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# INCREASED FEMORAL ANTEVERSION AND OSTEOARTHRITIS OF THE HIP JOINT

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The anteversion angle (AV-angle) of the femur was measured according to the method of Rippstein in a series of 50 patients with "primary" osteoarthritis of the hip, and in a control group of 30 individuals of the same age without hip disease. The median AV-angle of the hips in osteoarthritic patients was 17.5°, and in the control group 13°. Osteoarthritic patients had a significantly increased AV-angle in relation to the control group ($P = 0.0028$). The greatest AV-angle in the hips of the control group was 25°. In 18 hips of osteoarthritic patients an AV-angle greater than 25° was found. Osteoarthritis was found in 15 of these hips; there was no osteoarthritis in the remaining 3 hips.

Our results lead to the conclusion that increased femoral anteversion is a predisposing factor for hip osteoarthritis. This implies that derotational osteotomy in children can be a prophylactic procedure.

*Key words:* femoral anteversion; hip osteoarthritis

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It has long been an axiom that increased femoral anteversion in adults predisposes to osteoarthritis of the hip joint (Somerville 1957, Weber 1961, Shands 1961, Alvik 1962). However, this relationship has never been proved, and measurements of the angle of anteversion in a large series of patients with hip osteoarthritis do not exist (Jani 1979). In order to throw some light upon this controversial matter, we have studied the femoral anteversion in a series of patients with osteoarthritis of the hip, and in a control group.

## PATIENTS AND METHODS

The study was performed during the period March 1979–March 1981. The osteoarthritic series comprised 50 patients, 26 females and 24 males. They had all been admitted to the Orthopaedic Department because of pain in one or both hips, and functional disability. Their mean age was 65.1 years, ranging from 48 to 81 years. Twenty-seven patients had osteoarthritis of both hips, and 23 patients had unilateral involvement (16 right-sided, 7 left-sided).

The control group comprised 30 individuals with normal hips, 15 females and 15 males. Their mean age was 64.4 years, ranging from 52 to 84 years.

The patients and the control group were examined clinically and radiologically. The following groups of patients were excluded from the study:

1. Patients with previous known hip disease, or acetabular or femoral fracture.
2. Patients who could not be correctly positioned for the X-ray exposure because of insufficient mobility of the hips (patients with less than 90° of flexion, or less than 20° of abduction with the hips flexed to 90°).
3. Patients in which measurements of angles were unreliable because of large osteophytes or deformation of the joint.
4. Patients with CE-angles below 20° (Wiberg 1939).
5. Patients with a femoral head ratio (FHR) above 1.35 (Murray 1965).

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Two radiographic exposures were made according to the biplanar method of Dunlap, as modified by Ripp-stein (1955). All X-ray exposures were monitored by the same experienced orthopaedic radiologist, in order to minimize the error caused by incorrect positioning of the patients. The apparent anteversion angles (AV-angles) and caput-collum-diaphysis angles (CCD-angles) were measured, and the true angles determined by the standard conversion table of angles. The values were measured independently by two of the authors who were familiar with the methods. Most of the values were identical. In cases of disagreement, the X-ray pictures were re-examined by both persons, and the values agreed upon.

The Wilcoxon two-sample test (two-tailed test) was used to calculate the statistical differences between the various groups. Differences were considered significant at $P$-values below 0.05.

## RESULTS

The distribution of all AV-angles is shown in Figure 1. The median AV-angle of the hips of osteoarthritic patients and those in the control group was 17.5° and 13°, respectively (Table 1). The osteoarthritic patients had a significantly increased AV-angle ($P$ = 0.0028). There was no significant difference between the left and the right hip either in the control group or in the osteoarthritic series.

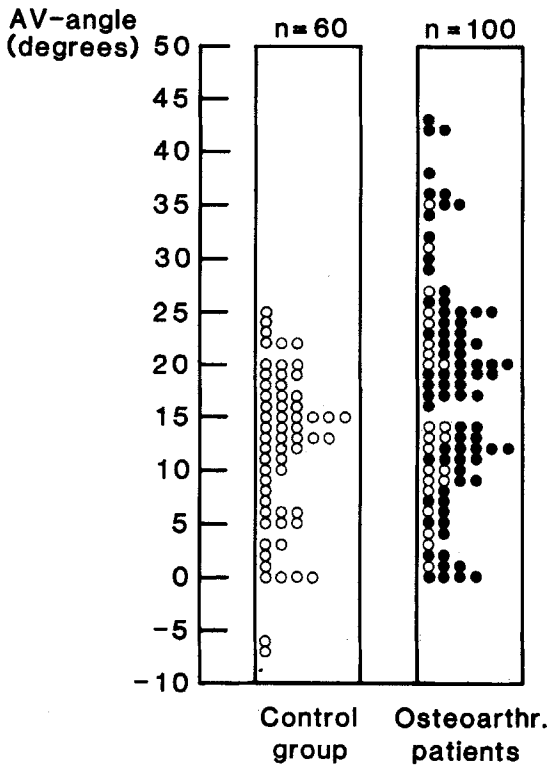


*Figure 1. Distribution of AV-angles in hips in the control group and in osteoarthritic patients. ○ Hips without osteoarthritis. ● Hips with osteoarthritis.*

*Table 1. AV, CCD and CE-angles (degrees) in hips of osteoarthritic patients and the control group*

| | | Osteoarthritic patients $n$=100 | Control group $n$=60 |
|---|---|---|---|
| AV-angle, | median | 17.5 | 13 |
| | range | 0–43 | –7–25 |
| CCD-angle, | median | 128 | 128.5 |
| | range | 115–155 | 112–135 |
| CE-angle, | median | 37 | 39 |
| | range | 20–55 | 28–50 |

*Table 2. AV-angles (degrees) in the hips of osteoarthritic patients divided according to the sex of the patients*

| | Females $n$=52 | Males $n$=48 |
|---|---|---|
| AV-angle, median | 19 | 17 |
| range | 0–43 | 0–34 |

*Table 3. AV-angles (degrees) in the hips of osteoarthritic patients divided according to the age of the patients*

| | Age 48–70 years $n$=68 | Age above 70 years $n$=32 |
|---|---|---|
| AV-angle, median | 19 | 14 |
| range | 0–43 | 0–36 |

Females had a greater AV-angle than males in the osteoarthritic patients, but the difference was not significant (Table 2).

Osteoarthritic patients below 70 years of age had a significantly increased AV-angle, compared both to patients above this age ($P$ = 0.025) and to the control group ($P$ = 0.0004) (Table 3). Patients above 70 years also had a significantly increased AV-angle compared to the control group ($P$ = 0.0032). No significant difference was

*Table 4. AV-angles (degrees) in the hips of osteoarthritic patients divided according to the presence of uni- and bilateral osteoarthritis*

| | Unilateral | | Bilateral |
|---|---|---|---|
| | Involved hip $n=23$ | Uninvolved hip $n=23$ | $n=54$ |
| AV-angle, median | 19 | 13 | 18 |
| range | 2–43 | 1–35 | 0–42 |

found between individuals below and above 70 years of age in the control group.

Table 4 shows the patient series divided into uni- and bilateral osteoarthritis. In unilateral cases, the AV-angle in the involved hip was significantly increased compared to the control group ($P = 0.0070$). A greater AV-angle in the involved hip than in the normal hip was also found, but the difference was not significant. The AV-angle in the normal hip was increased compared to the hips in the control group, but this difference was not significant either. Patients with bilateral osteoarthritis had a significantly increased AV-angle compared to the control group ($P = 0.0068$).

The greatest AV-angle in the control group was 25°. In the osteoarthritic series, 14 patients (28 per cent) had AV-angles above this value in one or both hips. The AV-angle was above 25° in 18 hips, and in 15 of these hips osteoarthritis was found, whereas no osteoarthritis was found in the remaining 3 hips (Figure 1).

Although the CCD-angle was somewhat greater in the patient series than in the control group, there was no significant difference. Neither was there any significant difference in the CE-angle.

## DISCUSSION

Osteoarthritis of the hip joint is usually classified into two groups. The condition is called "secondary" when it is related to a pre-existing abnormality. The commonest causes are congenital dislocation and dysplasia, epiphysiolysis of the femoral head, Legg-Calvé-Perthes disease, infection, rheumatoid disease, and trauma, including medial fracture of the femoral neck and acetabular fracture. In earlier series, from the years before 1960, "secondary" osteoarthritis was found in approximately half of the cases. In the other half no precipitating cause was found, and this type of osteoarthritis is called "primary" or "idiopathic". However, Murray (1965), in a series of 200 patients with "primary" osteoarthritis of the hip, found that in no less than 65 per cent the osteoarthritis was in reality secondary to a pre-existing asymptomatic anatomical abnormality. In 25.5 per cent the cause was found to be acetabular dysplasia, with a pathological CE-angle. In 39.5 per cent the cause was thought to be minor degrees of previous slipping of the femoral epiphysis, which gave the so-called tilt deformity in the X-ray pictures, and a pathological femoral head ratio (FHR above 1.35).

Wiberg (1939) considered a CE-angle below 20° as indicative of acetabular dysplasia, whereas Murray (1965) considered the lower normal limit to be 25°. In our study, we have excluded patients with CE-angles below 20°. Only three patients had a CE-angle between 20 and 25° degrees, and none of them had a pathologically increased AV-angle.

We also excluded patients with a pathologically high FHR. A few patients with borderline values at the recent radiological examination were not excluded, because previous X-ray pictures had shown normal values of FHR. Thus we have excluded all cases of possible previous epiphysiolysis of the femoral head.

In addition we excluded patients with previous hip disease. With these strict criteria, we feel that all patients in this study represent cases of "primary" osteoarthritis according to recent knowledge. But still the differentiation between "primary" and "secondary" osteoarthritis is uncertain. As new knowledge adds new causes which predispose to osteoarthritis, the relative number of cases of "primary" osteoarthritis decreases.

One cause of malfunction of the hip, which is suspected to predispose to osteoarthritis, is a pathologically increased anteversion of the femoral head and neck (Somerville 1957, Weber 1961, Alvik 1962, McSweeny 1971, Zinn 1970). To prove this hypothesis a series of individuals

with increased anteversion should be followed for several decades, to find the frequency of hip osteoarthritis. This has never been done. A more indirect way is to measure the AV-angles in patients with "primary" osteoarthritis and in a control group, as we have done in this study. Two previous reports on this matter seem to give contradictory results. However, neither of the studies was quite adequately performed. In a study of 36 individuals with hip osteoarthritis, pathological AV-angles were found in 41 per cent, compared to 55 per cent in a control group (Zinn 1970). The normal range of AV-angles was considered as 5–20°. The difference was not significant, and no figures were presented for the small group of "primary" osteoarthritis. Halpern et al. (1979) measured the AV-angles in 10 patients with "primary" osteoarthritis of the hip; 9 unilateral and 1 bilateral. In the 11 osteoarthritic hips the mean AV-angle was 24°, compared to 12.11° in the 9 uninvolved hips. They had no control group, and the number of patients was too small to draw any definite conclusions. However, the results suggest that increased anteversion in adults may contribute to later development of hip osteoarthritis. Our results support this view. We found a statistically significantly increased AV-angle in patients with osteoarthritis in relation to a control group of the same age. The greatest AV-angle in the control group was 25°, whereas values above this were found in 18 hips in the osteoarthritic group. In 15 of these hips osteoarthritis was found, and in the remaining 3 hips there was no osteoarthritis. Thus it seems that hips with increased anteversion do not always develop osteoarthritis. On the other hand, most osteoarthritic hips in our study had a normal AV-angle. We think increased anteversion, which is likely to give long-lasting malfunction of the hip, is a predisposing factor for osteoarthritis, but it is not the only factor. The interaction between anteversion and other, still unknown, factors, decides whether or not osteoarthritis will develop.

In the osteoarthritic patients with bilateral disease, and in the involved hip in unilateral disease, the AV-angle was significantly increased compared to the control group. In the normal hip in unilateral osteoarthritis no significant increase was found. These findings support the theory of a relationship between increased anteversion and hip osteoarthritis.

What are the consequences of this relationship? There are no great consequences for individuals who have already developed degenerative hip disease, with the possible exception that in some cases there might be an indication for derotational osteotomy of the femur, if the patients suffer pain and the X-ray pictures show slight or moderate osteoarthritis.

The controversial issue is the question of prophylactic derotational osteotomy of the femur in children. The indications for osteotomy vary. In a recent report it was recommended that the procedure should only be done in a child with persisting severe functional and cosmetic disability, and that it should not be done prophylactically (Staheli et al. 1980). On the other hand, several authors have recommended femoral osteotomy also because of the suspicion that the condition predisposes to later hip osteoarthritis (Somerville 1957, Weber 1961, Alvik 1962). Neither is there any agreement as to what degree increased anteversion spontaneously regresses during childhood. In children with increased anteversion, Fabry et al. (1973) found no significant change in AV-angle after the age of 8 years. The average follow-up time was 5½ years, and only a few children were followed to completion of growth. Another study of children with increased anteversion, in which all were followed up until completion of growth, showed different results (Jani 1979). Spontaneous regression was seen in a large percentage of cases. Furthermore, the regression continued during the growth spurt of puberty. The mean AV-angle was 52° in children below 8 years of age, 44° between 8 and 12 years, and had decreased to 27° after completion of growth.

Thus, there is still no agreement as to what degree increased anteversion regresses, at which age it regresses, and the indications for derotational osteotomy. Our study has shown that pathologically increased anteversion in adults may lead to later development of hip osteoarthritis. This implies that osteotomy in the child can in fact be a prophylactic procedure. However, only further investigations can clarify the correct indications for this treatment.

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