Factors Associated With Patient Satisfaction After Opening-Wedge High Tibial Osteotomy

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Background: Opening-wedge high tibial osteotomy (OWHTO) is expected to result in higher patient satisfaction compared with knee arthroplasty due to joint preservation. However, patient satisfaction rates as well as factors associated with satisfaction after OWHTO remain unclear.

Purpose: To evaluate patient subjective satisfaction after OWHTO and determine factors associated with patient satisfaction after OWHTO.

Study Design: Case-control study; Level of evidence, 3.

Methods: This study enrolled 123 patients (123 knees) who underwent unilateral OWHTO. Clinical parameters, including range of motion (ROM), visual analog scale (VAS) score for pain, Knee injury and Osteoarthritis Outcome Score (KOOS), weightbearing line ratio (WBLR), and medial proximal tibial angle (MPTA), were assessed before surgery and at the final follow-up at a minimum of 2 years. Patient satisfaction was evaluated using a 5-point scale regarding (1) surgery, (2) pain relief, (3) knee mobility, (4) daily living function, and (5) lower extremity alignment. The mean overall satisfaction scores for the 5 questions were calculated, and the sample was divided into 2 main groups (satisfied or unsatisfied). Preoperative characteristics, physical activity level, patient expectations for surgery, ROM, and KOOS were compared between the groups. Cartilage regeneration was assessed at the time of plate removal, and WBLR and MPTA were also assessed. Factors associated with patient satisfaction were analyzed using multivariable logistic regression analysis.

Results: The mean ± SD follow-up was 54.6 ± 20.6 months. The mean WBLR significantly changed from 20.7% ± 11.8% preoperatively to 66.9% ± 10.2% at the final follow-up, and all KOOS subscale scores significantly improved after surgery. Of the 123 patients, 109 (88.6%) were graded as satisfied. Factors associated with patient satisfaction were expectations met (odds ratio, 17.4; $P = .026$), better postoperative KOOS Pain score (odds ratio, 1.30; $P = .001$), and better postoperative KOOS Activities of Daily Living score (odds ratio, 1.36; $P = .002$).

Conclusion: OWHTO is an effective treatment in terms of subjective satisfactory outcomes. Patient expectations for surgery have a significant effect on patient satisfaction. Surgeons should consider patient expectations before OWHTO and provide patient education to improve patient satisfaction.

Keywords: opening-wedge high tibial osteotomy; patient-reported outcomes; patient satisfaction; associated factors

Opening-wedge high tibial osteotomy (OWHTO) with locking plates is a commonly used approach for the treatment of medial compartment osteoarthritis (OA) and osteonecrosis of the knee.[12,15,16,20] The biomechanical principle of high tibial osteotomy (HTO) is to redistribute weightbearing forces from the medial toward the lateral compartment by realignment of the mechanical axis. To ensure a satisfactory clinical outcome, several attempts have been made to find a consensus on relative and absolute contraindications for osteotomies over the past decade (Rand and Neyret, 2005, unpublished data). Good clinical results, including mid- to long-term outcomes, have been reported in recent years.[4,8,31,32] However, few studies have evaluated the subjective and self-reported satisfaction of patients after OWHTO. Patient-reported outcome measures (PROMs), including satisfaction, are increasingly accepted as essential

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in the assessment of postoperative outcome, based on the well-documented discrepancy between clinician and patient ratings of health status.[5,6] The rate of patient satisfaction after total knee arthroplasty (TKA) has been reported to be 81% to 85%.[5,29,36] Compared with TKA, HTO is expected to have higher patient satisfaction rates due to joint preservation, induction of biological remodeling, and cartilage regeneration. In fact, several studies on patient satisfaction after HTO have consistently shown relatively high patient satisfaction ratings.[27,30,33] However, most of these previous studies included only an estimation of overall satisfaction based on a simple satisfaction index and results after conventional HTO, not the modern OWHTO using a rigid locking plate. Because various factors can influence patient satisfaction levels, we believe that it is necessary to evaluate overall satisfaction as well as pain relief, daily living function, and alignment in HTO, as described in the report by Han et al.[18] In addition, limited data are available on the factors affecting patient satisfaction after OWHTO, such as age, preoperative OA grade, body mass index (BMI), postoperative alignment of the lower leg, and clinical outcomes including PROMs as well as cartilage regeneration after OWHTO.

The aims of the present study were to evaluate patient subjective satisfaction after OWHTO and determine the pre- and postoperative factors associated with patient satisfaction after OWHTO. We hypothesized that most patients would be satisfied with OWHTO and that postoperative patient-reported outcomes would be associated with patient satisfaction.

METHODS

This study was approved by our institutional review board as a retrospective case series. Overall, 141 consecutive patients (151 knees) who underwent OWHTO between January 2011 and December 2016 at our hospital were enrolled in this study. The exclusion criteria were bilateral OWHTO, severe postoperative comorbidity unrelated to the surgery, and HTO combined with anterior cruciate ligament (ACL) reconstruction. Of the 141 consecutive patients, 26 were excluded due to bilateral OWHTO (n = 20), severe postoperative comorbidity unrelated to HTO (n = 5), and HTO combined with ACL reconstruction (n = 1). The severe postoperative comorbidities were severe lumbar spinal canal stenosis (n = 2), cerebral infarction (n = 1), lung cancer (n = 1), and femoral neck fracture several years after HTO (n = 1), which were not related to the HTO surgery. In addition, we excluded the cases lost to follow-up (n = 2). In total, 123 patients were included in this study (Figure 1). The surgical indications for OWHTO were (1) symptomatic medial OA and osteonecrosis of the medial femoral condyle; (2) varus malalignment, which was defined as a femorotibial angle (FTA) >176°; and (3) active patients who demonstrated good compliance with the postoperative rehabilitation program. There were no age restrictions. The contraindications for OWHTO were (1) a history of joint infection, (2) symptomatic OA of the lateral compartment or patellofemoral joint, (3) joint instability, (4) FTA >185°, and (5) flexion contracture of >15°.

Surgical Procedure and Postoperative Rehabilitation

An anteroposterior long-leg weightbearing radiograph was used for preoperative planning. The weightbearing line was aimed at a point 65% to 70% lateral to the transverse diameter of the tibial plateau. Arthroscopy was routinely conducted before HTO to evaluate the medial, lateral, and patellofemoral cartilages. The medial proximal tibia was exposed using an oblique incision, and the superficial fibers of the medial collateral ligament were released distally. The upper border of the pes anserinus was defined as the starting point of the osteotomy. Two K-wires directed just proximal to the tibiofibular joint were used as place markers for the saw cut. The most lateral 10-mm portion of the tibial plateau was left intact and used as a hinge for the osteotomy. A separate ascending cut for the biplanar osteotomy was made 1.5 cm behind the tibial tuberosity in the frontal plane at an angle of 100° to 110° with the first osteotomy plane. Several chisels were used to gradually open the osteotomy, and a laminar spreader was used for the final opening. A TomoFix plate (DePuy Synthes) was inserted into a subcutaneous tunnel that was formed on the medial side of the tibia and was fixed in place with 8 locking screws. No bone graft or bone substitute was placed in the osteotomy site.

Isometric exercises of the quadriceps, active ankle exercises, and straight leg raises were started on postoperative day 1. The patients were allowed to begin partial weightbearing exercises with a walker 1 week after surgery. Full weightbearing starts 4 weeks after surgery.

Clinical Evaluation

Clinical parameters, including range of motion (ROM), visual analog scale (VAS) score for pain, physical activity level (Tegner activity level),[34] and the Knee injury and Osteoarthritis Outcome Score (KOOS),[28] were measured before surgery and at the final follow-up by a physician independent of the surgical team and blinded to the radiographic findings. The KOOS consists of 5 subscales: Symptoms, Pain, Activities of Daily Living (ADL), Sports/Recreational activities, and Quality of Life, in which each question is assigned a score from 0 to 4. A normalized score (100 indicating no symptoms and 0 indicating extreme symptoms) was calculated for each subscale. In addition, we evaluated postoperative complications that required additional surgery and could affect postoperative patient satisfaction.

Subjective Satisfaction

Patient satisfaction was evaluated using a questionnaire at final follow-up. The satisfaction questionnaire included 5 questions: (1) How satisfied are you with the results of your surgery? (2) How satisfied are you with your surgery in terms of reducing your pain? (3) How satisfied are you with your surgery in terms of improving your knee motion? (4) How satisfied are you with your surgery in terms of your ability to perform daily living functions, such as going upstairs, getting in or out of a car, rising from bed, lying

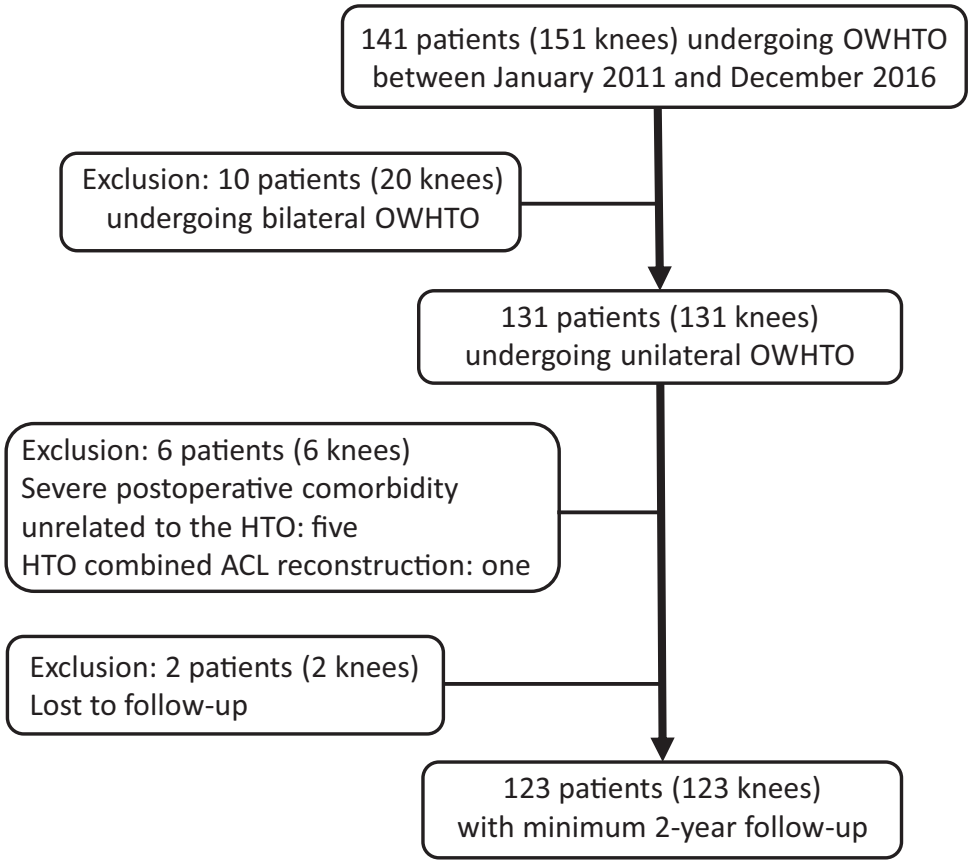

Figure 1. Study flowchart. ACL, anterior cruciate ligament; HTO, high tibial osteotomy; OWHTO, opening-wedge high tibial osteotomy.

in bed, and performing light domestic duties? (5) How satisfied are you with your surgery in terms of correcting the alignment of your lower extremity? All patients were asked to provide a response to each question using a 5-point scale, including very satisfied (5 points), satisfied (4 points), neutral (3 points), unsatisfied (2 points), and very unsatisfied (1 point). Also, patients were asked whether their expectations for surgery were met (expectation met: yes/not sure/no) at the same final follow-up visit when we asked the questions regarding satisfaction.

Depending on the responses to the 5 satisfaction questions, the patients were divided into the satisfied group (responses of *very satisfied* and *satisfied*) and the unsatisfied group (responses of *neutral*, *unsatisfied*, and *very unsatisfied*). The mean overall satisfaction scores were calculated to combine the responses to all 5 questions into a composite overall satisfaction score. We added all scores for each patient (maximum total of 25) and divided this value by 5 to obtain composite satisfaction scores. We then categorized the patients into 2 main groups, including the satisfied group (mean overall satisfaction score $\geq$4 points) and the unsatisfied group (mean overall satisfaction score $<$4 points). These 2 categories of satisfied and unsatisfied were the primary variables used in this study to statistically measure overall satisfaction.

Radiologic Evaluation

The radiologic outcomes, including weightbearing line ratio (WBLR) and medial proximal tibial angle (MPTA), were evaluated preoperatively and at the final follow-up. The WBLR was defined as the horizontal distance from the weightbearing line to the medial edge of the tibial plateau, divided by the width of the tibial plateau (Figure 2, A and B). WBLR at final follow-up $<$50% was classified as undercorrection and WBLR $\geq$75% was defined as overcorrection in this study. The MPTA was the medial angle formed between the mechanical tibial axis and the joint line of the proximal tibia (Figure 2C). All radiologic parameters were measured twice, with an interval of $>$4 weeks, by 2 observers who were blinded to the previous observations.

Arthroscopic Evaluation

For the evaluation of cartilage lesions, the medial femoral condyle, medial tibial plateau, lateral femoral condyle, and lateral tibial plateau were assessed by arthroscopy at the time of initial HTO and during plate removal. The grade of degeneration-associated cartilage injury was assessed in accordance with the International Cartilage Repair Society classification system. Based on cartilage regeneration in

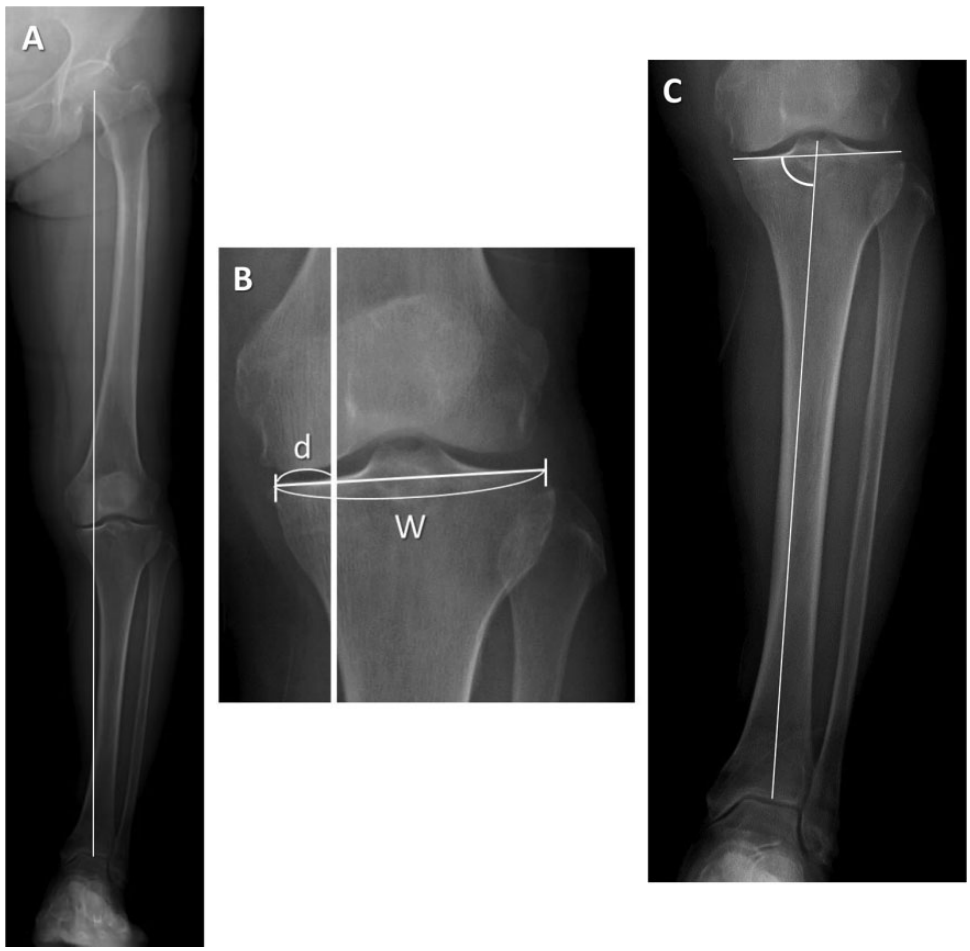

Figure 2. Radiologic assessments. (A, B) The weightbearing line ratio was calculated as the horizontal distance from the weightbearing line to the medial edge of the tibial plateau (*d*), divided by the width of the tibial plateau (*W*), as $d/W \times 100\%$. (C) The medial proximal tibial angle is the medial angle formed between the mechanical tibial axis and the joint line of the proximal tibia.

the medial compartment, the patients were classified into regeneration (cases with partial or complete newly formed cartilaginous tissue) and no-regeneration groups.[25]

Statistical Analysis

Data are presented as mean ± SD. The Shapiro-Wilks test was carried out to test the normality of the distributions. The satisfied and unsatisfied groups were compared in terms of the data on patient characteristics and the preoperative and postoperative variables. A chi-square test was used for categorical variables. The differences in continuous variables were analyzed with Student *t* test or Mann-Whitney test according to the test for normality. Multivariate logistic regression analysis was performed to determine the factors associated with patient satisfaction. $P < .05$ was considered statistically significant. The intrarater and interrater reliabilities of the measurements were assessed via the intraclass correlation coefficient. The radiologic measurements had an intrarater reliability of 0.98 (range, 0.96-0.99) and an interrater reliability of 0.96 (range, 0.89-0.99). A sample size of 120 was suggested for the multiple regression analysis, based on an effect size of 0.30, a significance level of .05, and a power of 95%. JMP Version 11 software (SAS Institute) was used to analyze and manage the data.

RESULTS

Patient Characteristics

The mean age at the time of surgery was 63.8 ± 10.5 years (range, 22-83 years), and the mean BMI was 24.5 ± 3.1 kg/m^2 (range, 16.1-32.5 kg/m^2). The mean follow-up period was 54.6 ± 20.6 months (range, 25-100 months). The patients' descriptive data are shown in Table 1. No significant differences were found between the original cohort and the final cohort.

Clinical and Radiologic Outcomes

As shown in Table 2, the mean WBLR significantly changed from 20.7% ± 11.8% (range, −25.9% to 46.0%) preoperatively to 66.9% ± 10.2% (range, 33.1% to 100%) at the final follow-up. The KOOS subscale scores for all variables significantly improved after surgery. Additional surgery was required for

TABLE 1
Patient Descriptive Data[a]

	Original Cohort (n = 151)	Final Cohort (n = 123)	*P* Value
Age, y	64.3 ± 10.4 (22 to 83)	63.8 ± 10.5 (22 to 83)	.585
Male/female, n	51/100	36/87	.425
Height, cm	158.4 ± 9.2 (141 to 182.3)	158.2 ± 8.8 (141 to 182.3)	.907
Body weight, kg	62.3 ± 11.4 (32.9 to 92.4)	61.7 ± 10.9 (32.9 to 92.4)	.671
BMI, kg/m^2	24.7 ± 3.1 (16.1 to 32.5)	24.5 ± 3.1 (16.1 to 32.5)	.648
Follow-up period, mo	55.9 ± 20.6 (25 to 100)	54.6 ± 20.6 (25 to 100)	.602
OA/ON, n	117/34	97/26	.784
OA grade[b] 1/2/3/4, n	16/36/48/17	15/31/37/14	.959
Opening width, mm	12.3 ± 2.6 (7.0 to 20.0)	12.0 ± 2.4 (7.0 to 20.0)	.366
Preoperative WBLR, %	20.1 ± 11.7 (−25.9 to 46.0)	20.7 ± 11.8 (−25.9 to 46.0)	.615

[a]Data are presented as mean ± SD (range) unless otherwise noted. Patient descriptive data (age, sex, height, body weight, and BMI) were collected at the time of inclusion. BMI, body mass index; OA, osteoarthritis; ON, osteonecrosis; WBLR, weightbearing line ratio.
[b]OA grade according to the Kellgren-Lawrence grading system.

TABLE 2
Comparison of Clinical and Radiological Outcomes Before and After OWHTO[a]

	Preoperative	Final Follow-up	*P* Value
Extension angle, deg	−4.2 ± 5.1 (−15.0 to 0.0)	−1.1 ± 2.4 (−10.0 to 0.0)	<.001
Flexion angle, deg	136.5 ± 8.4 (110 to 150)	140.5 ± 7.5 (105 to 150)	<.001
VAS pain score	62.6 ± 19.5 (13 to 100)	10.4 ± 14.9 (0 to 76)	<.001
KOOS subscale scores			
Symptoms	62.7 ± 19.0 (14.3 to 96.4)	85.1 ± 12.0 (53.6 to 100)	<.001
Pain	57.1 ± 18.2 (5.6 to 94.4)	86.2 ± 12.6 (50 to 100)	<.001
ADL	71.9 ± 16.8 (25 to 100)	91.8 ± 8.4 (58.8 to 100)	<.001
Sports/Recreation	35.9 ± 22.4 (0 to 95)	68.6 ± 24.5 (5 to 100)	<.001
QOL	35.3 ± 18.6 (0 to 75)	73.5 ± 19.4 (18.8 to 100)	<.001
WBLR, %	20.7 ± 11.8 (−25.9 to 46.0)	66.9 ± 10.2 (33.1 to 100)	<.001
MPTA, deg	83.9 ± 1.9 (78.4 to 88.0)	93.9 ± 3.0 (87.6 to 101.6)	<.001

[a]Data are presented as mean ± SD (range). ADL, Activities of Daily Living; KOOS, Knee injury and Osteoarthritis Outcome Score; MPTA, medial proximal tibial angle; OWHTO, opening-wedge high tibial osteotomy; QOL, Quality of Life; VAS, visual analog scale; WBLR, weightbearing line ratio.

5 complications, including delayed infection (n = 3), overcorrection (n = 1), and late lateral hinge fracture (n = 1).

Patient Satisfaction

The mean overall satisfaction score was 4.5 ± 0.6 (range, 2.6-5.0). Of the 123 knees, 109 (88.6%) were in the satisfied group and 14 (11.4%) were in the unsatisfied group. The distribution of the mean overall satisfaction score is shown in Figure 3. The numbers of patients who were satisfied in terms of the surgery, pain relief, knee mobility, daily living function, and lower extremity alignment were 116 (94.3%), 111 (90.2%), 115 (93.5%), 119 (96.7%), and 119 (96.7%), respectively (Figure 4).

Comparisons Between the Satisfied and Unsatisfied Groups

Pre-, Intra-, and Postoperative Factors. As shown in Table 3, no significant differences were found in the pre- and intraoperative factors between the groups. However, compared with the unsatisfied group, the satisfied group had a significantly shorter follow-up period, higher rates of fulfilled expectations on the surgery, and better postoperative clinical outcomes, including ROM, VAS, and KOOS (Table 4).

Cartilage Regeneration in the Medial Compartment. Of the 123 patients, 115 (93.5%) underwent hardware removal, and arthroscopic evaluation was performed during plate removal. The mean interval from the initial surgery to plate removal was 16.6 ± 5.6 months. The arthroscopic findings are shown in Table 5. Cartilage regeneration in the medial compartment was not significantly different between the groups.

Factors Associated With Patient Satisfaction

Multivariate logistic regression analysis demonstrated that the factors associated with patient satisfaction were expectations met (odds ratio = 17.4; $P = .026$), better postoperative KOOS pain score (odds ratio = 1.30; $P = .001$), and better postoperative KOOS ADL score (odds ratio = 1.36; $P = .002$) (Table 6).

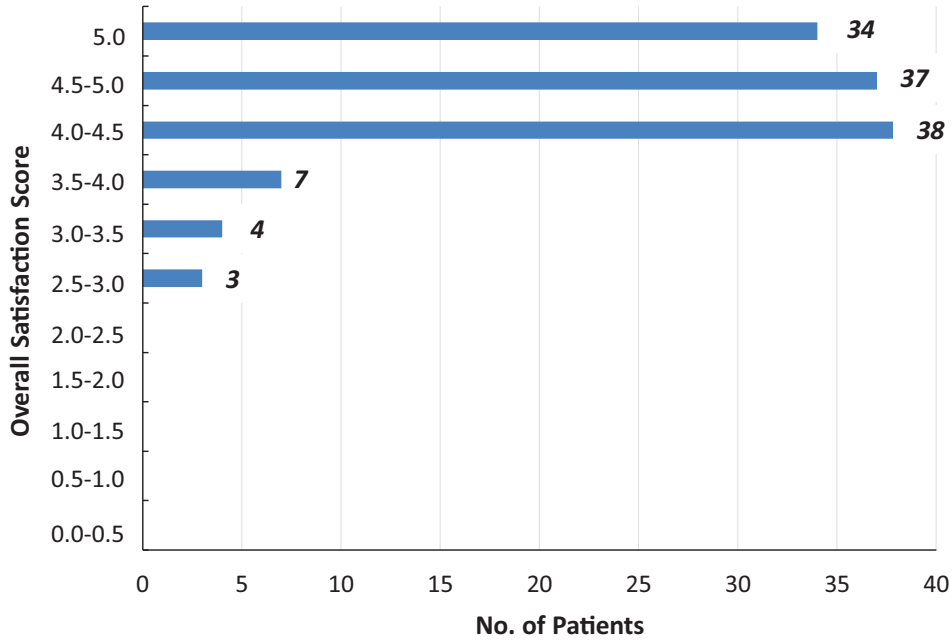

Figure 3. Distribution of the mean overall satisfaction scores.

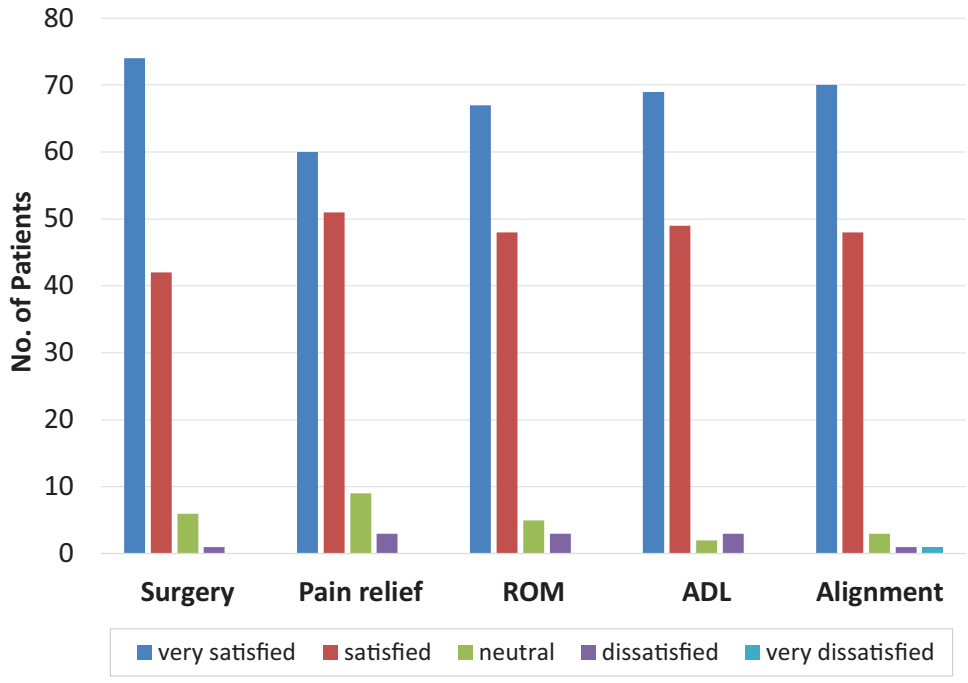

Figure 4. Patient satisfaction after opening-wedge high tibial osteotomy in 5 areas: surgery, pain relief, range of motion (ROM), activities of daily living (ADL), and alignment.

DISCUSSION

The principal findings of this study were that patient satisfaction after OWHTO with locking plates was 88.6% and that OWHTO was an effective procedure in terms of subjective satisfactory outcomes. The factors associated with patient satisfaction were expectations met, better postoperative pain score, and better postoperative KOOS ADL score.

Patient satisfaction after HTO was previously reported to be as high as 75% to 85%.[27,30,33] However, most of the previous studies estimated overall satisfactory outcomes based on a simple satisfaction index without further evaluating the specific categories of satisfaction and included

TABLE 3
Comparison of Pre- and Intraoperative Factors Between the Satisfied and Unsatisfied Groups[a]

	Satisfied (n = 109)	Unsatisfied (n = 14)	*P* Value
Preoperative factors			
Age, y	63.4 ± 10.7 (22 to 83)	66.7 ± 8.4 (54 to 79)	.403
Male/female, n	33/76	3/11	.493
BMI, kg/m^2	24.5 ± 3.0 (16.1 to 32.5)	24.4 ± 3.5 (18.9 to 32.3)	.918
OA/ON, n	86/23	11/3	.977
OA grade 1/2/3/4, n	15/29/31/12	0/3/6/2	.382
Tegner activity level	3.1 ± 1.2 (2 to 7)	2.6 ± 0.8 (2 to 5)	.171
Extension angle, deg	−4.1 ± 5.1 (−15.0 to 0.0)	−5.4 ± 5.4 (−15.0 to 0.0)	.401
Flexion angle, deg	136.6 ± 8.2 (110 to 150)	136.1 ± 10.6 (120 to 150)	.939
VAS pain score	61.6 ± 20.2 (13 to 100)	70.2 ± 11.9 (43 to 80)	.123
KOOS subscale scores			
Symptoms	62.9 ± 19.2 (14.3 to 96.4)	61.5 ± 17.7 (28.6 to 92.9)	.759
Pain	57.5 ± 18.3 (5.6 to 94.4)	53.2 ± 17.7 (22.2 to 80.6)	.403
ADL	72.5 ± 16.9 (25.0 to 100)	67.8 ± 15.8 (42.6 to 95.6)	.256
Sports/Recreation	36.8 ± 23.1 (0.0 to 95.0)	32.9 ± 16.8 (0.0 to 65.0)	.734
QOL	35.4 ± 18.7 (0.0 to 75.0)	34.8 ± 18.9 (0.0 to 62.5)	.92
WBLR, %	20.4 ± 12.1 (−25.9 to 41.8)	23.0 ± 9.2 (11.6 to 46.0)	.765
MPTA, deg	83.8 ± 1.9 (78.4 to 88.0)	84.7 ± 1.5 (82.0 to 86.7)	.081
Intraoperative factors			
Opening width, mm	12.0 ± 2.5 (7.0 to 20.0)	11.7 ± 1.8 (9.0 to 15.0)	.75

[a]Data are presented as mean ± SD (range) unless otherwise noted. ADL, Activities of Daily Living; BMI, body mass index; KOOS, Knee injury and Osteoarthritis Outcome Score; MPTA, medial proximal tibial angle; OA, osteoarthritis; ON, osteonecrosis; QOL, Quality of Life; VAS visual analog scale; WBLR, weightbearing line ratio.

TABLE 4
Comparison of Postoperative Factors Between the Satisfied and Unsatisfied Groups[a]

Postoperative Factors	Satisfied (n = 109)	Unsatisfied (n = 14)	*P* Value
Follow-up period, mo	53.0 ± 20.1 (25.2 to 97.5)	67.0 ± 20.7 (30.3 to 97.7)	.02
Complications, n (%)	4 (3.7)	1 (7.1)	.536
Expectations met, n (%)			
Yes	85 (78.0)	2 (14.3)	<.001
Not sure	17 (15.6)	0 (0.0)	
No	7 (6.4)	12 (85.7)	
Extension angle, deg	−0.8 ± 2.1 (−10.0 to 0.0)	−2.9 ± 3.8 (−10.0 to 0.0)	.007
Flexion angle, deg	141.4 ± 6.9 (120 to 150)	133.6 ± 11.0 (105 to 145)	.005
VAS pain score	8.1 ± 13.4 (0 to 76)	28.3 ± 13.9 (10-50)	<.001
KOOS subscale score			
Symptoms	86.5 ± 11.3 (53.6 to 100)	74.0 ± 12.1 (57.1 to 100)	<.001
Pain	88.9 ± 10.0 (63.9 to 100)	64.7 ± 9.5 (50.0 to 80.6)	<.001
ADL	93.5 ± 6.7 (64.7 to 100)	79.2 ± 9.4 (58.8 to 97.1)	<.001
Sports/Recreation	71.1 ± 23.7 (5.0 to 100)	49.3 ± 23.0 (15.0 to 80.0)	.002
QOL	75.5 ± 18.9 (18.8 to 100)	58.1 ± 16.3 (37.5 to 87.5)	.001
WBLR, %	66.7 ± 9.9 (33.1 to 88.6)	68.1 ± 12.2 (53.9 to 100)	.325
MPTA, deg	93.8 ± 2.9 (87.6 to 101.4)	95.0 ± 3.5 (89.7 to 101.6)	.087

[a]Data are presented as mean ± SD (range) unless otherwise noted. ADL, Activities of Daily Living; KOOS, Knee injury and Osteoarthritis Outcome Score; MPTA, medial proximal tibial angle; QOL, Quality of Life; VAS, visual analog scale; WBLR, weightbearing line ratio.

patients who underwent conventional HTO, not biplanar medial OWHTO using locking plates, which has become commonplace. In the present study, the 88.6% rate of patient satisfaction after OWHTO was comparable with the overall satisfaction after modern OWHTO, as reported by Han et al.[18] The advantages of high initial stability, early weightbearing after surgery, and satisfactory PROM-based clinical outcomes likely accounted for greater patient satisfaction after OWHTO with a rigid long plate than after conventional HTO.[12,15,16,20]

Only a few studies have reported on factors associated with patient satisfaction after OWHTO. Koh et al[23] showed that severe OA was associated with dissatisfaction after OWHTO. Han et al[18] reported that pre- and postoperative limb alignment as well as postoperative clinical scores were significant predictors of subjective satisfaction. In the

TABLE 5
Cartilage Regeneration in the Medial Compartment Between the Satisfied and Unsatisfied Groups[a]

	Satisfied (n = 99)	Unsatisfied (n = 14)	*P* Value
Regeneration in MFC, yes/no, n	66/33	10/4	.722
Regeneration rate of MFC, %	66.7	71.4	
Regeneration in MTP, yes/no, n	49/50	10/4	.124
Regeneration rate of MTP, %	49.5	71.4	

[a]MFC, medial femoral condyle; MTP, medial tibial plateau.

TABLE 6
Factors Associated With Patient Satisfaction[a]

	Odds Ratio	95% CI	*P* Value
Postoperative follow-up period	1.01	0.912-1.146	.852
Expectations met	17.4	1.406-215.693	.026
Postoperative extension angle	1.33	0.846-2.488	.227
Postoperative flexion angle	1.05	0799-1.447	.703
Postoperative VAS score	0.99	0.897-1.080	.853
Postoperative KOOS subscale scores			
Symptoms	0.96	0.763-1.213	.697
Pain	1.30	1.087-1.866	.001
ADL	1.36	1.095-2.116	.002
Sports/Recreation	0.94	0.829-1.022	.166
QOL	0.95	0.802-1.073	.412

[a]ADL, Activities of Daily Living; KOOS, Knee injury and Osteoarthritis Outcome Score; QOL, Quality of Life; VAS, visual analog scale.

present study, the factors associated with patient satisfaction after OWHTO were expectations met, better postoperative KOOS pain score, and better postoperative KOOS ADL score, whereas preoperative OA grade, pre- and postoperative alignment, and cartilage regeneration did not affect patient satisfaction.

Previous studies have shown an association between severe articular destruction and unfavorable clinical outcomes after HTO.[1,9,11,35] Moreover, Koh et al[23] reported that preoperative severe OA (Ahlbäck grade $\geq$2) was a significant predictor of patient dissatisfaction after OWHTO. In contrast, in a large series of 533 cases in which a rigid long plate was used, Floerkemeier et al[12] reported that the preoperative OA grade did not affect the Oxford Knee Score. In addition, Schuster et al[32] reported good 10-year results of medial OWHTO, even in cases of severe medial osteoarthritis (Kellgren-Lawrence grades 3 and 4). In the present study, preoperative OA grade did not affect postoperative patient satisfaction. We believed that aiming for a WBLR of 65% to 70% in cases of severe OA was sufficient to produced effective unloading effects on the medial compartment after OWHTO.

In this study, we found no association between cartilage regeneration and patient satisfaction after OWHTO. The association between cartilage regeneration and clinical results after HTO has been debated in the literature. Koshino et al[24] reported lower knee scores in patients with immature regeneration than in those with mature regeneration. However, many studies showed the absence of an association between cartilage regeneration and clinical outcomes.[21,22,25] In a previous study that used quantitative bone scintigraphy, the unloading effects of OWHTO led to pain relief after surgery, independent of cartilage regeneration.[16] Therefore, cartilage regeneration after HTO was unlikely to affect patient satisfaction.

In the present study, postoperative alignment did not affect patient satisfaction after OWHTO. The optimal alignment after HTO remains a matter of debate. Most surgeons agree that slight overcorrection of the mechanical axis to 3° to 5° valgus is essential to achieve satisfactory clinical results.[2,13,19] Han et al[18] reported that overcorrection was associated with cosmetic dissatisfaction and was furthermore a negative predictor of overall postoperative satisfaction. In contrast, Koh et al[23] reported that there was no association between dissatisfaction after OWHTO and postoperative alignment. In this study, we did not detect an association between the satisfied and dissatisfied groups with respect to the mean postoperative WBLR. In addition, 96.7% of our patients were satisfied with regard to postoperative alignment. Some authors suggested that overcorrection should be attained to ensure favorable long-term results after HTO.[7,26,37] Therefore, we thought that a certain degree of overcorrection would be necessary for postoperative pain relief, which was related more with patient satisfaction than cosmetic issues in our cohort.

Postoperative clinical outcomes were highly associated with patient satisfaction after HTO. Miller et al[27] demonstrated a positive correlation between the satisfaction score and the objective Lysholm score after medial OWHTO using an external fixator and Puddu plate. Han et al[18] reported that the mean American Knee Society knee score was a significant positive predictor of overall satisfaction after OWHTO with locking plates. Similar to the aforementioned results,[18,27] our results showed that KOOS Pain and ADL subscale scores were significant factors associated with patient satisfaction after OWHTO. Furthermore, patient expectation of surgery was highly associated with patient satisfaction. Recently, unmet expectations in other orthopaedic surgeries were reported to be related to patient dissatisfaction.[3,10,14] Bourne et al[5] demonstrated that among several predictors, unmet expectation was most highly related to patient dissatisfaction after TKA in 1703 cases. Likewise, in the current study, patient expectation regarding surgery had a significant effect on patient satisfaction after OWHTO. In addition, Grünwald et al[17] reported high patient expectations for ADL and pain relief after osteotomy around the knee. In our study, KOOS Pain and ADL subscale scores were significant factors associated with patient satisfaction after OWHTO, which suggested that actual clinical outcomes including pain and ADL may be at odds with patient expectations regarding postoperative pain and function. Therefore, surgeons should take into account patients' expectations before surgery. Patient education will be necessary to set appropriate expectations regarding the recovery process, especially with regard to

postoperative pain and function, which can ultimately improve patient satisfaction.

Limitations

The study had several noteworthy limitations. First, patient selection bias may have existed because this was not a prospective study and the data were retrospectively extracted from medical records. Second, patient satisfaction was evaluated at the final follow-up, which varied in the present study, and patient subjective satisfaction and objective clinical outcomes may change over time. Third, we did not evaluate the factors associated with patient satisfaction in each domain (surgery, pain relief, knee mobility, daily living function, and lower extremity alignment). Fourth, these findings may not be generalizable, because the descriptive characteristics and lifestyle factors in our cohort may have been different from those in Western populations. Fifth, we evaluated only the overall expectations of surgery and did not assess detailed expectations regarding postoperative pain, ROM, and participation in sports and recreational activities. Sixth, an HTO-specific method for assessment of satisfaction was not available. Therefore, future studies will need to validate a scoring system for satisfaction assessment that is specific for HTO. Despite these limitations, this study provides valuable information for surgeons who perform HTO regarding the importance of understanding patient expectations before surgery, which can improve patient satisfaction.

CONCLUSION

OWHTO is an effective treatment in terms of subjective satisfactory outcomes. Patient expectations for surgery have a significant effect on patient satisfaction. Surgeons should assess patient expectations before OWHTO and provide patient education to improve patient satisfaction.

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