Introduction:

Many surgical procedures of the knee, such as osteotomy and total arthroplasty, are dependent on properly assessing the mechanical alignment of the joint. Full leg standing (FLS) radiographs of the hip-knee-ankle (HKA) complex have long been considered the gold-standard for obtaining the proper measurements to restore mechanical axis alignment in surgical procedures [1].

One of the most common modes of failure for total knee arthroplasty is aseptic loosening of the components [2]. Aseptic loosening failure of both the femoral and tibial components has been shown to occur if the alignment of the knee occurs outside of ± 3° from the mechanical alignment in the coronal plane [3]. Proper mechanical alignment of the knee is dependent on the correct proximal varus/valgus tibia resection that is calculated from FLS radiographs. This study compares measurements made for tibial varus/valgus alignment from FLS radiographs to measurements made from anterior-posterior radiographs of just the tibia in an effort to show that FLS studies are accurate and robust enough, despite rotation that can be introduced due to the patient’s full leg deformity, to be used to correctly account for tibia bows in pre-operative planning for total knee arthroplasty.

Methods:

16 patients that were preparing to undergo total knee arthroplasty using patient specific cutting blocks received FLS radiograph studies as well as a separate, more focused anterior-posterior (AP) radiograph of just the tibia using an IDC Xplorer 1800 at 60 kVp and 10 mAs. The measurements obtained from the tibial radiograph served as reference points to which the FLS data was compared. From this point, the femur and tibia varus angle, full leg deformity, and tibia bow angle were calculated and recorded for each patient. Moreland defines the mechanical axis of the tibia to be a visually selected combination of the center of the soft tissue at the level of the cartilaginous space, the center of the tibia, the center of the femoral condyles at the level of the most proximal of the intercondylar notch, the center of the tibial spine, and the center of the femoral intercondylar notch to the center of the ankle joint [4]. For the purposes of this study, the tibial anatomical axis was calculated as the center point of the canal as measured from the medial to the lateral side. A tibia bow was found to be the difference, in degrees, between the tibial mechanical axis, as described above, and the tibial anatomical axis. All measurements were made by an experienced expert in the field and were blind with regard to soft tissue integrity and to all patient related demographic factors.

The mean difference between the mechanical axis derived from the FLS radiograph and the mechanical axis calculated from the individual tibia study was calculated to 0.25° with a standard deviation of ±0.24°. There were no obvious trends noted from the relation of full leg deformity, deformity type, or femur valgus angle to tibia bow measurements from both the FLS and individual tibia radiograph groups.

Discussion:

The importance of proper tibial component placement is crucial to positive outcomes in total knee arthroplasty when using patient specific cutting guides. In cases where there is a tibia bow, a correction is needed when placing the implanted components in alignment to the mechanical axis. FLS radiographs have been the standard to obtain the measurements needed to correct for tibia bows; however, in patients with severe deformities and osteoarthrits related wear, or even extreme amounts of pain, it may not be possible to obtain a FLS along the true anterior-posterior axis (Figure 1). The investigation we have performed has demonstrated that a FLS radiograph, regardless of overall deformity, has provided evidence that FLS studies are robust enough to provide data for tibial bow corrections when compared to tibia radiographs that are known to be along the AP axis.

The known, accepted criterion for increased implant survival is to be within ± 3° from the mechanical axis, as with every degree of increased mechanical varus, the risk of aseptic loosening increases 3.8-fold [3]. With n = 16 patients, the difference between FLS tibia bow measurements and tibia bows calculated from a single, isolated tibial radiograph, that was considered to be the ground truth, was found to be only, on the average, 0.25° with a standard deviation of ± 0.24°. The range of the differences between the two image acquisition techniques suggests that the maximum difference is not enough to reach the ± 3° deviation from the mechanical axis that acts as a catalyst for implant aseptic loosening.

Conclusions:

The rotation introduced to the knee joint from severe compartment wear or overall deformity is minimal and does not greatly impact tibia bow measurements. FLS radiographs provide accurate and precise measurements that are able to properly align total knee arthroplasty components to the mechanical axis when using patient specific cutting resection guides.

References: