Original Research Article

Anthropometric analysis of hip joint using Computed Tomography in a tertiary care centre in North India

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Received: 18-09-2020 / Revised: 22-10-2020 / Accepted: 23-11-2020

Abstract

Background: Hip joint has a significant functional modification on erect bipedal posture. The geometry of the hip joint is determined by genetic and environmental factors such as age, race, sex, and lifestyle. Anthropometric dimensions described for hip joint in Westerners might be quite different from those encountered among Indians. So this study was aimed to do anthropometric study of Hip joint by CT scan. **Material and Methods**: The study was conducted on a CT pelvis of normal patients who underwent CT pelvis for some other reason and having both hip joints radiologically normal. This study was conducted in Department of Orthopedics, BPS Govt. Medical College, Khanpur Kalan, Sonepat, Haryana. Anthropometric measurements of 162 hips were carried out by CT scan of patient who underwent CT scan of pelvis for some other reason and have normal radiological hip with the age group between 20 years to 70 years. Total 8 parameter HD, NW, NSA, HO, VO, AA, $CD_{LT,}$ AV of each hip joint were measured and compared between males and females and as per the side of the joint. **Results:** We found in our study that there is statistically significant difference between males and females in parameters like HD, NW, NSA, HO, VO, AA, $CD_{LT,}$ AV. The mentioned parameter has lesser values in females than the males. We also found that there is no statistically significant difference as per the side of the joint in any parameter we studied. At the end of the study, we did a anthropometric study of the various parameter of the hip joint which may help for the better designing of the implants which are being used for hip surgeries and replacement surgeries. **Conclusion:** However, our study population was small up to 162 hips and large multicentric study may require supporting this finding.

Keywords Anthropometric, Hip joint, Computed Tomography

Introduction

Hip joint has a significant functional modification on erect bipedal posture. The morphology of the proximal femur, especially the relationship between proximalfemur and the shaft of femur is an interesting subject in orthopaedic literature. The geometry of the hip joint is determined by genetic and environmental factors such as age, race, sex, and lifestyle[1-3].

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Anthropometric dimensions described for hip joint in Westerners might be quite different from those encountered among Indians[1]. Hence, the knowledge regarding proximal femur is important for understanding the biomechanics of the hip as well as surgical planning. Anthropometric analysis of the hip joint will be useful in the management of the pathological conditions such as osteoarthritis of the hip, fracture neck of femur, and per trochanteric fractures.Fractures around the hip and osteoarthritis of the hip joint are relatively common[4] and need ideal fixation for good functional and clinical outcome. Siwach et al[1] compared the parameters of the femurs of Indian cadavers with those of Western and Hong

Kong Chinese population[1]. They observed that the implants were oversized, and their angles and orientations have a mismatch, which can presumably lead to complications such as postoperative thigh pain and fractures around prosthesis[1]. Pathrot *et al*. using proximal femoral nails suggested design modifications for Indian population with lesser neck width (NW)[5]. This hip joint failure is due to the damage of hip joint mechanism which affects range of motion and ability to bear weight on the joint. Other conditions that lead to hip replacement surgery are rheumatoid arthritis, osteonecrosis, trauma and bone tumors[6]. The aim of any surgical procedure in proximal femur is to obtain stable and well-functioning hip joint during day to day normal work. The common implants used in the proximal femur are dynamic hip screw, dynamic condylar screw, proximal femoral nail, cancellous screws, and Hemi as well as Total replacement arthroplasty. Since the parameters of proximal femur morphometry for Indian population is lacking[6], the data about proximal femur geometry for the Western population are utilized in prosthetic designing. With no other available option, the same implants designed for the Western population is being used for Indian patients. It is also important to match the dimensions of the implant as much as possible with those of native femur to prevent complications resulting from mismatch which could be aseptic loosening, improper load distribution, stress shielding and discomfort.[6,7] In uncemented hip arthroplasty secondary biologic integration of a hip implant to surrounding native bones depends mainly on the quality of its primary stability [6]. Mismatch between bone and prosthesis will affect the bone ingrowth and uptake due to micro motion of the implants during the early postoperative period. It is also important to design a prosthesis through which adequate loads can be transferred to the bone to prevent stress shielding[6]. Improper load distribution leads to sever stress shielding around the prosthesis where periprosthetic fracture can happen in future. A thorough knowledge of hip joint anatomy is a prerequisite to understand its biomechanics. Relatively little has been written on what could be considered normal in an X-ray of hip and what is considered pathological or abnormal.

Mean values of anthropometric parameter of population do not provide much help in individual cases. It should be known how far normal standards deviate and where pathological values can be expected. More information is needed on the computed tomographic measurement of the hip joint, including its shape, its width at precise locations and influence of age, sex and congenital morphology[7, 8]. This study is aimed to get more information about hip joint geometry among Haryana population using computed tomography (CT).

Material and Methods

The study was conducted in out-patient department (OPD), department of Orthopaedics and dept. of radiodiagnosis, Bhagat Phool Singh Govt. Medical College for Women, Khanpur Kalan, Sonipat, Haryana, India.

Study Population

The study was conducted on patients coming to hospital and have undergone CT pelvis indicated for some other reason but have normal radiological hip.

Inclusion Criteria

Patient with normal radiological hip.
Patient between 20 and 70 years of age.
Consent to participate.

Exclusion Criteria: Patient on systemic or topical antibiotics, patient with acute Suppurative otitis media i.e. duration of less than 2 weeks, Patients with cleft palate, Patients /parent /care giver who does not give his or her consent.

Sample Size: The study was conducted in 61 patients with both hips (122 hips)

Sample Size Calculation: Using nMaster 2.0 software considering the previous study by Siwach et al[1] calculation were done, with 5% of alpha error and 90% power of study, the required sample size was 122 hips.

Sampling Technique: Simple random sampling was used and simple random sample was collected by using computerized generated simple random number table.

Study Design: This was a cross sectional study. After Institutional Ethics Committee (IEC) approval and written informed consent from the patient, a total of 122 hips of 20-70 year age group and others fitting into the inclusion criteria of all gender at BPS Government Medical College for Women was included in the study till the sample size was achieved.

Study Duration November 2018 to October 2019

Data Collection and Statistical Analysis

Collection of data of patients whose CT pelvis was done for some other reason

Both hip of each patient were studied.

Neck shaft angle, Neck width, Femoral head diameter, Acetabular angle, Horizontal offset, Vertical offset, Medullary canal diameter at the level of lesser trochanter and Acetabular version were measured by CT.

Data was stratified by gender and side of the hip.

Statistical Analysis: The data was analysed using Microsoft Excel spreadsheet and statistical software

SPSS® version 22. Mean with standard deviation (S.D) was calculated **.** Student 'T' test was used for normally distributed variable to find the mean difference. P value <0.05 was considered as statistically significant.

Methods:- Sixty one patients both male and female who underwent CT scan of pelvis in the age group between 20 and 70 years were evaluated after Ethical Committee clearance. Both the hip joints were analysed by PHILIPS 128 slice CT scan. The thickness of the CT slice was 2 mm. Superimpositions and motion artifacts were avoided. The neck-shaft angle (NSA), head diameter (HD), neck width (NW), acetabular angle (AA) , horizontal offset (HO), vertical offset (VO), medullary canal diameter at the level of lesser trochanter, and acetabular version (AV) were measured. Measuring process was optimized using the "full-screen" view, and the images were magnified to maximize resolution and accuracy.

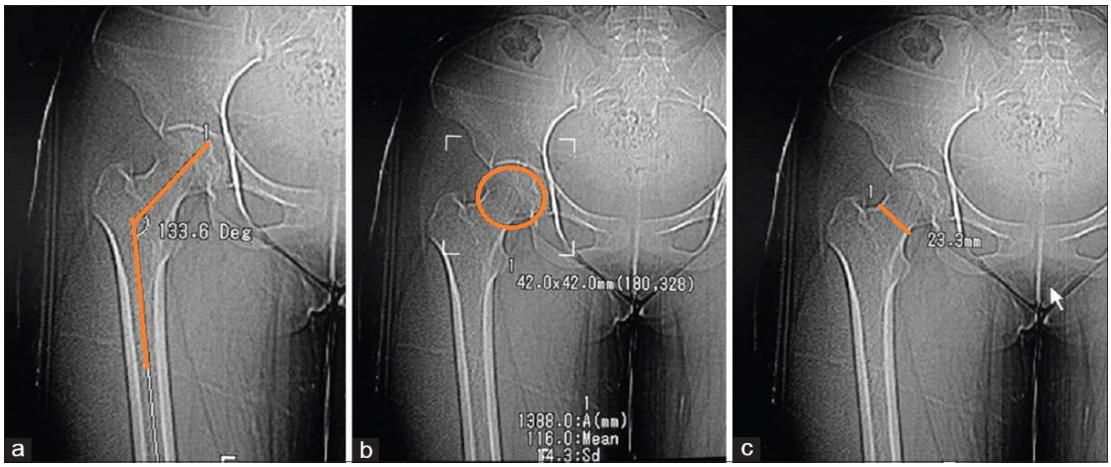

Fig 1: Sagittal CT scan of hip with thigh showing (a) Neck shaft angle (b) Head diameter (c) Width of the femoral neck

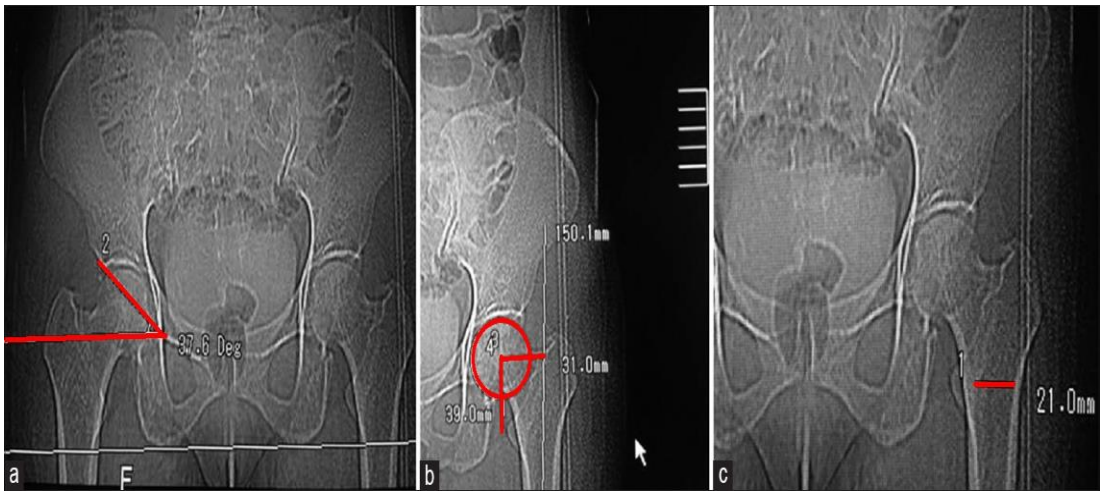

Fig 2: (a)CT scan pelvis with both hips showing acetabular angle (b) CT scan hip with hemipelvis showing horizontal and vertical offset (c) CT scan hip with pelvis showing medullary canal diameter at the level of lesser trochanter

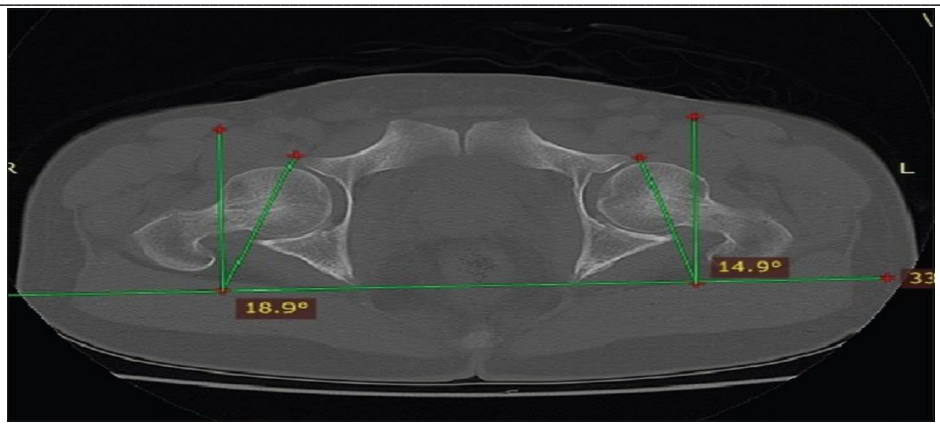

Fig 3: **CT scan axial cut pelvis showing acetabular version**.

Observation and Results

A total 62 male and 60 female hip CT scan and 61 right side and 61 left side hip joint was taken in the study. The mean value of the femoral HD in our study was 43.43 mm. The mean femoral HD among male and female was 44.16 and 42.68 mm, respectively. The values ranged from 37 to 51 mm among male and 37–46.7mm in female. The difference between Male and Female HD mean was found statistically significant. Between the right and left sides, the mean value was 43.39 and 43.8 mm, respectively. The *P* value was not statistically significant. The mean value of the NW in our study was 25.38 mm. Among the male, it ranged from 20 to 37 mm, and for the female, it was from 19 to 32 mm. The mean value was 26.58 mm among male, and it was 24.13 mm among females. The P value was statistically significant. In the right side, the NW ranged from 19 to 36 mm, and on the left side, it was 21–37 mm. The mean value was 25.31 mm on the right side and it was 25.44 mm on the left side. P value was not statistically significant.

Table 1: Analysis of various parameter as per the side of the Hip joint

Parameter	Side	No	Mean	Range	SD	SEM	P value
Femoral head diameter (mm)	Right	61	43.392	37-49	2.64	0.33	0.852
	Left	61	43.480	37.7-51	2.58	0.33	0.852
Neck width (mm)	Right	61	25.318	19-36	2.80	0.35	0.794
	Left	61	25.449	21-37	2.73	0.35	0.794
Neck shaft angle	Right	61	134.103	121-145	4.21	0.53	0.732
	Left	61	134.366	123-146	4.22	0.54	0.732
Horizontal offset (mm)	Right	61	37.621	32-43	1.93	0.24	0.684
	Left	61	37.767	34-44	2.01	0.25	0.684
Vertical offset (mm)	Right	61	47.551	34-59.9	6.01	0.77	0.988
	Left	61	47.567	34-60	6.03	0.77	0.988
Acetabular angle	Right	61	32.769	23-41	4.42	0.56	0.934
	Left	61	32.834	25-40.7	4.24	0.54	0.934
Medullary canal diameter at the level of lesser trochanter (mm)	Right	61	21.433	12-28	3.44	0.44	0.893
	Left	61	21.518	12-28	3.56	0.45	0.893
Acetabular version	Right	61	17.189	9.5-32	4.47	0.57	0.945
	Left	61	17.134	9-28	4.09	0.52	0.945

The mean value of the NSA in our study was 134.23°. Among male and female, the range of NSA was 127°–146° and 121°–144°. The mean value was 135.83° in male and 132.57° in females which was statistically significant. The right side it ranged from 121° to 145° and 123° to 146° on the left side. The mean value was 134.10° on the right side and it was 134.36° on the left side. The *P* value was not statistically significant. The mean value of the HO was 37.69 mm. Among males, it ranged from 35 to 44 mm and for the females 32–39

mm. The mean value for the males was 38.71, and for the females, it was 36.64 mm. P value was statistically significant. In the right side, the HO range was 32–43 mm, and on the left side, it was 34–44 mm, and the mean value was 37.62 on the right side and on the left side it was 37.76 mm. P value was not statistically significant. The mean value of the VO was 47.55 mm. Among males, it ranged from 39 to 60 mm and for the females 34 to 54 mm. The mean value for the males was 49.62 mm, and for the females, it was 45.42 mm. P value was statistically significant. In the right side, the VO range was 34–59.9 mm, and on the left side, it was 34–60 mm, and the mean value was 47.55 on the right side, and on the left side, it was 47.56 mm. The *P* value was not statistically significant. The mean value of the AA is 32.80°. Among males the range of AA of was 23°–41° and among female it was 23°-41°. The mean value among male and female was 33.73° and 31.84°. P value was statistically significant. Among the right and left sides, the range was 23°–41° and 25°–40.7°. The mean value among the right and left sides was 32.76° and 32.83°. P value not statistically significant. The mean value of the medullary canal diameter at the level of lesser trochanter (MD_{LT}) in our study was 21.47 mm. Among males and females, range was 12–29 mm and 12–26 mm, respectively. The mean value among male and female was 21.28 and 21.67 mm. P value was not statistically significant. Among the right and left sides, the range of values was 12–28mm on both sides. The mean value among the right and left side was 21.43mm and 21.51 mm. The *P* value was not statistically significant. The mean value of the AV in ;our study was 17.16°. Among males and females, range was 9°–32° and 10°–32°. The mean value among male and female was 16.65° and 17.68°. P value was statistically not significant. Among the right and left sides, the range of values was 9.5°–32° and 9°–28°. The mean value among the right and left side was 17.18° and 17.13°. The *P* value was not statistically significant. The present study was aimed to do anthropometric study of hip joint by CT scan. The study was conducted on a CT pelvis of normal patients who underwent CT pelvis for some other reason and having both hip joint radiologically normal. CT has helped in the detailed study of the hip joint than the dry bone study[7]. For anthropometric studies, Husmann et al and Noble et al. used plain radiolographs in their study[7,8] and CT was used by Rubin et al[9]. According to Rubin et al CT scan study is more accurate and feasible[9]. In this study total 8 parameter HD, NW, NSA, HO, VO, AA, $CD_{LT,}$ AV of each hip joint were measured and compared between males and females and as per the side of the joint. We found in our study that there is statistically significant difference between males and females. Females have lesser values than the males. We also found that there is no statistically significant difference as per the side of the joint in any parameter we studied. In this study we measured various hip joint anthropometric parameters and calculated population mean of each. We found that there is statistically significant difference between male and female hip joints in parameters like femoral head diameter, neck width, neck shaft angle, horizontal offset, vertical offset, acetabular angle. We also compared our study with the similar studies done elsewhere in India as well as in Western populations. We found that the parameters vary significantly from region to region within India and in Western populations as well. Due to lack of anthropometric data available for Indian populations, we have been using the same implants which are being used for Western populations. In these comparisons we noticed that the population which we included in our study have smaller head diameter, smaller neck width and increased neck shaft angle in comparison with the study done in other region.

Conclusion

We also compared our study with the similar studies done elsewhere in India as well as in Western populations. We found that the parameters vary significantly from region to region within India and in Western populations as well. Due to lack of anthropometric data available for Indian populations, we have been using the same implants which are being used for Western populations. In these comparisons we noticed that the population which we included in our study have smaller head diameter, smaller neck width and increased neck shaft angle in comparison with the study done in other region.

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Conflict of Interest: Nil
Source of support:Nil