INFLUENCE OF FEMORAL ROTATION ON RADIOGRAPHIC ALIGNMENT AFTER TOTAL KNEE ARTHROPLASTY

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Introduction: The long term success of common total knee arthroplasty is suggested to be dependent on the correct axial limb alignment and angulation of the prosthetic components. The ability to evaluate this alignment using postoperative radiographs might be confounded by limb rotation. The aim of the presented study was therefore to measure the effect of limb rotation on postoperative radiographic assessment and to introduce a mathematical correction to calculate the true axial alignment in cases of a confounded radiograph.

Materials and Methods: A synthetic lower left extremity (Sawbones®, Inc, Vashon Island, WA) were used to create a model resurfacing total knee arthroplasty of the Interax I.S.A.® knee prosthesis system (Stryker, Limerick, Ireland). Laser guided measurement of the tibia after preparation showed a straight lower limb with a femoral valgus angle of 6.5°. The model was fixed in an upright stand which positioned the limb in varying degrees of rotation. Five series of 10 anteroposterior (AP) radiographs were taken with the knee in full extension, with femoral limb rotation ranging from 20° external rotation to 20° internal rotation in respect to the x-ray beam and cassette, in 5° increments. After digitizing each radiograph, an independent observer measured the femoral valgus angle for each series of the long leg radiographs using a digital measurement software (MEDICAD®, Hectec, Altfraunhofen, Germany). Each observer was instructed to determine the femoral valgus angle following the software’s guidelines. In addition each observer measured the distances a and c of the femoral component figured on the radiographic film according to Figure 1. Using a student t-test, the effect of femoral limb rotation on the measured femoral valgus angle and a correlation between femoral rotation and femoral valgus angle was established. Then for each limb rotation c/a ratio was determined to calculate the limb rotation and to calculate a theoretical correction for each rotated limb radiograph to determine the real femoral valgus angle.

Results: Without an application of femoral rotation the femoral valgus angle was measured radiographically to be 6.5° (SD 0.4°). With external femoral rotation the measured femoral valgus angle linearly decreased to a minimum of 4.5° (SD 0.2°) at 20° femoral rotation (Fig. 2). In contrast, with increased internal femoral rotation the measured femoral valgus angle linearly increased up to 7.7° (SD 0.2°). The linear regression (R2=0.94) calculated a 0.09° change of radiographically measured femoral valgus angle per femoral rotation angle. With the femoral rotation the radiographically measured c/a ratio decreased linearly (R2=0.98) with further internal rotation (Fig. 3). The calculation of the real femoral valgus angle using the calculation of the c/a ratio showed a maximum difference of up to 0.7° (p=0.22) between the calculated and the real femoral valgus angle, which is supposed to be 6.5° at each femoral rotation angle.

Discussion: The results of the presented study suggest a significant influence of femoral rotation during radiographic evaluation of limb alignment after total knee arthroplasty. With further external femoral rotation the radiographically apparent femoral valgus angle decreases, with further internal rotation the femoral valgus angle increases. Therefore, correct femoral rotation in respect to the central x-ray beam and the cassette should be provided. As the apparent femoral valgus angle changes linearly in the range of 20° internal and external leg rotation, a calculation of the distances of the femoral component could be used to determine the real femoral valgus angle in cases of femoral limb rotation.