ANALYSIS OF FEMORAL NECK ANTEVERSION IN DRY ADULT BONES: A MORPHOMETRIC STUDY

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ABSTRACT

Introduction: The femoral neck anteversion can be defined as the angle between femoral bicondylar plane and a plane passing through the centre of the neck and head of femur. Adult femoral anteversion has been documented at the range between 7-16 degrees. This angle is widely recognized as an important factor for hip stability. The present study aimed to evaluate the normal anteversion range in adult Indian femur which would be of great help in explorative orthopedic procedures and in designing of hip prosthesis.

Materials and Methods: Study conducted in 202 femurs of 94 male (48 right and 46 left) and 108 female bones (52 right and 56 left). And the angle was measured using Kingsley Olmsted Method.

Observation and Results: The mean value of anteversion angle of femur was 7.61 degrees for male and 12.71 degrees for females. Mean anteversion angle for both male and female femur was 10.37 degrees. Retroversion was observed in 10 femurs (5%) and neutral version was observed in 12 femurs (5.9%).

Conclusion: Determining the anteversion angle is crucial for the diagnostic and therapeutic planning of patients with various pathologies such as hip development dysplasias, cerebral palsy, varum thigh, flat thigh, epiphysiolysis, congenital club foot, congenital dislocation of the hip and other development abnormalities. Statistical analysis revealed sexual dimorphism in anteversion in Indians being greater among females than males.

KEY WORDS: Neck of Femur, Anteversion, Retroversion, Neutral version, Total hip replacement, congenital dislocation of hip.

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and decreases progressively throughout growth [4] due to hereditary factors and local muscle forces, [5]. The average adult femoral anteverision has been documented at the range between 7-16 degrees in multiple skeletal surveys [6].

Anatomists and Orthopaedicians have long been interested in the femoral neck anteversion angle, since it is widely recognized as an important factor for hip stability [7]. There are several methods existing for the measurement of femoral anteverision such as dry bone study, roentgenographic techniques includes fluoroscopy, biplanar imaging, axial roentgenography, axial tomography, ultrasound and CT scanning.

The present study was aimed to evaluate the normal anteversion range in adult Indian femur and to compare it with other studies which would be of great help in explorative orthopedic procedures and in designing hip prosthesis.

MATERIALS AND METHODS

The study was conducted in the Department of Anatomy, Sri Ramachandra Medical College and Research Institute, Sri Ramachandra University, Chennai and SreeGokulam Medical College and Research Institute, Trivandrum, Kerala. A total of 202 adult Indian dried femurs, without any signs of erosion or any gross pathology were studied. The distribution by gender was 94 male (48 right and 46 left) and 108 female bones (52 right and 56 left). The angle of anteverision was measured by Kingsley Olmsted Method [8]. The femur was placed on a smooth level “L” shaped glass board, in such a way that the head is towards the vertical surface and the bone rests on three points namely the posterior aspects of the two femoral condyles and the posterior aspect of the greater trochanter on the horizontal surface. The horizontal surface represents the retro condylar plane. The centre of the head and neck of the femur was determined by using a Vernier caliper. A line was drawn connecting the centre of the head and neck of the femur on the vertical limb of the glass board, the line was extended till it meets the transcondylar plane. All the observations were made at the eye level and two observer method was used to eliminate the parallax error. The angle subtended between the two planes was then calculated using a protractor. The angle obtained by this method was then tabulated and statistically analyzed (fig 1 and fig 2).

**Fig 1:** Anteverision angle of femur

![Fig 1: Anteverision angle of femur](image)

**Fig 2:** Neutral version of femur

![Fig 2: Neutral version of femur](image)

RESULTS

In this study the angle of anteverision was measured in 202 femurs (94 male: 48 right and 46 left; 108 female: 52 right and 56 left).

The mean anteverision angle among males was $7.6 \pm 5.7$ degrees and $12.71 \pm 7.1$ degrees for females respectively.

In this study predominant number of male femurs showed retroversion and neutral version (3.5% each) when compared to the female femurs. Most of the male femurs were in the range of 6-10 degrees (18.8%) while most of the female femurs were in the range of 11-15 degrees (19.3%). Out of the total bones measured, 30.7% of the bones range between 6-10 degrees (Table 1).
The mean anteversion angle of 202 femurs was 10.37 ± 6.99 degrees. Mean anteversion angle for male right bones was 6.69 ± 5.98 degrees and for male left bones was 8.56± 5.46 degrees. The female right bones showed a mean anteversion angle of 11.63 ± 6.23 degrees and the female left bones showed a mean anteversion angle of 13.71 ± 7.76 degrees.

The lowest angle measured was -10 degrees and the highest was 20 degrees. Out of the total bones measured, 30.7% of the bones range between 6-10 degrees (Table 1).

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The highest angle measured was 29 degrees (Table 2). Therefore, left-sided bones had a higher anteversion angle than right side bones in both male and female group.

Multiple comparison of individual groups had the statistically significant difference between female right and male right (P: 0.003), female left and male right (P: 0.00), female left and male left anteversion angles (P: 0.002) (Table 3). Independent t-test between male and female bones had significant difference between male and female anteversion angles (P < 0.05).

**DISCUSSION**

Statistical analysis revealed sexual dimorphism in anteversion in Indians being greater in the females compared to males. A statistically significant difference was found for the angle of anteversion between the male and female femurs. Female femurs showed about 5 degrees higher anteversion angle compared to male femurs. Present study findings are in accordance with the findings of Parsons FG [9], who documented anteversion to be greater in females. Similarly, Kingsley PC et al [8] observed a negligible difference of 0.08 degrees, and Yoshioka et al [6] found a difference of 1°. Nagar Met al [10] conducted study on Indian femur and found greater average angle of anteversion among male femurs compared to the female femur in contrast to the present study and studies conducted by other researchers. Study conducted by Ankur Zalawadia et al [3] showed a similar value (around 1° difference) as that of the present study for the right male and female femurs, the left male femurs had about 5.7 degrees more and the left female bones had about 7.3 degree lesser angle than that of the present study (Table 4).

Many non-operative methods have been proposed (shoe wedges, twister cables, night splints) to treat abnormal anteversion or retroversion of femur. Appearance of increased femoral anteversion less than 8 years of age has to be observed and in 99% has spontaneous regression. This is confirmed by findings of Svenningsen S et al [4] who found that frequencies of in-toeing gait decreased from 30% in 4 years old children to 4% in adults.

<table>
<thead>
<tr>
<th>Researcher</th>
<th>Sample size</th>
<th>Mean angle of anteversion in degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western studies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kingsley PC et al (1948)</td>
<td>630</td>
<td>M-7.94 F-8.11</td>
</tr>
<tr>
<td>Parsons FG et al (1914)</td>
<td>266</td>
<td>M-13.0 F-18.0</td>
</tr>
<tr>
<td>Kate BR et al (1976)</td>
<td>108</td>
<td>M-8.6</td>
</tr>
<tr>
<td>Indian Studies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Present study (2012)</td>
<td>202</td>
<td>M-6.7 F-11.6</td>
</tr>
</tbody>
</table>

**CONCLUSION**

Our study concludes that the mean anteversion angle among females (12.7 ± 7.1) was higher than males (7.6 ± 5.7) among Indian population. The anteversion angle value is crucial for the diagnostic and therapeutic planning of patients with various pathologies such as hip development dysplasias, varum thigh, flat thigh, epiphysiodesis and so on. The knowledge of normal femoral anteversion holds great importance in selection of patients for prosthesis, pre-operative planning for total hip replacement (THR) surgery. Although newer methods using computed tomography (CT) have been shown to be ±1° accurate, there is no universal consensus for locating the femoral neck axis and the femoral condylar axis. Hence estimation of anteversion on dry bone is still considered the most accurate method.

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REFERENCES


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