Novel Method for Ensuring Leg Length in Total Hip Arthroplasty

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abstract

Despite the overwhelming clinical success of total hip arthroplasty, complications such as leg-length discrepancy can be a significant cause of functional impairment and patient dissatisfaction. Multiple intraoperative techniques are available for measuring femoral limb length; however, many require additional invasive hardware and those that do not are less accurate at measuring limb length. This article introduces a novel, noninvasive intraoperative technique that quickly and accurately measures limb length and prevents postoperative leg-length discrepancy.

The authors’ method relies on the accurate reproduction of a line perpendicular to the femoral axis near the proximal aspect of the greater trochanter intraoperatively and during preoperative planning and requires minor modifications to the instrumentation used. A narrow slot for the placement of a guide plate was machined into a standard trial head 37° from the axis of the neck for use with a high offset 127° Secur-Fit PLUS stem and 42° from the axis of the neck for use with a standard offset 132° Secur-Fit stem (Stryker Orthopaedics, Kalamazoo, Michigan). Once a broach is securely seated, a trial neck, slotted trial head, and guide plate are assembled and the distance from the guide plate to the proximal tip of the greater trochanter is compared with the preoperative planning measurements to assess the stem position.

A retrospective radiographic analysis of 31 consecutive primary total hip arthroplasty using this technique showed the mean postoperative leg-length discrepancy to be 2.18±0.06 mm. This method is an additional tool for the arthroplasty surgeon’s armamentarium to ensure accurate leg-length restoration.

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Along with the overwhelming clinical success of total hip arthroplasty (THA) comes the expectation of an excellent outcome in nearly every case. In this setting, leg-length discrepancy after THA can pose a significant problem for orthopedic surgeons. Although the primary goal of the operation is obtaining pain relief with a stable joint, the restoration of the hip mechanics, including leg-length and offset, is desirable. Minor leg-length discrepancies are common after THA and are usually well tolerated by patients. However, more significant leg-length discrepancies have been associated with complications, including sciatic, femoral, and peroneal nerve palsies. Sentinel event data published by the Joint Commission on Accreditation of Healthcare Organizations have shown the incidence of patient falls and leg-length discrepancy to be as high as 4.7% of all reported events. In addition, leg-length discrepancy can be a significant cause of patient dissatisfaction after THA and is among the leading causes of litigation against orthopedic surgeons.

Although leg-length discrepancies cannot be eliminated, they can be minimized with a thorough physical examination, radiographic evaluation, preoperative templating, and intraoperative leg-length assessment. In addition, it is vital to discuss the possibility of leg-length inequality with the patient preoperatively during informed consent to minimize patient dissatisfaction.

Intraoperative measurement is essential in ensuring leg-length equality because the exact size of the femoral component is predicted only 68% of the time by preoperative templating. Several methods have been reported in the literature for intraoperative leg-length measurement. However, most require the use of 1 or more reference screws or pins and require careful replication of the initial leg position prior to measurement. Mihalko et al reported a method in which a large unicortical fragment screw is placed above the superior rim of the acetabulum and a mark is made at the vastus tubercle of the greater trochanter for measurement prior to and after implantation of the trial prosthetic components. A similar method anchors a measuring suture in the skin superior to the incision cut to length at a mark made at the greater trochanter; the suture length is then compared with the mark on the greater trochanter after the trial components are implanted. Another method uses a Steinman pin driven into the pelvis above the acetabular rim that is then bent to make contact with the greater trochanter; a mark at this point serves as the reference point for measurements, and the pin can be swiveled out of the operative field for access.

### Surgical Technique

The current method relies on the accurate reproduction of a line perpendicular to the femoral axis near the proximal aspect of the greater trochanter intraoperatively and during preoperative planning. This line is easily marked during templating on an anteroposterior view of the hip by drawing a line at the proximal aspect of the greater trochanter perpendicular to the shaft of the femur (Figure 1). This line usually passes within millimeters of the new center of rotation of the femoral head, and it should be noted whether the line is above or below the center of rotation during templating.

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### Surgical Technique

The current method relies on the accurate reproduction of a line perpendicular to the femoral shaft at the proximal tip of the greater trochanter during preoperative templating. This line will be reproduced intraoperatively using the measuring guide plate.

The accurate and reliable intraoperative reproduction of this line requires minor modifications to the instrumentation. A narrow slot for the placement of a guide plate was machined into a standard trial head (Figure 2A). When used with a high offset Secur-Fit stem (Stryker Orthopaedics, Kalamazoo, Michigan), the slot is angled 37° clockwise from the neck.

A few additional steps are needed in this surgical technique. The authors use a posterior approach for access to the hip.
joint, but it is not required for use of this technique. After exposing the joint, the greater and lesser trochanters are clearly identified, and the neck is osteotomized and prepared.

Once a broach is securely seated, a trial neck, slotted trial head, and guide plate are placed (Figure 2B). The distance from the guide plate to the proximal tip of the greater trochanter is assessed and compared with the 90° line drawn during templating. No length is gained or lost by placing the femoral component if the distance from the guide plate to the proximal tip of the greater trochanter and the distance from the 90° line to the new center of rotation of joint are the same but in opposite directions. For example, based on the templating demonstrated in Figure 1, seating of the stem such that the measuring guide is approximately 3 mm below the tip of the greater trochanter would not cause a significant change in leg length due to the femoral component.

MATERIALS AND METHODS

After institutional review board approval was obtained, the authors performed a retrospective analysis of 31 consecutive primary THAs performed using this method for limb-length assessment by 1 adult reconstruction fellowship-trained surgeon (A.G.U.). Pre- and 2-week postoperative anteroposterior radiographs of the pelvis were reviewed for each patient, and measurements of leg-length discrepancies were made by 2 independent evaluators (A.E.W., J.R.L.) using validated techniques. A Pearson correlation coefficient was determined to assess for interrater reliability. A linear regression analysis was performed to assess for variability in the amount of intraoperative limb length alteration as a function of preoperative limb length. Statistical significance was set at a P value less than .05 for all statistical analyses.

RESULTS

Mean preoperative leg-length discrepancy was 4.43 ± 6.96 mm. Mean postoperative leg-length discrepancy was 2.18 ± 6.08 mm. The results of the regression analysis suggest that patients who were short preoperatively on the operative side received a larger lengthening than patients who were equivalent or long preoperatively on the operative side (P < .002). Excellent agreement was found between evaluators of leg-length discrepancy on the pre- and postoperative radiographic evaluations (.8 < P < 1.0).

CONCLUSION

Limb-length discrepancy leading to a poor clinical outcome is a known complication following THA. Multiple intraoperative techniques exist for the measurement and correction of limb-length equality during THA, with no clear gold standard. The authors report a novel, noninvasive, intraoperative technique that rapidly and accurately measures femoral limb length and has been used successfully for intraoperative leg-length assessment with reproducible and reliable results. This method is an additional tool for the arthroplasty surgeon’s armamentarium to ensure accurate leg-length restoration.

REFERENCES


