



Wedgeless 'V' shaped distal femoral osteotomy with internal fixation for genu valgum in adolescents and young adults

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The treatment of angular malalignment includes restoration of normal mechanical axis alignment and joint orientation. The supracondylar wedgeless distal femoral 'V' osteotomy, as a treatment modality, is sparsely explored in the literature.

This study was conducted at a tertiary level teaching referral hospital from October 2010 to September 2012. Forty six lower limbs (in 30 patients) were operated with a wedgeless 'V' osteotomy that was fixed with a buttress 'L' plate. The pre-operative deformity, post-operative correction and knee range of movement were noted. Mobilisation was started at 3 weeks after surgery and full weight-bearing was allowed at 3 months. The knee score by Bostman *et al.* was used for functional outcome.

The mean age of the patients in our study was 16.9 years (range : 15 years to 23 years). The patients were followed up for a mean period of 19.8 months (range, 15 months to 29 months). The mean radiological tibiofemoral angle was 22.2° (range, 16° to 29°) before surgery, that improved to a mean postoperative value of 5.1° (range, 0° to 10°) ($p < 0.001$). The mean preoperative lateral distal femoral angle was 79.23° that improved to a mean value of 89.13° after surgery ($p < 0.001$). The mean mechanical axis deviation was 19.56 mm before surgery that improved to a mean postoperative value of 3.7 mm ($p < 0.001$). All patients reached a correction of the deformity and 44 cases out of a total of 46 had an excellent functional outcome, 2 patients had a good functional outcome. None had an unsatisfactory outcome. Two cases had a deep wound infection that subsided after implant removal. None of the cases had other complications. The distal femoral 'V' shaped osteotomy is a simple procedure for the correction of genu valgum in indi-

viduals nearing skeletal maturity and is easy to perform. It has the advantage of being wedgeless as it does not cause limb length discrepancy. Internal fixation helps in early rehabilitation after surgery.

Key-words : Coronal plane deformity ; genu valgum ; corrective surgery ; osteotomy ; internal fixation.

INTRODUCTION

Coronal plane knee deformities are common disorders affecting adolescents. Nutritional rickets is the leading cause of these deformities in developing countries. The deformity may originate from the distal femur, proximal tibia, or knee joint (6,7,13). However, genu valgum usually originates from the distal femur that may be confirmed by various angle measurements on standing radiographs of

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both lower limbs including hips, knees, and ankles (13). Various types of corrective osteotomies of the distal femur have been described in the literature as there are : lateral opening wedge, medial closing wedge, dome osteotomy, wedge-less spike osteotomy, and wedge-less 'V' osteotomy (1,3-5,8-12,14,15). The distal femoral wedge-less 'V' osteotomy was originally described by Aglietti *et al*, however, the primary indication of performing the surgery was genu valgum secondary to lateral compartment osteoarthritis (1). The distal femoral wedge-less 'V' osteotomy, in our opinion, is a safe, effective, and easy to perform surgery with a short learning curve. As the literature on the 'V' osteotomy remains sparse, we prospectively sought to evaluate the results of this osteotomy with internal fixation in genu valgum deformity in adolescents and young adults.

PATIENTS AND METHODS

The study was prospectively conducted at the tertiary care referral, teaching hospital and included 30 adolescent or young adults presenting with a genu valgum deformity. Sixteen of them had bilateral deformity, 14 unilateral (in total 46 limbs). All the patients were selected from the outpatient department of the institute considering the inclusion criteria and were scrutinized through clinical assessment, radiological and biochemical investigations. The patients with genu valgum deformity having a tibiofemoral angle of more than 15° and an intermalleolar distance of more than 10 cm were considered for possible inclusion in the study. Patients who had severe collateral ligament instability, unstable knee with evidence of subluxation, and sagittal plane deformity (fixed flexion deformity > 15° or genu recurvatum) were excluded from the study. The patients were investigated for conditions like osteomalacia/ rickets, multiple epiphyseal dysplasia, or renal osteodystrophy etc. The blood profile included serum calcium/ phosphate, serum alkaline phosphatase and kidney function tests. Patients with active underlying disorder first underwent medical management prior to surgery. Patients who were considered suitable for surgery underwent a deformity correction by a supracondylar femoral wedgeless 'V' osteotomy, as described by Aglietti *et al* (1), with plate fixation.

The deformity assessment was done clinically and radiologically. The knee flexion test was used to assess the origin of the deformity (7). Clinically, the intermalle-

olar 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. Clinically, the tibiofemoral angle was also assessed by measuring the angle between the line drawn from the anterior superior iliac spine to the centre of the patella and the line joining the centre of the patella to the centre of the ankle joint. Standing anteroposterior and lateral radiographs of the affected limb were taken including the hip, knee and ankle joint (Fig. 1a). The radiological tibiofemoral angle was measured as the angle formed between the anatomical axes of tibia and femur. The mechanical axis of the lower limb was defined as the line drawn from the centre of the femoral head to the centre of the ankle. The distance between the mechanical axis line and the centre of the knee in the frontal plane was calculated as the mechanical axis deviation (MAD). The malalignment test (MAT), as described by Paley *et al*, was used to assess the severity of the deformity as it is the most specific test for the assessment of coronal plane deformities and helps to locate whether the deformity is in the distal femur or the proximal tibia or both (13). The lateral distal-femoral angle (LDFA) was calculated as the angle between the mechanical axis of the femur and the articular surface of the distal femur and the medial proximal tibial angle (MPTA) was calculated as the angle between the tibial mechanical axis and the articular surface of the proximal tibia.

The results were evaluated by the anatomical tibiofemoral angles before and after surgery that were measured on radiographs by drawing the longitudinal axis midway between tibial and femoral diaphyseal cortices.

Surgical Technique

The operation is performed under anaesthesia (general/spinal) with the patient supine on a radiolucent operating table under tourniquet control. The knee is flexed to 60° during the surgery to avoid pressure in the popliteal area by keeping a large bolster under it. During draping care is taken to expose the ankle so that the centre of the ankle could be determined easily. An ECG electrode is pasted on the skin overlying the center of the femoral head that was confirmed under C-arm image intensifier.

A medial longitudinal skin incision approximately 8-10 cm long is made extending from the level of the medial joint line to 5 cm above the adductor tubercle. The deep fascia is identified and incised in line with the incision. The vastus medialis is identified (Fig. 1b) and elevated anteriorly. The periosteum is incised and elevat-



Fig. 1a. — Pre-operative standing long leg radiograph including bilateral hips, knees, and ankles showing bilateral genu valgum deformity of femoral origin.



Fig. 1b. — Per-operative photograph of the patient showing identification of the vastus medialis (marked with blue colored star) which is to be lifted off anteriorly to expose bone.



Fig. 1c. — 'V' osteotomy, marked with methylene blue dye, has 2 limbs pointing distally (long anterior limb and short posterior limb) over the adductor tubercle.

ed anteriorly and posteriorly to expose the femoral metaphysis and to protect the popliteal vessels. The adductor tubercle is identified. The osteotomy is '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. The anterior arm of the 'V' is slightly longer than the posterior arm, both being perpendicular to each other (Fig. 1c). The slightly longer anterior arm resists backward rotator forces imposed by the pull of the gastrocnemius as the posterior cortex is much stronger than the anterior cortex. The osteotomy is first performed only on the medial cortex using an oscillating saw with a coarse, thick blade. The osteotomy is then completed with a thin osteotome. It decreases the risk of heat necrosis and

helps in thinning 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. A gentle valgus thrust is applied to break the lateral cortex gently. After the osteotomy is completed, the knee is extended and the deformity is corrected with the application of a gentle manual varus force. A small part of the bone from the proximal anterior and posterior segments of the medial cortex is nibbled using a bone nibbler. This is important as it allows the narrower medial cortex to penetrate the wider distal metaphysis after correction. The lateral cortex usually does not open up because of intact soft tissue cover. Therefore, the correction is obtained primarily by



Fig. 1d. — Clinical photograph of the patient showing excellent deformity correction.

the medial penetration and impaction of the cancellous bone. No wedges are taken and medial-lateral translation is not desirable or necessary as the osteotomy is close to the center of rotation of angulation. The alignment of the leg is repeatedly checked in extension and the amount of medial cortical penetration is closely monitored, to obtain the final alignment of about 5 to 7 degrees of valgus. The osteotomy is then stabilized further by internal fixation with a customised 'L' buttress compression plate and fixed with screws. The internal fixation was not originally described in the 'V' osteotomy (*1*). The deformity correction assessment (with the use of a cautery lead), position of screws and plate is finally done under image

intensifier. Stability of the osteotomy in flexion and extension is checked on the table after correction of the deformity. Tourniquet is released and haemostasis achieved. A suction drain is inserted and the wound is closed in layers. A high groin above knee slab is applied from groin to ankle to immobilise the knee joint for 3 weeks.

Post-operative care

The patient is kept recumbent for a few days until comfortable. The drain is removed at 24-48 hours after surgery and the amount of blood collected in the drain is noted. Sutures are removed at 2 weeks. The patients are kept non-weight bearing for 3 weeks to be followed by partial weight bearing with 2 crutches as tolerated. After removal of the cast, active assisted exercises are started. The patient is allowed full weight bearing and more demanding activities as his or her muscle strength and symptoms allows. Patients were reviewed at 3 weekly intervals.

Standing radiographs both AP and lateral views were taken in the immediate post-operative period and at 4 weekly intervals. The patients were evaluated clinically (Fig. 1d) and radiologically for the alignment and state of the union of the osteotomy (Fig. 1e). Patients were also evaluated for range of motion of the knee joint at each visit after cast removal. Patients were followed-up on an out-patient basis as the osteotomy united over a period of three months. The knee score as suggested by Bostman *et al* was used to assess the functional outcome (*2*). Patients with a score between 28 and 30 were classified as having excellent outcome. A score between 20 and 27 was good and a score below 20 was classified as unsatisfactory.

Statistical analysis

The student's paired t-test was used to analyze the difference of means for tibiofemoral angle, intermalleolar distance, mechanical axis deviation, and lateral distal femoral angulation values preoperatively and postoperatively to determine whether the results were statistically significant. A two-tailed p value of < 0.05 was considered significant.

RESULTS

Forty six limbs (24 left sided and 22 right sided) were operated in 30 patients and the patient cohort consisted of 25 females and 5 males. The mean age



Fig. 1e. — Post-operative standing long leg radiograph including bilateral hips, knees, and ankles showing adequate correction of the deformity at 24 months follow-up.

of the patients in our study was 16.9 years (range : 15 years to 23 years). The majority of the patients (27 out of 30) mentioned the cosmetic deformity of the knee as the presenting complaint, 11 patients had pain on presentation, 7 patients complained of gait abnormalities, and only 2 patients had a history of a fall while walking. In nineteen cases the deformity was considered idiopathic in nature, 10 of the patients had evidence of nutritional rickets/osteomalacia, and one patient had a post-traumatic genu valgum deformity. The average amount of blood loss was 125 ml (range, 40 ml - 250 ml). The mean duration of hospital stay was 4 days (range, 3 days - 7 days). The mean period of follow-up was 19.8 months (range, 15 months to 29 months).

The mean pre-operative intermalleolar distance was 13.83 cm (range, 9 cm - 21 cm) that improved to a mean post-operative value of 1.5 cm (range, 0 cm - 6 cm) ($p < 0.001$). The mean clinical tibio-

femoral angle was 23.5° (range, 18° to 30°) before surgery, that improved to a mean postoperative value of 6.1° (range, 0° to 10°) ($p < 0.001$). Similarly, the mean radiological tibiofemoral angle was 22.2° (range, 16° to 29° and standard deviation, 2.926) before surgery, that improved to a mean postoperative value of 5.1° (range, 0° to 10° and standard deviation, 2.126) ($p < 0.001$). The mean preoperative LDFA was 79.23° (range, 72° to 83° and standard deviation, 2.907) that improved to a mean value of 89.13° (range, 87° to 91° and standard deviation, 2.029) after surgery ($p < 0.001$). The mean MAD was 19.56 mm (range, 9 mm to 31 mm and standard deviation, 6.625) before surgery that improved to a mean postoperative value of 3.7 mm (range, 0 to 5 mm and standard deviation, 3.875) ($p < 0.001$). Forty four cases out of 46 (95.65%) had an excellent outcome with a knee score ≥ 28 . Two patients had good functional outcome and had a knee score of 27. None of the patients had an unsatisfactory knee score.

Two cases had a deep wound infection that required implant removal at 6 and 8 months respectively. Both cases responded well after implant removal. None of the cases had other complications like knee stiffness, recurrence of deformity, shortening, reversal of deformity, or non-union of the osteotomy site.

DISCUSSION

Genu valgum in adolescents and young adults is a frequent cause of orthopaedic referral (6). The coronal plane malalignment increases the risk of osteoarthritis development and progression (17). The abnormal biomechanical loads on the knee due to lateralization of the mechanical axis in genu valgum may lead to anterior knee pain, patella-femoral instability, circumduction gait, and difficulty in running. Significant valgus deformity requires surgical intervention to improve the biomechanics, thus improving appearance, gait and function (13).

An osteotomy to correct valgus deformity can be performed either at the lower end of the femur or at the upper end of the tibia. Valgus deformity of the knee is usually in the distal femur and probably the most common corrective procedure would be a

varus closing wedge distal femoral osteotomy (1,3,5,8-12,14,15) A closing wedge osteotomy carries the disadvantage of causing limb shortening. Additionally, it requires greater circumferential exposure of the bone to remove a wedge. The dome osteotomy also has some limitations (19). 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. The technique of osteotomy-osteoclasis is essentially a two-stage procedure (18).

Aglietti *et al* (1987) were the first to describe the supracondylar 'V' osteotomy in their study of 14 patients (age group, 15 to 77 years) who presented a mean tibiofemoral angle of 21° preoperatively, that improved to 2.3° after surgery (1). The majority of patients in their study (9 patients) had genu valgum secondary to lateral compartment osteoarthritis of the knee (age group, 52 to 77 years). The other 5 patients had genu valgum secondary to other causes like idiopathic, iatrogenic, juvenile rheumatoid arthritis, or neuropathic joint. They reported satisfactory preliminary experience with this procedure which is relatively simple with a low morbidity, good stability, no need for internal fixation and with the ability to adjust the alignment with a postoperative cast.

As apparent from its original description, Aglietti *et al* performed the 'V' osteotomy principally for genu valgum due to lateral compartment osteoarthritis (9 out of total 14 cases) (1). We performed this osteotomy for the surgical correction of genu valgum in adolescents and young adults only.

A similar type of operation, the so-called 'spike osteotomy', was reported by Dietz and Weinstein as they reviewed 50 cases with angular deformities of the long bones (5). The most common diagnosis for which they performed this osteotomy was Blount's disease (8 cases). They concluded it as safe and effective surgery, but reported loss of correction of > 5° in four cases.

Several authors have shared their experience with internal or external fixation following distal femoral osteotomy. Seah *et al* obtained accurate correction of deformities with either of the fixation techniques and suggested that the method to be used should be left to the discretion of the surgeon

and the wishes of the patient after pre-operative explanation of pros and cons of each of the techniques (19).

We performed a wedgeless supracondylar 'V' osteotomy in all of the described cases. Correction was obtained by medial penetration and crushing of the cancellous bone. Mediolateral translation was not necessary as no wedges were taken (1). Internal fixation was done with an 'L' buttress plate that was moulded to provide best fit for the medial condyle. The supracondylar 'V' osteotomy is very useful in a developing country like ours as surgical time and blood loss are minimal and, in our opinion, it has a short learning curve. The shape of the osteotomy allows correction while preserving sufficient stability. However, in its original description, the internal fixation was not performed; instead cast immobilization was considered for prolonged period. We prefer internal fixation with a buttress plate that has the advantage of early mobility and rehabilitation which may reduce the morbidity of the patient and save time in comparison to the correction without plate.

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