

Comparison of Limb-length Discrepancy After THA: With and Without Computer Navigation

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abstract

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Limb-length discrepancy following total hip arthroplasty (THA) is often cited as a reason for patient dissatisfaction and for hip instability. Various intraoperative techniques have been described to help restore normal limb length after THA. The purpose of this study was to assess whether a computer-navigated surgical technique would help restore limb-length equality following THA.

A retrospective study of 150 consecutive patients compared a free-hand (non-navigated) THA technique vs a computer-navigated THA technique. Each group contained 75 patients. The primary outcome measurement was limb-length discrepancy, which was evaluated using a digital anteroposterior pelvic radiograph. Secondary outcome measurements included a Harris Hip Score questionnaire and a single question evaluating the subjective feeling of the operative limb (longer, shorter, or equal). At a minimum 1-year follow-up, results showed that computer-navigated THA helped restore limb-length equality. An average leg-length difference of 0.3 mm (SD=0.3 mm) was found with computer-navigated THA compared with a leg-length difference of 1.8 mm (SD=0.7 mm) when a non-navigated THA was used. This was statistically significant. Both groups had similar Harris Hip Scores (computer-navigated group, 84.8; non-navigated group, 84.2; $P=.835$), and no difference was found between the 2 groups regarding the patient's perception of the operative limb length.

This study demonstrated that computer-navigated THA resulted in improved restoration of normal limb length and limited significant outliers but did not show improvement in Harris Hip Scores or patient's perception of limb-length equality.

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The authors have no relevant financial relationships to disclose.

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doi: 10.3928/01477447-20130426-13

Total hip arthroplasty (THA) is a successful surgery. Satisfaction rates and long-term survival are commonly reported as being greater than 90%.¹ However, limb-length discrepancy is common after THA. Recently, interest in computer navigation has increased. The use of computer navigation can potentially minimize surgical error and allow for improved and consistent placement of implant components. Previous studies have shown improved alignment accuracy regarding total knee arthroplasty implants, and more recently in THA implants.^{2,3} Limited published data specifically examine using computer navigation to successfully restore limb-length equality.^{4,5} The goal of this study was to evaluate the efficacy of computer navigation in regard to restoring limb-length equality. The hypothesis was that computer navigation would offer an advantage in restoring limb-length equality and improve postoperative function.

MATERIALS AND METHODS

After institutional review board approval was obtained, the authors retrospectively reviewed the charts of 150 patients who underwent THA between May 2007 and October 2010. All surgeries were performed by a fellowship-trained surgeon (J.L.O.) at 1 institution using a standard posterior approach. Prior to 2009, the primary surgeon (J.L.O.) used a standard technique to assess leg lengths using preoperative radiographic templating. Intraoperatively, knee and foot lengths between the limbs were assessed for equality after trial neck lengths and implant placement. Soft tissue tensioning and stability were checked using range of motion and shuck tests, essentially using a free-hand (non-navigated) technique. After 2009, the surgeon began using computer navigation to achieve appropriate limb length and offset.

Seventy-five consecutive patients were chosen for each group for the study. Inclusion criteria were patients with unilateral

hip degenerative changes due to isolated osteoarthritis or avascular osteonecrosis. Exclusion criteria were bilateral joint disease, posttraumatic arthrosis, hip dysplasia, and the absence of an adequate, non-rotated, postoperative anteroposterior pelvis radiograph. Digital radiographs were reviewed by an investigator (D.J.B.) using the universal picture archiving and communication system (UniPACS; MediVision, Israel). These radiographic images were used to measure limb lengths to the nearest 0.1 mm. The authors used the method reported by Kjellberg et al⁶ to evaluate limb-length equality. The current authors' secondary outcome measure involved using a modified Harris Hip Score questionnaire. The questionnaire was administered at a minimum of 1 year postoperatively.

Statistical analysis was performed using bivariate analysis *t* tests to assess for statistical differences between baseline characteristics, postoperative limb-length discrepancy, and modified Harris Hip Score between the 2 groups. The authors also assessed whether limb-length dis-

Table 1

Patient Demographics

Parameters	Mean±SD	P
Age, y		.658
Navigated	67±1.2	
Non-navigated	66.1±1.5	
Side		.416
Left	5.67±7.2	
Right	4.68±7.5	
Preoperative discrepancy, mm		.301
Navigated	4.5±0.9	
Non-navigated	5.8±0.7	

Table 2

Postoperative Leg-length Discreoancy and Modified Harris Hip Scores

Parameters	LLD Mean±SD	P
Postoperative discrepancy, mm		.008
Navigated	0.3±0.3	
Non-navigated	1.8±0.7	
Harris Hip Score		.835
Navigated	84.8±2.0	
Non-navigated	84.2±1.8	

Abbreviations: LLD, leg-length discrepancy.

Table 3

Effect of Leg-length Discrepancy on Modified Harris Hip Score

LLD	HHS, Mean±SD	Post Hoc	P
0-4.9 mm	84.2±14.6	1& 2	.504
5 -9.9 mm	89.5±9.9	2&3	.154
≥10 mm	78.4±15.7	1&3	.649

Abbreviations: HHS, Harris Hip Score; LLD, leg-length discrepancy.

crepancy was associated with changes in the modified Harris Hip Score by stratifying the leg-length discrepancies into 3 groups based on the discrepancy amount (0-4.9 mm; 5-9.9 mm, and 10 mm or

more). The authors performed a post hoc test of analysis of variance using the Bonferroni-Dunn Test to calculate the *P* value among the 3 groups of limb-length discrepancy in regard to the modified Harris Hip Score. The authors assessed whether computer-navigated surgery was more likely to be associated with the perception of limb-length equality by the patient using Pearson's chi-square test. Statistical significance was set at a *P* value of .05.

Computer-navigation Technique

The authors used the Orthosoft Hip 2.2 Universal Surgical Technique (Zimmer, Warsaw, Indiana) to help restore leg length and offset. The authors modified the standard technique and used the software to assess limb length and offset only. The technique first involves placing an electrocardiogram lead on the patella as a marker prior to prepping. Once surgery begins, 2 threaded pins are placed into the iliac crest near the anterosuperior iliac spine to which a tracking device is attached. A baseline recording is then taken using a registration pointer and a Mayo stand to define the plane of the table. Next, a standard posterior approach is performed. Before dislocation, another marker is placed using a 6.5×15-mm cancellous screw in the greater trochanter.

At this point, the baseline orientation of the femur is calculated by using the computer software to digitize the markers on the greater trochanter and patella with the registration pointer. Once completed, the operation continues in the standard fashion. After the acetabulum is exposed and the labral tissue is excised prior to reaming, the center of rotation of the acetabulum is digitized using the registration pointer. The acetabulum is then reamed in the standard fashion, and a cup and liner are placed. When the liner is placed, a second center of rotation is recorded. The femoral component is then prepared, and various trial neck lengths and offsets can be used to assess limb-length and offset changes by reducing the

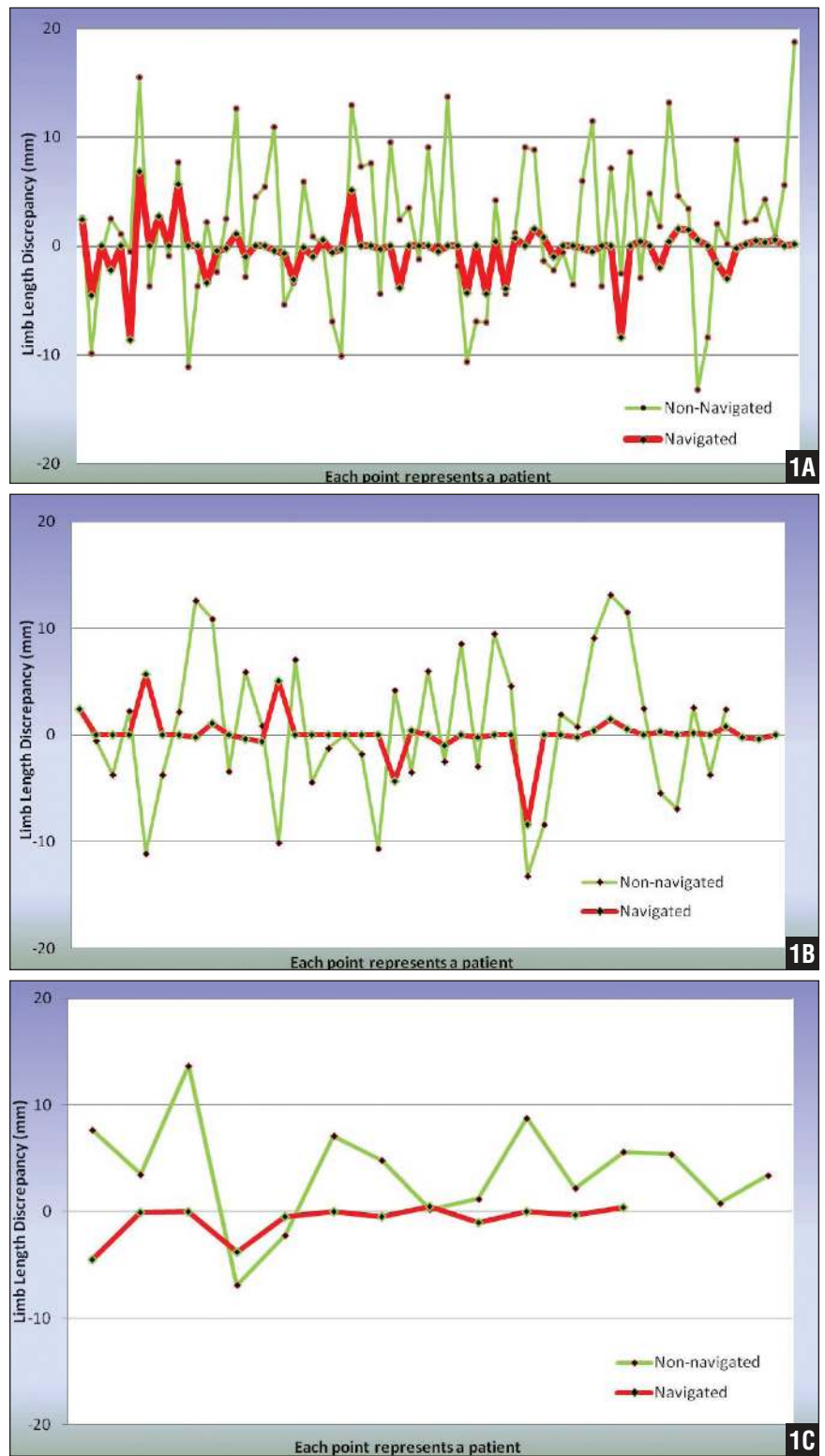


Figure 1: Comparison of leg-length discrepancy between the navigated and non-navigated total hip arthroplasty groups (A). Comparison of leg-length discrepancy in patients who felt their limb lengths were the same between non-navigated and navigated total hip arthroplasty (B). Comparison of leg-length discrepancy in patients who felt their limb lengths were different between non-navigated and navigated total hip arthroplasty (C).

Table 4

Perception of Leg-length Discrepancy After Total Hip Arthroplasty^a

Group	Patient Perception		Total
	Not Same	Same	
Non-navigated	15	40	55
Navigated	12	44	56
Total	27	84	111

^aPearson chi-square=0.5148 and Pr=0.473.

trial components and using the registration pointer to digitize the markers on the femur to assess changes in limb length and offset from the baseline orientation. This can be repeated with different trials as needed. The desired final limb length and offset changes of the diseased hip are based on the assessment of the preoperative template radiographs.

RESULTS

No preoperative statistical differences existed between the computer-navigated and non-navigated groups in age, operative limb side, or limb-length discrepancy (Table 1). Evaluation of postoperative limb-length inequality showed a statistically significant difference between the computer-navigated and non-navigated groups. Computer-navigated THA was more likely to achieve equal or near equal limb lengths than non-navigated THA (Table 2). When the outliers were assessed, no patients in the computer-navigated group had a limb-length discrepancy greater than 1 cm. In contrast, 11 (15%) of 75 patients in the non-navigated group had a limb-length discrepancy greater than 1 cm. No difference existed in the modified Harris Hip Scores between the 2 groups (Table 2). Similarly, when the limb-length discrepancies were stratified, no significant differences were detected in the modified Harris Hip Score, although a limb-length discrepancy of greater than 1 cm had the lowest average score of the

er-navigated group than the non-navigated group (79% vs 73%, respectively), it was not statistically significant.

DISCUSSION

Due to the significant benefits of regional anesthesia, the authors' institution began to use a combined spinal and epidural anesthetic in 2007. However, a decrease was noted in patient satisfaction with regard to leg lengthening after THA. It was thought that the motor blockade component of the regional anesthetic was altering the authors' interpretation of the stability of the soft tissues intraoperatively.⁷ With the recent advancement of computer-navigated surgery, the authors questioned whether this would be a useful tool to help restore limb-length equality after THA.

The computer-navigated group had significantly less limb-length discrepancy postoperatively compared with the non-navigated group (Table 2, Figure 1A). The computer-navigated group had no limb-length discrepancy outliers (greater than 1 cm). With regard to the clinical outcomes, no difference was detected between the 2 groups. No patient in either group required a shoe lift or had a postoperative hip dislocation. Inconsistencies existed between the patients' subjective and actual leg lengths. Many patients with a limb-length discrepancy approaching 1 cm or greater thought that their limb lengths were equal (Figure 1B). However,

3 subgroups (Table 3). Last, the perception of limb-length equality was not improved using computer navigation.

other patients with a limb-length discrepancy approaching 0 cm felt a subjective leg-length discrepancy (Figure 1C). The reasoning behind this is likely multifactorial, and computer-navigated THA did not improve this problem (Table 4).

This study had several limitations. First, it was a nonblinded, retrospective study in which 1 subinvestigator reviewed the radiographic outcomes. This introduces measurement bias into the radiologic measurements. However, the reduction of limb-length discrepancy outliers with the use of computer navigation was a real finding. Second, the accuracy in the use of radiographs to assess limb length has been debated and remains in question. Third, the intraoperative assessment of limb length using a non-navigated technique is varied. Possibly, the use of an intraoperative ruler technique or Steinmann pin to assess limb lengths may have been more helpful and may have changed the results. Last, the functional outcome follow-up was approximately 75%. The results may have been different with a longer follow-up or a larger overall study.

CONCLUSION

Computer-navigated surgery helped restore a more normal leg-length equality and remove the limb-length discrepancy outliers of greater than 1 cm after THA with the use of regional anesthesia. However, the restoration of limb-length equality did not lead to a better functioning hip or improved perception of limb-length equality, which raises the question of whether the added time and cost with the use of computer-navigated surgery was necessary in this situation. More studies with longer follow-up are needed to help determine the true benefits of using computer navigation in THA. □

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