Variation in cup orientation using conventional cup alignment techniques as measured by CT

MURPHY WS¹, KOWAL JH², MURPHY SB¹

¹Department of Orthopedic Surgery, New England Baptist Hospital, Boston, USA
²University of Bern, Bern, Switzerland

stephenbmurphymd@gmail.com

Introduction: Cup malposition in hip arthroplasty and hip resurfacing is associated with instability, accelerated wear, and the need for revision. A recent study measuring cup orientation on conventional radiodiographs demonstrated an incidence of cup malpositioning of 50% according to the safe zone that they defined¹,². A prior study of 105 conventionally placed cups using CT demonstrated a cup malpositioning incidence of 74%³. The current study similarly assesses the variation in cup position using conventional techniques as measured by CT.

Methods: We have performed CT-based navigation of hip arthroplasty and revision arthroplasty on a routine basis since 2003 and also use CT imaging to quantify periprosthetic osteolysis. In our image database, we have identified 91 hips in 87 patients (51 female, 36 male) who had a previously conventionally-placed cup on CT imaging. For each hip, cup orientation was determined in operative anteversion and operative inclination (according to the definitions of Murray⁴) using an application specific software application (HipSextant Research Application 1.0.7, Surgical Planning Associates Inc., Boston, Massachusetts). This application allows for determination of the Anterior Pelvic Plane coordinates from a 3D surface model. A multiplanar reconstruction module allows for creation of a plane parallel with the opening plane of the acetabulum and subsequent calculation of plane orientation in the AP Plane coordinate space.

Results: The conventionally placed cups ranged from -7.2° to 57.5° in operative anteversion (mean = 30.2°, SD = 11.6°) and 18.4° to 68.1° in operative inclination (mean = 37.6, SD = 8.2°). If a safe zone goal of 27 degrees of operative anteversion (± 10°) and 42 degrees of operative inclination (± 10°) is assumed, 29.7% of hips are out of the safe zone of operative anteversion, and 25.3% of hips are out of the safe zone of operative inclination. 45.1% of all hips are out of the safe zone in either operative anteversion, operative inclination, or both. If a goal of 20° of operative anteversion (± 10°) and 45° of operative inclination (± 10°) is assumed, 55.0% of hips are out of the safe zone in operative anteversion, 44.0% of hips are out of the safe zone in operative inclination, and 70.3% of hips are out of one or both safe zones.

Discussion and Conclusions: Most conventionally placed acetabular components are malpositioned and the current study confirms prior reports of the incidence of cup malposition as measure both by CT and plain radiographs. It is curious that most experienced surgeons who perform total hip arthroplasty using conventional methods of cup alignment believe that their accuracy quite good. Yet, multiple objective studies of cup alignment demonstrate that accuracy is quite poor. Since cup malposition is so closely associated with instability, impingement, wear, bearing fracture, osteolysis and loosening, questions remain as to how conventional methods of cup alignment remain an acceptable standard of care in our field.

References
