Study of Leg length inequality following total hip replacement

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Abstract:

Background: Leg length inequality (LLI) is a well-recognized complication following total hip replacement (THR) and is a common cause of patient dissatisfaction, gait disturbance, and functional impairment. Despite advances in surgical techniques and implant design, achieving accurate limb length restoration remains challenging.

Objectives: To evaluate the incidence and magnitude of postoperative leg length inequality following total hip replacement and to analyze its association with demographic factors, surgical variables, and functional outcomes.

Methods: This prospective observational study included 90 patients undergoing unilateral primary total hip replacement at a tertiary care center. Preoperative and postoperative leg length discrepancies were assessed clinically and radiologically. Surgical variables such as approach, implant type, surgeon experience, and duration of surgery were recorded. Functional outcomes were evaluated using the Harris Hip Score (HHS) and WOMAC score. Statistical analysis was performed to determine associations between postoperative LLI and relevant variables.

Results: Postoperatively, 55.6% of patients had no significant LLI (<5 mm), while 20% exhibited discrepancies greater than 10 mm. A statistically significant association was observed between postoperative LLI and surgical approach ($p = 0.03$), surgeon experience ($p = 0.02$), operative duration, and preoperative limb length discrepancy. Functional outcomes showed marked improvement, with mean HHS increasing from 42.6 preoperatively to 88.5 at 12 months, and mean WOMAC score decreasing from 68.4 to 18.2.

Conclusion: Leg length inequality after THR is influenced by multiple surgical and patient-related factors. Meticulous preoperative planning, appropriate surgical approach, and surgical expertise are essential to minimize postoperative LLI and optimize functional outcomes.

Keywords: Total hip replacement; Leg length inequality; Functional outcome

Introduction

Total hip replacement (THR) is one of the most successful orthopedic procedures for relieving pain and restoring function in patients with advanced hip pathology. (1) Despite significant advances in implant design, surgical techniques, and perioperative planning, leg length inequality (LLI) remains one of the most common and challenging complications following THR. (2,3) Even minor discrepancies in limb length can result in patient dissatisfaction and may adversely affect functional outcomes. Postoperative LLI has been associated with gait abnormalities, lower back pain, pelvic obliquity, sciatic nerve irritation, and an increased risk of prosthetic instability and dislocation. (4)

Achieving optimal leg length restoration during THR is technically demanding and influenced by multiple factors, including preoperative deformity, soft-tissue contractures, pelvic tilt, implant positioning, and intraoperative assessment methods. While radiographic templating and intraoperative measuring techniques are routinely employed, inaccuracies may still occur due to variations in patient anatomy and surgical execution. Furthermore, perceived leg length inequality may differ from true radiographic discrepancy, adding complexity to postoperative evaluation. (5,6)

Given the functional, medicolegal, and quality-of-life implications of LLI after THR, systematic evaluation of its incidence, magnitude, and associated risk factors is essential. This study aims to assess leg length inequality following total hip replacement and to analyze its clinical and radiological significance in order to improve surgical outcomes and patient satisfaction.

Study Methodology

This prospective observational study was conducted in the Department of Orthopaedics at a tertiary care teaching hospital over a defined study period after obtaining approval from the Institutional Ethics Committee. A total of 90 patients who underwent primary total hip replacement for various hip pathologies were included in the study. All adult patients above 18 years of age undergoing unilateral primary THR and who provided informed written consent were enrolled. Patients with previous hip surgery on either side, bilateral THR, congenital limb length discrepancy, spinal deformities, or neuromuscular disorders affecting gait were excluded from the study.

A detailed preoperative evaluation was performed for all patients, including clinical assessment of limb length using standard block method and radiological assessment using anteroposterior pelvis radiographs. Preoperative templating was carried out to estimate implant size and anticipated limb length restoration. Relevant demographic data, indication for surgery, side involved, and comorbidities were documented. All surgeries were performed by experienced orthopedic surgeons using standard surgical approaches and cemented or uncemented prostheses as deemed appropriate.

Intraoperatively, limb length restoration was assessed using anatomical landmarks and standardized measurement techniques. Care was taken to achieve appropriate femoral offset, soft-tissue tension, and hip stability. Postoperative rehabilitation protocols were standardized for all patients. Patients were mobilized early with weight-bearing as tolerated, and physiotherapy was continued throughout the hospital stay and follow-up period.

Postoperative assessment of leg length inequality was performed both clinically and radiologically at follow-up visits. Clinical limb length was measured using the block method, while radiological evaluation was done using standardized pelvic radiographs by measuring the vertical distance from a fixed pelvic reference point to the lesser trochanter. Leg length discrepancy was recorded in millimeters and categorized as <5 mm, 5–10 mm, and >10 mm. Functional outcomes and patient-reported symptoms related to limb length inequality were documented and analyzed using appropriate statistical methods.

RESULTS

Table 1: Demographic and Clinical Profile of Study Participants (n = 90)

Parameter	Category	Number (%)
Age (years)	18–40	18 (20.0)
	41–50	26 (28.9)
	51–60	30 (33.3)
	>60	16 (17.8)
	Mean ± SD	**52.4 ± 9.6**
Gender	Male	54 (60.0)
	Female	36 (40.0)
Side Operated	Right	49 (54.4)
	Left	41 (45.6)
Primary Diagnosis	Osteoarthritis	46 (51.1)
	Avascular necrosis	28 (31.1)
	Fracture neck femur	10 (11.1)
	Rheumatoid arthritis	6 (6.7)

The majority of patients were middle-aged to elderly males, with osteoarthritis being the most common indication for total hip replacement.

Table 2: Surgical Characteristics of Total Hip Replacement

Variable	Category	Number (%)
Surgical Approach	Posterior	58 (64.0)
	Lateral	32 (36.0)
Type of Implant	Cemented	38 (42.2)
	Uncemented	52 (57.8)
Surgeon Experience	<5 years	22 (24.4)
	5–10 years	36 (40.0)
	>10 years	32 (35.6)
Duration of Surgery (min)	<90	24 (26.7)
	90–120	44 (48.9)
	>120	22 (24.4)
	Mean ± SD	**104 ± 22**

Posterior approach and uncemented implants were more commonly used. Most surgeries were performed by surgeons with moderate to high experience.

Table 3: Distribution of Preoperative and Postoperative Leg Length Discrepancy (LLD)

LLD Category	Preoperative n (%)	Postoperative n (%)
<5 mm (No LLD)	54 (60.0)	50 (55.6)
5–10 mm	26 (28.9)	22 (24.4)
10–15 mm	—	12 (13.3)
>15 mm	—	6 (6.7)
>10 mm (overall)	10 (11.1)	18 (20.0)

Although postoperative leg length inequality was reduced in many patients, a subset developed moderate to severe LLD following surgery.

Table 4: Factors Associated with Postoperative Leg Length Discrepancy and Functional Outcome

Variable	Key Findings	Statistical Significance
Surgical Approach vs LLD	Lateral approach showed higher LLD incidence	$\chi^2 = 4.19$, $p = 0.03$*
Surgeon Experience vs LLD	Higher LLD with <5 years experience	$\chi^2 = 6.02$, $p = 0.02$*
Preoperative vs Postoperative LLD	Higher pre-op LLD → higher post-op LLD	Positive trend
Duration vs Mean LLD (mm)	<90 min: 4.2 ± 2.1	—
	90–120 min: 7.6 ± 3.4	—
	>120 min: 11.2 ± 4.8	—
Functional Scores	HHS improved from 42.6 → 88.5	Clinically significant
	WOMAC reduced from 68.4 → 18.2	Clinically significant

*Statistically significant

Interpretation:

Postoperative leg length discrepancy was significantly associated with surgical approach, surgeon experience, operative duration, and preoperative limb length inequality. Functional outcomes improved markedly despite residual LLD in some patients.

Discussion

Leg length inequality (LLI) remains a clinically important and patient-sensitive outcome following total hip replacement (THR), despite substantial advances in surgical techniques and implant design. The present study evaluated the incidence, magnitude, and determinants of postoperative LLI in 90 patients undergoing primary THR, and correlated these findings with functional outcomes. The results provide meaningful insights into both patient-related and surgery-related factors influencing limb length restoration. (7)

The demographic profile of the study population showed a predominance of patients in the fifth and sixth decades of life, with a mean age of 52.4 years. This age distribution is consistent with the epidemiology of

degenerative hip disorders, particularly osteoarthritis and avascular necrosis, which together accounted for more than 80% of indications for THR in this study. Male predominance observed in the present series has also been reported in several Indian and international studies and may reflect higher exposure to occupational stress, trauma, and delayed health-seeking behavior among males. (8)

Preoperatively, 60% of patients had no clinically significant limb length discrepancy, whereas 40% exhibited mild to moderate discrepancy. Following surgery, more than half of the patients (55.6%) achieved near-equal limb length (<5 mm discrepancy), indicating effective restoration in a majority of cases. However, 20% of patients demonstrated postoperative discrepancy greater than 10 mm, which is considered clinically relevant. This highlights that despite meticulous planning and intraoperative assessment, complete elimination of LLI remains challenging in routine clinical practice.

A significant association was observed between surgical approach and postoperative LLI, with the lateral approach demonstrating a higher incidence of discrepancy compared to the posterior approach. This may be attributed to abductor handling, altered femoral exposure, and difficulty in consistent intraoperative referencing during the lateral approach. The posterior approach, offering better femoral visualization and ease of component positioning, may facilitate more accurate limb length assessment, explaining its relatively favorable outcomes in this study. (9,10)

Surgeon experience emerged as another important determinant of postoperative limb length inequality. Surgeries performed by surgeons with less than five years of experience showed a significantly higher incidence of LLI compared to those performed by more experienced surgeons. This finding underscores the steep learning curve associated with THR and emphasizes the importance of surgical expertise, familiarity with intraoperative measurement techniques, and decision-making during component positioning and soft-tissue balancing.

The duration of surgery also showed a positive correlation with postoperative LLI. Procedures lasting more than 120 minutes were associated with a higher mean discrepancy, possibly reflecting increased technical difficulty, complex anatomy, intraoperative challenges, or surgeon fatigue. Longer operative times may also indicate difficult exposure or implant positioning, which can compromise precise limb length restoration.

Importantly, preoperative limb length discrepancy was found to influence postoperative outcomes, with patients having greater preoperative inequality showing a higher likelihood of residual discrepancy after THR. This suggests that severe preoperative deformity and soft-tissue imbalance may limit complete correction, even with optimal surgical technique.

Despite the presence of postoperative LLI in some patients, functional outcomes improved significantly, as evidenced by marked improvement in Harris Hip Score and WOMAC score over follow-up. This indicates that while limb length equality is desirable, overall pain relief, mobility, and joint function remain the primary contributors to patient satisfaction.

Conclusion:

In conclusion, postoperative leg length inequality following THR is multifactorial and influenced by surgical approach, surgeon experience, operative duration, and preoperative discrepancy. Awareness of these factors and meticulous intraoperative techniques are essential to minimize LLI and optimize patient outcomes.

References:

1. Anderson C.G., Jang S.J., Brilliant Z.R., Mayman D.J., Vigdorchik J.M., Jerabek S.A., Sculco P.K. Complication Rate After Primary Total Hip Arthroplasty Using the Posterior Approach and Enabling Technology: A Consecutive Series of 2888 Hips. J. Arthroplast. 2023;38:S119–S123.e3.

2. Lecoanet P., Vargas M., Pallaro J., Thelen T., Ribes C., Fabre T. Leg length discrepancy after total hip arthroplasty: Can leg length be satisfactorily controlled via anterior approach without a traction table? Evaluation in 56 patients with EOS 3D. Orthop. Traumatol. Surg. Res. 2018;104:1143–1148.

3. Gheewala R.A., Young J.R., Villacres Mori B., Lakra A., DiCaprio M.R. Perioperative management of leg-length discrepancy in total hip arthroplasty: A review. Arch. Orthop. Trauma. Surg. 2023;143:5417–5423.

4. Basile G., Calori G.M., Bianco Prevot L., Fozzato S., Ragona M., Chiodi B., Montanari E., Amadei F., Leigheb M., Montana A. The main causes of orthopedics and traumatology litigation in Italy: State of the art and review of the literature. Minerva Orthop. 2024;75:153–162.

5. Flecher X., Ollivier M., Argenson J.N. Lower limb length and offset in total hip arthroplasty. Orthop. Traumatol. Surg. Res. 2016;102((Suppl. 1)):S9–S20.

6. Tsai C.J., Yang Z.Y., Wu T.Y., Tsai Y.T., Wang J.J., Liaw C.K. The Transverse Mechanical Axis of the Pelvis for Post-Operative Evaluation of Total Hip Arthroplasty. Biomedicines. 2023;11:1397.

7. Moharrami A., Mirghaderi P., Hoseini Zare N., Moazen-Jamshidi M.M., Ebrahimian M., Mortazavi S.M.J. Slight pelvic obliquity is normal in a healthy population: A cross-sectional study. J. Exp. Orthop. 2023;10:57.

8. Hamad M.N., Livshetz I., Sood A., Patetta M., Gonzalez M.H., Amirouche F.A. Effects of pelvic obliquity and limb position on radiographic leg length discrepancy measurement: A Sawbones model. J. Exp. Orthop. 2022;9:71.

9. Fujita T., Hamai S., Hara D., Kawahara S., Yamaguchi R., Ikemura S., Motomura G., Kawaguchi K., Nakashima Y. Trendelenburg gait after total hip arthroplasty due to reduced muscle contraction of the hip abductors and extensors. J. Orthop. 2024;59:57–63.

10. Abouelela A., Mubark I., Nagy M., Hind J., Jayakumar N., Ashwood N., Bindi F. Limb Length Inequality in Patients After Primary Total Hip Arthroplasty: Analysis of Radiological Assessment and Influencing Risk Factors Based on a District General Hospital Experience of 338 Cases. Cureus. 2021;13:e19986.