Measuring acetabular component anteversion after total hip arthroplasty: CT or Plain Radiographs?
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INTRODUCTION:
Acetabular component version (ACV) is an important determinant of implant stability and bearing surface wear after total hip arthroplasty (THA). Accurate measurement of acetabular component anteversion and inclination is essential when evaluating patients with instability and/or pain after total hip arthroplasty (THA). The purpose of this study was to determine and compare the accuracy and reliability of measuring acetabular cup anteversion and inclination using plain radiographs and computed tomography (CT).

METHODS:
IRB approval was obtained for this controlled laboratory study. Twenty seven sawbones pelvises were implanted with an acetabular cup and a single screw using computer navigation at randomized degrees of anteversion and inclination, ranging from 30° of anteversion and 15° of retroversion, and 20° to 60° of cup inclination. Specimens were then securely fixed into radiolucent cardboard boxes after cup implantation so that the sacrum and bilateral posterior superior iliac spines (PSIS) were securely tied to the floor of the box to minimize pelvic tilt. Boxes were then covered with a lid to blind the radiology technician to the actual cup position.

AP pelvis, CT, cross table lateral (CTL), and modified CTL (MCTL) images were performed for each specimen. The modified cross-table lateral image was taken as the final image with the x-ray tube directed toward the pelvis at the exact angle of acetabular cup inclination as measured by the radiographer on the AP pelvis image, resulting in the x-ray beam being parallel to the base of the cup. (Figure 1)

Computed tomography (CT) of each specimen was performed on a 16-slice CT scanner acquiring 1mm contiguous axial images. Images were then manipulated through the use of a multiplanar reformatting function (MPR) in our Picture Archiving Communication System (PACS) into coronal and sagittal orthogonal images in order to accurately measure ACV. (Figure 2).

In order to ensure appropriate blinding and prevent bias, each radiograph or CT was assigned a randomized serial number, allowing the images to be dissociated from the specimen numbers so that one measurement would not influence the next. Two independent, blinded radiologists measured cup anteversion (for CT, CTL, MCTL) and inclination (AP pelvis) (Figure 3). Specimen characteristics were evaluated using means and standard deviations for continuous variables and frequencies and percentages for discrete variables. Intra- and Inter-rater correlations were calculated to evaluate measurement reliability. Finally, readings of the two raters were compared to the actual values, to evaluate the accuracy of the readings. To assess the precision of our estimates, 95% confidence intervals (95% CI) were calculated for each correlation with interpretations based on criteria described by Landis and Koch.

RESULTS:
Reliability measurements from all 4 imaging methods were in "almost perfect agreement" by Landis and Koch criteria. Inter-observer reliability was 0.994, 0.957, 0.987, and 0.987 for AP pelvis, CT, CTL, and MCTL respectively. Intra-observer reliability was 0.984 and 0.990 (AP pelvis), 0.946 and 0.978 (CT), 0.998 and 0.947 (CTL), and 0.999 and 0.956 (MCTL) for the 2 radiologists. Comparison of measurements to actual values demonstrated correlation coefficients of 0.988 and 0.988 (AP pelvis), 0.969 and 0.961 (CT), 0.962 and 0.865 (CTL), and 0.968 and 0.892 (MCTL) for the 2 respective radiologists.

DISCUSSION:
Using an AP pelvis radiograph, cup inclination can accurately and reliably be measured. Consistent with previously published data, CT imaging allows for the most accurate and reproducible measurement of acetabular cup anteversion after THA; however, a CTL radiograph is also highly reproducible and accurate.

SIGNIFICANCE:
In light of the added benefit of decreased cost and radiation exposure, we believe that the CTL radiograph remains a clinically useful imaging modality for the measurement of acetabular cup anteversion.