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Dr. Satyendra Ravidas
Junior Resident Academic, Department of Orthopaedics, RIMS Ranchi, Jharkhand, India

Dr. Jay Palak
M.S. Orthopaedics, Registrar, Department of Orthopaedics, RIMS Ranchi, Jharkhand, India

Dr. LB Manjhi
M.S. Orthopaedics, Professor and H.O.D, Department of Orthopaedics, RIMS Ranchi, Jharkhand, India

Corresponding Author:
Dr. Jay Palak
M.S. Orthopaedics, Registrar, Department of Orthopaedics, RIMS Ranchi, Jharkhand, India

Functional and radiological outcome of high tibial osteotomy in osteoarthritis patients with varus knee

Dr. Satyendra Ravidas, Dr. Jay Palak and Dr. LB Manjhi

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Abstract
Introduction: Osteoarthritis can affect any synovial joint in the body, however it occurs most often in weight-bearing joints, with the knee being one of the most commonly affected. Progressive loss of hyaline articular cartilage is often considered the hallmark of the disease. There are concomitant changes in the bone underneath the cartilage including sclerosis (remodelling and thickening) of the subchondral bone, and formation of osteophytes. Within the tibiofemoral joint; articular cartilage degradation is most prevalent in the medial compartment. Many techniques have been developed (i.e. closing wedge, opening wedge, dome and "en chevron" osteotomies), but opening (medial) and closing (lateral) wedge osteotomies are the most commonly used. The goal of the treatment is to relieve medial compartment knee pain and slow down the arthritic progression.
Materials and methods: This prospective non-randomized comparative study was carried out over a period of 12 months in a sample size of 30 adult patients of age more than 40 years with medial compartment osteoarthritis at Rajendra Institute of Medical Sciences [RIMS], Ranchi. Patients were followed up for 6 months and functional and radiological outcome were assessed based on knee society score 1(KSS1), knee society score functional (KSS2) and LYSHOLM scoring system.
Result: The average age of patients in this study was 54.8 years, with a female predominance (61.2%). KSS1 results were excellent in 80%, good in 14.4% and poor in 5.6% of patients. In terms of knee society score functional (KSS2) results were excellent (86.7%), good (13.3%). LYSHOLM Score results included excellent (20.2%), Good (46.6%), fair (26.6%), poor (6.6%).
Conclusion: The present study shows that HTO is a good option in isolated medial compartment OA of knee. It works by unloading the medial compartment and shifting the weight bearing axis to lateral compartment.

Keywords: Osteoarthritis with varus deformity, medial open wedge osteotomy, knee society score

Introduction
Medial opening wedge high tibial osteotomy (HTO) is surgical treatment option for the management of medial compartment knee osteoarthritis [1]. Many techniques have been developed (i.e. closing wedge, opening wedge, dome and "en chevron" osteotomies), but opening (medial) and closing (lateral) wedge osteotomies are the most commonly used. The goal of the treatment is to relieve medial compartment knee pain and slow down the arthritic progression. The surgery is described as a biomechanical intervention designed to alter dynamic knee joint loading, with the aim of improving patient function and decreasing pain. This is achieved by a partial unloading of the medial compartment with a slight overcorrection 3-5 degree of the mechanical axis.
This surgery was not popular until Coventry reported good results in 1973 [2]. HTO became more popular in young active patients after improvement in surgical technique, fixation devices, and patient selection with fewer complications. Although overall HTO results show the effectiveness of the procedure there are still some debated issues about osteotomies. These include the choice between opening or closing wedge tibial osteotomy, the graft selection in opening wedge osteotomies, the type of fixation, the comparison with uni-compartmental knee arthroplasty (UKA) and whether HTO affects a subsequent total knee replacement (TKR).

Aims and Objective
To evaluate the clinical, functional and radiological outcome achieved by high tibial

osteotomy performed in patients having osteoarthritis of knee with varus deformity.

Materials and Methods

This was a prospective non randomized study conducted in the Department of Orthopaedics at Rajendra Institute of Medical Sciences [RIMS], Ranchi from November 2017 to December 2018. The study included 30 adult patients of osteoarthritis of knee with varus deformity, of age more than 40 years.

Preoperative evaluation: Before the surgery, a preoperative assessment of the proposed HTO patients was done. The patient's symptoms, functional restrictions, activity, and job history were assessed, along with clinical assessments. Radiography was used to assess the extent of osteoarthritis and varus deformity of the knee. Radiographic scans (bilateral standing antero-posterior films) were taken. An Ortho roentgenogram was taken which included both head of femur with ankle in one film with guides to facilitate accurate measurement of angles of deformity and also preoperative planning of tibial cut [3].

A detailed discussion regarding the operative procedure of HTO and its probable complications was done and valid informed consent was taken from the patient.

Estimation of varus deformity and its correction

In our practice, we use a simple approach to determine the angle of correction that originally goes back to the research of Fujisawa *et al.* [4] and later adopted as a guideline to determine pre and postoperative amount of varus. The weight bearing line (WBL) should pass from 62.5% of the tibial plateau width when measured from the edge of the medial tibial plateau. This point – called Fujisawa point – matches over the mechanical axis with 3-5° valgus and locates slightly lateral to the lateral tibial spine. To determine the amount of required correction, a line is drawn from this point to the centre of the femoral head and another to the centre of the ankle joint. The angle created by these two lines indicates the amount of correction required. Then the osteotomy line is drawn at about 4 cm below the medial joint line toward the fibular head. This line is measured in millimetres and should be transferred to the apex of triangle that is now created. The width of the triangle's base is measured in millimetres, which corresponds to the amount of correction required during a medial open wedge osteotomy.

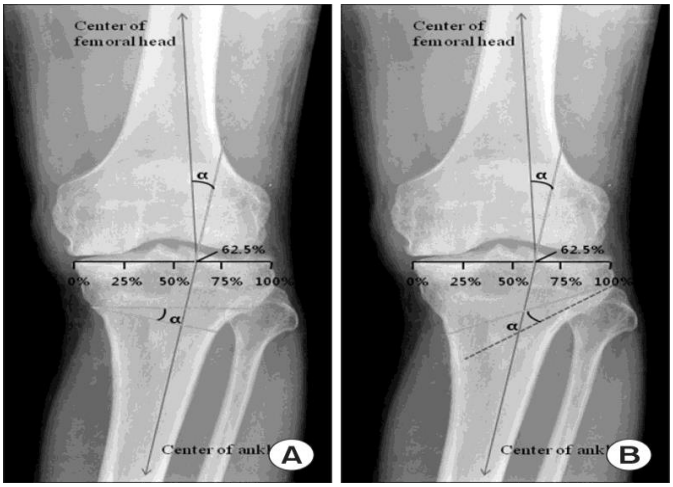

Fig 2: Radiological image showing Fujisawa point

Fujisawa point

Operative procedure

Patient was placed supine and spinal anaesthesia was given. The extremity was scrubbed with savlon, painted with antiseptic solutions and draped. A third-generation cephalosporin antibiotic (ceftriaxone) was routinely given intravenously (after proper sensitivity testing) just prior to making incision and repeated 6 hrs after completion of surgery. Surgery was done using pneumatic tourniquet control. A long midline incision was given. Adequate dissection was done to expose medial surface of tibia and pes anserinus was identified.

Two guide wires were drilled parallel to each other making the reference point of pes-anserinus and directed towards fibular head.

Fig 1: Fluoroscopic image showing linc of Osteotomy

A biplanar osteotomy, consisting of an osteotomy in the axial plane and an osteotomy in the frontal plane was performed in all patients [5]. First, the frontal plane osteotomy, starting in the anterior one-third of the proximal tibia underneath the tibial tuberosity was performed using an oscillating saw. After that axial osteotomy was done from the margin of the gracilis tendon to the tip of the fibular head, just proximal to the tibiofibular joint. The lateral cortex was left intact as a hinge for the osteotomy. Thereafter, the axial osteotomy was opened gradually by stepwise insertion of chisels. While doing the osteotomy special precautions were taken not to damage the posterior neurovascular bundle mainly by placing a curved Hohmann posteriorly. All the cortices must have been osteotomised completely before opening, except lateral cortex. The chisels were replaced by an osteotomy spreader, which opened the axial osteotomy until the preoperatively planned gap size was reached. The gap size was measured intraoperatively by scale. According to the preoperative planning, the weight bearing line was placed at 62.5% of the transverse diameter of the tibial plateau in patients with medial compartment osteoarthritis [4]. The position of the weight bearing axis was controlled intraoperatively with a straight alignment rod under fluoroscopy.

Methods of fixation: We used standard proximal medial tibial plate to stabilise the osteotomy part of tibia. One cortical screw was introduced distal to osteotomy to produce compression. All locking screws of proper size confirmed by depth gauze were given. The position of plate and screw length were confirmed in both AP & LAT plane.

Closure: Thorough lavage was done with normal saline. Site was closed in two layers and compressive bandage done.

Fig 3: Clinical image of pre-op and post-op. (left knee)

Fig 4: Radiological comparison of pre-op and post-op

Post-operative rehabilitation: All the exercises (static quadriceps drill, bed side knee bending, ankle ROM) were resumed from 2nd post-op day. First dressing was changed after 3rd day of operation and stitches were to be removed after 12-14 days after operation in their first follow-up visit. Patient was followed up at intervals of 2 wks, 1, 3, 6, 9, 12 months. After checking proper quadriceps power walking with partial weight bearing was allowed with help of walker after 6weeks. Full weight bearing was allowed after 12weeks only after achieving union.

Outcome measurement methods

1. **Clinical evaluation:** follow-up was based on axial alignment, range of motion, joint stability (anteroposterior, mediolateral), muscle atrophy, local findings, gait, stance, limb length discrepancy, and subjective symptoms.
2. **Functional evaluation:** results obtained at follow-up was by means of the knee society score-1 [6], knee society score-2 and the Lysholm-Gillquist score [7].
3. **Radiological evaluation:** Evaluation of the postoperative angle measurements [8].

Results

Among all the patients, maximum age was 70 years and minimum was 40 years, with average age of 54.8 years. 31.8% patients were in between 40-49, 62.80% were in between 50-59 and 5.4% were above 60 years.

There was a female predominance in osteoarthritis with 61.2% and male with 38.8%.

Among all the patients 60% were overweight having BMI between 25-29.9 and 40% were having normal weight of BMI 18.5-24.9.

Among all the patients 55% of patient were having left knee affected more than right and 45% were having right knee more than left.

Functional evaluation: Comparison between pre-operative and post-operative scores.

Three scoring system were used. The mean of KSS1 score increased from 52.6 to 80.2, mean of KSS2 score increased from 51.4 to 84.8 and mean of LYSHOLM score increased from 54.3 to 81.1 after 6 months of operation.

Table 1: Comparison between pre-operative and post-operative score

	Pre-op	Post-op
	Mean	Mean
KSS1	52.6	80.2
KSS2	51.4	84.8
Lysholm	54.3	81.1

KSS1: In preoperative period 6.2% of patient had excellent score, 6.8% had good score, 26.6% had fair and 60.4% had poor score which changed to 80% with excellent, 14.4% with good and 5.6% patients with poor score after 6 months of post-operative period.

Table 2: Outcome based on KSS1 score

KSS1	Pre-OP		Post-OP	
	NO.	Percentage	NO.	Percentage
Excellent	2	6.2%	24	80%
Good	2	6.8%	4	14.4%
Fair	4	26.6%	0	0
Poor	18	60.4%	2	5.6%

KSS2: In preoperative period 13.8% of patients had excellent score, 24.2% had good score, 8.6% had fair score and 53.4% had poor score which changed to 86.7% with excellent, 13.3% with good score after 6 months of post-operative period.

Table 3: Outcome based on KSS2 score

KSS2	Pre-OP		Post-OP	
	NO.	Percentage	NO.	Percentage
Excellent	4	13.8%	26	86.7%
Good	7	24.2%	4	13.3%
Fair	3	8.6%	0	0%
Poor	16	53.4%	0	0%

LYSHOLM score: In preoperative period 6.6% of patients had excellent score, 13.3% had fair and 80% had poor score which changed to 20% with excellent, 46.6% with good, 26.6% with fair and 6.6% of patients with poor score after 6 months of post-operative period.

Table 4: Outcome based on LYSHOLM score

LYSHOLM	PRE-OP		POST-OP	
	NO.	Percentage	NO.	Percentage
Excellent	2	6.2%	6	20.2%
Good	0	0%	14	46.6%
Fair	4	12.9%	8	26.6%
Poor	26	80.9%	2	6.6%

Radiological evaluation

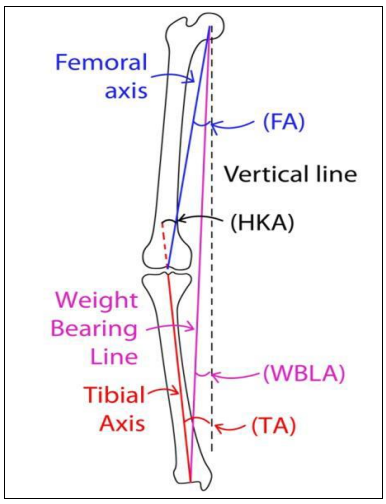

Fig 5: Pictorial diagram of radiological angles showing (Femoral angle, Tibial angle and Hip knee angle)

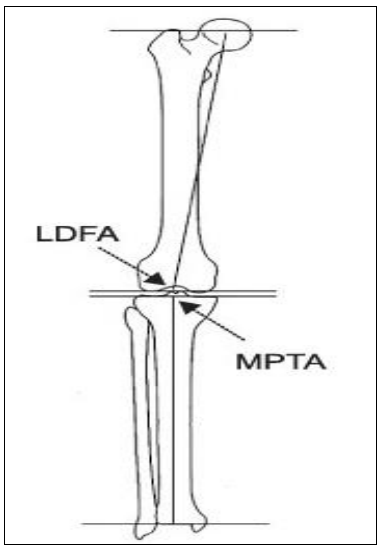

Fig 6: Pictorial diagram of radiological angles showing (LDFA and MPTA)

Hip knee angle (HKA): The mean of HKA was 169.8 degrees pre-operatively which increased to 175.24 degrees in post-operative period.

Femoral angle: The mean of FA was 2.72 degrees pre-operatively which reduced to 2.42 degrees in post-operative period.

Tibial angle: The mean of TA was 8.63 degrees pre-operatively which reduced to 4.23 degrees in post-operative period.

Weight bearing line angle (WBLA): The mean of WBLA was 3.46 degrees pre-operatively which reduced to 2.78 degrees in post-operative period.

Lateral distal femoral angle (LDFA): The mean of LDFA was 87.98 degrees pre-operatively which increased to 88.66 degrees in post-operative period.

Medial proximal tibial angle (MPTA): The mean of MPTA was 82.46 degrees pre-operatively which increased to 86.93 degrees in post-operative period.

Joint Angle: The mean of JA was 6 degrees pre-operatively which reduced to 4.42 degrees in post-operative period.

Discussion

HTO for the treatment of OA was popularised by Coventry. Our study of 30 cases done in period of 1 year showed impressive results. The study group had average age of 54.8 years, which was similar with the study of Brouwer RW *et al.* [9] on 92 patients with mean age of 50.2 years.

There was female predominance of 61.2% whereas in study of Spagn G *et al.* [10], male predominance were seen with 56.4% and female 44.6%. There was tendency of left knee (55%) involvement than right (45%), whereas 41.5% involvement of left knee and 58.5% of right knee was seen in study of Spagn G *et al.* [10]. There is profound correlation of osteoarthritis with obesity as 60% of patients were overweight (BMI- 25-29.9). Bonasia *et al.* [11] studying 99 Open Wedge HTO, concluded that in patients with a BMI greater than 30 the risk of unsuccessful surgery is 10 times higher, and Akizuki *et al.* [12] stated that a BMI greater than 27.5 is associated with early failure of the osteotomy.

All patients underwent medial open wedge osteotomy and fixation with proximal medial tibial plating. In study of Choi HR *et al.* [13] 92 patients having received an osteotomy using an angular stable plate, no loss of correction was found during a short-term follow-up. Three scoring systems (KSS1, KSS2, Lysholm) were used to evaluate the functional outcome and all three results showed considerable improvement. The mean score of knee society score I (KSSI) was increased from 52 to 80 and knee society score II (KSS2) from 51 to 84 after 6 month of operation. Similar results were also shown in the study of Kandaswami *et al.* [14] where mean knee society score and the mean functional score of the patients before surgery were 54.6 and 53.9 respectively and post operatively was 83.1 and 82 respectively. The mean LYSHOLM score was 81.1. This was very impressive as it was more than LYSHOLM score of 73 in the study of T.O. Smith *et al.* [15].

The mean average correction of HKA was 5.44^0 whereas in study of Moon-Jib Yoo *et al.* [16], it was 11.2^0. We had some cases of extreme HKA values due to which mean correction was less.

In our study the average correction in MPTA was 4.47^0 which was comparable to the study of Moon-Jib Yoo *et al.* [16] which was 4.8^0. This angle was most affected and important in HTO. 0.68^0 of average correction in LDFA was noted which was comparable to 0.6^0 in study of Adrien Durandet *et al.* [17]. The change of LDFA was not so much profound in HTO because the bony cuts were done only in tibia.

All osteotomies united clinico-radiologically in 2-3 months and consolidated after 6 months. Plate was removed after 6 months, checking healing of osteotomy site radiologically. Neither bone grafts nor fibular osteotomy were done in any of these cases.

Conclusion

HTO is a good treatment option in isolated medial compartment OA of knee. It reduces pain and varus deformity; thereby improving quality of life of the patients as shown by the increase in KSSI, KSS2 and LYSHOLM Score.

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