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Computer Navigation vs Extramedullary Guide for Sagittal Alignment of Tibial Components

Radiographic Study and Meta-Analysis

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Abstract: Sagittal alignment of tibial components using computer navigation was compared with conventional methods. A radiologic study was performed using 110 total knee arthroplasties from 3 groups: computer navigation, cutting block with extramedullary guide, and manual tilt of extramedullary guide. Posterior tibial slopes were measured from radiographs and compared using statistical methods. The cutting block method was the most accurate, and computer navigation was the most precise. The manual tilt group had the greatest variance, significantly greater than computer navigation. There was no significant difference between groups with respect to the percentage of knees with posterior slope within 3° of the desired slope. Meta-analysis of 10 studies found no reduction in outliers with computer navigation. Computer navigation offers greatest precision but does not reduce the number of outliers. **Keywords:** posterior slope, computer navigation, extramedullary guide, sagittal alignment of tibial component, radiographic study, meta-analysis.

Sagittal alignment of the tibial component is an important technical consideration during total knee arthroplasty. Posterior tibial slope of 3° to 7° has been suggested for cruciate-retaining knee implants to allow for appropriate femoral rollback and to prevent impingement of the tibial component on the posterior femur, thereby maximizing knee flexion [1-5]. On the other hand, excessive posterior tibial slope with some cruciate-substituting knee implant designs may result in impingement of the post within the cam [6]. This can lead to excessive polyethylene wear of the post, which may be detrimental to implant longevity. Any technique used to produce posterior tibial slope for either cruciate-retaining or cruciate-substituting knee arthroplasty implants should, therefore, be both accurate and precise.

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Computer navigation has been espoused as an accurate and precise method for placement of total knee arthroplasty components and has been in use for over a decade [7]. Multiple randomized controlled trials have compared navigation to conventional surgical techniques for total knee arthroplasty [8-22]. Three recent meta-analyses of the literature on computer navigation for total knee arthroplasty concluded that navigation reduced the risk of deviation by greater than 3° from the desired coronal mechanical axis [23-25]. Navigation studies have primarily focused on coronal alignment of the femoral and tibial components. Sagittal alignment of components has not been as well reported as coronal alignment in total knee arthroplasty navigation studies.

The extramedullary guide technique relies on palpation and observation of the anterior tibia by the surgeon as a reference to the sagittal mechanical axis of the tibia. The surgeon may place the extramedullary guide roughly parallel to the anatomical axis of the tibia and use a cutting block with a built-in posterior slope (we have termed this the "cutting block" method). Alternatively, the surgeon may use a cutting block without a built-in posterior slope (ie, a 0-degree cutting block) and manually tilt the extramedullary guide to produce a posterior slope (we have termed this the "manual tilt" method). Computer navigation relies on points mapped over the tibial plateau and ankle that the computer software uses to calculate the sagittal mechanical axis of the tibia. The computer software then determines the appropriate position of the cutting block to produce the desired posterior tibial slope.

The purpose of this study was to evaluate the accuracy and precision of 3 techniques that are commonly used to produce posterior tibial slope: (1) computer navigation, (2) cutting block, and (3) manual tilt. A systematic review and meta-analysis of the literature were performed on randomized controlled trials that have compared computer navigation with the use of an extramedullary guide for placement of the tibial component and reported sagittal alignment of the tibial component.

Materials and Methods

Radiographic Study

The study population consisted of 110 total knee arthroplasties in 102 patients who underwent total knee arthroplasty during a 4-year period (January 2005 to January 2009). Two senior staff surgeons using a standard medial parapatellar approach supervised all total knee arthroplasties. The Scorpio Knee System (Stryker, Mahwah, NJ) of implants and instruments was used in every case. Three treatment groups were identified retrospectively based on the method used to produce the posterior tibial slope: (1) computer navigation (Stryker Navigation System; Stryker; n = 30), (2) an extramedullary guide placed parallel to the anatomical axis of the tibia with a 5° posterior sloped cutting block (n = 40), and (3) an extramedullary guide with a 0-degree posterior sloped cutting block manually tilted to produce the desired posterior slope (n = 40). These 3 treatment groups are referred to as the navigation group, cutting block group, and manual tilt group, respectively.

The desired posterior slope was 3° for the computer navigation and manual tilt groups. These 2 treatment groups used posterior-stabilized knee implants, and therefore, minimal posterior tibial slope was desired. The cutting block group used cruciate-retaining knee implants, and the desired posterior tibial slope was 5°.

Posterior tibial slope was measured on lateral radiographs taken at a 6-week follow-up appointment. The tibial anatomical axis was measured using the radiographic method described by Dejour and Bonnin [26]. This method defines the *tibial anatomical axis* as a line intersecting 2 points equidistant between the anterior and posterior cortexes on the lateral radiograph: one point located at the level of the tibial tuberosity and the second point located 10 cm distal to the tibial tuberosity (Fig. 1). Posterior tibial slope was measured as the angle between the tibial plateau and a line perpendicular to the tibial anatomical axis [27]. Two independent reviewers who were blinded to the treatment groups measured and recorded the tibial slopes. The reported posterior tibial slope for each sample was the average of these 2 measurements. Intraclass correlation coefficient (ICC) was used to determine the level of agreement between the 2 reviewers measuring posterior tibial slope. The level of agreement for values of ICC was defined as follows: less than 0.2, poor agreement; 0.21 to 0.4, fair agreement; 0.41 to 0.6, moderate agreement; 0.61 to 0.8, substantial agreement; and more than 0.8, almost perfect agreement.

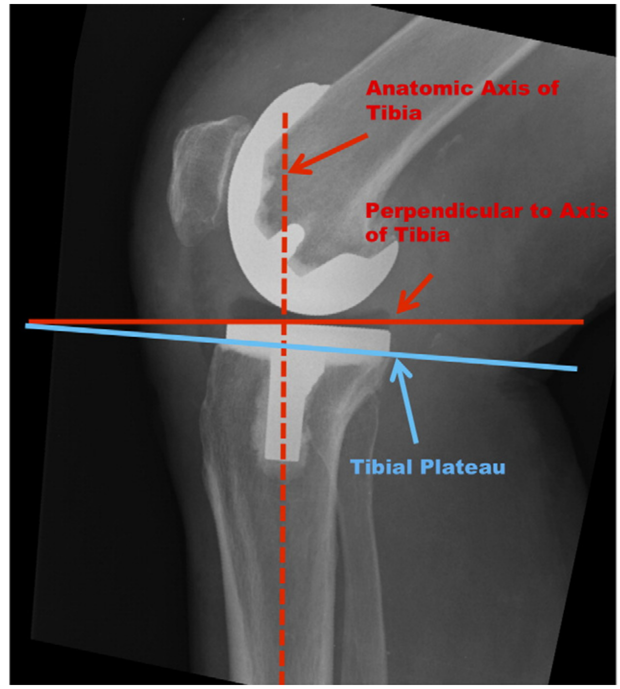

Fig. 1. Lateral radiograph illustrating measurement of the posterior tibial slope. The posterior tibial slope is the angle between the line perpendicular to the axis of the tibia (solid red line) and the tibial plateau (solid blue line).

Statistical calculations were carried out using SPSS Windows, version 16.0 (SPSS Inc, Chicago, Ill). Accuracy of the treatment group was evaluated using a 1-sample *t* test. A significant difference between the mean posterior slope of the treatment group and the desired slope would indicate that the method was not accurate, whereas no significant difference would indicate that the method was accurate. Precision was evaluated by comparing variances of the 3 treatment groups using Levene test for equality of variance. No significant difference in variance between treatment groups would indicate that there was no difference in precision. Percentage of knees in each group within ±3° of the desired slope was compared using a χ^2 test. All comparisons were 2-tailed, and a significant difference for any comparison was $P < .05$. Post hoc power analysis was performed with GPower 3 software [28] for all comparisons using 2-tailed tests, and $\alpha = .05$.