Variation in anatomical landmarks used for conventional cup alignment as measured by CT

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Introduction: Conventional methods of aligning the acetabular component during hip arthroplasty and hip resurfacing often rely upon anatomic information available to the surgeon. Such anatomical information includes the transverse acetabular ligament and the locations of the pubis, ischium and ilium. The current study assesses the variation in orientation of the plane defined by the pubis, ischium and ilium on a patient-specific basis as measured by CT.

Methods: To assess the reliability of anatomical landmarks in surgery, we assessed 54 hips in 51 patients (32 male, 22 female) who presented for CT-based surgical navigation of total hip arthroplasty. The HipSextant Research Application (version 1.0.7, Surgical Planning Associates Inc., Boston, Massachusetts) was used to perform the calculations. This application allows for determination of the Anterior Pelvic Plane coordinates from a 3D surface model. Standardized points on the ilium, ischium, and pubis were entered. To minimize the effects of the osteoarthritic process, on the pubis, the point chosen was 10mm from the acetabular rim and 10mm from the inferior border of the pubis. For the ischium, the point chosen was 10mm above the infracotyloid notch and just behind the posterior wall. For the ilium, the point chosen was 10mm above the lateral rim in the mid-coronal plane. These three points defined a plane and the orientation of the plane in the AP Plane coordinate system was calculated in degrees of operative anteversion and operative inclination according to the definitions of Murray¹.

Results: The plane representing cup position defined by the anatomical landmarks ranged from 7.8° to 64.6° in operative anteversion (mean = 32.1°, SD = 15.0°) and 37.6° to 68.2° in operative inclination (mean = 53.2, SD = 7.1°). If a safe zone of 27 degrees of operative anteversion (± 10°) and 42 degrees of operative inclination (± 10°) is selected, 50.0% of hips are out of the safe zone in operative anteversion, and 57.4% of hips are out of the safe zone in operative inclination. 83.3% of all hips are out of the safe zone in either operative anteversion, operative inclination, or both. If a safe zone of 20° of operative anteversion (± 10°) and 45° of operative inclination (± 10°) is assumed, 55.6% of hips are out of the safe zone in operative anteversion, 44.4% of hips are out of the safe zone in operative inclination, and 77.8% of hips are out of safe zone for either anteversion or inclination.

Discussion and Conclusions: Surgeons have very specific and limited anatomical information available at the time of surgery to assist in determining optimal component orientation². Alignment relative to the operating table and intraoperative signs such as the co-planar test are unreliable due to the wide variation of position of the pelvis during surgery. This leaves anatomical landmarks that can be palpated during surgery as one remaining method upon which component orientation may be based. Unfortunately, these anatomical landmarks vary quite widely on an individual patient basis, with 83.3% of hips out of the safe zone in this study of 27° of operative anteversion and 42° of operative inclination and 77.8% of hips out of a safe zone of 20 degrees of operative anteversion and 45 degrees of operative inclination. As such, internal anatomical landmarks are likely to lead to systematically high incidences of component malposition such as those repeatedly documented in the literature. Based on the current study we conclude that, unless the orientation of the palpable anatomical landmarks is assessed in three-dimensions pre-operatively, these anatomical landmarks provide poor and sometimes dangerously misleading information.
References