The safe zone for acetabular component orientation

MURPHY WS¹, WERNER SD¹, KOWAL JH², MURPHY SB¹

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

stephenbmurphymd@gmail.com

Introduction: Wear, wear-associated osteolysis, and instability are the most common reasons for revision total hip arthroplasty. These failures have been shown to be associated with acetabular component malpositioning. However, optimal acetabular component orientation in general or on a patient-specific basis is currently unknown. Lewinnek¹ introduced the concept of a safe zone for acetabular component orientation based on plain radiographic measurements. The current study uses CT to assess acetabular orientation in a group of unstable hips as compared to a control group of stable hips.

Methods: Our institutional database of CT studies performed in the region of the hip beginning in February of 1998 (41,975 CT studies) was compared against our institutional database of revision total hip arthroplasties beginning in August of 2003 (2262 Revision THA) to identify CT studies of any hip treated for recurrent instability either by repeated closed reduction or revision of the acetabular component. Nineteen hips in 19 patients with suitable CT studies were identified for the study group. Our control group consisted of 53 hips in 51 patients who had CT studies either for computer-assisted surgery on the contralateral side or for assessment of osteolysis. Using the CT data, the AP plane (APP) was defined, supine pelvic tilt was measured, and cup orientation was calculated by fitting a best fit plane to 6 points on the rim of the acetabular component. Cup orientation was calculated in degrees of operative anteversion and operative inclination according to the definitions of Murray. Both absolute cup position relative to the APP and tilt-adjusted cup position² were calculated.

Results: The study group of 19 hips treated for instability showed a mean operative anteversion of 35.5 degrees (SD 17.7, range 6.6 to 62.7) and a mean operative inclination of 38.2 degrees (SD 10.8, range 24 to 56.3). The control group of 53 hips showed a mean operative anteversion of 30.0 degrees (SD 9.71, range 8.2 to 56.3) and a mean operative inclination of 37.7 degrees (SD 8.0, range 20.7 to 56.9). The variance of the angle of operative anteversion was greater for the hips treated for instability than for the control group (p=.001, Bartlett’s test for equal variances). The variance of the angle of operative inclination was not statistically greater in either group. Most interestingly, all of the hips treated for instability had an operative anteversion of either 18.9 degrees or less or 35.7 degrees or more or operative inclination of either 28.9 degrees or less or 56.3 degrees or more, or both. The center of the safe zone in this study is 27.3 degrees of operative anteversion and 42.6 degrees of operative inclination (Figure 1). Calculation of the safe zone with tilt-adjusted anteversion did not increase the size of the safe zone. 2 of 53 or 3.8% of hips in the control group were within 5 degrees of the safe zone center for both anteversion and inclination. 16 of 53 or 30.2% of hips in the control group were within 7.5 degrees of the safe zone center for both anteversion and inclination. 29 of 53 or 51.9% of hips in the control group were within 10 degrees of the safe zone center for both anteversion and inclination.

Discussion and Conclusions: Most conventionally placed acetabular components are malpositioned but not all malpositioned acetabular components are associated with dislocation. The hip dislocation safe zone appears to be narrower in operative anteversion than in operative inclination and so that safe zone is better represented graphically as an oval as opposed to a box. The safe zone identified in the current study relates only to instability. Optimal positioning for reducing wear may narrow the safe zone further, particularly as it relates to the upper limit of operative inclination. Improved methods of improving the accuracy and reliability of acetabular component placement may reduce the incidence of cup malposition and its associated complications.
References