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Evaluation of medial open wedge high tibial osteotomy in patients with varus mal-union after fractures of proximal tibia

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Abstract
Background: Aim of our study was to assess the functional outcome of Medial Open Wedge High Tibial Osteotomy performed in patients of varus mal-union after intra-articular fractures of proximal tibia.
Methods: This study included prospective analysis of 16 patients of varus mal-union of tibia after intra-articular fractures of proximal tibia treated at our institute between June 2011 to January 2018. All patients were operated under spinal anaesthesia. Patients were called every 2 weeks for follow up examination till 3 months, every month till 6 months, every 2 months till one year and yearly thereafter. Radiographs were taken at 6^{th} and 12^{th} week. Knee Society Scoring system was used to evaluate Functional Outcome.
Results: 16 patients diagnosed as varus mal-union of tibia presenting after minimum of 6 months after the treatment for intra-articular fractures of proximal tibia were included in the study. There were 14 male patients and 2 female patients, with the mean age of 47 years (range, 26–55 years). Mean duration of follow-up from the time of Medial Open Wedge High Tibial Osteotomy was 3.2 years. (Range 2 – 4.5 years). All patients achieved clinical and radiological union from 3.5 to 6 months with mean interval of 4.2 months. Medial Proximal Tibial Angle was corrected from mean 75^0 (range 70^0-85^0) to mean 87^0 (range 83^0-90^0) (P<.001). Functional scores improved from mean of 27% to 89% (P<.001) at final follow up examination. 13 patients (81.25%) had excellent outcome (KSS > 90), 2 (12.5%) had good outcome (KSS 75-90) and one patient (6.25%) had fair outcome (KSS 60-75).
Conclusions: Our study results demonstrates that Medial Open Wedge High Tibial Osteotomy is safe and effective procedure for varus mal-united proximal Tibial fractures in relatively young patient category.

Keywords: High tibial osteotomy, medial open wedge, Va rus Mal-union

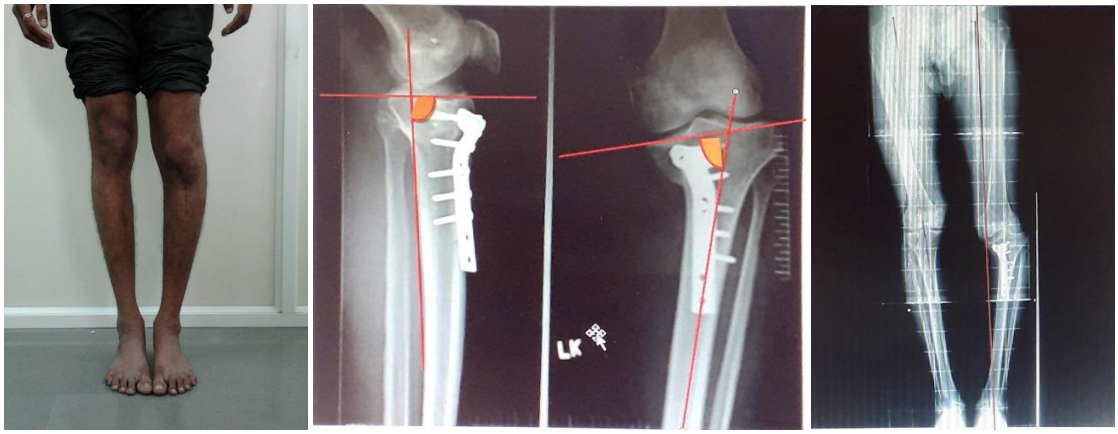
Introduction
Varus mal-union is a common complication after intra-articular fractures of proximal tibia. Various studies have shown an incidence of 9.6% to 27% cases of varus mal-union after intra-articular fractures of proximal tibia [1, 2]. Varus mal-union, especially in young active patients will lead to medial compartment overloading and development of secondary osteoarthritis [3, 4, 5]. It is important to delay and reduce the need of Total Knee Arthroplasty in young active patients with varus mal-union. Different types of High Tibial Osteotomies have been described for the correction of varus deformity. Controversy exists over the best type of High Tibial Osteotomy [6-9]. Aim of our study was to assess the functional outcome of Medial Open Wedge High Tibial Osteotomy performed in patients of varus mal-union after intra-articular fractures of proximal tibia. Our research question was whether Medial Open Wedge High Tibial Osteotomy achieves good results in young active patients presenting with varus mal-union after intra-articular fractures of proximal tibia.

Materials and methods
This study included prospective analysis of 16 patients of varus mal-union of tibia after intra-articular fractures of proximal tibia treated at our institute between June 2011 to January 2018. The study was approved by the Institutional Review Board. The study was performed according to the guidelines and ethical standards of the Heksinki declaration.

Informed consent was given by all the included patients. We included young patients of age between 25 to 55 years presenting with varus mal-union of tibia, moderate to severe pain, abnormal gait due to varus thrust, unstable knee and stage I or II arthritis. Patients with severe arthritis (stage III and stage IV), those with neurovascular complications, Rheumatoid Arthritis, Ankylosing Spondylitis and those above 55 years of age were excluded from the study.

Through clinical and radiological examination of all the Patients was done and following parameters were noted:

1. Varus deformity was calculated with Medial Proximal Tibial Angle on weight-bearing scanogram of both lower limbs.
2. Angle of sagital plane Proximal Tibial Articular Slope was measured on on Lateral Radiograph.
3. Limb length of both lower limbs in centimeters.
4. Degree of fixed flexion deformity (if present).
5. Medial laxity.
6. Antero-posterior laxity.
7. Modality of fixation used during previous surgery.
8. Body Mass Index.



A B C

Fig 1: A) Clinical photograph showing 11^0 varus deformity. **B)** Pre-operative Antero-posterior and Lateral Radiograph of knee showing implant of previous surgery and Medial Proximal Tibial Angle of 79^0 and Angle of sagital plane Proximal Tibial Articular Slope. **C)** Pre-operative standing Scanogram of both lower limbs showing Mechanical Axis passing medial to Medial joint line on Left side.

All patients were operated under spinal anaesthesia. Supine position was given on radio-lucent table and tourniquet was applied. Vertical medial incision was taken and any implants of previous surgeries were removed. To protect ligaments and soft tissue two Hohmann retractors were placed along anterior and posterior surface of proximal tibia and medial part of proximal tibia was exposed. With Image Intensifier level of tibial tuberosity and tip of fibular head was marked on medial surface of proximal tibia. 2 mm K-Wire was inserted from medial surface of proximal tibia distal to medial joint line and above the level of tibial tuberosity and tip of fibular head Under Image Intensifier control. Incomplete Osteotomy was performed with oscillating saw over K-Wire with Image Intensifier guidance. Later osteotomy was completed slowly and carefully with appropriate size osteotome with due care so as not to break lateral tibial cortex as intact lateral cortex increases the stability of the osteotomy. The lamina spreader was inserted in the osteotomy site and osteotomy was distracted till the correction is achieved as per pre-operative planning. Correction was checked with Image Intensifier Antero-posterior and Lateral views. Due attention was given to articular surface slope of proximal tibia in Lateral view. Optimum correction in both views was achieved. Alignment of the limb was checked with a sterile rod extending from centre of the hip to the centre of ankle, passing over knee lateral to lateral tibial spine [10]. Aim of this is to restore the HIP – Knee – Ankle axis similar to that of the opposite side. The distracted osteotomy gap was filled with tricortical iliac crest strut graft in such a way that correction is maintained in both, Antero-posterior and Lateral views. The osteotomy site was stabilized with a medial Locking Compression Plate and 3.5-mm locking screws. Wound closure was done in layers after through wash. Sterile dressing was applied and Long Leg Knee Brace was used for support.

Fig 2: Intra-operative photograph showing opening done medially at osteotomy site.

Non-weight bearing mobilisation was done from first post-operative day with walker. Intermittent passive range of motion exercises were started from first post-operative day. Active intermittent range of motion exercises were encouraged from third post-operative day. Patients were discharged from 5^{th} to 7^{th} post-operative day. Removal of sutures were done on 12^{th} to 15^{th} post-operative day in Out Patient Department. Patients were called every 2 weeks for follow up examination till 3 months, every month till 6 months, every 2 months till one year and yearly thereafter. Radiographs were taken at 6^{th} and 12^{th} week. Toe touch walking was allowed from 6^{th} week gradually. Full Weight Bearing was allowed from 12^{th} week. At follow up visits patients were assessed with following parameters:

1. Pain.
2. Range of motion.
3. Ability to do daily activities.
4. Radiological examination to assess union and alignment.

Knee Society Scoring system [11] was used to evaluate Functional Outcome.

A B

Fig 3: A) Post-operative Antero-posterior and Lateral Radiograph of knee showing correction of Medial Proximal Tibial Angle and sagital plane Proximal Tibial Articular Slope. B) Post-operative standing scanogram showing correction of mechanical axis on Left side.

A B C

Fig 4: Post-operative clinical photographs showing correction of deformity and Range of Movement.

Few patients had complications. Superficial infection and gaping of 1.3 cm occurred in one Patient. He was readmitted. Oral antibiotics and alternate day dressings were done. Complete cure of infection and healing of superficial gaping occurred 8 days. Under correction occurred in one patient. This Patient had severe varus malunion requiring 17 mm of distraction at osteotomy site. One patient had knee stiffness after surgery. Range of Movement was 10^0 to 100^0 post-operatively at 6 week follow up examination. Physiotherapy improved Range of Movement to 5^0 to 110^0.

Results

16 patients diagnosed as varus mal-union of tibia presenting after minimum of 6 months after the treatment for intra-articular fractures of proximal tibia were included in the study. There were 14 male patients and 2 female patients, with the mean age of 47 years (range, 26–55 years). Mean duration of follow-up from the time of Medial Open Wedge High Tibial Osteotomy was 3.2 years. (Range 2 – 4.5 years). Preoperative clinical and Radiologic Parameters of Study Patients are as shown in Table 1.

Table 1: Preoperative Clinical and Radiological Parameters of Study Patients.

Pre-operative Parameters		Data
Modality of treatment done previously at the time of proximal tibial fracture	LCP	9
	Cancellous screws	4
	Conservative treatment with cast.	3
Pre-operative Deformity	Varus	16 All patients had Varus deformity.
	Fixed Flexion deformity	2
Instability	Medial laxity	16 All patients had grade I/II medial laxity.
	Antero-posterior laxity	3 (2 patients had partial ACL tear and 1 patient had complete ACL tear
Medial Proximal Tibial Angle		Mean 75^0

All patients achieved clinical and radiological union from 3.5 to 6 months with mean interval of 4.2 months. Medial Proximal Tibial Angle was corrected from mean 75^0 (range 70^0-85^0) to mean 87^0 (range 83^0-90^0) (P<.001). Functional outcome was assessed by Knee Society Scoring System (KSS). This included Symptomatic parameters and the Functional parameters. Symptomatic parameters are pain, stiffness, swelling, instability, weakness and limping. Functional parameters are ability to walk, go up stairs, go down stairs, stand, kneel on front of knee, squat, sit with knee

bent, and rise from a chair [11]. All these parameters were scored on scale ranging from 5 to 0, with a score of 5 signifying no difficulty in performing these activities, and 0 representing severe difficulty in performing these activities. The score is calculated after summing of all parameters then dividing by 70 and multiplying by 100. A maximum score is 100%, which signifies no symptoms, and the minimum score is 0, representing inability to do all daily activities. Functional scores improved from mean of 27% to 89% (P<.001) at final follow up examination. 13 patients (81.25%) had excellent outcome (KSS > 90), 2 (12.5%) had good outcome (KSS 75-90) and one patient (6.25%) had fair outcome (KSS 60-75). 15 patients had no complaints of instability. One patients with associated complete Anterior Ligament injury had instability and he required ligament reconstruction one year after Osteotomy.

Discussion

Pain in varus mal-united fractures of proximal tibia is caused by abnormal weight distribution on medial compartment of the knee joint. This, if not treated in time, will lead to progressive cartilage wear, causes severe osteo-arthritis and loss of function which requires Total Knee Arthroplasty [12, 13]. In young active Patients, it is very important to reduce pain and prevent the need of Total Knee Replacement at young age. Since this disorder is mainly due to deranged mechanical axis, corrective High Tibial Osteotomy is the treatment of choice [14, 15, 16]. The goal of High Tibial Osteotomy is to shift the weight-bearing line laterally, with the post-operative mechanical axis running laterally through the tibial plateau, at 62% of its entire width (measured from the medial side).

Types of High Tibial Osteotomies described in the Literature are-

1. Lateral Closed Wedge Osteotomy.
2. Dome Osteotomy.
3. Medial Open Wedge High Tibial Osteotomy.

Lateral Closed Wedge Osteotomy is associated with certain disadvantages such as

- Ability to correct mal-alignment in only one plane (coronal) [17]
- Shortening of the leg [17].
- Loss of bone stock [17, 19].
- More difficult conversion to Arthroplasty [17, 18]
- Incidence of complications such as peroneal nerve palsy and compartment syndrome is high [16]

Dome High Tibial Osteotomy has some disadvantages like it requires External Distraction Device**.** This device is cumbersome to the patient, requires frequent pin site dressings, longer duration of treatment and fixator time.

Medial Open Wedge High Tibial Osteotomy has shown certain advantages like-

1. Ability to correct the alignment in two planes (coronal and sagital) [19]
2. Less risk of peroneal nerve injury [20]
3. Limb shortening does not occur [19, 20]
4. No need to detach the muscles [21]
5. Bone loss does not occur [21]
6. Easier conversion to Arthroplasty [22]
7. Ability to adjust the amount of correction during surgery [22].
8. Reduce the cartilage wear and facilitates cartilage regeneration [14, 15]
9. It improves stability in cases of associated cruciate ligament injuries, postero-lateral corner injury with and without ligament reconstruction [15]

Disadvantages of the Medial Open Wedge High Tibial Osteotomy are

1. The need for bone graft.
2. Risk of delayed union or nonunion [21, 22]
3. MCL becomes slightly tight after surgery.

All patients in the study achieved clinical and radiological union at mean duration of 4.3 months. The Medial Proximal Tibial Angle and abnormal anterior tibial slope were corrected to near- normal values. At final follow-up, the mean Knee Society Score improved from 27 (range 19%-49%) to 89% (range 65%-97%) (P<.001). 13 patients (81.25%) had excellent outcomes, 2 (12.5%) had good outcomes, and 1 (6.25%) had fair outcomes. In general, choosing between the best type of High Tibial Osteotomy will be based on personal preference and based on experience. Our study results demonstrates Medial Open Wedge High Tibial Osteotomy is safe and effective procedure for varus mal-united proximal Tibial fractures in relatively young patient category.

Limitations

The limitations of this study are the small number of patients and lack of the comparative group treated with other surgical technique.

Conclusions

Our study results demonstrates that Medial Open Wedge High Tibial Osteotomy is safe and effective procedure for varus mal-united proximal Tibial fractures. It provides excellent functional outcomes, carries minimal complications, provides structural and clinical improvement in relatively young patient category.

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