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Comparison of cemented versus uncemented acetabular component positioning using an imageless navigation system.

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Abstract

Hip Navigation was used as an assessment tool to compare ability to reproduce trial and definitive acetabular placement in total hip replacement, using cemented and uncemented components. We demonstrated a significant difference in reproducibility between components. Four of 20 (20%) uncemented cups deviated from the target inclination by 5 degrees or more compared to none of 21 in the cemented group (p=0.048). Seven of the 20 (35%) of the uncemented cups deviated from the target version by 5 degrees or more compared to none of 21 in the cemented group (p=0.003). This may explain higher rates of revision for dislocation with uncemented components. There was also a significant difference between the groups with regard to deviation from planned leg length (p<0.001).

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Introduction

Component position is an important factor in function and longevity of total hip replacement. Navigation was developed to improve accuracy of component implantation and provide real time feedback to the operating surgeon. Cemented, hybrid and uncemented hip replacements remain in common use (1), and all have their advocates. Both devices have advantages and disadvantages for specific patient characteristics. A recent paper by Conroy et al (2) reviewing Australian National Joint Registry data demonstrated a higher incidence of revision for dislocation with the use of uncemented acetabular components than cemented. In their review of the registry data they reported a 1.59 relative risk of dislocation requiring revision for patients undergoing primary THR with an uncemented acetabular component as compared to patients with a cemented cup. One of the potential causes of dislocation of THR is malposition of the components, in particular the position and orientation of the acetabular component.(3-5) Our study hypothesis was that malpositioning of THR components may be more prevalent with uncemented components and may be a contributing factor to the higher dislocation rate reported with their use. The navigation system was used as our measurement tool to compare the accuracy of our definitive component position with the desired position achieved at trial reduction. This study compares these parameters for patients undergoing THR with cemented and uncemented components.

In a sub group of these patients, the ability to restore leg length was also assessed.

Materials and Methods

Forty one patients were included in this prospective comparative study. All patients provided informed consent to participate in the study, which was approved by our institutional review board. All patients undergoing primary THR were eligible for inclusion in the study. Patients were examined preoperatively and leg lengths determined clinically and radiographically, and target leg length recorded. The decision to use cemented or uncemented components was consistent with the surgeon's preference and usual practice.

All procedures were carried out by the senior authors (Author5 and Author6) both of whom are experienced in navigated surgery and with the use of cemented and uncemented implants and there was no significant difference in outcome between surgeons. The Stryker™ imageless navigation system was used for all procedures which is accurate to 0.5°. Registration was performed supine and the patient then repositioned and secured in the lateral decubitus position in standard fashion. All procedures were performed through a standard posterior surgical approach and differed only in the type of component implanted and mode of fixation. The operating surgeon elected to use either a cemented Contemporary Exeter cup and an Exeter Universal stem (cemented group); or a press fit Trident cup and Securefit stem (uncemented group), on the basis of patient age, activity and surgeon preference.

Intraoperative data was collected with respect to acetabular component position and orientation using the navigation system as well as information regarding leg length. The version and inclination were recorded for the acetabulum at reaming, trial reduction, and after insertion of the definitive acetabular component. (Figure 1) The “target” position of version and inclination was determined by the surgeon and was individualized for each patient. This was declared and recorded prior to definitive implantation. During component insertion, live feedback from the navigation system allows component adjustment to target position. Once seated, no further readjustments were made. At implantation, the ability to reproduce the target cup position determined in the trialing stage was assessed. (Figure 1)

Statistical analysis

The mean and 95% confidence intervals (or median and interquartile range (IQR) for non parametric data) were determined for each measure in both groups. Differences between the study groups were determined with use of Analysis of Variance (ANOVA) and the nonparametric Mann-Whitney U test for independent samples where appropriate with a significance level of 5%. Levene’s test for homogeneity of variance was also used to determine differences in the variability of the two groups. Comparison of frequencies was made using the chi-squared test or Fishers Exact test where appropriate. Adjustment for multiple testing was made using the Bonferroni correction where necessary.

Results

There were forty one navigated THR’s performed with twenty one in the cemented group and twenty in the uncemented group. The average age at operation was 56.6 (SD 8.7) in the uncemented group and 72.4 (SD 11.5) in the cemented group. This difference was statistically significant at the 5% level when tested using ANOVA ($p<0.001$), which is not unexpected given the nature of the operative choice of implant. Fifty percent of the uncemented and 43% of the cemented group were males ($p=0.65$). There were 9 (45%) left sided operations in the uncemented group, and 12 (57%) in the cemented group (not significant, $p=0.44$). Eighteen of twenty (90%) of the uncemented group had an initial diagnosis of osteoarthritis, one for avascular necrosis and one of slipped upper femoral epiphysis, with 19 of the 21 (90.5%) of the cemented group being for osteoarthritis, one for avascular necrosis and one for inflammatory arthritis. The mean BMI for the uncemented group was 26.5 (SD 4.8) and for the cemented group was 28.1 (SD 7.9) which was not statistically significant ($p=0.43$). There were no dislocations in either group.

Overall there was no significant difference between the two groups with respect to definitive cup inclination and version (table 1) when adjusted for multiple testing. However, deviation of inclination from target position was significantly more in the uncemented group ($p=0.009$) and deviation from target for both inclination ($p=0.013$) and version ($p<0.001$) were significantly more variable in the uncemented group using the Levene's test for homogeneity of variance based on the median. Four of the 20 (20%) of the uncemented cups deviated from the target inclination by 5 degrees or more compared to none from the cemented group ($p=0.048$). Seven of the 20 (35%) of the uncemented cups deviated from the target version by 5 degrees or more compared to none from the cemented group ($p=0.003$).

Planned leg length discrepancy was recorded in 11 (55%) of uncemented and 12 (57%) of the cemented cases. Postoperative leg length discrepancy as expressed by the navigation system was used to calculate deviation from planned leg length. There was a significant difference between the groups with regard to deviation from planned leg length ($p<0.001$). Deviation from target leg length of greater than 5mm was found in 36.4% of the uncemented cases as compared to 8.3% of the cemented cases although due to the small numbers this was not statistically significant ($p=0.16$).

Discussion

Dislocation and impingement remains a problem in THR. There are several factors implicated in dislocation. These include soft tissue tension and offset, bone or soft tissue impingement, implant design, and patient related factors.(6) However, component malposition, especially of the acetabular component, remains responsible for the majority of dislocations.(3-5) Furthermore, malposition of the acetabular component predisposes to accelerated component wear, pelvic osteolysis and acetabular migration.(7) In an analysis of 58,109 THR's from the Australian National Joint Replacement Registry (2), 428 (0.7%) revisions were performed for recurrent dislocation. 369 (0.8%) (of a total of 49,027) of these were associated with an uncemented acetabular component and 59 (0.6%) (of a total of 9,082) with a cemented cup. This equates to a relative risk for dislocation requiring revision of 1.59, but given the small percentage difference, the clinical significance of this finding remains uncertain.

Based on the above we hypothesized that malpositioning may be more prevalent with uncemented components and may be a contributing factor to the higher dislocation rate. Our results show there is statistically significant reduction in accuracy of cup placement in both version and inclination with the use of uncemented components. This deviation occurs at the time of impaction of the implant and is probably multifactorial in origin. The uncemented cup used in this study obtains a scratch fit with the host bone and due to variances in both the bone and component surfaces may influence the final seating position of the implant. The long lever arm of the cup introducer magnifies small changes in position alterations at the time of implantation and may contribute to larger deviations from the target position seen with uncemented acetabular components. The use of a cemented cup allows some flexibility at the time of implantation and adjustment to the final seating position can be made during cementation which may be more difficult with an uncemented cup.

Although actual leg length differed significantly between the groups, the small numbers available has significantly reduced the power of this test, and so the number of cases with a deviation from target greater than 5mm is not statistically significant. However, although we were unable to demonstrate this in this study, the figures indicate that with more cases, target leg length would be more attainable in cemented than uncemented hips.

Conclusions

This study demonstrates the greater ability to consistently position cemented acetabular components in comparison with uncemented components. Since this study was completed, both senior authors have modified their method of uncemented cup insertion. Our current practice is for the operating surgeon to stabilize the introducer with both hands whilst the assistant seats the component. Further development of more precise instrumentation and/or improvement in surgical technique to improve the accuracy of insertion for uncemented components in total hip arthroplasty is required.

Tables and figures

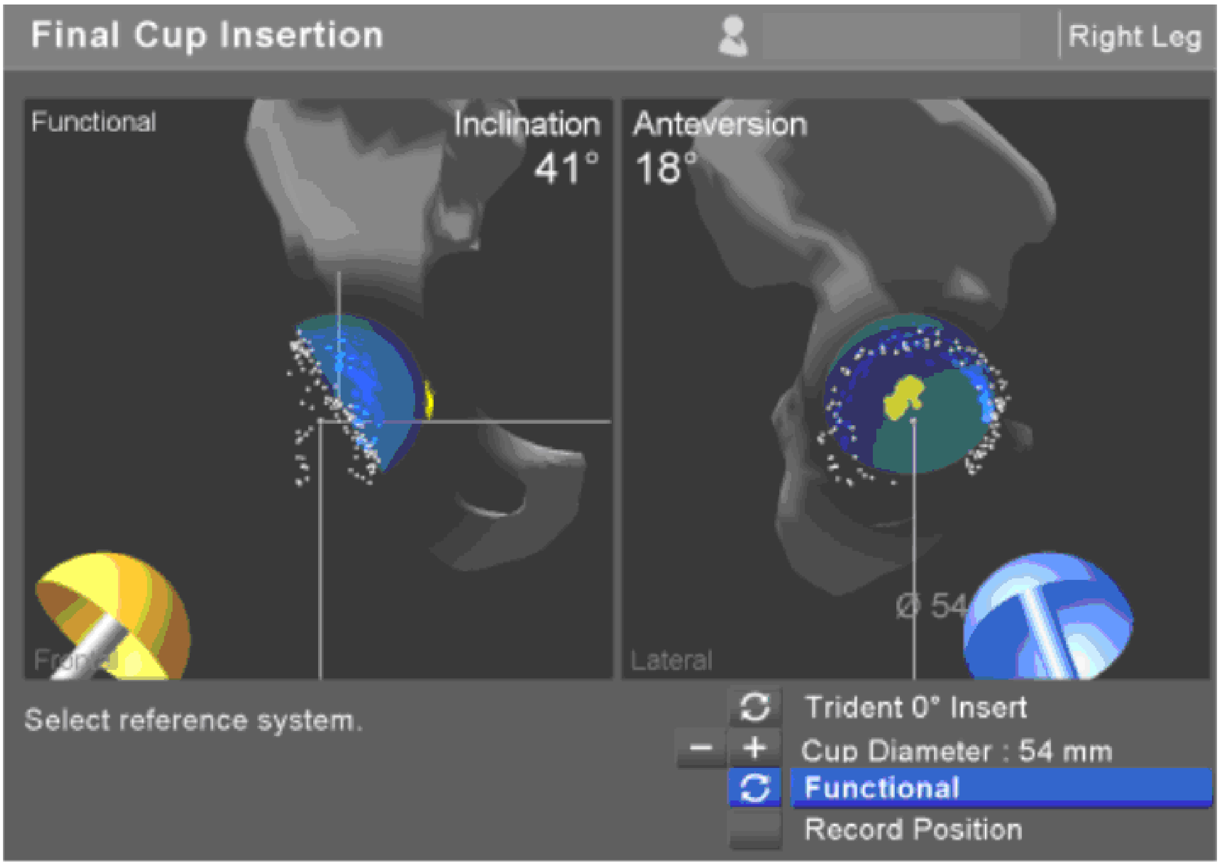

Figure 1: Navigation screen at trial stage

	Cemented	Uncemented	p-value (Mann Whitney test)	p-value (Levene's test)
Median (IQR) Inclination	45 (3)	47 (4)	0.052	0.952
Median (IQR) Version	25 (14)	24 (16)	0.556	0.801
Median (IQR) Deviation from target - inclination	0 (1)	1 (3)	0.009*	0.013*
Median (IQR) Deviation from target - version	0 (0)	1 (7)	0.406	<0.001*
No (%) deviating from target ≥5° – inclination	0/21 (0%)	4/20 (20%)	0.048 (Fishers Exact test)	
No (%) deviating from target ≥5° – version	0/21 (0%)	7/20 (35%)	0.003* (Fishers Exact test)	

* significant at 5% with adjustment for multiple testing

Table 1: Median (IQR) cup inclination and version and deviation from target ≥5° for both groups with p-values for tests

	Cemented	Uncemented	p-value
Planned leg length	5 (5)	7.6 (SD 6.0)	0.213
Deviation from planned leg length	0 (5)	4 (5)	<0.001*
No (%) deviation from planned leg length >5mm	0 (8.3)	4 (36.4%)	0.16
n	12	11	

* significant at 5% with adjustment for multiple testing

Table 2: Median (IQR) planned leg length and deviation from planned leg length.

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