The effect of total hip arthroplasty on pelvic tilt

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Introduction: While surgical navigation offers the opportunity to accurately place an acetabular component, questions remain as to the optimal goal for acetabular component positioning in individual patients. Overall functional orientation of the pelvis following surgery is one of the most important variables affecting the desired goal for acetabular component orientation. To study this issue, pelvic tilt before and more than a year after surgery was measured in patients treated by total hip arthroplasty.

Materials & Methods: Fifteen women and fifteen men who underwent computer-assisted CT-based navigation of acetabular component inserting during total hip arthroplasty were included in the current study. Each patient had anterior-posterior pelvis radiographs in the standing and supine positions prior to surgery. A high resolution pelvis CT scan was obtained for surgical navigation and preoperative planning. Post-operative supine and standing AP pelvic radiographs were again acquired at a minimum of one year after surgery. In order to be enrolled in the cohort, each subject needed the four radiographs with the anterior superior iliac spines and pubic symphysis visible to ensure accuracy of the analysis. The beam to X-ray plate distance was 40 inches. The mean age was 59.9 years (range 37 to 80). All surgeries were performed by one of the senior authors (SM) between July 2007 and May 2010.

For each image, pelvic tilt was calculated using a noncommercial two-dimensional/three-dimensional matching application (HipMatch; Institut for Surgical Technology and Biomechanics, Bern, Switzerland) [1]. This allows the user to calculate the pelvic tilt, or the angular difference between the anterior pelvic plane and the plane of the radiograph in the sagittal plane. HipMatch uses a fully automated registration procedure that can match the three- dimensional model of the preoperative CT with the projected pelvis on a postoperative radiograph. The details of the graphic matching algorithm, reproducibility and reliability have been previously reported.

To calculate pelvic tilt, a CT scan for each patient is segmented and a 3D model pelvis is produced. Points are placed on the 3D model pelvis to determine the anterior pelvic plane (APP). Landmarks are also entered onto the radiograph to allow for initial approximate alignment in order to minimize subsequent matching calculations. HipMatch then performs an automated 2D/3D matching algorithm to calculate the three-dimensional position of the pelvis at the time that the radiograph was acquired and superimposes a 3D model of the pelvis onto the radiograph at the completion of the calculation. HipMatch records the angle of the APP on the radiograph and reports the pelvic tilt as the angle in the sagittal plane between the Anterior Pelvic Plane and the plane of the radiograph. Pelvic tilt is positive if the anterior superior iliac spines are anterior to the pubic symphysis and negative if the pubic symphysis is anterior to the anterior superior iliac spines.

Statistical Methods: All analysis was performed with STATA statistical software (Release 10, StataCorp LP: College Station, TX). The assumption of data normality was tested with the Shapiro-Wilk test, and average preoperative and postoperative pelvic tilt was compared with a 2-tailed Student's T test. The Pearson correlation coefficient was used to determine association between preoperative and postoperative pelvic tilt.

Results: The mean supine pelvic tilt was 4.4° (95% CI 2.0° to 6.8°, range -7.7° to 20.8°) preoperatively and 6.3° (95% CI 3.9° to 8.8°, range -5.7° to 19.6°) postoperatively. The mean difference in supine pelvic tilt before and after THA was 1.9° (95% CI 0.7° to 3.2°, range -8.5° to 5.5°), (Figure 2). The change was statistically significant (p =.004). The preoperative supine pelvic tilt

was correlated to a postoperative supine pelvic tilt with a Pearson R^2 value was 0.75, representing very good correlation (Figure 3). Ninety percent of patients had a change in pelvic tilt within 5 degrees.

The mean standing pelvic tilt was 1.5° (95% CI -1.2° to 4.2°, range -13.1° to 12.8°) preoperatively, and 2.0° (95%CI -1° to 5.1°, range -12.3° to 16.8°) postoperatively. The mean difference in standing pelvic tilt before and after THA was 0.54° (95% CI -0.6° to 1.7°, range -5° to 7.2°). This change was not statistically significant (p =.34). The preoperative standing tilt was correlated with the postoperative tilt with an R^2 value of 0.87. Only two patients experienced change in pelvic tilt more than 5 degrees.

Discussion: The current study shows that in the population studied, pelvic tilt typically changes very little as a result of surgery and preoperative pelvic tilt is predictive of postoperative pelvic tilt in both the standing and supine positions. Between subjects, however, variability of pelvic tilt was high, suggesting that preoperative pelvic tilt should be considered when determining desired acetabular component positioning on a patient-specific basis.

References

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