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Original Research

The Joint Awareness Score: A Shortened, Simplified, Improved Alternative to the Forgotten Joint Score

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ABSTRACT

Background: The Forgotten Joint Score (FJS) is a 12-question patient-reported outcomes measure created to measure a patient's awareness of their artificial joint. The FJS has attained wide usage, though it is not without weaknesses. Our patients report that the semantics of the English translation are flawed and that the 5 answer options for each question are poorly differentiated. Additionally, the FJS will result in no score if 3 or more questions are unanswered. This prompted the development of an alternative patient-reported outcomes measure, the Joint Awareness Score (JAS), that builds upon the core concept of joint awareness underlying the FJS, but that is easier to understand and shorter to complete. We completed an exploratory, pilot study to evaluate this outcomes instrument. Our hypothesis is that the JAS will correlate strongly with the FJS and could be used as a substitute.
Methods: Knee arthroplasty patients in a prospective registry were administered the FJS and the JAS. Internal consistency and correlation were calculated with Cronbach's alpha and Pearson's correlation coefficient, respectively.
Results: This study included 174 patients. Cronbach's alpha for FJS was 0.97 for 6 months and 0.97 for 12 months, whereas JAS was 0.89 at 6 months and 0.85 at 12 months. Pearson correlation comparing FJS and JAS at 6 months was 0.88 (95% confidence interval: 0.83, 0.92) and 0.86 (95% confidence interval: 0.78, 0.92) at 12 months.
Conclusions: The Joint Awareness Score is a new patient-reported outcomes measure that is a substitute for the FJS, with half the number of questions, improved semantics, and simplified answers.
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Introduction

The incidence of total knee arthroplasty (TKA) grew from 97 procedures per 100,000 to 213 procedures per 100,000 people in the United States from 2000 to 2014, providing relief for a growing population affected by osteoarthritis [1,2]. Current projections of TKA estimate 930,000 primary TKAs and approximately 202,966 knee revisions for a total of 1,132,966 surgeries by 2030 [3]. This projected increase in TKA volume necessitates ongoing evaluation of costs and benefits of this medical intervention. Benefits analysis remains challenging due to the qualitative and limited nature of available data. Patient-reported outcome measures (PROMs) evolved as a means of collecting longitudinal qualitative data for evaluation of the efficacy of surgical intervention [4,5]. Effective PROM data collection requires question specificity and categorical answer choices ensuring dispersion of scores, to determine central tendency in relation to maximum and minimum responses [6,7]. Maximum and minimum responses greater than 15% of the total response indicate potential ceiling and floor effects, respectively, interfering with accuracy of population data [8]. Improvements in arthroplasty implants and surgical technique results in a higher proportion of maximum scores, generating a ceiling effect that degrades outcome measure validity.

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Behrend et al [9] developed the Forgotten Joint Score (FJS), a 12-question survey, as an answer for the ceiling effect of other PROMs, proposing that the degree to which a patient "forgets" their joint replacement will correlate with patient satisfaction and outcomes after arthroplasty. Following their initial 2012 report, further studies comparing the FJS with PROMs including the Oxford Knee Score [7], Knee Injury and Osteoarthritis Outcomes Score [10], Knee Society Score [11], and Western Ontario and McMaster Universities Osteoarthritis Index [12] demonstrated a low ceiling effect for the FJS. However, other studies have shown the FJS to have a ceiling effect up to 30% [13,14] along with issues present in the language [15-17].

Over years of administering thousands of FJS instruments to our arthroplasty patients, our clinical research site has identified several challenges with the FJS:

1) We have had many complaints from our patients that the translation of the FJS' native Norwegian into English is confusing due to the vagueness separating different responses that range from "never," "almost never," "seldom," "sometimes," "mostly," and "N/A."
2) The FJS commonly delivers a "no score" at the preoperative or early postoperative visits, due to the limited function of the patient, when 3 or more answers are "N/A".
3) The FJS instructions and answer wording does not easily lend itself to use at the preoperative baseline visit.

Material and methods

Background creation of 6-question Joint Awareness Score PROM

Recognizing this confusion regarding interpretation of the FJS within our patient population, we developed our own questionnaire, reviewing the individual questions, and attempting to improve the English semantics (Table 1). We also added additional questions to our survey to address common issues reported by our patient population, missing from the FJS. Additionally, we revised the number of answer choices from 5 to 3 to improve the interpretation of each possible answer option as discrete from the others, and also improving the English semantics. The FJS responses "never," "almost never," "seldom," "sometimes," and "mostly" translate into a 5-point Likert-response format translated linearly into a summative range from 0 to 100 scale with high values translating to the patient successfully "forgetting" about their joint during activities of daily living [9,18]. While "never" and "almost never" may be distinguished, "almost never," "seldom," and "sometimes" are all potentially indistinguishable from each other, and "mostly" is a poor synonym for "frequently," which would have been a better choice. The Joint Awareness Score (JAS) scaling simplifies responses and improves the ability to distinguish between response options, with the choices limited to "never/rarely," "sometimes," and "always/frequently" translating into values of 100, 50, and 0, respectively.

Additionally, we designed a scoring algorithm producing a score under all circumstances. Any unanswered ("N/A") responses to individual questions on the survey were counted as the "frequently" response choice for the JAS. As with the FJS, high JAS scores signify the desired goal of patients not thinking about their joint.

We also modified the wording of the answers so that it referred to the joint in general as opposed to referring specifically to the prosthetic joint. This allows use at the preoperative baseline visit. We added instructions that reinforced the ability to use the PROM preoperatively (Appendix A).

This process resulted in a new questionnaire totaling 16 questions, which we administered to a test group of subjects previously enrolled in an ongoing randomized trial [19], for the purposes of question validation and reduction to a smaller number of questions. After analysis of the responses to the 16 questions, we reduced the number of questions to the 6 which provided the best distinction between the 2 randomized groups. Recognizing the FJS and its core concept of joint awareness, we named the new PROM the JAS.

Study design

All patients in our prospective surgical outcomes registry database who underwent primary TKA from April 2020 through April 2022 were included. Patient demographic data including sex, age, body mass index, and TKA side were collected in Table 2. The FJS and the JAS were administered simultaneously at visits scheduled at 6 weeks, 6 months, and 1 year. An orthopaedic surgeon with

Table 1
Joint Awareness Score (JAS)/Forgotten Joint Score (FJS) questionnaires.

Forgotten Joint Score Are you aware of your joint…	Never	Almost never	Seldom	Sometimes	Mostly	N/A
1. In bed at night?	☐	☐	☐	☐	☐	☐
2. When sitting on a chair for more than an hour?	☐	☐	☐	☐	☐	☐
3. When walking for more than 15 minutes?	☐	☐	☐	☐	☐	☐
4. When taking a bath or shower?	☐	☐	☐	☐	☐	☐
5. When traveling in a car?	☐	☐	☐	☐	☐	☐
6. When climbing stairs?	☐	☐	☐	☐	☐	☐
7. When walking on uneven ground?	☐	☐	☐	☐	☐	☐
8. When standing up from a low-sitting position?	☐	☐	☐	☐	☐	☐
9. When standing for long periods of time?	☐	☐	☐	☐	☐	☐
10. When doing housework or gardening?	☐	☐	☐	☐	☐	☐
11. When taking a walk or hike?	☐	☐	☐	☐	☐	☐
12. When doing your favorite sport?	☐	☐	☐	☐	☐	☐

Joint Awareness Score Do you notice or think about your joint …	Never/rarely	Occasionally/infrequently	Frequently	N/A. I don't do this
1. When taking a bath or shower?	☐	☐	☐	☐
2. When getting in and out of a car?	☐	☐	☐	☐
3. When standing up from a low-sitting position?	☐	☐	☐	☐
4. When walking on uneven ground for more than 15 minutes?	☐	☐	☐	☐
5. When doing gardening, yard work, or snow removal?	☐	☐	☐	☐
6. When taking a longer walk or hike (more than half an hour)?	☐	☐	☐	☐

Table 2
Validation sample characteristics (N = 174).

Variables	N% or mean (range)
Sex	
Male	81/174 (46.55)
Female	93/174 (53.45)
Age at surgery	
Mean ± (SD)	64.9 (10.91)
Range	41-89
Body mass index	
Mean ± (SD)	32.52 (5.81)
Range	17.65-48.4
TKA side	
Left	87/174 (50%)
Right	87/174 (50%)

SD, standard deviation; TKA, total knee arthroplasty.

over 25 years of experience in joint arthroplasty performed the surgical procedure and follow-up appointments. All patients underwent an unrestricted kinematic alignment procedure with a medial-stabilized device.

Statistical analysis

The statistical analysis was performed in R (R Foundation for Statistical Computing, Vienna, Austria; http://www.R-project.org/). Internal consistency reliability for the FJS and JAS was calculated from Cronbach's alpha, with literature establishing that an alpha value of 0.70 operates as the acceptable threshold for group comparison, with internal consistency measurement increasing with values closer to 1 [20]. Construct validity was tested with the Pearson correlation coefficient measuring the linear association between FJS-12 and JAS scores [12]. Content validity is assumed as we are basing our analysis on the FJS as the referent, which has been previously validated and widely adopted.

Results

This study included 174 primary TKA patients. The registry sample was 53% (93/174) male and 47% (81/174) females, with 50% (87/174) of the sample undergoing left TKA and 50% (87/174) undergoing right TKA. The average patient age was 64.9 years with standard deviation ±10.9 years, ranging from 41 years at the youngest to 89 years at the oldest. There was no clear trend, or difference from the FJS, when stratifying by age. Average patient body mass index measured 32.5 (± standard deviation 5.81), ranging from 17.65 to 48.4. Cronbach's alpha for FJS was 0.97 for 6 months and 0.97 for 12 months, while JAS was 0.89 at 6 months and 0.85 at 12 months. Pearson correlation comparing FJS and JAS at 6 months was 0.88 (95% confidence interval: 0.83,0.92) and 0.86 (95% confidence interval: 0.78, 0.92) at 12 months. JAS ceiling effect was at 7% for 6 months and 16.9% at 12 months, floor effect was 14% at 6 months and 3.4% at 12 months. FJS ceiling effect was at 3% for 6 months and 11.7% at 12 months, FJS floor effect was 2% at 6 months and 1.7% at 12 months. All comparative values are summarized in Tables 3 and 4 with a direct comparison of scores plotted in

Table 3
FJS and JAS ceiling and floor effect comparison.

Time frame	JAS ceiling	FJS ceiling	JAS floor	FJS floor
6 mo	7%	3%	14%	2%
12 mo	16.9%	11.7%	3.4%	1.7%

JAS, Joint Awareness Score; FJS, Forgotten Joint Score.

Table 4
FJS-JAS Comparative results at 6 and 12 months.

Metric	6 mo	12 mo
FJS Cronbach's Alpha	0.97	0.97
JAS Cronbach's Alpha	0.89	0.85
FJS-JAS Pearson Correlation	0.88	0.86

JAS, Joint Awareness Score; FJS, Forgotten Joint Score.

Figure 1a and b. A comparison of the 2 scores stratified by age is plotted in Figure 2.

Discussion

Joint replacement of the knee is successful in allowing patients to resume a high level of activity, though limitations persist, such that the patient's perceived performance of the prosthetic joint may not equal that of the original. A review of the literature indicates a rising incidence of TKAs due to increased demand on joints associated with older patients, increased osteoarthritis incidence, obesity, and at times increased physical activity [21]. Traditionally, TKA assessments relied on radiographic comparison, implant survivorship, and clinical assessment through the physical examination [22]. PROMs were implemented to assess the patient's perspective of the performance of their implant. The FJS introduced the concept that the degree to which a patient "forgets" their joint replacement will correlate with patient satisfaction and outcomes after arthroplasty [9,16,23,24].

The high ceiling effect [7,9,11,16,24] seen in the Knee Society Score and other early PROMs can be partially explained by the fact that these measures were designed to evaluate a patient population consisting of elderly, sedentary patients with limited functional demands, yet TKA has subsequently expanded to a younger, more active patient group with higher functional requirements [25]. As TKA indications expanded to younger and more active patients [26,27] with greater physical demands, the measurement scale of these PROMs led to a high ceiling effect. Researchers attempted to find a new PROM standard for TKA evaluation, such as the High Flexion Knee Score developed by Na et al [28]. Noble et al [25] opted for revamping the familiar Knee Society Score, proposing the New Knee Society Score. The adoption of these new PROMs has lagged behind that of the FJS.

While Behrend's measure of joint awareness represents an improvement over pre-existing PROM outcome measures, it is not without weaknesses. The FJS has been translated into multiple languages, but cultural differences [29] must be considered in addition to linguistic differences with each patient population. Franklin et al [20] found when comparing Swiss and American arthroplasty patients that while Americans were younger with higher BMI and more likely to place greater demand on artificial joints, they reported lower pain than their Swiss counterparts. Hamilton et al [17] proposed validation of the FJS in British English, but there has yet to be the same validation for American English, with our English-speaking patient population regularly reporting confusion about the different questions and answer options of the FJS. Additionally, the FJS results in no score if 3 or more of the 12 questions are left unanswered, which is a distinct possibility in the early postoperative period.

This demonstrates a lack of precision in the pivotal question surrounding any arthroplasty: Is the joint replacement functioning at a level that is satisfactory to the patient? We propose that answering that question relies on careful selection of the specific activities most likely to distinguish between satisfactory performance and perceived limitations in performance. For example, the JAS asks the patient about their awareness of the joint during such
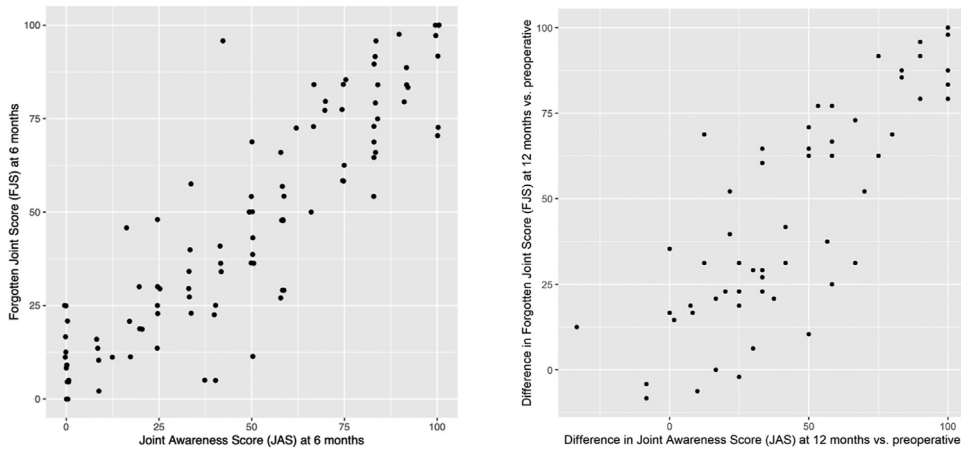
Figure 1. (a) Joint Awareness Score comparison with Forgotten Joint Score at 6 months. (b) Joint Awareness Score comparison with Forgotten Joint Score at 12 months.

pivotal actions as getting in and out of a vehicle, rather than asking about joint awareness while traveling in a vehicle as in the FJS. The JAS question evaluates more specifically a discrete functional activity, while the FJS question is rather vague, in that it could include the higher demand activity involved in getting in and out of the vehicle, though it could also be limited to the relatively lower demand activity of sitting. Additionally, we desire a PROM that will distinguish between a "good" and a "great" result, and so the JAS questions focus on activities of higher functional requirements. This creates an assessment tool that is better suited for the increasingly younger and more physically active total knee patient.

This pilot study revealed a high correlation between the JAS and the FJS, suggesting the possibility that one could substitute for the other. The ceiling effect was higher for the JAS, possibly due to the greater distinction between, and the lower number of, the answer options, primarily the difference between "sometimes" and "always/frequently," and 3 vs 5 answer options.

This study has limitations. PROM validation relies on sufficient data and accounting for missing values is an area of contention [30]. Chithartha et al [31] and Robinson et al [32] addressed the missing data in their studies by changing the FJS to the Modified FJS, while others like Rombach et al [33] choose reasonable estimated data input to correct the information gaps. At 6 months, 10% of patients presenting for follow up did not meet valid JAS score threshold based on survey response input, and at 12 months, 5% of patient inputs did not meet valid JAS threshold. Missing data are typically classified as missing completely at random, missing at random, or missing not at random, respectively [34]. We attributed our missing data to the missing not at random category, as we assess the missingness of data being related to patient response [35,36]. Our changing of the N/A selection to "frequently" selection for the JAS reflects an missing not at random assumption from observations that incomplete responses came from patients with diminished functional capabilities such that they were not capable of the performing the activity in the unanswered question(s). The validity of Cronbach's alpha for measuring internal consistency relies on our treatment of the joint replacement awareness as a unidimensional scale that the FJS and JAS scoring systems share with t-equivalence.

Another possible limitation is that, in removing 6 of the 12 questions from the FJS, potentially valuable information may be
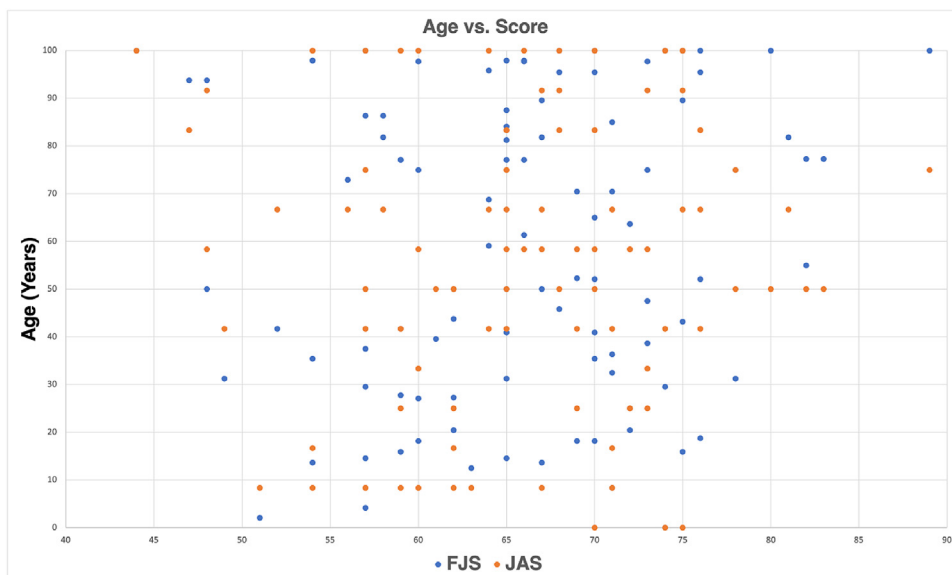
Figure 2. Comparison of the 2 scores stratified by age.

lost, and the JAS may be less comprehensive than the FJS. Additionally, it is possible that our choice of the remaining 6 questions may discriminate against patients who could be more active but are not due to their social and living circumstances.

Additionally, the data come from a single institution with 1 surgeon and a registry patient population with the potential for environmental bias. Additionally, our surgical volume was greatly reduced during the time of this data collection (April 2020-April 2022) due to hospital lockdowns and then reduced staffing and biased toward surgeries performed in our ambulatory surgery center. The potential for survey fatigue exists resulting from patients having to fill out both the FJS and the JAS scores at each visit. As our center first began collecting the FJS and JAS concurrently in 2020, we do not yet have a sufficient sample with follow-up beyond 1 year, though there is precedent in the current literature of validity in 1-year TKA PROM evaluation [37,38]. Additionally, it is possible that the surgical technique (kinematic alignment) and the TKA device utilized (medial-stabilized) may produce scores that are not directly comparable to other alignment techniques and implant designs. However, improved outcomes have been reported for this device [19,39-45] and procedure [46-51], therefore this could prove to be a worst-case scenario, likely to produce a substantial percentage of scores at the ceiling, yet this problem was not encountered.

To address these, and other, potential limitations, we hope to follow-up on this limited pilot study with a large multi-center trial to evaluate further the validity and reproducibility of the JAS, before we would encourage or expect wider adoption.

Conclusions

The JAS is a new PROM that may be a substitute for the JFS, with half the number of questions, improved semantics, simplified answers, and a score for every questionnaire. As total knee arthroplasty volume continues to grow, patients become younger, and functional expectations higher, there is an increasing need for a simple and reliable outcome measure to monitor the effectiveness of surgical intervention.

Conflicts of interest

David F. Scott received royalties from Innomed; is a paid consultant for Medacta USA, Microport Orthopedics, and NextStep; received research support from Medacta USA; is a reviewer and a part of the editorial Board for Journal of Arthroplasty and Journal of Knee Surgery. All other authors declare no potential conflicts of interest.

For full disclosure statements refer to https://doi.org/10.1016/j.artd.2023.101239.

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