Risk Factors Affecting Return to Sports and Patient-Reported Outcomes After Opening-Wedge High Tibial Osteotomy in Active Patients

Hiroki Katagiri,*† MD, PhD, Mikio Shioda,† MD, PhD, Yusuke Nakagawa,* MD, PhD, Toshiyuki Ohara,‡ MD, PhD, Nobutake Ozeki,‡ MD, PhD, Tomomasa Nakamura,* MD, PhD, Ichiro Sekiya,§ MD, PhD, and Hideyuki Koga,†|| MD, PhD

Investigation performed at Tokyo Medical and Dental University, Tokyo, Japan

Background: Although opening-wedge high tibial osteotomy (OWHTO) is favored for active patients who expect to return to sports, there is still a lack of robust evidence for factors affecting their recovery.

Purpose: To identify (1) risk factors leading to a decreased level of return to preoperative sports after OWHTO and (2) patient characteristics and intraoperative factors influencing patient-reported outcomes after return to sports.

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

Methods: Included were 69 patients who underwent OWHTO and who expected to return to their preoperative level of sports, measured as a Tegner activity level $\geq$2. All included patients had a minimum of 1 year of follow-up data. Logistic regression analyses were performed to assess the effect of independent variables on the level of return to preoperative sports after surgery; the independent variables were age, sex, body mass index, preoperative Tegner score, preoperative Kellgren-Lawrence grade, preoperative percentage of mechanical axis (%MA), opening gap width, concomitant meniscal treatment, postoperative %MA, postoperative medial proximal tibial angle (MPTA), and postoperative posterior tibial slope. Univariate and multiple regression analyses were performed to assess for influencing factors on postoperative International Knee Documentation Committee (IKDC) subjective scores in patients who were able to return to sports.

Results: Of the 69 patients, 51 (73.9%) returned to sports after OWHTO. High preoperative Tegner scores were statistically associated with a decrease in return to sports (odds ratio, 1.494; $P = .033$). Multiple regression analysis (n = 46 patients) identified that a higher postoperative MPTA was associated with a decreased IKDC subjective score after return to sports ($r = –0.345$; $P = .019$).

Conclusion: Higher postoperative MPTA was associated with the worsening of patient-reported outcomes among those patients who did return to their preoperative sports after OWHTO. Also, participation in high-activity sports was confirmed to be a significant risk factor for a decreased rate of return to preoperative sports. These findings can support preoperative planning and intraoperative decision making, particularly for active patients.

Keywords: opening-wedge high tibial osteotomy; risk factors; return to sport; Tegner activity score; medial proximal tibial angle

Opening-wedge high tibial osteotomy (OWHTO) has been favored for active patients with medial compartment osteoarthritis who have the expectation of returning to sports.[26] Compared with unicompartmental knee arthroplasty, OWHTO results in a significantly higher rate of patients who are able to resume impact sports after surgery.[11] However, systematic reviews have indicated that 2 or 3 of 10 patients are unable to return to the same level of sports after OWTHO, and some patients remain somewhat unsatisfied after their return to sports.[6,15,16]

Insight into the reasons why patients do not return to their previous level of activity is needed to raise the return-to-sports rate and to improve the subjective clinical outcomes after OWHTO. Patient age, body mass index (BMI), sex, preoperative sporting activity level, and concomitant procedures have been posited as possible factors influencing return to sports.[3,16,18,19] However, these results were based largely on an expert opinion level of evidence or 2-

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group comparison study without confounder adjustment. A systematic review conducted by Hoorntje et al[10] concluded that the existing evidence on factors influencing return to sports after OWHTO is scarce and inconclusive and called for more studies that control for confounders. However, a subsequent report by the same group is the only study of which we know that has used logistic regression analyses, and more studies with rigorous adjustment for confounders are needed.[9]

In terms of patient-reported outcomes after OWHTO, several preoperative factors, intraoperative procedures, and postoperative radiological parameters have been posited as candidate influencing factors.[1,7,27,29] The effects of these various factors suspected of influencing patient-reported outcomes have been evaluated using multiple regression analysis in heterogeneous cohorts that included sedentary recipients of OWHTO but not specifically active patient cohorts after they returned to sports. To obtain more satisfying results in active patients, more studies are needed for the clarification of risk factors that can support intraoperative decision making.

Joining this effort, the principal purposes of the current study were to further identify risk factors affecting return to same level of sports and to evaluate the characteristics and intraoperative factors influencing patient-reported outcomes in patients who did return to sports after OWHTO, with previously posited candidate factors as dependent variables. Our hypothesis was that patient characteristics and intraoperative factors would be detected as risk factors affecting return to sports after OWHTO and/or as factors influencing patient-reported outcomes.

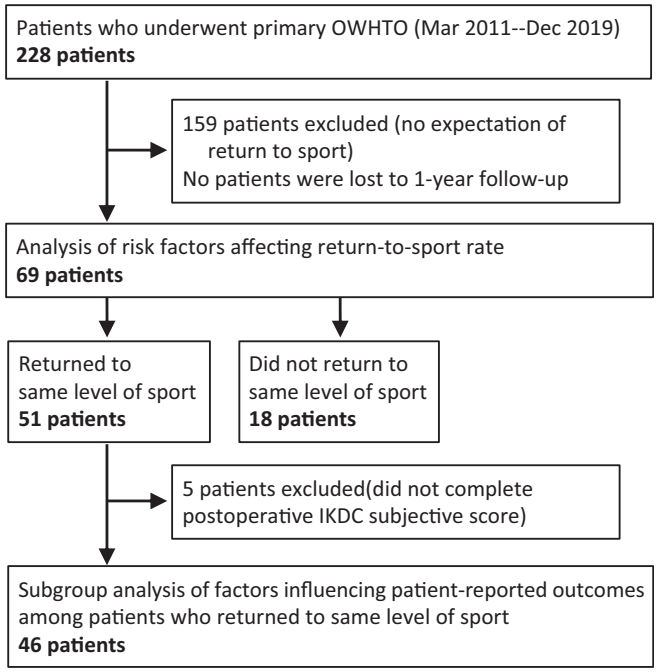

Figure 1. Flowchart of patient inclusion and exclusion. IKDC, International Knee Documentation Committee; OWHTO, opening-wedge high tibial osteotomy.

METHODS

Patients

This study was approved by the ethical review board of our institution, and all included patients provided their written informed consent for participation. Initially included were 228 patients who had undergone primary OWHTO performed between March 2011 and December 2019 at our institution. The exclusion criteria for the analysis of risk factors affecting return to sports were (1) patients with a Tegner activity level <2; (2) patients who, during preoperative counseling, did not express an expectation of returning to the same level of sports; and (3) loss to follow-up within the first postoperative year. Activities meeting the inclusion criteria included endurance exercises for older adults recommended by the National Institutes of Health (eg, brisk walking and dancing) as well as higher activity level sports (ie, Tegner activity level, ≥ 2).

Of the initial 228 patients, 69 patients were ultimately included. A subgroup analysis was performed on 51 patients who returned to the same level of sports, to determine factors influencing patient-reported outcomes in that cohort. Five patients in this subgroup did not complete postoperative International Knee Documentation Committee (IKDC) subjective scores, resulting in 46 patients being included for this analysis (Figure 1).

Surgical Procedure and Postoperative Management

A standard arthroscopic evaluation was performed before OWHTO. Any unstable meniscal tears were concomitantly repaired where possible. Meniscal extrusion was treated using centralization techniques in which the capsule

‖Address correspondence to Hideyuki Koga, MD, PhD, Department of Joint Surgery and Sports Medicine, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, 1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8519, Japan (email: koga.orj@tmd.ac.jp).
*Department of Joint Surgery and Sports Medicine, Graduate School of Medical and Dental Sciences, Tokyo Medical and Dental University, Tokyo, Japan.
†Department of Orthopaedic Surgery, Dokkyo Medical University Saitama Medical Center, Koshigaya, Saitama, Japan.
‡Department of Orthopaedic Surgery, Tokyo Medical and Dental University Hospital of Medicine, Tokyo, Japan.
§Center for Stem Cell and Regenerative Medicine, Tokyo Medical and Dental University, Tokyo, Japan.
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adjacent to the midbody of the medial meniscus was sutured to the peripheral rim of the tibial plateau using suture anchors.[13] All treatments for the meniscus were documented.

The OWHTO procedure followed the method proposed by Stäubli et al.[28] In brief, the preoperative plan involved shifting the mechanical axis to a point 57% lateral on the transverse diameter of the tibial plateau and measuring the opening width. The osteotomy site was opened to a width determined in the preoperative plan, while limb alignment was monitored under fluoroscopy to control the position of the alignment rod at the knee. Wedge-shaped beta tricalcium phosphates (Osferion 60; Olympus Terumo Biomaterials) were inserted into the open osteotomy site. A TriS medial HTO plate system (Olympus Terumo Biomaterials) or TomoFix plate (DePuy Synthes) was affixed to the osteotomy site using locking screws.

Postoperative rehabilitation began by practicing the range of motion combined with quadriceps setting exercises a day after surgery. One-third, two-thirds, and full weightbearing using crutches were initiated 3, 10, and 14 days after surgery, respectively. Patients were allowed to start running exercises at 3 months after confirming bone union and progressed to full activity after 6 months postoperatively.

Clinical Evaluation

Preoperatively, descriptive data including age, sex, BMI, and Tegner score were recorded. Radiographic evaluation included preoperative Kellgren-Lawrence (K-L) osteoarthritis grade, preoperative and postoperative percentage of mechanical axis (%MA), postoperative medial proximal tibial angle (MPTA), and postoperative posterior tibial slope, which were reviewed by a single orthopaedic surgeon (H.K.) with >15 years of experience in orthopaedic surgery and who did not perform any surgery in this series. The K-L grade and posterior tibial slope were measured on standing anteroposterior view and true lateral view, respectively. The %MA and MPTA were measured on long-leg weightbearing anteroposterior view.

Postoperatively, sports played (whether or not patients returned to previous sports), types of activities, and Tegner scores were recorded. Patients completed the IKDC subjective score at annual outpatient visits after surgery, and the latest data (at least 1 year after surgery) were collected from records in our institution's medical records database. Patient subjective knee satisfaction score (range, 0-100 points; 100 points was considered excellent) was also recorded preoperatively and at the final follow-up.

Statistical Analysis

Statistical analyses were performed using SPSS Version 25.0 (IBM Corp). Data were reported as means with standard deviations and ranges. Baseline differences between patients who did and did not return to sports were performed using the *t* test and the chi-square test. Logistic regression analyses were conducted using a forward-stepwise approach to assess the effect of independent variables on return to sports. Independent variables were age at the time of surgery, sex, BMI, preoperative Tegner score, preoperative K-L grade, preoperative %MA, opening gap width, concomitant meniscal treatments, postoperative %MA, postoperative MPTA, and postoperative posterior tibial slope. $P < .05$ was considered statistically significant.

For the analyses to identify factors influencing patient-reported outcomes, we conducted univariate regression analyses between all selected potential predictor variables and postoperative IKDC subjective knee scores. Potential predictor variables were age at the time of surgery, sex, BMI, preoperative Tegner score, preoperative K-L grade, preoperative %MA, opening gap width, concomitant meniscal treatment, postoperative %MA, postoperative MPTA, postoperative posterior tibial slope, and change of %MA. The alpha level was set at .2 to ensure that potential risk factors were not excluded at this stage.

Independent variables having a P value <.2 were included in a further multiple regression analysis. Multiple regression analyses using a forward stepwise approach were performed to assess the effect of independent variables on postoperative IKDC subjective scores. $P < .05$ was considered statistically significant.

A post hoc power analysis revealed that, with an alpha value of .05, the current study achieved a power of 70.8% for the difference in preoperative Tegner scores between patients who did versus did not return to the same level of sports.

TABLE 1
Characteristics of Patients Included in the Analysis of Risk Factors Affecting Return to Sports After OWHTO (N = 69)[a]

Variable	Value
Age at the time of surgery, y	59.2 ± 9.5 (36 to 75)
Sex, female/male, n	35/34
Body mass index	24.2 ± 3.4 (17.8 to 34.0)
Preoperative Tegner score	5.0 ± 1.6
Tegner score 0/1/2/3/4/5/6/7/8/9/10, n	0/0/5/7/11/24/4/14/4/0/0
Preoperative K-L grade 1/2/3/4, n	3/24/31/12
Preoperative %MA	18.8 ± 14.2 (–31 to 46)
Opening gap width, mm	10.6 ± 2.6 (5.5 to 16.5)
Concomitant meniscal treatment, yes/no, n	33/36
Postoperative %MA	57.5 ± 9.0 (42.0 to 88.0)
Postoperative MPTA, deg	92.0 ± 2.6 (87.0 to 98.0)
Postoperative posterior tibial slope, deg	9.2 ± 3.4 (2.0 to 18.0)
Postoperative follow-up period, mo	28.5 ± 17.3 (12 to 60)
Change in weightbearing line ratio, %	38.7 ± 15.4 (5.0 to 84.0)

[a]Data are expressed as mean ± SD (range) unless otherwise indicated. K-L, Kellgren-Lawrence; %MA, percentage of mechanical axis; MPTA, medial proximal tibial angle; OWHTO, opening-wedge high tibial osteotomy.

RESULTS

Of the 69 study patients, 51 (73.9%) returned to the same preoperative sports level after OWHTO. Patient characteristics are shown in Table 1. No significant differences in

TABLE 2
Comparison of Patients Who Did and Did Not Return to Same Level of Sports After OWHTO (N = 69)[a]

	Returned to Same Level of Sports (n = 51)	Did Not Return to Same Level of Sports (n = 18)	*P*
Age, y	59.5 ± 9.4 (43 to 75)	58.3 ± 10.1 (36 to 75)	.64
Sex, female/male, n	28/23	7/11	.28
Body mass index	23.8 ± 3.3 (17.8 to 32.0)	25.2 ± 3.8 (19.9 to 34.0)	.13
Preoperative Tegner score	4.8 ± 1.6	5.8 ± 1.3	**.03**
Tegner score 0/1/2/3/4/5/6/7/8/9/10, n	0/0/5/6/10/16/3/9/2/0/0	0/0/0/1/1/8/1/5/2/0/0	
Preoperative K-L grade 1/2/3/4, n	2/18/25/6	1/6/6/5	.50
Preoperative %MA	18.5 ± 13.0 (–17 to 42)	19.7 ± 17.8 (–31 to 46)	.75
Opening gap width, mm	10.7 ± 2.6 (5.5 to 16.5)	10.5 ± 2.7 (7.5 to 16.0)	.78
Concomitant meniscal treatment, yes/no, n	26/25	7/11	.42
Postoperative %MA	57.4 ± 9.2 (43.0 to 88.0)	57.8 ± 8.9 (42.0 to 72.0)	.85
Postoperative MPTA, deg	92.0 ± 2.4 (87.0 to 98.0)	91.9 ± 3.2 (87.0 to 96.5)	.96
Postoperative posterior tibial slope, deg	8.9 ± 3.5 (2.0 to 16.0)	10.0 ± 3.3 (6.0 to 18.0)	.24
Postoperative follow-up period, mo	29.4 ± 17.5 (12 to 60)	26.0 ± 17.1 (12 to 60)	.48
Change in %MA	38.2 ± 13.0 (16.0 to 68.0)	38.8 ± 20.0 (5.0 to 84.0)	.88

[a]Data are expressed as mean ± SD (range) unless otherwise indicated. Boldface *P* value indicates a statistically significant difference between groups ($P < .05$). K-L, Kellgren-Lawrence; %MA, percentage of mechanical axis; MPTA, medial proximal tibial angle; OWHTO, opening-wedge high tibial osteotomy.

TABLE 3
Logistic Regression Model of Risk Factor Effects on Not Returning to Same Level of Sports After OWHTO[a]

	Regression Coefficient	SD	OR (95% CI)	*P*
Tegner score	0.401	0.188	1.494 (1.033-2.159)	**.033**

[a]Boldface *P* value indicates statistical significance ($P < .05$). OR, odds ratio; OWHTO, opening-wedge high tibial osteotomy.

patient characteristics were found except for preoperative Tegner scores between patients who did return to the same sports level and patients who did not (Table 2).

Logistic regression analyses indicated that high preoperative Tegner scores were statistically associated with a decrease in return to sports (odds ratio, 1.494; $P = .033$) (Table 3). The percentage of patients who did not return to sports after surgery exceeded 20% in patients with a preoperative Tegner score ≥5 (Figure 2).

Patient characteristics for the subgroup analysis (n = 46) to identify factors influencing patient-reported outcomes are shown in Table 4. Univariate regression analyses indicated that $P = .2$ was reached for sex, age at the time of surgery, postoperative %MA, postoperative MPTA, and postoperative posterior tibial slope (Table 5). Those factors were included in the multiple regression analysis.

Results of the multiple regression analysis indicated that a higher postoperative MPTA was significantly associated with a decreased IKDC subjective score after return to sports (standardized partial regression coefficient, –0.345; $P = .019$) (Table 6, Figure 3).

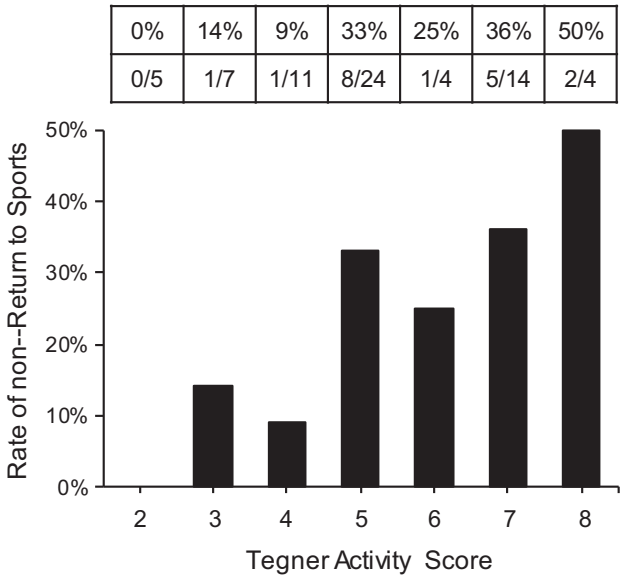

Figure 2. Bar graph showing the percentage of patients who did not return to their preoperative level of sports after surgery, based on Tegner score. Values in the box show the number and percentage of patients who did not return of the total patients for that preoperative Tegner level.

DISCUSSION

The most important finding of the present study was that a high postoperative MPTA constitutes a prognostic risk factor for unsatisfactory patient-reported outcomes after return to sports after OWHTO. This study also confirmed what was intuitively known: a high preoperative Tegner scores constitutes the most significant prognostic risk factor for not returning to one's preoperative level of sports after OWHTO. In this investigation, 3 in 4 patients were able to return to their preoperative level of sports after OWHTO.

A previous systematic review covering 616 cases reported a 75.7% pooled rate of return to sports after

TABLE 4
Patient Characteristics for the Subgroup Analysis of Factors Influencing Patient-Reported Outcomes (n = 46)[a]

Variable	Value
Age at the time of surgery, y	59.7 ± 9.4 (43 to 75)
Sex, female/male, n	26/20
Body mass index	23.4 ± 2.9 (17.8 to 31.0)
Preoperative Tegner score	4.8 ± 1.7
Tegner score 0/1/2/3/4/5/6/7/8/9/10, n	0/0/5/6/8/14/3/8/2/0/0
Preoperative K-L grade 1/2/3/4, n	0/17/24/5
Preoperative %MA	19.0 ± 12.2 (–17.8 to 42.0)
Preoperative patient knee satisfaction score	20.3 ± 17.8 (0 to 60)
Preoperative NRS for pain during walking	4.8 ± 2.0 (1 to 8)
Opening gap width, mm	10.6 ± 2.4 (5.5 to 15.5)
Concomitant meniscal treatment, yes/no, n	25/21
Postoperative %MA	57.1 ± 9.2 (43.0 to 88.0)
Postoperative MPTA, deg	92.1 ± 2.4 (87.0 to 98.0)
Postoperative posterior tibial slope, deg	9.0 ± 3.5 (2.0 to 16.0)
Postoperative follow-up period, mo	30.4 ± 15.7 (12 to 60)
Postoperative NRS for pain during walking	1.2 ± 1.6 (0 to 5)
Postoperative patient knee satisfaction score	79.9 ± 16.4 (40 to 100)
Postoperative IKDC score	74.1 ± 13.5 (40.2 to 94.3)
Change in %MA	38.2 ± 12.7 (16.0 to 68.0)

[a]Data are expressed as mean ± SD (range) unless otherwise indicated. IKDC, International Knee Documentation Committee; K-L, Kellgren-Lawrence; %MA, percentage of mechanical axis; MPTA, medial proximal tibial angle; NRS, Numeric Rating Scale.

TABLE 5
Results of Univariate Regression Analysis of IKDC Subjective Score[a]

	Pearson *r*	*P*
Male sex	0.238	.110
Age at the time of surgery	0.278	.062
Body mass index	0.006	.968
Preoperative Tegner score	0.159	.290
Preoperative K-L grade	–0.153	.310
Preoperative %MA	–0.158	.294
Preoperative patient knee satisfaction score	0.037	.810
Preoperative NRS for pain during walking	0.111	.469
Opening gap width	0.056	.714
Concomitant meniscal treatment	0.005	.974
Postoperative %MA	–0.331	**.025**
Postoperative MPTA	–0.345	**.019**
Postoperative posterior tibial slope	0.208	.165
Change in %MA	–0.088	.560

[a]Boldface *P* values indicate a statistically significant difference between groups ($P < .05$). IKDC, International Documentation Committee; K-L, Kellgren-Lawrence; %MA, percentage of mechanical axis; MPTA, medial proximal tibial angle; NRS, Numeric Rating Scale.

OWHTO.[15] For the individual studies, the minimum return-to-sports rate was 55.5%, whereas the maximum was 100% for those participating in sports preoperatively.[2,3,5,12] The current results fell within that range. Variations in preoperative K-L grade, age, level of sports, and motivation between studied cohorts included in the systematic review as well as the cohort in the current study may contribute to variations in the return-to-sports rate. Also, the inclusion of heterogeneous patient populations further exacerbates the methodological challenges already inherent in the comparison between studies.

A previous study reported a 86% return-to-sports rate for medium-intensity sports and 40% for high-intensity sports.[16] Similarly, another study reported that although 40% of patients indicated a desire to participate in high-intensity sports, only 28% regularly participated in high-intensity sports after HTO.[3] Another study that compared pre- and postoperative activity levels reported a significant drop in Tegner scores from 4.9 preoperatively to 4.3 after OWHTO.[24] In light of these previous reports and the current findings, a generalization could be made that the rate of return to sports for patients motivated to participate in high-intensity sports was lower than that for patients expecting to return to low-intensity sports. The current analyses contribute reliable evidence in support of this generalization by answering previous calls to more rigorously account for possible confounding factors that might affect rates of return to sports after HTO. The current logistic regression analyses adjusted for the broadest range of possible confounding factors to date as far as we are aware, providing evidence that a high preoperative Tegner score is a risk factor affecting return to same level of sports after OWHTO.

Participating in high-intensity sports is believed to increase the risk of developing osteoarthritis.[4] Patients may be concerned that participating in high-intensity sports could lead to disease progression and conversion to joint arthroplasty. On the other hand, evidence of the effect of high-intensity sports on long-term clinical outcomes after OWHTO is ambiguous. The observed decreased return-to-sports rate in high-intensity sports may be influenced by patients being advised in general to participate in low-intensity sports, while participation in high-intensity sports is weakly recommended.

The current study differed from the previously mentioned logistic regression model study conducted by Hoorntje et al,[9] in which the strongest prognostic factor favoring a successful return to sports was "continued sports participation in the year before surgery" and the level of sports intensity was not fully examined as a candidate factor. In that study, a directed acyclic graph was used for describing causal assumptions and determining a causal path, so while the level of sports intensity was found to be associated with return to sports in their univariate analysis ($P = .04$), it was eliminated from their covariate subanalyses because of a hypothesized relationship between the level of sports intensity and sports participation during 1 year preoperatively. In clinical practice, both sports participation during the 1 year preoperatively and sports activity

TABLE 6
Results of Multiple Regression Analysis of IKDC Subjective Scores[a]

	Regression Coefficient	SD	Standardized Partial Regression Coefficient (95% CI)	*P*
Postoperative MPTA	–1.968	0.807	–0.345 (–3.594 to –0.342)	**.019**

[a]Boldface *P* value indicates statistical significance ($P < .05$). IKDC, International Knee Documentation Committee; MPTA, medial proximal tibial angle.

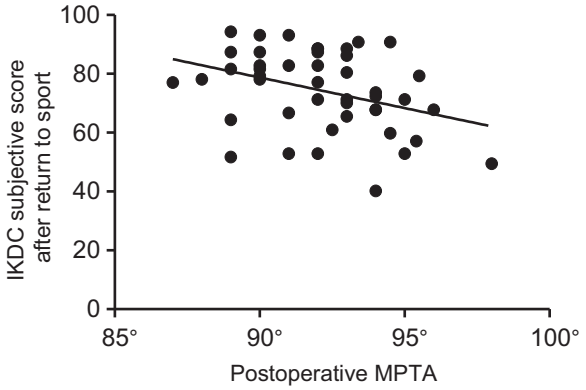

Figure 3. Scatterplot of International Knee Documentation Committee (IKDC) subjective scores after return to sports and postoperative medial proximal tibial angle (MPTA).

levels are easily discoverable via a single questionnaire (Tegner) plus 1 interview question that could improve the preoperative decision making that is so essential in obtaining satisfying results in patients who have expectations of returning to sports.

The current findings generally concur with previous reports that excessively increased MPTA had worsening effects on clinical outcomes after OWHTO.[1,14,21,25] Akamatsu et al[1] divided primary OWHTO recipients into 2 groups using an MPTA of 95° as the dividing line. Patients with a postoperative MPTA >95° had lower Knee injury and Osteoarthritis Outcome Score Sport and Recreation subscale scores than did patients with a postoperative MPTA of ≤95° at 2 years postoperatively. The influence of postoperative alignment on clinical outcomes was evaluated using multiple regression analyses in 79 consecutive patients treated with primary OWHTO.[21] Postoperative MPTA showed a significant negative correlation with postoperative clinical outcomes ($r = -0.21$; $P = .01$). The authors explained that the observed effects of high postoperative MPTA on sports-related patient-reported outcomes arose from the shearing force caused by the lateral inclination of the tibial plateau after OWHTO. However, other studies have shown conflicting results in which high MPTA after OWHTO did not correlate with clinical outcomes.[8,23] More studies are needed to provide robust evidence relative to the effect of high postoperative MPTA on patient-reported outcomes after return to sports after OWHTO.

Mechanisms underlying the current results might be explained by a biomechanical study from Nakayama et al[20] using a finite element model in which excessive shear stress in the tibial articular cartilage was identified as a causal mechanism induced by overcorrection when resultant joint-line obliquity exceeded 5°. In another study using an in vivo sheep OWHTO model, Madry et al[17] found that overcorrection significantly decreased the proliferative activity of the cells in the lateral menisci, although no detectable morphological degeneration was found in 6 months. A study examining the influence of MPTA and postoperative ΔMPTA on degeneration of the anterior cruciate ligament (ACL) after OWHTO implicated another mechanism possibly affecting the current results.[22] Increased ACL degeneration was significantly correlated with increased ΔMPTA ($r = 0.343$; $P < .01$), while association with short-term clinical outcomes was not detected. The authors suggested that to prevent ACL degeneration after OWHTO in the long term, excessively high MPTA should be avoided, particularly in patients with ACL injury.

Another aspect to keep in mind was highlighted by a study designed to identify parameters associated with deterioration of patellofemoral cartilage after OWHTO. The study found that MPTA after OWHTO was significantly greater among the group with progressed deterioration of the patellofemoral cartilage than among the nonprogressed group.[30] Thus, because of the complexities of this pathology, there is insufficient evidence to reach a consensus regarding any single mechanism that would worsen patient-reported outcomes after return to sports.

Limitations

In considering limitations of the present study, first, while significant risk factors were detected, the results are based on a small number of patients at a single institution. Were the study to be replicated at other facilities, indications for surgery and patients' characteristics could emerge as confounders in the judgments regarding return to sports and patient-reported outcomes. Second, analyses of factors pertaining to postoperative rehabilitation and the period before return to sports were outside the scope of this study. Finally, even if the current preliminary findings are valid, the identification of high postoperative MPTA as a risk factor for unsatisfactory patient-reported outcomes after return to sports raises questions regarding causal mechanisms that must yet be clarified in order to find ways to mitigate them in the clinical setting.

The clinical relevance of this study was that the current logistic regression analyses contribute data on the risk factors affecting return to sports after OWHTO that could

improve preoperative decision making particularly for active patients who wish to know whether they can return to sports-related activities. Additionally, the current multiple regression analyses contribute data on the risk factors affecting unsatisfactory patient-reported outcomes after return to sports after OWHTO that could improve the preoperative planning and intraoperative decision making particularly for active patients. Based on these results, to improve patient-reported outcomes in active patients who have expectations for returning to sports, surgeons should aim for adequate postoperative alignment but consider avoiding overcorrection to abnormally high postoperative MPTA or choose alternative operative strategies, such as double-level osteotomy, when preoperative planning indicates an abnormally high postoperative MPTA increase.

CONCLUSION

High postoperative MPTA was associated with the worsening of patient-reported outcomes among those patients who did return to their preoperative sports after OWHTO. Also, as already intuitively known, high-activity sports were further confirmed to be a significant risk factor contributing to a decrease in the rate of return to preoperative sports level after OWHTO. These findings can support preoperative planning and intraoperative decision making particularly for active patients.

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