Effect of incorrect docking on clinical accuracy of the HipSextant™ navigation system

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Introduction: Cup malposition leads to increased incidences of dislocation, impingement, wear, and revision. The HipSextant navigation system is a smart mechanical navigation device designed to indicate correct cup orientation at surgery. The system has proven to be accurate and reliable in clinical practice¹. The current study assesses the effect of deliberately mis-docking the device on clinical accuracy.

Methods: Ten patients (5 men and 5 women) presenting for total hip arthroplasty were assessed. Planning for the HipSextant Navigation System (Surgical Planning Associates, Inc., Boston, MA) was performed as usual. This is done by first creating a 3D surface model from CT imaging, establishing an Anterior Pelvic Plane coordinate system, and then creating a patient-specific HipSextant coordinate system. This coordinate system is defined by three points. The first point, called the basepoint, is located just behind the posterior wall of the acetabulum a fixed distance above the infracotyloid notch. The second point is located on the lateral aspect of the anterior superior iliac spine. The third point is located on the surface of the ilium and equally distant from the other two points. These three points define a patient-specific coordinate system that is known relative to the APP. Clinically, the instrument is then docked according to the plan and two protractors on the top of the instrument allow a direction indicator to point in the direction of desired cup orientation.

For each of the hips, after the HipSextant plan was created (Figure 1), two

Figure 1. HipSextant docked on a patient specific basis with the basepoint in the standard location behind the posterior rim of the acetabulum.
additional plans were created: one where the basepoint was docked 5mm closer to the infracotyloid notch than originally planned and one where the basepoint was docked 5mm further from the infracotyloid notch than originally planned. The effect of the deliberate mis-docking was measured in degrees of operative anteversion and operative inclination.

**Results:** Docking the basepoint 5mm lower than planned led to an average increase in anteversion of 2.5 degrees, a range of 2 to 3 degrees, and a standard deviation of 0.5 degrees and an average decrease in inclination of 0.5 degrees, a range of 0 to -2 degrees, and a standard deviation of 0.7 degrees. Docking the basepoint 5mm higher than planned led to a decrease in anteversion of 2.4 degrees, a range of 0 to -3 degrees, and a standard deviation of 1 degree and an average increase in inclination of 0.1 degrees, a range of 1 to -1 degrees, and a standard deviation of 0.7 degrees.

**Discussion:** Improving cup orientation on a routine clinical basis remains an important and challenging problem in hip arthroplasty. Traditional navigation techniques can lead to improved accuracy but their use has not been adopted on a routine basis, possibly due to the additional time, complexity, and expense associated with these technologies. The application of robotics to this problem further exaggerates these problems. Simple smart mechanical navigation instruments will likely play an increasing role due to their efficiency, simplicity, and accuracy. Since mechanical navigation instruments self-register, there is no ability to calculate the registration accuracy intra-operatively as might be done with image-based navigation systems. The effect of docking a mechanical navigation instrument incorrectly then becomes an increasingly important question. The current study demonstrates that mis-docking of the HipSextant navigation system leads to relatively small errors when compared to the errors of traditional navigation systems which have cumulative registration, tracking errors. Deliberate mis-docking of the instrument affects accuracy in anteversion more than inclination. The very widely based percutaneous docking of the instrument system may contribute to its resilience.

**References**