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HIP – LEG LENGTH AND OFFSET

Kelley T.C. and Swank M.L. (2009)

- Using CAS leads to more accurate positioning within the safe zone (inclination between 30° and 50°, anteversion between 5° and 25°)
- CAS improves acetabular component position and can enable minimal invasive hip surgery
- Navigated THA may become standard of care
- Navigation helps quantifying changes in leg length

Manzotti A. et al. (2009)

- Limb length restoration significantly better in THR with computer navigation.
- Computer navigation represents practical way to achieve a more anatomical hip arthroplasty

Lecerf G. et al. (2009)

- Femoral offset restoration is essential for function, joint stability and implant longevity.
- Navigation systems permit proper restorations of limb length and improve femoral offset restoration, as well.

Murphy S.B. and Ecker T.M. (2007)

- The Brainlab navigational measurement algorithm to determine the leg length is efficient, reliable and reproducible.
- Additional benefits like accelerated recovery and less invasiveness are reached with a reliable computer-assisted leg length measurement.

Renkawitz T. et al. (2010)

- With pinless navigation reliable leg length and offset measurements are reached.
- Pinless navigation avoids the pin-related risks like fracture, infection or pin loosening.

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Role of Navigation in Total Hip Arthroplasty

Role of Navigation in Total Hip Arthroplasty

J Bone Joint Surg Am. 2009 Feb; 91 Suppl 1:153-8

Kelley T.C. and Swank M.L.

ABSTRACT

Current uses of computed tomography-based and imageless navigation systems for total hip arthroplasty include proper placement of the acetabular component, measurement of limb-length changes, enablement of minimally invasive surgery, and proper placement of components for hip resurfacing procedures.

This article provides an overview of the rationale for computer-assisted surgery in total hip arthroplasty and hip resurfacing.

The experience of the senior author (M.L.S.) with computer-assisted surgery for hip arthroplasty has demonstrated improved position of the acetabular component as compared with the position attainable with use of mechanical instruments, maintenance of appropriate position of the acetabular component during minimally invasive surgery, and appropriate positioning of the femoral and acetabular components during the learning curve for hip resurfacing procedures.

SUMMARY

The authors highlight key aspects in total hip arthroplasty (THA) like cup positioning and leg length measurement. Proper cup positioning,according to this paper, not only prevents impingement and dislocation but also pelvic osteolysis, acetabular migration and implant wear.

Mechanical alignment guides show clear limitations in accurate and precise positioning of implants whereas CAS, after a learning curve, provides for decreased variability with regard to orientation of the acetabular component and increased accuracy.

CONCLUSION

Using CAS leads to more accurate positioning within the safe zone (inclination between 30° and 50°, anteversion between 5° and 25°)

“(…) recent literature has demonstrated that the percentage of cetabular components being placed in the target safe zone was higher in computer-navigated hips than in nonnavigated controls, with less variation in implant position.”

CAS improves acetabular component position and can enable minimal invasive hip surgery

“Computer-assisted surgery has contributed to reproducible and accurate positioning of hip arthroplasty implants.Computer navigation for minimally invasive approaches as well as hip resurfacing continues to evolve.”

(continued…)

Navigated THA may become standard of care
“Taking into account the economic considerations of long-term implant survivorship, computer-assisted total hip arthroplasty may become the standard of care.”

Navigation helps quantifying changes in leg length
“Postoperative limb-length inequality remains a major cause of patient dissatisfaction and litigation after hip replacement. Navigation has shown potential to help quantify intraoperative limb length and potentially reduce the risk for postoperative limb-length inequality.”
Additionally Renkawitz et al. recently “found femoral pinless leg length and offset measures reliable in conjunction with an imageless navigation technique of realignment during THA” performing a study on 18 cadaveric hips

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Does computer-assisted surgery benefit leg length restoration in THR? Navigation versus conventional freehand

Int Orthop 2011 Jan;35(1):19-24.

Manzotti A. et al.

ABSTRACT

Leg length discrepancy following total hip replacement (THR) can contribute to poor hip function. Abnormal gait, pain, neurological disturbance and patient dissatisfaction have all been described as a result of leg length inequality after THR. The purpose of this study was to determine whether the use of computer navigation in THR can improve limb length restoration and early clinical outcomes. We performed a matched-pair study comparing 48 computer-assisted THR with 48 THRs performed using a traditional freehand alignment method. The same implant with a straight non-modular femoral stem was used in all cases. The navigation system used allowed the surgeon to monitor both acetabular cup placement and all the phases of femoral stem implantation including rasping. Patients were matched for age, sex, arthritis level, pre-operative diagnosis and pre-operative leg length discrepancy. At a minimum follow-up of six months, limb length discrepancy was measured using digital radiographs and a standardised protocol. The number of patients with a residual discrepancy of 10 mm or more and/or a post-operative over-lengthening were measured.

The clinical outcome was evaluated using both the Harris Hip Score and the normalised Western Ontario and McMaster Universities (WOMAC) Arthritis Index. Restoration of limb length was significantly better in the computer-assisted THR group. The number of patients with a residual limb length discrepancy greater than 10 mm and/or a post-operative over-lengthening was significantly lower. No significant difference in the Harris Hip Score or normalised WOMAC Arthritis Index was seen between the two groups. The surgical time was significantly longer in the computer-assisted THR group. No post-operative dislocations were seen.

SUMMARY

Matched pair study with a comparison of 48 computer-assisted THA (used Brainlab navigation) with 48 free-hand alignment THA surgeries. The limb length was determined pre-operatively and 6 months post-operatively.

The clinical outcome was evaluated using two different scores and revealed better outcome for navigated hips, whereas not significant.

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✓ CONCLUSION

Limb length restoration significantly better in THR with computer navigation.

“[…] our results demonstrated that in THR computer navigation significantly improves the restoration of limb length.”

“In the computer-assisted group, the mean post-operative leg length discrepancy was reduced to 5.06 mm (range: 0–12) compared to 7.64 mm (range: 0–20) in the freehand group.”

Computer navigation represents practical way to achieve a more anatomical hip arthroplasty

“We believe that computer navigation of both the femoral stem and acetabular cup in THR represents a practical way to achieve a more ‘anatomical hip arthroplasty’.”

BRAINLAB

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Femoral offset: Anatomical concept, definition, assessment, implications for preoperative templating and hip arthroplasty

Orthop Traumatol Surg Res. 2009 May;95(3):210-9

Lecerf G. et al.

ABSTRACT

There is a strong correlation between femoral offset, abductors lever arm and hip abductor strength. Hip lateralization is independent of the femoral endomedullary characteristics. The abductors lever arm is highly correlated to the gluteus medius activation angle. There were correlations between femoral offset and endomedullary shape. The hip center was high and medial for stovepipe metaphysis while it was lower and lateralized for champagne flute upper femur. A study was performed to compare the femoral offset measured by X-ray and CT-scan in 50 patients, demonstrated that plain radiography underestimates offset mea surement. The 2D templating cannot appreciate the rotation of the lower limb. Taking into account the horizontal plane is essential to obtain proper 3D planning of the femoral offset. A randomized study was designed to compare femoral offset measurements after hip resurfacing and total hip arthroplasty. This study underlined hip resurfacing reduced the femoral offset, while hip replacement increased offset. However, the reduction of femoral offset after hip

resurfacing does not affect the function. A pilot study was designed to assess the results of 120 hip arthroplasties with a modularfemoral neck

This study showed that the use of a modular collar ensures an easier restoration of the femoral offset. A cohort of high offset stems (Lubinus 117◦) was retrospectively assessed. The survival rate was slightly lower that the standard design reported in the Swedish register. Finally, the measurement of offset and leg length was assessed with the help of computer assistance. The software changed the initial schedule (obtained by templating) in 29%. Conclusion. Therefore, femoral offset restoration is essential to improve function and longevity of hip arthroplasty.

CT-scan is more accurate than plain radiography to assess femoral offset. Hip resurfacing decreases offset without effect on function. Modular neck and computer assistance may improve intraoperative calculation and reproduction of femoral offset. Increasing offset with a standard cemented design may decrease long-term fixation.

SUMMARY

In this collection of independent anatomic,radiological and clinical works the implications of femoral offset for THA and preoperative templating are assessed.

The authors compile how to measure femoral offset and show the impact and methods of restoring the femoral offset in THA.

✓ CONCLUSION

Femoral offset restoration is essential for function, joint stability and implant longevity.

“[…] femoral offset restoration is essential to improve function and longevity of hip arthroplasty”

“Femoral offset restoration is recognized as an important part of THA procedure to improve joint stability and implant longevity.”

Navigation systems permit proper restorations of limb length and improve femoral offset restoration, as well.

“[...] the use of a navigational system allows proper restoration of limb length in all patients, by intraoperatively informing the surgeon of the changes to bring to reach the planned objectives. It also improves both offset and length which restoration is only limited by intraoperative selection of the available prostheses.”

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Evaluation of a New Leg Length Measurement Algorithm in Hip Arthroplasty

Stephen B. Murphy, MD, and Timo M. Ecker, MD

Evaluation of a New Leg Length Measurement Algorithm in Hip Arthroplasty.

Clin Orthop Relat Res. 2007 Oct;463:85-9

Murphy S.B. and Ecker T.M.

ABSTRACT

Leg length inequality after hip arthroplasty is a major source of patient dissatisfaction and dysfunction. Despite numerous reported methods to intraoperatively determine leg length change, it remains a challenge. We developed a reliable and reproducible method to measure leg length change using surgical navigation. The method measures the change in position of the femur relative to the pelvis and the pelvic coordinate system without the need to establish a femoral coordinate system. We replaced 112 hips using the new leg length measurement algorithm. Leg length change measured at surgery was compared with leg length change as measured on magnification-corrected pre- and postoperative radiographs. Compared with radiographically measured leg length change, the leg length changes measured intraoperatively

had a mean difference of −0.5 ± 1.77 mm (range, −5–3.9 mm).

We found no difference between radiographic data and navigation data. Leg length change measured using surgical navigation, measuring the change in position of the femur relative to the pelvic coordinate system, without establishing a femoral coordinate system is easy and reliable.

Level of Evidence: Level IV, therapeutic study. See the Guidelines for Authors for a complete description of levels of evidence.

SUMMARY

Within a therapeutic study including 107 patients the leg length change was measured in 112 THA surgeries using a CT-based hip navigation system (Brainlab®hip CT) with a newly developed measurement algorithm.

Comparing these results with the radiographically measured leg length change revealed no differences. The authors conclude that the navigational measurements are reliable and reproducible.

CONCLUSION

The Brainlab navigational measurement algorithm to determine the leg length is efficient, reliable and reproducible.

“Our data demonstrate this method of measuring leg length change during surgery is efficient, reliable and reproducible.”

Additional benefits like accelerated recovery and less invasiveness are reached with a reliable computer-assisted leg length measurement.

“Thus, reliable computer-assisted methods of measuring leg length may be even more important to allow the benefits of accelerated recovery with tissue-preserving, less invasive arthroplasty techniques without creating larger difficulties with management of leg length change.”

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Leg Length and Offset Measures with a Pinless Femoral Reference Array during THA.

Clin Orthop Relat Res. 2010 Jul; 468(7):1862-8

Renkawitz T. et al.

ABSTRACT

The bony fixation of reference marker arrays used for computer-assisted navigation during total hip arthroplasty (THA) theoretically involves the risk of fracture, infection, and/or pin loosening. We asked whether intraoperative assessment of leg length (LL) and offset (OS) changes would be accurate using a novel pinless femoral reference system in conjunction with an imageless measurement algorithm based on specific realignment of

the relationship between a dynamic femoral and pelvis reference array. LL/OS measurements were recorded during THA in 17 cadaver specimen hips.

Preoperatively and postoperatively, specimens were scanned using CT. Linear radiographic LL/OS changes were determined by two investigators using visible fiducial landmarks and image processing software. We found a high correlation of repeated measurements within and between (both 0.95 o greater) the two examiners who did the CT assessments. Pinless LL/OS values showed mean differences less than 1 mm and correlations when compared with CT measurements.

SUMMARY

In this case study including 10 specimens it was analyzed if the intraoperative leg length and offset changes could be measured accurately using a pinless and imageless CAS procedure (Brainlab navigation used).

The results of 17 THA surgeries were compared to an analysis of pre- and postoperative CT scans made by two examiners. The authors report a high correlation of the leg length and offset measurement methods.

CONCLUSION

With pinless navigation reliable leg length and offset measurements are reached.

“We found a high correlation of repeated measurements within and between […] the two examiners who did the CT assessments. Pinless LL/OS values showed mean differences less than 1 mm and correlations when compared with CT measurements.”

“We found femoral pinless LL and OS measures reliable in conjunction with an imageless navigation technique of realignment during THA in an experimental cadaver study.”

(continued…)

Pinless navigation avoids the pin-related risks like fracture, infection or pin loosening.

“[…] bony fixation of reference marker arrays used for navigation theoretically involves the risk of fracture, infection, and/or pin loosening”

“Application of noninvasive, femoral pinless reference systems could further reduce the risks of systems depending on pins while minimizing the risk of LL discrepancies.”