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Hip–Knee–Ankle Radiographs Are More Appropriate for Assessment of Post-Operative Mechanical Alignment of Total Knee Arthroplasties than Standard AP Knee Radiographs

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ABSTRACT

Weight-bearing hip–knee–ankle (HKA) radiographs are the gold standard for measuring lower limb alignment after total knee arthroplasty (TKA), however the majority of UK units use standardised anteroposterior (AP) knee radiographs. This study aimed to determine whether standardised AP knee radiographs adequately assess lower limb alignment after TKA. HKA radiographs from 50 post-operative TKAs were cropped to the size of a standardised AP knee radiograph allowing comparison of mechanical and anatomical alignment measurements between the two views. Repeatability of alignment measurements was significantly better for HKA radiographs, however, there was poor agreement of the mechanical alignment measured between the two views. Standardised AP knee radiographs are insufficient to assess the mechanical alignment of post-operative TKA and we recommend routinely using HKA radiographs.

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Post-operative coronal alignment in TKA has been linked to implant longevity [1–3]. It is therefore important to accurately assess lower limb alignment post-operatively to identify implants that may be at risk of premature failure. While it is widely accepted that the gold standard coronal measurement in knee arthroplasty is the weight bearing HKA radiograph [4], the majority of institutions routinely use AP and lateral knee radiographs following arthroplasty. MRI and CT although widely available, are rarely used.

The recommendation to use HKA radiographs in TKA is longstanding [5,6] (Macquet, Moreland). Several studies have looked at native knees and shown that HKA radiographs are better than standardised AP knee radiographs (also called short views) for the assessment of alignment as a risk factor for progression of OA [7–9]. These focus on the classification of knees into varus, valgus or neutral. In this application, the classification of the alignment of into varus or valgus is important, the accuracy of the amount of deformity less so. However, for TKA it is important to know the mechanical femorotibial (MFT) angle. In addition, when looking at post-operative TKAs, the range of alignments seen is much smaller and the limits of acceptability (widely quoted as $\pm$ 3° from the mechanical axis) mean that it is important to be able to identify the mechanical alignment accurately. Although other authors [7,10] have looked at which constructions of the anatomical axes on standardised AP knee radiographs give the best agreement/correlation with the anatomical axes on HKA films, these are not directly relevant to post-operative TKA assessment. Some authors [7,9] have used the anatomical axes with an offset to quantify the mechanical alignment on a standardised AP knee radiograph and used this to compare with measurements taken from an HKA radiograph in the native knee. Ishii et al [11] looked at post-operative TKA radiographs and corresponding standardised AP knee radiographs. However, their work focuses exclusively on the anatomical axes, as did Peterson and Engh [12].

As there is wide variation in the angle between anatomical and mechanical femoral axes between individuals, in general anatomical alignment relates poorly to actual mechanical alignment [13]. These papers, as other authors [9–11], also used correlation between the two measurements, which gives no indication of the errors or variation that would be expected.

There are no published literature on the level of agreement between the mechanical alignment of a TKA on an HKA radiograph and on a standardised AP knee radiograph and so no clear evidence as to the magnitude of errors that might be expected. This is necessary to determine whether a standardised AP knee radiograph is suitable for post-operative TKA assessment. Therefore, the aim of this study was to see if any meaningful comment could be made on mechanical lower limb

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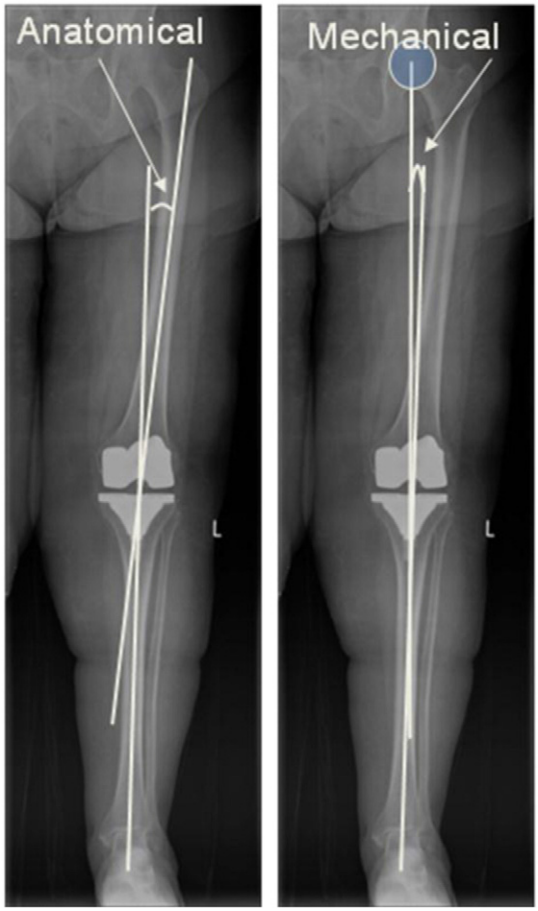

Fig. 1. Anatomical and mechanical axes on HKA radiographs.

alignment after knee arthroplasty using standardised AP knee radiographs by comparing the post-operative coronal alignment measured on standardised AP knee radiographs to the 'gold standard' HKA radiograph. The hypothesis was that the standardised AP knee radiograph would identify the same anatomical and mechanical lower limb alignment as the HKA radiograph, whether defined as a numeric angle or as a deformity (varus, neutral or valgus).

Materials and Methods

This was a retrospective study of data collected routinely as part of our patients' care and therefore did not require ethical approval [14].

Fifty consecutive HKA radiographs of patients who had undergone TKA at our institution were selected. These radiographs were taken at routine follow-up six weeks post-operatively and stored digitally on Kodak Picture Archiving Communications System (PACS). The HKA radiographs were taken as an antero-posterior view of the knee joint including hip and ankle. Patients were positioned in a bi-pedal stance at a standard distance of 180 cm in front of the x-ray source tube (GE Definium 8000). The knee was rotated internally by 5° to bring the intercondylar line parallel to the plane of the detector. The average total dose of radiation was 6.5 dGy.

As previously described [7,8,11] a standardised AP radiograph of the knee was generated from an HKA radiograph by cropping the image. Therefore any differences in measured implant orientation would be due to the interpretation of the radiographs rather than any other variables such as rotation. To size the standardised AP knee radiograph, we looked at 20 conventional standardised AP knee radiographs taken in our institution and measured the lengths (from the joint line) of tibia and femur that was visible on these radiographs. The mean of these values was then calculated and used to define the standard size view of the knee available on a standardised AP knee radiograph.

Fifty HKA and fifty generated standardised AP knee radiographs were measured independently at different times by one observer. On each radiograph the anatomical and mechanical axes of the femur and tibia were identified and the femorotibial angle calculated. Intra-observer and inter-observer reliability was established using a subset sample of 20 matched HKA and standardised AP knee radiographs and a second observer. All measurements were performed digitally using the PACS software measurement tools.

On HKA radiographs, the anatomical axes of the femur and tibia were defined by following the mid-diaphyseal path of each long bone [6]. The mechanical axes of the femur and tibia were generated using

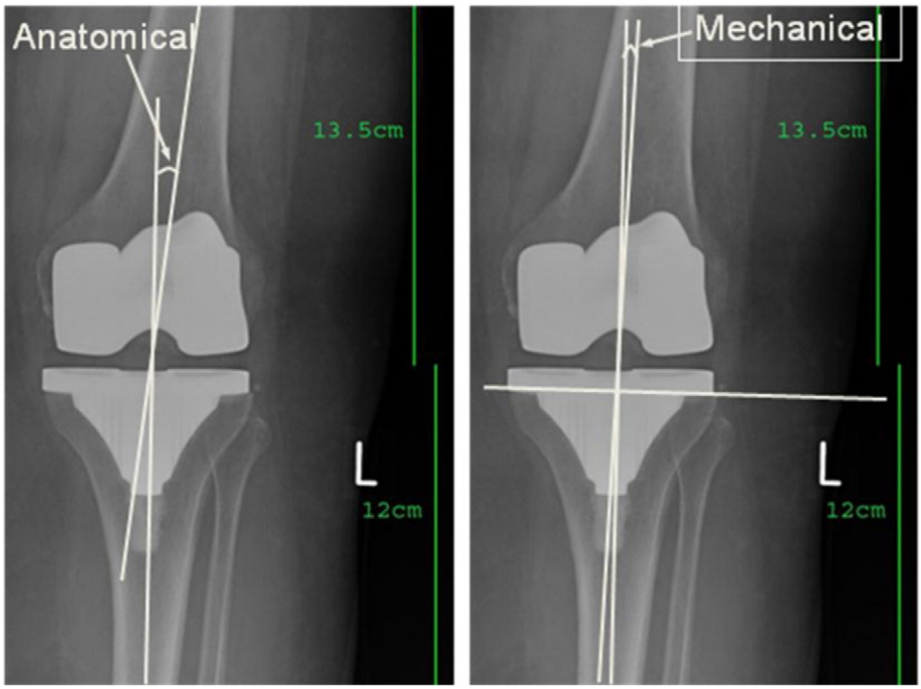

Fig. 2. Anatomical and mechanical axes on standardised AP knee radiographs.

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