Limb-Length Measurement in Total Hip Arthroplasty Using a Calipers Dual Pin Retractor

Iori Takigami, M.D., Mansho Itokazu, M.D., Ph.D., Yoshiki Itoh, M.D., Ph.D., Kazu Matsumoto, M.D., Ph.D., Takatoshi Yamamoto, M.D., and Katsuji Shimizu, M.D., D.M.Sc.

Abstract

Background: Limb-length inequality is not uncommon after total hip arthroplasty (THA) and may cause subjective problems for patients. During THA a stable reference point must be established to determine changes in leg length. Several methods have been useful in minimizing the incidence and magnitude of this problem. The equalization of leg-length discrepancy during THA can be achieved through the use of a simple measuring device, the calipers dual pin retractor (CDPR).

Materials and methods: The CDPR was developed to establish a fixed point on the pelvis that would remain constant throughout the procedure and from which the distance to the greater trochanter could be measured prior to dislocation of the hip. Limb lengths were measured in 56 patients undergoing primary THA, between 2004 and 2006. The CDPR was used in all cases.

Results: The preoperative diagnoses were osteoarthritis in 44 patients, osteonecrosis in five, and rheumatoid arthritis in seven. Average postoperative limb-length inequality was 4.2 mm. None of the patients had to use shoe lifts for equalization of limb lengths or complained of limb-length inequality.

Conclusion: This method of measurement is beneficial with most THA approaches, and the technique is helpful for minimizing limb-length inequality during THA.

Limb-length inequality after total hip arthroplasty (THA) is not uncommon and can be a cause of patient dissatisfaction. Several methods of measuring limb length directly or indirectly during THA have been described. As examples of the indirect methods, Charnley reported comparison of the limb length by palpation of the medial malleoli and what is commonly called the “shuck” test of the operated hip. Measurement of the distance between two reference points on the ilium and the femur has been one of the most commonly employed approaches of the direct methods. Most of the reports adopt Kirschner wires or Steinmann pins, but we believe that there is a risk of intraoperative loosening. The measurement may not be accurate if the pin in the ilium is not fixed firmly to the bone and it loosens during the procedure. Therefore, a stable pelvic reference point must be established during surgery to determine changes in limb length. We use the calipers dual pin retractor (CPDR), which has two 4-inch pins that cannot be dislodged from the ilium, as an intraoperative measuring device to prevent limb-length inequality after THA.

Materials and Methods

During THA, a stable reference point must be established to determine changes in leg length. The CDPR was developed to establish a fixed point on the pelvis that would remain constant throughout the procedure and from which the distance to the greater trochanter could be measured prior to dislocation of the hip.

The CDPR utilizes the design of a Charnley’s pin retractor used intraoperatively for reflecting the gluteal muscle. The retractor consists of two 4-inch pins joined by a “shoulder,” which carries a guide pin. The base of the measuring ruler arm fits over the guide pin (Fig. 1). The dual pins are inserted into the pelvis about 2 to 3 cm proximal to the acetabulum within the operative site (Fig. 2) and before the femoral head is dislocated. The femoral reference point is then...
marked over the most lateral prominent point of the greater trochanter using electrocautery. The baseline measurement of the distance is measured with the adjustable caliper in the hip neutral position. The neutral position is determined by maintaining the thigh parallel to the body axis and lower thigh parallel to operating table with the knee 90° flexed (Fig. 3). The caliper is removed after the measurement, and the dual pins in the ilium are left to serve as a retractor. The hip is then dislocated, and arthroplasty is performed. After reduction with the trial components in place, the caliper is attached to the pins in the hip neutral position, and intraoperative limb-length measurement is done by measuring the change in distance.

We studied a total of 56 patients undergoing primary THA between June 2004 and July 2006. Revisions, THAs requiring osteotomies, and the first operations of staged bilateral THAs were excluded. Limb-length inequalities were evaluated during the second operation in these cases. All operations were performed using the anterolateral approach, and the CDPR was used in all cases.

All THAs in this study were performed with cementless fixation. Spong metal Lübeck stems (S&G, ESKA, Lübeck, Germany) were used in 48 cases, SL-plus stems (Endoplus, Rotkreuz, Switzerland) in five cases, S-ROM (Deupy Orthopaedics, Inc., Warsaw, Indiana) stems in two cases, and Anca Fit stem (Cremascoli Wright, Milan, Italy) in one case. Spong metal Lübeck cups (S&G, ESKA) were used in 53 cases, TriAD HA cups (Stryker, Mahwah, New Jersey) in two cases, and Anca Fit cup (Cremascoli Wright) in one case.

Limb-length discrepancy was evaluated from an anteroposterior radiograph of the pelvis with bilateral hips in neutral position. The radiographs were recorded on a CIS system (CIS-image/Viewer for Windows version 2.8.26, IBM Japan Ltd., Tokyo, Japan) at a resolution of 1536 x 2048 pixels. A horizontal line was drawn through the bottom of the ischial tuberosities. The differences in limb length were measured using the relationship between this line and the most prominent point of the lesser trochanter in the electronic medical chart (Fig. 4).

Clinical evaluations were based on the Japanese Orthopaedic Association hip score system (JOA hip score). The measurements are presented as a mean with standard deviation. Student’s t-tests were performed to determine the relationships of measured parameters. Spearman’s correlation was carried out for analyzing the correlation between
limb-length inequality and JOA hip score. A p value of less than 0.01 was considered to be a significant difference.

Results

The mean patient age at the time of surgery was 62 years (range: 36 to 86). The preoperative diagnoses were primary or secondary osteoarthritis in 44 patients, osteonecrosis in five, and rheumatoid arthritis in seven. The average follow-up period was 25 months (range: 12 to 37).

Preoperative radiographic limb-length inequality averaged 14.2 ± 9.3 mm, ranging from 31 mm of shortening to 10 mm of lengthening of the operative limb. The limb-length inequality showed significant improvement, with a postoperative average of 4.2 ± 3.2 mm (range: 0 to 13) (p < 0.0001). None of the patients had to use shoe lifts for equalization of limb lengths or complained of limb-length inequality. No complications associated with the insertion of CDPRs were noted. There were no other major complications, such as dislocation, infection, fracture, or sciatic nerve palsy in this series.

JOA hip scores showed significant increases after the operation, from 45.9 ± 14.2 points preoperation to 83.3 ± 12.6 points of the latest follow-up (p < 0.0001). There was no significant correlation between improvement of limb-length inequality and JOA hip score (r = -0.260, p = 0.093).

Case Presentation

A 74-year-old female was referred to our clinic complaining of severe pain and limited range of motion (ROM) in her left hip. Following evaluation, she was diagnosed with osteoarthritis (Fig. 5A). Preoperative limb-length inequality was 14.6 mm. THA was performed using CDPR (Fig. 5B). Postoperative limb-length inequality was 0 mm. The patient experienced great alleviation of pain following the THA and improvement of her ROM, without severe complications.

Discussion

The goals of THA are equalization of limb lengths and restoration of the anatomic geometry of the hip to achieve normal gait and function. However, limb-length inequality is a well-known complication of THA. The procedure also may cause subjective problems for patients, such as limping or lower back pain. In a large series, Williamson and Reckling reported that 27% of patients required heel lifts on the contralateral side after THA to gain a satisfactory gait pattern. Love and Wright reported limb lengthening of greater than 1.5 cm in 18% of the 40 patients in their series. Edeen and colleagues noted that a significant number (32%) of patients were aware of limb-length inequality after THA, and that more than half required corrective contralateral shoe lifts.

Several methods using pins, rulers, and calipers have been described for intraoperative correction of limb-length inequality. Typically, measurement of the distance between two reference points marked on the pelvis and femur has been performed. Methods using the anterior superior iliac spine or iliac wing as a reference point may make it dif-
Difficult to gain accurate measurements since these landmarks are located away from the center of rotation of the hip. A guide wire may prick the surgeon’s glove and finger during surgery or may become dislodged from the pelvis in some cases. The CDPR utilizes the design of a Charnley pin retractor and has two pins to reduce intraoperative loosening. It does not require a separate incision and has a feature on the retractor for reflecting the gluteal muscle. Furthermore, this device can minimize the error of measurement, because it is inserted close to the center of rotation of the hip. In the present series, the average limb-length inequality after THA was 4.2 mm. No complications associated with the use of the device occurred, and none of the patients expressed dissatisfaction about limb-length inequality after surgery.

In summary, the CDPR is a relatively accurate and useful device that can be employed easily for intraoperative limb-length measurement during THA. The measurement can be used to aid the proper placement of the femoral component. This method is applicable with most THA approaches, and the technique aids in minimizing limb-length inequality during THA.

Disclosure Statement
None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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