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Original Article

Orthopaedics Section

Analysis of Achievement of Radiological Parameters in Uncemented Total Hip Replacement: A Retrospective Cohort Study

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ABSTRACT

Introduction: The Total Hip Replacement (THR) procedure is indicated to the treatment of choice in chronic refractory joint pain and some types of proximal femoral fractures. Component malalignment is a major cause of THR failure, making it crucial to position the components anatomically for long-term joint survival.

Aim: To assess the radiological parameters of uncemented THR surgery.

Materials and Methods: This retrospective cohort study was conducted in the Department of Orthopaedic Surgery, King's George Medical University (KGMU), Lucknow, Uttar Pradesh, India, from June 2017 to May 2021. It included 72 patients who underwent unilateral uncemented THR for isolated hip diseases. Data was collected over the first two years and analysed. Demographic information and radiographic characteristics such as acetabular cup inclination and anteversion, femoral stem placement, vertical and horizontal centers of rotation, and limb length discrepancy were determined. Data was entered into Microsoft Excel 2018-19, and Statistical Package for the Social Sciences (SPSS) software version 28.0 was used for statistical analysis.

Results: The average age of the patients was 50.75±9.1 years. Comparison of acetabular cup inclination (preoperative 41.4±3.9° and postoperative 42.2±5.1°) and anteversion (preoperative 13.1±2.96° and postoperative 14.5±3.75°) showed non significant differences following treatment with a normal hip. However, there was a significant difference in the horizontal and vertical Centers Of Rotation (COR) following treatment with a normal hip.

Conclusion: Preoperative radiological characteristics of the damaged hip were significantly restored to normal anatomy and alignment following surgery.

Keywords: Anteversion, Inclination, Total hip arthroplasty, Vertical offset

INTRODUCTION

The THR is commonly performed to manage chronic arthritis of the hip joint and certain types of proximal femoral fractures. Osteoarthritis (OA) of the hip joint is the most common disorder that requires THR, along with conditions such as rheumatoid arthritis, fractures, and avascular necrosis of the femoral head [1]. Brazilian patient records indicate that OA was the primary indication for THR, with hypertension as the main co-morbidity among the patients. Joint replacement is a safe intervention that can result in significant pain relief and diminish disability for permitting the joint to work normally [2]. The increasing use of THR procedures has led to favourable outcomes, and it is projected that the number of THR indications will rise by 40% in developed countries by 2030 [3].

In India, the total number of hip replacements has been increasing exponentially over the past decade [3]. Initially, THR procedures were primarily performed on individuals with higher socio-economic status and sedentary lifestyles. However, there has been a recent trend of THR being performed on people from lower socio-economic classes in India [4]. Unlike total knee replacement, THR has been performed in significant numbers in India for the past four decades, resulting in a high annual revision load (>20%), although it currently stands at 4% in their institute [5]. In western countries, historical data (1999-2002) showed revision rates for THR ranging from 11-18%. However, recent data indicates a significant decline in these rates to 9-11% for hips [6].

Postoperative instability is a major cause of morbidity following THR. Efforts have been made to reduce medical and mechanical complications after the procedure. Risk factors for instability after THR can be patient-specific (gender, age, and abductor deficiency) or associated with operative parameters (surgical methodology, implant malposition, and femoral head diameter) [7]. The frequency of instability after primary and revision replacements has been reported as high as 7% and 25%, respectively. The cumulative risk of first-time dislocation is 2% at 1st year and 7% after 15 years of primary hip replacement [8].

Accurate positioning of the acetabular component is crucial in THR as malpositioning has been linked to hip instability, recurrent dislocations, impingement, and accelerated wear of polyethylene [9]. The native acetabulum is typically subhemispherical, while the acetabular components used in THA are hemispherical, leading to displacement of COR when the implant is fully contained [10]. To minimise the adverse effects of COR displacement, it is recommended to restore the COR <3 mm superiorly and <5 mm medially [8].

Although Magnetic Resonance Imaging (MRI), Computed Tomography (CT) and sonography are commonly used for joint imaging, postoperative radiographs remain the primary source for assessing arthroplasty components due to their availability, affordability, absence of metal artifacts, and longitudinal comparison capabilities.

Most published studies focus on preoperative and postoperative 2D templating in uncemented THR. While 2D templating remains the gold standard technique worldwide, it has lower accuracy with cementless components compared to cemented implants [11-13]. Therefore, this study aims to analyse the achievement of radiological parameters in uncemented THR.

MATERIALS AND METHODS

This retrospective cohort study was conducted in the Department of Orthopaedic Surgery, King's George Medical University (KGMU), Lucknow, Uttar Pradesh, India, from June 2017 to May 2021. The data was analysed once the sample size for the study was obtained

(from January 2021 to May 2021). Ethical approval was obtained from the Institutional Ethics Committee (IEC) (reference no.VI-PGTSC-II/A/P39), and written informed consent was obtained from all study subjects.

Inclusion criteria: The study included a total of 72 patients, aged ≥18 years, of both genders, who visited the orthopaedic Outpatient Department (OPD) with primary and secondary arthritis of the hip. Uncemented THR was performed on either side of the hip joint at our hospital in the last five years.

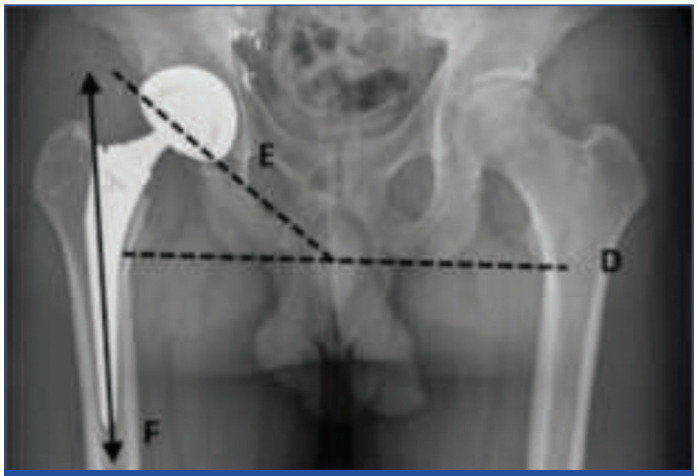
Exclusion criteria: Patients with bilateral hip pathologies, pre-existing weakness, neuromuscular weakness, spinal deformities (e.g., scoliosis), heterotopic ossification, acetabular fractures, neurological diseases (e.g., cerebral thrombosis, Parkinson's disease) compromising walking ability, those who underwent cemented THR or bilateral THR, and non willing patients were excluded from the study.

Data collection: Demographic parameters such as name, age, sex, weight, height, Body Mass Index (BMI), residence, and occupation were recorded. Pre- and postoperative radiographs of patients who underwent unilateral uncemented THR for primary and secondary arthritis of the hip in the last five years were obtained in the form of anteroposterior and lateral views of the pelvis with both hips and proximal thighs.

Various radiological parameters, including acetabular cup inclination and anteversion, femoral stem positioning, vertical and horizontal COR, and limb length discrepancy, were measured preoperatively and postoperatively. Similar data from the normal hip were collected and used for comparison with postoperative data during analysis. All measurements have been standardised to the scale mentioned on the X-rays of the patients under study. Measurements were done using the software IC measure.

Radiological parameters to be assessed [14].

1) **Acetabular cup inclination:** Measured by drawing a line through the medial and lateral margins of the cup (line E) and measuring the angle with the transverse pelvic axis (line D) [Table/Fig-1].



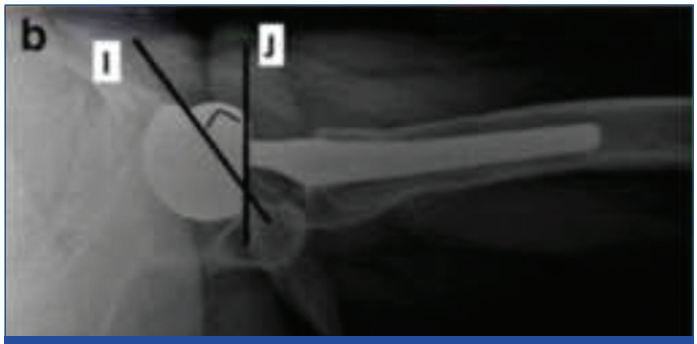
[Table/Fig-1]: Acetabular cup inclination.

2) **Acetabular cup anteversion:** The acetabular anteversion is defined by the angle between the acetabular axis (line I) and the coronal plane (line J) [Table/Fig-2].

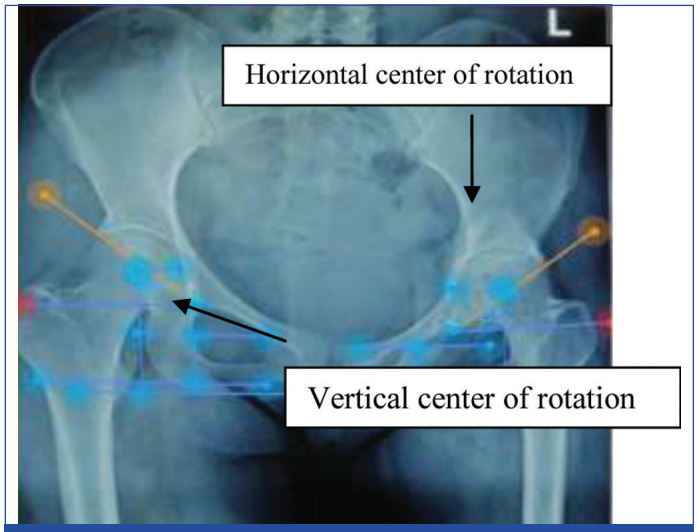
3) **Horizontal and vertical COR:** The horizontal COR is defined as the distance between the centre of the femoral head (point C) and the lateral outline of the acetabular teardrop. The vertical COR is defined as the distance between the center of the femoral head (point C) and the transischial tuberosity line (line D) [Table/Fig-3].

4) **Femoral stem positioning** [Table/Fig-4].

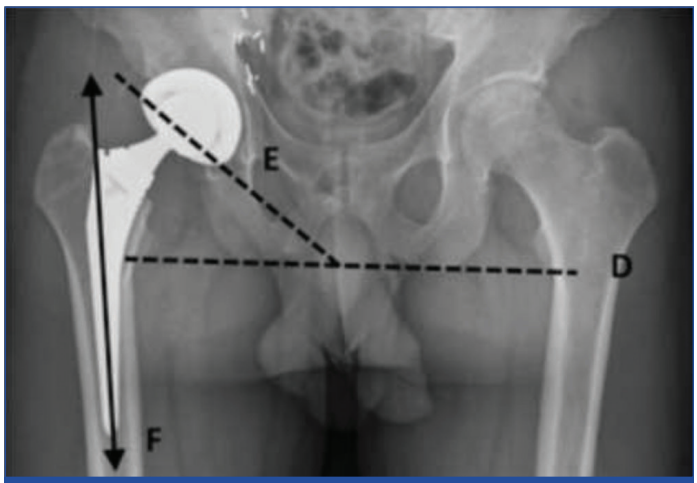
5) **Limb length discrepancy:** The leg length is measured as the distance between line A (connecting the undersurface of the teardrop shadows) and line B (through the mid of the lesser trochanter) [Table/Fig-5].



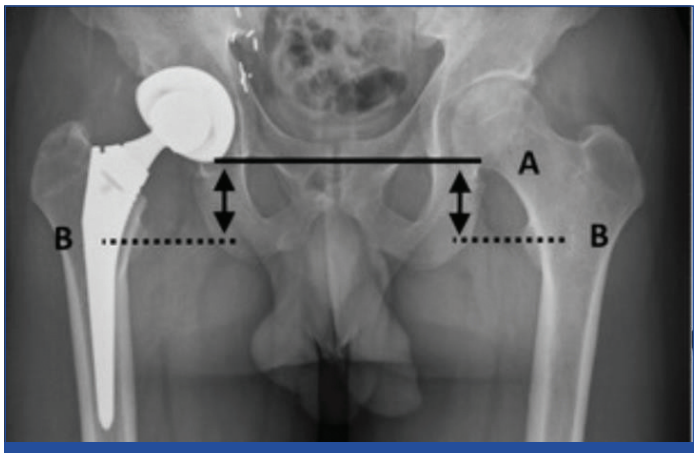
[Table/Fig-2]: Acetabular cup anteversion.



[Table/Fig-3]: Horizontal and vertical Centre Of Rotation (COR).



[Table/Fig-4]: Femoral stem positioning.



[Table/Fig-5]: Method to measure limb length discrepancy.

STATISTICAL ANALYSIS

The collected data was entered into Microsoft Excel 2018-19, and SPSS software version 28.0 was used for statistical analysis. Descriptive analysis was performed, and numbers, proportions, percentages, averages, and standard deviations were calculated. The data was presented in tables and graphs as necessary. A p-value <0.05 was considered significant.

RESULTS

Among the 72 patients, the mean age was 50.75±9.1 years, ranging from 24 to 60 years. The majority of patients (66.7%) were above 50 years of age, 19.4% were between 41-50 years, and only 13.8% were below 40 years. Of the patients, 69.4% were male and 30.6% were female. The majority of patients (93.1%) had a BMI between 18.0-22.9 kg/m^2 [Table/Fig-6].

Demographic data		N (%)
Age group (in years)	21-30	5 (6.9)
	31-40	5 (6.9)
	41-50	14 (19.5)
	>50	48 (66.7)
Mean±SD (Min.-Max.)		50.75±9.1 years (24-60 years)
Gender	Male	50 (69.4)
	Female	22 (30.6)
BMI (kg/m^2)	18.5-22.9	67 (93.1)
	23-24.9	5 (6.9)
	≥25	0
Mean±SD (Min.-Max.)		21.26±0.9 kg/m^2 (18.5-23.5 kg/m^2)

[Table/Fig-6]: Demographic profile of studied patients.

While the majority of patients 23 (31.9%) were diagnosed as Avascular Necrosis Hip (AVN), 15 (20.8%) Among themtubercular arthritis hip, 13 (18.1%) were diagnosed with post-traumatic arthritis hip [Table/Fig-7].

Pathology	N (%)
Avascular necrosis hip	23 (31.9)
Tubercular arthritis hip	15 (20.8)
Post-traumatic arthritis hip	13 (18.1)
Ankylosing spondylosis hip	10 (13.9)
Osteoarthritis hip	6 (8.3)
Rheumatoid arthritis hip	3 (4.2)
Sequelae of Perthe's disease	2 (2.8)

[Table/Fig-7]: Distribution of pathological findings.

The distribution of acetabular cup inclination after uncemented THR was analysed. The majority of patients had an inclination between 41-45° (36.1%), followed by 46-50° (26.4%) cases [Table/Fig-8]. Only 5.6% had an anteversion >20° in 4 (5.6%) patients. Acetabular cup anteversion <10° was noticed in 11 (15.3%) patients, 11-15° was seen in 29 (40.3%) patients and 16-20° was seen in 28 (38.9%) patients [Table/Fig-9].

Acetabular Cup Inclination (in °)	n (%)
31-35	9 (12.5)
36-40	15 (20.8)
41-45	26 (36.1)
46-50	19 (26.4)
>50	3 (4.2)
Mean	42.19°
Median	43°
Range (Min.-Max.)	31-52°

[Table/Fig-8]: Acetabular cup inclination after uncemented Total Hip Replacement (THR).

Acetabular cup anteversion (in °)	n (%)
6-10	11 (15.3)
11-15	29 (40.3)
16-20	28 (38.9)
>20	4 (5.6)
Mean	14.57°
Median	14.50°
Range (Min.-Max.)	6-24°

[Table/Fig-9]: Distribution of Acetabular cup anteversion after uncemented Total Hip Replacement (THR).

The femoral stem positioning showed that 81.25% of patients had valgus positioning and 18.75% had varus positioning. The mean valgus angulation was 2.53±1.4 degrees, while the mean varus angulation was 3.0±1.8 degrees in nine patients [Table/Fig-10]. Difference in horizontal and vertical COR as well as limb length discrepancy were recorded. The mean values for horizontal COR, vertical COR, and limb length discrepancy were 1.9±0.3 cm, 3.6±0.3 cm, and 0.056±0.08 cm, (Illustrative Case).

	Valgus (N=39)	Varus (N=9)
Mean±SD (°)	2.53±1.4	3.0±1.8
Median (°)	2	3
Range (Min.-Max.) (°)	1-7	1-7

[Table/Fig-10]: Femoral stem positioning in the studied patients.

Before treatment, the mean/average horizontal and vertical COR in studied patients was 1.99±0.19 cm and 3.68±0.28, respectively in normal hip, and good (significant) improvement in both parameters after THA was observed that was close to normal mean values i.e. horizontal COR was 1.87±0.29 cm and vertical COR was 3.60±0.30 cm [Table/Fig-11].

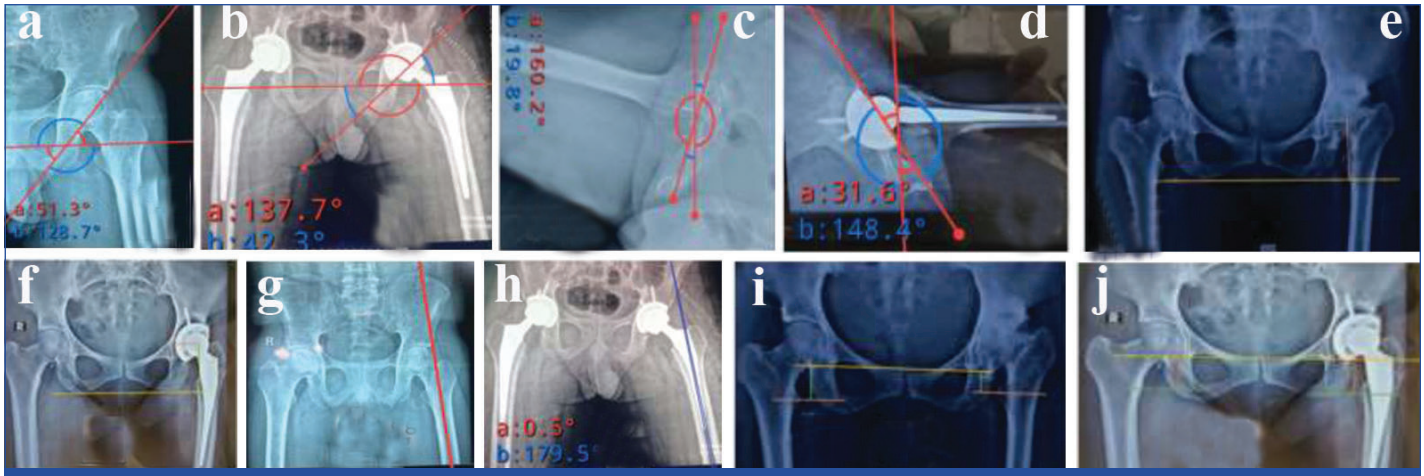
Variables	Normal hip	Affected hip before treatment	Affected hip after treatment	p-value (normal vs before)	p-value (normal vs after)	p-value (before and after)
Acetabular cup inclination (°)	41.8±4.8	41.4±3.9	42.2±5.1	0.072	0.674	0.292
Acetabular cup anteversion (°)	13.5±2.92	13.1±2.96	14.5±3.75	0.046	0.054	0.014
Horizontal center of rotation (cm)	1.99±0.19	1.71±0.19	1.87±0.29	<0.001	<0.001	0.001
Vertical center of rotation (cm)	3.68±0.28	3.37±0.24	3.60±0.30	<0.001	<0.001	0.001

[Table/Fig-11]: Comparison of mean value of acetabular cup inclination, anteversion, horizontal center of rotation (in cm), and vertical center of rotation (in cm) among groups.

The association between acetabular cup inclination and anteversion was non-significant after treatment compared to the normal hip. However, a significant difference was found in the horizontal and vertical COR before and after treatment compared to the normal hip [Table/Fig-11]. The p-values for acetabular cup inclination and anteversion before and after treatment were non-significant, while the p-value for horizontal and vertical COR was significant (p-value <0.001) [Table/Fig-11]. Pre and post-radiographic images for all parameters are shown in [Table/Fig-12].

DISCUSSION

The purpose of THR surgery was to eliminate pain and restore normal or near-normal function of the hip joint. The success of the surgery depends on achieving the normal anatomy of the hip joint. Failure to do



[Table/Fig-12]: Image showing preoperative and postoperative images of each parameter i.e., (a and b) pre and postoperative acetabular inclination, (c and d) pre and postoperative acetabular anteversion; (e and f) Horizontal and vertical Centre Of Rotation (COR); (g and h), and pre and postoperative femoral stem position; (i and j) Pre and postoperative limb length measurement.

so can lead to complications such as dislocation, muscle weakness, persistent limp, impingement, increased component wear, and early loosening of the implant. One of the key factors in restoring normal hip anatomy is leg length equality and femoral offset. Failure to achieve leg length equality can result in hip instability, knee pain, low back pain, abnormal force transmission, and potential loosening of the prosthesis [15-17].

In this study, standardised anteroposterior preoperative and postoperative radiographs were used to assess the radiological parameters of uncemented THR. The radiographs were taken with the patient lying supine with the legs positioned in 15° of internal rotation. Radiographs were not accepted if the coccyx was not centered on the pubic symphysis and located within 4 cm, or if both of the entire lesser trochanters were not seen. This ensured proper positioning of the pelvis in both the frontal and sagittal planes [18]. The preoperative radiographs were used to compare preoperative measurements in the admitted patients. The postoperative radiograph of the pelvis was used to compare the operated hip with the contralateral hip. For preoperative and postoperative analysis, all measurements were taken from the same radiograph, respectively, thus magnification was constant.

Most of these methods have similar accuracy but differ in complexity and requirements [10,15,17]. To the best of our knowledge, there is no retrospective study to assess the radiological parameters of uncemented THR through, a method that requires only a commonly used goniometer and divider/calliper without any tables calculators, algorithms, protractors, etc. Present retrospective study assessed the radiological parameters of uncemented THR in terms of acetabular cup inclination, acetabular cup anteversion, femoral stem positioning, horizontal and vertical COR and limb length discrepancy.

Similarly, previously reported studies were also assessed post-treatment radiological parameters of THR using different methods. Widmer KH studied a simplified method to determine acetabular cup anteversion from plain radiographs. They reported simply measuring the length of the short ellipse axis and the total length of the projected ellipse axis cross-section along the short axis, which provides the radiographic acetabular anteversion [19]. Liaw CK et al., assessed a new tool for measuring cup orientation in total hip arthroplasties from plain radiographs and found no difference between the two methods [20]. Recently Yeh KL et al., did a retrospective study to evaluate the accuracy of radiographic and Liaw's anteversion measurements using the ellipse method. They reported that ellipse measurement can be helpful to surgeons in placing the acetabular shell into the precise position and enabling early acetabulum loosening diagnosis [21].

The mean age of the patients in this study was 50.75±9.1 years, with the majority being above 50 years of age. There were more male patients (69.4%) than female patients (30.6%). Similarly, the study by Yu-Shu L et al., reported that the mean age of the patients was 55 years, and 60% were men for THR surgery in Taiwan [22]. Yeh KL et al., analysed 434 radiographic images from 105 postoperative total hip replacement surgeries in 82 patients (53 women, 29 men; age range: 28-86 years) [21]. The pathological findings were indicated that the majority of patients 23 (31.9%) were diagnosed as suffering from avascular necrosis hip followed by 15 (20.8%) patients of tubercular arthritis hip, 13 (18.1%) patients of post-traumatic arthritis hip and 6 (8.3%) were patients of osteoarthritis hip. These findings were similar to study done by Yu-Shu L et al., reported the three most common diagnoses were avascular necrosis hip (46.9%), OA (41.6%) and fracture neck femur (1.5%) [22]. In contrast, Smith MC et al., reported that OA was the dominant indication for hip replacement in the Asian ethnic group [23].

Parker MJ in a review of displaced femoral neck fractures stated that preservation of the femoral head is of paramount importance in younger patients of age less than 50-60 years [24]. With increasing age, the arguments against arthroplasty reduce since the patient's life expectancy becomes less than that of the arthroplasty and the functional demands on the hip are less. The incidence of non union increases progressively with age, while symptomatic avascular necrosis is less common in the elderly.

The incidence of instability after primary and revision replacement has been reported to be as high as 7% and 25%, respectively [25]. Murray DW has defined cup position as radiographic, operative, and anatomical inclination and anteversion [26]. McKibbin, B reported the two reference planes for measuring cup position are the anterior pelvic plane and the functional coronal plane [26]. Anteversion can be measured using a true lateral radiograph as the angle formed by a line drawn tangential to the face of the acetabulum and a line perpendicular to the horizontal plane and normal values range from 5 to 25° [27]. Present study noted after uncemented THR, the Acetabular cup inclination was 42.19° (31-52°) and Acetabular cup anteversion was 14.57° (6-24°).

It is worth noting that different methods have been used in previous studies to assess radiological parameters of THR, including more complex techniques and tools [20]. This study used a simplified method that only required a goniometer and divider/calliper, making it a practical and accessible approach [21].

Widmer KH reported a linear correlation between 10 to 30° of anteversion, with an inverse sinus function representing the ellipse

bisecting the total acetabular cross-section [19]. Mohanty A et al., also reported similar findings for acetabular inclination angle [28].

In terms of femoral stem positioning, Biedermann R et al., [29] reported mean values of 15° for anteversion and 44° for abduction in control patients. Patients with anterior dislocation after primary THR showed significant differences in the mean angle of anteversion (17°), and abduction (48°), as did patients with posterior dislocation (anteversion 11°, abduction 42°), which was almost similar to present study.

Risk factors for dislocation after primary cementless total hip prosthesis were identified by Kim YH et al., who performed clinical, radiographic, and CT examinations on a consecutive series of 1268 patients (1648 hips) and determined the factors including female sex, advanced age, high American Society of Anaesthesiologists score, fracture of the femoral neck, non-repair of the posterior soft-tissue sleeve, and low or high cup and stem anteversion, and low height of hip rotation center [30].

Amiri S et al., reported pelvic tilt was measured with an accuracy of 0.1 deg and SD of 0.4 deg [31]. Pelvic tilt, cup inclination, and anteversion can be accurately measured, with improvements achieved by subtracting systematic bias. Limb Length Discrepancy (LLD) is common after hip arthroplasty, the mean LLD varies from 1 to 15.9 mm [19]. LLD has been seen in between 6% [32] and 32% [33] of patients and seen in all cases when shortening exceeds 10 mm and lengthening exceeded 6 mm [34]. In present study, the discrepancy observed was 0.056±0.08 cm ranging from 0.0-0.3 cm. Kruse C et al., [35] reported the patients in the Lateral Approach (LA) group had a smaller change in femoral offset ($p=0.006$), change in total offset ($p<0.001$) and change in abductor moment arm ($p=0.001$) than patients in the Posterior Approach (PA) group. There was no statistically significant difference between the groups in change in cup offset ($p=0.08$) and change in leg length discrepancy ($p=0.3$). Sakalkale DP et al., concluded that a lateralised femoral component more closely restored hip biomechanics to the preoperative state [36]. Cassidy KA et al., found a similar inclination regarding more use of lateralised stems in the unchanged femoral offset group [37].

Limitation(s)

The limitations include its retrospective nature due to the Coronavirus Disease-2019 (COVID-19) pandemic, a small sample size, and the lack of follow-up X-rays to assess complications and outcomes.

CONCLUSION(S)

In conclusion, present study found significant restoration of radiological parameters after uncemented THR surgeries compared to normal hip anatomy and alignment. Sequential radiography is a valuable tool for assessing complications, especially in low-resource settings. Further studies with larger cohorts are needed to provide better guidelines for evaluating component placement in uncemented THR and documenting related complications.

REFERENCES

[1] Siddiqui MM, Yeo SJ, Sivaiah P, Chia SL, Chin PL, Lo NN. Function and quality of life in patients with recurvatum deformity after primary total knee arthroplasty: A review of our joint registry. J Arthroplasty. 2012;27(6):1106-10.

[2] Ethgen O, Bruière O, Richy F, Dardennes C, Reginster JY. Health related quality of life in total hip and total knee arthroplasty. A qualitative and systematic review of the literature. J Bone Joint Surg Am. 2004;86(5):963-74.

[3] Singh JA. Epidemiology of knee and hip arthroplasty: A systematic review. Open Orthop J. 2011;5:80-85.

[4] Pandian PM, Vignesh KA, Raman DT. Analysis of functional outcome of total hip arthroplasty in lower socio-economic people. Int J Orthop Sci. 2019;5(2):260-67.

[5] Kulshrestha V, Mittal G, Datta B, Kumar S. Epidemiology of revision total knee arthroplasty: A single center's experience. Indian J Orthop. 2019;53(2):282-88.

[6] McGrory BJ, Etkin CD, Lewallen DG. Comparing contemporary revision burden among hip and knee joint replacement registries. Arthroplasty. 2016;2(2):83-86.

[7] Prudhon JL, Ferreira A, Verdier R. Dual mobility cup: Dislocation rate and survivors hip at ten years of follow-up. Orthop Traumatol Surg Res. 2013;99(2):2345-50.

[8] Berry DJ, von Knoch M, Schleck CD, Harmsen WS. The cumulative long-term risk of dislocation after primary Charnley total hip arthroplasty. J Bone Joint Surg Am. 2004;86(1):09-14. Doi: 10.2106/00004623-200401000-00003.

[9] Robinson M, Bornstein L, Mennear B. Effect of restoration of combined offset on stability of large head THA. Hip Int. 2012;22(3):248-53.

[10] Köhnlein W, Ganz R, Impellizzeri FM, Leunig M. Acetabular morphology: Implications for joint-preserving surgery. Clin Orthop Relat Res. 2009;467:682-91.

[11] Gamble P, De Beer J, Petrucelli D, Winemaker M. The accuracy of digital templating in uncemented total hip arthroplasty. J Arthroplasty. 2010;25:529-32.

[12] Smith JBV, Bishi H, Wang C, Asopa V, Field RE, Sochart DH. The accuracy and reliability of preoperative digital 2D templating in prosthesis size prediction in uncemented versus cemented total hip arthroplasty: A systematic review and meta-analysis. EFORT Open Rev. 2021;6(11):1020-39. Doi: 10.1302/2058-5241.6.210048. PMID: 34909222; PMCID: PMC8631246.

[13] Mirghaderi SP, Sharifpour S, Moharrami A, Ahmadi N, Makuku R, Salimi M, et al. Determining the accuracy of preoperative total hip replacement 2D templating using the mediCAD® software open access. J Orthop Surg Res. 2022;17(1):222. Doi: 10.1186/s13018-022-03086-5.

[14] Vanrusselt J, Vanrusselt M, Vanderschueren G, Vanhoencker F. Postoperative radiograph of the hip arthroplasty: What the radiologist should know. Insights Imaging. 2015;6(6):591-600.

[15] Siwach R, Kadyan VS, Sangwan S, Gupta R. A retrospective study of total hip arthroplasty. Indian J Orthop. 2007;41:62-66.

[16] Asayama I. Relationship between radiographic measurements of reconstructed hip joint position and the Trendelenburg sign. J Arthroplasty. 2002;17:747-51.

[17] Bose WJ. Accurate limb-length equalization during total hip arthroplasty. Orthopaedics. 2000;23:33.

[18] Tannast M. Tilt and rotation correction of acetabular version on pelvic radiographs. Clin Orthop. 2005;438:182-90.

[19] Widmer KH. A simplified method to determine acetabular cup anteversion from plain radiographs. J Arthroplasty. 2004;19:387-90.

[20] Liaw CK, Hou SM, Yang RS, Wu TY, Fuh CS. A new tool for measuring cup orientation in total hip arthroplasties from plain radiographs. Clin Orthop Relat Res. 2006;451:134-39. Doi. https://doi.org/10.1097/01.blo.0000223988.41776.fa.

[21] Yeh KL, Wu TY, Ma HH. Ellipse method for measuring Liaw's anteversion of the acetabular component after total hip arthroplasty. BMC Musculoskelet Disord. 2020;21:667.

[22] Yu-Shu L, Hung-Wen W, Cheng-Kung C. Incidence of hip replacement among national health insurance enrollees in Taiwan. J Orthop Surg. 2008;10:1186/1749.

[23] Smith MC, Ben-Shlomo Y, Dieppe P, Beswick AD, Adebajo AO, Wilkinson JM, et al. Rates of hip and knee joint replacement amongst different ethnic groups in England: An analysis of National Joint Registry data. Osteoarthritis and Cartilage. 2017;254:448-54.

[24] Parker MJ. The management of intracapsular fractures of the proximal femur. J Bone Joint Surg Br. 2000;82:937-41.

[25] Patel PD, Potts A, Froimson MI. The dislocating hiparthroplasty: Prevention and treatment. J Arthroplasty. 2007;22:86-90.

[26] Murray DW. The definition and measurement of acetabular orientation. J Bone Joint Surg. 1993;75:228-32.

[27] Mc Kibbin B. Anatomical factors in the stability of the hip joint in the newborn. J Bone Joint Surg. 1970;52:148-59.

[28] Mohanty A, Parida S, Biswas R, Mohanty A. Evaluation of uncemented total hip arthroplasty in acetabular protrusio. Int J Cont Med Res. 2020;7:05-11.

[29] Biedermann R, Tonin A, Krismer M, Rachbauer F, Eibl G, Stöckl B. Reducing the risk of dislocation after total hip arthroplasty: The effect of orientation of the acetabular component. J Bone Joint Surg Br. 2005;87:762-69.

[30] Kim YH, Choi Y, Kim JS. Influence of patient-design-and surgery-related factors on rate of dislocation after primary cementless total hip arthroplasty. J Arthroplasty. 2009;24:1258-63.

[31] Amiri S, Masri BA, Garbuz D, Anglin C, Wilson DR. A multiplanar radiography method for assessing cup orientation in total hip arthroplasty. J Biomech Eng. 2012;134:101008.

[32] Love BRT, Wright K. Leg length discrepancy after total hip replacement. J Bone Joint Surg [Br].1983;65:103.

[33] Edeen J, Sharkey PF, Alexander AH. Clinical significance of leg-length inequality after total hip arthroplasty. Am J Orthop. 1995;24:347-51.

[34] Sarangi PP, Bannister GC. Leg length discrepancy after total hip replacement. Hip. 1997;7:121-24.

[35] Kruse C, Rosenlund S, Broeng L, Overgaard S. Radiographic cup position following posterior and lateral approach to total hip arthroplasty. An explorative randomized controlled trial. PLoS One. 2018;29:0191401.

[36] Sakalkale DP, Sharkey PF, Eng K, Hozack WJ, Rothman RH. Effect of femoral component off set on polyethylene wear in total hip arthroplasty. Clin Orthop Rel Res. 2001;125:34.

[37] Cassidy KA, Noticewala MS, Macaulay W, Lee JH, Geller JA. Effect of femoral offset on pain and function after total hip arthroplasty. J Arthroplasty. 2012;27(10):1863-69.

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