Radiographic Measurement to Restore Femoral Head Center in Hip Arthroplasty

Phonthakorn Panichkul MD*,
Piya Pinsornsak MD*

* Department of Orthopaedic Surgery, Faculty of Medicine, Thammasat University, Pathumthani, Thailand

Objective: The purpose of the present study was to find the anatomical landmarks used as a reference for restoration of the femoral head center in hip arthroplasty patients.

Material and Method: One hundred anterior-posterior digital radiographs of the hip with no magnification were analyzed to measure the correlation between the distance from the center of the femoral head to the most prominent part of lesser trochanter and the femoral head diameter, and the relationship between the level of tip of the greater trochanter and the level of femoral head center.

Results: The authors found the linear correlation between the distance from the femoral head center to the lesser trochanter and the femoral head diameter (Pearson’s correlation coefficient = 0.95) with the average ratio of 1.023. The level of tip of the greater trochanter was found 75% higher than the femoral head center, 15% below the femoral head center, and 10% at the same level. The average level of the tip of greater trochanter was 8 mm above the femoral head center.

Conclusion: The distance from the center of the femoral head to the most prominent part of the lesser trochanter is approximately equal to the diameter of the femoral head. The use of the level of the tip of greater trochanter as a reference point for the level of the femoral head center should be carefully evaluated because of the variability of anatomy.

Keywords: Radiographic measurement, Femoral head diameter, Lesser trochanter, Tip of greater trochanter, Hip arthroplasty, Limb length discrepancy

J Med Assoc Thai 2012; 95 (Suppl. 10): S32-S36
Full text. e-Journal: http://jmat.mat.or.th

Limb length discrepancy (LLD) is one of the most concern problems observed in patients following hip arthroplasty. Some patients feel uncomforted with the result, even with a small leg length difference. Importantly, this disappointment, despite otherwise satisfactory operation, is a potential reason for litigation. Failure to restore limb length has a potential risk of hip instability, dislocation and abnormal gait pattern. The compromised hip biomechanics caused by LLD worsen patients’ functional outcomes and long-term clinical results.

There were many techniques for minimizing LLD after hip arthroplasty, including preoperative templates, intraoperative measurement devices, intraoperative palpation of bony landmarks with soft tissue tension and computer navigation. However, these techniques are of limited value when working within the distorted hip anatomy, such as femoral neck fracture.

The present study objective was to find the anatomical landmark that can use as a reference to identify the original location of femoral head center in hip arthroplasty patients. Based on a literature review, the distance from center of the femoral head to lesser trochanter was nearly equal to diameter of the femoral head. This finding would be one of helpful tools for identifying the original location of the femoral head even with distorted hip anatomy in femoral neck fracture. The primary objective of the present study was to find a correlation between the distance from the center of femoral head to the lesser trochanter and the femoral head diameter (FHD) in the preoperative anterior-posterior (AP) radiograph. The secondary objective was to identify the relationship between the levels of the tip of greater trochanter and femoral head center. If the correlations between these landmarks are consistent, they will be one of the helpful tools to identify the original location of the femoral head.

Material and Method

A total of 100AP digital radiographs of the hip with no magnification were analyzed to measure the correlation between the distance from the center of
femoral head to the most prominent part of lesser trochanter and FHD. Additionally, the level of the tip of the greater trochanter was compared with the level of the femoral head center.

Hips with pathologic deformities of the proximal femur, a deformed femoral head (such as by avascular necrosis or slipped capital femoral epiphysis), or inflammatory arthritis were excluded from the present study.

The present study subjects comprised 52 female and 48 male patients with an average age of 67.3 years (range, 45-94 years). The center of femoral head was identified using the perfect circle generated by computer around femoral head. The center of the circle was identified as the center of femoral head. The distance between the center of femoral head and the most prominent part of lesser trochanter was measured. This line was compared to the measured FHD (Fig. 1).

Femoral shaft axis was made by plotting center of the canal in three points level. These points were joined to produce the anatomical axis of femur. The perpendicular line to the anatomical axis was drawn at the level of the tip of greater trochanter to behave as the level of greater trochanter. The vertical distance between this line and the femoral head center was measured (Fig. 2).

Statistical analysis of results was performed using SPSS statistical software system. Pearson’s correlations were calculated between the distance from the lesser trochanter to femoral head center and the femoral head diameter.

Results

From the present study, we found the average distance from the center of femoral head to the lesser trochanter was $51.85 \pm 4.58$ mm ($54.69 \pm 3.61$ mm in male and $49.21 \pm 3.75$ mm in female). The average FHD was $50.66 \pm 4.26$ mm ($53.39 \pm 3.33$ mm in male and $48.15 \pm 3.39$ mm in female). The ratio between the distance from the center of femoral head to the lesser trochanter and the FHD was 1.023 (1.024 in male and 1.022 in female). In 75% of cases, the level of the tip of greater trochanter lied at the same level as the femoral head center. However, the clinical success of these techniques is varied and depends on many factors, such as patient positioning, type of anesthesia and muscle relaxation and soft tissue contracture. Some of these techniques cannot be used as a reference in a patient with distorted hip anatomy, such as femoral neck fracture.

Discussion

The LLD is one of the most concerns problems in patients after hip arthroplasty operation. This problem caused patient dissatisfaction, mechanical problems, pain and neurological deficit. Several techniques have been advocated to minimize LLD problems after hip arthroplasty, including preoperative and intraoperative measurements.

Preoperative measurements by the templating technique is one of the most popular methods to identify the femoral head center and neck resection level. The intraoperative techniques could be performed by direct leg length comparison of the operative limb with the contralateral limb, distance from the bony landmark at the pelvis to the greater trochanter and the level of the tip of the greater trochanter. However, the clinical success of these techniques is varied and depends on many factors, such as patient positioning, type of anesthesia and muscle relaxation and soft tissue contracture. Some of these techniques cannot be used as a reference in a patient with distorted hip anatomy, such as femoral neck fracture.
nations of techniques to identify the correct level of the femoral head center in hip arthroplasty.

The present study had a number of limitations. A single author obtained the measurements, which leaves open the possibility of inter-observer variation. The measurement of the FHD on AP radiographs could not represent the thickness of cartilage, it could underestimate the head diameter. But the technique that using the digital template circle was simple and accuracy method to identify the femoral head center. The prominent part of lesser trochanter was easier to identify when compared with the cadaveric model. The distance would be more accurate than manual method.

**Conclusion**

Based on the present study, the distance from the center of the femoral head to the most prominent part of lesser trochanter is approximately equal to the diameter of the femoral head. Assessing the femoral head center by this technique is a helpful measurement in relocating the center of the femoral head during hip arthroplasty. The use of the level of the tip of greater trochanter as a reference point for the level of the femoral head center should be carefully evaluated because of the variability of anatomy.

**Potential conflicts of interest**

None.

**References**

1. Maloney WJ, Keeney JA. Leg length discrepancy


การวัดภาพถ่ายรังสีเพื่อหาจุดศูนย์กลางของหัวกระดูกต้นขาในการผ่าตัดเปลี่ยนข้อสะโพกเทียม

พนธกร พนิษฐกุล, ปิยะ ปิ่นศรศักดิ์

วัตถุประสงค์: จุดประสงค์ของการศึกษานี้คือ การหาจุดทางกายวิภาคเพื่อใช้ในการวางแผนในการหาจุดศูนย์กลางของหัวกระดูกต้นขา ในผู้ป่วยที่ได้รับการผ่าตัดเปลี่ยนข้อสะโพกเทียม

วิสัยและวิธีการ: ทำการศึกษาภาพถ่ายทางรังสีดิจิตอลหน้าหลังของข้อสะโพกต็มจำนวน 100 ภาพ เพื่อหาความสัมพันธ์ระหว่างระยะทางจากจุดศูนย์กลางของหัวกระดูกต้นขาไปยังจุดที่สูงที่สุดของบุ่มกระดูกเลสเซอร์โทรแคนเตอร์กับระยะความยาวของหัวกระดูกต้นขา และหาความสัมพันธ์ระหว่างระดับยอดของบุ่มกระดูกเกรทเตอร์โทรแคนเตอร์กับระดับของจุดศูนย์กลางหัวกระดูกต้นขา

ผลการศึกษา: พบว่ามีความสัมพันธ์แบบเส้นตรงระหว่างระยะทางจากจุดศูนย์กลางของหัวกระดูกต้นขาไปยังจุดที่สูงที่สุดของบุ่มกระดูกเลสเซอร์โทรแคนเตอร์ ถึงระยะความยาวของหัวกระดูกต้นขา (Pearson's correlation coefficient = 0.95) โดยมีอัตราส่วนเป็น 1.023 และรอยละ 75 ของกลุ่มตัวอย่างมีระดับยอดของบุ่มกระดูกเกรทเตอร์โทรแคนเตอร์สูงกว่าระดับยอดของจุดศูนย์กลางหัวกระดูกต้นขา, รอยละ 15 อยู่ต่ำกว่า และมีเพียงรอยละ 10 ที่อยู่ระดับเดียวกัน ดังนี้ระยะทางเฉลี่ยของระดับยอดของบุ่มกระดูกเกรทเตอร์โทรแคนเตอร์จะสูงกว่าระดับของจุดศูนย์กลางหัวกระดูกต้นขาประมาณ 8 มิลลิเมตร

สรุป: ระยะทางจากจุดศูนย์กลางของหัวกระดูกต้นขาไปยังจุดที่สูงที่สุดของบุ่มกระดูกเลสเซอร์โทรแคนเตอร์มีระยะทางที่ใกล้เคียงกับระยะความยาวของหัวกระดูกต้นขา และการใช้ระดับยอดของบุ่มกระดูกเกรทเตอร์โทรแคนเตอร์เพื่อเป็นจุดทางกายวิภาคในการหาจุดศูนย์กลางหัวกระดูกต้นขา ควรใช้ต่ำความระมัดระวัง เนื่องจากมีความแตกต่างกันของลักษณะทางกายวิภาคในแต่ละราย

S36