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FUNCTIONAL OUTCOME ANALYSIS WITH REGARDS TO CUP INCLINATION AND ACETABULAR VERSION IN TOTAL HIP ARTHROPLASTY: A CASE SERIES

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Abstract
Total Hip Arthroplasty (THA) is regarded as one of the most successful reconstructive procedures in orthopaedic surgery for relieving pain and restoring function in patients with end-stage hip diseases. Despite advances in implant design and surgical techniques, improper positioning of the acetabular component remains a significant cause of complications such as dislocation, impingement, accelerated polyethylene wear, reduced range of motion, and early implant failure. Acetabular cup inclination and anteversion (version) are two important radiographic parameters that influence postoperative biomechanics and functional outcomes.
Aim: To evaluate the relationship between acetabular cup inclination, acetabular version, and functional outcome following primary Total Hip Arthroplasty.
Objectives:
• To measure postoperative cup inclination and acetabular version on radiographs.
• To assess functional outcomes using the Harris Hip Score (HHS).
• To determine the correlation between cup position and functional outcome.
• To evaluate complications associated with malpositioned cups.
Materials and Methods: A prospective observational study will be conducted on 30 patients undergoing primary THA. Standardized postoperative anteroposterior pelvic radiographs will be obtained. Cup inclination and acetabular version will be measured using digital radiographic software. Functional outcome will be assessed using the Harris Hip Score at 6 weeks, 3 months, 6 months, and 1 year. Statistical analysis will determine correlations between radiographic parameters and functional scores.
Conclusion: Accurate acetabular cup positioning contributes significantly to successful functional recovery following THA. This case highlights the importance of meticulous surgical technique and appropriate rehabilitation in achieving favourable clinical and radiological outcomes.

KEYWORDS: Total hip arthroplasty; Fracture neck femur; Acetabular inclination; Acetabular anteversion; Modified Harris Hip Score.

INTRODUCTION

Total Hip Arthroplasty (THA) has revolutionized the treatment of advanced hip disorders including osteoarthritis, avascular necrosis of the femoral head, inflammatory arthritis, femoral neck fractures, and developmental dysplasia of the hip. Since the pioneering work of Sir John Charnley, THA has consistently demonstrated excellent long-term pain relief, restoration of mobility, and improvement in quality of life.
Although implant survival has improved considerably due to advances in biomaterials and bearing surfaces, implant positioning continues to play a vital role in determining clinical success. Among all implant-related variables, acetabular cup orientation is one of the most critical determinants of postoperative stability and longevity.
Acetabular cup orientation is described by two parameters: inclination and anteversion. Cup inclination refers to the angle between the acetabular face and the horizontal plane on the anteroposterior pelvic radiograph.
Excessive inclination increases edge loading, polyethylene wear, ceramic fracture risk, and instability, whereas inadequate inclination may reduce range of motion and increase impingement.
Acetabular anteversion represents the forward orientation of the cup. Excessive anteversion predisposes to anterior instability, whereas inadequate anteversion increases posterior dislocation and impingement. Proper cup positioning facilitates restoration of normal hip biomechanics and decreases the risk of revision surgery.
Lewinnek and colleagues proposed the “safe zone” of 40° ± 10° inclination and 15° ± 10° anteversion, although more recent studies suggest that patient-specific factors, spinopelvic mobility, surgical approach, and implant design also influence optimal cup positioning. Consequently, controversy remains regarding the ideal acetabular orientation.

Functional assessment following THA is commonly performed using the Harris Hip Score, which evaluates pain, function, deformity, and range of motion. Correlating radiographic cup orientation with functional outcome may help identify optimal positioning that maximizes patient satisfaction and minimizes complications.
This prospective study aims to evaluate postoperative acetabular cup inclination and version in patients undergoing primary THA and correlate these radiographic parameters with functional outcomes measured using the Harris Hip Score.

Case Presentation
Thirty patients underwent primary total hip arthroplasty and were followed for a mean duration of 12 months. The mean age was 56.8 years, with a male predominance (60%). Avascular necrosis was the most common indication for surgery (40%), followed by primary osteoarthritis (30%). The mean acetabular cup inclination was 42.8°, and the mean anteversion was 17.1°, both within accepted target ranges. Functional outcomes improved significantly, with the mean Harris Hip Score increasing from 42.5 preoperatively to 89.3 postoperatively. Eighteen patients (60%) achieved excellent outcomes, while nine (30%) had good outcomes. Only two minor complications and one dislocation were observed. Statistical analysis demonstrated no significant correlation between acetabular cup inclination or anteversion and postoperative Harris Hip Score, suggesting that while appropriate cup positioning is essential for implant stability, postoperative function is influenced by multiple patient- and surgery-related factors.

Investigations
Anteroposterior radiograph of the pelvis demonstrated a displaced fracture neck of the right femur.

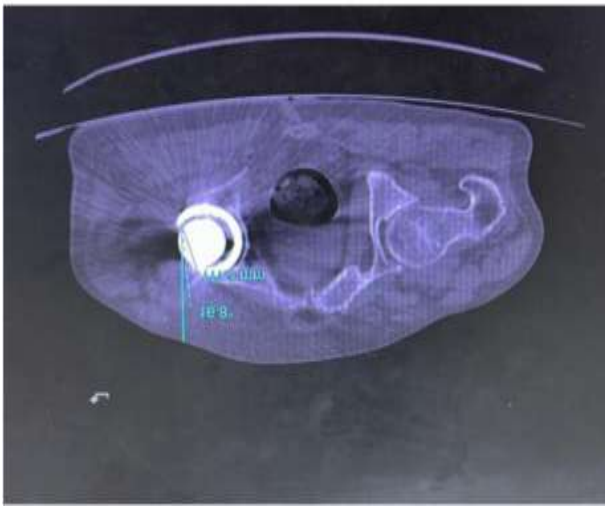
Figure 1. Preoperative AP pelvis radiograph demonstrating fracture neck of femur.

Surgical Procedure
The patient underwent primary cementless total hip arthroplasty under standard aseptic precautions. The acetabulum was sequentially reamed until adequate bleeding cancellous bone was obtained. A press-fit acetabular shell was implanted with satisfactory primary stability, followed by insertion of a polyethylene liner. Femoral preparation was performed using sequential broaches, and an appropriately sized femoral stem was implanted. Trial reduction confirmed restoration of leg length, stability, and hip biomechanics before implantation of the definitive femoral head.
Postoperative radiographs confirmed satisfactory implant positioning.

Figure 2. Immediate postoperative radiograph following THA.

Radiological Assessment
Radiographic measurements demonstrated:
•Acetabular inclination: 37.5°

•Acetabular anteversion: 16.8°
Both measurements were within accepted ranges for stable acetabular component placement.



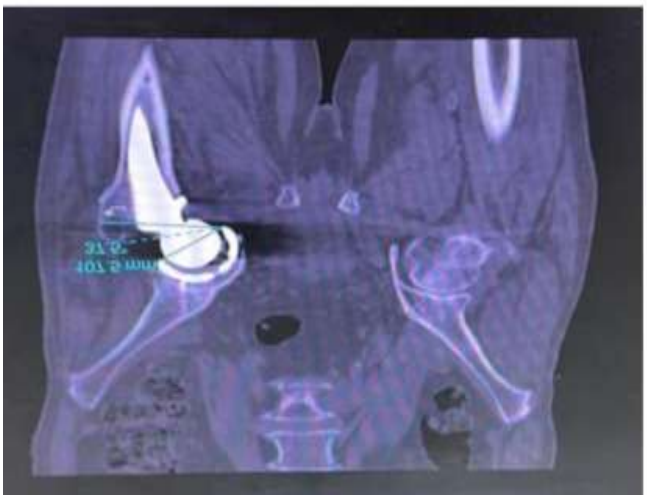


Figure 3. Measurement of acetabular anteversion. **Figure 4. Measurement of acetabular cup inclination.**

Postoperative Rehabilitation

Early postoperative rehabilitation included quadriceps strengthening exercises, ankle pump exercises, progressive range-of-motion exercises, gait training with walker support, and gradual progression to full weight-bearing according to patient tolerance. Hip precautions were maintained during the initial postoperative period to minimise dislocation risk.

Functional Outcome

Clinical follow-up demonstrated satisfactory wound healing without evidence of infection, implant loosening, or dislocation. Progressive improvement in gait and hip function was observed.
The patient achieved a Modified Harris Hip Score of 82.3, indicating a good functional outcome. Clinical photographs demonstrated satisfactory hip flexion and functional recovery.

Figure 5. Clinical photograph demonstrating postoperative hip movements.

Statistic	Cup inclination (°)	Acetabular version (°)
Mean	41.28	18.49
Standard deviation	6.40	4.43
Minimum	31.3	9.3
Maximum	55.0	28.5

Complication	n	Incidence (%)
Wound infection	4	13.3
Pressure sore	1	3.3
Stress fracture (femoral neck)	1	3.3
Prosthetic dislocation	2	6.7

	Thromboembolism	0	0
	Avascular necrosis	0	0
Complications Wound infection Pressure sore Stress fracture(femoral neck) Prosthetic dislocation Thromboembolism Avascular necrosis			

Time point	**Mean HHS**	**SD**	**p-value**
Pre-operative	37.24	6.79	
Post- operative day 1	44.96	7.67	
6 weeks	60.29	7.76	
3 months	73.73	10.07	
6 months	83.37	8.80	<0.001*

Variable	**Correlation coefficient (r)**	**p-value**
Cup inclination vs 6 - month mHHS	0.155	0.413
Acetabular version vs 6 -month mHHS	–0.213	0.259

DISCUSSION

This study evaluated the clinical and radiological outcomes of Total Hip Arthroplasty (THA) in 30 patients, with particular emphasis on acetabular cup inclination and anteversion. The mean acetabular inclination was 41.28° ± 6.4°, while the mean anteversion was 18.49° ± 4.43°, both of which were within the widely accepted safe range for optimal implant positioning. Appropriate cup orientation is essential for maintaining hip stability, minimizing implant wear, and reducing the risk of dislocation. Functional outcomes improved significantly following THA, with a marked increase in the modified Harris Hip Score at six months ($p < 0.001$), demonstrating substantial pain relief and restoration of hip function. Although two patients experienced postoperative dislocation and a few developed minor complications, the overall complication rate was low.

Correlation analysis revealed no statistically significant association between acetabular inclination or anteversion and short-term functional outcomes, likely because most acetabular components were accurately positioned within the recommended radiological limits. Overall, the findings support THA as a safe and effective procedure, with accurate acetabular cup orientation contributing to implant stability, favorable biomechanics, and improved postoperative outcomes.

CONCLUSION

Based on the findings of the present study involving + patients, Total Hip Arthroplasty (THA) proved to be an effective surgical intervention for relieving pain and restoring hip function in patients with advanced hip joint disorders. A significant improvement in postoperative functional outcomes was observed, as demonstrated by the marked increase in the modified Harris Hip Score (mHHS) during follow-up. Radiological assessment showed that the majority of acetabular components in the 30 patients were positioned within the recommended clinical ranges for cup inclination and anteversion. Appropriate implant positioning contributed to satisfactory joint stability and is expected to minimize the risk of postoperative complications such as dislocation, impingement, and accelerated implant wear. Statistical analysis did not reveal a significant association between acetabular component orientation and short-term functional outcomes in this cohort of 30 patients.

Nevertheless, maintaining optimal cup inclination and anteversion remains essential for ensuring favorable implant biomechanics and long-term prosthesis survival. Overall, the findings of this study support THA as a safe, reliable, and effective treatment modality for advanced hip joint pathology, providing substantial functional improvement and enhanced quality of life. Further prospective studies with larger sample sizes and longer follow-up durations are recommended to better evaluate the long-term influence of acetabular component positioning on functional outcomes and implant longevity.

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