International Journal of Research in Orthopaedics
Pilar A et al. Int J Res Orthop. 2020 Nov;6(6):1258-1262
http://www.ijoro.org

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20204594

Original Research Article

Trans-osseous intraoperative limb length measurement in hip replacement surgery

Anoop Pilar, Srivatsa Nagaraj Rao, Madan Mohan Muniswamy, Sandesh G. Manohar*, Rajkumar S. Amaravathi

Department of Orthopedics, St. Johns Medical College and Hospital, Bangalore, Karnataka, India

Received: 14 August 2020
Revised: 02 October 2020
Accepted: 05 October 2020

***Correspondence:**
Dr. Sandesh G. Manohar,
E-mail: sandeshmanohar@yahoo.com

ABSTRACT

Background: Discrepancy of the limb length following total hip replacement is one of common complication. To reduce the occurrence, various modalities are used like pre-operative templating, navigation assisted measurements and intraoperative methods. This study was done using trans-osseous method of measurement using hip gauge which provides a faster, simpler assessment of limb length.
Methods: A prospective study of 25 patients who underwent uncemented hip arthroplasty was taken in the study and the LLD was measured before and after the surgical procedure. Patient were re-assessed for limb length discrepancy after 6 months with functional Harris hip score and radiological analysis on weight bearing standard X-ray antero-posterior view of the pelvis with bilateral hip joint.
Results: The results showed significant improvement in limb length discrepancy, and analysis of postoperative radiographs found the mean length difference of 2.44 mm and average Harris hip score was 95.5. No device related complications were reported, and none of them complained of the discomfort related to limb-length discrepancy after surgery.
Conclusions: Trans-osseous fixed method using hip gauge provides a faster, reproducible and simpler method for the assessment of Limb length and aids with offset placement, acetabular anteversion for precise cup placement. This is a reliable method as it can be used both in the primary and revision hip surgery and most importantly doesn't require any additional intraoperative imaging.

Keywords: Arthroplasty, Hip, Limb length discrepancy, Trans-osseous, Technique

INTRODUCTION

Incidence of postoperative limb length discrepancy ranges from 1% to 27%, lengthening is more frequent than shortening with a variation of 3 mm to 70 mm.[1,2]

Post-operative limb length discrepancies (LLD) can be true LLD which is caused by lengthening of the prosthetic head-neck distance and functional LLD which is caused by the tightness of the soft tissues about the hip or scoliosis of the lumbar spine, causing obliquity of the pelvis.[3]

The True LLD can be measured with the help of a full-length AP radiographs of the lower limb where a line drawn from the centre of the femoral head to the centre of the ankle joint, or by measuring the vertical line passed from the inter tear drop line to lesser trochanter or by comparing the tip of the medial malleoli in supine position after squaring the pelvis.[4-6] The functional LLD

is measured typically assessed when the patient is standing and feels a sense of imbalance.[7] To measure this discrepancy , measuring blocks are placed under the short limb until the legs feel equal.[8,9]

The LLD is acceptable are those small LLD's less than 1 cm which are usually well tolerated by patients and may go unnoticed.[10] When the discrepancies are between 1 and 2 cm the studies have shown to affect the functional outcome scores and LLD'S greater than 2 cm may lead to greater patient dissatisfaction with altered balancing, instability at the hip, back pain, gait disturbance, generalized hip pain, nerve stretch pain, sciatic nerve palsy, ipsilateral knee pain , need for shoe rise and on longer run may cause aseptic prosthesis loosening and revision surgery.[11-14]

Post-operative limb shortening is caused due to inaccurate pre-operative planning, flexion contracture of the hip joint before the surgery, excessive acetabular reaming during the surgery and sinking of the collarless stem.[15-17]

To overcome the LLD various methods have been described like pre-operative templating, intraoperative pelvic or femoral markers for reference and computer-assisted surgery or with the help of CT and navigation assisted.[18-20]

Goal of an ideal referencing system is to improve the accuracy of component position, minimize errors of leg length, eliminate instability, maximize range of motion (ROM), minimize component impingement, improve hip mechanics and functionality.[21]

Presented method of referencing was an intra-operative method with hip gauge, based on fixed bony landmark in the lateral decubitus position where anterior superior iliac spine and greater trochanter was used as the fixed bony points and intraoperative LLD is calculated by summing the preoperative LLD with the change in length demonstrated by the calliper.

This is a reliable method as it can be used both in the primary and revision hip surgery and most importantly doesn't require any additional intraoperative imaging and provides a faster, simple assessment of limb length and placement of the offset.

Objective of current study was to analysis the accuracy and reliability of the simple trans osseous technique to minimize the limb length discrepancy post arthroplasty of the hip joint.

METHODS

This prospective study was done on 25 patients who underwent uncemented hip arthroplasty at St. Johns medical hospital, Bangalore between June 2017 to December 2019 after the intuitional ethical board clearance for the study and after taking valid informed consent from the patients. The measurements were recorded before and after the surgical procedure. We included all the primary and revision single hip replacement cases for the study.

We measured the intra-operative limb length measurement using hip gauge based on the static points on the iliac crest in line with the greater trochanter and second point on the greater trochanter (Figure 1).

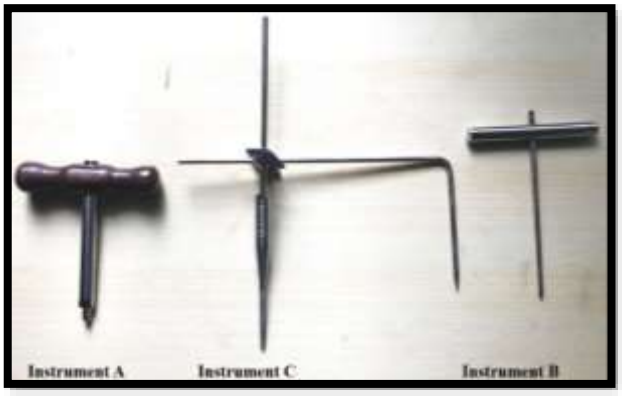

Figure 1: Hip-gauge instruments.

Standard posterior approach was used and before dislocation of the hip the first static point was established on the iliac crest in line with the greater trochanter using instrument A, second point was marked using electrocautery on the most lateral point of the greater trochanter following which instrument B is tapped trans-osseous and instrument C which is the measuring arm is attached to A and adjusted to extend till instrument B and locked in position. This was the starting point position; offset and leg length were captured as zero (Figure 2).

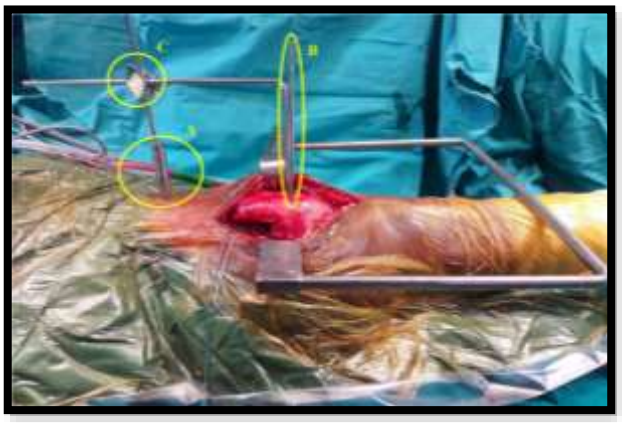

Figure 2: First point established just distal to iliac crest using instrument A, second point arbitrarily chosen over greater trochanter and the instrument B tapped intra osseous and instrument C is attached to A and adjusted to extend till instrument B.

The hip was made neutral in order to determine the limb length and the hip gauge assembly was detached from the greater trochanter and then the hip was dislocated. The hip gauge assembly was reattached after stable reduction with the trial components in place, instrument C was moved to the femoral reference point with the hip in the same position as before dislocation. Limb lengthening was measured as displacement between the vertical component the vertical component (instrument A) of the measuring arm and the trochanteric marker pin (instrument B) reflects a change from the initial leg length.

The differential measurements were recorded as absolute values. The pre and post-operative femoral offset value was correlated and compared with contralateral side. The postoperative offset was correlated with the intraoperative offset estimation was the addition of the change in offset demonstrated by the calliper with the preoperative radiographic femoral offset (Figure 3).

Figure 3: Post-operative change in offset demonstrated by the calliper.

Post operatively the limb length was measured clinically after squaring the pelvis and distance from ASIS to the tip of the medial malleoli and post-operative weight bearing standard x ray of pelvis with both hip joint in 10 degrees of internal rotation and centred on the pubic symphysis. Through the inferior aspect of tear drop a horizontal line were drawn. Using templates the vertical distance between the trans-teardrop line and the prominent point on the lesser trochanter was made both pre and post operatively.

After 6 weeks the patient was evaluated clinically, radiologically for limb length discrepancy and functionally with Harris hip score at 6 months. The research analysis of the data was done using IBM SPSS Statistics data management tool version 25.0 (64-bit).

RESULTS

Study involved 25 patients with an average age of 60.6 years with a range between 45 to 78 years. The average BMI was 23.8 kg/m$^{2.}$ There were 17 males and 8 females in the study group. The primary aetiology was Grade 4 Avascular necrosis of femoral head with arthritis in 60% of our cases, 20% cases were secondary to post trauma and 20% cases were due to secondary arthritis due to inflammatory pathology. The cause of AVN was most commonly idiopathic in 80% of cases (Table 1).

Table 1: Demography data.

Variables	Data
Total number of patients	25
Average age (years)	60.6
BMI (kg/m^2)	23.8
Male	17
Female	08
Etiology	
Avascular necrosis (AVN)	15
Osteoarthritis post trauma.	05
Inflammatory arthritis	05

The results showed significant improvement in limb length discrepancy and symptomatically the patients did not complain of any limb length discrepancies and clinical examination did not reveal any gait disturbance, and analysis of postoperative radiographs found the mean length difference of 2.44 mm with the standard deviation of 1.9 mm from an average pre-operative limb length discrepancy of 15.73 mm and mean Harris hip score was 95.5.

No device or surgery related complications were reported. and all the cases had been rehabilitated according to standard post-operative THR protocols program and 92% patients returned back to activity of daily living without any discomfort and 8% patients required longer rehabilitation in the form of gait training, muscle strengthening and postural correction to return their daily routine activity.

DISCUSSION

Limb length discrepancy (LLD) is one of the most common complications of total hip replacement and its restoration along with accurate offset is vital not only for improved clinical outcomes but for the longevity of the implants as well.

6 to 32% of patients perceive limb length discrepancy following the surgery and when the shortening exceeds 10 mm and lengthened more than 6 mm all the patients complain of LLD.[21,22] 32% of patients were aware of LLD with an average LLD of 15 mm concluded Edeen et al.[23]

In another study by Knoyves and Bannister, 33% of patients perceived lengthening and 18 % of patients had worst functional hip scores who perceived true lengthening at the end of 12 months after surgery.[24]

Commonly a free hand technique is used based on the pre-operative templating and intraoperative tissue tension and comparing with opposite lower limb to assess adequate limb length. Intraoperative techniques to measure limb length based on soft tissue tension like the Shuck test can be biased based on the positioning of the patient and the type of anesthesia.[25] Comparing the length with opposite side also has several confounding factors and palpation of bony landmarks is difficult and often inaccurate. Naito et al, concluded shuck test was an indicator of soft tissue balance rather than measurement of LLD.[26]

McWilliams et al in their systematic review concluded that postoperative LLD varied from 20 mm shortening to 35 mm lengthening with multiple intraoperative techniques.[27] In another study Desai et al implied that the use of intraoperative devices to measure limb length combined with preoperative templating is a reliable method to overcome LLD after total hip replacement.[22]

Woolson et al suggested pre-operative templating along with use of an intraoperative measurement technique is more accurate among the various methods available to prevent limb length discrepancies.[28] Bose et al compared the LLD using gauge and free hand technique and concluded better results with use of gauge.[21]

Our technique of trans-osseous measurement of intraoperative measurement using hip calibration gauge provides a fast, simple assessment of limb length and offset. The advantage is it can be used in both primary and revision hip surgery, with any implant and there is no additional imaging in the form fluoroscopy and CT scan required.

The limitations of our study are reproduction of the same position of the lower limb for measurement using the guide before and after dislocation and use of trial components as any change in position of the lower limb will give erroneous result. To minimize the error, we used the same assistant and the leg was held parallel to the ground and at most precaution was taken to reproduce the same position of the lower limb before and after dislocation and use of trial components. All the radiographs were taken in the same hospital and care was taken to account for positioning of the patient for radiographs and magnification and quality of the radiograph.

CONCLUSION

Restoration of limb length and precise positioning of the components improves the biomechanics and overall outcome of total hip replacement. Our method utilizing preoperative templating, intraoperative limb length measurement using hip calibration guide resulted in accurate limb length restoration compared to other devices mentioned in the literature and are better than freehand techniques. However, stability of the hip is the most important goal of the surgery when compared with limb length discrepancy as dislocation of the hip is a dreaded complication. We recommend the use of hip calibration guide as it gives good feedback intraoperatively and helps is avoiding major post op surprises.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Kayani B, Pietrzak J, Hossain FS, Konan S, Haddad FS. Prevention of limb length discrepancy in total hip arthroplasty. Br J Hosp Med (Lond). 2017;78 (7):385-90.
2. Abraham WD, Dimon JH 3rd. Leg length discrepancy in total hip arthroplasty. Orthop Clin North Am. 1992;23(2):201-9.
3. Ng VY, Kean JR, Glassman AH. Limb-length discrepancy after hip arthroplasty. J Bone Joint Surg Am. 2013;95(15):1426-36.
4. Tipton SC, Sutherland JK, Schwarzkopf R. The Assessment of Limb Length Discrepancy Before Total Hip Arthroplasty. J Arthroplasty. 2016;31(4): 88892.
5. Herisson O, Felden A, Hamadouche M, Anract P, Biau DJ. Validity and Reliability of Intraoperative Radiographs to Assess Leg Length During Total Hip Arthroplasty: Correlation and Reproducibility of Anatomic Distances. J Arthroplasty. 2016; 31(12):2784-8.
6. McWilliams AB, Grainger AJ, O'Connor PJ, Redmond AC, Stewart TD, Stone MH. Assessing reproducibility for radiographic measurement of leg length inequality after total hip replacement. Hip Int. 2012;22(5):539-44.
7. Piyakunmala K, Sangkomkamhang T. Measurement of patient's perception on limb-length discrepancy compared with weight-bearing orthoroentgeno-graphy in total hip arthroplasty: a prospective study. J Arthroplasty. 2018;33(7):2301-5.
8. Goldstein WM, Gordon A, Branson JJ. Leg length inequality in total hip arthroplasty. Orthopedics. 2005;28(9 Suppl):s1037-40.
9. Ng VY, Kean JR, Glassman AH. Limb-length discrepancy after hip arthroplasty. J Bone Joint Surg Am. 2013;95(15):1426-36.
10. Ranawat CS, Rodriguez JA. Functional leg-length inequality following total hip arthroplasty. J Arthroplasty. 1997;12(4):359-64.
11. Betsch M, Michalik R, Graber M, Wild M, Krauspe R, Zilkens C. Influence of leg length inequalities on pelvis and spine in patients with total hip arthroplasty. PLoS One. 2019;14(8):e0221695.
12. Enke O, Levy YD, Bruce WJ. Accuracy of leg length and femoral offset restoration after total hip

arthroplasty with the utilisation of an intraoperative calibration gauge. Hip Int. 2020;30(3):296-302.
13. Blizzard DJ, Nickel BT, Seyler TM, Bolognesi MP. The impact of lumbar spine disease and deformity on total hip arthroplasty outcomes. Orthop Clin North Am. 2016;47(1):19-28.
14. Sultan AA, Khlopas A, Piuzzi NS, Chughtai M, Sodhi N, Mont MA. The impact of spino-pelvic alignment on total hip arthroplasty outcomes: a critical analysis of current evidence. J Arthroplasty. 2018;33(5):1606-16.
15. Meermans G, Malik A, Witt J, Haddad F. Preoperative radiographic assessment of limb-length discrepancy in total hip arthroplasty. Clin Orthop Relat Res. 2011;469(6):1677-82.
16. Mavčič B, Dolinar D, Pompe B, Antolič V. Patient-dependent risk factors for self-perceived leg length discrepancy after total hip arthroplasty. Eur J Orthop Surg Traumatol. 2019;29(4):793-9.
17. Lecerf G, Fessy MH, Philippot R, Massin P, Giraud F, Flecher X, et al. Femoral offset: anatomical concept, definition, assessment, implications for preoperative templating and hip arthroplasty. Orthop Traumatol Surg Res. 2009;95(3):210-9.
18. Dundon JM, Mays RR. Revising substantial leg length discrepancy in total hip arthroplasty using computer-assisted navigated systems: a case series of three patients. Cureus. 2019;11(7):e5137.
19. Hofmann AA, Bolognesi M, Lahav A, Kurtin S. Minimizing leg-length inequality in total hip arthroplasty: use of preoperative templating and an intraoperative x-ray. Am J Orthop (Belle Mead NJ). 2008;37(1):18-23.
20. Strøm NJ, Reikerås O. Templating in uncemented THA. On accuracy and postoperative leg length discrepancy. J Orthop. 2018;15(1):146-50.
21. Bose WJ. Accurate limb-length equalization during total hip arthroplasty. Orthopedics. 2000;23(5):433-6.
22. Desai AS, Dramis A, Board TN. Leg length discrepancy after total hip arthroplasty: a review of literature. Curr Rev Musculoskelet Med. 2013;6(4):336-41.
23. Edeen J, Sharkey PF, Alexander AH. Clinical significance of leg-length inequality after total hip arthroplasty. Am J Orthop (Belle Mead NJ). 1995;24(4):347-51.
24. Konyves A, Bannister GC. The importance of leg length discrepancy after total hip arthroplasty. J Bone Joint Surg Br. 2005;87(2):155-7.
25. Ranawat CS, Rao RR, Rodriguez JA, Bhende HS. Correction of limb-length inequality during total hip arthroplasty. J Arthroplasty. 2001;16(6):715-20.
26. Naito M, Ogata K, Asayama I. Intraoperative limb length measurement in total hip arthroplasty. Int Orthop. 1999;23(1):31-3.
27. McWilliams AB, Grainger AJ, O'Connor PJ, Redmond AC, Stewart TD, Stone MH. A review of symptomatic leg length inequality following total hip arthroplasty. Hip Int. 2013;23(1):6-14.
28. Woolson ST, Hartford JM, Sawyer A. Results of a method of leg-length equalization for patients undergoing primary total hip replacement. J Arthroplasty. 1999;14(2):159-64.

Cite this article as: Pilar A, Rao SN, Muniswamy MM, Manohar SG, Amaravathi RS. Trans-osseous intraoperative limb length measurement in hip replacement surgery. Int J Res Orthop 2020;6:1258-62.