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Knee Osteoarthritis Patients Can Provide Useful Estimates of Passive Knee Range of Motion: Development and Validation of the Copenhagen Knee ROM Scale

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ABSTRACT

Background: Knee arthroplasty does not always require extensive long-term follow-up. If knee range of motion (ROM) could be assessed reliably by patients, some follow-up visits might be replaced by patient-reported outcome measures, and this additional information could be reported directly to registers. We developed and tested the validity and reliability of a simple scale for patients to self-report their passive knee ROM.

Methods: Through an iterative process, we created a 2-item scale with 11 illustrations of knee motion in 15° increments. The validity and reliability was tested in knee osteoarthritis and arthroplasty patients at different treatment stages, many with poor ROM. Patient estimates were compared to passive goniometer measurements performed blindly by a physiotherapist and a junior orthopedic surgeon.

Results: The mean difference between 100 patients' (70.9 years) estimates and goniometer measurements was -0.7° (standard deviation, 12.3°) for flexion and 1.1° (standard deviation, 11.6°) for extension, both not significant. Correlation was 0.79 and 0.63, and kappa values at retest were 0.84 and 0.66. For flexion $< 110^\circ$, sensitivity of patient estimates was 88% and specificity was 88%. For a limit of 100° , values were 95% and 81%. For extension deficits $> 10^\circ$, sensitivity was 78% and specificity 70%. Values were 100% and 66% for a 15° limit.

Conclusion: The Copenhagen Knee ROM Scale is a patient-friendly and feasible alternative to passive ROM measurement for registers, research, and selected clinical use. This scale appears reliable and valid compared to reports of similar tools, and patient estimates are better correlated to goniometer measurements.

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With increasing attention to the advantages of the use of patient-reported outcome measures in knee arthroplasty, it has been suggested that patient-reported outcome measures replace some postoperative clinical follow-up visits in uncomplicated cases [1–4]. An important barrier, however, is that information about range of motion (ROM) is not available if patients do not attend a healthcare clinic in person.

Attempts have been made to have patients self-report ROM, and the need for a tool to make this possible has been recognized [1,2,4–6]. For surgeons to rely on patient-reported ROM to replace a

clinical follow-up visit, the tool must be valid and sensitive. The same applies for use in research and registries. Previous studies have reported promising results [3–6], but we sought to explore whether a new, simple patient-reported ROM tool, in which patient-friendliness was highly prioritized, could provide satisfactory accuracy and sensitivity. The purpose of this study was to develop an illustration-based scale for patients to report passive knee ROM and to test the validity and reliability among knee osteoarthritis (OA) and knee arthroplasty patients.

Materials and Methods

Development Process

Our first focus was to design a questionnaire, based on drawings, that patients of any adult age would easily understand and be able to complete unassisted at home. The process was guided by 3 relevant guidelines: (1) Guidelines for Reporting Reliability and Agreement Studies (GRRAS); (2) The STARD Statement for reporting studies of diagnostic accuracy; and (3) The COSMIN checklist for evaluating the methodological quality of studies on measurement properties of health status measurement instruments [7–12].

We met with 18 individual knee OA patients (7 men, 11 women; mean age, 69.9 years) who were facing or had just undergone knee arthroplasty. They were asked to show in their own preferable way how much they could bend and straighten their affected knee. We observed that the majority of patients got up from the chair or bed to show their extension, although some remained seated with their leg stretched out with the heel on the floor, or balancing the leg in the air in front of themselves. To show flexion, most patients sat on a chair or remained in bed. Many patients used their hands to pull the ankle backward.

Through an iterative process of testing and improving our draft illustrations, a total of 34 knee arthroplasty patients (23 preoperative and 11 postoperative patients: 13 men, 21 women; mean age, 70.4 years) were shown several drafts of knees in different positions from a lateral view. Patients were asked to describe what they saw in the illustrations and mark the option that fit their knee motion. Some drafts had dotted horizontal and vertical lines to aid estimation of angles. However, with exception of an engineer and a carpenter, most people found the lines more confusing than helpful. Adding a seat and the contralateral leg as navigation points and adding arrows to show the direction of force gradually enhanced the patients' understanding of the intentions of this tool (Fig. 1). Instructions were made short, here regarding flexion: "How much can you bend your knee? Please push your lower leg as far back as possible. You can use your hand to pull your lower leg in the direction of the arrow. Tick the box that fits your situation."

For flexion, we found 6 pictures to be appropriate: 60°, 75°, 90°, 105°, 120°, and 135°. For extension, 5 illustrations of 45°, 30°, 15°, 0°, and –15° were found suitable. We chose 15° increments between the pictures for 3 reasons: Firstly, only differences above 5°–10° represent a true difference in ROM [13,14]. Secondly, with 10° intervals even the authors of this article were unable to tell the difference between neighbor illustrations. In the development phase, we noted that many patients exaggerated their ROM, both in terms of good and bad results. Particularly flexion contractures were overestimated. Collins et al [5] reported the same tendency when using 5°–10° intervals. Therefore, we considered more options to be redundant, as patients would use the scale widely no matter the underlying intervals between measures. Thirdly, our goal of making the questionnaire very easy to overview would be compromised with a higher number of illustrations.

We deliberately chose not to write the underlying angle on each picture because we wanted patients to report their unbiased

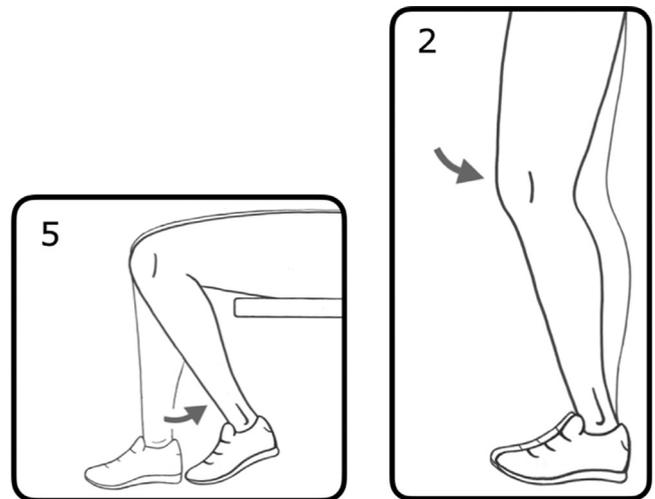


Fig. 1. Examples of illustrations of flexion and extension, respectively. Full questionnaires are available in Appendix A.

perception of pictures. If angles had been shown, there would be a risk of priming patients to a certain answer, in case they had recently been told their exact ROM measure, for example, by their physiotherapist.

Options were placed in one row with the best score last to show a logical direction of motion. To meet patients with locked bandages or extremely limited motion, we made extra options named (for flexion) "Impossible. I am not able to bend my knee as much as in picture no. 1".

Although all illustrations show left-side knees, no patients were in doubt of which knee to think of. Some patients asked how much it was meant to hurt during testing. However, because pain level varies greatly, this subject could not be fit into instructions in a sensible manner.

The development process ended when there were no longer any new comments to facilitate meaningful changes in layout or wording, and patients understood the task without further explanation. The final version, Copenhagen Knee ROM Scale (CKRS) can be viewed in an English version in Appendix A and is available free of charge (with English or Danish text) at www.procordo.com/docs/copenhagen_rom.

Translation

Questionnaires were evaluated and tested in the original Danish version. The wording was translated into English for publication, independently by 3 bilingual persons: 1 native English layperson and 2 native Danish doctors (1 resident and 1 orthopedic knee arthroplasty surgeon with 4 years of experience from English hospitals). The 3 versions were combined to a final version by the first author. When in doubt, the native English layperson had the final say. The resulting English version of CKRS has not been evaluated among English-speaking OA patients.

Clinical Testing

A patient-reported ROM tool is probably of most clinical value in the follow-up period after knee arthroplasty. However, it may be of great value for patients considering arthroplasty to be informed of what knee motion to expect in the months and years following surgery, compared to the knee motion they have with OA. Therefore, we found the whole spectrum of patients, from the first visit in

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