

Clinical Accuracy of a Novel Patient-Specific Instrumentation System (Trinity OPS) for Acetabular Cup Orientation

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Introduction

Appropriate acetabular cup orientation is an important factor in reducing instability and maximising the performance of the bearing after Total Hip Arthroplasty (THA). However, postoperative analyses of two large cohorts in the US have shown that more than half of cups are malorientated. In addition, there is no consensus as to what inclination and anteversion angles should be targeted, with contemporary literature suggesting that the orientation should be customised for each individual patient.

The aim of this study was to measure the accuracy of a novel patient specific instrumentation system in a consecutive series of 22 acetabular cups, each with a customised orientation.

Methodology

Twenty-two consecutive total hip replacement patients were sent for Trinity Optimized Positioning System (OPS) acetabular planning (Optimized Ortho, Sydney). The Trinity OPS planning is a preoperative, dynamic analysis of each patient performing a deep flexion and full extension activity. The software calculates the dynamic force at the hip to be replaced and plots the bearing contact patch as it traces across the articulating surface. The software modelled multiple cup orientations and the alignment which best centralised the load was chosen by the surgeon from the preoperative reports. Once the target orientations had been determined, a unique patient specific guide was 3D printed and used intra-operatively with a laser guided system to achieve the planned alignment, Fig 1. All patients received a post-operative CT scan at 3 months and the radiographic cup inclination and anteversion was measured. The study was ethically approved by The Avenue Hospital Human Research Ethics Committee, Trial Number 176.

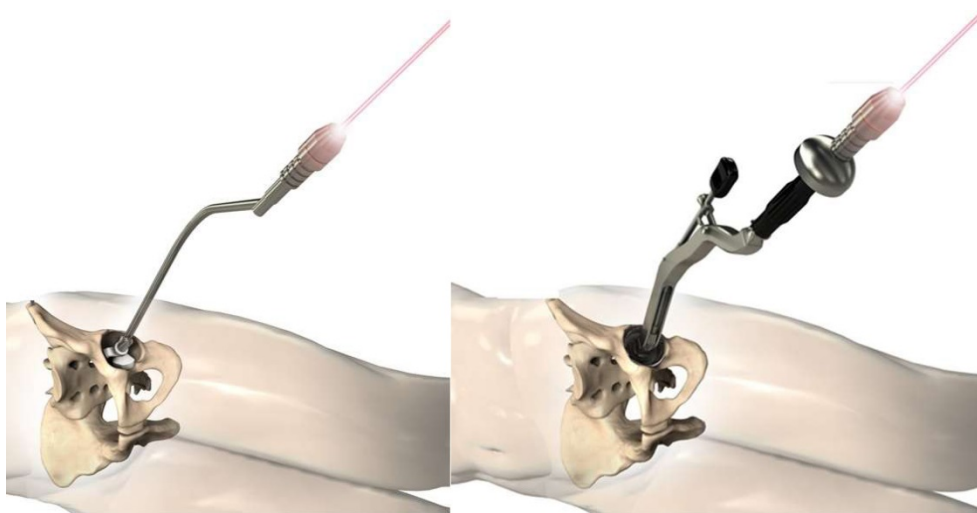


Fig 1. The Trinity OPS™ patient specific guide is used with laser alignment to achieve the desired acetabular cup orientation

Results

The mean planned radiographic inclination, reference to the Anterior Pelvic Plane (APP), was 42.8° (range $36.2^\circ - 50.1^\circ$). The mean planned radiographic anteversion, reference to the APP, was 28.3° (range $19.4^\circ - 37.0^\circ$). Only 23% of the planned orientations fell within Lewinnek's "safe zone", taking into consideration that that this safe zone is not comparable to the coronal plane of radiographs. However, all 22 cups were planned within a range of $40^\circ \pm 10^\circ$ of inclination and $25^\circ \pm 10^\circ$ of anteversion, when referenced to the coronal plane when supine. The mean inclination difference between the planned and achieved orientations was -1.3° (range $-7.6^\circ - 9.2^\circ$). The mean anteversion difference was 1.2° (range $-5.3^\circ - 7.0^\circ$). The mean absolute difference was 4.2° for inclination (range $0.4^\circ - 9.2^\circ$) and 3.6° for anteversion (range $0.6^\circ - 7.0^\circ$). All 22 cups were within $\pm 10^\circ$ of their intended target orientation, Fig 2.

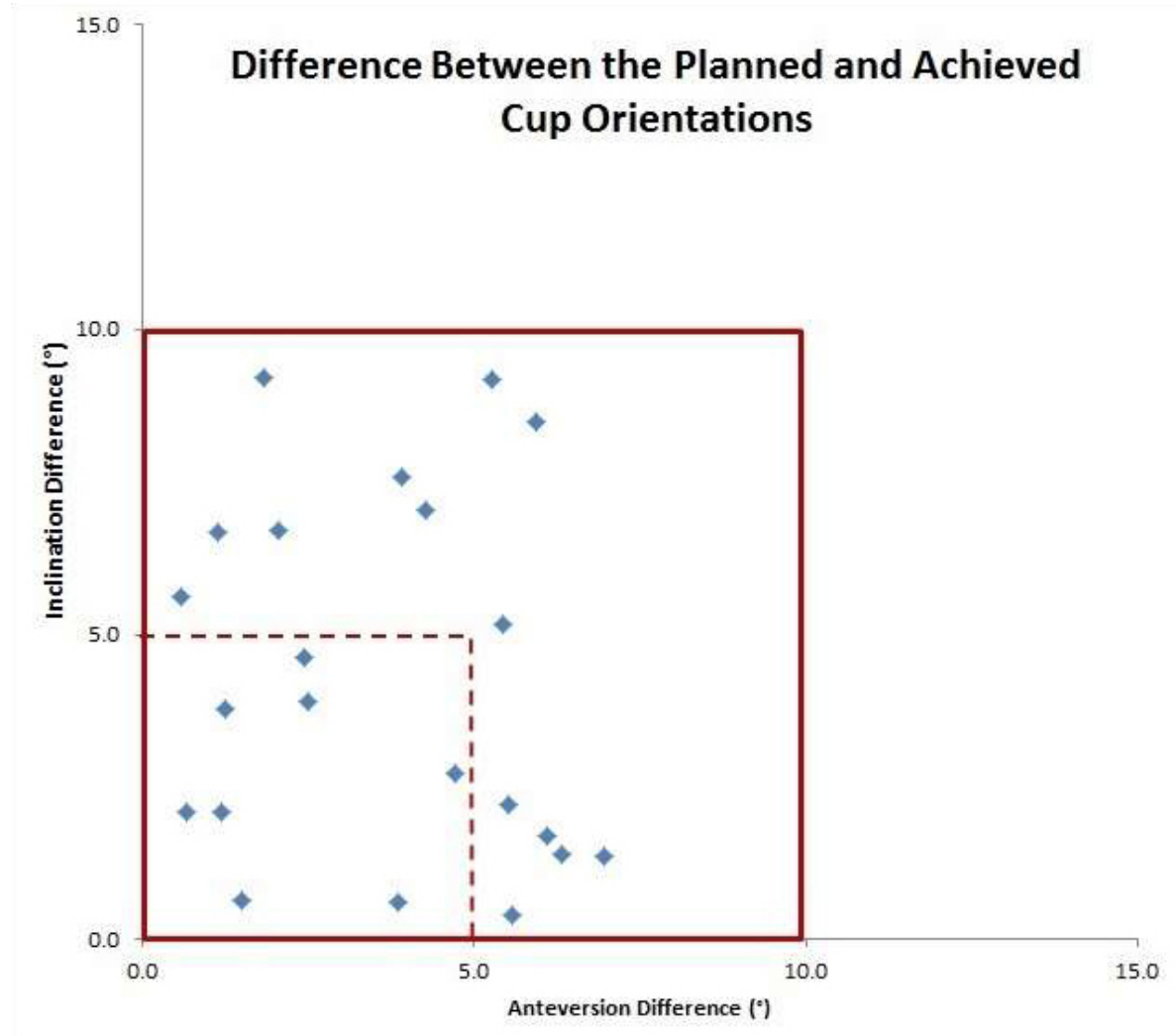


Fig 2. The absolute inclination and anteversion difference between the planned and achieve cup orientations

All 22 cups were within the range of $40^\circ \pm 10^\circ$ of inclination and $25^\circ \pm 10^\circ$ of anteversion, when reference to the coronal plane when supine, Fig 3.

Post-op Supine Cup Orientations from CT

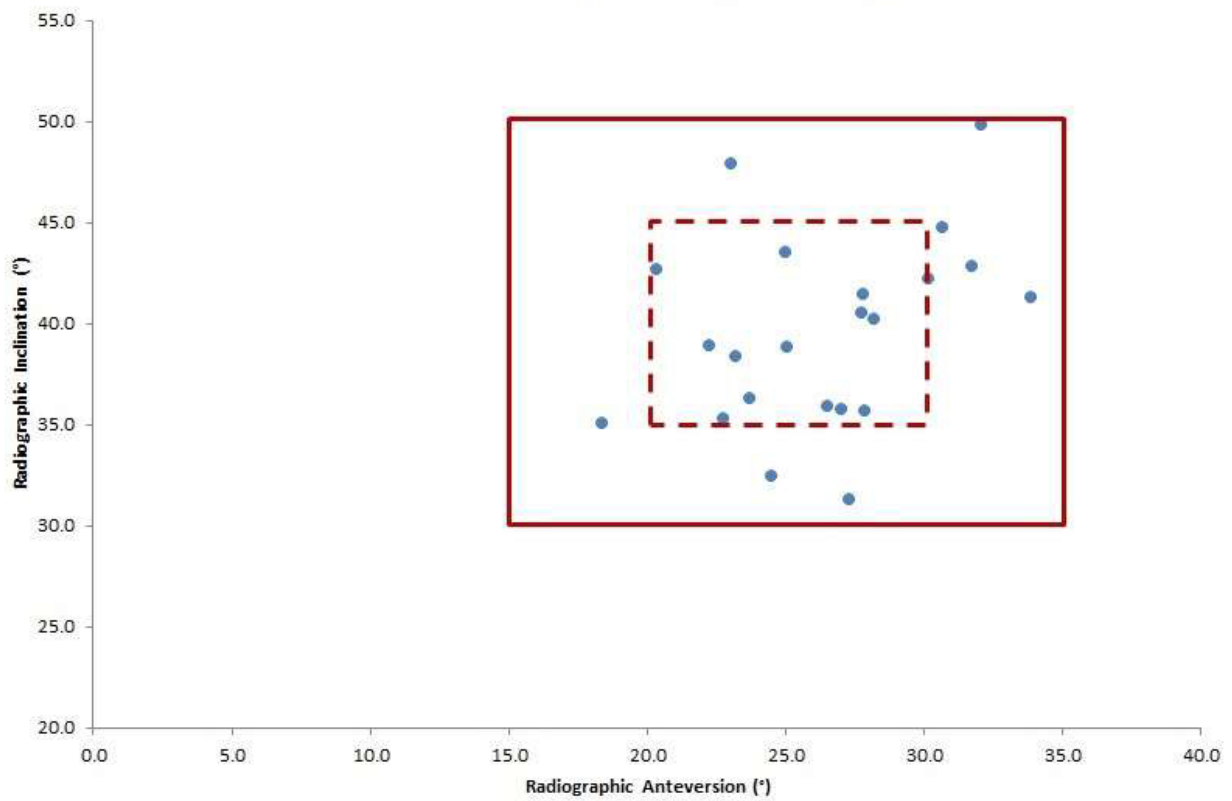


Fig 3. Postoperative cup orientations of all 22 patients measured to the coronal plan when supine using CT

Conclusions

These are the early results of a new technology for planning and delivering a customised acetabular cup orientation. We expect further improvements in accuracy with current developments. However, the results suggest that Trinity OPS is a simple way to achieve a patient-specific cup orientation, with accuracy comparable to imageless navigation.