Accuracy and precision of computer navigation in total hip arthroplasty

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Introduction: Restoration of normal hip biomechanics is vital for success of total hip arthroplasty (THA). This requires accurate placement of implants and restoration of limb length and offset. The purpose of this study was to assess the precision and accuracy of computer navigation system in predicting cup placement and restoring limb length and offset.

Material and Methods: An analysis of 259 consecutive patients who had THA performed with a particular imageless computer navigation system was carried out. All surgeries were done by single surgeon using similar technique. Bony landmarks were palpated while patient in lateral decubitus position, irrespective of patients BMI. Intraoperative goal was to place cup in “safe zone” of abduction and anteversion, i.e. 45°±10° for abduction and 15°±10° for anteversion. Acetabular cup abduction and anteversion were calculated in postop radiographs and assessed for the cup placement in safe zone. Medialisation or lateralisation of offset and limb length change were also compared between navigation measurements and follow-up radiographs. Precision, accuracy, sensitivity and specificity were calculated to assess navigation for cup orientation and student t-test used for evaluation of offset and limb length change. A p value of <0.05 was considered significant for evaluation.

Results: There were 145 females and 114 males with mean age of 67 years (SD, 9.4). Mean BMI of patients was 29.69 (SD, 5.33). Mean cup abduction and anteversion was 40.35° (SD, 5.81) and 18.46° (SD, 6.79) in postop radiographs compared to 41° (SD, 5.03) and 14.76° (SD, 6.11) for navigation measurements. Intraoperative navigation measurements had high precision and specificity for determining cup abduction and anteversion (precision >95%, specificity >90%). Accuracy for determining cup abduction was 96.13% compared to 72.2% for cup anteversion. Change in limb length and offset was mean 6.46mm (SD,5.68) and -1.07mm (SD,5.75) on radiograph evaluation and 5.41mm (SD,5.11) and -2.24mm (SD,5.87) from navigation measurements, the difference being not significant in both (p value>0.2). Radiograph and navigation had a mean difference of 1.01mm (SD, 2.83) for offset measurements and a mean difference of 1.05mm (SD, 4.37) for postop limb length assessment.

Discussion: To the best of our knowledge this is the largest single surgeon study of navigated THA. We first to point out that the data reported here is from the use of one specific imageless computer navigation system used and for the technique used in palpatating and registering the bony landmarks in patients in lateral decubitus position. We chose postoperative radiographs for comparison, as this method of determining postoperative cup position is the most commonly used technique used in routine practice by majority of surgeons, inspite of the fact that there may be errors in obtaining the values of inclination and anteversion from the radiographs. We found that computer navigation assessment of acetabular cup abduction and anteversion and limb length and offset restoration has high probability of predicting correct placement of implants. To conclude, navigation can serve as an excellent tool for appropriate placement of implants and restoring limb length and offset in total hip arthroplasty.