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Research Article

FUNCTIONAL OUTCOME OF PATIENTS WITH MODERATE-TO-SEVERE MEDIAL COMPARTMENT OSTEOARTHRITIS KNEE TREATED BY HIGH TIBIAL OSTEOTOMY AT A TERTIARY CARE CENTER

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ABSTRACT

Objectives: (1) The aims and objectives of the study are to assess functional outcomes in knee osteoarthritis (OA) cases treated by high tibial osteotomy (HTO) and (2) to study the complications in patients undergoing HTO.

Methods: This was a prospective study conducted in the Department of Orthopedics of a tertiary care medical college. 50 patients with moderate-to-severe OA of medial compartment of knee were included in this study. All patients underwent HTO. Post-operatively, patients were followed up for 6 months. During follow-up visits, reduction in pain intensity and functional outcome were assessed by visual analog scale (VAS) score and Japanese Orthopedic Association (JOA) Score. Patients were also assessed for complications if any. For statistical purposes, $p<0.05$ was taken as statistically significant.

Results: Out of 50 studied cases, there was a female preponderance with an M: F ratio of 1:1.38. The mean age of affected cases was found to be 62.32±8.94 years. 11 (22.00%) patients were obese (body mass index [BMI] ≥30) and 32 (64.00%) patients were overweight (BMI ≥25 but <30). 7 (14.00%) patients had BMI <25. 38 (76%) patients had severe OA whereas in remaining 12 (24%) patients, there was moderate OA. There was a significant reduction in pain, as assessed by VAS score, at the time of final follow-up as compared to VAS score at the time of presentation ($p<0.0001$). Similarly, there was a significant functional improvement, as assessed by JOA score, at the time of final follow-up as compared to JOA score at the time of presentation ($p<0.0001$). 7 (14%) patients developed minor complications. All these complications were managed conservatively.

Conclusion: Patients with moderate to severe OA of medial compartment of knee treated by HTO show excellent outcomes in terms of pain relief and functional outcomes.

Keywords: Knee osteoarthritis, Medial compartment, Tibial osteotomy, Functional outcome.

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INTRODUCTION

Arthritis is a widespread chronic inflammatory condition affecting millions of individuals worldwide, and among its various manifestations, knee arthritis stands as a substantial burden on both patients and health-care systems. Knee arthritis, predominantly in the form of osteoarthritis (OA), represents a complex interplay of genetic, mechanical, biochemical, and environmental factors [1]. Genetic predisposition can amplify the risk of accelerated cartilage degeneration, altered bone morphology, and systemic influences that contribute to arthritis. Mechanically, OA may be caused by malalignment, joint instability, or incongruity. These factors can induce abnormal loading on the knee joint, hastening articular cartilage degeneration. Moreover, biochemical factors, including metabolic conditions such as obesity and systemic inflammation, lead to biochemical alterations within the joint, promoting inflammation and cartilage breakdown. Environmental factors, such as traumatic injuries, repetitive microtrauma, and occupation-related stress, may also be responsible for knee OA [2].

Predisposing factors for knee arthritis are multifaceted and may consist of demographic and environmental elements. Age is a critical factor, with the risk of knee arthritis increasing with advancing years, as the joint undergoes natural degenerative changes over time. Gender also plays a role, with women being more predisposed to knee arthritis. Female preponderance is partly attributed to hormonal influences and differences in joint biomechanics. In addition, obesity is a known risk factor, as excess body weight places an increased mechanical burden on the knee joint, accelerating the wear and tear of articular cartilage. A history of previous knee injuries, particularly ligament and meniscal injuries, can lead to altered joint biomechanics, heightening the risk of arthritis [3].

Patients with knee arthritis commonly present with symptoms of joint pain, stiffness, and functional limitation. Pain, often exacerbated by weight-bearing activities, is a hallmark complaint. Stiffness, particularly following periods of inactivity, is another characteristic feature, impacting a patient's mobility. Functional limitations, such as difficulty in climbing stairs, kneeling, or squatting, significantly affect daily activities. In more advanced cases, joint deformities and loss of range of motion become apparent [4].

To diagnose knee arthritis and evaluate its severity, a combination of clinical assessment and various diagnostic investigations are employed. Radiographic imaging, such as X-rays, may show combination of features such as joint space narrowing, osteophyte formation, and bony changes characteristic of OA. Magnetic resonance imaging (MRI) provides a more detailed assessment of soft tissue structures and cartilage integrity. Joint aspiration and analysis of synovial fluid can aid in excluding other inflammatory arthropathies and evaluating joint inflammation. Moreover, computed tomography (CT) scans may be utilized to assess bone morphology and alignment, which can be particularly informative in surgical planning [5].

The management of knee arthritis spans a spectrum of approaches, ranging from conservative to surgical interventions. Conservative treatments encompass lifestyle modifications, weight management,

physical therapy, analgesics, non-steroidal anti-inflammatory drugs, and intra-articular injections of corticosteroids or hyaluronic acid. These interventions aim to alleviate symptoms, improve joint function, and delay the progression of the disease. However, they may have limited efficacy in advanced cases and might not address the underlying structural abnormalities contributing to arthritis [6].

High tibial osteotomy (HTO) represents a surgical intervention with a growing role in the management of knee arthritis, particularly in patients with malalignment or localized joint disease. This procedure involves the realignment of the tibial plateau to offload damaged joint surfaces, redistributing forces within the knee joint and potentially delaying or averting the need for total knee replacement. HTO has gained popularity due to its potential to provide lasting pain relief and improved joint function while preserving the native knee joint [7].

We undertook this study to analyze functional outcome of patients with OA knee who were surgically treated by HTO.

METHODS

This was a prospective observational study conducted in the Department of Orthopedics of a Tertiary Care Medical College situated in an urban area. 50 patients with knee OA were included on the basis of a pre-defined inclusion and exclusion criteria. Written informed consent to be part of study was obtained from each patient. Using OPENEPI software version 3 on the basis of pilot study done on the topic of surgical management of OA of knee assuming 90% power and 95% confidence interval, and based on central limit theorem, sample size was determined to be enough if it was more than 45 and thus 50 patients were included in this study. Demographic details such as age, gender, body mass index (BMI), and occupation of all the patients were noted. A detailed history with respect to the duration of symptoms and functional disability as manifested by difficulty in climbing stairs, kneeling, or squatting was asked for and noted. An X-ray of both knees in AP weight-bearing view was done in all cases. CT and MRI were done in selected cases.
OA was classified into moderate OA (moderate multiple osteophytes, definitively narrowed joint space, and some sclerosis and moderate deformity of bone ends) or severe OA (large multiple osteophytes, extensive narrowing of joint space, severe sclerosis, and definite deformity of bone ends) on the basis of Kellgren and Lawrence system.

All patients underwent routine investigations such as complete blood count, coagulation profile, hepatic and renal function tests, HIV, Hepatitis B surface antigen, and blood grouping before surgery. ECG and 2 D ECHO were done in selected patients as per physicians' advice. Following pre-anesthetic evaluation, all patients underwent elective HTO.

Surgical procedure

All patients underwent surgery under spinal anesthesia. Following spinal anesthesia patients were positioned in the supine position. A skin incision was made, starting from the point where the pes anserinus attaches, and extending in a posterior and cranial direction. The tendons of the pes were moved downward. The superficial fibers of the medial collateral ligament were gently released, revealing the medial edge of the patellar ligament. To guide the osteotomy procedure, two 2.3-mm guide wires were used, directed toward the upper third of the proximal tibiofibular joint, with the wires ending precisely at the lateral cortex. The length of the osteotomy was determined using these guide wires, and the depth of the osteotomy was marked on the saw blade. In the posterior two-thirds of the tibia, a horizontal osteotomy was performed just below the guide wires, leaving a lateral bone bridge of 10 mm. An anterior ascending osteotomy was done at an angle of 110°. The osteotomy site was opened with broad, flat chisels, and the osteotomy was widened. An arthrodesis spreader was inserted on the cortical surface of the posteromedial corner of the osteotomy. Particular attention was paid to the tibial slope. The alignment of the leg was assessed clinically and radiographically with the knee in full extension. A plate was placed, and the proximal screws were secured. A temporary lag screw was then inserted into the first hole of the plate, distal to the osteotomy. Subsequently, screws were inserted into the remaining plate holes from distal to proximal after removing the spacers. Lag screws were replaced with a bicortical locking screw. In some cases, the gap was filled with autologous cancellous bone graft. Radiographic documentation was obtained in both planes, and wound closure was performed.

After surgery, usual knee motion was allowed from day 2. Physiotherapy and full weight bearing were allowed from post-operative D3 and patients were discharged on D4 with an advice for regular follow-up. Follow-up visits were done at 15 days, 1 month, 2 months, 3 months, and 6 months. In each follow-up visit, functional assessment was done by Japanese orthopedic association score (JOA) and assessment of range of motion [8]. Patients were also assessed for pain (visual analog scale [VAS] score) and for the presence of complications. Qualitative data were expressed in terms of percentages, while quantitative data were presented using the mean and standard deviation. $p<0.05$ was taken as statistically significant.

Inclusion criteria

1. Patients with moderate-to-severe medial compartment knee OA (as per Kellgren and Lawrence system) and not responding to non-surgical management.
2. Those who gave consent to be part of study.
3. Patients having age more than 18 years.

Exclusion criteria

1. Patients <18 years of age.
2. Those patients who refused consent.
3. Patients having progressive diseases such as psoriatic arthritis, systemic lupus erythematosus, rheumatoid arthritis, gout, or any other autoimmune or systemic condition likely to interfere with assessment of functional outcome.
4. Patients with renal failure, malignancies, and those on chemotherapy.

RESULTS

Fifty cases of moderate-to-severe medial compartment knee OA not responding to medical management treated by HTO were included in this study. Out of studied cases, there were 21 (42%) males and 29 (58%) were females. There was a female preponderance with an M: F ratio of 1:1.38 (Fig. 1). 16 (40.7%) of the participants had right side affected whereas 18 (53.3%) of the participants had left knee OA. 6 (15.00%) patients had bilateral OA changes. The right and left side was affected predominantly in 22 (44%) and 19 (38%) patients, respectively. In 9 patients, both knees were affected. In 19 (38%), the duration of symptoms was more than 3 years (Table 1).

The most common affected age group was above 65 years (32.50%) followed by 61–65 years (27.50%) and 51–60 years (17.50%). Only 5 (12.50%) patients were below 51 years of age. The mean age of affected cases was found to be 62.32±8.94 years (Table 2).

Obesity was found to be associated with increased risk for the development of knee OA. The analysis of BMI in studied cases showed

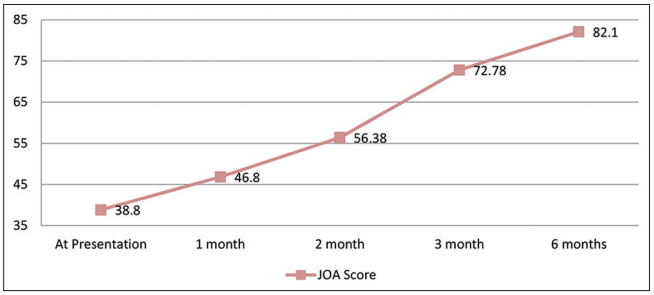

Fig. 1: Functional outcome of cases as determined by Japanese Orthopedic Association Score

Table 1: Gender, affected side, and duration of symptoms in studied cases

Gender, affected side and duration of symptoms	No of cases	Percentage
Gender		
Males	21	42.00
Females	29	58.00
Total	50	100.00
Affected side		
Right	22	44.00
Left	19	38.00
Bilateral	9	18.00
Total	50	100.00
Duration of symptoms		
<1 year	5	10.00
1–2 years	14	28.00
2–3 years	12	24.00
>3 years	19	38.00
Total	50	100.00

Table 2: Age distribution of the studied cases

Age in years	No of cases	Percentage
18–40	1	2.00
41–50	3	6.00
51–60	9	18.00
61–65	31	62.00
Above 65	6	12.00
Total	100	100

Mean age: 62.32±8.94 years

that among 50 patients, 11 (22.00%) patients were obese (BMI ≥30) and 32 (64.00%) patients were overweight (BMI ≥25 but <30). 7 (14.00%) patients had BMI <25 (Table 3).

The severity of OA was assessed using Kellgren and Lawrence system. Out of the 50 cases, 38 (76%) patients had severe OA whereas in remaining 12 (24%) patients, there was moderate OA (Table 4).

At the time of presentation, all patients were found to have severe pain. The mean VAS score at the time of presentation was 8.12±3.68. Post-surgery during each follow-up visit, the intensity of pain was assessed by VAS score. The assessment of the pain was done at each follow-up visit. Mean VAS score at 1-, 2-, and 3-month follow-up was found to be 5.12±2.34, 4.10±1.98, and 3.24±1.02. At the time of final follow-up, the mean VAS score was found to be 1.04±0.54. The difference in VAS score at the time of presentation and final follow-up was found to be statistically highly significant (p<0.0001) (Table 5).

During each follow-up visits, the functional assessment was done on the basis of JOA score. Mean pre-operative JOA score was found to be 38.8±22.4. The mean JOA scores at 1-, 2-, and 3-month follow-up were found to be 46.8±12.64, 56.38±10.36, and 72.78±9.38. At the time of final follow-up, the mean VAS score was found to be 82.10±11.34. The difference in VAS score at the time of presentation and final follow-up was found to be statistically highly significant (p<0.0001) (Fig. 1).

No serious surgery related complication was seen in any of the cases. In 43 (86%) cases, the surgery and post-surgical period was uneventful. Total 7 (14%) patients developed complication. 3 (6%) patients developed wound infection and peroneal nerve palsy was seen in 1 (2%) patient. External hallucis longus weakness was seen in 2 (4%) patients and 1 (2%) patient developed dorsal numbness. All these complications were managed conservatively (Fig. 2).

DISCUSSION

In this study on HTO for moderate-to-severe OA, 50 cases were examined. The participants consisted of 21 (42%) males and 29 (58%)

Table 3: Body mass index in studied cases

Body mass index	Number of patients	Percentage
Healthy weight (18.5–24.9)	7	14.00
Overweight (25–29.9)	32	64.00
Obese (30 or above)	11	22.00
Total	40	100.00

Table 4: Severity of osteoarthritis by Kellgren and Lawrence system

Kellgren and Lawrence system of grading	No of cases	Percentage
Moderate osteoarthritis	38	76
Severe osteoarthritis	12	24
Total	50	100.00

Table 5: Mean VAS score of the cases at presentation and during follow-up

Mean VAS score	Mean±SD	p-value
At presentation	8.12±3.68	p<0.0001 (paired t-test) highly significant
At 1 month	5.12±2.34	
At 2 months	4.10±1.98	
At 3 months	3.24±1.02	
Final follow-up (6 months)	1.04±0.54	

VAS: Visual analog scale

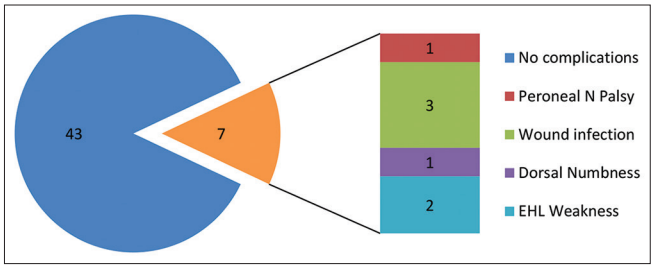

Fig. 2: Complications in studied cases

females, indicating a female preponderance with a male-to-female ratio of 1:1.38. Although exact cause of increased incidence of OA in females is not known, influence of hormonal factors, particularly the decline in estrogen levels during menopause, is thought to be one of the important factors contributing to OA in females. Estrogen has a protective effect on cartilage, and its reduction may contribute to the higher prevalence of knee OA in post-menopausal women. Furthermore, differences in knee joint anatomy, muscle strength imbalances, and gait patterns have been identified in women, potentially increasing the biomechanical stress on the knee joint. Srikanth *et al*. conducted a meta-analysis to address uncertainties regarding gender disparities in OA, examining its prevalence, incidence, and severity [9]. The meta-analysis found that OA in the knee and hand was significantly less common in males. In contrast, females, especially those aged 55 or older, tended to exhibit more severe knee OA. Heterogeneity in prevalence estimates was largely attributed to factors such as age and study design. These findings highlighted gender-based differences in OA, suggesting that females are generally at a greater risk, emphasizing the importance of further research into the underlying mechanisms of OA across different joint sites. Similar female preponderance for the development of OA knee was also reported by authors such as O'Connor [10] and Laitner *et al*. [11].

The most common affected age group was above 65 years (32.50%) followed by 61–65 years (27.50%) and 51–60 years (17.50%). Only 5 (12.50%) patients were below 51 years of age. The mean age of

affected cases was found to be 62.32±8.94 years. Increasing age was found to be one of the contributory factors for increasing severity of OA. There exists a strong correlation between advancing age and the prevalence of knee OA. As individuals grow older, the cumulative wear and tear on the knee joint, along with age-related changes in joint tissues, play a pivotal role in the pathogenesis of OA. Moreover, age-related comorbidities and diminished regenerative capacity of cartilage contribute to this association. Prashansanie Hettihewa *et al*. conducted a study to determine the prevalence of clinical KOA and radiographic KOA and to assess the severity of it [12]. Study included 666 patients with a response rate of 99.4%. The mean age was 63.3 years (±9.29 years). A total of 134 were found to satisfy ACR criteria resulting in a crude prevalence of clinical KOA of 20.1%. Estimated age-standardized prevalence of clinical KOA was 21.8%. Similar mean age for moderate-to-severe knee OA was also reported by authors such Michael *et al*. [13] and Jaiswal *et al*. [14].

Similar to increasing age being overweight and obese also was found to be associated with increased risk of OA. In our study, only 7 (14%) patients were found to have a BMI of <25. Majority of the patients 43 (86%) were either overweight or obese. The connection between obesity and knee OA is believed to involve both biomechanical and metabolic factors. Importantly, weight loss in obese patients with knee OA is shown to be beneficial, reducing pain and improving function. Roy MK conducted a study to estimate the prevalence of knee OA among women in the age group of 46–65 years and the effect of age and BMI on knee OA [15]. 100 cases were included in the age group of 46–55 years 39 (39%) and 56–65 years 61 (61%). A total of 65 (65%) participants were affected with knee OA. Among them, 19 (29.2%) participants were in the age group of 46–55 years and 46 (70.8%) participants were in the age group of 55–65 years, and thus, in the advanced age group, knee OA is remarkably more. Participants affected with knee OA with BMI ≥25 were significantly more affected 45 (69.2%) compared with participants with normal BMI 20 (30.2%). The authors concluded that knee OA was significantly associated with advanced age and obesity. Similar positive correlation between obesity and knee OA was also reported by the authors such as King *et al*. [16] and Lee and Kean [17].

In our study, at the time of presentation, the mean VAS score was 8.12±3.68, indicating severe pain. However, post-surgery, the pain intensity significantly decreased during follow-up visits at 1, 2, and 3 months, with mean VAS scores of 5.12±2.34, 4.10±1.98, and 3.24±1.02, respectively, reaching a final follow-up mean VAS score of 1.04±0.54. Functional assessment, as measured by the JOA score, also significantly improved over time, with a mean pre-operative JOA score of 38.8±22.4 and mean scores of 46.8±12.64, 56.38±10.36, and 72.78±9.38 at 1-, 2-, and 3-month follow-up, respectively, reaching a final follow-up mean JOA score of 82.10±11.34. This reduction in VAS scores and improvement in JOA score were highly statistically significant ($p<0.0001$). Mukherjee *et al*. conducted a study of 42 patients with knee OA treated by HTO [18]. The authors found that at 6-month follow-up, 6–10° of valgus correction at the site of osteotomy was maintained. The VAS score improved from mean of 5.77 to 1.5. Approximately 19 were satisfied with this operation. The JOA score mean 55 (range 45–61) improved to 86.18 (range 82–89). The activity of daily living (ADL) such as rising from chair and going upstairs and downstair improved in all patients. Walking distance improved in all patients. No patient was lost any pre-operative knee function. Similar excellent results of HTO for knee OA were also reported by authors such as Kanakamedala *et al*. [19] and Khakha *et al*. [20].

CONCLUSION

Patients with moderate-to-severe OA of medial compartment of knee treated by HTO show significant improvement in functional outcome, reduction in severity of pain with acceptable complication rate.

CONFLICT OF INTEREST

None.

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