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ORIGINAL STUDY

Genu valgum deformity – correction by a wedgeless implantless femoral "V" osteotomy

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Coronal malalignment of the knee joint is very common in developing countries especially because of nutritional rickets. Significant valgus deformity needs to be treated surgically to improve appearance, gait and function of the patient. The purpose of this prospective study was to evaluate the results of supracondylar "V" osteotomy as a surgical technique for correction of the valgus knee deformity.

This study was conducted in a tertiary level teaching hospital and 30 cases were included in the study. For all the patients deformity was assessed using anatomical tibiofemoral angle, mechanical axis deviation and intermalleolar distance preoperatively and postoperatively.

The average age of our patients was 13.7 years and the average follow up was3.29 years (1.39-14.22 yrs). Clinically the average value of intermalleolar distance preoperatively was 16cm and 3.2 cm postperatively. Average pre-operative tibiofemoral angle was 23° and the average postoperative angle was 6^0 which was found to be statistically significant using the Paired t test ($p<0.005$). The average value of preoperative mechanical axis deviation was 3.1 cm which decreased to an average value of 1.1 cm postoperatively.

The results with this technique have been encouraging. The advantages of this technique are low morbidity, good stability allowing early ambulation, ability to adjust alignment postoperatively by casting and no need for internal fixation. Few studies have been conducted on osteotomies that do not require internal fixation and are inherently stable. This technique has the advantage of practically no occurrence of any infection or a second surgery to remove hardware in children and adolescents. Since no specialized instrumentation, image intensifier and implants are required, it is cost effective and can be used in any primary care or district level surgical setup in a developing country like ours.

Keywords : genu valgum ; osteotomy ; deformity ; paediatric ; knee.

INTRODUCTION

Deformities of the knee joint are probably the most common and obvious malalignment seen in orthopaedic practice. Genu valgum can be caused by a variety of metabolic conditions like rickets, epiphyseal damage due to trauma, infection or tumor *(1)*. Nutritional rickets is one of the most common cause in developing countries. Any shift in the normal axis of the lower limb alignment

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Figure 1. — Skin Incision.

Figure 2. — "V" osteotomy marked on the medial supracondylar region of the femur.

Figure 3. — Completion of osteotomy before deformity correction with anterior arm of v longer than the posterior arm.

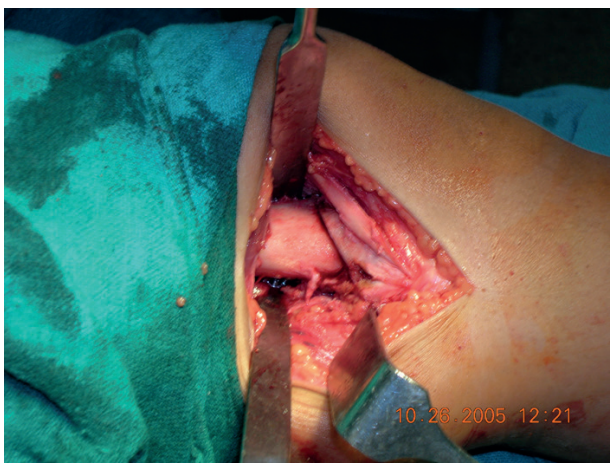

Figure 4. — The narrower medial proximal cortex penetrating the wider distal cancellous metaphyseal area after deformity correction.

may affect mechanical load distribution at the knee and has been shown to predispose to osteoarthritis progression in animal studies *(2)*. Sharma et al *(3)* in their study found that varus and valgus malalignment increases risk of osteoarthritis development and progression. Also abnormal biomechanical loads on the knee due to lateralization of mechanical axis can lead to anterior knee pain, patellofemoral instability, circumduction gait, difficulty in running and increase chances of accelerated degenerative changes *(4)*. Uncorrected significant valgus deformity requires a surgical intervention to improve appearance, gait and function. Surgical procedures for correction of these deformities include hemiepiphysiodesis and osteotomies. The most common location of the genu valgum deformity is the distal femur and various kinds of osteotomies like the opening wedge, closing wedge and dome technique have been used for corrective surgery. Most of them generally require some kind of internal fixation.

This prospective study was done to evaluate the results of supracondylar V osteotomy as a surgical technique for correction of the genu valgum knee deformity. The advantages of this relatively simple technique include low morbidity, good stability, early weight bearing, no need for internal fixation and ability to adjust alignment postoperatively by casting. Few studies have been conducted on

Figure 5A. — Preoperative deformity in patient no 1 (bilateral deformity).

Figure 5B. — Postoperative picture of patient no1 (bilateral deformity).

Figure 5C. — Functional status of the patient no1 showing full range of motion at the knee joint.

Figure 5D. — Preoperative radiographs (Rt : Tibio Femoral Angle- 22 degrees .Mechanical axis deviation 3.0 cm.Lt : Tibio-Femoral Angle : 26 degrees. Mechanical axis deviation 3.3 cm)..

Figure 5E. — Postoperative radiographs (Rt : Tibio Femoral Angle- 2 degrees .Mechanical axis deviation 0.7 cm.Lt : Tibio-Femoral Angle : 6 degrees. Mechanical axis deviation 0.4 cm).

osteotomies that do not require internal fixation and are inherently stable. This technique has the advantage of practically no occurrence of any infection or a second surgery to remove hardware in children and adolescents and a short learning curve. Since no specialised instrumentation and implants are required, it is cost effective and can be used in any primary care surgical setup in a developing country like ours.

MATERIALS AND METHODS

We studied 30 cases (limbs) in a total of 17 patients, 13 of which had bilateral and 4 had unilateral genu valgum deformity. This study was conducted over a period of 3 years between 2005 and 2008 after institutional approval in a tertiary care teaching hospital. Patients with significant or symptomatic genu valgum deformity (>15 degrees of tibio femoral angle or intermalleolar distance greater than 10 cm) *(5)* were included in the study. Patients with severe ligament laxity and coexistent severe sagittal plane deformity were excluded from this study.

Complete history including the onset of deformity, its progression and associated problems were recorded. A complete physical examination was performed for every patient. The knee flexion test was used to ascertain the site of the deformity. In patients with deformity in the distal femur the deformity disappears when the patient squats or

Figure 6A. — Preoperative deformity in patient no 2 (bilateral deformity).

Figure 6B. — Postoperative deformity in patient no 2 (bilateral deformity).

Figure 6C. — Functional status of the patient no2 sitting cross legged (bilateral deformity).

Figure 6D. — Functional status of the patient no2 squatting showing full range of motion at the knee joint.

Figure 6E. — Preoperative radiographs (Rt : Tibio Femoral Angle- 26 degrees .Mechanical axis deviation 5.1 cm.Lt: Tibio-Femoral Angle: 19 degrees. Mechanical axis deviation 3.15 cm).

Figure 6F. — Postoperative radiographs (Rt : Tibio Femoral Angle- 6 degrees. Mechanical axis deviation 0.1 cm.Lt : Tibio-Femoral Angle : 7 degrees. Mechanical axis deviation 0.1 cm).

flexes his knees. Clinically the intermalleolar distance was measured in a standing position with the patella facing forward, the knees extended and the medial surface of the knees touching each other.

The patients were investigated for conditions like osteomalacia, rickets, multiple epiphyseal dysplasia and renal osteodystrophy to ascertain the cause of genu valgum deformity. Serum calcium/phosphate, serum alkaline phosphate and kidney function test were done for all the patients. Patients were taken up for osteotomy only after the medical correction of the underlying metabolic disorder.

Standing anteroposterior and lateral radiographs were taken of the affected limb including the hip, the knee and the ankle joint. The anatomical tibiofemoral angle between the anatomical axes of tibia and femur was calculated on the standing full length radiograph using a specialised software. The Malalignment test (MAT) as described by Paley et al *(6,7,8)* was used to assess the severity of the deformity. Mechanical axis was drawn from centre of femoral head to the ankle joint. Mechanical axis deviation (MAD) was calculated as the distance between the centre of knee joint and the mechanical axis in the frontal plane. Accurate location of the site of deformity and its magnitude was calculated preoperatively using the Paley test. The Lateral Distal Femoral Angle (LDFA) and the Medial Proximal Tibial angle (MPTA) as described by Paley were recorded to ascertain the location and magnitude of the deformity. Osteotomy was done keeping these parameters in mind so as to restore the mechanical axis (as measured by MAD) and the joint line orientation (as measured by LDFA) back to normal values. Postoperatively after union these parameters were again measured on full length standing xrays to corroborate the clinical results.

The operation was performed under spinal/ general anaesthesia with the patients supine on a normal operating table. Tourniquet was applied over the upper one third of the thigh. The knee was flexed to 60° 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.

A medial longitudinal skin incision approximately 8-10cm long is made extending over the supracondylar area from the level of the medial joint line to 5cm above the adductor tubercle. The vastus medialis was identified and elevated. Periosteum was incised and stripped anteriorly and posteriorly except laterally to expose the femoral metaphysis and to protect the popliteal vessels. Adductor tubercle was identified.

The osteotomy is "V" shaped in the frontal plane. The apex of the "V" lies directly above the adductor tubercle, close to the top of the inter condylar notch. The posterior arm of the "V" is slightly shorter than the anterior arm and the angle between the two is 90^0. A slightly longer anterior arm is desirable, because it resists backward rotatory forces imposed by the pull of the gastrocnemius and because the posterior cortex is much stronger than the anterior cortex *(14)*. The osteotomy was first marked using the osteotome. The osteotomy was initially performed only on the medial cortex using an oscillating saw with a coarse thick blade. The osteotomy was then completed with thin osteotomes. It decreases the risk of heat necrosis and gently fractures the lateral cortex without undue periosteal disruption. An aggressive division of the periosteum and soft tissues on the lateral side can make the osteotomy more unstable. Irrigation with saline was done during the osteotomy to reduce heart necrosis. After the osteotomy was completed the knee was extended and the deformity was corrected with the application of a gentle manual force without the use of traction.

A small part of the bone from the anterior and posterior segments of the proximal medial cortex was removed. Because of the shape of the medial aspect of lower femur, it allowed the narrower medial proximal cortex to penetrate the wider distal cancellous metaphyseal area after correction. The soft tissue towards the lateral cortex was not disrupted and there was no opening or translation of the lateral cortex. Therefore correction was obtained mainly by the medial penetration and crushing of the cancellous bone. Medial or lateral translation was not necessary or desirable and no wedges were taken. The alignment of the leg in extension was checked visually and also confirmed by the bovie cord or alignment rod to obtain a final alignment of about 5 to 7° of valgus.

Stability of the osteotomy in flexion and extension was checked on table after correction of the deformity.

The osteotomy was sufficiently stable and there was no need for internal fixation. Tourniquet was released and haemostasis achieved. A suction drain was inserted and the wound was closed in layers. A cylindrical long leg cast was applied from the groin to the ankle to immobilize the knee joint.

The patient was kept recumbent for a few days until comfortable. Drain was removed at 48 hours after the surgery and amount of blood collected in

the drain was noted. The patients were kept non weight bearing for 3-6 weeks depending on the age. It was followed by partial weight bearing with 2 crutches as tolerated. The plaster cast was kept till there was clinical and radiological evidence of the union of the osteotomy. After removal of the cast active assisted range of motion exercises were started. The patient was allowed full weight bearing and more demanding activities as his or her muscle strength and symptoms allowed. Patients were reviewed at 3 weeks interval.

Standing X-ray both AP and lateral views were taken at immediate postoperative period and at 3 weekly intervals. The patients were evaluated clinically and radiologically for the alignment and state of union of the osteotomy. The patients were also evaluated for the range of motion of knee joint at each visit after cast removal. The final results were calculated at the end of three months. All the parameters mentioned earlier such as intermalleolar distance, anatomical tibiofemoral angle, LDFA, MPTA, MAD were calculated postoperatively.

Anatomical tibiofemoral angle before and after the surgery was used to evaluate the results. Paired t-test was used as the statistical method to determine whether the results were statistically significant ($p<0.05$) or not. Patients were followed up every 3 months thereafter to look for any recurrence or late complication.

RESULTS

Our study included 30 limbs in 17 children and adolescents presenting with coronal plane deformity around the knee joint. Rickets is still one of the major causes of knock knees and bow legs in developing countries. In this study rickets was the cause of genu valgum in 9 children. Three patients with bilateral genu valgum had skeletal findings suggestive of multiple epiphyseal dysplasia. A skeletal survey was performed for these patients. In the remaining 5 patients no abnormality could be detected and they were classified as idiopathic. Patients were taken up for osteotomy only after the correction of the underlying metabolic abnormality.

The average age of patients in our study was 13.7 years (range 11-19 yrs)(Table 1). The average follow up was 3.29 years (1.39-14.22 yrs). Out of the total 17 patients, 11 patients were female and 6 patients were male (Table 1). The right side was affected in 14 cases and the left side in 16 cases. The average tibiofemoral preoperatively in our study was 23^0 and postoperatively was 6^0 (Table 2). Paired t test was used as the statistical method and the difference between the preoperative and postoperative values of tibiofemoral angles was found to be statistically significant (p value<.005). Clinically the average value of intermalleolar distance preoperatively was 16 cm and 3.2 cm postperatively (Table 2). The average value of preoperative mechanical axis deviation was 3.1cm which decreased to an average value of 1.1 cm postoperatively (Table 2).

Table 1

Age (in years)	13.7 (11-19)
Sex	
Male	6
Female	11
Average follow up (in years)	2.09 (1.39-2.90)
Operative time	29
Average blood loss (ml)	184

Table 2

	Preoperative value	Postoperative value
Tibiofemoral angle	23^0	6^0
Intermalleolar distance	16 cm	3.2 cm
Mechanical axis deviation	3.1 cm	1.1 cm
Lateral distal femoral angle	77^0	90^0

The average value for Lateral distal femoral angle (LDFA) before surgery was 77^0 and after surgery was 90^0 (Table 2). The average operation time in our study was 29 minutes and the average blood loss was 184ml (Table 1). 28 cases achieved range of motion more than 120^0 after three months of cast removal at the knee joint. 1 patient with a bilateral deformity could only regain motion till 100°.

2 patients developed superficial wound infection in stitch line which healed with regular dressings and a course of oral antibiotics. There were no cases of nonunion of the osteotomy site.

However there was a late recurrence of the valgus deformity in a female patient. She had bilateral genu valgum deformity which was operated when she

was 13 years of age in 2006 and her intermalleolar distance improved from 13 cm to 4 cm with surgery. This patient developed a recurrence of deformity when she had a growth spurt and increase in height towards the end of her teenage. Probably she had some unrecognized physeal damage which caused a visible recurrence when she gained height.

She was again operated at nineteen years of age with distal femoral osteotomy with plate fixation. Her deformity was corrected and she has been in follow up since then for fourteen years now with no recurrence.

DISCUSSION

Accurate correction of malalignment and joint orientation is important for optimal function and to prevent joint degeneration. Valgus deformity at knee usually is in the distal femur and probably the most common corrective procedure would be a varus osteotomy through distal femur *(9)*. Various other studies have also recommended distal femoral osteotomy over proximal tibial osteotomy. *(10,11,12,13,14,15)*. Various types of femoral osteotomies and methods of fixation have been used to correct the genu valgum deformity with the aim to achieve a normal alignment of the lower limbs.

An opening wedge technique is not recommended for routine correction of bilateral physiologic genu valgum. It is only recommended if the patient has a limb length discrepancy *(16)*. The opening wedge osteotomy can cause traction injury to the nerves and vessels *(17,18)*. The bone grafting of the osteotomy site is associated with potential problems regarding consolidation and stability of the osteotomy site. Besides the requirement for iliac crest bone graft for the opening wedge technique, healing is much slower and loss of correction with recurrent valgus is a distinct possibility due to graft resorbption or failure of internal fixation before union of the osteotomy site. Moreover it requires a second operation for harvesting the graft thereby increasing the morbidity *(19)*. Intercondylar osteotomy is an intra-articular procedure and is only found to be useful if the patient has associated conditions such as incongruence of the femoral and tibial articular surfaces *(20,21).*

Closing wedge osteotomies have the disadvantages of needing greater exposure of the bone circumferentially to remove safely a wedge of bone and can also cause limb shortening *(22,23)*. The valgus barrel vault or dome osteotomy *(24,25,26)* also has some limitations. The associated axial rotation cannot be corrected and in severe cases the excessive translation required at the osteotomy site may limit the full correction of the deformity *(27)*. The disadvantage of technique of incomplete osteotomy followed by osteoclasis as described by Smith et al. *(28)* is it being a two stage procedure . Various methods of internal and external fixation have been used to achieve osteosynthesis of the osteotomy site *(18,27,29)*.

Aglietti et al. *(14)* presented a series or 14 patients for correction of valgus deformity of knee by V shaped supracondylar femoral osteotomy. They attributed various advantages to this procedure like early weight bearing and good stability. The osteotomy is performed over the metaphyseal area with good amount of cancellous bone and involves a large area of bony contact. No important change in the relationship between patella and femur resulted. The medial exposure required was small and the entire operation was done without entering the knee joint.

The supracondylar "V" osteotomy has various advantages as concluded in our study. The surgical time and blood loss are minimal. No implants are required making this procedure very cost effective. Moreover there is no need for second surgery for removal of implants. The "V" shape allows correction while preserving sufficient interfragmentary stability and allows minor degree of malalignment to be corrected postoperatively by adjusting the postoperative cast. The correction is obtained mainly by crushing of the cancellous bone in the metaphyseal region. This ensures early union of osteotomy permitting early weight bearing and the chances of non union are very low. Better cosmesis of the surgical scar since the osteotomy involves only a small skin incision on the medial side of the lower femur. This osteotomy is simple to perform and has a short learning curve. No translation occurs at the osteotomy site. Thus weight-bearing alignment of the lower limb is maintained. The whole procedure

is extra articular reducing the potential incidence of postoperative stiffness and intra articular infection.

Our experience and clinical results obtained with this relatively new technique for correcting the valgus deformity at the knee joint have been satisfactory. Few studies have been conducted on osteotomies that do not require internal fixation and are inherently stable. This technique has the advantage of practically no occurrence of any infection or a second surgery to remove hardware in children and adolescents. Also no specialised instrumentation, image intensifier and implants are required, The supracondylar "V" osteotomy for the correction of the coronal plane deformities of the knee joint is a very simple and cost effective procedure and can be used in any primary care or district level surgical setup in a developing country like ours.

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