

Using a Modified Ball-Tip Guide Rod to Equalize Leg Length and Restore Femoral Offset

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Abstract

Goals of total hip arthroplasty (THA) include pain alleviation, motion restoration, and normalization of leg-length inequality. Asymmetric leg lengths are associated with nerve traction injuries, lower extremity joint pain, sacroiliac discomfort, low back pain, and patient dissatisfaction. The authors present an innovative use of a modified ball-tip guide rod to help accurately restore leg length and femoral offset during direct anterior THA.

Patient satisfaction scores after total hip arthroplasty (THA) approach 100%.¹ Goals of this surgery include pain alleviation, motion restoration, and normalization of leg-length inequality. Asymmetric leg lengths are associated with nerve traction injuries, lower extremity joint pain, sacroiliac discomfort, low back pain, and patient dissatisfaction.¹⁻³ For these reasons, post-operative leg-length discrepancy has become the most common reason for THA-related litigation.^{1,4}

With preoperative education, patients and surgeons can discuss realistic THA goals and expectations. Besides ensuring that the correct tools and implants are available for the procedure, radiographic templating alerts surgeons to certain intraoperative issues that may arise during cases. For instance, an extremity may need to be lengthened during the surgery in order to generate the amount of soft-tissue tension needed to convey adequate stability to the hip joint.

In asymptomatic populations, lower extremity leg lengths inherently vary by an average of 5 mm.⁵ Studies have found normal populations are unable to accurately perceive a leg-length inequality of <1 cm.^{3,6,7} Lengthening an extremity >2.5

cm causes sciatic nerve symptoms.² Patients may notice a leg-length discrepancy during the first few months after hip replacement, but this perception often subsides as gait normalizes and soft tissues acclimatize.

Our hospital uses a special arthroplasty table and intraoperative fluoroscopy for direct anterior (DA) THA cases. The table permits the operative extremity to undergo traction and the necessary mobility for proximal femur exposure. Fluoroscopy has been shown to significantly improve the position and orientation of the implanted hip components.⁸

We have developed an innovative use for a ball-tip guide rod (3.0 mm × 1000 mm; Smith & Nephew) to help accurately restore leg length and femoral offset after DA-THA. The ball-tip guide rod was modified to a length of 500 mm and rough edges were smoothed.

Technique

After the patient is prepared and draped in standard fashion on the operating table, a 10-cm skin incision is made directly over the proximal aspect of the tensor fascia lata muscle. Soft tissues are dissected down to the hip capsule, which is then incised and tagged for closure at the end of the case.

The fluoroscopic C-arm is sterilely draped and positioned from the nonoperative side. The image intensifier is centered over the pubic symphysis and lowered within 1 inch of the perineal post and surgical drapes. The C-arm unit is then aimed 10° to 15° cephalad until the size and orientation of the obturator foramina on fluoroscopic imaging coincide with the preoperative template.

Next, the modified guide rod, ball tip first, is carefully advanced toward the nonoperative side and over the surgical drapes between the pelvis and the C-arm image intensifier. Care is taken to avoid violating the sterile field by inadvertently puncturing the surgical drapes with the guide rod. The lower extremities are externally rotated 20° to

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bring the lesser tuberosities into profile view. With use of several fluoroscopic views, the guide rod is aligned with the inferior borders of the ischial tuberosities or the obturator foramens, whichever are more readily identified on the intraoperative images. A skin marker is then used to illustrate the position of the guide rod on the operative drapes for future reference.

At this point, the relationship between the radiopaque guide rod and the lesser trochanters is noted to gain a sense of native femoral leg length and offset, and the image (**Figure 1**) is saved in the C-arm computer for later recall and comparison views.

Next, the femoral neck osteotomy is performed according to the preoperative template. Acetabular preparation and component insertion are completed under fluoroscopic guidance.

After appropriate soft-tissue releases, the operating table is used to position the operative leg in extension, external rotation, and adduction. The femur is then sequentially broached until the template size is reached or until there is an audible change in pitch. At this point, a trial neck with head ball is fixed to the broach, and the hip is reduced.

The fluoroscopic C-arm is then repositioned over the pelvis, as previously described, with the guide rod over the pelvis and tangential to the ischial tuberosities. A new image (**Figure 2**) is obtained with the trial components in place. The 2 images (**Figures 1, 2**) are compared side by side, on the dual monitors of the fluoroscopy unit.

The radiopaque line generated by the guide rod represents a reference point that permits objective comparison of femoral leg length and offset based on distance to the lesser trochanters. Different modular components can be trialed until the correct combination of variables accurately restores the desired parameters.

Once parameters are restored, trial femoral components are removed, and a corresponding monolithic femoral stem is gently impacted into the proximal femur and fitted with the appropriate head ball. A final image is obtained with the guide rod and implants in place and is saved as proof of restoration of leg length.

Discussion

Various techniques of assessing intraoperative leg length have been described, and each has its advantages and disadvantages. Relying on abductor tension or comparing leg lengths on the operating table is not always accurate and is strongly dependent on patient position.^{2,6}

Referencing the tip of the greater trochanter to a Steinmann pin inserted into the ilium provides a precise reference point, but this invasive technique has the potential for fracture propagation through the drill hole.^{2,7}

Superimposing a trial femoral component over the proximal femur to determine the appropriate femoral neck osteotomy has been described, but this process can be difficult through a tight DA approach.⁹

Numerous measuring devices have been designed to help restore leg length, but in many cases the purchase cost and required maintenance outweigh their utility.² Gilliland and colleagues¹⁰ developed a reusable fluoroscopic transparent grid system that significantly improves component positioning during DA-THA.

The modified ball-tip guide rod is relatively inexpensive (<\$100) and has several practical purposes in total joint surgery. The guide rod historically has been used

Take-Home Points

- Preoperative radiographic templating alerts surgeons to certain intraoperative issues that may arise during surgery.
- Intraoperative fluoroscopy has been shown to significantly improve the position and orientation of the implanted hip arthroplasty components.
- Numerous measuring devices have been designed to help restore leg length, but in many cases the purchase cost and required maintenance outweigh their utility.
- A radiopaque line generated by the guide rod serves as a reference point that permits immediate objective comparison of femoral leg length and offset intraoperatively.
- The modified ball-tip guide rod is relatively inexpensive and has several practical purposes in total joint surgery.

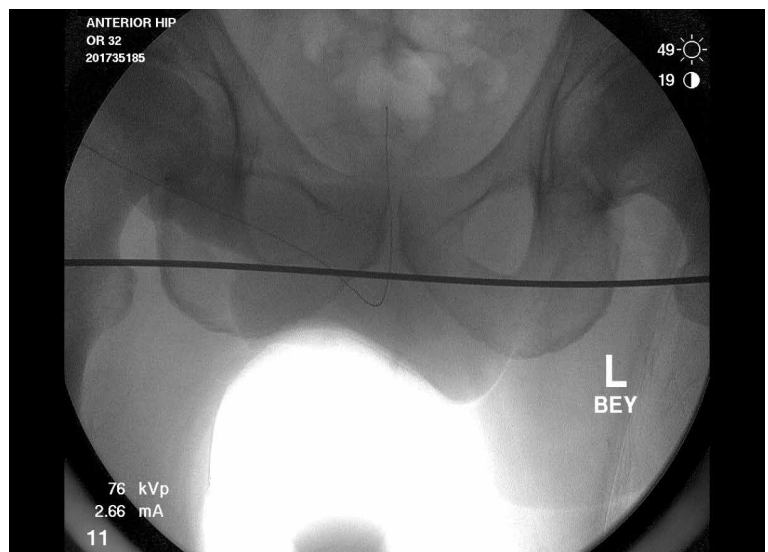


Figure 1. Intraoperative anteroposterior view of pelvis is obtained before femoral neck osteotomy. Field of view incorporates right and left lesser tuberosities. Modified ball-tip guide rod is carefully placed on sterile surgical drapes and positioned tangential to inferior borders of obturator foramens with aid of fluoroscopy to generate radiopaque line of reference. In this example, operative left extremity is 3 mm to 4 mm shorter than uninvolved side in comparison made where the reference line intersects lesser tuberosities.

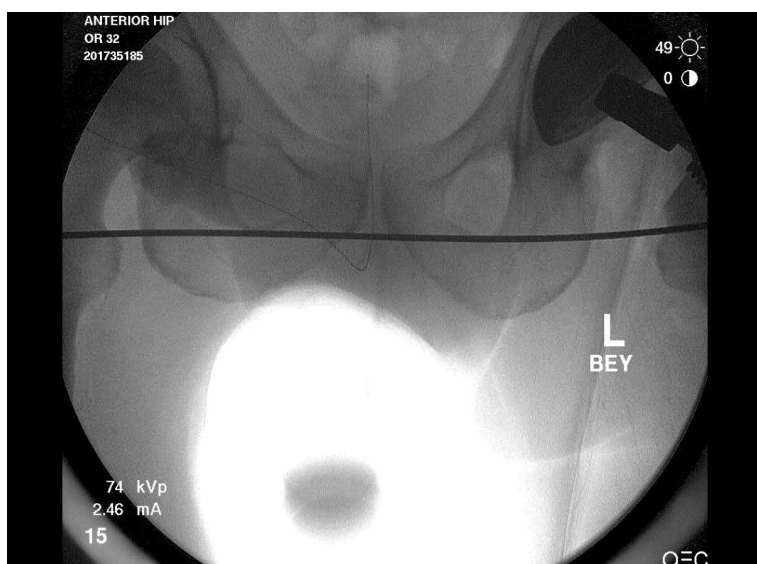


Figure 2. Final intraoperative anteroposterior pelvis image is obtained with guide rod positioned as previously described in Figure 1. Again with comparison made where radiopaque reference line intersects lesser tuberosities, left hip is easily recognized as appropriately reconstructed, given leg lengths are now equal. Femoral offset is slightly increased compared with before.

to sound the center of the femoral canal before broaching. In revision cases and in cases of poor bone stock, the tool can be used to verify that cortical perforation has not occurred during canal preparation. In this article, we describe another realistic use for the guide rod: to create, during DA-THA, a radiographic reference line that can be used to help restore leg length and femoral offset.

Several authors have mentioned surgeons' drawing the reference line on paper printouts of intraoperative images.¹¹ Not only is this practice fraught with potential contamination of the operative field, but valuable time is lost waiting for paper copies and putting on a new gown and gloves before reentering the sterile field.

We used to train a radiologic technician or operating room nurse to draw a computerized reference line connecting the lesser trochanters on the fluoroscopic image. Problems arose in working with revolving nursing staff and in distinguishing the thin black line on computer monitors. In contrast, the radiopaque line from the guide rod is easily differentiated on fluoroscopic images, the technique poses less of a risk to the sterile field, and proper orientation of the guide rod to obtain the appropriate reference line is entirely surgeon-dependent.

A drawback of this technique is the additional radiation exposure that occurs when extra images are obtained to ensure satisfactory alignment of the guide rod. Another issue is fluoroscopic paral-

ax. Some machines in the operating department generate a magnetic field that can interfere with the fluoroscopy beam and thereby slightly distort the intraoperative images.⁸ Therefore, it is imperative that the guide rod remain perfectly straight to avoid confounding measurements.

Our modified guide rod technique is a reliable, quick, and inexpensive intraoperative tool that helps in accurately restoring leg length and femoral offset during DA-THA.

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