



COMPUTED TOMOGRAPHY–BASED EVALUATION OF FEMORAL ANTEVERSION RESTORATION AND ITS IMPACT ON FUNCTIONAL OUTCOME FOLLOWING HEMIARTHROPLASTY: A PROSPECTIVE STUDY

Orthopaedics

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ABSTRACT

Introduction: Inaccurate restoration of femoral anteversion following hemiarthroplasty can result in hip instability and compromised functional outcomes, making accurate intraoperative restoration essential for optimal postoperative recovery. **Objective:** The objective of this study was to compare femoral anteversion between the operated and contralateral normal sides using computed tomography and to evaluate its correlation with postoperative functional outcomes following hemiarthroplasty. **Material and Method:** This prospective observational study included 39 elderly patients with displaced intracapsular femoral neck fractures treated with primary hemiarthroplasty. Femoral anteversion was restored intraoperatively using the lesser trochanter as an anatomical landmark. Postoperative femoral anteversion was assessed using computed tomography and compared with the contralateral normal side. Functional outcomes were evaluated using the Modified Harris Hip Score at 6 weeks, 3 months, 6 months, and 12 months postoperatively. **Results:** The mean femoral anteversion was $18.35 \pm 5.57^\circ$ on the operated side and $15.79 \pm 4.90^\circ$ on the normal side, with a mean difference of $4.96 \pm 4.43^\circ$. Femoral anteversion was restored within 5° of the normal side in 58.9% of patients. Accurate restoration demonstrated a statistically significant correlation with improved functional outcomes ($\chi^2 = 17.47$, $p = 0.007$). The mean Harris Hip Score improved from 61.28 ± 7.67 at 6 weeks to 88.79 ± 5.69 at 12 months. **Conclusion:** Restoration of femoral anteversion within 5° of the contralateral normal side, using the lesser trochanter as an intraoperative reference, significantly improves postoperative stability and functional outcomes following hemiarthroplasty.

KEYWORDS

Hemiarthroplasty, Femoral Anteversion, Harris Hip Score, Radiological Correlation, Functional Outcome.

INTRODUCTION

Femoral anteversion plays a crucial role in hip biomechanics, influencing joint stability, range of motion, gait, and functional outcome after hip surgery [1]. It represents the angular relationship between the femoral neck and the femoral condylar axis, and deviations from the native angle can alter load distribution across the hip, leading to instability, impingement, and compromised function. Accurate restoration of femoral anteversion is particularly important in hemiarthroplasty for displaced femoral neck fractures in the elderly. Intraoperative assessment is commonly based on anatomical landmarks such as the lesser trochanter, though its reliability remains variable. While clinical methods lack precision, computed tomography (CT) provides the most accurate and reproducible measurement of femoral version [2, 3].

With the rising incidence of hip fractures in the elderly population, especially in developing countries like India, optimizing surgical technique is essential to improve outcomes [4]. Despite widespread use of hemiarthroplasty, limited Indian literature has correlated CT-based femoral anteversion with postoperative functional outcomes. This study aims to compare CT-measured femoral anteversion between the operated and contralateral normal hips following hemiarthroplasty and to evaluate its relationship with functional recovery using the Harris Hip Score.

MATERIALS AND METHODS

This prospective observational study was conducted in a tertiary medical college in Western Uttar Pradesh, India. A total of 39 elderly patients presenting with displaced intracapsular fractures of the femoral neck and treated with primary hemiarthroplasty were prospectively enrolled after obtaining informed written consent and institutional ethical clearance.

Patients were included if they had a unilateral displaced femoral neck fracture, underwent primary hemiarthroplasty, consented for postoperative radiological and CT evaluation, and were willing to comply with scheduled follow-ups. Patients with bilateral hip involvement, congenital hip or spinal deformities, pathological fractures, prior ipsilateral hip surgery, neuromuscular disorders

affecting gait, early periprosthetic infection or revision within six weeks, and cognitive impairment precluding valid functional assessment were excluded.

Preoperatively, all patients underwent standard anteroposterior and lateral radiographs of the pelvis and hip. Hemiarthroplasty was performed using a modular bipolar prosthesis of Indian manufacture, a commonly used implant in elderly fracture management. Intraoperatively, femoral anteversion was restored using the lesser trochanter as the primary anatomical reference; in cases where the lesser trochanter was deficient, the transcondylar axis was used as an alternative landmark. Limb length was restored using standard intraoperative techniques, with postoperative discrepancy maintained below 1 cm in all cases.

Postoperatively, CT scans were obtained to measure femoral anteversion on both the operated and contralateral normal sides. Functional outcomes were assessed using the Modified Harris Hip Score at 6 weeks, 3 months, 6 months, and 12 months. Data were recorded and analyzed using IBM SPSS Statistics version 26. Tests for normality were performed, and appropriate parametric or non-parametric tests were applied. The association between femoral anteversion deviation and functional outcome was assessed using the Chi-square test, and regression analysis was used to evaluate predictors of functional recovery. Data were analysed using SPSS v26. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 39 patients who underwent hemiarthroplasty for displaced femoral neck fractures were included in the analysis. The study population comprised 20 males (51.3%) and 19 females (48.7%), showing an almost equal gender distribution (Table 1). The left hip was more commonly involved, accounting for 64.1% ($n = 25$) of cases, while the right side constituted 35.9% ($n = 14$) (Table 2).

Table 1: Distribution of the Cases Based on Gender (n=39)

Gender	No. of cases (n=39)	Percentage
Male	20	51.3%
Female	19	48.7%

Table 2: Distribution of the Cases Based on the Side of Surgery

Side of surgery	No. of cases (n=39)	Percentage
Right	14	35.9%
Left	25	64.1%

CT-based assessment revealed that the mean femoral anteversion on the operated side was $18.35 \pm 5.57^\circ$, compared with $15.79 \pm 4.90^\circ$ on the contralateral normal side. The mean difference in anteversion between the two sides was $4.96 \pm 4.43^\circ$ (Table 3). Based on deviation from the normal side, 58.9% (n = 23) of patients had femoral anteversion restored within 5° , 30.8% (n = 12) had a deviation between 5° and 10° , and 10.3% (n = 4) demonstrated a deviation greater than 10° (Figure 1).

Table 3: Comparison of Femoral Anteversion Between Operated and Contralateral Normal Side After Hemiarthroplasty (n = 39)

Parameter	Value
Femoral Anteversion – Operated Side (degrees)	18.35 ± 5.57
Femoral Anteversion – Normal Side (degrees)	15.79 ± 4.90
Mean Difference in Anteversion (degrees)	4.96 ± 4.43

Distribution of Femoral Anteversion Deviation

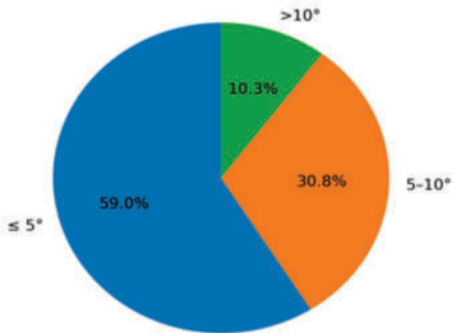


Figure 1: Distribution of Femoral Anteversion Deviation from the Contralateral Normal Side Following Hemiarthroplasty.

Functional outcomes showed a significant association with the degree of femoral anteversion restoration. Among patients with anteversion maintained within 5° of the normal side (n = 23), excellent outcomes were observed in 56.5% (n = 13), good outcomes in 39.1% (n = 9), and fair outcomes in 4.3% (n = 1), with no poor results. In patients with a deviation of $5^\circ-10^\circ$ (n = 12), excellent, good, and fair outcomes were seen in 33.3% (n = 4), 58.3% (n = 7), and 8.3% (n = 1), respectively. When the deviation exceeded 10° (n = 4), outcomes deteriorated, with no excellent results, good outcomes in 25% (n = 1), and fair outcomes in 75% (n = 3). No patient in any group demonstrated a poor outcome. Statistical analysis confirmed a significant correlation between femoral anteversion accuracy and functional outcome ($\chi^2 = 17.47$, p = 0.007) (Table 4).

Table 4: Effect of Angle of Femoral Anteversion on Early Functional Outcome for HRA

Angle of Anteversion (relative to normal side)	Excellent Outcome n (%)	Good Outcome n (%)	Fair Outcome n (%)	Poor Outcome n (%)	p-value / χ^2
Within 5° of normal side (n=23)	13 (56.5)	9 (39.1)	1 (4.3)	0 (0.0)	$\chi^2 = 17.47$
$5-10^\circ$ of normal side (n=12)	4 (33.3)	7 (58.3)	1 (8.3)	0 (0.0)	p = 0.007
$> 10^\circ$ of normal side (n=4)	0 (0.0)	1 (25.0)	3 (75.0)	0 (0.0)	

Serial assessment using the Modified Harris Hip Score demonstrated progressive and statistically significant improvement at each follow-up interval (p = 0.001). The mean score increased from 61.28 ± 7.67 at 6 weeks to 69.21 ± 7.28 at 12 weeks, 81.79 ± 6.76 at 6 months, and 88.79 ± 5.69 at 12 months (Table 5, Figure 2), indicating sustained functional recovery over time. Limb length discrepancy was less than 1 cm in all cases and did not influence functional outcomes.

Table 5: Harris Hip Score (HHS) at Different Follow-ups

Follow-up Duration	HRA (n=39) Mean $\pm$ SD	p-value
6 weeks	61.28 ± 7.67	0.001
12 weeks	69.21 ± 7.28	0.001

6 months	81.79 ± 6.76	0.001
12 months	88.79 ± 5.69	0.001

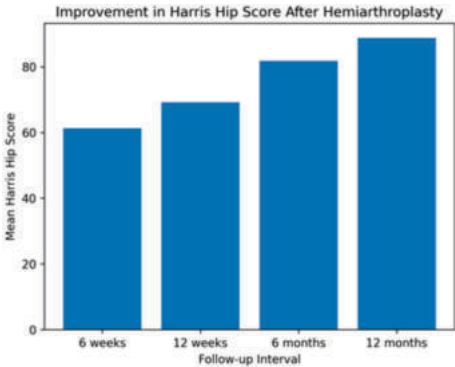


Figure 2: Progressive Improvement in Mean Harris Hip Score at Follow-up Intervals After Hemiarthroplasty.

DISCUSSION

Accurate restoration of femoral anteversion is a key determinant of stability and functional recovery following hemiarthroplasty. Malalignment of the femoral component alters hip biomechanics and may lead to instability, impingement, and inferior clinical outcomes. This study used CT-based assessment to objectively evaluate postoperative femoral anteversion and correlate it with functional outcomes. The mean femoral anteversion of the operated hips ($18.35 \pm 5.57^\circ$) was slightly higher than that of the contralateral normal side ($15.79 \pm 4.90^\circ$), with a mean difference of $4.96 \pm 4.43^\circ$. Similar findings were reported by van Embden et al. [5], who observed mild over-anteversion in hemiarthroplasty cases and cautioned that excessive deviation could adversely affect outcomes. In the present study, 58.9% of patients had anteversion restored within 5° of the normal side, indicating that the lesser trochanter is a reliable intraoperative landmark. This aligns with Deb and Mallick [6], who demonstrated good agreement between intraoperative anatomical referencing and postoperative radiological measurements. A significant association was observed between femoral anteversion accuracy and functional outcome. Patients with anteversion restored within 5° of the contralateral side achieved excellent or good outcomes in 95.6% of cases, whereas deviations greater than 10° were associated predominantly with fair results ($\chi^2 = 17.47$, p = 0.007). These findings support earlier reports that emphasize the biomechanical importance of optimal femoral version. Parker et al. [7] also noted that abnormal femoral anteversion adversely affects joint loading and functional performance.

Functional outcomes, measured using the Modified Harris Hip Score, improved progressively over follow-up, reflecting satisfactory implant performance and rehabilitation. However, patients with accurate anteversion demonstrated superior early recovery, reinforcing the role of precise femoral alignment. While Westberry et al. [8] reported limited correlation between static radiological measurements and dynamic gait parameters, the present study highlights that correct anteversion remains a fundamental contributor to early functional success. Gender distribution and laterality did not influence femoral anteversion or functional outcomes, consistent with previous studies. Although CT is the gold standard for anteversion assessment, its routine use may be limited by availability; nevertheless, it serves as a valuable tool for postoperative evaluation and surgical audit. Importantly, this study demonstrates that acceptable femoral anteversion can be achieved without navigation or robotic assistance when anatomical landmarks are meticulously respected.

The limitations include a relatively small sample size and follow-up limited to one year, with no dynamic gait analysis. Despite these constraints, the study provides meaningful evidence from an Indian clinical setting that restoring femoral anteversion within 5° of the native anatomy significantly improves early functional outcomes following hemiarthroplasty.

CONCLUSION

This prospective study demonstrates that accurate restoration of femoral anteversion is a key determinant of early functional recovery following hemiarthroplasty. Restoration of femoral anteversion to within 5° of the contralateral normal side, achieved using the lesser

trochanter as an intraoperative anatomical landmark, was associated with significantly better Harris Hip Scores and improved functional outcomes. Patients with deviations greater than 10° showed inferior functional results. CT-based postoperative assessment confirms that precise intraoperative femoral component alignment enhances hip stability and recovery. Routine attention to femoral anteversion during hemiarthroplasty, with a target deviation of $\leq 5^\circ$, is strongly recommended to optimize postoperative outcomes.

Conflict of Interest: None.

Funding: None.

Ethical Approval: Obtained

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