



International Journal of Orthopaedics Sciences

E-ISSN: 2395-1958
P-ISSN: 2706-6630
IJOS 2021; 7(2): 249-254
© 2021 IJOS
www.orthopaper.com
Received: 26-01-2021
Accepted: 08-03-2021

Dr. Avinash Parthasarathy
Professor of Orthopaedics,
Sanjay Gandhi Institute of
Trauma and Orthopaedics,
Bangalore, Karnataka, India

Dr. Prakashappa TH
Professor and HOD, Dept. of
orthopaedics, Sanjay Gandhi
Institute of Trauma and
Orthopaedics, Bangalore,
Karnataka, India

Chandrashekar Bhasgi
Junior Resident in Orthopaedics,
Sanjay Gandhi Institute of
Trauma and Orthopaedics,
Bangalore, Karnataka, India

Dr. Nagegowda KN
Junior Resident in Orthopaedics,
Sanjay Gandhi Institute of
Trauma and Orthopaedics,
Bangalore, Karnataka, India

Corresponding Author:
Chandrashekar Bhasgi
Junior Resident in Orthopaedics,
Sanjay Gandhi Institute of
Trauma and Orthopaedics,
Bangalore, Karnataka, India

Accuracy of Radiographic Assessment of acetabular component anteversion and inclination after tha in Comparison to CT based Measurement

Dr. Avinash Parthasarathy, Dr. Prakashappa TH, Chandrashekar Bhasgi and Dr. Nagegowda KN

DOI: <https://doi.org/10.22271/ortho.2021.v7.i2d.2638>

Abstract

Introduction: Malposition of the acetabular component after total hip arthroplasty (THA) is related to dislocation of the prosthetic femoral head, increased polyethylene liner wear, and limited range of motion 1, 2, 3, 4, 5. The orientation of the acetabular component comprises inclination and anteversion. Although the inclination of the acetabular component can be easily measured on plain radiographs, calculation of the anteversion is difficult. There are several radiological methods for measuring the anteversion of the acetabular component after THA, and a single standardized method has not been established.

Objectives

- To assess the accuracy of measurement of acetabular cup anteversion and inclination after THA using plain radiographs vs computed tomography-based measurements.
- To determine if plain radiograph is reliable method for determining acetabular cup anteversion and inclination.

Methodology: The present descriptive observational study was carried out at Department of Orthopaedics, Sanjay Gandhi Institute of trauma and Orthopaedics, Bangalore during the period of November 2019 to October 2020 including 40 patients admitted for THA at Department of Orthopaedics, Sanjay Gandhi Institute of trauma and Orthopaedics, Bangalore with the objective to assess the accuracy of measurement of acetabular cup anteversion and inclination after THA using plain radiographs vs computed tomography based measurements and to determine if plain radiograph is reliable method for determining acetabular cup anteversion and inclination.

Results: The angle of anteversion assessed on X ray and on CT, the difference was not statistically significant. It means though the anteversion angle on CT was slightly higher, but it was not significantly higher compared with X ray angle. ($p > 0.05$). The angle of inclination assessed on X ray and on CT, the difference was not statistically significant. It means though the inclination angle on CT was slightly higher, but it was not significantly higher compared with X ray angle. ($p > 0.05$).

Conclusion: Accuracy of measurement of acetabular cup anteversion and inclination after THA using plain radiographs is almost equal with computed tomography-based measurements.

Keywords: Anteversion, inclination, retroversion

1. Introduction

Total hip arthroplasty (THA) has become one of the most successful and cost-effective interventions in the history of medicine. Over time patient demands have increased significantly, with a greater focus on range of motion and function as well as pain relief. Malposition of the acetabular component after total hip arthroplasty (THA) is related to dislocation of the prosthetic femoral head, increased polyethylene liner wear, and limited range of motion. 1, 2, 3, 4, 5 The orientation of the acetabular component comprises inclination and anteversion. Although the inclination of the acetabular component can be easily measured on plain radiographs, calculation of the anteversion is difficult. Orientations of inclination and anteversion are currently defined in 3 different measurement systems: the radiographic, anatomical and operative orientations; with conversion equations 21 allowing comparison between different manufacturers and literature guidelines.

Lewinnick's²² definition of a 40° lateral opening angle and 15° anteversion with a safety zone

of $\pm 10^\circ$ appears to be the most widely accepted as the desired orientation for the acetabular cup and adherence to these guidelines has been shown to reduce the chance of dislocation.

Materials and Methods

Study setting: Department of Orthopaedics, Sanjay Gandhi Institute of trauma and Orthopaedics, Bangalore

Study population: All the patients admitted for THA at Department of Orthopaedics, Sanjay Gandhi Institute of trauma and Orthopaedics, Bangalore

Study period: November 2019 to October 2020

Study design: Descriptive observational study

Formula for sample size calculation

(Source for formula: Patrikar S. In Text book of Community Medicine 1st Ed, 2009. Ed. Bhalwar R. Dept of Community Medicine AFMC Pune. Publ. WHO India Office, New Delhi)

$$n = \frac{Z1^2 S^2}{d^2}$$

Variable considered for calculation of sample size: Mean anteversion is considered here for calculation of sample size

Reference article used for sample size calculation: Park YS⁶², Shin WC, Lee SM, Kwak SH, Bae JY, Suh KT. The best method for evaluating anteversion of the acetabular component after total hip arthroplasty on plain radiographs. J Orthop Surg Res. 2018 Apr 2;13(1):66.

M	Your guess of Population M	19.40
S	Standard deviation of M	6.80
1- α	Set level of confidence (value < 1.0)	0.95
Z1	Z value associated with confidence	1.96
d	Absolute precision (=Value <M)	2.1
n	Minimum sample size	40

So, the minimum sample size was 40.

Sampling technique: Simple random sampling

Inclusion criteria:

- Patients with the age of more than 30 years and less than 80
- Patients with osteoarthritis of hip (primary and secondary) indicated for total hip replacement
- Both the genders- male and female
- Patient willing for total hip replacement surgery and giving informed written consent

Exclusion criteria

- Patients under going complex primary THA in protrusion acetabuli, dysplastic acetabulum, acetabular fractures
- Patients with septic arthritis
- Patients with neuropathic joints with neurological deficit around hip (paralyzed abductors)
- Patients who are unfit for surgery due to associated medical problems
- Presence of active foci of infection in the body
- Patients not willing for surgery

Variables used in study: Age, gender, anteversion angle on radiography

Methods of data collection

After obtaining institutional ethics committee clearance,

written informed consent (Annexure 1), inpatients of Department of Orthopaedics fulfilling the inclusion and exclusion criteria will be enrolled in the study. Each patient will be given unique identity number, demographic data, history, clinical examination, physical examination including recording of vital signs and details of investigations and details of implant used by treating doctor, interventions will be recorded in the study proforma and radiological assessment as mentioned in (Annexure 2) will be done after THA in the post-operative period.

Measurement of the anteversion of the acetabular component on AP plain radiographs

The method of Liaw *et al*^[8] (fig 1)

Version $\frac{1}{4} \sin^{-1} \tan \beta$ where β angle is the angle between the long axis of the component (AB in Fig. 1a) and the line connecting the end of AB with the end-point of the ellipse (Fig. 1).

Measurement of the anteversion of the acetabular component on CT scan (fig 1a)

- The largest section of acetabular component selected in CT axial view
- First line connecting centres of two hips
- Second line perpendicular to first
- Third line from most anterior point of component to its most posterior point

The angle between second- and third-line measures version which is reference standard.

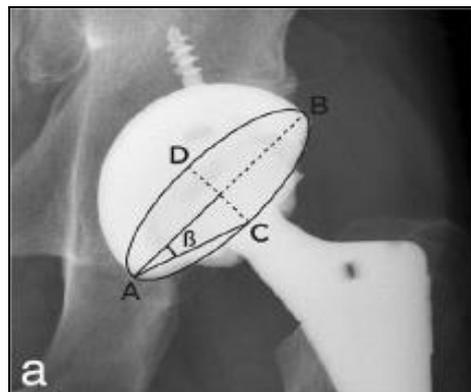


Fig 1: Measurement of the anteversion of the acetabular component on AP plain radiographs

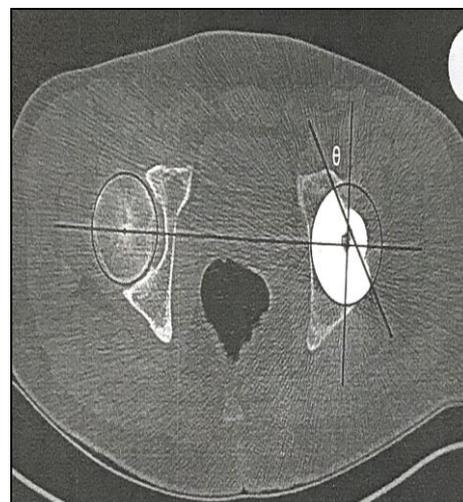


Fig 1a. Measurement of the anteversion of the acetabular component on CT scan

Measurement of the inclination of the acetabular component on AP plain radiographs (fig 2)

Inclination is the angle between transischial tuberosity line and the acetabular axis projected on to the coronal plane.



Fig 2a: Measurement of the inclination of the acetabular component on AP plain radiographs

Measurement of the inclination of the acetabular component on CT scan (fig 2a)

Inclination is the angle between trans pubic tubercal line and the acetabular axis projected on to the coronal plane.



Fig 2b: Measurement of the inclination of the acetabular component on CT scan

Statistical analysis

Data was collected by using a structure proforma. Data thus was entered in MS excel sheet and analysed by using SPSS 24.0 version IBM USA.

Qualitative data was expressed in terms of percentages and proportions Quantitative data was expressed in terms of Mean and Standard deviation Association between two qualitative variables was seen by using Chi square/ Fischer’s exact test Comparison of mean and SD between two groups will be

done by using unpaired t test to assess whether the mean difference between groups is significant or not Descriptive statistics of each variable was presented in terms of Mean, standard deviation, standard error of mean.

A p value of <0.05 was considered as statistically significant whereas a p value <0.001 was considered as highly significant.

Results

Table 1: Distribution according to diagnosis

		Frequency	Percent
Diagnosis	Aseptic loosening of right amp	1	2.5
	Bilateral AVN hip	8	20.0
	Bilateral osteoarthritis hip	1	2.5
	Left AVN hip	9	22.5
	Left hip arthritis secondary to AS	1	2.5
	Left neck of femur fracture	1	2.5
	Left OA hip	2	5.0
	Right osteoarthritis hip	1	2.5
	Right AVN hip	12	30.0
	Right osteoarthritis hip	4	10.0
	Total	40	100.0

Majority of the patients i.e., 12(30%) had right AVN hip, 9(22.5%) had left AVN hip, 8(20%) had bilateral AVN hip

and 4(10%) had right osteoarthritis hip.

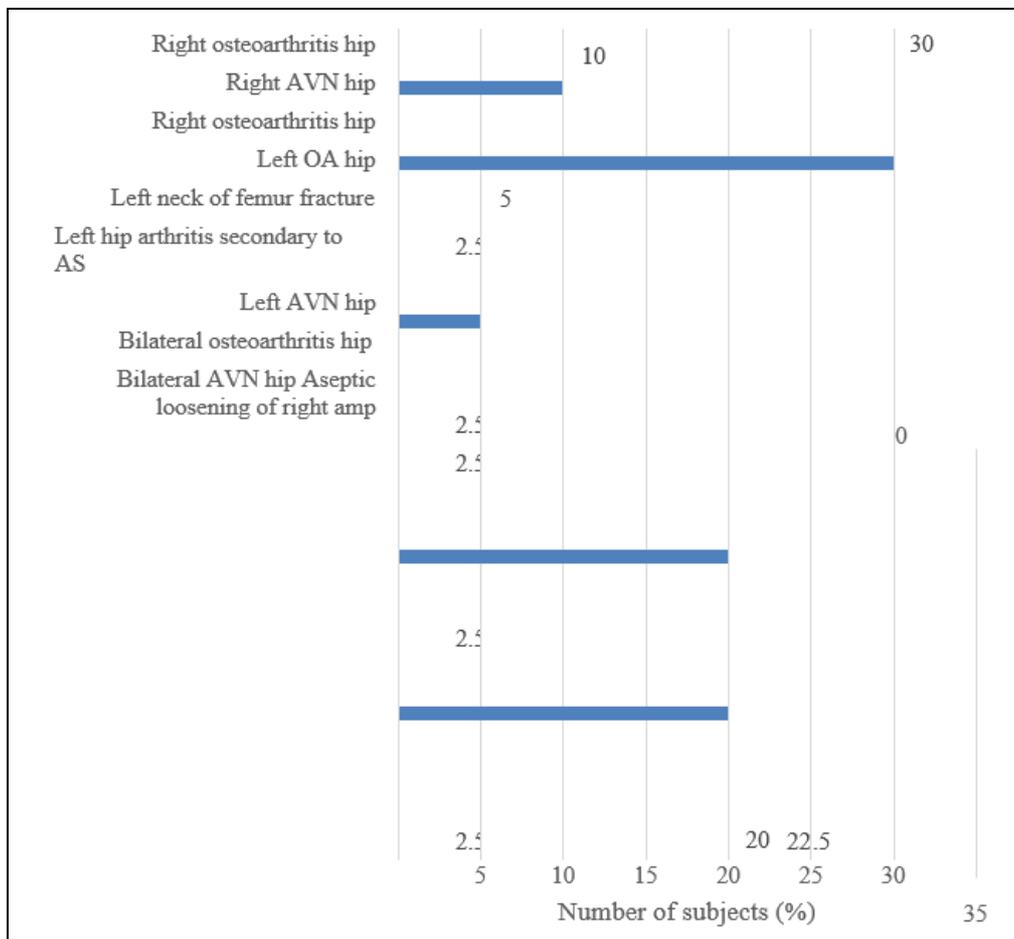


Fig 3: Distribution according to diagnosis

Table 2: Distribution according to type of surgery

		Frequency	Percent
Surgery	Left Thr	17	42.5
	Right Thr	23	57.5
	Total	40	100.0

Out of 40 patients, majority were operated for right sided THR i.e. 23(57.5%) and remaining 17(42.5%) for left sided THR.

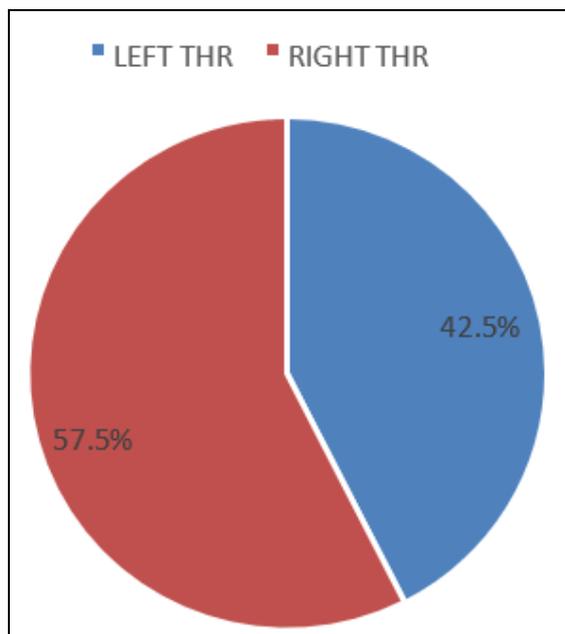


Fig 4: Distribution according to type of surgery

Table 3: Comparison of anteversion angle on X ray and on CT

		N	Mean	Std. Deviation	t	p	Inference
Anteversion	On X ray	40	18.78	3.90	-0.33	0.743	Not significant (>0.05)
	On CT	40	18.85	4.28			

Angle of anteversion assessed on X ray was 18.78±3.9 degree and on CT it was 18.85±4.28 degrees. When we compared the angle of anteversion assessed on X ray and on CT, the difference was not statistically significant. It means though the anteversion angle on CT was slightly higher, but it was not significantly higher compared with X ray angle. (p>0.05)

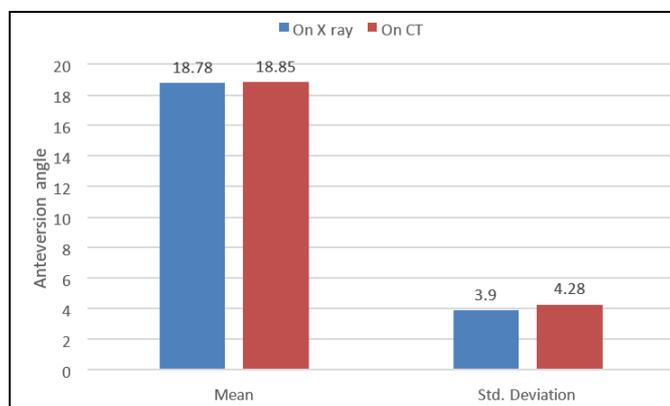


Fig 5: Comparison of anteversion angle on X ray and on CT

Table 4: Comparison of inclination angle on X ray and on CT

		N	Mean	Std. Deviation	t	p	Inference
Inclination	On X ray	40	39.83	2.45	-1.81	0.078	Not significant
	On CT	40	40.10	2.23			

Angle of inclination assessed on X ray was 39.83±2.45 degree and on CT it was 40.10±2.23 degrees. When we compared the angle of inclination assessed on X ray and on CT, the difference was not statistically significant. It means though

the inclination angle on CT was slightly higher, but it was not significantly higher compared with X ray angle. (p>0.05)

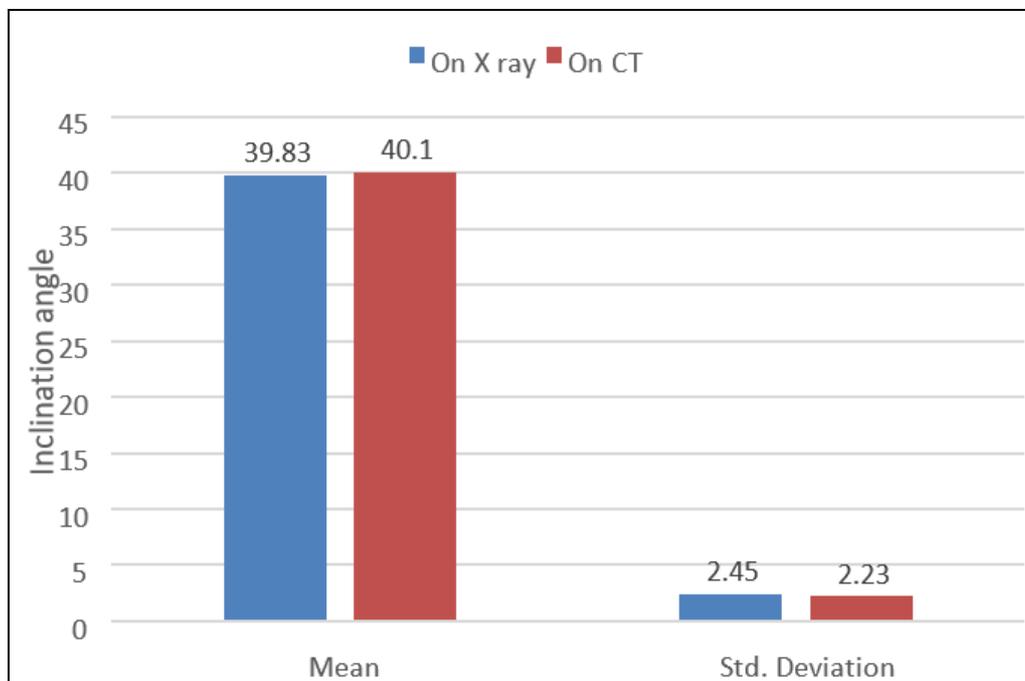


Fig 6: Comparison of inclination angle on X ray and on CT

Table 1: Descriptive statistics of the variables

	N	Mean	Standard Deviation	Std error	Range	Minimum	Maximum
AGE	40	47.3	11.12	1.75	40	30	70
Anteversion on X ray	40	18.78	3.90	0.62	14	12	26
Inclination on X ray	40	39.83	2.45	0.39	8	36	44
Anteversion on CT	40	18.85	4.28	0.68	16	12	28
Inclination on CT	40	40.10	2.23	0.35	7	37	44

Mean age of the patient was 47.3±11.12 years. Mean angle of anteversion on X ray 18.78±3.90 degree. Mean angle of inclination on X ray 39.83±2.45 degree. Mean angle of anteversion on CT 18.85±4.28 degree. Mean angle of inclination on CT 40.10±2.23 degree.

Discussion

Discussion

Optimal acetabular cup orientation is of substantial importance to good long-term function and low complication rates after total hip arthroplasty (THA). Improper cup positioning always leads to limited range-of-motion, accelerated wear, and early dislocation postoperatively and inclination (RI) angles, respectively, by Murray [6].

Anteversion and inclination angle on X ray and CT

Angle of anteversion assessed on X ray was 18.78±3.9 degree and on CT it was 18.85±4.28 degrees. When we compared the angle of anteversion assessed on X ray and on CT, the difference was not statistically significant. It means though the anteversion angle on CT was slightly higher, but it was not significantly higher compared with X ray angle (p>0.05).

So we can use X ray for assessment of anteversion angle in our study.

Angle of inclination assessed on X ray was 39.83±2.45 degree and on CT it was 40.10±2.23 degrees. When we compared the angle of inclination assessed on X ray and on CT, the difference was not statistically significant. It means though the inclination angle on CT was slightly higher, but it was not significantly higher compared with X ray angle (p>0.05). So we can use X ray for assessment of anteversion angle in our study.

The plain radiograph remains the mainstream tool for evaluation of the cup orientation intra- or postoperatively.

Conclusion

Accuracy of measurement of acetabular cup anteversion and inclination after THA using plain radiographs is almost equal with computed tomography-based measurements. So we can use plain radiograph for determining acetabular cup anteversion and inclination. This will be easy and cost-effective approach. Measurement of the orientation of acetabular components on plain AP radiographs is reliable and accurate compared with measurement on CT.

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