Periprosthetic Femur Fracture Through A Computer Navigated Tracking Pin Site

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INTRODUCTION

Computer assisted navigation (CAN) and robotic-assisted (RA) total knee arthroplasty (TKA) are relatively new methods for achieving reproducible position of TKA components. Over the past 15 years, the number of technology-assisted TKA have steadily increased to nearly 7% of all knee replacements[1] The software that processes live input requires tracking devices be affixed to the patient. This is achieved through the use of skeletal pins ranging from 3.2 to 5.0mm in diameter placed into the femur and the tibia.[2] The tracking pins must be rigidly affixed to the patient's bone because any movement of the tracking pins can induce error in component position.[3]

CAN and RA-TKA utilize 3 components. The computer platform for display, the tracking system and the rigidly mounted pins. The computer platform processes input from the tracking system and mounted pins and calculates the 3 dimensional position of the trackers in space[4].

TECHNOLOGY IN TKA

Although conventional TKA have shown excellent long-term longevity in multiple studies[5-7], efforts to further improve implant survivorship, functional outcomes while decreasing revision rates and cost continue to be pivotal in providing value-based care.[8-10] As multiple studies have demonstrated more reliable overall mechanical alignment restoration[11-20] and immediate improvement in implant placement, surgical quality and accuracy without subjecting the patient or surgeon to a clinically significant learning curve[21-23], there is inconclusive data regarding the effects of technology assistance on revision rates, patient-reported outcome measures (PROMs) and complication rates.[17,24-26]

Technology-assisted TKA, however, has been associated with unique complications not encountered in conventional TKA. In most types of navigation-assisted surgery, several temporary pins must be placed either within the operative field or percutaneously through separate stab incisions in the femur and tibia.[21]

The supplemental sites of metal fixation present additional opportunities for complications, such as pin tract infections and pin-related fractures. Although rare, periprosthetic fractures through CAN and RA-TKA pin sites have been reported but are limited to several small case series and case reports. We present a case of diaphyseal femur fracture through a pin related stress riser from our institution.

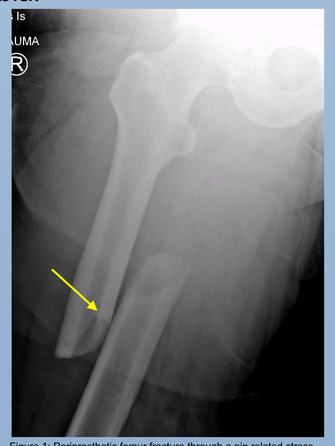

Figure 1: Periprosthetic femur fracture through a pin related stress riser following CAN TKA

CASE REPORT

A 53 year old male presented to our university trauma center with right leg deformity. He twisted his leg and heard a sudden, loud crack and had immediate pain, deformity, and inability to bear weight. Six weeks prior he underwent CAN TKA at an outside facility. He stated that he had been having thigh pain ever since the date of surgery and that he had been having difficulty with physical therapy. This was attributed to tourniquet pain and general post operative soreness. Given the low energy nature of his diaphyseal femur fracture, a CT scan was ordered to evaluate for possible pathologic fracture. The CT scan revealed that the fracture had occurred through a trans-cortical pin site. He was placed in skeletal traction and was taken to the operating room the following day for antegrade intramedullary nailing.

Figure 2A: Coronal CT scan right femur demonstrating a trans-cortical pin site in the lateral aspect of the femur at the origin of the fracture

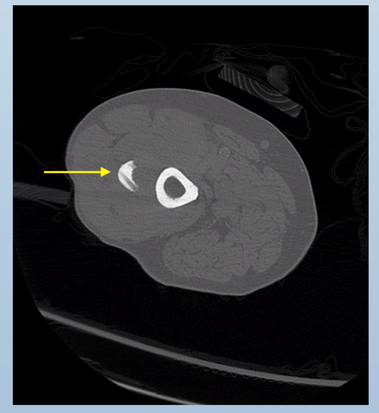

Figure 2B: Axial CT scan right femur demonstrating a trans-cortical pin site in the lateral aspect of the femur at the origin of the fracture.

Intraoperatively, the fracture was notably difficult to reduce given the patient's muscle mass and the short oblique nature of the fracture. Two unicortical Shanz pins attached to T handles were inserted proximal and distal to the fracture site from the lateral aspect of the leg. These were used as joysticks to gain control of the fracture site and aid in reduction. A guide wire was passed and the canal reamed to fit an 11 x 480mm Stryker T2 Recon cephalomedullary nail.

Figure 3: 3-D CT Reconstruction of Right femur demonstrating periprosthetic pin site fracture.

POST OPERATIVE OUTCOME

The patient tolerated the procedure well and was brought from the operating room to PACU without event. He was ultimately returned to the medical floor for convalescence and physical therapy. On post operative day 1 the patient was weight bearing as tolerated and ambulated with physical therapy to the bathroom. He was ultimately deemed safe for return to his home with home physical therapy.

At 6 week follow up the patient reports that his thigh pain has markedly improved from his preoperative levels. He ambulates without any assistive devices and has been participating in his regularly scheduled rehab for his total knee arthroplasty. His knee range of motion is 0-120 degrees and the rotational alignment of his lower extremity is within 15 degrees of the contralateral side. His incision sites are clean, dry and well healed without evidence of infection. Radiographs demonstrate a healing fracture with early callus formation (Figure 4A, 4B).

Figure 4A: Post operative AP right femur

Figure 4B: Post operative lateral right femur demonstrating near anatomic alignment of the fracture site

CONCLUSION

Surgeons should maintain a high index of suspicion for pin related fractures in patients with ongoing leg or thigh pain after CAN or robotic-assisted TKA in order to avoid fracture displacement and additional morbidity. Although CAN and RA-TKA have improved component placement and alignment, its inconclusive benefit of superior implant longevity, clinical functional outcomes, decrease revision rates coupled with unique complication risks continues the debate regarding the value of technology assisted TKA and its cost-effectiveness.

REFERENCES

1. Antonios JK, Korber S, Sivasundaram L, et al. Trends in computer navigation and robotic assistance for total knee arthroplasty in the United States: an analysis of patient and hospital factors. Arthroplasty Today. 2019;5(1):88-95. doi:10.1016/j.artd.2019.01.002
2. Bonutti P, Dethmers D, Stiehl JB. Case Report: Femoral Shaft Fracture Resulting From Femoral Tracker Placement in Navigated TKA. Clinical Orthopaedics and Related Research. 2008;466(6):1499-1502. doi:10.1007/s11999-008-0150-6
3. Haaker RG, Stockheim M, Kamp M, Proff G, Breitenfelder J, Ottersbach A. Computer-assisted navigation increases precision of component placement in total knee arthroplasty. Clin Orthop Relat Res. 2005;(433):152-159. doi:10.1097/01.blo.0000150564.31880.d4
4. Siddiqi A, Smith T, McPhilemy JJ, Ranawat AS, Sculco PK, Chen AF. Soft-Tissue Balancing Technology for Total Knee Arthroplasty. JBJS Rev. 2020;8(1):e0050. doi:10.2106/JBJS.RVW.19.00050
5. Hopley CDJ, Crossett LS, Chen AF. Long-Term Clinical Outcomes and Survivorship After Total Knee Arthroplasty Using a Rotating Platform Knee Prosthesis: A Meta-Analysis. *J Arthroplasty*. 2013. doi:10.1016/j.arth.2012.04.026
6. Ritter MA, Meneghini RM. Twenty-year survivorship of cementless anatomic graduated component total knee arthroplasty. *J Arthroplasty*. 2010. doi:10.1016/j.arth.2009.04.018
7. Bae DK, Song SJ, Park MJ, Eoh JH, Song JH, Park CH. Twenty-Year Survival Analysis in Total Knee Arthroplasty by a Single Surgeon. *J Arthroplasty*. 2012. doi:10.1016/j.arth.2011.10.027
8. Bumpass DB, Nunley RM. Assessing the value of a total joint replacement. *Curr Rev Musculoskelet Med*. 2012. doi:10.1007/s12178-012-9139-9
9. Weber M, Renkawitz T, Voellner F, et al. Revision Surgery in Total Joint Replacement Is Cost-Intensive. *Biomed Res Int*. 2018. doi:10.1155/2018/8987104
10. Waddell BS, Carroll K, Jerabek S. Technology in Arthroplasty: Are We Improving Value? *Curr Rev Musculoskelet Med*. 2017. doi:10.1007/s12178-017-9415-6
11. Anderson KC, Buehler KC, Markel DC. Computer assisted navigation in total knee arthroplasty: Comparison with conventional methods. In: *Journal of Arthroplasty* . ; 2005. doi:10.1016/j.arth.2004.10.004
12. Bäthis H, Perlick L, Tingart M, Lüring C, Zurakowski D, Grifka J. Alignment in total knee arthroplasty. A comparison of computer-assisted surgery with the conventional technique. *J Bone Jt Surg - Ser B*. 2004. doi:10.1302/0301-620X.86B5.14927
13. Barrett WP, Mason JB, Moskal JT, Dalury DF, Olashinzazi A, Fisher DA. Comparison of radiographic alignment of imageless computer-assisted surgery vs conventional instrumentation in primary total knee arthroplasty. *J Arthroplasty*. 2011. doi:10.1016/j.arth.2011.04.037
14. Chauhan SK, Scott RG, Breidahl W, Beaver RJ. Computer-assisted knee arthroplasty versus a conventional jig-based technique. A randomised, prospective trial. *J Bone Jt Surg - Ser B*. 2004. doi:10.1302/0301-620X.86B3.14643
15. Chin PL, Kuang YY, Seng JY, Ngai N Lo. Randomized control trial comparing radiographic total knee arthroplasty implant placement using computer navigation versus conventional technique. *J Arthroplasty*. 2005. doi:10.1016/j.arth.2005.04.004
16. Clark TC, Schmidt FH. Robot-Assisted Navigation versus Computer-Assisted Navigation in Primary Total Knee Arthroplasty: Efficiency and Accuracy. *ISRN Orthop*. 2013. doi:10.1155/2013/794827
17. Choong PF, Dowsey MM, Stoney JD. Does Accurate Anatomical Alignment Result in Better Function and Quality of Life? Comparing Conventional and Computer-Assisted Total Knee Arthroplasty. *J Arthroplasty*. 2009. doi:10.1016/j.arth.2008.02.018
18. Hetaimish BM, Khan MM, Simunovic N, Al-Harbi HH, Bhandari M, Zalzal PK. Meta-Analysis of Navigation vs Conventional Total Knee Arthroplasty. *J Arthroplasty*. 2012. doi:10.1016/j.arth.2011.12.028
19. Matziolis G, Krocker D, Weiss U, Tohtz S, Perka C. A prospective, randomized study of computer-assisted and conventional total knee arthroplasty: Three-dimensional evaluation of implant alignment and rotation. *J Bone Jt Surg - Ser A*. 2007. doi:10.2106/JBJS.F.00366
20. Yang HY, Seon JK, Shin YJ, Lim HA, Song EK. Robotic total knee arthroplasty with a cruciate-retaining implant: A 10-year follow-up study. *CiOS Clin Orthop Surg*. 2017. doi:10.4055/cios.2017.9.2.169
21. Kamara E, Berliner ZP, Hepinstall MS, Cooper HJ. Pin Site Complications Associated With Computer-Assisted Navigation in Hip and Knee Arthroplasty. *J Arthroplasty*. 2017. doi:10.1016/j.arth.2017.03.073
22. Bell SW, Anthony I, Jones B, MacLean A, Rowe P, Blyth M. Improved Accuracy of Component Positioning with Robotic-Assisted Unicompartmental Knee Arthroplasty: Data from a Prospective, Randomized Controlled Study. *J Bone Joint Surg Am*. 2016. doi:10.2106/JBJS.15.00664
23. Kamara E, Robinson J, Bas MA, Rodriguez JA, Hepinstall MS. Adoption of Robotic vs Fluoroscopic Guidance in Total Hip Arthroplasty: Is Acetabular Positioning Improved in the Learning Curve? *J Arthroplasty*. 2017. doi:10.1016/j.arth.2016.06.03933.
24. Kalairajah Y, Cossey AJ, Verrall GM, Ludbrook G, Spriggins AJ. Are systemic emboli reduced in computer-assisted knee surgery? A prospective, randomised, clinical trial. *J Bone Jt Surg - Ser B*. 2006. doi:10.1302/0301-620X.88B2.16906
25. Kim YH, Park JW, Kim JS. The clinical outcome of computer-navigated compared with conventional knee arthroplasty in the same patients: A prospective, randomized, double-blind, long-term study. *J Bone Jt Surg - Am Vol*. 2017. doi:10.2106/JBJS.16.00791
26. De Steiger RN, Liu YL, Graves SE. Computer navigation for total knee arthroplasty reduces revision rate for patients less than sixty-five years of age. *J Bone Jt Surg - Am Vol*. 2015. doi:10.2106/JBJS.M.01496