SAGE Open Medical Case Reports

SAGE Open Medical Case Reports
Volume 7: 1–4

DOI: 10.1177/2050313X19827743
journals.sagepub.com/home/sco
SAGE

Computer-assisted navigation as a diagnostic tool in revision total hip arthroplasty: A case report

Wayne G Paprosky[1], John Vincent[2], Jennifer R Sostak[1] and Jeffrey M Muir[3]

Abstract

Revision total hip arthroplasty is a costly procedure accounting for approximately 14% of all hip arthroplasties. Compounding the cost considerations is the potential for serious injury to the patient when removing existing components. Such injury can result in not only increased morbidity but also dramatically increased costs. The use of computer-assisted navigation in revision total hip arthroplasty, while relatively uncommon, offers surgeons the ability to measure component position and orientation intraoperatively, thus allowing them the opportunity to modify their surgical plan, with the potential for decreasing both costs and iatrogenic injury. Here, we report a case of revision total hip arthroplasty where the use of computer-assisted navigation as a diagnostic tool allowed for intraoperative alterations in surgical plan and resulted in improved post-operative outcomes.

Keywords

Total hip arthroplasty, computer-assisted navigation, revision total hip arthroplasty

Date received: 21 March 2018; accepted: 10 January 2019

Introduction

Despite its overall high success rate, total hip arthroplasty (THA) is nevertheless associated with gradual wearing of components and subsequent revision surgery in up to 13.9% of cases.[1] Given the expected two-fold increase in the demands for revision THA (rTHA) in the coming decade[1] and the high costs of revision procedures, which can reach $54,000 per case in the United States,[2] the importance of methods that help maximize component longevity, especially in revision procedures, is obvious.

Key in maximizing component longevity is the accurate placement of components during THA.[3] Computer-assisted navigation, an increasingly common adjunct to primary THA, has demonstrated an excellent ability to improve component accuracy, although there are few studies reporting the use of this technology in rTHA.[4] Here, we report a case of rTHA performed with the assistance of an imageless computer navigation system, the use of which resulted in intraoperative alterations in the surgical plan that would not have otherwise been possible.

Case presentation

A 58-year-old female presented with a chief complaint of left hip pain of 5 months' duration. The patient had been seen approximately 10 months prior to presentation, shortly after experiencing a "clunk" in her right hip. She reported that her pain was stable and had not increased since that episode. Relevant history included a left primary THA approximately 25 years ago. The patient also reported a right primary THA at the age of 33 years, followed by a head and liner exchange 10 years later due to poly wear and broken tine. A right total knee arthroplasty procedure was performed approximately 1 year ago. Comorbid conditions reported included degenerative joint disease, thrombocytopenia, cirrhosis of the liver, lumbar spondylosis and anemia. The patient had been managing any ongoing hip pain with anti-inflammatories and routine monitoring of poly wear with annual radiographs.

On physical examination, a pain-free range of motion (ROM) of the affected hip was noted, although the patient demonstrated hesitation at the extremes of motion. Slightly reduced ROM was noted with internal and external rotation

[1]Northwestern Medicine Central DuPage Hospital, Winfield, IL, USA
[2]School of Public Health and Health Systems, Faculty of Applied Health Sciences, University of Waterloo, Waterloo, ON, Canada
[3]Intellijoint Surgical, Waterloo, ON, Canada

Corresponding Author:
Jeffrey M Muir, Intellijoint Surgical, 60 Bathurst St., Suite 6, Waterloo, ON N2V 2A9, Canada.
Email: j.muir@intellijointsurgical.com

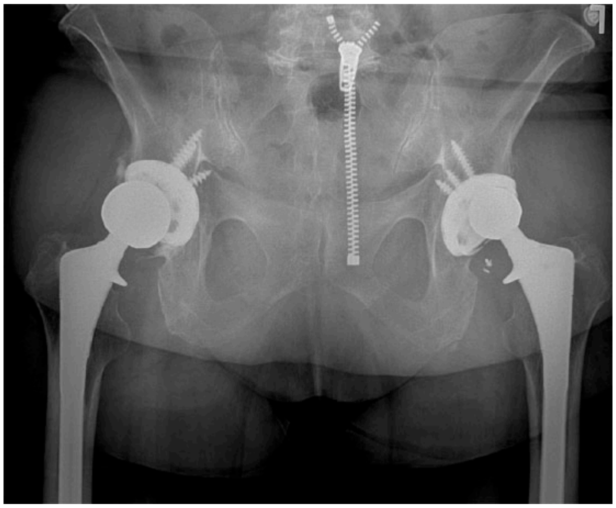

Figure 1. AP pelvic pre-operative radiograph. Polyethylene wear and asymmetrical positioning of the femoral head are visible in the left hip.

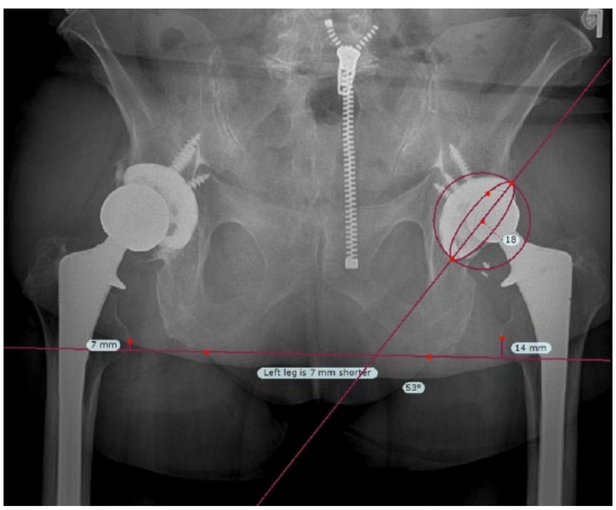

Figure 2. Anteversion was measured intraoperatively using navigation and found to be more retroverted than indicated on pre-operative radiographs (5° vs 18°), leading to revision of the cup component.

when compared with the right hip. Erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) were normal. Radiographs were obtained and revealed severe polyethylene wear and asymmetry in the left hip (Figure 1). Some acetabular and proximal femoral lysis was noted, although there was no change in the acetabulofemoral component interface.

The pre-operative plan for this patient was to exchange the polyethylene liner only; however, during surgery, it was observed that the locking mechanism on the poly component was incompetent. Furthermore, intraoperative measurement

Figure 3. Post-operative radiograph shows the revised left hip with new acetabular cup component and liner with improved joint articulation.

with the navigation system indicated anteversion of 5° (radiographic definition), revealing a cup component significantly more retroverted than the 18° indicated by the pre-operative radiograph (Figure 2). A decision was made to exchange both the liner and the cup component (Figure 3).

Surgery was successful, and post-operatively, the patient was prescribed standard posterior hip precautions with toe-touch weight-bearing for 6 weeks. At 2 weeks post-op, the patient was progressing well.

Discussion

Revision THA is a costly procedure that places a substantial financial burden on the healthcare system. With costs reaching US$50,000 per procedure, revision THA alone is responsible for potential annual expenditures of over US$2 billion per year.[2,5] With cost-containment an ongoing consideration in today's healthcare climate, especially given the proposed bundled payment system for procedures such as THA,[6,7] there is an enhanced need for cost-saving solutions in THA.

The case summarized in this report utilized an imageless, computer-assisted navigation system (Intellijoint HIP®; Intellijoint Surgical, Inc., Waterloo, ON) to provide intraoperative cup position data.[8–10] Acetabular orientation is measured by the device using the radiographic definition of cup position, to provide measurements that align closely with those provided by pre- and post-operative radiographs, thus minimizing the likelihood of error associated with the use of differing frames of reference.[11,12] In the presented case, the data provided by the navigation device were integral in intraoperative decision making. The case demonstrates the value of accurate measurement of the position of the acetabular cup component during revision THA, measurements that provide the opportunity for alterations in the surgical plan. In cases where the acetabular component is fixed and stable and in an appropriate orientation, preservation of the cup becomes a viable option, one that can help limit both the potential injury associated with the removal of components that may be firmly held in place by years of bony ingrowth and the costs associated with that removal. For the device used in this case, the potential savings in preserving components greatly offset any costs associated with the device (no capital costs, $1200–$1400 per use). Indeed, this has been illustrated in a previous report of rTHA using this device, where intraoperative measurements allowed for preservation of the cup component, thus saving the far greater costs associated with both the new implant and the additional operating room (OR) time.[9] In the current case, the revision of the cup component as well as the femoral components, based on intraoperative data provided by the navigation device, should contribute to improved long-term stability, as the initial cup was found to be in a sub-optimal orientation.

Previous studies have documented significant acetabular and pelvic injuries and loss of native bone stock associated with the removal of an inserted cup.[13,14] Furthermore, as acetabular component malposition is known to contribute substantially to instability and dislocation,[3,15] and the risk of dislocation increases as the cup becomes more retroverted,[16,17] the ability to not only identify a malpositioned cup but also to optimize the orientation of the new cup contributes to the long-term stability of the new joint and helps to minimize the potential for post-revision dislocations and re-revision surgery. Finally, the increased costs associated with bone grafts[13,18] or specialized cup components[19,20] when inserting a new implant can be significant. The ability to measure the orientation of the cup intraoperatively and make alterations to the surgical plan thus represents an important adjunct to rTHA, one that has the potential to decrease both costs and the potential for injury.

Conclusion

Given the increased costs and potential for injury in revision THA, the ability to intraoperatively measure cup position and inform intraoperative decision-making is an important addition to rTHA. While there is currently little evidence available in the literature on the specific use of computer-assisted navigation in rTHA,[4] the case discussed here suggests a potential role for navigation during this common procedure. While this role requires further research to fully characterize, surgeons performing revision THA may wish to consider the addition of navigation to their procedural toolbox.

Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: W.G.P has received consultancy fees from Intellijoint Surgical, Inc. J.M.M. is an employee of Intellijoint Surgical, Inc. J.V. and J.R.S. report no potential conflicts.

Ethics approval

Our institution does not require ethical approval for reporting individual cases or case series.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

Informed consent

Written informed consent was obtained from the patient(s) for their anonymized information to be published in this article.

ORCID iD

Jeffrey M Muir https://orcid.org/0000-0003-3932-7636

References

1. Kurtz S, Ong K, Lau E, et al. Projections of primary and revision hip and knee arthroplasty in the United States from 2005 to 2030. *J Bone Joint Surg Am* 2007; 89(4): 780–785.
2. Bozic KJ, Kurtz SM, Lau E, et al. The epidemiology of revision total hip arthroplasty in the United States. *J Bone Joint Surg Am* 2009; 91(1): 128–133.
3. Masaoka T, Yamamoto K, Shishido T, et al. Study of hip joint dislocation after total hip arthroplasty. *Int Orthop* 2006; 30(1): 26–30.
4. Franke J, Zheng G, Wendl K, et al. Clinical experience with computer navigation in revision total hip arthroplasty. *Proc Inst Mech Eng H* 2012; 226(12): 919–926.
5. Gross A and Muir JM. Identifying the procedural gap and improved methods for maintaining accuracy during total hip arthroplasty. *Med Hypotheses* 2016; 94: 93–98.
6. Kurtz SM, Lau EC, Ong KL, et al. Which clinical and patient factors influence the national economic burden of hospital readmissions after total joint arthroplasty? *Clin Orthop Relat Res* 2017; 475: 2926–2937.
7. Nichols CI and Vose JG. Clinical outcomes and costs within 90 days of primary or revision total joint arthroplasty. *J Arthroplasty* 2016; 31: 1400–146.e3.
8. Vigdorchik JM, Cross MB, Bogner EA, et al. A cadaver study to evaluate the accuracy of a new 3D mini-optical navigation tool for total hip arthroplasty. *Surg Technol Int* 2017; 30: 447–454.
9. Vincent J, Alshaygy I, Muir JM, et al. Preservation of the acetabular cup component during revision THA using a novel mini-navigation tool: a case report. *J Orthop Case Rep* 2018; 9: 53–56.
10. Pitta M, Ponzio D, Mayman DJ, et al. Validating the accuracy of a novel computer-assisted system using two-dimensional and three-dimensional radiographic analysis. In: *13th congress of the European hip society*, The Hague, 20–22 September 2018.
11. Murray DW. The definition and measurement of acetabular orientation. *J Bone Joint Surg Br* 1993; 75(2): 228–232.
12. Snijders TE, Willemsen K, vanGaalen SM, et al. Lack of consensus on optimal acetabular cup orientation because of

variation in assessment methods in total hip arthroplasty: a systematic review. *Hip Int*. Epub ahead of print 1 May 2018. DOI: 10.1177/1120700018759306.
13. Sheth NP, Nelson CL, Springer BD, et al. Acetabular bone loss in revision total hip arthroplasty: evaluation and management. *J Am Acad Orthop Surg* 2013; 21(3): 128–139.
14. Paprosky WG, Weeden SH and Bowling JW Jr. Component removal in revision total hip arthroplasty. *Clin Orthop Relat Res* 2001; 393: 181–193.
15. Malik A, Maheshwari A and Dorr LD. Impingement with total hip replacement. *J Bone Joint Surg Am* 2007; 89(8): 1832–1842.
16. Vanrusselt J, Vansevenant M, Vanderschueren G, et al. Postoperative radiograph of the hip arthroplasty: what the radiologist should know. *Insig Imag* 2015; 6(6): 591–600.
17. Dargel J, Oppermann J, Bruggemann G-P, et al. Dislocation following total hip replacement. *Dtsch Arztebl Int* 2014; 111(51–52): 884–890.
18. Mall NA, Nunley RM, Smith KE, et al. The fate of grafting acetabular defects during revision total hip arthroplasty. *Clin Orthop Relat Res* 2010; 468(12): 3286–3294.
19. Wind MA Jr, Swank ML and Sorger JI. Short-term results of a custom triflange acetabular component for massive acetabular bone loss in revision THA. *Orthopedics* 2013; 36(3): e260–e265.
20. Mao Y, Xu C, Xu J, et al. The use of customized cages in revision total hip arthroplasty for Paprosky type III acetabular bone defects. *Int Orthop* 2015; 39(10): 2023–2030.