

Imageless navigation to manage leg length discrepancy during total hip arthroplasty with extended trochanteric osteotomy



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Abstract

A primary challenge of revision total hip arthroplasty (rTHA) is the thorough removal of old prosthetic implants. Extended trochanteric osteotomy (ETO) provides increased access to the femoral canal, aiding in complete removal of primary components without damaging patient anatomy. As with any surgical procedure; however, rTHA via ETO is not without limitations, one of which is ensuring postoperative equalization of leg lengths. This report documents two cases of rTHA requiring ETO assisted by an imageless computer navigation system, which provided intraoperative measurements of cup positioning and leg length.

Keywords

Total hip arthroplasty, extended trochanteric osteotomy, computer-assisted navigation, revision THA

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Introduction

Despite its overall high success rate, total hip arthroplasty (THA) is susceptible to complications such as dislocation and mechanical failures, resulting in up to 13.9% of primary cases requiring revision surgery [1]. Revision THA (rTHA) itself is associated with unique challenges. In particular, thorough removal of femoral components can be especially difficult and require the use of additional procedures such as osteotomies. One variation of this approach, the extended trochanteric osteotomy (ETO), is commonly performed during rTHA to provide increased exposure to the femoral medullary canal [2]. While generally associated with positive results, ETO can introduce potential new complications, chief among them being the challenge in equalizing leg lengths (LLs) postoperatively [3]. Therefore, intraoperative vigilance is necessary when performing ETO to avoid postoperative leg length discrepancy (LLD). Here, we report the

outcomes of two cases of revision hip arthroplasty requiring ETO, in which a miniature surgical navigation tool was used to assist with accurate intraoperative determination of leg length.

Case Presentations

Case 1

A 69-year old male presented with a chief complaint of pain in the right hip that was continuous and gradually worsening in nature. Specifically, the pain was located in the midthigh, groin and greater trochanter. Relevant history

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included a femoral neck fracture fixation in 1986 followed by hardware removal in 1988, a right THA for avascular necrosis (AVN) in 2002, and subsequent open reduction and internal fixation (ORIF) for a periprosthetic fracture in 2013 (Figure 1a).

On physical examination, the patient's right leg was shorter, with a LLD estimated at 15 mm. The patient presented an antalgic gait, requiring him to use a cane. Reported difficulties included start-up pain and stiffness in the hip. Range of motion (ROM) was decreased and measured at: 80° of flexion, 15° of extension, 5° of internal rotation (IR), 15° of abduction, and 15° of adduction. Abductor strength on the affected side was 2/5. Neurological examination was unremarkable. Preoperative radiographic analysis demonstrated polyethylene wear with signs of femoral loosening, and a LLD measured at 30 mm (Figure 1a). Following consultation with the patient, a preoperative plan of revision THA with ETO to revise the femoral component to a long ZMR stem and lengthen the leg by 30 mm was set. The plan also called for preservation of the acetabular cup component (pending intraoperative assessment of cup stability) and position and exchange of the polyethylene liner.

Imageless, computer-assisted navigation was used during surgery to assist with leg length equalization and component placement. The acetabular component was confirmed intraoperatively to be stable and secure, and the navigation device verified a suitable cup position of 45° inclination and 5° anteversion. As such, the preoperative plan to preserve the cup was not changed. The device successfully guided placement of the new liner, providing updated measurements until a final liner orientation of 40° inclination and 15° anteversion was achieved. The preoperative LLD of 30 mm was restored, while the change in offset was -10 mm. The surgery was successful with no complications.

Postoperative radiographs showed implants to be in good position and alignment (Figure 1b). At

6-weeks post-procedure, the patient was reported to be progressing well.

Case 2

A 75-year old male presented with a chief complaint of worsening pain in the left hip. The patient also complained of lower back pain due to a recent fall and pain referred to the groin, as well as the anterolateral area of the thigh. He experienced pain at the start of movement, which increased with prolonged walking. Relevant history included a right THA in 2002, followed by a left THA in 2014. Previous treatments used to manage hip pain included Tylenol and Advil.

On physical examination, low back pain was experienced on extension and side bending. No gross LLD was observed. No pain was reported during ROM testing of the hip. The patient walked with a limp on the left side. Neurological testing was unremarkable. Preoperative radiographs revealed an acetabular component oriented somewhat vertically (Figure 2a) and no obvious signs of femoral loosening, although a subsequent bone scan showed increased uptake around the femoral component. As such, the pre-operative plan included revision of the femoral stem via ETO, with a possible revision of the acetabular component.

Imageless, computer-assisted navigation was again used to assist with the surgical procedure. The navigation device measured the existing acetabular component at 55° inclination and 18° anteversion. Based on these values, it was decided intraoperatively to revise both the femoral and cup components. After insertion, the new cup component was confirmed by the navigation device to be oriented satisfactorily at 36° inclination and 20° anteversion. A face-changing liner was used, with the final liner orientation measured at 39° inclination and 24° anteversion. Navigation measurements confirmed lengthening of the operative leg by 11 mm, with an offset change of -24 mm. The procedure was uneventful with no complications.

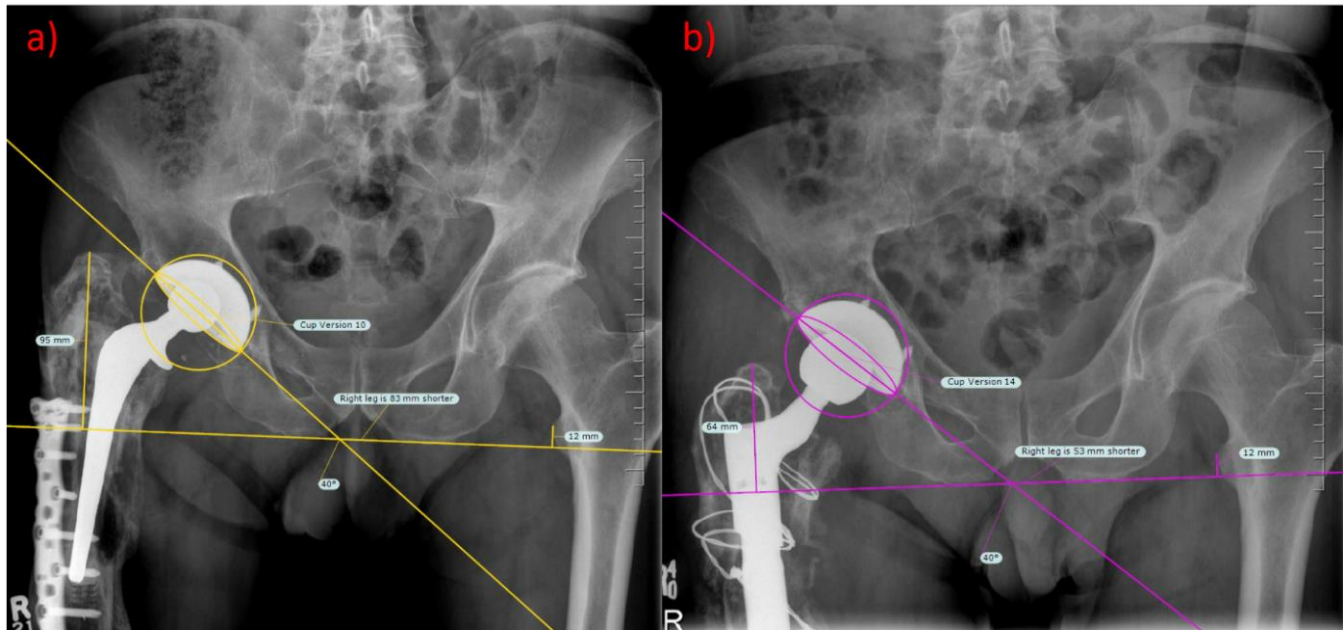


Figure 1. Pre- (a) and postoperative (b) radiographs for Case 1. The preoperative LLD of 30 mm was equalized. Due to anterior pelvic tilt, measurements reported by the radiographs are slightly different than those of the device.

Immediate postoperative radiographs revealed the cup and femoral components to be in good position and alignment (Figure 2b). At 6-week follow-up, the patient was reported to be progressing well.

Discussion

The complex nature of revision hip procedures introduces increased risk and potential for complications. Adjunctive procedures such as ETO, by enhancing femoral exposure, are valuable in facilitating the removal of well-fixed cementless stems, or removal of cement from the femoral canal, while avoiding damage to the parent bone [4]. Although an important tool, ETO requires a substantially longer femoral cut than other trochanteric osteotomies. Such cuts can contribute to unique complications, such as postoperative LLD [3]. Technologies that allow intraoperative monitoring of leg length changes during THA represent a new and potentially beneficial method of minimizing this postoperative complication. Here, we report two cases of rTHA via ETO that utilized an imageless, computer-assisted navigation tool (Intellijoint HIP[®], Intellijoint Surgical Inc., Kitchener, ON) to assist with the procedure. The device provided real-time, intraoperative

measurements that played an essential role in monitoring leg lengths.

The significant cuts made to the femur during ETO can result in structural weakness, leading to complications such as fracture of the osteotomy fragment, fixation failures, and subsidence, the last of which can contribute to postoperative LLD [2]. Subsidence following ETO is a relatively common occurrence, occurring in up to 22.6% of cases by some estimates, with resulting LLDs ranging from 5-22 mm [5]. Indeed, in one study of 20 patients who underwent ETO during their rTHA, 5 reported post-operative LLDs (3 lengthening, 2 shortening) [3]. It is important to note that, while postoperative LLD is often addressed with heel lifts and rehabilitation, LLDs >5 mm are clinically important, as patients are known to perceive LLDs of that magnitude following THA [6]. The resulting inconvenience to daily functioning contributes to postoperative LLD being among the leading causes of litigation against orthopaedic surgeons [7]. Prevention of these postoperative complications is key to negating the requirement for superficial adjustments and/or further surgery. In our report, large preoperative LLDs were noted, including a substantial discrepancy of 30 mm in one patient.

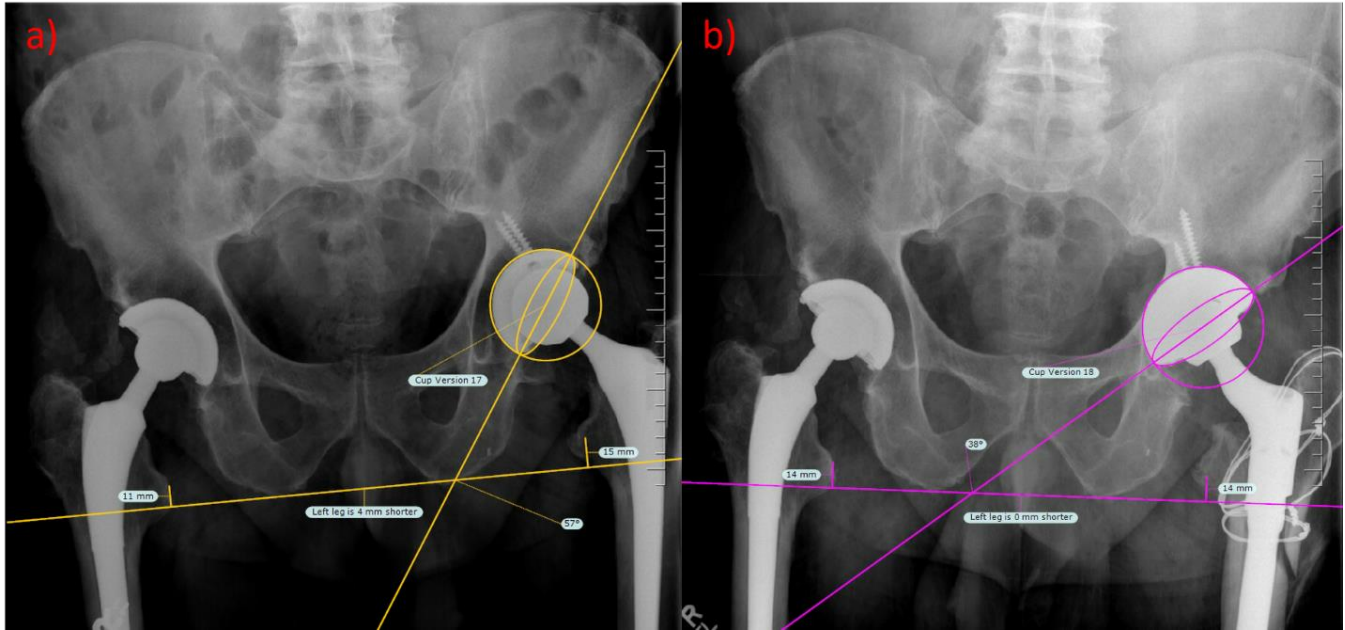


Figure 2. Pre- (a) and postoperative (b) radiographs of Case 2. Due to increased abduction in the preoperative radiograph, there is some discrepancy of LLDs measured between the radiographs and the device.

Intraoperative feedback from the navigation device allowed the surgeon to correct their component selection and positioning to their desired measurements. This real-time data provides increased feedback during trialing and provides valuable information regarding the final positioning of components. In cases where large, disruptive cuts are made, such as ETO, this additional intraoperative data allows for the creation of a stronger, more stable final construct. The results from our study mirror those of others using the same navigation device. In one case series, 3 cases of significant preoperative LLDs ranging from 30 to 45 mm were successfully corrected with the assistance of the navigation tool [8]. Another study focusing on two cases of Legg-Calve-Perthes disease demonstrated corrections of preoperative LLDs of 25 mm and 35 mm with assistance from the navigation tool [9]. In these cases, and those summarized in the current report, the ability of the device to provide intraoperative data on leg length was integral in allowing for more accurate selection of components and reduced the likelihood of postoperative complications attributed to LLDs.

Conclusion

This report highlights the ability of a novel surgical navigation tool to assist in revision THA requiring ETO. In particular, the device allowed for improved accuracy of femoral component placement by providing intraoperative leg length measurements. The findings from this report may be promising for mitigating occurrences of LLDs associated with revision THAs requiring ETO.

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Declaration of conflicting interest

SW and JMM are employees of Intellijoint Surgical, Inc.

Informed consent

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

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