Editorial

The potential utility of patient-reported range of motion after total knee arthroplasty

Jack Weick, Harpreet S. Bawa

Department of Orthopaedic Surgery and Rehabilitation Medicine, University of Chicago Medicine and Biological Sciences, Chicago, Illinois 60637, USA
Correspondence to: Harpreet S. Bawa, MD. Department of Orthopaedic Surgery and Rehabilitation Medicine, University of Chicago Medicine and Biological Sciences, 5841 South Maryland Avenue MC 3079, Chicago, Illinois 60637, USA. Email: hbawa@uchicago.edu.

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Total knee arthroplasty (TKA) is a safe, cost-effective treatment for pain relief and improvement of knee function in patients with knee arthritis (1-3). The procedure has become extremely common in the United States: in 2008 alone, over 615,000 TKAs were performed (4) mainly driven by the high prevalence of symptomatic osteoarthritis (OA) (5). Candidates for the procedure typically have diminished quality of life due to persistent knee pain and significant functional limitation (1). OA is the main clinical indication for TKA (approximately 97% of cases) (6). Advanced OA is associated with reduced knee range of motion (ROM), which leads to increased disability (7,8): an individual requires 67° of knee flexion to walk normally, 83° of flexion to climb stairs, 90° to walk down stairs, 105° to get up from a chair, and 115° to rise from a sofa (9,10).

A variety of measures exist to assess the outcome after TKA, however, there is no universal standard (11). The American Knee Society Score (AKSS) is one of the most widely used scoring systems to assess knee functionality. It consists of both a clinical score and a functional score and is typically administered in office visits (12,13). ROM measurements are an integral component of the AKSS score. Final ROM achieved after TKA is an important determinant of both patient satisfaction and function (14,15). ROM is traditionally measured by clinicians or trained researchers using a goniometer to assess angle of flexion and extension. Goniometer measurements have been found to be highly reproducible between trained measurers when the same technique is used (16).

ROM after TKA is influenced by numerous factors including pre-operative ROM, age, body mass index, comorbidities (particularly diabetes mellitus), and intraoperative variables such as implant type and anesthesia modalities (17-22). Patients with stiffness and poor ROM post-TKA are typically managed first with aggressive physical therapy. If stiffness persists, patients may require more invasive measures such as manipulation under anesthesia (MUA) or arthroscopic lysis of adhesions. MUA is typically performed under general or regional anesthesia to allow complete muscle relaxation. The hip is flexed to 90° and the knee is bent until a firm end point is encountered. Although most patients experience improvements in ROM after MUA, patients with diabetes mellitus or patients who received a cruciate-retaining prosthesis have been found to be at risk for lower final ROM (23).

Long-term follow-up of patients after TKA is necessary. However, with the rapidly increasing population of patients undergoing TKA and its more prevalent use in younger patients, in-office follow-up can become burdensome and expensive (4,24). The necessity of using trained clinicians or technicians to measure ROM with a goniometer only amplifies the time and cost of in-office long-term follow-up visits. Questionnaires such as the Oxford Knee Score (25) attempt to assess patients' evaluation of knee function and impact on quality of life. These questionnaires can be administered by phone, mail, or online thereby potentially reducing the need for an office visit, thus potentially reducing the burden on the healthcare system of long-term follow-up post-TKA. Although previous studies have shown a correlation between patient-reported questionnaires such as the Oxford Knee Score and more thorough knee evaluations such as the AKSS 2 years after TKA, no long-term (5 and 10 years post-TKA) correlation is observed (26). Furthermore, patient-reported questionnaires such as the

Oxford Knee Score do not properly assess ROM, a vital component to evaluating knee functionality. Though the idea of self-reported outcomes such as the Oxford Knee Score present a potential way of reducing the burden of long-term post-operative follow-up, these simple at home questionnaires miss vital components of a more thorough clinical assessment.

A recent study by Collins *et al.* in the *Journal of Arthroplasty* proposed a new solution (27). This study utilized a method of patient-reported outcomes initially developed by Gioe *et al.* in which post-operative TKA patients were mailed surveys with lateral knee photographs that showed knee ROM in small increments to compare to their knee ROM (28). This method was further validated by Khanna *et al.* in 2011 (29). Khanna and colleagues compared patient-reported ROM using similar methods developed by Gioe *et al.* with clinically measured ROM using a goniometer. They stated that patient-reported ROM using photographs could be considered accurate for the purposes of long-term follow-up of patients after TKA. Patient recorded flexion assessed by the use of photographs was not significantly different than clinician-measured flexion as determined by goniometer measurements—a difference of just 0.7° (P=0.48). Although the assessment of extension was significantly different between the self-reported method and the clinician measurements (difference of 1.7°, P<0.001), the small absolute measurements of extension (often 1-4°) makes the comparison more difficult. Additionally, previous studies have shown a correlation between patient-report extension using photographs and physician-measure extension using a goniometer (28). These studies using patient-reported ROM with photographs only looked at patients after TKA. Understanding the ROM before TKA is important, as pre-operative ROM is the key determinant of post-operative ROM (17). Neither study evaluated change in patient-reported ROM over time or compared patient-reported ROM at baseline before surgery and after TKA.

To address these gaps in the data and further validate this patient-reported ROM methodology, Collins *et al.* enrolled 112 TKA patients. Subjects were assessed at baseline (pre-TKA), 3 months post-operatively, and 6 months post-operatively. ROM (both flexion and extension) were assessed either in office by goniometer measurement from a trained research assistant or at home using photographs depicting varying ranges of flexion and extension and asking the patients to select the photograph closest to their current ability to flex or extend. The authors found a statistically significant association between the objective measurements using the goniometer and self-reported ROM using the photograph method for both flexion and extension, thus further validating this method as a way of assessing ROM.

Collins and colleagues were also able to show that self-reporting of ROM using this method was valid over time: reports of improvement, worsening, or stable ROM was associated with clinical goniometer measured changes over time. This has important implications in long-term follow-up of TKA patients post-operatively. Younger patients generally have greater rates of revision of TKA than older patients likely due to longer required lifespan of the prosthesis as well as better post-operative health and mobility resulting in increased wear-and-tear (30). Additionally, as the lifespan of the population as a whole increases and the popularity of TKAs continue to rise, the number of knee arthroplasties that become functionally compromised years after the operation will continue to increase as well. Although the follow-up time used by Collins *et al.* was limited to 3 and 6 months, the accuracy of the changes in measurement over time suggest that this method may be valid for not only short term, but longer follow-up intervals as well.

As Collins demonstrated, the patient-reported ROM using photographs was sensitive to change—both increasing ROM and decreasing ROM. The ability to accurately detect changes in ROM over time is vital. Early detection of a change in ROM and instability can indicate early failure and therefore allow earlier intervention. Polyethylene wear can lead to osteolysis, deterioration of bone, and eventual loosening. This process can begin before a patient is symptomatic and may only be evident on radiographs (31). Often, patients do not present with a prosthesis in which function has become compromised until there is pain, sensation of instability, recurrent joint effusions, or dramatic decrease in functionality. Delayed detection can lead to a more technically challenging revision procedure because of decreased bone stock. However, with accurate patient-reported ROM in small, 5° increments as used by Collins and Khanna, it is possible that a potential impending failure can be detected earlier, before significant polyethylene wear and osteolysis occurs. Consequently, a partial or complete revision would likely have greater rates of success with early detection. In the immediate post-operative period evaluation of ROM patient progress can be recorded and intervention can be performed sooner if patients are not achieving an adequate arc of motion. Aggressive physical therapy is typically the first line intervention however if

patients do not make adequate improvements with therapy alone then and MUA is indicated. Shorter intervals between TKA and any intervention allow greater success than if therapy or MUA are delayed and significant functional limitations have already been realized (23).

This study validated this patient-reported method and was able to show accurate measurements over time and changing ROM. The short-term follow-up time points used by Collins *et al.* (3 and 6 months post-operatively) are important as they can play a role in determining whether there is stiffness and poor ROM that needs treatment with physical therapy or MUA. Evidence suggests MUA within 90-day results in greater ROM compared to longer intervals (32,33). Although survival of TKAs is high years after the operation (10-year survival, 85-97%) (34,35), long-term follow-up on patients with TKA is needed as there are still a considerable number of patients requiring therapy or revision years after the operation. The results from Collins and colleagues suggest that this method may be valid with longer follow-up; however, future work confirming the ability of this method to detect changes in ROM and stability over a long time period post-operatively (5, 10, 15 years) would be ideal. Now that this methodology has been validated in several studies, there is a need for determination of the appropriate way to incorporate this patient-reported ROM into clinical practice. Clearly, this could reduce the number of in-office follow-up visits after TKA. However, the proper balance of patient-reported outcomes and evaluation by a clinician must be maintained to ensure proper long-term care for patients with a knee replacement. Additionally, cost-effective analysis of widespread, long-term employment of this technique is necessary to determine if this does truly benefit the healthcare system.

With the increasing prevalence of TKAs, validated patient-reported outcomes such as self-reported ROM using photographs as described above could help relieve some of the burden that is placed on both patients and the healthcare system with the necessary follow-up of patients with TKA. The cost and resource savings that could result from implementation of this technique could help make TKAs—which are already considered highly cost-effective (2)—even more efficient long-term result in significant savings in cost and resources.

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Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

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