgum usually originates from the distal femur [1]. In genu valgum, there is increased anatomic tibio-femoral angle (>12 degree), increase inter-malleolar distance (>8cm) and lateralization of mechanical axis. A decreased mechanical lateral distal -femoral angle (mLDFA; normal range 85–90°) indicates genu valgum is arising from distal femur [2]. Medial hamstrings muscle weakness in genu valgum patients cause lateral tibial rotation [3]. The causes of genu valgum in adolescents can be idiopathic, post-traumatic, metabolic, neuromuscular, or post-infectious. If the tibio-femoral angle of more than 15 degrees or an intra-malleolar distance of 10 cm persists after age of 10 years, spontaneous correction is unlikely to occur, and operative treatment is likely to be necessary. The goal of operative treatment of pathological genu valgum is restoration of normal mechanical-axis alignment and joint orientation [4, 5].

Various types of corrective osteotomies of distal femur have been described in literature. Tibial medial closing wedge osteotomy, lateral femoral opening wedge osteotomy, medial femoral closing wedge osteotomy, dome osteotomy and wedgeless “V” osteotomy. Corrective osteotomies can be performed to correct both congenital mal alignment and post traumatic deformity.
The patient with tibio-femoral angle >12-15 degree and inter-malleolar distance >10cm are considered for corrective osteotomy.

Lateral femoral open wedge osteotomy causes lengthening of the limb, stretching of the ilio-tibial band, delayed union with more restricted weight bearing, non-union, requirement of bone grafting, and secondary translational deformity of the osteotomy fragments. It becomes unstable if a large wedge is removed [6]. Disadvantages of distal femoral medial closing wedge osteotomy are long healing time, proximity to popliteal vessels, and secondary translational deformity of the osteotomy fragment and stretching of the ilio-tibial band [7]. It can become unstable if a large wedge is removed, as is required in correction of severe valgus. In such situations, fixation with a blade plate is required, which is technically difficult because of open growth plate in children [8, 9].

Dome osteotomy leads to complete axial realignment and without translation of osteotomy fragments and limb length alteration. It is chosen instead of a wedge osteotomy to avoid limb shortening that occurs in closing wedge osteotomy. Complications of dome osteotomy are non-union, failure of fixation and peroneal neuropathy [10].

The wedgeless ‘V’ shaped distal femoral osteotomy has the advantage of being wedgeless and hence it does not cause limb length discrepancy. Small surgical exposure, small operating time, no bleeding when done under a tourniquet, and the entire surgery is done without entering the knee joint. This reduces potential incidence of stiffness, adhesion formation and intra-articular infection. The apex of “V” that is embedded in the metaphyseal bone gives an additional inherent stability to the osteotomy. The other advantages of this surgery are alignment can be adjusted after surgery at the time of cast application, cancellous bone graft from proximal “V” fragment is available for enhancement and early union at osteotomy site, minor changes in alignment possible since fixation with Kirschner wires is non-rigid and limited period of immobilization in above knee cast which may reduce the morbidity of the patients [11]. The purpose of the present study was to evaluate the functional and radiological outcome and to check for complications, if any, of wedgeless ‘V’ shaped distal femoral osteotomy for genu valgum in adolescents (13-18yrs).

Aims and Objectives
To evaluate the functional outcome of wedgeless ‘V’ shape distal femoral Osteotomy on the basis of clinical and radiological assessment.

Material and Methods
The study was conducted at a tertiary hospital, Delhi from 2016 to 2018, after obtaining informed consent from the patients & written clearance from the scientific and ethical committee. Thirty adolescent patients (13-18 years), patients with tibio-femoral angle >15 degree or inter-malleolar distance >10cm were included in this study. Patients with severe collateral ligament instability, subluxation and sagittal plane deformity >15 degree or genu valgum due to tibial deformity were excluded. Preoperative evaluation and clinical evaluation (Bostman’s et al. knee score, inter-malleolar distance, knee-flexion test) were done for all patients. X-ray AP and lateral views of knee with hip and ankle (single film) in standing position were done and following parameters were noted tibio-femoral angle, mechanical axis deviation and mechanical lateral distal femoral angle.

The operation was performed under anaesthesia (general/spinal) with the patient supine on the operation table under tourniquet control. The knee was flexed to 60 degree during the surgery to avoid pressure in the popliteal area. During draping, care was taken to expose the ankle so that the centre of the ankle could be determined easily. The position of limb made in figure of four by flexing the knee. A medial longitudinal skin incision approximately 6-8 cm long is made extending from the level of the medial joint line to 5 cm above the adductor tubercle, the deep fascia was identified and incised in line with the incision. (Picture 1) The vastus medialis was identified and elevated anteriorly. The periosteum incised and elevated anteriorly and posteriorly to expose the femoral metaphysis and to protect the popliteal vessels.

The osteotomy was ‘V’ shaped in the frontal plane. The apex of the ‘V’ lies directly above the adductor tubercle, close to the tip of the intercondylar notch. (Picture 2) The anterior arm of the ‘V’ was slightly longer than the posterior arm, angle between the two was 90 degree. Before performing the osteotomy, a 2mm Kirschner wire was introduced 2-3mm proximal to the adductor tubercle, parallel to distal femoral condyles, and the position was checked by C-arm. Ideally two osteotomy planes should be joined along the wire. The osteotomy was initially performed only on the medial cortex using an oscillating saw with coarse thick blade. The osteotomy was than completed with a thin osteotome.

After completing the osteotomy, the knee was extended and the deformity was corrected with the application of a gentle manual varus force without the use of traction. To obtain correction, 2 mm bone from proximal anterior and posterior segment of the medial cortex was removed. This was important because it allows the narrower medial proximal cortex to penetrate the wider distal metaphysis after correction. The lateral cortex usually was not open in hinge manner but it was stabilized by soft tissue. Therefore, correction was obtained mainly by medial penetration and crushing of cancellous bone. The alignment of the leg was repeatedly checked in extension and amount of medial cortex penetration was closely monitored. Two crossed K-wire were passed from medial and lateral side to stabilize the osteotomy. (Picture 3) A suction drain was placed at the osteotomy site for 24 hours and the wound was closed in layers. Sterile dressing was done and high groin cast extending from groin to ankle was applied. (Picture 4)

Post operatively, antero-posterior and lateral views of the operated knee were done on the first post-operative day intravenous antibiotics were given for 3 days post operatively. Sutures were removed after two weeks. K-wires were removed after 6 weeks, after removing cast. After cast removal at 6 week, the patient was kept on non-weight bearing crutch walk for 3weeks and knee was mobilized. Partial weight bearing with two crutches started at 9 weeks. Full weight bearing started at the end of 12 weeks.

The patients were followed up weekly for one month, fortnightly for two months, monthly till six months of surgery. The parameters of Bostman’s score was evaluated at 6 week, 3 month and then at 6 month. Radiological assessment of the knee was done at 6, 12 and 24 weeks to look for tibio-femoral angle correction, mechanical axis deviation correction, mechanical lateral distal femoral angle correction. The inter-malleolar distance was evaluated at six week and then at three month and then at six month. Any complication like infection, loss of correction, non-union of osteotomy, were observed and managed accordingly.

Categorical variables were presented in number and
percentage (%) and continuous variables were presented as mean ± SD and median. Normality of data was tested by Kolmogorov-Smirnov test. Quantitative variables were compared using Wilcoxon signed rank test (as the data sets were not normally distributed) across follow up. The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

Observations and Results
Thirty Adolescent patients (13-18 years) of genu valgum in which deformity was in femur with tibio-femoral angle >15 degree and inter-malleolar distance >10cm with no collateral ligament instability and no subluxation and sagittal plane deformity were in our cohort. The mean age was 15.4 ± 1.54 and median age was 15. There were 18 females (60 %) and 12 males (40 %) in the study population.

4 cases (13.33 %) were bilateral, 12 cases (43.33 %) were right sided and 14 cases (43.33 %) were left sided. The cause of genu valgum in 18 cases (60.00 %) was post rachitic, in 10 cases (33.33%) the cause was idiopathic, and in 2 cases deformity was due to the trauma. Limb length discrepancy of 1 cm was present in a case preoperatively which remained the same in post op case also. The mean TF angle preoperative was 20.3±3.63 degrees which was 2.9 ± 0.92 degrees at 6 weeks and 5.5±0.73 degrees at 6 months. (p<0.0001) The mean IM distance preoperative was 12.45±2.2 cm which was 1.2±0.34 cm at 6 weeks and 1.63±0.32 cm at 6 months. (p<0.0001) The mean MAD preoperative was 18.96±2.62 which was 1.48±0.5 at 6 weeks and 2.8±0.39 at 6 months. (p<0.0001) The mean LDFA angle preoperative was 76.9±3.33 degrees which was 88.83±1.05 degrees at 6 weeks and 87.7±0.83 degrees at 6 months. (p<0.0001) The complications reported included infection in 2 patients, hypertrophic scar in 1 patient, neuropraxia in one patient. (Table 1) The mean Bostman’s score preoperative was 30±0 which was 5.27±0.98 at 6 weeks, 26.2±1.79 at 3 months and 29.47±0.9 at 6 months. (Table 2) The summary of measurements has been mentioned in Table 3.

Table 1: Showing complications in our cohort

| Complication       | No of patients |
|--------------------|----------------|
| CPN Neuropraxia    | 1              |
| Hypertrophic Scar  | 1              |
| Infection          | 2              |
| Total              | 4              |

Table 2: Table showing Bostman’s knee score

| Bostman’s Knee Score | 6 Weeks | 3 Months | 6 Months |
|----------------------|---------|----------|----------|
| Excellent (28-30)     | 6.66%   | 36.66%   | 96.67%   |
| Good (20-27)          | 33.33%  | 53.34%   | 3.33%    |
| Satisfactory (<20)    | 60.01%  | 10%      | 0%       |

Table 3: Summary of measurements in our cohort

| Parameter                              | Mean     | Median   | P value  |
|----------------------------------------|----------|----------|----------|
| Tibio Femoral Angle                    |          |          | <0.0001  |
| • Pre-op                               | 20.3±3.63| 19.5     |          |
| • 6 weeks                              | 2.9±0.92 | 3        |          |
| • 3 months                             | 4.7±0.84 | 5        |          |
| • 6 months                             | 5.5±7.3  | 5        |          |
| Inter Malleolar Distance               |          |          | <0.0001  |
| • Pre-op                               | 12.45±2.2| 11.7     |          |
| • 6 weeks                              | 1.2±0.34 | 1        |          |
| • 3 months                             | 1.55±0.3 | 1.5      |          |
| • 6 months                             | 1.63±0.32| 1.5      |          |
| Mechanical Axis Deviation              |          |          | <0.0001  |
| • Pre-op                               | 18.96±2.62| 19       |          |
| • 6 weeks                              | 1.48±0.5 | 1.5      |          |
| • 3 months                             | 2.35±0.42| 2.5      |          |
| • 6 months                             | 2.8±0.39 | 2.75     |          |
| Bostman’s Score                        |          |          | <0.0001  |
| • Pre-op                               | 30±0     | 30       |          |
| • 6 weeks                              | 5.27±0.98| 6        |          |
| • 3 months                             | 26.2±7.9 | 27       |          |
| • 6 months                             | 29.47±0.9| 30       |          |
| Mechanical Lateral Distal Femoral Angle|          |          | <0.0001  |
| • Pre-op                               | 76.9±3.33| 76.5     |          |
| • 6 weeks                              | 88.83±1.05| 89       |          |
| • 3 months                             | 87.7±0.99| 88       |          |
| • 6 months                             | 87.17±0.83| 87      |          |
ml in their study which was significant as compared to our study 10 ml on average. ($P<0.0001$) The most important advantage of our technique was flexibility of staged gradual correction which was required to prevent common peroneal nerve stretching although we had one case of CPN neuropraxia which resolved with conservative treatment. Some authors used K-wires from the medial side for the fixation of osteotomy site done for deformity correction in rickets patients and achieved an excellent result in 88.9%.[14]. We felt that K-wire insertion from one side may be sufficient in younger age; however, it is not sufficient enough to hold the fragment in place in young adults or adolescents > 15 years and overweight patients. We reported excellent results (96.67%) with crossed wires and felt it a better mode of implant use for securing fixation. Regarding the union of osteotomy site, they observed shorter periods (6 weeks) than ours (average 9 weeks). This may be due difference in the patient’s age; patients of age 10-12 years in their cohort and 13-18 years in our study.

Slippage of distal femoral epiphysis was observed in study conducted by Agarwal et al. The probable reason was an excessive intraoperative force to crush distal metaphyseal cancellous bone might cause such slippage.[14] However, in our cohort, all patients had either fused or about of fuse distal physis, and hence, this complication was not encountered.

We observed one case of infection similar to their study which was controlled with oral antibiotics. Also, we encountered one patient with common peroneal neuropraxia, who had correction of TFA from 33° pre-operative to 5° post-operatively which resolved on its own with conservative treatment. Although, we encountered CPN neuropraxia, but still we advise staged correction in case with TFA more than 25° to prevent nerve stretching. This benefit of gradual correction is not possible with rigid implants and additional common peroneal nerve decompression is required if full correction is done at a time. Thus, another incision on the lateral aspect of the knee is required leading to another scar which might not be acceptable to most patients’ especially young females.

Our study had few limitations despite excellent results. Firstly, it was a prospective study where comparison between the techniques or implants could not be reported. However, our results were comparable to other studies done. Moreover, we could not predict the effects of osteotomy and change in joint biomechanics during adult life. Lastly, any effects on future knee replacement surgery in such patients, if required.

**Conclusion**

We conclude that wedgeless ‘V’ shaped distal femoral osteotomy could be a viable option for correction of genu valgum deformity. The potential advantages included small incision, minimal blood loss, no leg length discrepancy, decrease chances of knee stiffness, non-rigid fixation and early union. Patients could have excellent range of motion and functional activities.

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**Conflict of Interest:** Authors have no conflict of interest.

**Ethics Clearance:** Taken

**Disclosure:** None
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