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Development of a Modern Knee Society Radiographic Evaluation System and Methodology for Total Knee Arthroplasty



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ABSTRACT

To accompany the new clinical Knee Society Score, a committee was formed to develop an updated radiographic assessment and evaluation system. The purpose is to accumulate radiographic data in a standardized manner to facilitate more accurate interpretation, documentation and clinical correlation. We systematically reviewed the TKA radiographic evaluation literature as well as the original Knee Society Radiographic Evaluation and Scoring System. A modern system was developed, approved by the Knee Society membership, which ensured proper radiographic documentation of coronal and sagittal implant alignment, fixation interface integrity with respect to radiolucent lines and osteolysis, and a zonal classification system to document precise deficiency locations. It is hoped that data may be accumulated in a standardized manner with eventual formulation of implant risk "criteria" or "scores'.

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In 1989, the original Knee Society Clinical Rating System was developed to assess the clinical and functional status of patients after total knee arthroplasty (TKA) [1]. It was accompanied by a radiographic evaluation and scoring method published in the same year [2]. Recently, a new Knee Society Scoring System was developed to objectively evaluate patients with TKA clinically with respect to function, expectations, pain and satisfaction. The purpose of creating the new scoring system was to modernize this outcome measure with greater utility, sensitivity and validity in contemporary knee arthroplasty patients, who have increasing physical demands and activities [3,4]. Subsequently, a modernized and updated radiographic evaluation system for total knee arthroplasty was necessary, particularly in light of the diverse and complex variety of knee designs that have emerged over the past 25 years.

Due to the increase in primary and revision knee arthroplasty surgery that is projected to occur [5], it is essential to develop a consistent

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and standardized methodology to obtain and perform a radiographic evaluation of these procedures. When compared to the original Knee Society Scoring system [2], a newer practical approach was needed to be established to update and standardize guidelines for the specific radiographs to be obtained, the techniques used to obtain them, and the methods for evaluation and reporting upon the status of the implants. Due to the lack of studies with sufficient statistical power to correlate specific radiographic findings with outcomes, as well as the numerous implant designs, it was beyond the scope of this system to define specific x-ray parameter values that would deem implants as "normal", "abnormal" or "at-risk." Rather, it is proposed that this radiographic evaluation system be used to accumulate radiographic data in a standardized manner in order to facilitate more accurate x-ray interpretation, documentation and clinical correlation. In addition to primary TKA implants, schematics and methodology are provided for the evaluation of revision knee arthroplasty systems.

Methods

A committee of six Knee Society members was formed with the specific task of developing an updated radiographic assessment and evaluation system. The committee was composed of knee arthroplasty

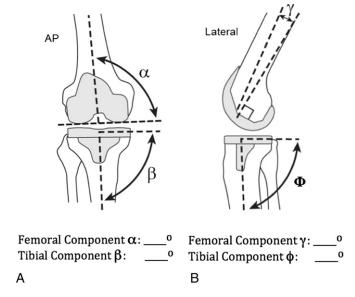


Fig. 1. (A) Schematic of coronal plane radiographic measurements (in degrees) that denote femoral and tibial anatomic axis based on the implant alignment. (B) Schematic of sagittal plane radiographic measurements (in degrees) that denote femoral component flexion and tibial slope.

surgeons who had extensive experience in primary and revision total knee arthroplasty and who undertook a systematic review of the pertinent TKA radiographic evaluation literature, as well as a review of the original Knee Society Radiographic Evaluation and Scoring System [2].

A structured search of 4 electronic databases of EMBASE, CINAHL-plus, PubMed, and SCOPUS was conducted to identify reports between January 1980 and September 2013 concerning radiographic evaluation of knee arthroplasties. The authors used a combination of the Boolean search strings knee, arthroplasty* replacement*, radiograph*, revis*, x-ray*, and osteolysis*, to identify evaluation metrics regarding knee arthroplasty procedures. Bibliographies of all reports identified were individually searched to extract additional studies for the final analysis that may have been overlooked after the initial search.

Based on the information obtained in those searches and reviews, a modern and updated evaluation system was developed for both primary and revision TKA and then this was distributed to the entire Knee Society membership for scrutinized evaluation, feedback, and suggested edits. The feedback from the membership was consolidated and

incorporated into the final Knee Society Radiographic Evaluation System presented in this manuscript and in the accompanying schematics.

Standard Postoperative Radiographs

Serial radiographs are recommended for interval comparison of radiographic metrics such as radiolucent lines and component position. The techniques employed by the staff in obtaining the radiographic views of the TKA are critical to ensuring accurate evaluation. The three essential views that must be obtained for a complete and accurate TKA radiographic evaluation are listed below with a suggested description of an optimal technique.

- Weight-bearing antero-posterior (AP) view: The technique should emphasize targeting the x-ray beam parallel and in line with the approximate slope of the tibial component baseplate. This provides optimal visualization of the various tibial fixation interfaces to accurately assess the location and the magnitude of radiolucent lines. The knee should be positioned with the patella facing towards the x-ray beam in order to minimize limb rotation and to more accurately assess alignment in the coronal plane.
- <u>Lateral view</u>: The technique should be taken with the knee flexed 30° with the patient lying on the affected side with an emphasis on obtaining a true lateral of the femoral component, where the posterior femoral condyles are superimposed. This facilitates a tangential view of the implant fixation interfaces to accurately assess radiolucent lines, femoral component positions, sizes, tibial slopes, as well as the patella implant, patellar bone, and the patella tendon relationship.
- Patello-femoral view: The preferred view is the Merchant view, and is obtained with the patient lying supine with knees flexed to 45°, typically held with a fixed or adjustable platform, and the x-ray beam angled at 30° from the horizontal [6]. This view is used to evaluate the patellar implant fixation integrity, the patellar bone, and the patellar alignment with respect to tilt and subluxation.

Radiographic Evaluation Metrics

Alignment/Component Position

 Coronal alignment is evaluated on the AP radiograph. The coronal "anatomic" alignment of the femoral component is comprised of the distal femoral component surface with respect to the anatomic axis of the femoral shaft. Similarly, the tibial component alignment is determined by the angle between the baseplate and the

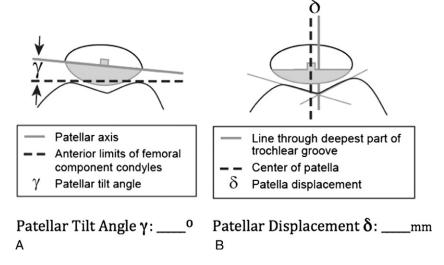


Fig. 2. (A) Schematic of radiographic patella tilt measurement (in degrees) relative to the femoral component denoted on the Merchant view radiograph. (B) Schematic of radiographic patella displacement measurement (in millimeters) relative to the central trochlea of the femoral component denoted on the Merchant view radiograph.

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