Leg Length Discrepancy After Total Hip Arthroplasty

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Abstract: Restoration of hip biomechanics, including femoral offset and leg length are desired goals in performing total hip arthroplasty. Minor leg length discrepancies, less than a centimeter, are common after total hip arthroplasty and usually well tolerated. However, in some patients, even these small discrepancies are a source of dissatisfaction. In addition, more significant discrepancies can be a risk factor for nerve injury and are a relatively common cause of litigation. Although leg length discrepancy cannot be eliminated after hip arthroplasty, it can be minimized through a series of steps both preoperatively and intraoperatively. These include physical examination to determine true and apparent leg length, and radiographic evaluation to both assess leg length and to preoperatively template the surgical procedure. Finally, the preoperative plan needs to be executed in the operating room using appropriate intraoperative cues. Key words: leg length discrepancy, total hip arthroplasty, primary.

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Total hip arthroplasty is a reliable procedure for relief of pain. In order to optimize function, hip mechanics should be restored to as near normal as possible. This includes restoration of leg length as well as femoral offset. Leg length discrepancy following total hip arthroplasty is a significant source of patient dissatisfaction. Patients can sometimes detect relatively minor increases in leg length and are unhappy when they have to wear a lift in the contralateral shoe. Significant lengthening of the leg can be a contributory factor in the development of nerve palsy, especially sciatic nerve palsy. As a result of patient dissatisfaction, leg length inequality following total hip arthroplasty is a leading cause of litigation.

Although leg length inequality after total hip arthroplasty cannot be eliminated, the problem can be minimized. There are a variety of important steps in the process, including physical examination, radiographic evaluation, preoperative templating, and intraoperative confirmation of the preoperative plan.

Preoperative Evaluation

The first step in evaluating a patient for total hip arthroplasty involves a history and physical examination. In the assessment of leg length, there are 2 important measurements to perform. True leg length is determined by the distance from the anterior superior iliac spine to the medial malleolus and reflects the actual length of the extremity. Preoperative leg length assessment may also be influenced by apparent leg length discrepancies. Apparent leg length takes into account contractures about the hip as well as lumbar spine pathology that can result in pelvic obliquity. Apparent leg length is measured from the umbilicus to the medial malleo-
The involved side or a secondary to either a hip abduction contracture on length suggests the involved extremity is longer than the contralateral normal hip while the apparent leg ment to identify the involved hip as shorter than the opposite. It is possible for the true leg length measure-

spine pathology can produce an apparent leg length discrepancy. Chronic lumbar spine disease. Both of these conditions result in elevation of the unaffected hemi-pelvis and give the appearance of shortening of the unaffected leg.

As noted previously, pelvic obliquity results in an apparent leg length discrepancy. Chronic lumbar spine pathology can produce a fixed pelvic obliquity. The surgeon must realize this preoperatively and inform these patients that the surgical team can not equalize apparent leg length discrepancy during the hip operation. Attempting to do so could lead to significant lengthening or shortening of the true leg length, both of which are associated with potential problems. Shortening of the true leg length can lead to hip instability. Lengthening of the lower extremity beyond the true leg length can be associated with nerve injury.

Hip pathology can produce an apparent leg length discrepancy through the development of either an adduction or abduction contracture of the involved side. Both types of contracture lead to pelvic obliquity. An abduction contracture results in an obliquity with the involved hemipelvis being lower than the uninvolved side and yields an apparently long leg. An adduction contracture does just the opposite. It leads a pelvic obliquity with the involved hemipelvis being higher than the uninvolved side and gives the appearance of a short leg. Patients with hip adduction contracture and osteo-
arthritis of the hip will appear to have a very short leg because the two factors are additive. However, one only has to correct in surgery for the true leg length discrepancy. The hip arthroplasty in and of itself will alleviate the pelvic obliquity related to an adduction contracture and over time the pelvis will once again balance.

The next step in the process involves analysis of radiographs. The radiographs should be used to confirm the clinical measurements. In addition, the use of preoperative templating to identify the level of the osteotomy cut, neck length and femoral offset is important in reestablishing hip biomechanics and minimizing leg length discrepancy. Increased femoral neck offset options allow more accurate soft tissue tensioning without lengthening the leg.

There are a variety of ways to plan the operative procedure. In assessing leg length, I prefer to draw a line across the inferior aspect of the pelvis and reference that line to a fixed point on the lesser trochanters. This provides a reasonable assessment of the difference in leg lengths when using a ruler that accounts for magnification. The next step is to template the implants to determine the height of the osteotomy as well as the neck length. When unilateral hip disease is present, the goal is to match the opposite leg in terms of leg length. Provided that the socket will be reconstructed at the normal hip center, one can use the unaffected hip for templating—planning to maintain the leg length—and then execute that plan on the involved side.

**Surgical Technique**

During surgery, a number of intraoperative cues to assess reproduction of the preoperative plan can be used. Before prepping and draping the leg, with the patient positioned on their side, the relative position of the patient’s feet with symmetric knee flexion can be assessed. This provides a good idea of the starting leg length relationship. Usually, the up (treated) leg will appear slightly shorter than the down (nonoperative) leg because it is in an adducted position when the patient is lying on the side. During the surgical procedure, one can measure the height of the osteotomy from the top of the lesser trochanter and perform the osteotomy at the level determined by preoperative templating. After the osteotomy is finished, remeasure to ensure that the femoral neck has been cut at the planned height. After the trial reduction is performed, the surgeon can re-assess the relationship of the feet with the knees bent equally. As an additional cross-reference, one can use the relationship of the tip of the greater trochanter with respect to the center of the femoral head, both before and after femoral neck osteotomy, to assess restoration of leg length.

**Assessment of the Technique**

Fifty consecutive primary total hip arthroplasties performed in patients with unilateral hip disease between July 2002 and August 2003 were retrospectively reviewed to assess preoperative and postoperative leg length discrepancy using the technique described previously. Before surgery, the leg length discrepancy of the involved hip ranged from –25 to 0 mm (mean, 6.6 mm short) compared with the unaffected side. After reconstruction, the leg length discrepancy ranged from –12 mm to 7 mm (mean, –1.0 mm). The mean increase in leg length after surgery was 5.6 mm. Postoperatively, 41 of 50 hips (82 percent) were within ± 5 mm of the
contralateral limb. Eight of the nine remaining patients were a mean of 13 mm short preoperatively (range, 7–22 mm) and were improved to a mean of 9 mm short postoperatively (range, 6–12 mm).

The remaining patient had osteonecrosis of both hips without collapse of the femoral heads. There was significant head involvement bilaterally, and the symptomatic side had a crescent sign consistent with a subchondral fracture. Preoperatively, the leg lengths were equal. Postoperatively, the symptomatic side was 7 mm long. The patient noted the leg length discrepancy, which was subsequently corrected when the contra-lateral femoral head collapsed and the patient required hip arthroplasty surgery. No patient reported symptomatic leg length inequality comparable with others reports in the literature.

Discussion

There are other methods for assessing leg length changes in surgery. A variety of measurement devices are available to determine prearthroplasty and postarthroplasty leg lengths. Commercially available leg length calipers allow the assessment of both length and femoral offset, referencing with respect from the ipsilateral ilium. Ranawat and Rao et al. [4] also described the use of a vertical Steinmann pin placed into the ischium at the infracotyloid groove of the acetabulum to assist in the determination of leg length restoration during surgery. Placing a suture in the skin immediately superior to the incision can also provide a reference for assessing the restoration of leg length, although this technique does not simultaneously evaluate recreation of femoral neck offset.

In the future, navigation that is emerging as a potentially useful tool in total hip arthroplasty may be helpful for both implant positioning and leg length restoration. In general, there is still work to be done with navigation before widespread release. For example, implant positioning is critically dependent on appropriate registration. The process of landmark registration must be reproducible to provide accurate information. However, one thing that can be done relatively accurately now using navigation equipment is measuring leg length before and after femoral neck osteotomy after trial implantation. Currently, the technology is relatively expensive, but it will likely be available on a more widespread basis in the near future.

In summary, it is not possible to eliminate leg length discrepancy after total hip arthroplasty. However it can be minimized with preoperative planning, including templating, and executing the plan in the operating room using intraoperative cues that help to ensure accomplishment of planned goals.

References