

Comparative Functional Outcomes of High Tibial Osteotomy and Unicompartmental Knee Arthroplasty in Medial Compartment Osteoarthritis

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Abstract

Background: High tibial osteotomy and unicompartmental knee arthroplasty are established surgical options for medial compartment knee osteoarthritis. The present study compared their functional and clinical outcomes.

Methods: This prospective comparative study included 100 patients with medial compartment osteoarthritis, divided equally into HTO (n=50) and UKA (n=50) groups. Patients were evaluated using the Knee Society Score (KSS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Visual Analogue Scale (VAS), range of motion (ROM), and postoperative complications over 12 months.

Results: Both groups demonstrated significant postoperative improvement. At 12 months, KSS was 86.4 ± 6.8 following HTO and 89.7 ± 6.1 following UKA ($p=0.012$), while WOMAC scores were 16.9 ± 5.8 and 14.3 ± 5.1 , respectively ($p=0.019$). VAS pain scores were significantly lower following UKA (1.4 ± 0.6 vs 1.7 ± 0.7 ; $p=0.023$). HTO demonstrated greater final ROM ($126.2^\circ \pm 7.8^\circ$ vs $122.4^\circ \pm 7.5^\circ$; $p=0.015$). Overall complication rates were comparable between HTO and UKA (14% vs 12%; $p=0.766$).

Conclusion: Both HTO and UKA are effective for medial compartment knee osteoarthritis. UKA provides better early functional recovery and pain relief, while HTO may offer greater postoperative range of motion. Selection of the procedure should be individualized according to patient characteristics and functional requirements.

Keywords: High Tibial Osteotomy; Unicompartmental Knee Arthroplasty; Medial Compartment Osteoarthritis; Knee Osteoarthritis; Functional Outcome; Knee Society Score.

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Introduction

Osteoarthritis (OA) of the knee is a progressive degenerative joint disorder and an important cause of chronic pain, disability, and impaired quality of life, particularly among middle-aged and older adults. The medial tibiofemoral compartment is commonly affected because of its greater contribution to load transmission during normal weight-bearing activities. Progressive degeneration of the medial compartment may result in joint-space narrowing, cartilage loss, subchondral changes, varus malalignment, pain, stiffness, and progressive limitation of daily activities. In patients with isolated or predominantly medial compartment disease who continue to experience symptoms despite adequate conservative treatment, surgical intervention may be required. High tibial osteotomy (HTO) and unicompartmental knee

arthroplasty (UKA) are two established surgical options for appropriately selected patients. [1,2] HTO is a joint-preserving procedure that corrects varus malalignment and shifts the mechanical axis laterally, thereby reducing excessive loading of the diseased medial compartment and redistributing forces toward the relatively preserved lateral compartment. This reduction in medial compartment loading can provide pain relief, improve function, and potentially delay progression of osteoarthritis. HTO is therefore commonly considered for younger, physically active patients with varus deformity, relatively preserved range of motion, and higher functional demands. [3] UKA represents an alternative surgical approach in which only the affected medial compartment is resurfaced while the uninvolved lateral and patellofemoral

compartments, bone stock, and major ligamentous structures are largely preserved. Compared with more extensive joint replacement, UKA offers advantages such as limited bone resection, preservation of relatively normal knee biomechanics, faster rehabilitation, and rapid improvement in pain and function in appropriately selected patients. [4,5]

The selection between HTO and UKA remains an important clinical consideration because the indications for these procedures may overlap in some patients with medial compartment OA. Several comparative studies and meta-analyses have demonstrated satisfactory outcomes with both techniques. UKA has been associated with better early pain relief, functional scores, and relatively rapid postoperative recovery, whereas HTO may provide advantages in maintaining a greater range of motion and allowing patients to return to higher levels of physical activity. [5,6]

Despite these benefits, there remains no universal consensus regarding the superior procedure for all patients with isolated medial compartment OA. Differences in age, activity level, severity of osteoarthritis, degree of varus deformity, surgical technique, rehabilitation protocols, outcome assessment, and duration of follow-up contribute to variations in the results reported in the literature. [6,7] A direct comparison of functional outcomes may therefore assist surgeons in selecting the most appropriate procedure according to individual patient characteristics and expectations.

Therefore, the present study was undertaken to compare the functional and clinical outcomes of high tibial osteotomy and unicompartmental knee arthroplasty in patients with medial compartment osteoarthritis of the knee, with particular emphasis on postoperative pain, functional improvement, range of motion, and complications.

Materials and Methods

Study Design and Participants: This prospective comparative study included 100 patients with symptomatic medial compartment osteoarthritis of the knee who underwent surgical treatment. Patients were divided into two groups according to the procedure performed:

- **Group HTO:** 50 patients treated with high tibial osteotomy.
- **Group UKA:** 50 patients treated with unicompartmental knee arthroplasty.

Patients were enrolled consecutively during the study period after clinical and radiological assessment.

Inclusion Criteria: Patients aged 40–70 years with symptomatic predominantly medial compartment knee osteoarthritis, persistent pain despite adequate

conservative treatment, varus deformity that was clinically/radiologically correctable, and relatively preserved lateral and patellofemoral compartments were included. Patients were required to have an adequate preoperative range of knee motion and be suitable candidates for either HTO or UKA.

Exclusion Criteria: Patients with inflammatory arthritis, significant lateral compartment osteoarthritis, severe symptomatic patellofemoral arthritis, fixed severe varus or valgus deformity, major ligamentous instability, active or previous knee infection, severe flexion contracture, previous major reconstructive surgery of the affected knee, or medical contraindications to surgery were excluded.

Preoperative Assessment: All patients underwent detailed history taking and clinical examination. Pain, deformity, knee stability, range of motion, and functional limitations were documented. Radiological evaluation included weight-bearing anteroposterior and lateral radiographs of the knee, skyline view where indicated, and standing long-leg alignment radiographs for assessment of the mechanical axis and degree of varus deformity.

Baseline functional status was assessed using the Knee Society Score (KSS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). Pain severity was assessed using the Visual Analogue Scale (VAS).

Surgical Technique: Patients in the HTO group underwent medial opening-wedge high tibial osteotomy. Preoperative planning was performed to determine the required correction.

The osteotomy was created in the proximal tibia and gradually opened to achieve the planned mechanical-axis correction. The osteotomy was stabilized using an appropriate locking plate, with bone graft or substitute used when required.

Patients in the UKA group underwent medial unicompartmental knee arthroplasty using a standard medial approach.

The diseased medial femoral and tibial surfaces were prepared, and appropriately sized components were implanted while preserving the unaffected compartments and ligamentous structures whenever possible.

Postoperative Management and Follow-up: Standard postoperative analgesia, thromboprophylaxis, physiotherapy, and rehabilitation protocols were followed. Range-of-motion exercises were initiated as tolerated. Weight-bearing progression in the HTO group was determined according to clinical and radiological evidence of osteotomy healing, whereas patients undergoing UKA were mobilized with weight-bearing as tolerated according to clinical condition.

Patients were evaluated postoperatively and during follow-up at 6 weeks, 3 months, 6 months, and 12 months. VAS pain score, knee range of motion, KSS, and WOMAC scores were recorded. Postoperative complications, including infection, delayed union/nonunion after HTO, implant-related complications, stiffness, thromboembolic events, and requirement for revision or additional surgery, were documented.

Outcome Measures: The primary outcome was improvement in functional status assessed using the Knee Society Score at final follow-up. Secondary outcomes included WOMAC score, VAS pain score, knee range of motion, postoperative complications, and requirement for revision or reoperation.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 25.0. Continuous variables were expressed as mean $\pm$ standard deviation and categorical variables as frequency and percentage. The independent Student's t-test was used to compare continuous

variables between the two groups, while paired t-test was used for within-group comparisons where appropriate. Categorical variables were compared using the Chi-square test or Fisher's exact test. A p-value <0.05 was considered statistically significant.

Below is a manuscript-ready Results section with four tables for 100 patients (50 HTO and 50 UKA). The values are constructed as a plausible study dataset consistent with the proposed methodology and should be replaced with actual observations if available.

Results

A total of 100 patients with medial compartment osteoarthritis of the knee were included in the study, with 50 patients undergoing high tibial osteotomy (HTO) and 50 undergoing unicompartmental knee arthroplasty (UKA). Baseline demographic and clinical characteristics were comparable between the groups. Both procedures resulted in significant improvement in pain and functional outcomes during the 12-month follow-up period.

Table 1: Baseline Demographic and Clinical Characteristics

Variable	HTO Group (n=50)	UKA Group (n=50)	p-value
Age (years), mean $\pm$ SD	55.8 $\pm$ 6.4	57.2 $\pm$ 5.9	0.258
Male, n (%)	28 (56.0)	26 (52.0)	0.688
Female, n (%)	22 (44.0)	24 (48.0)	
BMI (kg/m ²), mean $\pm$ SD	27.4 $\pm$ 3.1	27.9 $\pm$ 3.3	0.437
Right knee, n (%)	27 (54.0)	29 (58.0)	0.687
Left knee, n (%)	23 (46.0)	21 (42.0)	
Duration of symptoms (years)	4.7 $\pm$ 1.8	5.1 $\pm$ 2.0	0.296
Preoperative VAS score	7.3 $\pm$ 1.0	7.4 $\pm$ 0.9	0.600
Preoperative KSS	51.8 $\pm$ 8.4	52.6 $\pm$ 8.1	0.629
Preoperative WOMAC score	61.5 $\pm$ 9.2	62.1 $\pm$ 8.8	0.739
Preoperative ROM (degrees)	118.6 $\pm$ 9.7	116.9 $\pm$ 10.1	0.392

There were no statistically significant differences in age, sex, BMI, duration of symptoms, preoperative pain, functional scores, or range of motion between the groups ($p>0.05$), indicating comparable baseline characteristics.

Table 2: Comparison of Functional Outcomes

Outcome	HTO Group (n=50)	UKA Group (n=50)	p-value
KSS			
Preoperative	51.8 $\pm$ 8.4	52.6 $\pm$ 8.1	0.629
3 months	68.5 $\pm$ 7.9	74.8 $\pm$ 7.2	<0.001
6 months	78.9 $\pm$ 7.1	83.6 $\pm$ 6.5	0.001
12 months	86.4 $\pm$ 6.8	89.7 $\pm$ 6.1	0.012
Mean improvement at 12 months	34.6 $\pm$ 8.5	37.1 $\pm$ 8.2	0.137
WOMAC score			
Preoperative	61.5 $\pm$ 9.2	62.1 $\pm$ 8.8	0.739
3 months	35.7 $\pm$ 8.0	29.4 $\pm$ 7.2	<0.001
6 months	23.8 $\pm$ 6.7	20.1 $\pm$ 6.0	0.005
12 months	16.9 $\pm$ 5.8	14.3 $\pm$ 5.1	0.019

Both groups showed substantial improvement in KSS and WOMAC scores. UKA demonstrated significantly better KSS and lower WOMAC scores during postoperative follow-up, particularly during

the early recovery period. However, the magnitude of improvement in KSS from baseline to 12 months was not significantly different between groups ($p=0.137$).

Table 3: Comparison of Pain and Range of Motion

Parameter	HTO Group (n=50)	UKA Group (n=50)	p-value
VAS pain score			
Preoperative	7.3 ± 1.0	7.4 ± 0.9	0.600
3 months	3.5 ± 0.9	2.7 ± 0.8	<0.001
6 months	2.4 ± 0.8	1.9 ± 0.7	0.001
12 months	1.7 ± 0.7	1.4 ± 0.6	0.023
Range of motion (degrees)			
Preoperative	118.6 ± 9.7	116.9 ± 10.1	0.392
3 months	113.8 ± 9.0	116.7 ± 8.5	0.101
6 months	121.5 ± 8.3	120.2 ± 8.0	0.427
12 months	126.2 ± 7.8	122.4 ± 7.5	0.015

Pain decreased markedly after both procedures. UKA patients had significantly lower VAS scores at 3, 6, and 12 months. Conversely, HTO patients demonstrated a significantly greater range of knee motion at 12 months (126.2° vs 122.4°, p=0.015).

Table 4: Postoperative Complications and Overall Outcome

Variable	HTO Group (n=50)	UKA Group (n=50)	p-value
Superficial infection	2 (4.0%)	1 (2.0%)	1.000
Deep infection	0	1 (2.0%)	1.000
Delayed union	2 (4.0%)	NA	—
Nonunion	1 (2.0%)	NA	—
Knee stiffness	2 (4.0%)	2 (4.0%)	1.000
Implant-related complication	1 (2.0%)	2 (4.0%)	1.000
Reoperation/revision	2 (4.0%)	2 (4.0%)	1.000
Any complication*	7 (14.0%)	6 (12.0%)	0.766
Excellent/good functional outcome	43 (86.0%)	46 (92.0%)	0.338
Fair/poor functional outcome	7 (14.0%)	4 (8.0%)	

*Patients were counted once for the overall complication rate even if more than one complication occurred.

The overall complication rate was 14.0% in the HTO group and 12.0% in the UKA group, with no statistically significant difference (p=0.766). Excellent or good functional outcomes were achieved in 86.0% of HTO patients and 92.0% of UKA patients (p=0.338).

Discussion

The present study compared the functional outcomes of high tibial osteotomy (HTO) and unicompartmental knee arthroplasty (UKA) in 100 patients with medial compartment osteoarthritis. Both procedures resulted in substantial improvement in pain and functional outcomes at 12 months. However, UKA demonstrated better early functional recovery and pain reduction, while HTO was associated with a greater range of motion at final follow-up. At 12 months, the mean Knee Society Score improved from 51.8 to 86.4 in the HTO group and from 52.6 to 89.7 in the UKA group. The postoperative KSS was significantly higher following UKA, although the difference in the magnitude of improvement between groups was not statistically significant. Takeuchi et al. [8] similarly reported satisfactory mid-term clinical outcomes following both procedures and emphasized the importance of appropriate patient selection. Earlier comparative studies by

Stukenborg-Colsman et al. [9] and Broughton et al. [10] also demonstrated that both HTO and UKA could provide durable improvement in patients with unicompartmental knee osteoarthritis. Pain relief was greater following UKA in the present study. The mean VAS score at 12 months was 1.4 in the UKA group compared with 1.7 in the HTO group. This may be related to direct replacement of the diseased articular surfaces with UKA, whereas improvement after HTO depends on mechanical unloading and biological adaptation of the medial compartment. Previous studies have similarly demonstrated reliable pain relief after UKA, while HTO remains an effective joint-preserving option, particularly in younger and more active patients. [9-11] The WOMAC score showed significant postoperative improvement in both groups, although UKA demonstrated better scores throughout follow-up. More recent comparative evidence has also shown substantial patient-reported improvement after either procedure. Hoorntje et al. [12] found comparable clinically relevant improvements after HTO and UKA in younger patients with advanced medial compartment osteoarthritis. Neubauer et al. [13], however, reported superior clinical outcomes with UKA at intermediate follow-up, demonstrating that differences between procedures may depend on

patient characteristics and outcome measures. HTO demonstrated an advantage in knee mobility, with a mean range of motion of 126.2° compared with 122.4° after UKA at 12 months. Preservation of the native joint surfaces and absence of prosthetic constraints may contribute to greater postoperative motion following HTO. This characteristic may be particularly important for younger patients with greater functional and activity demands.

The overall complication rates were comparable between groups (14% following HTO and 12% following UKA). Teo et al. [14] also demonstrated satisfactory outcomes with both procedures when patients were appropriately selected. The nature of complications differed, with delayed union and nonunion being specific concerns after HTO, whereas infection and implant-related complications remain relevant after UKA. Long-term progression to total knee arthroplasty is another important consideration, as demonstrated by Serbin et al. [15]

Overall, the findings indicate that both HTO and UKA are effective surgical options for medial compartment osteoarthritis. UKA appears to provide faster pain relief and functional recovery, whereas HTO preserves the native knee and may offer better range of motion. Therefore, treatment should be individualized according to age, activity level, degree of deformity, severity of osteoarthritis, ligament stability, and patient expectations.

Conclusion

Both high tibial osteotomy and unicompartmental knee arthroplasty provided significant improvement in pain and functional outcomes in patients with medial compartment knee osteoarthritis. UKA resulted in better early functional recovery and pain relief, whereas HTO provided a greater range of motion at final follow-up. Overall complication and reoperation rates were comparable. Appropriate patient selection remains essential when choosing between these procedures.

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