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A Comparative Analysis of Clinical Versus Radiological Methods for Assessing Limb Length Discrepancy Following Unilateral Total Hip Arthroplasty

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Abstract: ***Background: Limb Length Discrepancy (LLD) is a common complication following Total Hip Arthroplasty (THA), linked to dissatisfaction, abnormal gait, and prothesis-related issues. Accurate assessment is crucial, yet there is still debate over the optimal method. This study aims to compare the reliability of clinical and radiological methods for measuring LLD in patients undergoing unilateral THA. Methods: A prospective study was conducted on 30 patients undergoing primary unilateral THA. Preoperative and postoperative LLD was measured using two methods: (1) Clinical (Absolute) Method: measuring the distance from the Anterior Superior Iliac Spine (ASIS) to the medial malleolus; (2) Radiological (Trochanteric) Method: measuring the vertical distance from the interteardrop line to the lesser trochanter on anteroposterior pelvic radiographs. The measurements were compared using paired t-tests, Pearson's correlation, and Intraclass Correlation Coefficient (ICC). Results: The mean age of participants was 48.3 years, with a male preponderance (56.7%). Preoperatively, a significant statistical difference was found between the mean LLD measured clinically (1.35 cm) and radiologically (1.26 cm) (p=0.655). The correlation was weak (r=0.724, ICC=0.722). Postoperatively, the mean clinical LLD was 1.12 cm and radiological was 0.82 cm, with no significant statistical difference (p>0.05). The postoperative correlation improved but remained moderate (r=0.325, ICC=0.315). Conclusion: The radiological (trochanteric) method is a more accurate and reliable tool for assessing LLD in THA patients, particularly preoperatively. While the clinical method shows improved correlation postoperatively, it should be used with caution. We recommend the radiological method as the gold standard for precise LLD evaluation in both pre-operative planning and post-operative assessment.***

Keywords: Arthroplasty, Replacement, Hip; Leg Length Inequality; Radiography; Orthopedic Procedures; Intraoperative Complications; Postoperative Complications

1. Introduction

Total Hip Arthroplasty (THA) is a highly successful orthopaedic procedure that reliably alleviates pain and restores function in patients with end-stage hip disease.[1] Despite its success, Limb Length Discrepancy (LLD) remains a prevalent and significant complication, with reported incidences varying widely.[2] Post-operative LLD has been linked to a spectrum of issues including gait disorders (limping), lower back pain, sciatic nerve palsy, general patient dissatisfaction, instability, and accelerated aseptic loosening of prosthetic components.[3,4]

The pursuit of leg length equality is a fundamental goal in THA. Even minor discrepancies can be perceptible to patients and impact functional outcomes. Love and Wright reported that up to 18% of patients had a lengthening of more than 1.5 cm, with 6% requiring shoe corrections.[5] Consequently, an otherwise technically perfect arthroplasty can be deemed a failure from the patient's perspective if complicated by a symptomatic LLD.[6]

Accurate measurement is the cornerstone of managing LLD. Numerous methods, both clinical and radiological, have been described. Clinical methods, such as the measurement from the Anterior Superior Iliac Spine (ASIS) to the medial malleolus (the absolute method), are simple and inexpensive but can be influenced by anatomical variations, soft tissue contractures and pelvic tilt.[7] Radiological methods, particularly the trochanteric method using standardized pelvic radiographs, are generally considered more objective and reproducible.[8] This method utilizes the interteardrop line as a stable pelvic reference point, minimizing errors from radiographic rotation.[9]

Despite the acknowledged superiority of radiological techniques, clinical assessment remains widely used in many settings due to its quick execution and zero cost. However, a direct comparison of these methods in the context of unilateral THA, both pre- and post-operatively, is essential to guide clinical practice. This study aims to determine the incidence of LLD in unilateral THA and to compare the accuracy and reliability of clinical (absolute) and radiological (trochanteric) methods in its assessment.

2. Materials and Methods

Study Design and Population

A prospective study was conducted in the Department of Orthopaedics at a tertiary care institute from 2015 to 2017. After obtaining institutional ethical clearance and informed consent, 30 patients undergoing primary unilateral THA were enrolled.

Inclusion and Exclusion Criteria

Inclusion criteria comprised patients with unilateral hip disease scheduled for primary THA. Exclusion criteria were a history of previous spinal, pelvic, or lower limb fractures; bilateral hip disease; ankylosing spondylitis; progressive neurological diseases; and patients scheduled for revision THA.

Surgical Technique and Post-operative Care

All procedures were performed by senior surgeons using either an anterolateral or posterolateral approach with the patient in the lateral decubitus position. Standard protocols were used for osteotomy, acetabular reaming and component implantation. Post-operatively, patients were managed with an abduction pillow, and partial weight-bearing began on the second post-operative day, progressing to full weight-bearing by six weeks.

Assessment of Limb Length Discrepancy

LLD was assessed preoperatively and at the 3-month postoperative follow-up using two methods:

1) *Clinical (Absolute) Method:* With the patient supine, the distance from the ASIS to the ipsilateral medial malleolus was measured bilaterally using a tape measure. The LLD was calculated as the difference between the two sides (see Figure 1).
2) *Radiological (Trochanteric) Method:* On standardized anteroposterior (AP) pelvic radiographs, a horizontal interteardrop line was drawn. The perpendicular vertical distance from this line to the tip of each lesser trochanter was measured. The difference between the two sides represented the radiological limb length discrepancy (LLD) (see Figure 2 and 3).

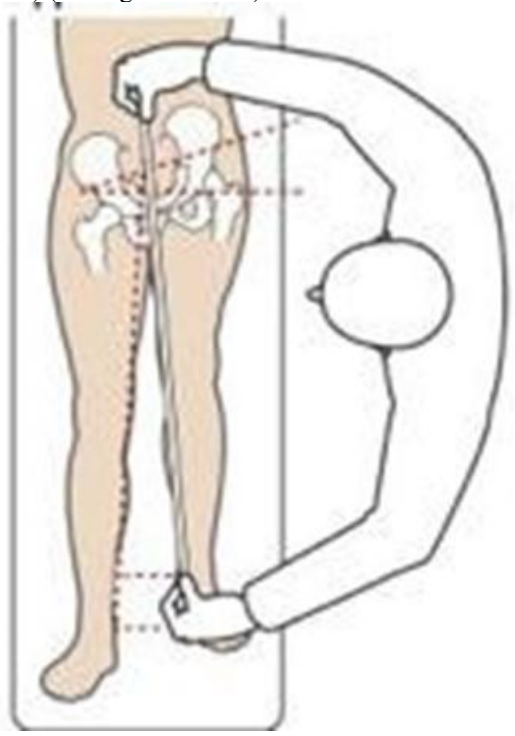


Figure 1: Absolute method - Anterior superior iliac spine to the medial malleolus

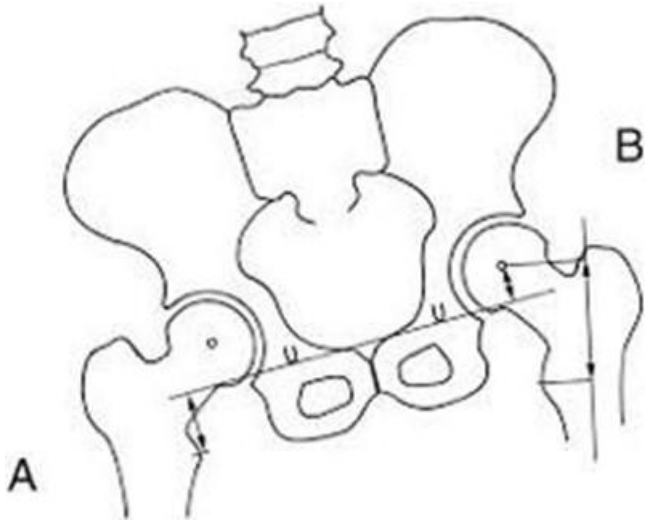


Figure 2: Trochanteric method of LLD measurement is based on perpendicular vertical measurements from the interteardrop line to the tip of the lesser trochanter (A)

Figure 3: Radiological (Trochanteric) Method

Statistical Analysis

Data were analyzed using SPSS software. Descriptive statistics were expressed as mean and standard deviation. Paired t-tests were used to compare mean LLD values between the two methods. Pearson's correlation coefficient (r) and Intraclass Correlation Coefficient (ICC) were calculated to assess the agreement between clinical and radiological measurements. A p-value of <0.05 was considered statistically significant.

3. Results

Patient Demographics

A total of 30 patients were included in the study. The mean age was 48.3 years (Range: 25-74 years). There was a slight male preponderance (17 males, 56.7%; 13 females, 43.3%). The most common diagnosis was Osteoarthritis (OA) (40%), followed by Femoral Neck Fracture (#NOF) (36.7%) and Avascular Necrosis (AVN) (23.3%). Surgery was performed on the right hip in 60% of cases (see Table 4).

Table 4: Baseline Demographic and Clinical Characteristics of the Study Cohort (N=30)

Characteristic	Value
Mean Age (years)	48.3 ± 14.5
Gender, n (%)	
• Male	17 (56.7%)
• Female	13 (43.3%)
Diagnosis, n (%)	
• Osteoarthritis (OA)	12 (40.0%)
• Femoral Neck Fracture (#NOF)	11 (36.7%)
• Avascular Necrosis (AVN)	7 (23.3%)
Side Operated, n (%)	
• Right	18 (60.0%)
• Left	12 (40.0%)

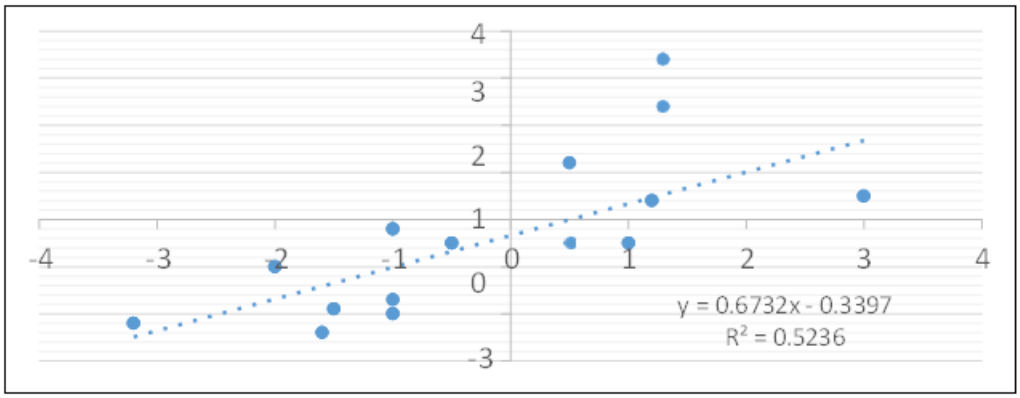
Preoperative Limb Length Discrepancy

Preoperatively, the mean LLD measured clinically was 1.35 cm (SD=0.80), which was greater than the mean radiological LLD of 1.26 cm (SD=0.88). The paired t-test showed no significant difference between mean values ($p>0.05$). Pearson's correlation was 0.724 ($p<0.001$), and the ICC was

0.722, indicating a fair but not excellent agreement (Table 5, Graph 6).

Table 5: Comparison of Preoperative and Postoperative LLD Measurements

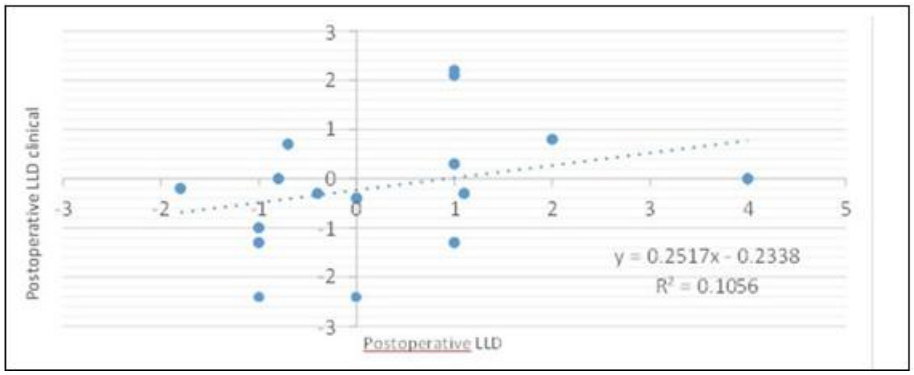
Time of Measurement	Method	Mean LLD (cm)	SD	p-value (t-test)	Pearson r	ICC
Preoperative	Clinical	1.35	0.80	0.655	0.724	0.722
	Radiological	1.26	0.88			
Postoperative	Clinical	1.12	0.94	>0.05	0.325	0.315
	Radiological	0.82	0.76			



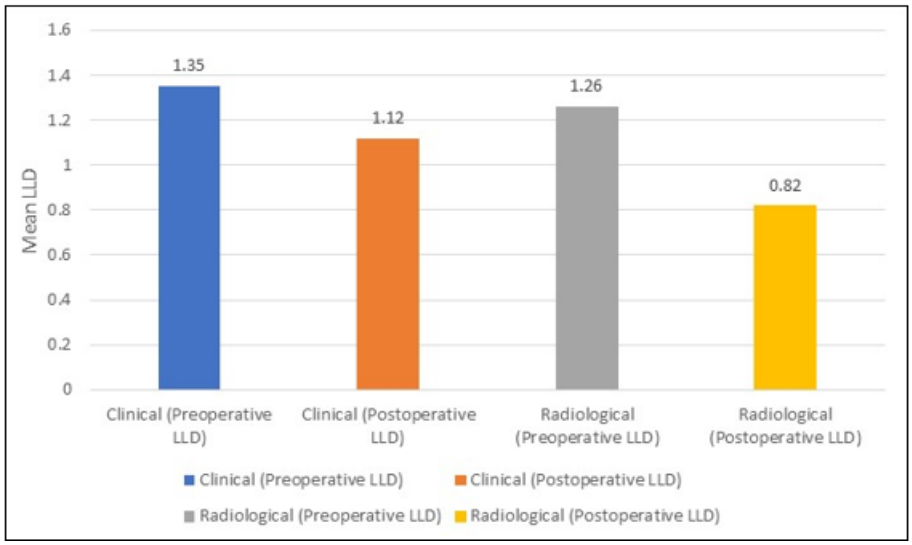
Graph 6: Scatter Plot Showing Correlation Between Preoperative Clinical and Radiological LLD

Postoperative Limb Length Discrepancy

Postoperatively, the mean LLD decreased with both methods. The clinical method showed a mean LLD of 1.12 cm (SD=0.94), while the radiological method showed a mean of 0.82 cm (SD=0.76). There was no statistically significant difference between the mean values (p>0.05). However, the correlation between the methods weakened postoperatively, with a Pearson's r of 0.325 (p=0.080) and an ICC of 0.315, indicating a limited agreement between methods at the individual level (see Table 5, Graph 7).



Graph 7: Scatter Plot Showing Correlation Between Postoperative Clinical and Radiological LLD



Graph 8: Bar Chart Comparing Mean LLD Preoperatively and Postoperatively by Method

4. Discussion

This prospective study highlights the critical differences between clinical and radiological assessments of LLD in patients undergoing unilateral THA. Our findings affirm that the method of measurement has a considerable effect on the measured discrepancy of LLD.

Preoperatively, we observed a significant difference between clinical and radiological measurements, with the clinical method tending to overestimate the discrepancy. This can be attributed to several factors common in the arthritic hip, such as fixed pelvic obliquity, flexion or adduction contractures, and joint space collapse.[10] These soft tissue factors distort clinical measurements like the ASIS-to-malleolus distance, while the radiological method, using the stable interteardrop line, provides a more direct bony assessment, less affected by soft tissue contractures. The fair correlation (ICC=0.722) preoperatively suggests that while related, the two methods are not interchangeable.

The mean LLD decreased postoperatively, indicating improved limb length balance. Interestingly, the statistical difference between the mean values of the two methods was no longer significant. This likely stems from the correction of soft tissue contractures and pelvic tilt during surgery, allowing for a more neutral pelvic position during clinical examination. However, the correlation between the methods paradoxically weakened (ICC=0.315). This indicates that while the average discrepancy is similar, the agreement on a per-patient basis is poor. The radiological method consistently recorded a lower mean LLD, suggesting that the clinical method may be less precise in detecting the true, structurally based discrepancy after surgery, potentially due to residual postoperative swelling or slight inconsistencies in measurement technique.

Our results are consistent with previous literature. Friberg *et al.* reported differences of up to 8.6 mm between clinical ASIS-malleolus measurements and standing radiographs.[7] In contrast, Gogia *et al.* found excellent reliability for the clinical method,[11] a finding not fully supported by our data. The trochanteric radiological method used in our study has been validated by others; Woolson *et al.* reported high inter-observer reliability, and Goodman *et al.* recommended the teardrop point as a reliable landmark due to its resistance to pelvic rotation.[8,9]

The primary limitation of our study is the relatively small sample size of 30 patients. Furthermore, the precision of the clinical tape measurement method is inherently lower than that of standardized radiographs, a factor that could influence the correlation results.

5. Conclusion

In conclusion, this study demonstrates that the radiological (trochanteric) method is a superior, more accurate, and reliable tool for assessing LLD in patients undergoing THA, both before and after surgery. While the clinical (absolute) method is simple and accessible, its results should be interpreted with caution, especially in the pre-operative setting where soft tissue pathology can confound measurements. For precise surgical planning and objective post-operative evaluation, we recommend the use of standardized AP pelvic radiographs with the trochanteric method as the preferred technique for quantifying limb length discrepancy.

Conflict of Interest Statement
The authors declare no conflict of interest.

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