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A Study of Bilateral Asymmetry and Sexual Dimorphism of Hip Joint Bones of Pune Region Cadavers

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Abstract

The hip joint bonesundergo a continuous process of remodelling throughout life depending upon various degrees and direction of tensile force and compressive force applied over it due to day to day activities. As these forces are different on either side and gender, it leads to bilateral variability and sexual dimorphism. Many studies have carried out on dry bones but few studies have demonstrated on bones with soft tissue in situ which is important because it is more close to the normal physiology. Moreover, geographical area and environmental factors affect the remodelling process. Hence we sought to study the Vertical diameter of head of femur, Diameter of acetabulum and Depth of acetabulumin 55 cadaveric hip joints on both sides in Pune region. Our study finding showed that there is no bilateral asymmetry but it demonstrated sexual dimorphism with male hip joint bone dimensions being greater than female. Present study also conclude that hip joints are congruent and thus primary osteoarthritis is rare in Pune region as compared to western countries.Population specific hip joint prosthesis can be manufactured using the average hip joint bone dimensions provided in this study for Pune region. Thus the present study data is important to the radiologist, orthopaedic surgeons, forensic experts, biomedical engineers and prosthetics.

Keywords: Cadaveric Study; Vertical Diameter of Head of Femur; Diameter of Acetabulum; Depth of Acetabulum; Hip Joint.

Introduction

The hip joint is a ball socket joint which is also a rotational conchoid [1]. The head of femur articulates with the cup shaped acetabulum. The articular surfaces are reciprocally curved but entire head of femur is not lying within the acetabular socket. Being a rotational conchoid,hip joint is less likely to subluxate and wear [1]. Remodelling of bone continues throughout life. According to Wolf's law tensile force favours bone formation whereas compressive force favours bone resorption[2]. Different degrees of stress on two sides of body is responsible for bilateral variability. Lower limbs are used for walking, usually there is equal use of both lower limbs except there is some gait deformity. Many authors performed studies on dry bones of hip joint [3,4]. Some authors observed heavier dry bones on right side and some on left [5,6]. Very few Cadaveric hip joint studies have been done to assess bilateral variability but results are conflicting [7,8].

Nutrition, hormones and environment plays a role in sexual dimorphism. Male hormones lead to more muscular development leading to more tensile force and bone deposition making them stronger and heavier. Now a days, division of labour leads to non-significant difference between male and female hip joint dimensions. There are many studies on dry bones [9-12] and using radiographs [13-16] of hip joint, but very few studies have been conducted on cadaveric hip joints with soft tissues.

Anthropometric parameters of bone are influenced by genetics, hereditary, environment and geographical location. Cadaveric studies have been conducted in different geographical areas of India.

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To the best of our knowledge not much literature is available on these dimensions in Pune region hip joints therefore weplanned the present study with following aims and objectives

Aims and Objectives

1. To compare betweendimensions of right side and left side hip joint in male.
2. To compare between dimensions of right side and left side hip joint in female.
3. To comparedimensions of hip joint between male and female.
4. To correlate the vertical diameter of head of femur with diameter of acetabulum in male and female.
5. To derive the average mean, maximum and minimum values of vertical diameter of head of the femur, diameter of acetabulum and depth of the acetabulum for manufacturing prosthesis in male and female subjects.

Materials and Methods

The present study was conducted in the Anatomy department of B.J. Medical college, Pune and Medical colleges around it.Fifty cadaveric hip joints were dissected. All cadavers were belonging to 40 -60 years. Out of 50 cadavers, 38 were male and 12 were female. The specimens were grossly inspected for any osteoarthritic changes. The hip joints were included in the study only when 1) articular cartilage of femoral head was smooth and was of uniform appearance with no evidence of marginal ossification and osteophytes. 2) the acetabulum was hemispherical and cartilage lining it was smooth and was horse shoe shaped. Outer edge of cartilage and labrum are continuous with each other, then the acetabular fossa that filled with fibro-fatty tissue.

Vertical diameter of head of femur, Diameter of acetabulum and Depth of acetabulum were measured on fifty hip joints on both sides right and left.

Measurements were taken using a vernier calliper 1/100 mm accuracy and a thin metallic scale:

1. Vertical diameter of head of femur: was taken as the distance between the most superior and most inferior point on head of femur at right angle to the neck of the femur.It was measured with the help of outside jaw of Vernier calliper.
2. Diameter of acetabulum: was measured as the maximum transverse diameter of acetabulum.It was taken with the help of inside jaw of Vernier calliper.
3. Depth of acetabulum: athin metallic scale was placed across the diameter of acetabulum. Depth was measured from centre of acetabulum to the metallic scale with the help of depth probe of Vernier calliper.

All the measurements were taken three times and the mean of three measurements was noted down. Data was tabulated and statistically analyzed by using Microsoft excel andgraphpad prism software.

Observations

Table 1 shows that difference between left and right side measurements of vertical diameter of head of femur, Depth of acetabulum and Diameter of acetabulum was statistically insignificant for both male and female cadavers. But the difference between male and female measurements of vertical diameter of head of femur, Depth of acetabulum and Diameter of acetabulum was statistically significant for both sides.

Table 2 shows that vertical diameter of head of

Table 1: Showing the comparison between left and right side hip joint measurements in both the sexes

Dimensions	Male			Female			Male Vs Female	
	Right	Left	P value	Right	Left	P value	Right P value	Left P value
Vertical diameter of head of femur (mm)	43.4±2.53	43.34±2.34	0.9179	39.67±1.84	38.5±2.18	0.1226	<0.0001 ****	<0.0001 ****
Depth of acetabulum (mm)	30.97±3.78	30.84±4.06	0.8842	28.67±1.17	27.67±1.17	0.0734	0.0446 *	0.010 *
Diameter of acetabulum (mm)	44.32±2.47	44±2.64	0.5921	41.08±1.70	40.08±1.71	0.1179	<0.0001 ****	<0.0001 ****

(* indicates level of significance, P value < 0.05 considered as statistically significant)

Table 2: Showing comparison between vertical diameter of head of femur and diameter of acetabulum for both genders

Gender	Vertical diameter of head of femur (Mean)	Diameter of acetabulum (Mean)	P value
Male	43.37±2.42	44.16±2.55	0.005*
Female	39.08±1.84	40.58±0.37	0.0038**

(* indicates level of significance, P value < 0.05 considered as statistically significant)

Table 3: Shows the descriptive analysis of dimensions of Vertical diameter of head of femur in male and female

	Male		Female	
	Right	Left	Right	Left
Maximum Value	50.1	49	43	42
Minimum Value	40	40	37	36
Mean	43.4	43.34	39.67	38.5
Standard Deviation	2.53	2.34	1.84	2.18

Table 4: Shows the descriptive analysis of dimensions of depth of acetabulum in male and female cadavers.

	Male		Female	
	Right	Left	Right	Left
Maximum Value	39	40	31	30
Minimum Value	25	25	27	26
Mean	30.97	30.84	28.67	27.67
Standard Deviation	3.78	4.06	1.17	1.17

Table 5: Shows the descriptive analysis of dimensions of diameter of acetabulum in male and female cadavers

	Male		Female	
	Right	Left	Right	Left
Maximum Value	49	48	44	43
Minimum Value	41	40	39	38
Mean	44.31	44	41.08	40.08
Standard Deviation	2.47	2.64	1.71	1.70

femur was significantly lower than diameter of acetabulum for both genders.

Table 3 shows the maximum value, minimum value, mean and standard deviation of Vertical diameter of head of femur in male and female cadavers.

Table 4 shows the maximum value, minimum value, mean and standard deviation of depth of acetabulum in male and female cadavers.

Table 5 Shows descriptive analysis of dimensions of Diameter of acetabulum in male and female cadavers. It depicts the maximum and minimum values of all the measurements.

Discussion

In the present study we measured various dimensions of hip joint with soft tissues in cadavers from Pune region. Our study finding suggests that there is no statistically significant bilateral variability in male and female cadavers. Similar findings were depicted by Afroze et al on Bangladeshi population by radiographic study [14]. In cadaveric study similar results were obtained by Chouhan R [17], Kamdi et al [7] Khobragade et al [18] and Arounprasath et al [19]. But few studies on dry bones showed left sided dimensions were more than right side [4,6,20]. Also few studies have obtained right sided dimensions greater than left [5,8, 21]. This variation in findings may be due to different geographical areas of study. The present study finding suggests that there is no bilateral variability in hip joint dimensions in Pune region.

Our study finding suggests that hip joint dimensions are greater in males as compared to females.Similar finding were depicted in dry bones by Asala S A et al [9], Khobragade et al [18] Maske S S et al [11,12] and Pandya et al[10]. Also the cadaveric study done by Chouhan R et al [17], Patel et al [8] and Kamdi et al [7] have obtained similar findings. Probable reason for greater dimensions in male as compared to females is that more muscle mass and bulky body in males. To carry this mass and heavy body weight male bones are larger and heavier.

Our study finding suggests that in Indian

population diameter of acetabulum is significantly greater than vertical diameter of head of femur. Thus in Indian population hip joint is mostly congruent. Therefore, primary osteoarthritis of hip joint is less common in Indian population. Hoaglund et al [22], Mukhopadhyaya et al [21] and Chouhan R et al [17] have obtained similar findings in Indian population.

The anatomical dimensions of hip joint are very important for the prosthetics and biomedical engineers to design the suitable prosthesis which are population specific for the hip replacement surgeriescarried out in India. This study will give specific suitable dimensions to very specific Pune region population. Therefore, prosthetics can design better prosthesis. This can lead to prevention of mismatch complications of unsuitable prosthesis as most of them are designed according to western standards.This study is important as the measurements were taken with soft tissues in place and this gives average dimensions of various parameters close to the normal physiological situations. Thickness of articular cartilage is approximately 3mm [17]. Assessment of these parameters by radiological techniques like X-rays, CT scans and MRI includes magnification errors and these methods are costlier especially for developing nation like India. One of the important limitation of present study is that hip joint measurements were taken on embalmed and preserved cadavers which make a possibility that soft tissues are shrinked therefore giving higher values. But previous investigations done by Kurrat HJ et al [23] have shown that method of embalming has no measurable effect on cartilage thickness.

Also anatomical dimensions of the hip joint are very important for understanding of pathogenesis of diseases like primary osteoarthritis of hip joint.An incongruous joint is more prone to develop degenerative changes than a joint having normal anatomy. From this study we can say that primary osteoarthritis is rare in India because diameter of acetabulum is more than vertical diameter of head of femur.Also this data is useful in early detection of disputed sex from the fragmented bones of hip joint by forensic experts.

Conclusion

We conclude that hip joint bone dimensions of Pune region population shows no bilateral asymmetry but shows sexual dimorphism with male hip joint bone dimensions being greater than female. Knowledge of various anthropometric dimensions of hip joint will help the radiologist,orthopaedic surgeons, forensic experts, biomedical engineers and prosthetics. Present study also conclude that hip joints are congruent and thus primary osteoarthritis is rare in Pune region. Population specific hip joint prosthesis can be made from the average dimensions provided in this study for Pune region.

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