Anatomical Parameters Of North Indian Hip Joints – Cadaveric Study.

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Abstract. In the recent years measurements on the cadaveric hip joints have not been carried out. As the environment plays an important role in the development of human being it was thought that the change in the environment might have led to some kind of change in the parameters of the bony component of the hip joint. Therefore, 54 cadaveric hip joints with soft tissue in situ were studied. Dimensions of acetabulum and femoral head were obtained with Vernier scale. It was observed that these dimensions were greater in males when compared with that of females but the difference was statistically insignificant. On the left side the parameters measured were greater than those of the right side in both the sexes but of no statistical significance. Acetabular diameter was greater than the diameter of femoral head in both the genders. Clinically, this knowledge plays an important role in understanding the rarity of occurrence of primary osteoarthrosis in Indians. The present study is of value to the forensic experts, orthopaedicians and prosthetists as it gives the dimensions of acetabulum and femoral head in the present era.

Key words: Acetabulum, femoral head, Diameters, measurements.

Introduction :

The hip joint which was originally referred to as a ball and socket joint is now being described theoretically as a rotational conchoid (Menschik 1987; Menschik 1993). The work of Menschik (1997) also shows that hip joint is more of a conchoid than a ball and socket type. To understand the hip joint mechanics the knowledge of anatomy of proximal femur is a pre-requisite. Also, knowledge of various bony components of hip joint will not only help the radiologists but will also be of immense importance to the orthopaedicians and prosthetists. As race, clime, heredity and geographical areas have strong influence over the anthropometric parameters of bone therefore, the present study was undertaken to note the average diameter of the femoral head and the average diameter & depth of acetabulum in North Indian cadaveric hip joints. Although various dimensions of acetabulum and femoral head have been measured by several investigators but all such studies have been conducted on dry specimen. This study is unique in measuring the parameters with soft tissues in situ. Availability of such data can help in constructing best possible prostheses for patients of total hip replacement in North India. No such study on North Indian hip joints is available since nearly four decades. Any deviations of these dimensions from normal have strong correlation with development of various kinds of pathologies of hip joint. Fifty four cadaveric hip joints were dissected in the Anatomy department of Maulana Azad Medical College, New Delhi. All measurements were taken with Vernier scale, and the data obtained was scrupulously analyzed and interpreted.

Materials and Methods :

This study was conducted in the department of Anatomy, Maulana Azad Medical College and associated hospitals, New Delhi. Fifty four cadaveric hip joints belonging to the age group of 50-70 years of both sexes were dissected. The specimens were grossly inspected for the presence of any osteoarthritic changes which if present would alter the geometry of the joint. The hip joints were considered normal when (a) the articular cartilage of femoral head was smooth and was of uniform appearance till the margin where it disappeared with no evidence of marginal ossification (b) the acetabulum was hemispherical and cartilage lining it was smooth and horse shoe shaped, ending abruptly at the inner margin framing the acetabular fossa as unbroken line. Outer edge of cartilage and labrum blended without any distinctive demarcation. Acetabular fossa was filled with fibrofatty tissue with a smooth surface. Six hip joints were excluded from the study because of the presence of irregularity in the cartilage and osteophytes. Various parameters of the acetabulum and the upper end of femur of the
remaining forty-eight joints (36 male, 12 female; 24 right, 24 left) were measured as following:

1. **Depth of acetabulum** : A thin metallic strip was placed across the diameter of the acetabulum. Depth of the acetabulum was measured in millimeters using vernier scale from the center of the acetabulum to the metallic strip (fig. 1). Measurements could be made as accurate as 1/10 of a millimeter by this scale.

2. **Diameter of acetabulum** : Maximum transverse diameter of the acetabulum was measured using vernier scale (fig. 2).

3. **Vertical diameter of femoral head** : Vernier scale was used to measure the vertical diameter of the femoral head. It was taken at right angle to the long axis of the neck of femur which meant the straight distance between the most superior to the most inferior points of the femoral head (fig. 3).

Intraobserver variation was avoided by measuring each parameter three times by each of the three investigators and mean of the reading obtained was recorded.

**Observations and Results**:

Fifty four hip joints were dissected and grossly inspected. Six of these displayed osteoarthritic changes in the form of erosion of cartilage and presence of osteophytes. The remaining hip joints which grossly appeared normal were measured. The data obtained was analysed in the following manner: (a) measurements of right side in males were compared with measurements of right side in females (b) measurements of left side in males were compared with left side measurements in females and (c) right side measurements were compared with left side measurements in males (d) right side measurements of females were compared with left side measurements. It was observed that the depth of the acetabulum was greater in males than females both on right and left side (table I). On the right side the difference being statistically significant (right p=0.02, left P=0.06). It was noticed that the depth of the left acetabulum was greater than that of the right side in both sexes but the difference was statistically insignificant (male p=0.34, female p=0.20). The diameter of acetabulum was greater in males than females as can be depicted by table II. On the right side there was marginal statistically significant difference in the diameter of acetabulum between the two sexes (right p=0.049, left p=0.22). In both the genders left acetabulum had greater diameter than that of right side but of no statistical significance (male p=0.75, female p=0.06). The vertical diameter of femoral head was greater in males than in females both on right and left sides (table III) but was statistically insignificant (right p=0.42, left p=0.42). It was also noticed that in both sexes the vertical diameter was more on the left side than the right side though the difference was

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**Table : I Depth Of Acetabulum (n = 48; right = 24, left = 24)**

<table>
<thead>
<tr>
<th>Male (n = 36)</th>
<th>Female (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>right = 18</td>
<td>left = 18</td>
</tr>
<tr>
<td>range of depth of acetabulum (in mm)</td>
<td>23.0-34.0</td>
</tr>
<tr>
<td>Average depth of acetabulum (in mm)</td>
<td>27.4±2.70</td>
</tr>
<tr>
<td>SEM</td>
<td>0.64</td>
</tr>
</tbody>
</table>

**Table : II Diameter Of Acetabulum (n = 48; right = 24, left = 24)**

<table>
<thead>
<tr>
<th>Male (n = 36)</th>
<th>Female (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>right = 18</td>
<td>left = 18</td>
</tr>
<tr>
<td>range of diameter of acetabulum (in mm)</td>
<td>40.0-52.3</td>
</tr>
<tr>
<td>Average diameter of acetabulum (in mm)</td>
<td>47.1±2.90</td>
</tr>
<tr>
<td>SEM</td>
<td>0.68</td>
</tr>
</tbody>
</table>

**Table : III Vertical Diameter Of Femoral Head (n = 48; right = 24, left = 24)**

<table>
<thead>
<tr>
<th>Male (n = 36)</th>
<th>Female (n = 12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>right = 18</td>
<td>left = 18</td>
</tr>
<tr>
<td>range of femoral head diameter (in mm)</td>
<td>38-51</td>
</tr>
<tr>
<td>Average diameter of femoral head (in mm)</td>
<td>45.4±3.07</td>
</tr>
<tr>
<td>SEM</td>
<td>0.72</td>
</tr>
</tbody>
</table>
Discussion:

Hip joint is one of the major joints of the body. Though described conventionally as a ball and socket variety of synovial joint, Menschik (1997) reports it to be a rotational conchoid. Knowledge of the anatomical parameters of the bony components of hip joint is very essential as it will open new horizons into better understanding of etiopathogenesis of diseases like primary osteoarthrosis of hip joint. An incongruous joint is more prone to develop degenerative changes than a joint having normal anatomy (Murray 1965)

Awareness of the average dimensions of the bones of the hip joint in both sexes will also help in early detection of disputed sex by Forensic experts. As total hip replacement is a common surgery performed now a days a knowledge of the dimensions of acetabulum and femoral head will assist, prosthettists to construct suitable prostheses for North Indians. To the best of our knowledge not much literature is avaialble on these parameters of North Indian hip joints therefore the need for the present study to be carried out was felt. Studying cadaveric hip joints is of immense importance as various dimensions are taken with the soft tissues in place. This gives the average values of various parameters to near normal situations as would be encountered in the patients at operation table. Assessment of these parameters to detect the sex by radiographs, CT scans and MRI would include magnification errors and may not be cost effective for a developing nation like ours.

Study conducted on the femora of Nigerians revealed that the mean vertical diameter of the head of femur on the right and left sides in males is 54.23 mm and 54.08 mm respectively and in females it is 47.14 mm and 46.83 mm (Asala, Mbabjirgou and Papandro, 1998). It was noticed by Prasad, Vettivel, Jeyaseelan, Isaac and Chandi (1996) that the vertical diameter of the head of dry femora had an average value of 43.0 mm in males and 39.1 mm in females in South Indian population. Javadekar (1961) was of the opinion that the average diameter in males is 45.26 mm and in females is 40.37 mm. In contrast according to the present study the femoral head diameter on an average is 45.44 mm and 43.87 mm in males and females respectively on the right side and 45.84 mm and 44.67 mm respectively on the left side. According to Isaac, Vettivel, Prasad, Jeyaseelan and Chandi (1997) short statured have smaller diameter of femoral head which can be easily appreciated when the present study is compared with that of Asala et al (1998). Nigerians are taller than average Indians and so their femoral heads are bigger than that of Indians.

There is not much of difference in the measurement of femoral head diameter amongst North and South Indians as the study conducted on bones belonging to South Indians were on dried specimens whereas the study in question included soft tissues as well while measuring various parameters. Cartilage adds 3 mm to the diameter (Javadekar 1961). Average vertical diameter of femoral head is nearly the same as seen by Mukhopadhaya and Barooh (1967) though minor variations may persist as they have not segregated the joints according to sex.

A particular sex can not be determined only by visual examination of the bone as reported by Krogman (1946) and Stewart (1948) though to some extent it can be possible by seeing the hip bone as reported by Asala et al. (1998). Therefore, in addition to the already existing knowledge on the hip bone for determining sex of an individual it would be benificial if the dimensions of acetabulum could also be incorporated. Measurements of acetabulum are scarcely found in literature as far as our knowledge extends. Average depth of acetabulum according to Mukhopadhaya and Barooh (1967) on right and left sides are 24.7 mm and 24.5 mm respectively. Difference in their observations when compared with the present study exists as they included the dimensions of both the sexes while calculating the mean. Also, they worked upon fresh specimens where as the study in question was on preserved specimens. It is likely that in preserved materials, the soft tissues shrink and therefore the emergence of higher values in the present study. Average diameter of acetabulum was 48.5 mm and 46.0 mm on the right and left side
respectively (Mukhopadhaya and Barooah 1967) which is nearly the same as seen in our study.

It would be noticed that in the North Indian hip joints belonging to males or females, the average diameter of femoral head is smaller than the average diameter of acetabulum impressing upon the fact that the femoral head is snugly fitted into the acetabulum which is one of the major reasons why primary osteoarthrosis of hip joint is so uncommon in Indians. Various parameters measured had a higher value on left side than right. Chhibber and Singh (1970); Singh (1970); Dogra and Singh (1971) suggest that left limb is dominant. Whether a person is right handed or left handed more people use left lower limb for weight bearing. (Chhibber and Singh 1970). Therefore, the dimensions of the bones forming the hip joint of left side should be more so as to bear greater loading force on femur. Though, in the present study left hip joint dimensions are greater than the right yet they are statistically insignificant. There should not be much of a difference between the sides otherwise everyone would be walking with an abnormal gait! The present study hence provides valuable parameters which would help the forensic anthropologists, orthopaedicians and prosthetists to deliver excellent performance in their respective specialities. It was concluded from this study that the regional variations in the parameters measured do exist when the data of two different countries are considered but within a country there is not much variation. Moreover, in last four decades the dimensions of the bony components of the hip joints studied have not changed much.

References:

Figure 1
Method of measurement of depth of acetabulum.

Figure 2
Method of measurement of diameter of acetabulum.

Figure 3
Method of measurement of diameter of femoral head.