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High tibial osteotomy in geriatric patients with gonarthrosis

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Abstract

Background To evaluate the efficacy of medial opening wedge high tibial osteotomy (MOWHTO) as a treatment modality in geriatric patients aged over 65 presenting with advanced gonarthrosis and severe clinical and functional knee problems.

Methods A retrospective review was conducted on the medical records of 134 patients aged 65 and older who underwent MOWHTO at our clinic between 2016 and 2022. All patients' preoperative knee radiographs were independently evaluated by different orthopedic surgeons to assess the degree of osteoarthritis, and deviations in anatomical and mechanical axis values were measured using ortho-radiograms. In cases where radiological imaging posed difficulties in evaluation, classification was performed using magnetic resonance imaging. The surgeries were conducted at a single center. Sixty-six patients with grade III-IV gonarthrosis constituted Group I, while 57 patients with grade I-II gonarthrosis formed Group II. The groups were evaluated clinically and functionally using the Lysholm Knee Scoring Scale, Hospital for Special Surgery Knee-Rating Scale (HSS), and Visual Analog Scale (VAS) preoperatively and at the postoperative sixth, 12th, and 18th months to determine the efficacy of MOWHTO.

Results Group I exhibited significantly higher preoperative and postoperative VAS scores compared to Group II ($p=0.0001$). Group II had significantly higher preoperative and postoperative Lysholm and HSS scores than Group I ($p=0.0001$). In Group I, seven patients underwent total knee arthroplasty (TKA) within the postoperative first year, and 21 patients within the second year. In Group II, no patients required TKA within the first year, and only three patients required revision to TKA within the second year. In Group I, the main reason for conversion to TKA surgery in 28 patients within the first two years following MOWHTO was the presence of grade IV osteoarthritis according to the Kellgren and Lawrence classification and the age range of 70–75 years.

Conclusion MOWHTO is a highly effective procedure for mitigating pain and functional limitations associated with osteoarthritis in geriatric patients with grade I-II gonarthrosis. The efficacy of MOWHTO in patients with grade III-IV osteoarthritis is significantly lower than that in grades I-II, and the treatment method should be selected with caution.

Keywords Geriatrics, Osteoarthritis, Osteotomy, Orthopedic surgery, Arthroplasty

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Introduction

Osteoarthritis is a degenerative joint disease affecting load-bearing joints, such as the knee and hip, leading to pain and functional impairment. Although the exact mechanism is not yet fully understood, osteoarthritis is known to alter gait and movement strategies, resulting in misalignment and increased cartilage degeneration in the joints [1, 2]. Mechanical axis deviation in the lower extremity affects the load-bearing capacity of the knee's medial and lateral compartments, leading to varus or valgus deformities. The mechanical axis, defined by a line drawn from the center of the femoral head to the center of the ankle (the Mikulicz line), typically passes 2–5 mm medially from the center of the knee joint. A deviation of this axis of more than 15 mm medially or 10 mm laterally is considered a mechanical axis deviation [3, 4].

Normally, 60% of the knee joint load is transmitted through the medial compartment and 40% through the lateral compartment [3–5]. A medial shift in the mechanical axis increases the load per unit area in the medial compartment, leading to cartilage and bone degeneration and, consequently, osteoarthritis. Osteoarthritis of the knee is a pathology that usually develops due to deviation in the mechanical axis, such as varus deformity, and results in medial joint narrowing [5, 6]. Medial compartment involvement is ten times more frequent than lateral compartment involvement, causing significant reductions in quality of life due to pain and movement restrictions. In the treatment of gonarthrosis, the severity of arthritis dictates the treatment approach, ranging from conservative to surgical options [6–9]. Conservative treatment offers only symptomatic and temporary relief, while surgical procedures such as a high tibial osteotomy and arthroplasty are prominent. The biomechanical mechanism of medial opening wedge high tibial osteotomy (MOWHTO) involves shifting weight-bearing alignment from the inflamed and worn medial compartment to the relatively healthy lateral compartment,



Fig. 1 Preoperative and postoperative radiography images of a 67-year-old patient with grade II gonarthrosis who underwent medial opening wedge high tibial osteotomy

thereby alleviating arthritis symptoms and delaying or preventing knee replacement [9, 10]. While the ideal age for MOWHTO has traditionally been defined as 40–60 years, advancements in surgical techniques and implant designs have broadened the age indications for this procedure [10–12]. However, there is still no consensus in the literature concerning the ideal age range for MOWHTO.

This study aimed to retrospectively examine the clinical and functional outcomes of MOWHTO as an alternative to TKA in geriatric patients aged over 65 presenting with grade III–IV gonarthrosis.

Methods

A retrospective review was conducted on the records of 134 patients aged over 65 who underwent MOWHTO at our clinic between 2016 and 2022. Ethical approval for the study was obtained from the Sakarya University Faculty of Medicine (document number: E-71522473-050.01.04–216225-20, date: January 31, 2023).

A total of 11 patients were excluded due to reasons such as non-compliance with regular follow-up, morbid obesity, undergoing oncological treatment, the absence of genu varum, a history of fractures, or the presence of three or more comorbidities. The sample consisted of 123 patients. All patients' preoperative knee radiographs were independently evaluated by different orthopedic surgeons to assess the degree of osteoarthritis, and deviations in anatomical and mechanical axis values were measured using ortho-radiograms. In cases where radiological imaging posed difficulties in evaluation, classification was performed using magnetic resonance imaging. The surgeries were conducted at a single center by a dedicated team of three orthopedic surgeons. The surgical approach employed was MOWHTO, which was indicated for patients whose medial axis passed 15 mm or more medially and who had active joint range of motion between 90° and 120°, flexion contracture of less than 5°, and regional pain that increased with movement associated with osteoarthritis. In contrast, this procedure was contraindicated for patients with diffuse degenerative arthritis, inflammatory arthritis, tibiofemoral subluxation, advanced osteoporosis, joint range of motion less than 90°, or significant vascular pathology. Based on the indication for MOWHTO, 66 patients with grade III–IV gonarthrosis were categorized as Group I, and 57 patients with grade I–II gonarthrosis were categorized as Group II.

All patients underwent surgery under epidural anesthesia and tourniquet application. The surgical technique involved an anteromedial incision of approximately 8–10 cm from the tibial tuberosity, extending medially to laterally toward the fibular head, resulting in an incomplete opening wedge osteotomy using TomoFix HTO

plates (Fig. 1). The osteotomy angle was adjusted using 6-, 8-, and 10-mm metal wedges, based on preoperative measurements aimed at correcting the varus deformity. No allografts were used in any of the patients; instead, all received synthetic grafts in volumes ranging from 5 to 15 cc (Fig. 2). Following surgery, hemostasis was achieved, The layers were closed anatomically, a suction drain was placed to remove any excess fluids, and an elastic bandage was applied. Prophylactic treatment included 3 × 1 g cephazolin, 1 × 6,000 IU enoxaparin, and analgesics (Fig. 3). One of the most critical phases of rehabilitation following high tibial osteotomy is the restoration of range of motion. By the end of the second postoperative week, the rehabilitation goal was to achieve 90° of knee flexion and full extension. Beginning in the first week, the patients commenced isometric quadriceps exercises along with passive range of motion protocols. Once 90° of knee flexion was achieved, exercises such as chair rolling, wall slides, and passive quadriceps stretching were introduced to promote full joint mobility. Between weeks four and six, rehabilitation continued with both isotonic and isometric exercises. Partial weight-bearing was allowed during the first four weeks. Isotonic strengthening was maintained through postoperative weeks seven to eight. The rehabilitation program continued until the 12th week with isometric quadriceps femoris contractions in full extension and straight leg raise exercises. Clinical and functional evaluations were conducted preoperatively and at six, 12, and 18 months postoperatively using the Lysholm Knee Scoring Scale, HSS and VAS for pain to assess the efficacy of MOWHTO in patients with grade III-IV gonarthrosis [8, 13–15].

Statistical analysis

Statistical analyses were performed using the Number Cruncher Statistical System (NCSS) 2007 Statistical Software (Utah, USA). In addition to descriptive statistical methods (mean, standard deviation, median, and inter quartile range), the Shapiro-Wilk normality test was used to assess the distribution of variables. For normally distributed variables, the paired t-test was utilized for time comparisons and the independent t-test for the comparison of two groups. For non-normally distributed variables, the Wilcoxon test was used for time comparisons, and the Mann-Whitney U test was employed for the comparison of two groups. Qualitative data were compared using the chi-square test. The results were considered significant at $p < 0.05$.

Results

No statistically significant difference was observed between Group I and Group II in terms of mean age and gender distribution. The mean age was 71.30 ± 4.74 years for Group I and 72.23 ± 6.01 years for Group II. The mean

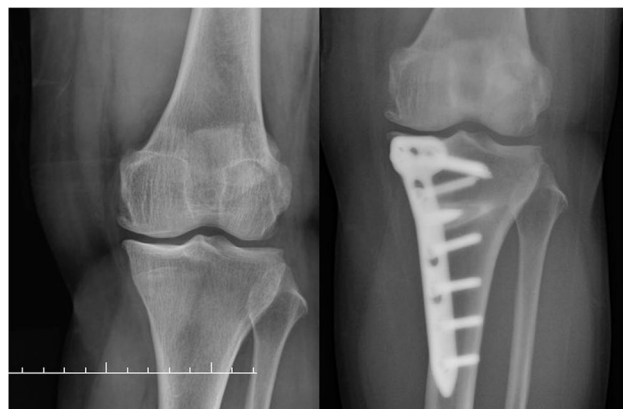


Fig. 2 Preoperative and postoperative radiography images of a 69-year-old patient with grade II gonarthrosis who underwent medial opening wedge high tibial osteotomy



Fig. 3 Radiography images of a 66-year-old with grade IV gonarthrosis who required TKA revision due to the failure of medial opening wedge high tibial osteotomy

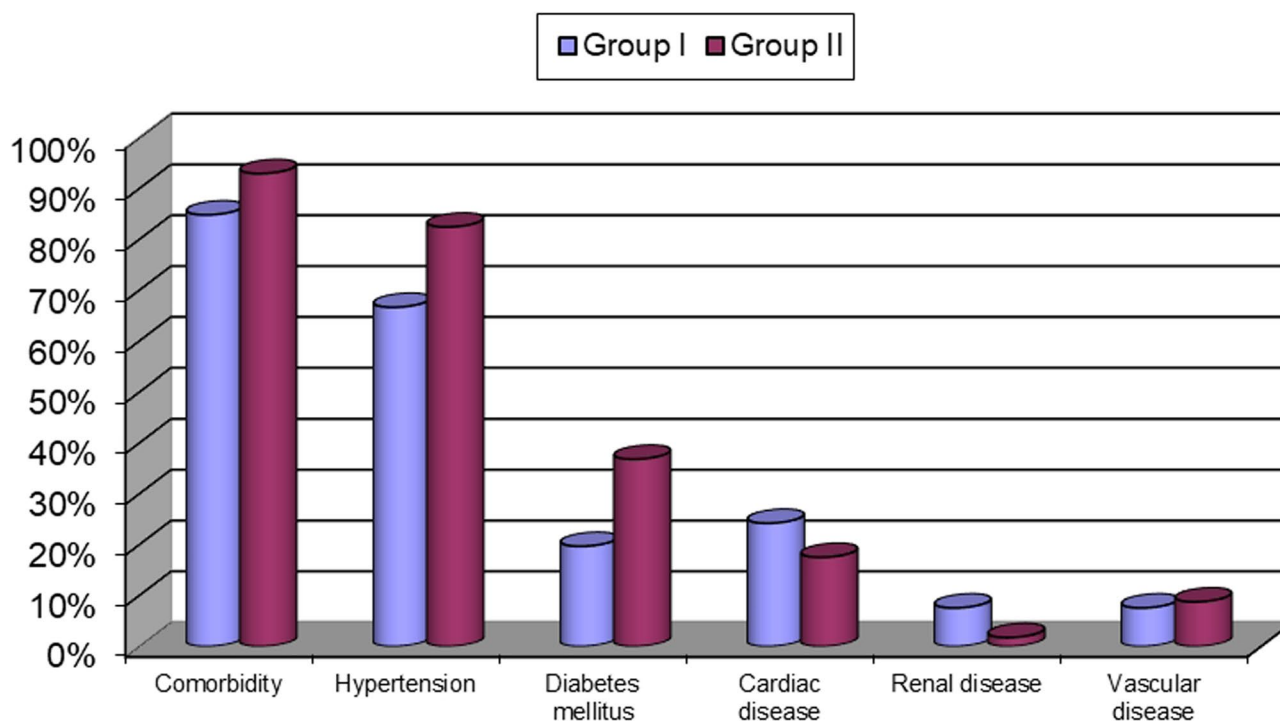
follow-up duration for both groups was 28.02 ± 3.06 months. There was no statistically significant difference in the comorbidity distribution between the two groups ($p = 0.157$). However, the rate of hypertension was significantly higher in Group II compared to Group I ($p = 0.047$) (Table 1). The rate of diabetes was also significantly higher in Group II ($p = 0.034$) (Fig. 4). Among the patients in Group I, the preoperative medial proximal tibial angle (MPTA) was measured between 81 and 84 degrees in 49 patients and between 77 and 80 degrees in 17 patients. In Group II, 38 patients had a preoperative MPTA of 81–84 degrees, 17 patients had 85–87 degrees, and two patients had 77–80 degrees. Postoperatively, 61 patients in Group I had an MPTA of 86–90 degrees, and five had 83–85 degrees. In Group II, all patients had postoperative MPTA measured between 85 and 90 degrees.

Table 1 Comparison of demographic characteristics between groups

		Group I		Group II		p
Age	Mean $\pm$ SD	71.30 $\pm$ 4.74		72.23 $\pm$ 6.01		0.342*
Gender	Male	4	6.06%	6	10.53%	0.366+
	Female	62	93.94%	51	89.47%	
Comorbidity	Absent	10	15.15%	4	7.02%	0.157+
	Present	56	84.85%	53	92.98%	
Hypertension	Absent	22	33.33%	10	17.54%	0.047+
	Present	44	66.67%	47	82.46%	
Diabetes mellitus	Absent	53	80.30%	36	63.16%	0.034+
	Present	13	19.70%	21	36.84%	
Cardiac disease	Absent	50	75.76%	47	82.46%	0.364+
	Present	16	24.24%	10	17.54%	
Renal disease	Absent	61	92.42%	56	98.25%	0.135+
	Present	5	7.58%	1	1.75%	
Vascular disease	Absent	61	92.42%	52	91.23%	0.809+
	Present	5	7.58%	5	8.77%	
Conversion arthroplasty at year 1	Revision (-)	59	89.39%	57	100.00%	0.032
	Revision (+)	7	10.61%	0	0.00%	
Conversion arthroplasty at year 2	Revision (-)	45	68.18%	53	92.98%	0.006
	Revision (+)	21	31.82%	3	5.26%	

*Independent t-test + chi-square test

Group I: grade III-IV Gonarthrosis, Group II: Grade I-II gonarthrosis, SD Standard deviation

**Fig. 4** Distribution of comorbidities by group

In Group I, seven patients required revision to TKA within the first year due to increased complaints, and 21 patients required TKA within the first two years. In contrast, none of the patients in Group II required revision to TKA within the first year, although three patients underwent TKA within the first two years. The rate of

revision to TKA at one year was significantly higher in Group I compared to Group II ($p=0.047$). Similarly, the rate of revision to TKA at two years was significantly higher in Group I compared to Group II ($p=0.006$).

Preoperative and postoperative VAS scores were significantly higher in Group I compared to Group II

($p=0.0001$). Postoperative VAS scores were significantly lower than preoperative scores in both groups (Group I: $p=0.003$, Group II: $p=0.0001$) (Table 2). Preoperative and postoperative Lysholm score averages were significantly higher in Group II compared to Group I ($p=0.0001$). Postoperative Lysholm scores were significantly higher than preoperative scores in both groups (Group I: $p=0.04$, Group II: $p=0.0001$) (Fig. 5). Preoperative and postoperative HSS score averages were significantly higher in Group II compared to Group I ($p=0.0001$) (Fig. 6). There was no statistically significant difference between preoperative and postoperative HSS scores in Group I ($p=0.209$), while postoperative HSS scores were significantly higher than preoperative scores in Group II ($p=0.0001$).

In Group I, there was no statistically significant difference between preoperative and postoperative HSS scores ($p=0.209$). In contrast, in Group II, the postoperative HSS scores were significantly higher compared to the preoperative HSS scores ($p=0.0001$). The average preoperative-postoperative VAS delta values were statistically significantly lower in Group I than in Group II ($p=0.0001$). Similarly, the average preoperative-postoperative Lysholm score delta values of Group I were statistically significantly lower compared to those of Group II ($p=0.0001$). Lastly, the average postoperative-preoperative HSS score delta values in Group I were significantly lower than those in Group II ($p=0.0001$) (Table 3).

Discussion

Osteoarthritis is a degenerative disease that predominantly affects weight-bearing joints in geriatric patients, significantly impairing social and physical activities at an advanced age. Various conservative and surgical treatment options exist for managing gonarthrosis, with the

overarching aim being to enhance social and physical activity levels while implementing the safest and most effective treatment for elderly patients [16, 17]. While the ideal patient age for MOWHTO has traditionally been defined as 40–60 years, advancements in implant design and surgical techniques have broadened the age indication for this procedure [17, 18]. In Group I, the main reason for conversion to TKA surgery in 28 patients within the first two years following MOWHTO was the presence of grade IV osteoarthritis according to the Kellgren and Lawrence classification and the age range of 70–75 years. These findings demonstrate that high tibial osteotomy is a challenging indication for this degree of osteoarthritis and age group. In stage III–IV gonarthrosis, both medial and lateral compartments are severely affected. The primary aim of MOWHTO surgery is to shift the load from the damaged medial compartment to the intact or minimally damaged lateral compartment. Although the osteotomy shifts the load laterally, if the lateral compartment is also severely damaged, clinical and functional outcomes are negatively impacted. Furthermore, inadequate preoperative joint range of motion adversely affects the success of MOWHTO. In contrast, in grade I–II gonarthrosis, although the medial compartment is damaged, the lateral compartment is either intact or minimally damaged, and joint range of motion is nearly normal. This contributes positively to achieving the desired clinical outcomes in surgery. Additionally, while the postoperative rehabilitation program yields poor results in Group I due to challenges, favorable outcomes are observed in Group II. An intact lateral compartment, nearly normal joint range of motion, and successful implementation of the postoperative rehabilitation program can enhance the efficacy of MOWHTO. Therefore, detailed preoperative

Table 2 Comparison of preoperative and postoperative measurements of the groups

			Group I	Group II	<i>p</i>
VAS score	Preoperative	Mean $\pm$ SD	6.44 $\pm$ 1.04	4.84 $\pm$ 0.82	0.0001‡
		Median (IQR)	7 (6–7)	5 (4–5.5)	
	Postoperative	Mean $\pm$ SD	6 $\pm$ 0.98	2.39 $\pm$ 1.01	0.0001‡
		Median (IQR)	6 (5–6.25)	2 (2–3)	
	p†		0.003	0.0001	
Lysholm score	Preoperative	Mean $\pm$ SD	52.17 $\pm$ 9.62	67.18 $\pm$ 8.00	0.0001*
	Postoperative	Mean $\pm$ SD	54.67 $\pm$ 9.72	87.05 $\pm$ 5.69	0.0001*
	p‡		0.04	0.0001	
HSS score	Preoperative	Mean $\pm$ SD	55.14 $\pm$ 7.34	63.32 $\pm$ 5.08	0.0001*
	Postoperative	Mean $\pm$ SD	56.61 $\pm$ 8.72	81.32 $\pm$ 6.63	0.0001*
	p‡		0.209	0.0001	

*Independent t-test

‡Paired t-test

‡Mann-Whitney U test

†Wilcoxon test

Group I: grade III–IV gonarthrosis, Group II: grade I–II gonarthrosis, SD Standard deviation, IQR Interquartile range

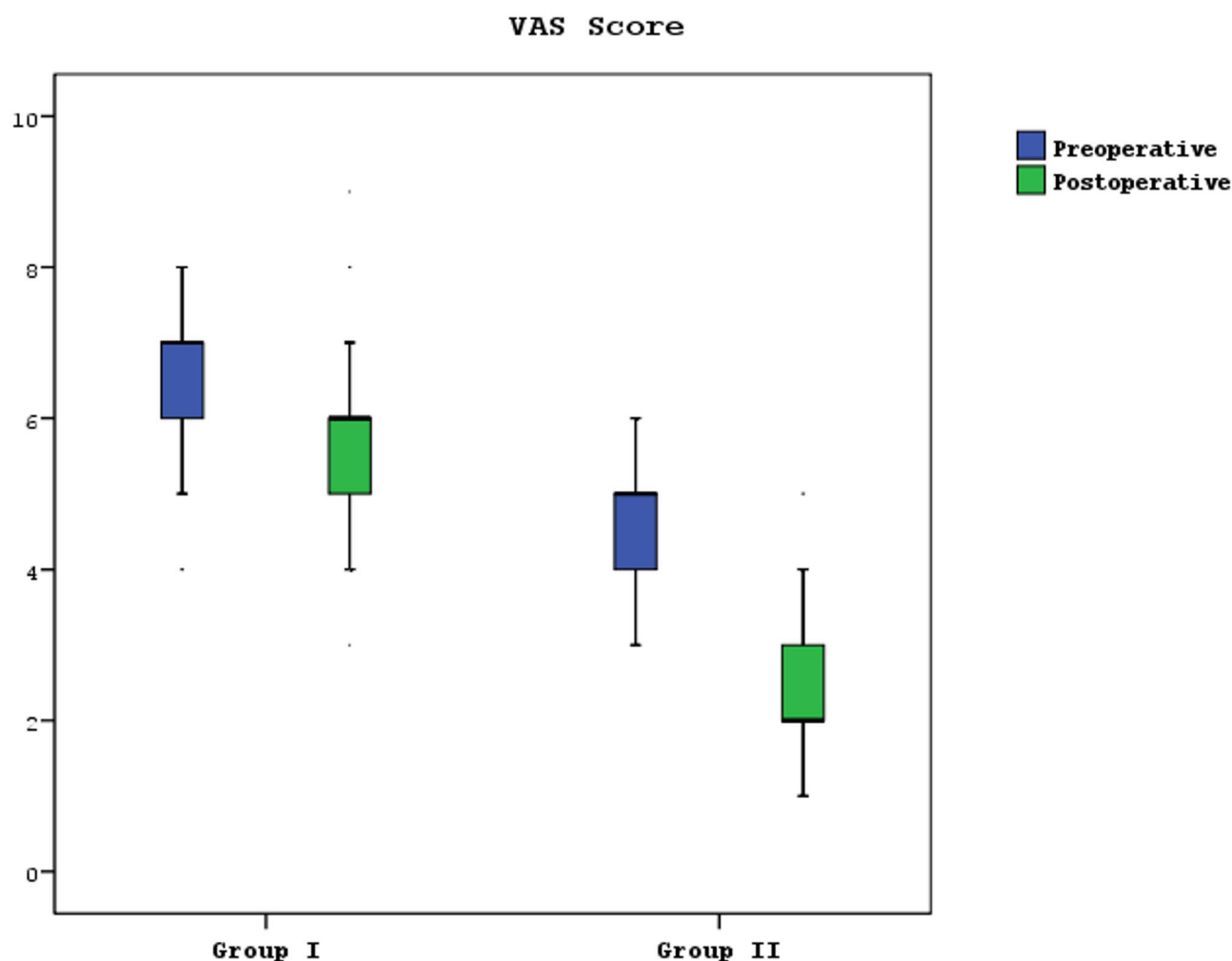


Fig. 5 Comparison of preoperative and postoperative VAS scores of the groups

evaluation, correct indication, and appropriate patient selection are extremely important prior to surgery.

The current study revealed that MOWHTO, which is a less invasive procedure compared to arthroplasty, was clinically and functionally inadequate for patients over 65 with grade III-IV gonarthrosis. A significant portion of these patients required revision to TKA within two years postoperatively. In a study involving nine middle-aged and elderly patients, Nakamura et al. reported that eight patients (11 out of 12 knees) returned to pain-free sports activities following MOWHTO, indicating the efficacy of this treatment. However, that study did not account for the degree of arthrosis, focusing only on genu varum and age factors [13]. Although we accept that MOWHTO is effective for patients with grade I-II arthrosis, we do not think that it is an effective option in terms of clinical and functional outcomes for those with grade III-IV arthrosis.

In their retrospective study of 76 patients, Li et al. noted that MOWHTO might prevent secondary knee surgeries in the short term for elderly patients.

However, due to prolonged bone healing times in the geriatric population, the clinical and functional outcomes might not meet expectations [14]. Similarly, Lee et al. suggested that while MOWHTO could delay the revision to TKA, particularly in patients under 60 years, the increased perioperative complications in patients aged 60–65 and over 65 resulted in higher failure rates [19]. Our study is consistent with these findings, indicating that MOWHTO is not effective for advanced arthrosis in patients over 65.

Kuwashima et al. observed that elderly patients over 65 who underwent MOWHTO experienced pain relief comparable to younger patients, although functional activity was adversely affected by age [20]. Papachristou et al. concluded that MOWHTO was a safe procedure that facilitated immediate mobilization in patients under 60 who suffered from early medial arthrosis [15]. The authors reported that an osteotomy effectively distributed stress in the medium term and had favorable outcomes. They also suggested that this type of surgery

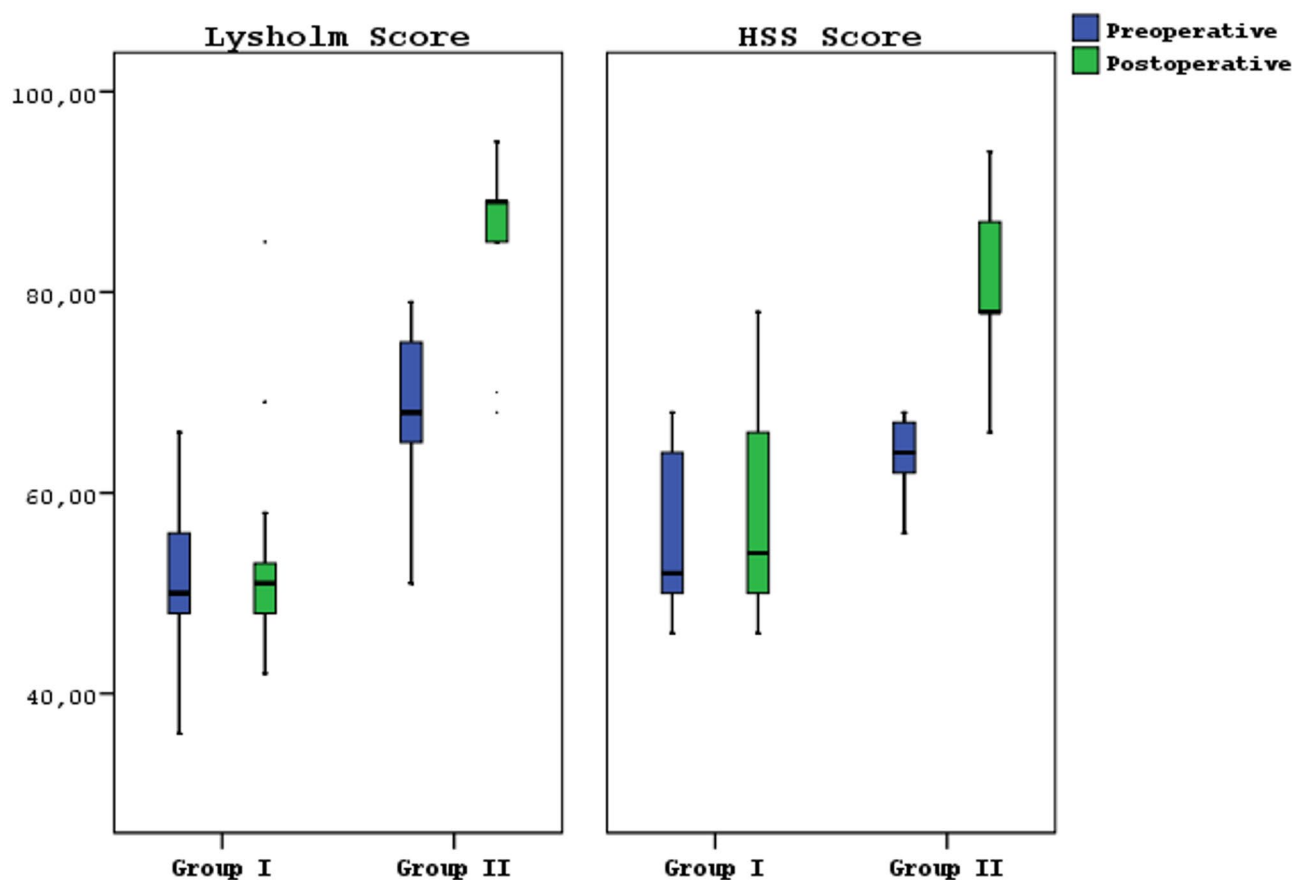


Fig. 6 Comparison of preoperative and postoperative Lysholm and HSS scores of the groups

Table 3 Comparison of VAS, lysholm, and HSS delta values of the groups

			Group I	Group II	<i>p</i>
VAS score	Preop-postop	Mean $\pm$ SD	0.44 $\pm$ 1.12	2.46 $\pm$ 1.23	0.0001 [‡]
	Δ value	Median (IQR)	1 (0–1)	2 (2–3)	
Lysholm score	Postop-preop	Mean $\pm$ SD	2.5 $\pm$ 9.69	19.88 $\pm$ 9.18	0.0001 [‡]
	Δ value	Median (IQR)	3 (–3–9)	20 (14.5–24)	
HSS score	Postop-Preop	Mean $\pm$ SD	1.47 $\pm$ 9.41	18 $\pm$ 9.26	0.0001 [‡]
	Δ value	Median (IQR)	0 (–2.5–6.5)	18 (11–24)	

[‡]Mann-Whitney U test

Group I: grade III–IV gonarthrosis, Group II: grade I–II gonarthrosis, *SD* Standard deviation, *IQR* Interquartile range, *VAS* Visual Analog Scale, *HSS* Hospital for Special Surgery Knee-Rating Scale

could allow patients to lead a normal life for 10–15 years. In another study comparing 27 MOWHTO cases over the age of 65 and 67 MOWHTO cases under the age of 65, Trieb et al. determined that the risk of failure increased by 7.6% per year of age, advocating against MOWHTO for patients over 65 due to the elevated risk of age-related failure [21]. In contrast, Kohn et al. argued that MOWHTO was an effective procedure for treating medial gonarthrosis independent of the patient's age, suggesting that age should not be a consideration when opting for MOWHTO [22]. Our findings suggest that while MOWHTO is effective for grade I–II gonarthrosis in patients over 65, it is ineffective for those with

grade III–IV gonarthrosis. Ruangsomborn et al. noted that MOWHTO yielded good outcomes with acceptable complications in patients over 65, indicating that this procedure might be a viable alternative for treating gonarthrosis in the elderly [23]. Jin et al. identified inadequate correction of the varus angle as a significant risk factor for failure in elderly patients with medial arthrosis [24]. In a study of 247 high tibial osteotomy cases, Guarino et al. reported that 33 were converted to TKA within three years. The authors stated that the risk of conversion to TKA increased in older patients, those with obesity, and those with grade III–IV osteoarthritis [25]. Floerkemeier et al. determined that even in elderly

patients with high-grade cartilage damage, positive mid-term outcomes were observed following high tibial open-wedge osteotomy for varus osteoarthritis [26]. Berruto et al. stated that high tibial osteotomy was successful in patients with varus deformity and advanced osteoarthritis. Although the success rate decreased with age, it remained a strong surgical option in older patients [27]. Kumagai et al. concluded that in patients with advanced osteoarthritis who underwent MOWHTO, age, sex, and clinical outcomes did not affect cartilage regeneration, but patient selection based on body mass index was more appropriate [28]. In a study involving 140 patients with advanced osteoarthritis who underwent MOWHTO, Sohn et al. reported that 24 patients (17.1%) were highly dissatisfied and emphasized that surgeons should be cautious and selective when determining indications [29]. In the current study, we found that MOWHTO was effective for clinical and functional outcomes in geriatric patients with adequate muscle strength and without advanced gonarthrosis, but it was ineffective for those with advanced gonarthrosis.

This study has several limitations. First, the retrospective design of the study, which did not involve randomization of patients prior to surgery, may impact the generalizability of the findings. Second, accurately assessing the degree of gonarthrosis using direct radiographs is challenging. Third, the sample size may be insufficient to draw definitive conclusions. Thus, there is a need for prospective studies that include a larger number of patients and a broader range of comorbidities to address these limitations.

Conclusion

As life expectancy increases, deformities in weight-bearing joints parallelly increase with age. Enhancing the quality of social and functional life in advanced age involves preserving, and even preventing, joint deformities. MOWHTO is highly effective in preventing the progression of arthrosis and alleviating arthrosis-related pain and functional limitations in geriatric patients with grade I-II gonarthrosis. However, the same procedure does not yield similar benefits for patients with grade III-IV gonarthrosis. Therefore, we do not consider MOWHTO a realistic indication for elderly patients over 65 with grade III-IV arthrosis. For this patient group, TKA is a more appropriate option if preoperative clinical and functional findings are severely compromised.

We hope that this study will illuminate further research on the treatment of gonarthrosis in geriatric patients. We believe that additional studies involving a larger patient cohort and a broader range of parameters are necessary to improve treatment outcomes.

Abbreviations

MOWHTO	Medial Opening Wedge High Tibial Osteotomy
VAS	Visual Analog Scale
HSS	Hospital for Special Surgery Knee-Rating Scale
TKA	Total Knee Arthroplasty
MPTA	Medial Proximal Tibial Angle

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Clinical trial number

Not applicable.

Authors' contributions

Author's Contribution Bedrettin Akar and Yusuf Ozturkmen: Writing—original draft, Visualization, Methodology, Resources, Investigation, Conceptualization, Supervision, Data curation, Formal analysis. Mehmet Balioglu, Fatih Ugur and Erhan Sükür: Writing—review & editing, Software, Methodology, Formal analysis, Conceptualization, Project administration.

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Data availability

All data generated or analyzed during this study are included in this published article.

Declaration

Ethics approval and consent to participate

As research involving human participants, this study was conducted in accordance with the ethical standards set forth in the 1964 Declaration of Helsinki and its later amendments, and it was approved by the Ethics Committee of Sakarya University Faculty of Medicine (Approval number: E-71522473-050.01.04-216225-20; Date: January 31, 2023). The Ethics Committee of Sakarya University Faculty of Medicine operates in full compliance with international guidelines for the protection of human research participants, including the Declaration of Helsinki. An exemption from informed consent was granted by the same ethics committee.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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