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Impact of Visual Awareness of Postoperative Appearance on Functional Recovery After High Tibial Osteotomy: A Retrospective Case-Control Study

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Abstract:

Objective: This study aimed to evaluate the impact of visual awareness of preoperative and postoperative leg appearance on patient satisfaction and functional recovery after medial open-wedge high tibial osteotomy (MOWHTO) in patients with varus malalignment. We hypothesized that providing patients with visual feedback of their cosmetic improvement may enhance perceived functional outcomes and overall satisfaction.

Methods: A retrospective case-control study was conducted including 57 patients who underwent MOWHTO for varus malalignment between 2019 and 2023. Patients were divided into two groups: Group 1 (n=24), who were shown preoperative and postoperative leg photographs, and Group 2 (n=33), who were not. Functional outcomes were assessed using the Short Form-36 (SF-36) physical and mental scores and Lysholm score. Radiological parameters and joint range of motion were also evaluated preoperatively and at final follow-up.

Results: Both groups showed significant postoperative improvements in SF-36 and Lysholm scores ($P<0.05$). However, Group 1 demonstrated significantly higher postoperative SF-36 physical ($P=0.001$), SF-36 mental ($P=0.001$), and Lysholm scores ($P=0.002$) compared to Group 2. Although radiological parameters and joint range of motion improved significantly in both groups, there were no significant differences between groups.

Conclusion: Visual presentation of preoperative and postoperative leg photographs may increase patient awareness of surgical changes and be associated with improved patient-reported outcomes and satisfaction following MOWHTO. Incorporating visual methods into patient education may represent a simple approach to influencing postoperative perception.

Keywords: High Tibial Osteotomy, Varus Malalignment, Functional Outcomes, Patient Satisfaction, Visual Feedback, Aesthetic Perception

The knee joint is a complex structure that functions biomechanically in alignment with the lower extremity and can withstand mechanical stress during weight-bearing [1]. Lower-extremity malalignment disrupts force distribution among the intra-articular structures of the knee, leading to abnormal loading and, over time, degenerative changes [2, 3]. Varus malalignment is a common knee pathology that increases loading on the medial compartment, resulting in increased stress on the articular cartilage and meniscus [4].

Corrective osteotomies are performed in patients

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with varus malalignment to reduce excessive loading on the medial compartment [5, 6]. In general, medial open-wedge or lateral closed-wedge high tibial osteotomies are among the commonly preferred surgical approaches for these patients [4, 5]. These corrective osteotomies are performed in patients with medial compartment pain and associated symptoms and are often combined with cartilage or meniscal procedures. Medial open-wedge high tibial osteotomy (MOWHTO) has become more widely preferred, particularly after advancements in rigid fixation devices that help maintain alignment. The primary advantages of this technique include avoiding fibular osteotomy and preserving tibial bone stock [1, 4, 7].

In orthopedic surgeries, postoperative satisfaction criteria may differ between surgeons and patients [8, 9]. For surgeons, one of the most important indicators of functional recovery is pain reduction [9]. However, studies focusing on the patient perspective are limited, and the literature on this topic remains insufficient [8, 10, 11]. Few studies in the literature highlight the discrepancy between the surgeon's perception of satisfactory cosmetic outcomes and the patient's perspective following orthopedic procedures [8, 9, 12]. Moreover, research examining the impact of photographic documentation on patient education and postoperative satisfaction is also scarce [8, 13, 14]. Considering the correction of varus deformity following medial MOWHTO, it is evident that a significant cosmetic change occurs. However, there is insufficient data on the extent to which this positive change influences functional outcomes from the patient's perspective.

The aim of this study is to evaluate the impact of cosmetic improvement following MOWHTO on patient satisfaction and functional scores in patients with varus malalignment. Our hypothesis is that sharing preoperative and postoperative photographs with patients may enhance their awareness of the improvement in their postoperative clinical appearance, thereby positively influencing their satisfaction and functional outcomes.

METHODS

Study Population

The medical records of 79 patients who underwent MOWHTO due to varus malalignment between January 2019 and December 2023 were retrospectively reviewed at Department of Orthopedics and Traumatology, Eskişehir City Hospital, Türkiye. Patients under the age of 60 years with Kellgren and Lawrence grade 1-2 osteoarthritis and varus malalignment were included in the study [15]. The exclusion criteria were as follows: patients with Kellgren and Lawrence grade 3-4 osteoarthritis (n=5), those with tumors, trauma, or inflammatory diseases that could affect clinical outcomes (n=3), those with a follow-up period of less than one year (n=6), those without adequate radiographic follow-up data (n=2), and those who had previously undergone

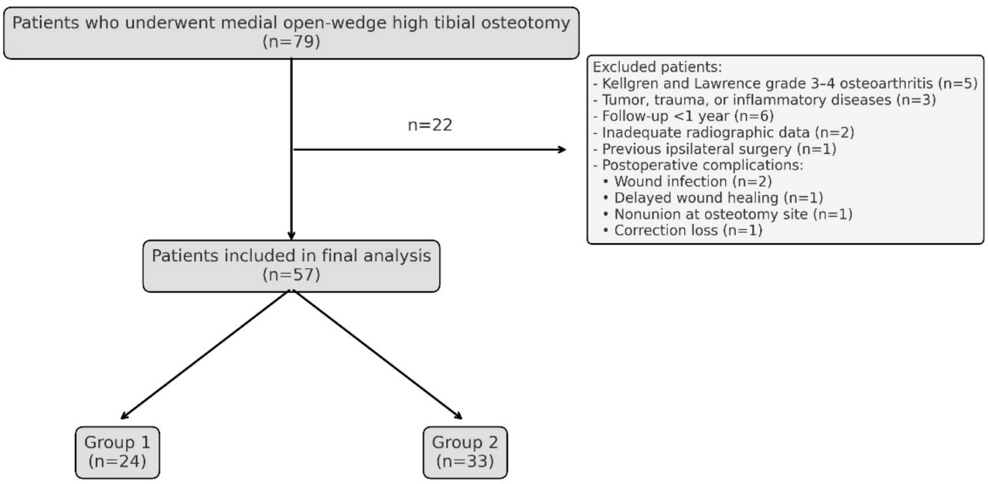

FIGURE 1. Flow diagram of patient selection.

surgery in the same region (n=1). Additionally, patients who experienced postoperative complications that could influence outcomes, such as wound infection (n=2), delayed wound healing (n=1), nonunion at the osteotomy site (n=1), and symptomatic implant correction loss (n=1), were also excluded. After applying the exclusion criteria, 22 patients were removed from the study, leaving a final cohort of 57 patients (Figure 1). The included patients were divided into two groups. Patients whose preoperative and postoperative photographs of the operated region were taken and recorded were assigned to Group 1, while those who were not shown their surgical photographs were assigned to Group 2. Group 1 consisted of 24 patients, and Group 2 included 33 patients. Among the total study population, 36 (63.2%) patients were male, and 21 (36.8%) patients were female, with a mean age of 49.5±4.6 years.

Photographic Documentation of Patients' Clinical Appearance

For patients in Group 1, preoperative photographs were taken one day before surgery, while postoperative photographs were captured at the sixth week after surgery. The sixth postoperative week was chosen to ensure complete wound closure and to exclude potential wound complications. The presentation of preoperative and postoperative photographs was performed according to the operating surgeon's routine clinical preference. All photographs were obtained under standardized conditions in the same examination room, using the same digital camera, under consistent lighting settings, and at a fixed distance. Patient positioning was standardized and maintained identically during all imaging sessions to ensure objective comparability (Figure 2).

The photographs were presented to patients during

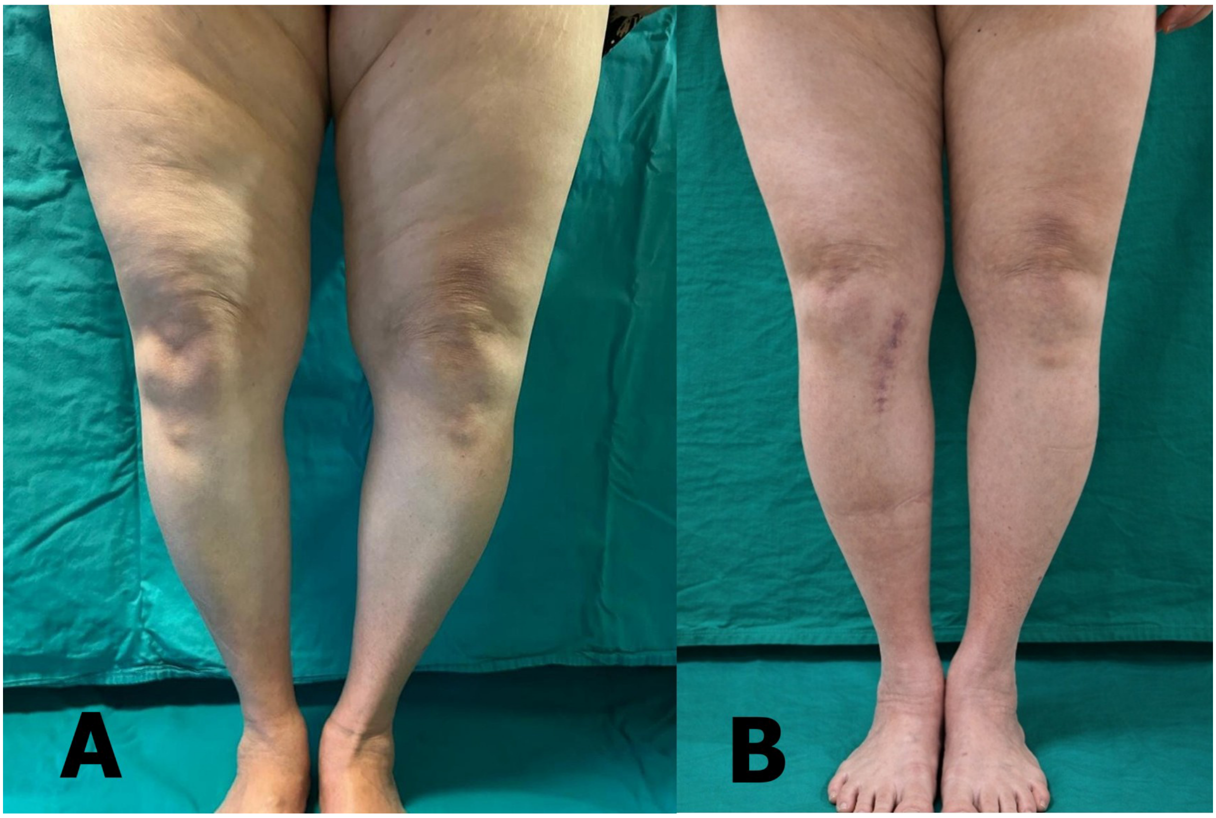

FIGURE 2. Preoperative (A) and postoperative (B) full-length leg photographs.

routine outpatient clinic visits. All images were shown in the outpatient examination room under standardized conditions using the same clinical computer system. The presentation setting was kept consistent for all patients in Group 1 to ensure methodological uniformity and reproducibility.

Surgical Procedure and Rehabilitation

All patients underwent diagnostic arthroscopy prior to MOWHTO to evaluate the intra-articular structures of the knee. The correction angle for each patient was determined based on preoperative full-length weight-bearing radiographs [4]. The final

FIGURE 3. Preoperative (A) and postoperative (B) full-length standing anteroposterior radiographs.

correction angle was adjusted at the discretion of the surgeon based on the severity of the varus deformity. The MOWHTO procedure was performed using a Tomofix plate (Mathys Inc., Bettlach, Switzerland), with appropriate screw fixation (Figure 3). A standardized postoperative rehabilitation protocol was applied to all patients. Active and passive physiotherapy was initiated immediately after surgery to facilitate early restoration of nearly full range of motion. Patients were allowed toe-touch weight-bearing using an adjustable knee brace and crutches for the first six weeks. Full weight-bearing was permitted from the sixth week onward. Postoperatively, all patients received low-molecular-weight heparin for 45 days for thromboprophylaxis. Bone healing was defined as the completion of ossification at the osteotomy site beneath the plate [16].

Data Evaluation

Patient medical records were thoroughly reviewed, and data including age, sex, side of the affected limb, body mass index (BMI), follow-up duration, preoperative complaints, and physical examination findings such as flexion and extension angles were recorded for analysis. Patients were scheduled for follow-up visits at the 2nd and 6th postoperative weeks, as well as at the 3rd, 6th, and 12th postoperative months, during which detailed physical examinations and full-length standing anteroposterior radiographs were performed. Radiological assessment included hip-knee angle and medial proximal tibial angle (MPTA) measurements, which were obtained preoperatively and at the final postoperative follow-up for comparison [4]. Radiographs were digitized using Picture Archiving and Communication System (PACS) software (PiViewStar®; Infinit Technology, Seoul, Korea), and all measurements were conducted with a digital goniometer with 1/1000 precision. Radiological measurements and Kellgren-Lawrence classification assessments were performed in a blinded manner by an orthopedic specialist with at least seven years of experience. Functional outcomes were assessed using Short Form 36 (SF-36) physical functioning and mental health scores and the Lysholm scoring system [17,18]. Preoperative assessments were performed the day before surgery and postoperative assessments were performed at the last follow-up. Before answering the functional scoring questionnaires, Group 1 patients were provided printed A4 sheets containing their preoperative and sixth-week postoperative photographs and allowed sufficient time for examination, with no verbal guidance or influence. In Group 2, functional scoring questionnaires were administered during the final follow-up without additional interventions.

Statistical Analysis

Statistical analysis was conducted using IBM SPSS 25.0 software (IBM Corp., Armonk, NY, USA). Descriptive statistical methods (mean, standard deviation, frequency, minimum, maximum) were used to summarize the data. The Shapiro-Wilk test was applied to assess the normality of continuous variables, while Pearson's Chi-square test was used to evaluate the independence of categorical variables. For data comparisons, the Mann-Whitney U test was used for non-normally distributed variables, whereas the Independent Samples t-test was applied for normally distributed variables. A P-value <0.05 was considered statistically significant. To assess the clinical significance of differences between groups, Cohen's d effect size was calculated, with values categorized as small ($d<0.2$), moderate ($d=0.5$), and large ($d\geq0.8$) [18]. Power analysis was performed using pilot calculations based on mean and standard deviation values from previous studies evaluating similar clinical scores, determining a Cohen's d effect size of 0.8, indicating a large effect size. The analysis confirmed that a sample size of 57 patients was sufficient to achieve 90% statistical power ($\alpha=0.05$, effect size=0.8).

RESULTS

Demographic data are presented in Table 1. No significant differences were observed between the two groups in terms of age, sex, affected side, BMI, follow-up duration, or preoperative complaints.

In the evaluation of joint range of motion, the preoperative mean flexion angle was 125±13.8° in Group 1 and 126.8±12.1° in Group 2, while the preoperative mean extension angle was 3.9±2.0° in

TABLE 1. Comparison of Demographic Data Between Groups

Variables	Group 1 (n=24)	Group 2 (n=33)	P-value
Age (years)	50.3±4.1	48.9±5.02	0.26*
Gender			
Female	9 (35%)	12 (36.5%)	0.93**
Male	15 (65%)	21 (63.6%)	
Side			
Right	13 (54.2%)	19 (57.6%)	0.76**
Left	11 (45.8%)	14 (42.4%)	
BMI (kg/m^2)	28.6±1.7	29.7±3.2	0.15*
Follow-up period (months)	24.1±4.5	25.4±5.3	0.35*
Preoperative complaints			
Pain	14 (58.4%)	17 (51.5%)	0.72***
Crepitation	5 (20.8%)	10 (30.3%)	
Cosmetic	5 (20.8%)	6 (18.2%)	

Data are shown as mean±standard deviation or n (%) where appropriate. BMI, body mass index.
*Independent samples t-test, **Chi-square test, ***Chi-square test with Monte Carlo simulation.

Group 1 and 4.1±1.8° in Group 2. Postoperatively, the mean flexion angle improved to 131±11.2° in Group 1 and 133.6±8.9° in Group 2, while the mean extension angle improved to 2.9±1.8° in Group 1 and 2.4±1.5° in Group 2. Although both groups showed significant postoperative improvements in flexion and extension angles, there were no significant differences between the groups in preoperative and postoperative comparisons (Table 2). Similarly, hip-knee angle and MPTA measurements before and after surgery showed no significant differences between the two groups (Table 2). However, both Group 1 and Group 2 exhibited significant postoperative improvements in hip-knee angle and MPTA compared to their preoperative values (Table 2).

The functional score results are summarized in Table 3. There was no significant difference between the two groups in terms of preoperative mean SF-36 physical and mental scores or Lysholm score. However, postoperative mean SF-36 physical and mental scores, as well as the Lysholm score, were significantly higher in Group 1 compared to Group 2 (P=0.001, P=0.001, P=0.002, respectively). Additionally, both Group 1 and Group 2 showed significant improvements in SF-36 physical and mental scores and Lysholm score postoperatively compared to their preoperative values (P<0.05).

Effect sizes were calculated along with P-values. For SF-36 Mental Score, Cohen's d was 1.48 with P=0.001, indicating a statistically significant and large difference. For SF-36 Physical Score, Cohen's d was 1.12 with P=0.001, also representing a large effect size. For the Lysholm score, Cohen's d was 0.97 with P=0.002, suggesting a statistically significant difference with a moderate-to-large effect size. For other parameters where statistical significance was not observed, small effect sizes were calculated. For instance, for MPTA, Cohen's d was 0.08 with P=0.719, indicating a negligible effect. The average Cohen's d effect size for all variables in our study was determined to be 0.55. However, when considering only statistically significant variables (P<0.05), this value increased to 1.12. Power analysis demonstrated that the study had 98.4% statistical power, confirming that statistically significant differences were reliably detected.

DISCUSSION

This study aimed to determine the impact of cosmetic improvement on postoperative functional scores in

TABLE 2. Comparison of Joint Range of Motion and Radiological Parameters Between Groups

Variables		Group 1 (n=24)	Group 2 (n=33)	P-value
Flexion angle				
Preoperative		125±13.8	126.8±12.1	0.60*
Postoperative		131±11.2	133.6±8.9	0.33*
	P-value (Within Group)	**0.011****	**0.001****	
Extension angle				
Preoperative		3.9±2	4.1±1.8	0.78***
Postoperative		2.9±1.8	2.4±1.5	0.15***
	P-value (Within Group)	**0.007******	**0.001******	
Hip-knee angle				
Preoperative		13.5±2	12.8±1.6	0.19***
Postoperative		1.4±0.4	1.2±0.6	0.56***
	P-value (Within Group)	**0.001******	**0.001******	
MPTA				
Preoperative		83.5±2.3	82.6±2.3	0.72***
Postoperative		87.4±1	87.3±1.3	0.71***
	P-value (Within Group)	**0.001****	**0.001****	

Data are shown as mean±standard deviation. MPTA, medial proximal tibial angle.
*Independent samples t-test, **Paired samples t-test, ***Mann–Whitney U test, ****Wilcoxon signed-rank test.
Statistically significant P-values are shown in bold.

patients who underwent MOWHTO due to varus malalignment. The most significant finding of our study was that patients whose preoperative and postoperative photographs of the operated region were recorded exhibited higher SF-36 physical and mental scores, as well as Lysholm scores, compared to those who were not shown their postoperative photographs. MOWHTO is based on the principle of realigning the mechanical axis of the lower extremity, shifting the weight-bearing center from the medial to the lateral compartment [1, 4]. In recent years, advancements in implant technology have led to a significant increase in the frequency of its application. However, there is no clear consensus regarding the indications and contraindications for this procedure [19]. Recent studies have reported a notable increase in the number of studies demonstrating successful clinical outcomes following MOWHTO [20-23]. However, very few studies have evaluated patient-reported satisfaction following MOWHTO [10, 24, 25]. The growing number of studies highlighting inconsistencies between patient and clinician assessments of health status has increasingly emphasized the importance of various patient-reported outcome measures, including satisfaction [10, 26].

Previous studies have reported patient satisfaction rates between 75% and 85% following MOWHTO [21, 25, 27]. Given the high satisfaction rate associated with this procedure, identifying the factors that influence patient satisfaction is crucial. Studies have identified several factors affecting postoperative satisfaction, including age, BMI, preoperative osteoarthritis severity, postoperative lower limb alignment, postoperative pain improvement, and better functional outcomes [1, 22, 24, 28]. However, the relationship between mechanical axis correction and

TABLE 3. **Comparison of Clinical Scores Between Groups**

Variables		Group 1 (n=24)	Group 2 (n=33)	P-value
SF-36 Physical Score				
Preoperative		69.8±2.3	70.1±3.3	0.77*
Postoperative		88.2±3.5	84.5±3.7	**0.001***
	P-value (Within Group)	**0.001****	**0.001****	
SF-36 Mental Score				
Preoperative		61±2.4	59.6±2.9	**0.06***
Postoperative		79±4.4	72.4±4.5	**0.001***
	P-value (Within Group)	**0.001****	**0.001****	
Lysholm Score				
Preoperative		56.6±5.6	58.3±4.6	0.22*
Postoperative		87.8±4.1	84.12±4.4	**0.002***
	P-value (Within Group)	**0.001****	**0.001****	

Data are presented as mean±standard deviation. SF-36, short form-36.
*Independent samples t-test, **Paired samples t-test.
Statistically significant P-values are shown in bold.

patient satisfaction remains controversial [24, 29]. Some studies suggest that mechanical axis correction does not significantly impact patient satisfaction [1, 22, 24, 29], while others argue that overcorrection of the mechanical axis is necessary to achieve long-term positive satisfaction outcomes [30]. Han et al. [22] demonstrated that both lower extremity realignment and improvements in clinical scores play a crucial role in postoperative patient satisfaction. Among the most important factors associated with high patient satisfaction are favorable clinical outcomes [31]. Miller et al. [25] found a positive correlation between high Lysholm scores and patient satisfaction following MOWHTO. Similarly, Goshima et al. [1] demonstrated that the Knee injury and Osteoarthritis Outcome Score (KOOS) are a significant factor influencing postoperative patient satisfaction [1]. In our study, patients who underwent MOWHTO exhibited significant improvements in functional scores. Both Group 1 and Group 2 showed statistically significant increases in SF-36 physical and mental scores, as well as Lysholm scores, compared to their preoperative values. This finding suggests that MOWHTO not only corrects the mechanical axis but also improves patients' functional capacity in daily activities and positively impacts their overall health perception. Additionally, both groups demonstrated notable improvements in joint range of motion and radiological parameters assessing knee biomechanics. However, how patients perceive these objective improvements may play a critical role in shaping their postoperative satisfaction. Importantly, given the absence of significant differences in objective parameters between the groups, the observed differences in functional scores should be interpreted as reflecting variations in patient perception rather than direct functional superiority. Our findings suggest that MOWHTO provides favorable outcomes not only in terms of surgical success but also from a patient-centered perspective, particularly in relation to patient-reported outcomes.

Successful surgical outcomes are not only dependent on anatomical and functional improvements but also on psychological and emotional perception [11, 32]. In modern reconstructive surgeries, patients' cosmetic expectations have become an increasingly important factor in evaluating postoperative outcomes [32]. Recent studies have demonstrated a direct correlation between postoperative patient satisfaction and aesthetic results [11, 32]. Reconstructive procedures play a significant role in orthopedic surgery. Notably, hallux valgus surgery, scoliosis surgery, and kyphosis surgery serve as prime examples of such procedures. Although limited, studies have investigated the impact of cosmetic improvement on clinical outcomes in these conditions [1, 13, 33]. Bahar et al. [13] examined hallux valgus surgery and found that showing patients preoperative and postoperative foot photographs enhanced their aesthetic satisfaction, which in turn led to higher postoperative pain relief and better functional recovery scores. Similarly, studies examining cosmetic improvement in scoliosis and kyphosis surgeries have reported its influence on patient satisfaction [33, 34]. In a study by Albayrak et al. [33], cosmetic correction following kyphosis surgery was reported to provide both psychological and social benefits. Patients noted an increase in self-confidence due to the positive impact of spinal realignment on their aesthetic appearance. Another study on scoliosis surgery revealed that cosmetic improvement enhances self-esteem and is directly associated with patient satisfaction [34].

MOWHTO is an orthopedic surgical procedure that influences patient satisfaction not only through functional improvement but also through aesthetic enhancement [1, 35]. Patients undergoing MOWHTO, particularly those with medial compartment osteoarthritis, often present with significant varus deformity, which may impact their self-confidence in various aspects of daily life, including clothing choices and overall self-image. The correction of varus deformity in the postoperative period leads not only to a pain-free lifestyle but also contributes to psychological well-being, allowing patients to feel more confident [1]. There is a scarcity of studies in the literature investigating the effect of aesthetic improvement on patient satisfaction following MOWHTO [1, 22, 28, 35]. Based on our findings, patients who were shown their preoperative and postoperative photographs exhibited significantly higher Lysholm and SF-36 score averages. To further evaluate the impact of preoperative photographic visualization on patient satisfaction and functional scores, Cohen's d effect sizes were calculated. The effect sizes for SF-36 physical and mental scores, as well as the Lysholm score, were large, indicating not only statistically significant differences but also clinically meaningful improvements. Additionally, the 98.4% statistical power of our study reinforces the high reliability of these statistically significant findings. Compared to previous studies, the large effect sizes observed in our study emphasize the substantial impact of preoperative visual awareness on postoperative patient satisfaction and functional assessment. However, whether this effect is solely attributable to visual awareness remains debatable. For instance, patients in Group 1 may have had higher preoperative expectations, which could have directly influenced their postoperative satisfaction levels. Furthermore, considering that mechanical axis correction is known to contribute directly to functional recovery, it is essential to acknowledge that patient satisfaction is influenced not only by cosmetic improvements but also by objective functional gains. Future studies incorporating preoperative patient expectations and psychosocial factors will allow for a more comprehensive interpretation of the findings, further clarifying the relationship between visual awareness, functional outcomes, and patient satisfaction.

Strengths and Limitations

This study addresses a relatively underexplored, patient-centered factor by evaluating the impact of visual awareness on postoperative outcomes, providing novel insight into the psychological dimension of recovery after MOWHTO. Additionally, the use of standardized photographic acquisition and presentation protocols, combined with comparable baseline characteristics between groups, strengthens the internal validity of the findings.

First, the retrospective and non-randomized design of the study introduces an inherent risk of selection bias, as group allocation was determined by the surgeon's routine clinical preference rather than a predefined protocol. Therefore, potential differences in patient characteristics, expectations, or psychological profiles between groups cannot be fully excluded. Second, the sample size was limited and derived from a single center, which may affect generalizability. Third, only short-term outcomes were evaluated, and long-term effects on satisfaction remain unknown. Furthermore, differences in data collection methods between the groups may have introduced response and perceptual bias, as patients in Group 1 evaluated their condition after viewing photographs, whereas those in Group 2 did not. Similarly, the timing difference between photographic documentation (6 weeks postoperatively) and final clinical assessments may have created a temporal discrepancy between patient perception and actual clinical status. Lastly, no specific aesthetic satisfaction scoring tools were used, limiting the ability to directly quantify the cosmetic impact. Future multi-center, randomized, and long-term follow-up studies will contribute to a more comprehensive assessment of patient satisfaction and functional recovery following MOWHTO.

CONCLUSION

This study demonstrated that MOWHTO significantly improves functional outcomes in patients with varus malalignment. Both groups exhibited notable postoperative increases in SF-36 physical and mental scores, as well as Lysholm scores, indicating that MOWHTO contributes to functional gains in daily activities beyond mechanical axis correction. Additionally, our findings suggest that documenting preoperative deformities with photographs and presenting them to patients postoperatively may increase their awareness of surgical changes and may be associated with higher reported satisfaction. The observed differences in functional scores may reflect variations in patient perception rather than direct functional superiority, highlighting the potential role of cosmetic awareness and patient education in orthopedic surgeries.

Ethics Approval and Consent to Participate

This study was approved by the Eskişehir City Hospital Scientific Research Ethics Committee. (Decision No: ESH/BAEK 2025/103; date: 20/02/2025). All procedures were conducted in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments. Due to the retrospective design of the study, the Institutional Review Board waived the requirement for study-specific informed consent. However, in routine clinical practice, written informed consent had been obtained from all patients solely for the surgical procedure.

Data Availability

All data generated or analyzed during this study are included in this published article. The data that support the findings of this study are available on request from the corresponding author, upon reasonable request.

Authors' Contribution

Study Conception: HÇB, BK; Study Design: BK; Supervision: BK; Funding: HÇB, BK; Materials: HÇB; Data Collection and/or Processing: HÇB, BK; Statistical Analysis and/or Data Interpretation: HÇB; Literature Review: HÇB, BK; Manuscript Preparation: HÇB; and Critical Review: HÇB, BK.

Conflict of Interest

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Generative Artificial Intelligence Statement

The author(s) declare that no artificial intelligence-based tools or applications were used during the preparation process of this manuscript. AI tools were used only for limited language editing and improvement of English expression. The all content of the study was produced by the author(s) in accordance with scientific research methods and academic ethical principles.

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