Accuracy of Knee Range of Motion Assessment After Total Knee Arthroplasty

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Abstract: Measurement of knee joint range of motion (ROM) is important to assess after total knee arthroplasty. Our objective was to determine level of agreement and accuracy between observers with different knowledge on total ROM after total knee arthroplasty. Forty-one patients underwent x-ray of active and passive knee ROM (gold standard). Five different raters evaluated observed and measured ROM: orthopedic surgeon, clinical fellow, physician assistant, research fellow, and a physical therapist. A 1-way analysis of variance was used to determine differences in ROM between raters over both conditions. Limit of agreement for each rater for both active and passive total ROM under both conditions was calculated. Analysis of variance indicated a difference between raters for all conditions (range, $P = .004$ to $P \leq .0001$). The trend for all raters was to overestimate ROM at higher ranges. Assessment of ROM through direct observation without a goniometer provides inaccurate findings.
Key words: range of motion, total knee arthroplasty, knee flexion.

Accurate measurement of knee joint range of motion (ROM) is extremely important for orthopedic surgeons (OSs). These measurements have prognostic significance preoperatively and are used to delineate postoperative rehabilitation. Sufficient knee joint flexion is required to safely complete activities of daily living such as stair climbing, walking, and rising from a chair [1,2]. Assessment of knee joint ROM before and after knee arthroplasty surgery is also used in outcome assessment measures such as knee scoring instruments [3]. In the last 3 to 4 years, multiple high-flexion knee devices have been introduced in the marketplace by several manufacturers (ie, DePuy and Biomet). Most of these manufacturers claim that specific design features allow the devices to flex "safely" past 140°. In the next decade, accurate assessment of ROM will become even more important as we monitor the performance of these new devices.

Multiple authors have reported on the consistency of measuring knee joint ROM, within-tester and between-tester reliability [4-7]. Visual inspection of submaximal knee joint ROM using a goniometer has been reported to be very close to the gold standard (radiographic image) [8]. Edwards et al [9] reported that the intertester reliability (.91) was high between 3 different testers: an attending surgeon, senior orthopedic surgery resident, and physician assistant (PA). However, no study has evaluated the accuracy of assessing knee joint ROM between different health care providers (ie, surgeons, physical therapists [PTs], and fellows) and compared it with the gold standard, roetgenographic measurement. Our first objective was to determine level of agreement between raters on observed and measured total ROM (active and passive) with x-ray measurement after total knee arthroplasty (TKA). The second objective was to

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evaluate the accuracy of assessing active and passive observed and measured ROM between raters.

Methods

Forty-one consecutive patients (25 females and 16 males), a minimum of 1 year post-TKA, volunteered and gave written consent to participate in this study. All patients gave written informed consent to participate. These patients had primary TKA performed by the senior author and received 8 different combinations of implant design and tibial insert. Fifteen patients received NexGen CR (Zimmer) implants, 13 received NexGen CR-Flex (Zimmer), 5 received anatomic modular knee (AMK, DePuy), 4 patients received low contact stress (LCS, DePuy), 3 patients received NexGen legacy knee constrained condylar knee (LCCK, Zimmer), and 1 patient received a Duracon (Howmedica) implant. Radiographic evaluation was done with the patient supine and the hip flexed on the x-ray table. A lateral x-ray of the knee was taken in passive and active flexion by a technician not involved in the clinical measurement phase of the study. The radiographs were taken using a digital radiograph x-ray system. All measurements were performed on a picture archiving and communication system (PACS, software E-Film, Milwaukee, Wisconsin) using the angle between lines drawn down the midshafts of the femur and tibia. The degree of flexion was obtained by measuring the angle between lines drawn down the posterior cortex of the femur and tibia (Fig. 1). The radiographic measurements were done with no knowledge of the clinical measurements.

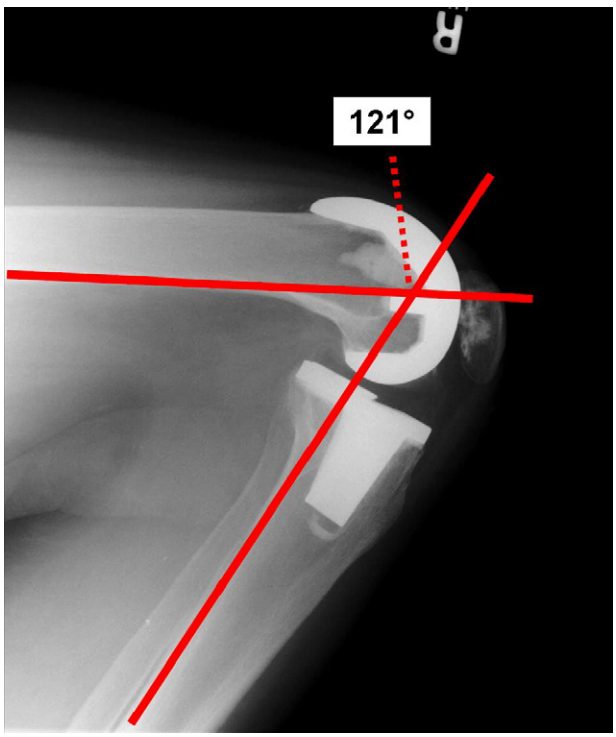

Fig. 1. Radiograph showing measurement lines for knee flexion angle of 121°.

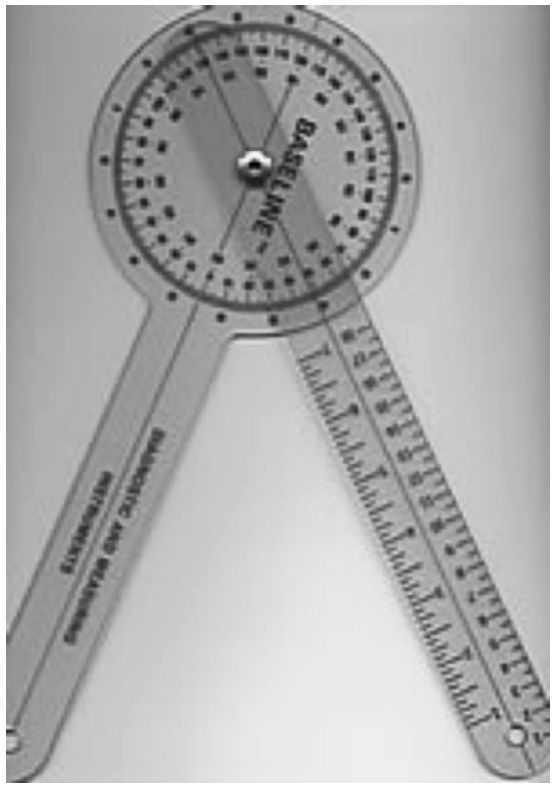

Fig. 2. Standard goniometer.

Five different raters evaluated the ROM in all patients. These included an experienced fellowship-trained OS, a clinical fellow (CF), a PA, a research fellow (RF), and a clinical PT. Each performed 4 measurements in all patients: visual (observed) and measured (goniometer) assessments of passive and active motion were noted in each case. Evaluations by raters consisted of visually estimating (observed) total ROM from extension into flexion followed by actual measurement of ROM using a handheld 2-arm goniometer (26-cm arms with 2° markings; Fig. 2). Both observed and measured ROMs were assessed actively and passively. For measurement using the goniometer, 1 arm of the goniometer was placed parallel to the shaft of the femur lining up with the greater trochanter, and the other arm was placed parallel to the shaft of the lower leg lining up with the lateral malleolus of the fibula. The axis of the goniometer was placed over the approximate knee joint line, slightly below the lateral femoral epicondyle. The dependent variable was total ROM from full available extension to full available knee flexion. Each evaluator was blinded to all measurements by the other raters.