Comparison of 3 Knee-Specific Quality-of-Life Instruments for Patients With Meniscal Tears

Mirco Sgroi,*† MD, Semra Kocak,† Heiko Reichel,† MD, and Thomas Kappe,† MD

Investigation performed at Department for Orthopedic Surgery, RKU, University of Ulm, Ulm, Germany

Background: Meniscal tears are a common cause of knee pain and disability. The objective measurement of the health-related quality of life of patients with meniscal tears plays a key role in clinical evaluation and therapeutic decision making. Several evaluation tools have been used to measure the effects of meniscal tears on knee function and quality of life. However, most of these tools are nonspecific for meniscal pathology.

Purpose/Hypothesis: The purpose of the present study was to compare the capability of 3 commonly used knee assessment tools to measure the impact of meniscal tears on knee function and quality of life: the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), the Knee injury and Osteoarthritis Outcome Score (KOOS), and the Western Ontario Meniscal Evaluation Tool (WOMET). Our null hypothesis was that no difference would exist among the 3 assessment tools.

Study Design: Cohort study (diagnosis); Level of evidence, 2.

Methods: A total of 207 consecutive patients (mean ± SD: age, 52.6 ± 14.3 years) with arthroscopically confirmed meniscal tear were included. Preoperatively, 3 knee function and quality-of-life scores were obtained: KOOS, WOMAC, and WOMET. The relative outcome scores of the questionnaires were compared postoperatively.

Results: The sum scores (relative scores) were as follows: 234.2 ± 92.5 (55.7%) for the KOOS, 132.6 ± 54.3 (55.5%) for the WOMAC, and 113 ± 30.8 (71%) for the WOMET. The relative score results for the WOMET were significantly higher than those for the WOMAC and the KOOS (both $P < .01$), while no significant difference was found between the WOMAC and the KOOS ($P = .735$).

Conclusion: A greater impact on health-related quality of life for patients with meniscal tears can be measured with the WOMET when compared with the WOMAC and the KOOS. Therefore, using the WOMET can be recommended for the evaluation of knee function and quality-of-life impairment of patients with meniscal tears.

Keywords: WOMET; WOMAC; KOOS; meniscal tear

The preintervention objective measurement of health-related quality of life (HRQoL) attributed to a pathologic condition is of great importance for the evaluation and comparison of treatment modalities.[5] Several studies have shown self-reported questionnaires to be a useful tool to measure HRQoL from the patients' perspective.[5,6] Numerous self-reported questionnaires for knee pathologies have been developed, such as the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) and the Knee injury and Osteoarthritis Outcome Score (KOOS).[1,2,14] While the WOMAC was primarily developed to analyze the HRQoL of patients with osteoarthritis, the KOOS was designed for patients with knee injuries.[2,10] Neither of these is specifically designed to analyze the HRQoL of patients with meniscal tears, although both have been used for this purpose.[4,13,19]

The WOMAC, developed in 1988, is a standardized self-reported questionnaire that examines the HRQoL of patients with osteoarthritis of the knee and hip.[2] The WOMAC contains 5 items for pain, 2 for stiffness, and 17 for functional limitations.[2] Lower scores indicate better outcome. Internal consistency of the WOMAC has ranged between 0.75 and 0.82, and test-retest reliability has been calculated as 0.92.[2]

*Address correspondence to Mirco Sgroi, MD, Kurze Lemppen 5, DE-89075 Ulm, Germany (email: sgroi.mirco@yahoo.de).

†Department for Orthopaedic Surgery, University of Ulm, Ulm, Germany.

The authors declared that they have no conflicts of interest in the authorship and publication of this contribution.

Ethical approval for this study was obtained from Ulm University.

The Orthopaedic Journal of Sports Medicine, 6(1), 2325967117750082
DOI: 10.1177/2325967117750082

The KOOS, first described in 1998, was primarily designed to evaluate reduction of HRQoL in the setting of knee ligament injury. The KOOS consists of 5 subscales: pain (9 items), symptoms (7 items), functions of daily living (15 items), function in sport and recreation (5 items), and knee-related quality of life (4 items).[10] Higher scores indicate better outcome. Internal consistency and test-retest reliability of the KOOS have been calculated to range from 0.71 to 0.95 and 0.75 to 0.93, respectively.[10,11]

The Western Ontario Meniscal Evaluation Tool (WOMET) was developed in 2007 by Kirkley et al,[9] and it represents the first self-reported questionnaire to specifically assess the HRQoL of patients with meniscal pathologies. The WOMET consists of 16 questions divided into 3 subgroups: physical symptoms (9 items), sports/recreation/work/lifestyle (4 items), and emotions (3 items).[9,14] Lower scores indicate better outcome. Internal consistency and test-retest reliability of the WOMET had been estimated to be 0.92 for both.[9,12] It has rarely been utilized in studies investigating meniscal tears, however.[9,14] While the psychometric properties of the WOMET have been established, its ability to measure the HRQoL of patients with meniscal tear, in comparison with other knee questionnaires, has not been studied intensively.

Therefore, the purpose of the present study was to analyze the capability of the WOMET to measure the impact of meniscal tears on knee function and HRQoL in comparison with the WOMAC and KOOS. Our null hypothesis was that there would be no difference between the WOMET, WOMAC, and KOOS in the ability to measure the HRQoL of patients with meniscal tears.

METHODS

Patient Recruitment

All patients referred to our outpatient sports medicine clinic for meniscal pathology during a 26-month time frame were checked for eligibility to be included in the study. The primary inclusion criterion was the arthroscopically confirmed diagnosis of a meniscal tear treated by partial meniscectomy or meniscal repair. Patients with the following characteristics were excluded from the study: patients (1) without an arthroscopically confirmed meniscal tear, (2) who were <18 years old, (3) who did not provide informed consent, (4) who were not able to understand the self-administrated questionnaire because of a lack of language skills, or (5) who had concomitant radiographically or arthroscopically confirmed ligament injuries or advanced osteoarthritis (Kellgren and Lawrence grades III-IV).

All patients were examined by 2 experienced orthopaedic surgeons. Selected patients were invited to participate in the study. Informed consent was obtained from all participants. Patients were then asked to complete 3 knee function and HRQoL measures prior to surgical treatment: KOOS, WOMAC, and WOMET. To assess the severity of osteoarthritis or ligamentous injuries, plain radiographs as well as knee magnetic resonance imaging (MRI) were obtained preoperatively for all patients. All patients underwent arthroscopy of the knee, in which inclusion and exclusion criteria were examined again and meniscal tears treated by partial meniscectomy or meniscal repair. Definite inclusion into the present study occurred after intraoperative confirmation of the diagnosis. All arthroscopies were performed by 2 experienced orthopaedic surgeons. A sample size of 150 was estimated according to previous studies[1,14] and Guyatt et al.[7]

Statistical Analysis

All data were secured in a computerized database. Statistical analysis was performed with SPSS (v 21; IBM). In this study, to provide a higher degree of measurement precision and better ability to detect changes, a 10-point Likert scale was used for all examined questionnaires. To be able to compare the 3 questionnaires directly, a scale transformation of the KOOS was made; thus, higher scores in the KOOS meant, in this study, worse outcome. Descriptive statistics were used. To compare the ability of all 3 questionnaires to detect meniscal pathologies, ranges and medians were calculated and compared with analysis of variance (ANOVA). Relative scores were calculated according to this formula: *sum score/maximum score* $\times$ 100. ANOVA was used to investigate whether an overall difference among the questionnaires existed, but it was not able to show which questionnaires significantly differed. After a test of homogeneity of variances, the Games-Howell test was used to investigate where the differences occurred among the questionnaires. In addition, means and SD were calculated and compared with previous studies. Furthermore, to evaluate content validity, SEM, minimal detectable change (MDC), and floor or ceiling effects were determined. MDC was calculated with the following formula: $SEM \times 1.4142 \times 1.96$. To measure distribution of the relative scores in the quartiles of the KOOS, the WOMAC, and the WOMET, the percentage of patients with the maximum or minimum score was assessed, as well as the percentage of patients reaching the maximum score minus the MDC or the minimum score plus the MDC, respectively. Correlations among the analyzed tools, demographic factors, and item ratings were assessed with Pearson correlation coefficient for interval scales. Differences were considered significant for P values <.05. This study was approved by our institutional review board (registration 43/14).

RESULTS

Patient Demographics

A total of 207 patients were included in the present study. All patients underwent arthroscopy, and in all cases, a meniscal tear was confirmed and treated by a partial meniscectomy or meniscal repair. Participant demographics are presented in Table 1.

Evaluation of the Instruments

The sum scores (mean ± SD) and relative scores were 234.2 ± 92.5 and 55.7% for the KOOS, 132.6 ± 54.3 and 55.5% for

TABLE 1
Patient Demographic Characteristics for the Overall Cohort

Characteristic	No. or Mean ± SD
Total population	207
Sex	
Male	105
Female	102
Age, y	52.6 ± 14.3
Side involved	
Right	94
Left	113
Surgical treatment	
Meniscal repair	27
Meniscectomy	180
Involved meniscus	
Medial	179
Lateral	27
Medial + lateral	1

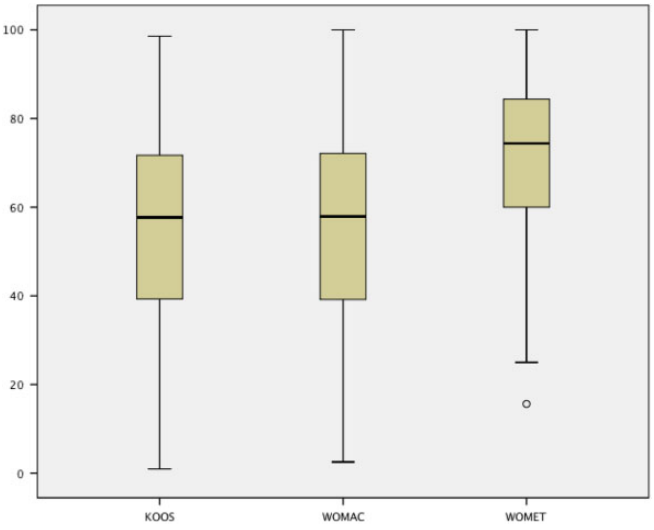

Figure 1. Box plot of the sum scores of the KOOS, WOMAC, and WOMET. Values are presented as mean ± SD. KOOS, Knee injury and Osteoarthritis Outcome Score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; WOMET, Western Ontario Meniscal Evaluation Tool.

the WOMAC, and 113 ± 30.8 and 71% for the WOMET (Figure 1).

Significant sex-based differences were found for the WOMAC and KOOS but not for the WOMET, but no significant difference was found in all analyzed questionnaires between patients with tears of the medial and lateral meniscus (Tables 2 and 3).

ANOVA revealed significant differences among the relative sum score results ($F = 27$, $P < .05$). The test for homogeneity of variances indicated that the data were not homogeneous ($P = .019$). The Games-Howell test showed a significant difference between the WOMET and both the KOOS ($P < .01$) and WOMAC ($P < .01$). In contrast, the

TABLE 2
Comparison of Sum Scores Between Sexes[a]

	Sum Score, Mean ± SD		
Measure	Male	Female	*P* Value
WOMET	109.3 ± 31.9	117.5 ± 29.2	.055
KOOS	212.7 ± 95.9	256.3 ± 83.7	.01[b]
WOMAC	118.8 ± 53	148.4 ± 47.7	.0001[b]

[a]KOOS, Knee injury and Osteoarthritis Outcome Score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; WOMET, Western Ontario Meniscal Evaluation Tool.
[b]$P < .05$.

TABLE 3
Comparison Between Sum Scores of Patients With Medial or Lateral Meniscus Lesions[a]

	Sum Score, Mean ± SD	
Measure	Medial	Lateral
WOMET	114.2 ± 29.7	106.1 ± 37.0
KOOS	236.0 ± 89.4	217.3 ± 109.9
WOMAC	134.3 ± 51.2	124.7 ± 59.8

[a]None of the comparisons reached statistical significance. KOOS, Knee injury and Osteoarthritis Outcome Score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; WOMET, Western Ontario Meniscal Evaluation Tool.

difference between the KOOS and WOMAC was not significant ($P = .735$). In the present study, the MDC was calculated for all questionnaires (Table 4). Statistical analysis of each questionnaire showed that more patients reached the maximum score minus the MDC with the WOMET (Table 4 and Figure 2).

Correlations between the WOMET and KOOS ($r = 0.666$, $P < .01$) and the WOMET and WOMAC ($r = 0.535$, $P < .01$) were moderate (Figure 3). Correlation between the KOOS and WOMAC was excellent ($r = 0.851$, $P < .01$).

A strong correlation was observed between the WOMET subscores "physical symptoms" and "sports/recreation/work/lifestyle" and all the subscores of the other 2 measures. The correlation between the WOMET subscore "emotions" and the subscores of the other 2 questionnaires was moderate ($r < 0.6$).

DISCUSSION

In the present study, the relative score of the WOMET was 15.3% and 15.5% higher than the KOOS and the WOMAC, respectively. The differences between the WOMET and the other 2 questionnaires were significant, but no significant difference was found between the WOMAC and the KOOS. In addition, a significantly higher number of patients achieved a WOMET result in the upper quartile than in the WOMAC and KOOS. The results of the current study

TABLE 4
Analysis of MDC per Questionnaire[a]

Measure	Score, No.		MDC	Maximum – MDC, No. (%)	Minimum + MDC, No. (%)
	Maximum	Minimum			
WOMET	2	0	5.9	13 (6.2)	0
KOOS	0	0	17.7	2 (0.9)	0
WOMAC	4	1	10.4	4 (1.9)	1 (0.5)

[a]KOOS, Knee injury and Osteoarthritis Outcome Score; MDC, minimal detectable change; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; WOMET, Western Ontario Meniscal Evaluation Tool.

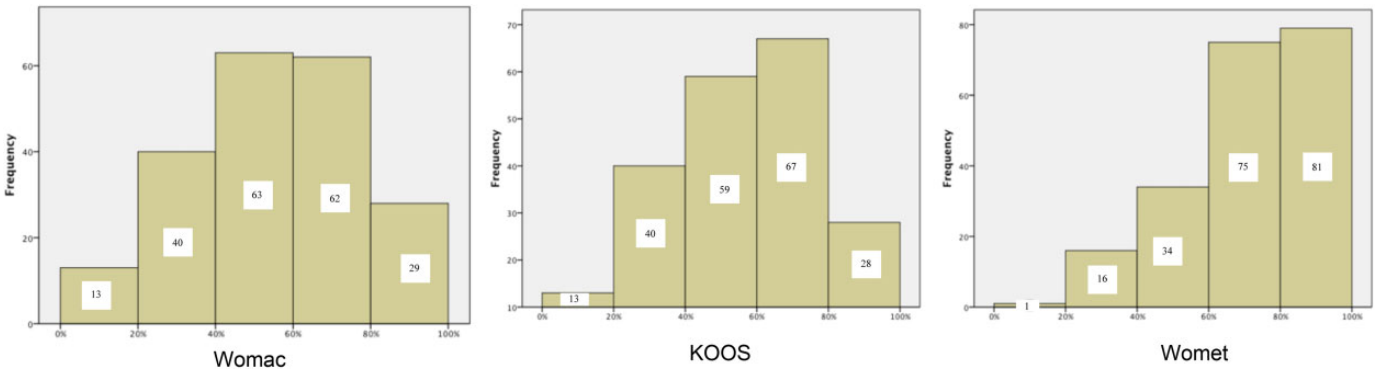

Figure 2. Frequency of the relative scores of the WOMAC, KOOS, and WOMET. KOOS, Knee injury and Osteoarthritis Outcome Score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; WOMET, Western Ontario Meniscal Evaluation Tool.

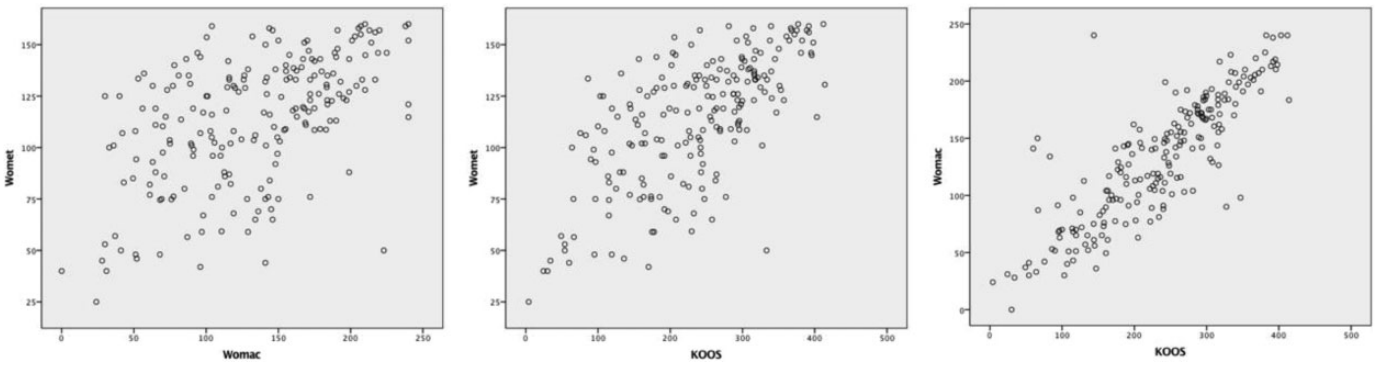

Figure 3. Scatter charts of the correlations among the WOMAC, KOOS, and WOMET. KOOS, Knee injury and Osteoarthritis Outcome Score; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; WOMET, Western Ontario Meniscal Evaluation Tool.

therefore suggest that the WOMET has a better ability to detect meniscal tears than the WOMAC or the KOOS.

The systematic survey of patient-specific symptoms plays a key role in the preoperative diagnosis of knee pathologies.[3,15] Many questionnaires have been published for evaluation of knee pathologies.[1,3,18] Most of these questionnaires were not developed for the evaluation of patients with meniscal tears.[11,14] Nevertheless, several of these nonspecific questionnaires have been extensively used in studies investigating meniscal pathologies.[8,16,17] However, the WOMET, the only questionnaire developed to specifically evaluate meniscal pathologies, has rarely been used for scientific purposes.[12,14] We could not find any study that directly compared the WOMET, KOOS, and WOMAC in the evaluation of meniscal pathologies.

In a study by Kirkley et al,[9] patients with a meniscal lesion confirmed by MRI were selected and divided into 2 cohorts. The first cohort consisted of patients scheduled for arthroscopy and was used during the pretesting phase for validation of the questionnaire. The second cohort involved

patients after arthroscopy with confirmed meniscal tear and was used to determine the reliability and validity of the questionnaire. In that study, the WOMET demonstrated a better capability to detect meniscal pathologies as compared with the Lysholm knee score and the Anterior Cruciate Ligament Quality of Life Questionnaire score. In the present study, as shown in Figure 2, significantly more patients reached the maximum sum score minus the MDC with the WOMET. These results confirm the findings of the study by Kirkley et al[9] and indicate the better ability of the WOMET to measure the impact of meniscal tears on HRQoL as compared with the KOOS and WOMAC.

Tanner et al[14] examined the specificity of the WOMET to detect meniscal tears as compared with 6 other knee questionnaires, including the KOOS. In that study, 94% of the questions were supported by at least 51% of the patients, and the WOMET was rated as the best questionnaire for meniscal lesions. The KOOS ranked third of the 6 questionnaires examined, at 87%. In the present study, the WOMET reached a relative score of 71%, the highest value of the studied instruments. In other words, in the present study, patients achieved with the WOMET 15.3% and 15.5% superior relative scores as compared with the other 2 questionnaires (KOOS and WOMAC, respectively). Given that relative scores describe the ability of each questionnaire to accurately detect the patient's HRQoL and that all patients in the current analysis had an arthroscopically confirmed meniscal tear, these results suggest that the WOMET has a better ability to measure impairment of HRQoL among patients with meniscal tears. In the current study, larger differences were found between the WOMET and KOOS than in the aforementioned study.[14] Even if we take into account the different study designs, both studies show better specificity of the WOMET as compared with the KOOS for meniscal pathologies, with even greater differences observed in the present study.

In the current study, statistical analysis showed a strong correlation between the KOOS and the WOMAC and a weak correlation between the WOMET and the other 2 examined questionnaires. Note that the KOOS was based on the original WOMAC questions; as such, the strong correlation between the KOOS and the WOMAC was expected and not surprising. However, the weak correlation between the WOMET and the other 2 examined questionnaires, in light of the significantly better specificity of the WOMET, provides further evidence of the superior ability of the WOMET to accurately reflect patient impairment in the setting of meniscal injuries.

Another interesting finding is the difference between the WOMET and the other diagnostic tools in terms of sex-related differences. Significant differences between the sum scores of men and women were found for the WOMAC and KOOS but not for the WOMET. This finding to our knowledge has never been described before.

The present study has several limitations. First, a small cohort was analyzed—this is because at our institution meniscal tears are predominantly treated nonoperatively. Patients with meniscal tear were initially treated by physical therapy and analgesia for several weeks. Surgical intervention was taken into consideration only in case of failed conservative therapy. Second, the present study did not investigate the psychometric properties of the WOMET. As mentioned, the psychometric properties of the WOMET have been reported by various studies.[9,14] Third, in accordance with previous studies, the sensitivity to change was not evaluated.[14] We were interested in the capability of the WOMET to preoperatively evaluate the knee function and HRQoL of patients with meniscal tears. Determining sensitivity to change would not have given any additional information in this respect. Finally, and most important, a selection bias must be considered. In the present study, only patients with a meniscal lesion were included. Patients with advanced osteoarthritis or concomitant ligamentous injury were excluded, given the study design and intention.

CONCLUSION

In summary, among patients with meniscal tears, the WOMET displayed a greater magnitude of HRQoL and knee function limitation in comparison with the KOOS and WOMAC. The impact of meniscal tears on HRQoL and knee function could be better measured with the WOMET as compared with the other 2 questionnaires. Based on the results of the current study, the WOMET should be the knee score of choice for evaluating patients with meniscal tears.

REFERENCES

1. Beirer M, Fiedler N, Huber S, et al. The Munich Knee Questionnaire: development and validation of a new patient-reported outcome measurement tool for knee disorders. *Arthroscopy*. 2015;31(8):1522-1529.
2. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J Rheumatol*. 1988;15(12):1833-1840.
3. Collins NJ, Misra D, Felson DT, Crossley KM, Roos EM. Measures of knee function. *Arthritis Care Res (Hoboken)*. 2011;63(suppl 11): S208-S228.
4. ElAttrache N, Lattermann C, Hannon M, Cole B. *New England Journal of Medicine* article evaluating the usefulness of meniscectomy is flawed. *Arthroscopy*. 2014;30(5):542-543.
5. Garratt AM, Brealey S, Gillespie WJ; DAMASK Trial Team. Patient-assessed health instruments for the knee: a structured review. *Rheumatology (Oxford)*. 2004;43(11):1414-1423.
6. Graham B, Green A, James M, Katz J, Swiontkowski M. Measuring patient satisfaction in orthopaedic surgery. *J Bone Joint Surg Am*. 2015;97(1):80-84.
7. Guyatt GH, Mills EJ, Elbourne D. In the era of systematic reviews, does the size of an individual trial still matter? *PLoS Med*. 2008; 5(1):E4.
8. Hare KB, Lohmander LS, Christensen R, Roos EM. Arthroscopic partial meniscectomy in middle-aged patients with mild or no knee osteoarthritis: a protocol for a double-blind, randomized sham-controlled multi-centre trial. *BMC Musculoskelet Disord*. 2013;14:71.
9. Kirkley A, Griffin S, Whelan D. The development and validation of a quality of life-measurement tool for patients with meniscal pathology: the Western Ontario Meniscal Evaluation Tool (WOMET). *Clin J Sport Med*. 2007;17(5):349-356.
10. Roos EM, Roos HP, Lohmander LS, Ekdahl C, Beynnon BD. Knee injury and Osteoarthritis Outcome Score (KOOS)—development of a

self-administered outcome measure. *J Orthop Sports Phys Ther*. 1998;28(2):88-96.
11. Roos EM, Toksvig-Larsen S. Knee injury and Osteoarthritis Outcome Score (KOOS)—validation and comparison to the WOMAC in total knee replacement. *Health Qual Life Outcomes*. 2003;1:17.
12. Sihvonen R, Järvelä T, Aho H, Järvinen TLN. Validation of the Western Ontario Meniscal Evaluation Tool (WOMET) for patients with a degenerative meniscal tear: a meniscal pathology-specific quality-of-life index. *J Bone Joint Surg Am*. 2012;94(10):e65.
13. Sihvonen R, Paavola M, Malmivaara A, et al. Arthroscopic partial meniscectomy versus sham surgery for a degenerative meniscal tear. *N Engl J Med*. 2013;369(26):2515-2524.
14. Tanner SM, Dainty KN, Marx RG, Kirkley A. Knee-specific quality-of-life instruments: which ones measure symptoms and disabilities most important to patients? *Am J Sports Med*. 2007;35(9):1450-1458.
15. Terwee CB, Bot SDM, de Boer MR, et al. Quality criteria were proposed for measurement properties of health status questionnaires. *J Clin Epidemiol*. 2007;60(1):34-42.
16. Thorlund JB, Englund M, Christensen R, et al. Patient reported outcomes in patients undergoing arthroscopic partial meniscectomy for traumatic or degenerative meniscal tears: comparative prospective cohort study. *BMJ*. 2017;356:j356.
17. van de Graaf VA, Wolterbeek N, Mutsaerts EL, et al. Arthroscopic partial meniscectomy or conservative treatment for nonobstructive meniscal tears: a systematic review and meta-analysis of randomized controlled trials. *Arthroscopy*. 2016;32(9):1855-1865.
18. Wang D, Jones MH, Khair MM, Miniaci A. Patient-reported outcome measures for the knee. *J Knee Surg*. 2010;23(3):137-151.
19. Yim J-H, Seon J-K, Song E-K, et al. A comparative study of meniscectomy and nonoperative treatment for degenerative horizontal tears of the medial meniscus. *Am J Sports Med*. 2013;41(7):1565-1570.