

Functional and Clinical Outcomes after Medial Unicompartmental Knee Arthroplasty Compared with High Tibial Osteotomy in Isolated Medial Compartment Osteoarthritis

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Learning Point of the Article:

In isolated medial compartment osteoarthritis, both high tibial osteotomy (HTO) and unicompartmental knee arthroplasty (UKA) effectively reduce pain and improve function. However, UKA demonstrates superior functional outcomes and range of motion (ROM), making it a preferred option in appropriately selected patients.

Abstract

Introduction: Medial compartment osteoarthritis (OA) causes pain, functional limitation, and reduced quality of life. When conservative treatment fails, surgical options include high tibial osteotomy (HTO) and unicompartmental knee arthroplasty (UKA), both aimed at pain relief and functional improvement.

Materials and Methods: This prospective comparative study included 50 patients with isolated medial compartment OA, divided into UKA (n = 25) and HTO (n = 25) groups. Clinical parameters, including Visual Analog Scale (VAS) pain score, ROM, and post-operative complications, were analyzed, with P < 0.05 considered significant.

Results: Most patients were males (60%) and aged 50–70 years (76%). Pre-operative VAS scores were comparable (UKA: 7.8 ± 0.9; HTO: 7.6 ± 1.0). Post-operatively, pain significantly decreased in both groups but was lower in UKA (2.1 ± 0.8 vs. 3.2 ± 1.0; P = 0.01). Functional outcomes were better in the UKA group (knee society score: 86.4 ± 6.5 vs. 79.2 ± 7.3), with greater improvement in ROM (125° vs. 118°). Most patients (88%) had no complications.

Conclusion: Both HTO and UKA are effective for medial compartment OA; however, UKA provides superior functional outcomes and range of motion.

Keywords: Functional outcome, high tibial osteotomy, knee society score, medial compartment osteoarthritis, unicompartmental knee arthroplasty.

Introduction

Knee osteoarthritis (OA) is a leading cause of disability, pain, and diminished quality of life among people globally. Inflammation of the synovia, remodeling of the bone underneath the cartilage, development of osteophytes, and gradual loss of joint cartilage

characterize this degenerative joint condition. Knee problems are common because the knee joint bears a disproportionate share of the body's weight and experiences repetitive mechanical stress when performing common daily tasks, such as walking, stair climbing, and squatting. Since the lower leg is in a varus

Author's Photo Gallery



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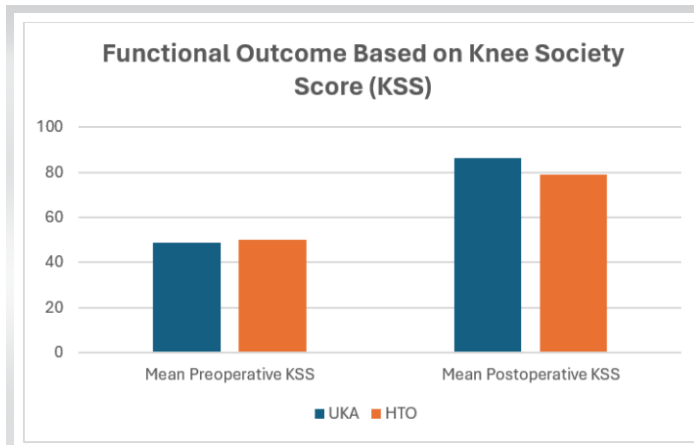


Figure 1: Functional outcome based on the Knee Society Score.

posture by nature, more weight is transmitted to the medial side of the knee, making it the most afflicted compartment of the knee joint. Patients with medial compartment OA have a lot of trouble moving about and doing everyday tasks since the condition is characterized by increasing pain, stiffness, deformity, and functional limitations [1,2]. The primary treatment for knee OA starts with conservative care methods. “The treatment program requires people to change their daily habits and achieve weight loss while they complete their physical therapy sessions and use pain relief medication, non-steroidal anti-inflammatory drugs and joint injections of corticosteroids or hyaluronic acid. The treatments succeed in symptom reduction, but they do not prevent disease progression. Surgical procedures become necessary when a patient with chronic pain and functional impairment fails to respond to standard treatment methods. For younger patients who experience active medial compartment OA with preserved patellofemoral and lateral compartments, joint-preserving surgical methods may be preferable than complete knee arthroplasty [3,4]. The ancient surgical procedure, high tibial osteotomy (HTO), operates as a medical treatment for varus deformity medial compartment OA. The primary goal of HTO is to realign the lower limb’s mechanical axis by shifting the lower limb’s weight-bearing axis to a more advantageous side of the lateral compartment. The HTO procedure uses weight distribution across the knee joint to decrease medial compartment stress, which provides pain relief while postponing OA progression. The method displays effective results for younger patients with high energy levels who want to boost their physical activity. Some research suggests that HTO may delay the need for complete knee replacement, improve functional capacity, and alleviate pain to a satisfactory degree. However, there is a longer recovery period involved, and problems, such as non-union, loss of correction, and irritation of hardware are possible [5,6].

Individuals suffering from medial compartment OA have an additional surgical option: Medial unicompartmental knee arthroplasty (UKA), sometimes known as partial knee replacement. When compared to HTO, which keeps the knee joint together and realigns the limbs, UKA is used to replace the damaged knee joint while preserving the healthy ligaments, bone, and cartilage in the others. In comparison to HTO, this procedure takes less time to recover from and produces faster pain relief by restoring normal joint kinematics. Patients undergoing UKA often report better functional outcomes, faster mobilization, and increased range of motion (ROM). It is also easy to make revisions to a UKA if necessary in the future since less bone and soft tissue is removed compared to a total knee arthroplasty [7,8]. Medial UKA and high tibia osteotomy both have its advantages, but which one is better is still up for debate. There are indications, benefits, and limitations to every surgery. UKA may be recommended for elderly patients with local cartilage loss and generally stable ligaments, whereas HTO is often utilized for individuals with significant varus malalignment and high activity levels. There is, however, an ongoing debate about whether procedure provides superior functional recovery, analgesia, and post-operative clinical outcomes due to the muddled symptoms and developments in surgical art [9,10].

Multiple studies have investigated the comparison between UKA and HTO outcomes for people who have isolated medial compartment OA. Research shows that UKA delivers quicker pain relief together with improved initial functional results, while HTO offers better joint preservation during the long term for younger patients. The various studies reached different conclusions because researchers employed different methods to select patients, conduct surgeries, and evaluate results [11,12]. The comparison of HTO functional and clinical outcomes with those of medial UKA must take place before

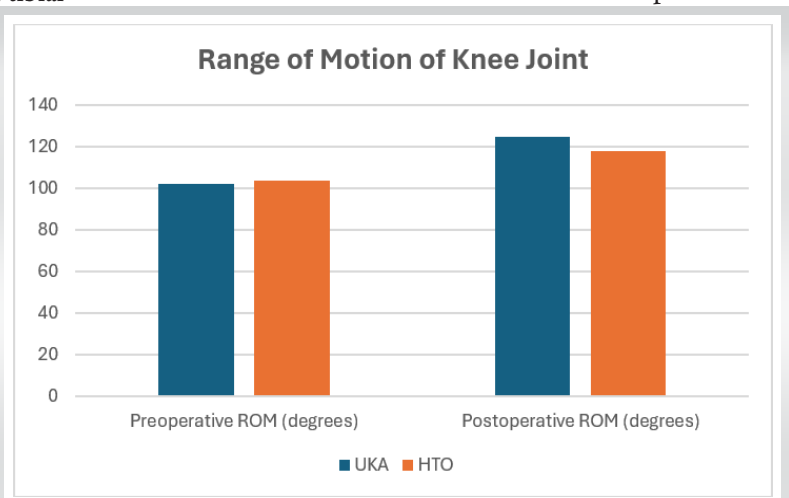


Figure 2: Range of motion of the knee joint.

Table 1: Functional outcome based on KSS

Group	Mean pre-operative KSS	Mean post-operative KSS
UKA	48.6±7.2	86.4±6.5
HTO	50.1±6.8	79.2±7.3

KSS: Knee society score, UKA: Unicompartmental knee arthroplasty, HTO: High tibial osteotomy

surgical procedure selection. The advantages and disadvantages of various treatments for isolated medial compartment OA should be understood by professionals to determine the best treatment option for their patients. The study will evaluate functional outcomes and pain relief together with clinical effectiveness of medial UKA combined with HTO for patients with isolated medial compartment OA.

Despite the increasing use of both HTO and UKA for isolated medial compartment OA, there remains ongoing controversy regarding the optimal surgical procedure in terms of pain relief, functional recovery, ROM, and complication profile. Furthermore, limited prospective comparative data are available from the Indian population evaluating the clinical effectiveness of these procedures. Therefore, the present study was conducted to compare the functional and clinical outcomes of medial UKA and HTO in patients with isolated medial compartment OA of the knee.

Materials and Methods

Study design

This study was designed as a prospective comparative observational study conducted to evaluate and compare the functional and clinical outcomes of medial UKA and HTO in patients with isolated medial compartment OA of the knee. The study protocol was approved by the Institutional Ethics Committee, and written informed consent was obtained from all patients before inclusion in the study.

Study setting

The study was conducted in the Orthopaedics department of a tertiary care teaching hospital.

Study duration

The study was carried out over a period of 18 months, including patient recruitment, surgical intervention, and post-operative follow-up.

Participants

Patients diagnosed with isolated medial compartment OA of the knee, who presented to the orthopedic outpatient department and were planned for surgical treatment, were considered for participation in the study.

Inclusion criteria

- Patients aged between 40 and 70 years
- Patients diagnosed with isolated medial compartment OA of the knee, confirmed clinically and radiologically
- Patients with persistent knee pain and functional limitation despite conservative treatment
- Patients suitable for either medial UKA or HTO as determined by the orthopedic surgeon
- Patients who provided written informed consent to participate in the study.

Exclusion criteria

- Patients with bicompartamental or tricompartmental OA of the knee
- Patients with inflammatory arthritis, such as rheumatoid arthritis
- Patients with previous knee surgery or fractures around the knee joint
- Patients with severe ligament instability of the knee
- Patients with severe systemic illness or contraindications to surgery
- Patients who were unwilling to participate or unable to comply with follow-up.

Study sampling

A consecutive sampling technique was used in the study. The research staff selected study participants from all patients who visited the orthopedic outpatient department during the study period while meeting the research requirements until they

Table 2: Range of motion of knee joint

Group	Pre-operative ROM (degrees)	Post-operative ROM (degrees)
UKA	102±10	125±8
HTO	104±9	118±10

UKA: Unicompartmental knee arthroplasty, HTO: High tibial osteotomy, ROM: Range of motion

reached their target study sample size. The research study used this sampling approach to provide equal chances for all eligible patients to join the study who showed up at the research site during the study period.

Study sample size

The sample size was calculated based on previous studies comparing functional outcomes between UKA and HTO groups, considering the post-operative knee society score (KSS) as the primary outcome variable. Assuming a confidence level of 95%, a power of 80%, and an expected mean difference (MD) between groups, the minimum required sample size was calculated to be 22 patients in each group. To account for possible loss to follow-up, 25 patients were included in each group, resulting in a total sample size of 50 patients.

Study groups

The enrolled patients were divided into two groups based on the surgical procedure performed.

- Group A: Patients who underwent Medial UKA.
- Group B: Patients who underwent HTO.

Each group included 25 patients. Group allocation was performed based on clinical decision-making by the treating orthopedic surgeon after evaluation of patient age, activity level, severity of varus deformity, radiological findings, cartilage status, and patient preference. Randomization was not performed in the present study.

Study parameters

The research examined both clinical results and functional results in patients who underwent two different surgical methods. The study measured the following parameters:

- Demographic variables, such as age, gender, and body mass index (BMI)
- The time period between the start of symptoms and the patient's condition before surgery
- Pain intensity, assessed using the visual analog scale (VAS)
- The study measured functional results through standardized knee assessment tools, which included the KSS and Oxford Knee Score
- ROM of the knee joint measured using a goniometer
- Radiological assessment, including the degree of varus deformity and compartment involvement
- Post-operative complications, if any.

Study procedure

Pre-operative clinical assessments for all patients included obtaining their medical history, doing a physical examination, and ordering imaging studies, such as lateral and weight-bearing anteroposterior and X-rays of the knee, to ensure a proper fit for the operation. Both UKA and HTO were to be administered to individuals who were determined to have isolated medial compartment OA and who met the eligibility criteria. The goal of medial UKA is to restore the patient's knee joint's healthy medial compartment while keeping the patient's healthy lateral compartment, anterior cruciate ligament, and other bone structures. To alleviate pressure on the affected region, the patient who had had a HTO had to have the proximal tibia realigned during surgery so that the lower limb's mechanical axis would be on the lateral side rather than the medial side. Following the procedure, all patients were given the standard care medications, including antibiotics, physiotherapy, and pain medication. It was encouraged to begin therapy and movement early to improve joint mobility and recovery.

Study data collection

A pre-designed structured pro forma was used to collect data. Before the operation, demographic information, clinical results, and radiological parameters were documented. The follow-up evaluation was conducted periodically, where it was observed to record pain ratings, function results, range of movement, and complications. All the clinical data were captured in a systematic manner to make the data complete and accurate.

Data analysis

The data obtained were put into Microsoft Excel and were analyzed with the help of Statistical Package of Social Sciences software. Demographic and clinical variables were summarized by using descriptive statistics, including mean, standard deviation, frequencies, and percentages. The two study groups were compared based on the relevant statistical tests, which included the use of an independent t-test in the examination of continuous variables and the chi-square test in the examination

Table 3: Post-operative complications

Complication	UKA	HTO	Total
Infection	1	2	3
Implant loosening	1	0	1
Delayed union	0	2	2
No complication	23	21	44



of categorical variables. The $P < 0.05$ was taken to be statistically significant.

Results

A total of 50 patients with isolated medial compartment OA were included and equally divided into UKA ($n = 25$) and HTO ($n = 25$) groups. The majority of patients were in the 50–59 years and 60–70 years age groups (38% each). HTO was more commonly performed in relatively younger patients (40–59 years), whereas UKA was predominantly done in older patients (60–70 years), reflecting procedure selection based on age and activity level.

Gender distribution showed a male predominance, with 30 males (60%) and 20 females (40%). A higher proportion of males underwent both procedures, particularly HTO, suggesting a greater burden of symptomatic medial compartment OA requiring surgery among male patients.

Regarding BMI, most patients were overweight (46%), followed by normal BMI (28%) and obese (26%). Both groups had a similar BMI distribution, indicating that increased body weight is a significant contributing factor to the development of medial compartment OA.

The duration of symptoms revealed that 48% of patients had symptoms for 1–3 years, 28% for more than 3 years, and 24% for <1 year. This suggests that most patients underwent surgery after prolonged symptom duration and failure of conservative management.

Preoperatively, both groups had comparable pain levels, with mean VAS scores of 7.8 ± 0.9 in the UKA group and 7.6 ± 1.0 in the HTO group, indicating severe baseline pain.

Post-operatively, both groups showed significant pain reduction; however, the UKA group demonstrated superior outcomes with a mean VAS score of 2.1 ± 0.8 compared to 3.2 ± 1.0 in the HTO group, which was statistically significant ($P = 0.01$). This indicates better early pain relief following UKA.

Both groups showed significant improvement in functional outcome after surgery. The UKA group demonstrated higher post-operative KSS (86.4) compared to the HTO group (79.2), indicating better functional recovery following UKA (Table 1 and Fig. 1).

The ROM improved in both groups after surgery. However, the UKA group achieved a greater post-operative ROM (125°) compared to the HTO group (118°). This suggests that UKA may provide better post-operative knee mobility (Table 2 and Fig. 2).

Post-operative complications were minimal, with 44 patients (88%) experiencing no complications. Minor complications

included infection in 3 patients (UKA: 1, HTO: 2), implant loosening in 1 patient (UKA), and delayed union in 2 patients (HTO). Delayed union was exclusive to the HTO group, while implant-related issues were observed only in the UKA group, indicating low and procedure-specific complication profiles (Table 3).

In terms of functional outcomes, 80% of patients achieved good to excellent results, with 19 patients (38%) classified as excellent and 21 patients (42%) as good. The UKA group showed a higher proportion of excellent outcomes (12 vs. 7), whereas fair (3 vs. 5) and poor outcomes (0 vs. 2) were more common in the HTO group, suggesting comparatively better functional recovery with UKA.

Discussion

This study aimed to assess the functional and clinical outcomes of two procedures for patients with isolated medial compartment OA of the knee: Medial UKA and HTO. We included 50 patients total; 25 of them received UKA and 25 received HTO. Topics included in the study were demographics, pain treatment, functional performance, ROM, complications, and overall results after surgery. The present research study finds its most beneficial application through the assessment of effectiveness between two surgical techniques for medial compartment OA treatment. The majority of patients, 50–60 years old, made up 38% of the total patient population in this study. HTO patients showed a younger age pattern since their median age reached 40–59 years while UKA patients showed a 60–70-year age range. The research demonstrates that HTO treatment shows better results when doctors treat young active patients who need UKA than when doctors treat elderly patients with compartmentalized degeneration. With a mean age of 67.9 ± 9.0 years for the mobile bearing UKA group and 58.4 ± 5.5 years for the open-ended HTO group, Cho et al. [13] also found a comparable age difference between the two surgical groups, demonstrating that UKA is typically used in older patients with progressive medial OA. Among the patients surveyed for this research, 60% were men and 40% were female, according to the available data. Among these, 14 have had UKA performed on them, while 11 have had HTO done on them. A possible explanation for the somewhat higher incidence in men may be the increased mechanical stress on the knee joint caused by a wider variety of jobs. Even yet, there was little difference in the demographic make-up of the two categories. There was no statistically significant difference in age or BMI between patients who had HTO or UKA ($P > 0.05$) in the research by Cigercioglu et al. [14], demonstrating a similar equilibrium between the two groups.

Blood pressure and BMI were also measured in this research.

Overweight patients accounted for 46% of the total, whereas normal weight individuals made for 28%, and obese patients 26%. Twelve patients in the UKA group were overweight, compared to eleven in the HTO group. Overweight people are more likely to develop medial compartment OA, which puts extra stress on the knee joint, and the frequency of this condition is a testament to this. The average BMI in the HTO group was 30.93 ± 3.33 kg/m² and in the UKA group it was 30.48 ± 3.57 kg/m²; this indicates that surgical intervention is often necessary for those who are overweight or obese to treat knee OA, as described by Cigercioglu et al. [14]. Symptom count before to surgery was also assessed in this research. Half of the patients had symptoms for 1–3 years, a quarter for <1 year, and a quarter for more than 3 years. The majority of patients had surgery after a protracted duration of symptoms and ineffectiveness of conservative treatments, according to these findings. This pattern is often seen in the OA literature, when surgical intervention is suggested as a solution after non-surgical methods of pain and functional limitation relief have been exhausted. When it comes to knee OA surgery, alleviating pain is one of the most important factors in determining a successful outcome. Results show that both the UKA and HTO groups had significant pain before to surgery, with a pre-operative VAS score of 7.8, 0.9, and 7.6, 1.0, respectively. The VAS scores of the UKA and HTO groups declined to $2.1 + -0.8$ and $3.2 + -1.0$, respectively, after the surgeries because both treatments proved successful for pain relief. The UKA group, however, showed a statistically significant improvement ($P = 0.01$). Our results match those of another meta-analysis conducted by Han et al. [15], which showed UKA patients experienced reduced post-operative pain when compared to HTO patients (odds ratio [OR] 0.28, 95% confidence intervals [CI]: 0.12–0.62; $P = 0.002$). The study by Zhang et al. [16] found that UKA decreased post-operative pain while reducing complications at a statistically significant level because their P-value remained below 0.05. The research team used the KSS to evaluate functional outcomes of the study. The UKA group had an average pre-operative KSS score of $48.6 + 7.2$, while the HTO group posted $50.1 + 6.8$, which showed both groups had inadequate knee function before their operations. The UKA and HTO groups both achieved substantial functional enhancements after their surgical procedures, which resulted in their scores reaching 86.4 ± 6.5 and 79.2 ± 7.3 . It seems that more joint functioning was restored following surgery, as the UKA group had a higher improvement after surgery. Results were comparable in a study by Nanda et al. [17], which found that after 24 months of follow-up, UKA had superior functional outcomes (40.1) compared to HTO (34.8) ($P = 0.001$). In addition, the functional scores, such as the Lysholm score (MD -2.78) and the Hospital for Special Surgery score (MD -2.80) were found to be considerably lower

in the HTO group compared to the UKA group, as reported by Huang et al. [18]. The ROM of the knee joint is another important metric for assessing its functional status. Post-operative ROM increased from $102^\circ \text{C } 10$ before surgery in the UKA and $104^\circ \text{C } 10$ in the HTO, respectively, to $125^\circ \text{C } 8$ and $118^\circ \text{C } 10$, after the operation. There was an improvement in both groups; however, the UKA group had a little more advanced improvement. However, the results of ROM have been reported in a variety of ways. To provide an example, whereas Zhang et al. [16] proposed that HTO provided more mobility than UKA, Huang et al. [18] found no difference in post-operative ROM between HTO and mobile bearing UKA (MD -3.78, 95% CI -15.78 8.22). Of note, 44 patients (88%) in the present research did not have any problems after surgery. A few minor issues were infections in three patients, loose implants in one, and delayed union in two. The healing of the osteotomy was the only reason for the delayed union seen in the HTO group. As a consequence of a much higher complication rate in the HTO group (OR 4.88, 95% CI: 2.92686) compared to the UKA group, Huang et al. [18] also found comparable outcomes. The authors of the aforementioned study [15] also discovered that HTO significantly increased the risk of post-operative complications (OR 2.48, 95% CI: 1.264.90; $P = 0.009$).

Finally, the present study's overall functional outcomes showed that 12 patients in the UKA group had outstanding functional outcomes, compared to 7 patients in the HTO group. Meanwhile, 10 patients in the UKA group and 11 patients in the HTO group fared well. The only group that had shown any good outcomes was the HTO group. Despite the fact that both surgical procedures provide respectable clinical results, our findings indicate that UKA is more likely to achieve a larger proportion of good outcomes, measured by improved functional recovery and reduced discomfort. Similarly, Cho et al. [13] found that mobile-bearing UKA outperformed open-wedge HTO in terms of short-term clinical results, HSS improvements, and knee ratings. Both medial UKA and HTO have been reported in the literature as effective surgical treatments for isolated medial compartment OA; the present study's findings corroborate these claims." While HTO is a fantastic joint-preserving procedure, particularly for younger, more active patients, UKA has been shown to be superior in pain control, functional performance, and complication rates. Accordingly, it is advised that the correct surgical treatment be chosen on an individual basis based on patient age, activity level, deformity level, and expectations.

The present study has several strengths. It was a prospective comparative study with uniform clinical assessment and standardized post-operative evaluation of both surgical

procedures. Multiple outcome parameters, including pain score, functional outcome, ROM, and complications, were evaluated, allowing comprehensive comparison between UKA and HTO.

However, the study also has certain limitations. The sample size was relatively small, and the follow-up duration was short, limiting assessment of long-term implant survival and disease progression. The study was conducted at a single center, which may limit the generalizability of the findings. In addition, randomization was not performed, which may introduce selection bias during the allocation of surgical procedures. Further multicentric studies with a larger sample size and longer follow-up are recommended for more definitive conclusions.

Conclusion

Both medial UKA and HTO are effective surgical options for

isolated medial compartment OA of the knee. However, UKA demonstrated comparatively better functional recovery, pain relief, and post-operative knee mobility. HTO remains a valuable joint-preserving procedure, particularly in younger and physically active individuals. Appropriate procedure selection should be individualized according to patient characteristics, deformity, activity level, and surgeon expertise.

Clinical Message

Both UKA and HTO are effective for isolated medial compartment osteoarthritis, but UKA provides superior short-term pain relief, function, and range of motion. HTO remains a valuable joint-preserving option in younger, active patients, and procedure selection should be individualized based on patient profile and surgeon expertise.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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