

## Due to great variability fixed HKS angle for alignment of the distal cut leads to a significant error in coronal TKA orientation

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### PURPOSE

For coronal alignment in total knee arthroplasty (TKA) most surgeons use the patient's individual hip-knee shaft (HKS) angle (angle between the anatomical axis and the mechanical axis of the femur). The major problem of the sole use of HKS angle is that the individual patient's distal femoral asymmetry is not considered. The purpose of this study was to determine the variability of the HKS angle, the mechanical femoral angle (FMA) and to evaluate whether or not one of the two angles is more important for TKA alignment strategy. It was the hypothesis that HKS and FMA are not directly related to each other and hence HKS should not be considered as guide for coronal alignment.

### METHODS

Prospectively collected CT data of 1480 consecutive patients who underwent 3D reconstructed CT scans before TKA was used for this retrospective registry study [882 women and 598 men, mean age  $\pm$  standard deviation  $71 \pm 9$  years (34-99 years)]. The CT protocol was modified according to the Imperial Knee Protocol, which is a lowdose CT protocol that includes high-resolution 0.75-mm slices of the knee and 3-mm slices of the hip and ankle joints. All measurements were done using Symbios 3D knee preoperative planning's software (Symbios, Yverdon les Bains, Switzerland). The HKS, FMA and hip-knee-ankle (HKA) angles were measured. Angles measured were displayed as mean, standard deviation (SD) and range. In addition, the angles were shown as percentages after categorization. The HKS was categorized between  $3^\circ$  and  $9^\circ$  in  $1^\circ$  increments. The FMA was categorized between  $83.5^\circ$  and  $98.5^\circ$  in  $3^\circ$  increments. The HKA was categorized between  $12.5^\circ$  varus  $5.5^\circ$  valgus in  $3^\circ$  increments. Pearson correlations were used to investigate correlation of HKS and FMA ( $p < 0.05$ ).

### RESULTS

The HKS angle was not constant at  $7^\circ$  but averaged  $6^\circ$ , and ranged from  $2.5^\circ$  to  $9^\circ$ . The FMA angle was on average  $93^\circ$  but varied more than  $20^\circ$ , ranging from  $75^\circ$  (varus) to  $104^\circ$  (valgus). The mean HKA  $\pm$  SD was  $-3.4^\circ \pm 5.7^\circ$  (range  $-23.0^\circ$  to  $15.0^\circ$ ). The mean HKSSD was  $5.6^\circ \pm 0.9^\circ$  (range  $2.5^\circ$ - $8.8^\circ$ ). The mean FMA SD was  $92.6^\circ \pm 2.8^\circ$  (range  $75.2^\circ$ - $103.5^\circ$ ). The Pearson

correlations of all measured angles are presented in Table 1. HKS significantly correlated negatively with HKA and FMA ( $p < 0.001$ ). FMA and HKA were strongly correlated with each other ( $p < 0.0001$ ). Considering the HKS angle as a constant angle can induce a deviation of up to  $5^\circ$  with respect to an orthogonal distal femoral cutting objective. The great variability of the FMA angle implies that the FMA seems more relevant than the HKS angle to define the strategy of realignment of the lower limb. However, then patient specific instrumentation has to be used to precisely transfer the planning to the surgical technique. Having the aim of a more personalized TKA alignment in mind the individual constitutional knee phenotype should be taken into account.

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