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Case Series

Results of unicompartmental osteoarthritis knee treated with high tibial osteotomy: a case series

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ABSTRACT

High tibial osteotomy (HTO) being a re-emerged common procedure in orthopaedic practice now, which is safe and relatively simple and cost-effective technique requiring careful selection of subjects and precision of technique. Background: In isolated medial unicompartmental osteoarthritis (OA) of knee, in a physiologically young and high demanding individual, where preservation of knee is required, unicompartmental knee arthroplasty and total knee arthroplasty are not considered as treatment options. HTO is an excellent treatment option where the requirement of technical skills and infrastructure are less and high-volume low-cost surgeries can be performed with minimum instrumentation. 20 selected patients with unicompartmental OA of knee who attended the OPD of orthopaedics, Jorhat Medical College and Hospital were the subjects of this study, during the period of study from June 2020 to May 2021. In our study, average age was 55.9 years; higher incidence among females; higher incidence of OA in left knee; 80% of cases presented at Kellgren and Lawrence grade 2 and 3; most of the cases were having BMI within normal range and varus deformity of knee; plate and screw fixation after HTO provides more rigid fixation than staples alone. In this study, we got 60% good and 30% fair results after 6 months to 1 year of follow-up. Successful HTO is a very effective alternative low-cost surgery that makes it possible to delay or avoid knee arthroplasty in well selected patients.

Keywords: Unicompartmental osteoarthritis of knee, Varus deformity, High tibial osteotomy, Lateral close wedge, WOMAC score

INTRODUCTION

Osteoarthritis is the single most common cause of disability in older adults.[1] Osteoarthritis is the most frequent joint disease in the world.[2] An estimated 10% to 15% of all adults aged over 60 have some degree of OA, with prevalence higher among women than men.[3] By 2050, 130 million people will suffer from OA worldwide, of whom 40 million will be severely disabled by the disease.[4] As per available data, high prevalence of OA shows a substantial economic burden. Despite the increasing prevalence of OA in India, there is little published data on epidemiology, burden, and cost effectiveness of treatment of OA from our country.[5] Clinically, the disease characterized by joint pain, limitation of movement, crepitus, occasional effusion, and variable local inflammation, but without systemic effects; pathologically, irregularly distributed loss of cartilage more frequently in areas of increased load, sclerosis of subchondral bone, subchondral cysts, marginal osteophytes, increased metaphyseal blood flow, and variable synovial inflammation and , alteration in collagen fibril size and weave, and increased synthesis along with degradation of matrix macromolecules.[6] The risks associated with kneeling, squatting were higher in subjects who also reported occupational weight lifting, and interact multiplicatively with the risk by obesity.[7] Indian women particularly having a sedentary life style mostly, with

customary squatting habits are at a higher risk for developing OA knee. The predominance of varus and the concomitant increased medial compartment joint loads are thought to be responsible, in part, for the greater incidence of osteoarthritis in this knee joint compartment.[8] In isolated medial unicompartmental OA of knee, in a physiologically young and high demanding individual, where preservation of knee is required, unicompartmetal knee arthroplasty and total knee arthroplasty are not considered as treatment options. High tibial osteotomy is a tested and time honoured procedure in the management of osteoarthritis knee, especially when the disease is unicompartmental.[9] Most reports shown a satisfactory result in about 80% at 5 years and 60% at 10 years after high tibial osteotomy.[10]

CASE SERIES

This case series was carried out on patients of department of orthopedics at Jorhat Medical College and Hospital, Jorhat, Assam, India from June 2020 to May 2021. A total 20 adult subjects (both male and females) of aged ≥18, years were for in this study.

Study design

It was a prospective interventional study.

Study location

This was a tertiary care teaching hospital based study done in department of orthopedics at Jorhat Medical College and Hospital, Jorhat, Assam, India.

Study duration

The duration of the study was from June 2020 to May 2021.

Sample size

The sample size was 20 patients.

Inclusion criteria

Cases during the study period from June 2020 to May 2021, symptomatic unicompartmental osteoarthritis of knee joint with corresponding valgus or varus deformity, radiologically evident unicompartmental osteoarthritis of knee joint, age more than 40 years and upto 60 years, failed conservative treatment, and both sexes were included.

Exclusion criteria

Bicompartmental or tricompartmental osteoarthritis of knee joint, secondary osteoarthritis, high varus/valgus deformity requiring more than 20 degrees of correction, obese patients, abnormal hip joint or ankle joint of the affected side, abnormal neurological and vascular status of the affected limb, patients having any absolute contraindications for routine elective surgery, with severe osteoporosis, with flexion contracture of knee more than 15 degrees, with knee flexion of an arc of less than 90 degrees, and refusal of informed consent were excluded.

Presentation of cases

On receiving the physiologically active patient, a detailed clinical history was taken and was followed by thorough clinical examination to rule out systemic associated conditions such as inflammatory arthritis and to rule out infective arthritis. Local knee examination done to assess the pre-operative arc of motion of at least 90 degrees, and to rule out flexion deformities, and ligamentous instabilities. Examination of hip joint and ankle joint of the affected side also done. After examination, patients were sent for weight bearing radiographs of affected knee both anteroposterior and lateral views. As soon as the patient is diagnosed to have unicompartmental osteoarthritis of knee and assessing the valgus or varus less than 20 degrees, they were admitted in the Orthopaedics ward for further management. All the necessary preoperative investigations were done. Patients with co-mobidities like diabetes mellitus, hypertension, coronary artery diseases, bronchial asthma, chronic obstructive airway disease, and cardiovascular diseases, were taken for surgery as soon as fit for anaesthesia. Pre- operative assessment done to determine the length of the base of osteotomy required based on valgus or varus deformity of the knee, determined radiologically and the type of osteotomy whether closed or open. Preoperative pre-anaesthetic checkup was done and obtained fitness for anaesthesia and consent for the procedure was taken. Pre-operative prophylactic 3rd generation cephalosporin antibiotics on the evening before surgery and just before skin incision were given. Shaving of the affected knee also done. Inside OT, either spinal anaesthesia or general anaesthesia was given. The field of operation was washed with savlon and povidone iodine and draped separately.

Surgical steps

Patient under the effect of either spinal anesthesia or general anesthesia and positioned on the table in supine lying and a sandbag is placed under the hip on affected side. A pneumatic tourniquet is applied to the thigh on the affected side and the affected limb is elevated 3–5 minutes and tourniquet inflated. Then knee on the affected side is flexed to 90 degrees and flexion maintained. A 10 cm straight incision for a lateral approach from lateral joint line distally along posterior border of fibular head and tibialis anterior muscle of proximal tibia is elevated to expose the proximal tibiofibular joint. Then Kirschner wire passed under IITV guidance across the joint to identify the joint line and used a s guide for subsequent osteotomy planes. Proximal tibio-fibular joint syndesmosis disruption from anterior to posterior. And a retractor placed under lateral margin of patellar tendon for protection. Another blunt retractor positioned along posterolateral aspect of tibia to protect the neurovascular

bundle. The osteotomy is made above the level of tibial tuberosity; 2 cm distal to knee joint, at the metaphyseal area avoiding shaft area parallel to articular surface under IITV guidance, guided by K wire. Using saw blade proximal transverse limb of osteotomy made, keeping a thin bridge of about 1cm of the medial cortex intact. Base of the wedge of osteotomy is determined based on the preoperative radiographs assessment of degree of varus/valgus deformity and correction required. The oblique osteotomy plane is cut directing towards the opposite tip of the proximal transverse osteotomy site to allow the desired degree of correction. The oblique portion of the osteotomy made, and the obliquely placed osteotome removed, leaving the K wire in place. The wedge of bone removed, and the osteotomy site carefully inspected to ensure no residual bone is left and then valgus osteotomy site closed by giving valgus stressing force (varus stressing force for valgus deformity). A coventry staple or recon plate fixed with cortical/cancellous screws to stabilize the osteotomy site. When osteotomy is closed, overall alignment evaluated with an electrocautery cord. When aligned from the centre of the hip to the center of the ankle, the plumb line should pass through the lateral compartment of the knee at about 62.5 % of the width of the tibial plateau from medial end of tibial plateau. The alignment and placement of the plate/staple confirmed with anteroposterior and lateral radiographs or fluoroscopy. The torniquet released and hemostasis ensured. The wound irrigated well and the fascia and iliotibial band loosely approximated with interrupted sutures. The subcutaneous tissue and the skin sutured. Antiseptic dressing applied. Compressive jones dressing followed by POP slab applied at the end.

Post-operative management

On post-operative day 1, anteroposterior and lateral radiographs of the operated knee done. Intravenous antibiotics continued for 5 days post operatively. Wound inspection done on post-operative day 5 and patient allowed to sit up in the bed the day after surgery, and static quadriceps exercises started immediately post operatively and was observed for presence of deep vein thrombosis, compartment syndrome and other surgical complications. Sutures removed at post op day 14. Cylinder POP cast applied, and patient is mobilized with it. Patient sent back home and reviewed after 6 weeks, when POP removed and weight bearing allowed.

Follow up

Patients followed up clinically at 6, 12 and 24 weeks. Then patients are examined and functional outcome evaluated based on WOMAC scoring system. Radiological assessment of knee done at 6, 12, 24 weeks to look for union, amount of valgus positioning of the leg, overcorrection or under correction or if any loss of fixation. Results are analyzed based upon Devgan et al criteria as good/fair/poor, patients are encouraged to reduce body weight, reduce support while walking as the union progresses and are advised to avoid squatting and climbing steps for 12 weeks. Local heat application and isometric knee exercises encouraged throughout follow-up.

Calculation of surgical correction

Calculating degree of correction in coronal plane: bilateral longview films/scanogram are taken to measure the mechanical axis and degree of correction needed. For medial compartment arthritis, overcorrection is usually needed to the 62.5% lateral weight bearing line; which is roughly two-thirds of the width of the tibial plateau. For unloading and cartilage restoration process, correction of the mechanical axis to neutral (centre of Plateau) is sufficient. The point of the desired mechanical axis is marked on the tibial plateau. A line is drawn from center of femoral head to the desired point on the plateau. Another line is drawn from the point on the plateau to the center of tibial plafond. The angle formed by the two lines is the degree of correction needed (ɵ). The amount of wedge base to be resected (W).

$$W = Diameter\ of\ the\ bone\ (At\ the\ level\ of\ proximal\ cut) \times Tan\ ɵ$$

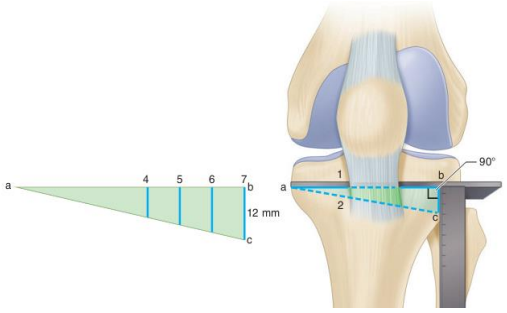

Figure 1: Calculation of degree of correction in coronal plane.

Roughly 1 mm of opening wedge corresponds to 1 degree of correction, but only true for a tibial width of 57 mm and could not be applied to all cases. For unloading cartilage restoration procedures, correction of the mechanical axis to neutral (center of plateau) is sufficient.

Degree of correction in sagittal plane

Increasing the tibial slope will worsen symptoms with anterior cruciate ligament (ACL) instability and improve symptoms with posterior cruciate ligament (PCL) instability. While decreasing the tibial slope will improve symptoms with ACL instability and worsen symptoms with PCL instability.

Techniques for valgus proximal tibial osteotomy

Many techniques have been described for valgus proximal tibial osteotomy. Basically four types are used.

Lateral closed wedge HTO, medial open wedge HTO, Dome HTO, medial opening hemicallotosis. The technique most frequently used since years is the lateral closed wedge osteotomy first discovered by Coventry. Therefore, we opted to do this in our setup in our patients.

Lateral closed wedge high tibial osteotomy

Coventry described a closing wedge osteotomy made proximal to the tibial tuberosity, and recommended a lateral approach to correct varus deformity and a medial approach to correct a valgus deformity. Advantages are: the osteotomy is made near the knee joint, where is the deformity; osteotomy is made through the widest part at metaphysic of proximal tibia through the cancellous bone only, without extending into the shaft, hence heals early and rapidly; it permits the fragments to be held firmly in position by staples or a rigid fixation device, such as a plate and screw construct; after the procedure, risk of delayed unioin or non-union is mild only, and prolonged immobilization in POP cast is unnecessary, with rigid internal fixation.

Statistical analysis

Data was analyzed using statistical package for the social sciences (SPSS) version 20. Student's t-test was used to ascertain the significance of differences between mean values of WOMAC scores before performing high tibial osteotomy procedure and six months after performing high tibial osteotomy procedure postoperatively and p value was found significant, concluding that high tibial osteotomy is an effective intervention for reducing the symptoms of the patients with osteoarthritis knee. In our study, maximum number of cases of OA knee were found in age between 56–60 years, at an average age of 55.9 years (Table 1).

Table 1: Age distribution.

Age group (in years)	Number (n)	Percentage (%)
40–45	0	0.00
46–50	3	15.00
51–55	4	20.00
56–60	13	65.00
Total	20	100.00
Mean±SD	55.90±4.15 years	

This study shows higher incidence of OA knee in females (Table 2).

Table 2: Sex wise distribution.

Sex	Number (n)	Percentage (%)	Ratio (male: female)
Male	4	20.00	1: 4
Female	16	80.00	
Total	20	100.00	

Our study reveals higher incidence of osteoarthritis in left knee (Table 3).

Table 3: Side wise distribution.

Laterality	Number (n)	Percentage (%)
Unilateral		
Right	5	25.00
Left	10	50.00
Bilateral	5	25.00
Total	20	100.00

This study reveals that most of the cases (80%) presented at Kellgren and Lawrence grade 2 and 3 (Table 4).

Table 4: Kellgren and Lawrence radiological grade distribution.

Grading	Number (n)	Percentage (%)
Grade 1	4	20.00
Grade 2	8	40.00
Grade 3	8	40.00
Grade 4	0	0.00
Total	20	100.00

Our study reveals that most of the cases were having BMI within normal range only. And few were in grade 1 overweight. So, it appears that obesity is not the only responsible factor for OA (Table 5).

Table 5: BMI distribution.

Body mass index (kg/m^2)	Number (n)	Percentage (%)
Underweight (<18.5)	0	0.00
Normal (18.5–24.9)	15	75.00
Overweight (25.0–29.9)	5	25.00
Obese (≥30.0)	0	0.00
Total	20	100.00
Mean±SD	23.47±1.69 kg/m^2	

Our study reveals that most of the osteoarthritis knee cases were presented with varus deformity of knee (Table 6).

Table 6: Deformity distribution.

Deformity	Number (n)	Percentage (%)
Varus	18	90.00
Valgus	2	10.00
Total	20	100.00

In our study, most of the cases were with varus deformity, and was subsequently treated with lateral closed wedge high tibial osteotomy, and only few were with valgus

deformity and was treated with medial close wedge osteotomy (Table 7).

Table 7: Types of high tibial osteotomy performed.

HTO	Number (n)	Percentage (%)
Lateral closed wedge	18	90.00
Medial closed wedge	2	10.00
Total	20	100.00

In our study, plate and screw fixation after HTO provides more rigid fixation than staples alone, and hence early mobilization was possible with it (Table 8).

Table 8: Distribution of fixation devices used.

SMD	Number (n)	Percentage (%)
Staples	5	25.00
Plate and screws	15	75.00
Total	20	100.00

In our study, we assessed WOMAC score before and after intervention (HTO), and found out the p value was significant, thus HTO is an affective intervention for reducing the symptoms of the patients with osteoarthritis knee (Table 9).

Table 9: WOMAC score before HTO and six months after HTO.

HTO procedure	WOMAC score		P value*
	Mean	±S.D.	
Before	64.50	7.23	<0.001
After	46.80	7.72	

*Student t test; the p value is significant at 5% level of significance

Our study shows that the results of HTO are favourable in 90% of well selected group of patients. Only 10% cases showed poor results (Table 10).

Table 10: Evaluation of results (based on Devgan et al criteria).

Evaluation	Number (n)	Percentage (%)
Good	12	60.00
Fair	6	30.00
Poor	2	10.00
Total	20	100.00

DISCUSSION

This study shows the age of onset of symptoms may varies. The youngest age in our study was 47 years, and the oldest was 60 years, with a mean age of 55.9 years. In our study, majority of the subjects were females, comprising 80%.

Felson et al in the Framingham OA study found that the incidence of OA is 1.7 times higher in women than in men (95 % CI), and progressive disease occurred slightly more often in women.[11] The prevalence of OA increases significantly with age in women, but not in men. Also symptomatic OA knee was more common among females –for age adjusted difference between sexes.

Marra et al, in their study of improving osteoarthritis detection in the community, to identify symptomatic undiagnosed osteoarthritis cases, 62 % cases were females, with mean age of 62 years.[12]

In our study, there was higher incidence of unicompartmental OA knee in the left side comprising 50% of the total sample.

Stoddart et al, in their study, there was higher incidence ofunicompartmental OA knee comprises of 50%, bicompartmental 33% and tricompartmental comprises of 17%. Incidence of isolated medial compartmental disease occurring in 27%, isolated patellofemoral OA in 18% and tricompartmental disease in 23%. Isolated lateral compartment OA were less occurring in 15%.[13]

Neame et al, in their study shows, more global tibio-femoral joint OA and higher osteophyte scores on the right side. And medial compartment showed more narrowing on the right, but the lateral compartment was wider on the right. And this finding is consistent with the observation that OA targets the medial tibiofemoral joint more commonly than the lateral tibiofemoral joint, and that as the medial compartment narrows, there is widening of the lateral compartment.[14]

Van Saase et al, in the Zoetermeer survey, they found that global OA was equally distributed between the right and left knees. In our study, there was a higher incidence of OA in Hindu population and a lesser incidence in muslim population.[15]

Chokkhanchitchai et al study reveals Muslims had higher number of daily religious practices than their Buddhist neighbors ($p<0.001$). Muslims had a lower prevalence of OA than their Buddhists counterparts, but with different religious practice. The way of praying among Muslims since childhood, forcing knees to full flexion, stretches the soft tissue surrounding the knee and decrease stiffness and contact pressure of the articular cartilage.[16]

Osama et al study shows, even prayer is practised by all Muslims, evidence is very limited regarding the biomechanics and the therapeutic effects of salat (prayer) as an exercise. Salat is found to improve balance in healthy individuals as well as stroke patients, and decreases the chances of development of knee osteoarthritis. In current study, most of the cases were having a BMI within normal limits and few were in grade 1 overweight. So, it appears that obesity is not the only responsible factor for OA.[17]

Badley et al, according to their study, the postulated mechanism forrole of obesity in OA is that the adipokines from adipose tissue act as systemic inflammatory mediators that cause a low-grade inflammatory state involving damage to joints. The lack of an association of BMI (obesity) with number of painful joint sites in OA raises questions about the role of these risk factors and our understanding of OA.[18]

Thijssen et al, *a*ccording to their study in 2015, high incidence of knee OA in obese people led to the assumption historically that the link was purely mechanical, that is overweight increases the joint loading, resulting in wear and tear of joints resulting in OA. But, obesity is also a risk factor for OA in non-weight-bearing joints, like hand and wrist, indicating that excessive joint load, that is the mechanical factor alone cannot fully explain the link between OA and obesity. Now, role for adipose tissue suggested in obesity related OA. In obesity, adipocytes are inflamed and secretes proinflammatory adipokines like leptin, resistin, visfatin, lipocalin-2, chemerin which causes a low-grade inflammation.[19]

Eti et al observed that obesity was present in 19.04 % of cases of patellofemoral OA and in 10.57% of cases of femorotibial osteoarthritis.[20]

Felson et al, in this Framingham study of risk factors for incident radiographic knee OA in elderly, out of 598 patients without knee OA at baseline after adjusting multiple risk factors it was evident that higher baseline body mass index increases the risk of OA and weight change was directly correlated with the risk of OA.[21]

In this study, higher WOMAC score has higher grades of lesions. Five out of eight grade III lesions (62.5%) has high WOMAC score. As it is evident that low grade lesions also had sometimes higher WOMAC score, maybe because of the subjective nature of evaluation of the WOMAC scoring.

Wolfe in his study of determinants of WOMAC function, pain and stiffness scores: evidence for the role of low back pain, symptom counts, fatigue and depression in osteoarthritis, rheumatoid arthritis and fibromyalgia; he found that, WOMAC score is influenced clearly by the presence of fatigue, symptom counts, depression and low back pain. WOMAC score also appears to reflect psychological and constitutional status.[22]

In this study, incidence of knee pain is more in outdoor workers was 60% (n=20), all of them were manual labourers. This is probably because they use to engage in hard manual works which they require kneeling and squatting that increases the risk of OA. And among indoor workers, majorities are housewives. This was probably because of the nature of their job that requires kneeling and squatting that increases the risk of OA. In this study, we found that 90% cases (n=20) of OA knee presented with varus deformity and 10% (n=20) patients presented with valgus. All the cases were unicompartmental OA.

Chang et al in their study in 2010, revealed that, varus deformity in unilateral OA or bilateral OA knee was present in 32.1% (502 of 1566) persons without radiographic knee OA and in 36.7% (743 of 2026) persons with radiographic knee OA. Valgus deformity in unilateral knee or bilateral knees was present in 7.2% (113 of 1566) persons without radiographic knee OA and in 9.1% (185 of 2026) persons with radiographic knee OA.[23]

Teichtahl et al in their study in 2009, In multivariate analyses for every 1 degrees change toward genu varum, there was an associated 0.44% increase in the rate of annual medial tibial cartilage volume loss, implying the importance of medial tibial cartilage volume loss. But, change in knee angle did not significantly affect the rate of loss of the lateral tibial cartilage volume (p=0.95). Their results have demonstrated that progressive change toward genu valgum reduced the annual rate of medial tibial cartilage volume loss in people with knee OA, without expediting the rate of lateral tibial cartilage volume loss, indicating knee with varus deformity increasingly progresses to OA knee as compared to knee with valgus deformity.[24]

In this study, symptoms like swelling, crepetitions and stiffness were found in majority of cases. Patients with severe radiographic OA had symptoms more often than with milder radiographic abnormalities. However, in few cases, radiographic appearance was not corresponding to the clinical presentation.

Son et al in 2020, their study on Absence of pain in subjects with advanced radiographic knee osteoarthritis, they concluded that, a considerable number of subjects with KL grade 4 OA did not report pain. This indicates that not all the cases with a high KL score on radiological diagnosis of OA knee may have significant symptoms. This is comparable with our current study finding.[25]

In our study, minor trauma was associated with 6 cases (30%, n=20). Major trauma to knee were excluded in our study protocol. It seems from our study that, minor trauma maybe one of the risk factors for knee OA.

Kellgren and Lawrence found in their study, that a history of previous trauma in almost 40% of men and 20% of women aged 55-64 years with OA knee. This finding is comparable with our current study.

In our study, 90 % cases (n=20) were with varus deformity and was treated with lateral close wedge high tibial oseotomy, and only few 10% (n=20) were with valgus deformity and was treated with medial close wedge high tibial osteotomy.

In our study, we found that plate and screws fixation after HTO provides more rigid fixation than staples alone, and hence early mobilization was possible with it.

Agarwala et al, in their study in 2008 on staple versus locking compression plate fixation after lateral closing wedge high tibial osteotomy, they concluded that at 6 months after the operation, the median HSS score and the proportion of patients with excellent or good scores were significantly higher in the case of locking compression plate than the staple fixation group (76 versus 62, p=0.003; 75% versus 42%, p=0.0354), but not at one and 3 years. And the range of movement was significantly greater in the case of locking compression plate fixation group in the short term (6 weeks, 3 and 6 months), but not after one year. The median time to full weight bearing was significantly shorter in the locking compression plate fixation group (86 versus 116 days, p<0.001). Plate and screw fixation obviates the use of plaster casts, enables early mobilization of the patient and bone union, and reduces the numbers with delayed union and the time to full weight bearing. This conclusion is comparable with our result of HTO with plate and screws than staples alone.[26]

In this study, 60% (n=20) had good results, 30% (n=20) had fair results and 10% (n=20) had poor results after 6 months to 1 year of follow-up based on Devgan et al criteria. Our results are comparable to study by Devgan et al were good results were seen in 60% cases, fair results in 36% cases at eve after a follow up of average 7.5 years.[27]

CONCLUSION

A detailed preoperative assessment, adequate and exact angle of correction, stable fixation, planned postoperative rehabilitation, along with good patient motivation make the procedure rewarding and ensure a good long-term survivorship. In third world countries and in a country like India, where the majority of the population is with low socioeconomic status and low income, high tibial osteotomy perhaps offers an attractive low cost procedure with high volume of cases, which can be performed in most of our hospitals with minimal instrumentation and cost, without vigorous training for orthopaedic surgeons in joint replacement surgeries. High tibial osteotomy is effective in minimizing the complications of total knee replacements as well as maintains the option of future conversion to total knee replacement alive, if needed.

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