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A Comparison of Variable Angle Versus Fixed Angle Distal Femoral Resection in Primary Total Knee Arthroplasty

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ABSTRACT

This study assessed whether using a variable distal valgus resection angle improved post-operative coronal lower limb alignment in total knee arthroplasty (TKA). Two groups were compared: Fixed (n = 124), where a fixed distal valgus resection angle of 7° was used; Variable (n = 87), where the resection angle was adjusted to the measured femoral mechanical anatomical (FMA) angle of the patient. FMA and mechanical femoro-tibial (MFT) angles were measured on pre-operative and post-operative hip-knee-ankle radiographs. 85% of patients in the Variable group had a post-operative MFT angle within 0° ± 3°compared to 69% in the Fixed group ($P = 0.006$). The use of a fixed distal femoral resection angle for all patients is not appropriate. Setting the resection to an individual patient's FMA angle can significantly improve the post-operative MFT angle.

It has long been accepted that postoperative lower limb alignment is an important parameter in the outcome of total knee arthroplasty (TKA) [1]. Historically the proposed aim for coronal alignment, as measured by the mechanical femorotibial angle (MFT angle), has been to be within ±3° of 0° [1–5]. More recent work has shown that these may not be absolute mechanical limits but still conclude that, in the absence of other information, TKA surgeons should aim for a coronal alignment of the lower limb of 0° [6–8].

In the case of the femur the mechanical and anatomical axes are not coincident and form the femoral mechanical anatomical (FMA) angle. Achieving a mechanical alignment of 0° in the coronal plane requires the placement of the femoral and tibial components perpendicular to the femoral and tibial mechanical axes respectively [1,3,4,9]. Therefore when using intramedullary instrumentation, which is aligned to the anatomical axis, the distal valgus resection angle should be equal to the FMA angle. Generally during conventional TKA with this instrumentation most surgeons use the same fixed distal valgus resection angle (4°–7°) for all their patients.

However the use of the same resection for all patients implies that they all have the same FMA angle. There are a number of published papers that indicate that this is not the case [10–14]. A previously published study within our own patient population found that the FMA angle could vary between 2° and 9° [15]. This led to a change of our practice to adjust the femoral distal valgus resection angle to the individual patient's FMA angle. Recently a number of authors have drawn different conclusions as to whether it is appropriate to use the same fixed distal valgus resection angle for all patients [11,16]. However there is little published evidence on the actual effect of using a fixed or variable distal femoral resection angle with traditional instrumentation on postoperative lower limb alignment.

The aim of this study was to assess the postoperative coronal lower limb alignment of two groups of TKA patients, one where a fixed distal valgus resection angle was used and one where a variable one was employed. The hypothesis was that the use of a variable distal valgus resection angle would improve postoperative coronal lower limb alignment with more patients having alignment within ±3°. A secondary aim of the study was to confirm the findings of our previous publication [15].

Patients and Methods

This was a retrospective cohort study comparing two groups of patients. The local Research Ethics Service was approached and they determined that ethical approval was not required. Therefore the study was carried out under the clinical governance procedures of our institution.

All patients were under the care of the senior author (MS). The first group was all primary TKA patients operated on between January 2007 and October 2007 when his standard practice was to use a fixed distal valgus resection angle of 7° in all patients. The second was all patients between August 2008 and March 2009 when the standard practice was to adjust the distal valgus resection angle to the measured FMA angle of the patient. Patients who had both a pre-operative and post-operative Hip–Knee–Ankle radiographs (long leg films) available were included in the study. Those who either had radiographic data missing or had their TKA carried out using a computer navigation system were excluded.

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All TKAs in the study were either carried out or directly supervised by the senior author using a medial paratellar approach with Scorpio CR primary TKA components (Stryker, Kalamazoo, MI, USA). Medial releases during all the procedures were achieved by only exposing the antero-medial aspect of the proximal tibia. Lateral releases were not used in any cases.

The long-leg radiograph was an antero-posterior view of the knee joint including hip and ankle was taken at six-weeks post-operation using a standardised protocol. The patient assumed a bi-pedal stance 180 cm in front of the x-ray source tube (GE Definium 8000, Chalfont St Giles, Buckinghamshire, UK). The knee was rotated internally by 5° to bring the intercondylar line parallel to the plane of the detector. These radiographs were then stored in the Kodak Picture Archiving Communications System (PACS) (Eastman Kodak Company, 10.1_SP1, 2006, Rochester, NY, USA). On the radiographs the following anatomical points were identified; hip joint centre was identified using Moses circles [17]; knee joint centre was defined as the apex of the intercondylar notch; ankle joint centre was defined as the centre of the talus. The femoral anatomic axis was defined as a straight line along the mid-diaphyseal path of the femur. The femoral mechanical axis was given by a line joining the centre of the hip and knee and the tibial mechanical axis by a line joining the centre of the knee and the ankle. The FMA angle was then the angle between the femoral anatomic and mechanical axes and the MFT angle the deviation of the line joining the hip, knee and ankle centres away from 180° (Fig. 1). Varus knees were given a negative angle and valgus knees were given a positive angle.

Measurements were taken by four orthopaedic clinical fellows, two for each group. To assess the repeatability of the measurements of the radiographs for the Fixed group 48 radiographs that covered the range of deformities seen were selected (by AHD who was independent of the surgery or the measurement of the radiographs) and these were measured by both observers and twice by each observer. Eighty two of the radiographs from the Variable group were measured by both observers. The measurements for each group were taken independently, with the Fixed cohort being measured in January 2008 and the Variable cohort measured after the change in practice in September 2009. The clinical fellows measuring Variable cohort had no access to the post-operative results from the fixed cohort.

Other data were collected from the patient records (patient case notes and hospital databases).

There were initially 167 patients (170 knees) who had a primary TKA between January 2007 and October 2007 using a fixed distal femoral resection angle (Fixed group). Of these 25 knees had a TKA with computer navigation and a further 21 did not have both pre-operative and post-operative long leg radiographs. These were excluded, leaving 124 knees (121 patients) in the Fixed group. It should be noted that this is a subset of the patients reported in Deakin et al 2012 but due to the exclusions required for this second study the group is not exactly the same [15]. In the period from August 2008 to March 2009 when the variable resection angle was used (Variable group) there were 105 knees (104 patients). Of these 11 were operated on using a computer navigation system and 7 did not have both pre-operative and post-operative long leg radiographs available. Therefore the Variable group was 87 knees (86 patients). Demographic data are given in Table 1. Within the Variable group the set distal valgus resection angle differed by more than 1° from the measured FMA angle in nine patients. However these were all within 2° so were still included in the study. The distribution of resection angles used in the Variable group is given in Table 2.

Statistical Analysis

Statistical analysis was completed using SPSS 17.0 (IBM Corp, Somers, NY, USA). Statistical significance was set at $P < 0.05$. Intra and inter observer variability was assessed using the intra-class correlation coefficient. Correlation between FMA angle and pre-operative MFT angle was assessed using Peason's correlation coefficient. Comparison between FMA angle in males and females was made using a Mann–Whitney test. For each group the proportion with a post-operative MFT angle within ±3° were calculated and the groups compared using a Chi-squared test.

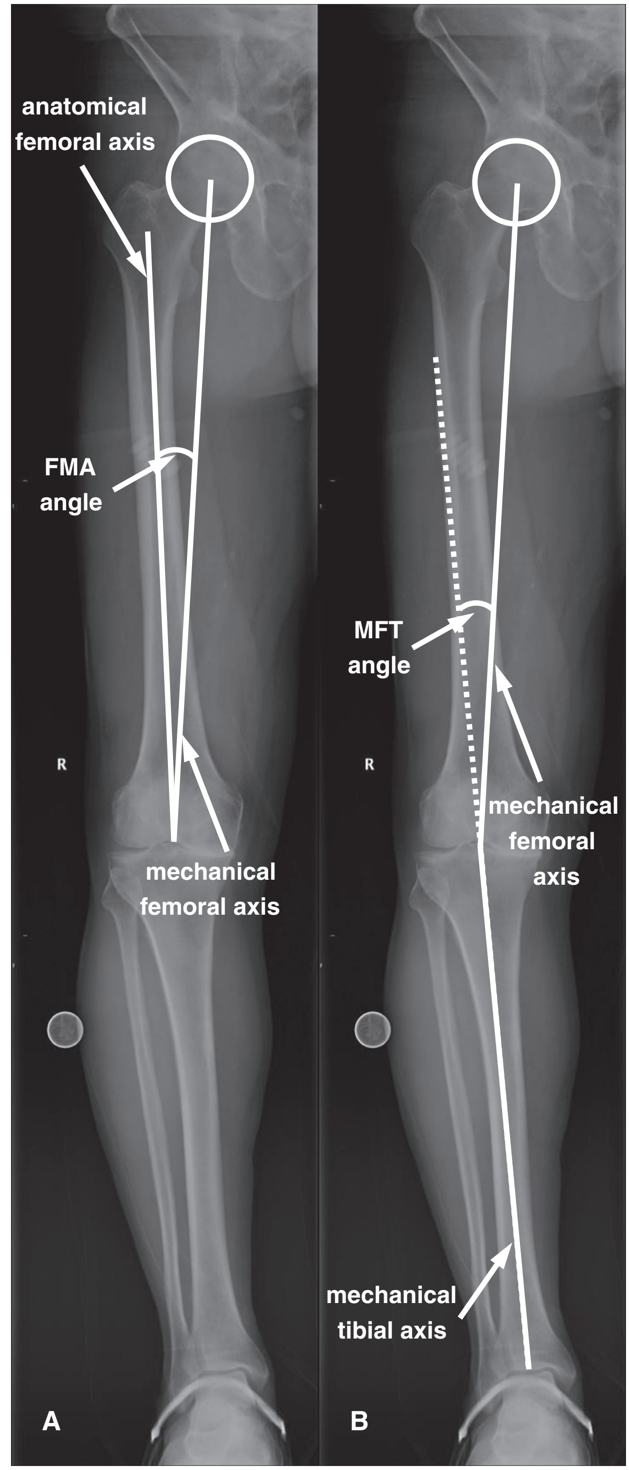

Fig. 1. Identification of hip, knee and ankle centres, construction of axes (mechanical femoral axis, mechanical tibial axis and anatomic femoral axis) and angles (A) FMA angle and (B) MFT angle.

Data were then divided into three subgroups based on pre-operative MFT alignment as defined in previous work [15]. These subgroups (moderate deformity (8° varus to 1° valgus), larger varus (>8° varus) and valgus (>1° valgus)) had been defined using cluster