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TWO SOURCES OF ERROR IN MEASUREMENT OF THE ANTEVERSION ANGLE OF THE FEMUR

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Measurement of the so-called anteversion angle of the femur, *i.e.*, the angle formed by the longitudinal axis of the femoral neck and the frontal plane of the posterior part of the femoral condyle in a person in the erect position, has attracted much interest. The angle is said to be normally about 12° in adults and about 30° in newborns. In children with congenital dislocation of the hip or acetabular dysplasia, this angle is often increased and may then be of diagnostic and prognostic importance. Knowledge of the size of the angle is also therapeutically useful because several authors believe that if the angle exceeds a certain value, correction with rotation osteotomy is indicated.

Several methods have been described for determining this anteversion angle roentgenologically. Most of the methods used in Scandinavia are based on the principle that the patient is allowed to lie on an examination table with the lower legs hanging over the edge of the table, the central beam directed vertically. By rotating the femur inwards, it is seen on the fluoroscopic screen or in serial films when the femoral neck is projected to its maximum length on the screen or the film, *i.e.*, when the longitudinal axis of the femoral neck is horizontal. The lower leg, hanging over the edge of the table serves as an indicator: the number of degrees it deviates from the vertical is taken as a measure of the degree of anteversion (figs. 1 A and B).

This examination method is based on two assumptions:

1) that the posterior plane of the condyle in the position in question is horizontal (fig. 1 A).
2) the absence of any substantial instability of the knee joint, flexed at about 90°.

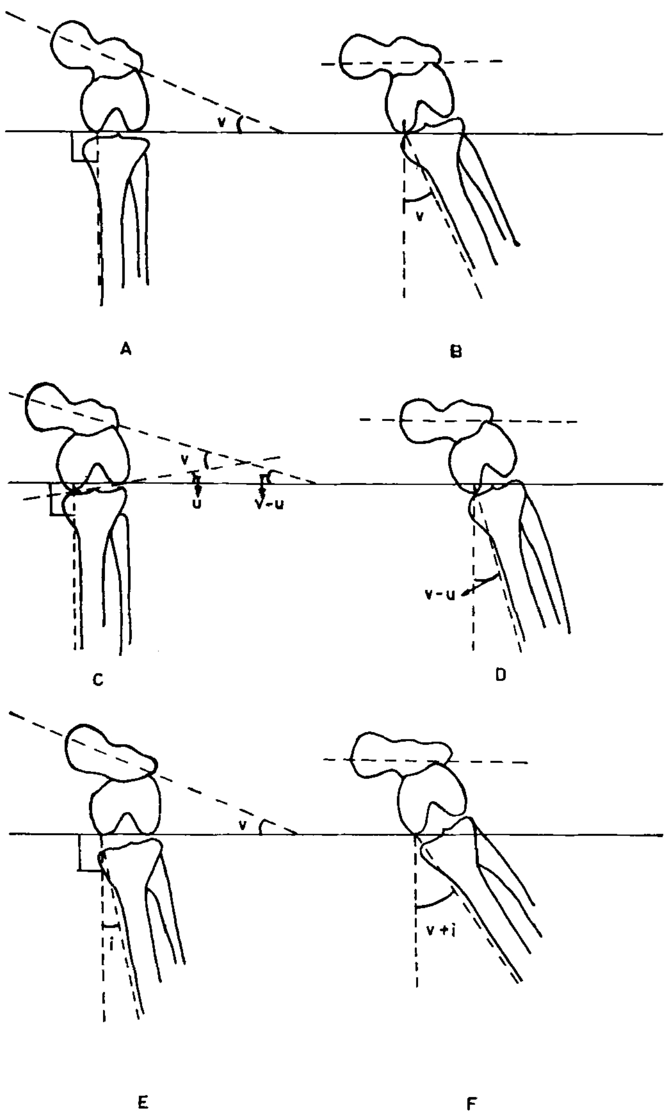

Fig. 1.
A and B show the ideal, theoretical conditions in measuring the anteversion angle (v°); C and D show the influence of the position of the condyles: the line through the condyles forms an angle of u° with the horizontal line and we get a value of the anteversion angle, which is u° smaller than the real one. E and F show the influence of the instability of the flexed knee: we get a value of the anteversion angle, which is i° (see text) greater than the real one.

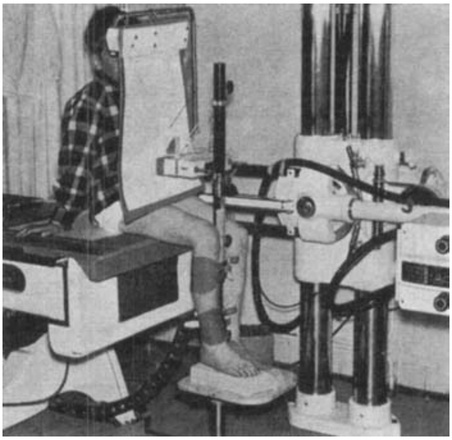

Fig. 2.
The patient on the table, the lower leg fixed, a cassette in the knee fold.

Ad. 1. Fifty males and fifty females were examined roentgenologically under standardized conditions, and the position of the femoral condyles in relation to the horizontal line was determined. The patient was sitting on an examination table with the knees flexed about 90°, the lower leg was vertical (medial tibial condyle and medial malleolus in same vertical line (fig. 2)). The cassette was placed in the knee fold, the roentgen tube was centered upon the joint space. The table was provided with a metal wire, which is projected on to the film and represents the horizontal line.

It was then found that the level of the medial condyle is nearly always lower than that of the lateral condyle. In only 5 of these 100 persons with healthy knees was the medial condyle in the same horizontal plane as the lateral, in the remaining 95 the posterior line of the condyle formed an angle of 1–8° with the horizontal line, on the average 3° in the males and 4° in the females (fig. 1 C). Similar observations were made in 15 children below 12 years.

The angle indicated by the longitudinal axis of the lower leg when the axis of the femoral neck is horizontal is thus not the true anteversion angle (figs. 1 C and D). The true angle is 3–4° greater. Here, then, is a systematic error in the measurement of the anteversion angle by the method described, an error which gives a false low value for the angle.

Ad. 2. When the leg is stretched, the knee is stable. On flexion of the knee, the ligaments are stretched and relaxed according to a complex pattern, but a certain degree of lateral instability of the flexed knee is always demonstrable. I made an examination of the degree of lateral instability of the knee, flexed about 90°.

To fix the femur is difficult; I therefore fixed the tibia and allowed the femur to be movable. See fig. 2. If the patient, illustrated in the figure, for example, is instructed to try to pendulate the fixed foot medially, he contracts the outward rotators of the femur, and the femur rotates outwardly as much as the instability of the knee will allow and the medial joint space is widened. And reversely: if the patient tries to pendulate the foot laterally, the lateral part of the joint space is widened.

When measuring the angle of anteversion, it is the medial widening that is of interest and may influence the result. An example: the starting position is given in fig. 1 A, *i.e.*, the condylar plane is horizontal and the lower leg is vertical. We now allow the foot to pendulate laterally to rotate in the hip and to get the femoral neck horizontal. In the presence of an instability of, say, i° medially, the foot will pendulate laterally i° without any associated movement of the femur (fig. 1 E), not until afterwards does the pendulation of the lower leg become a direct indicator of the rotation of the femur and thereby provide a possibility of measuring the anteversion angle. The angle measured is thus the sum of the true anteversion angle and "the instability angle" (fig. 1 F).

We measure the anteversion angle of hips, which are often painful and their range of movement limited. It appears reasonable to assume that because of the pain the degree of instability is utilized to a maximum before the femur begins to rotate. I have examined 15 children below 12 years for this instability, both laterally and medially. All had clinically normal hips and knees.

The results varied widely, *inter alia,* because of the varying capacity of the children to cooperate, but the slightest medial instability noted, was 2°, and in 2 of the patients it was more than 10° from the starting position. The lateral instability was usually a few degrees more.

Here, too, then, is a systematic error, this time in a positive direction, *i.e.*, the method gives a falsely large anteversion angle.

These two errors partly neutralize one another, but I believe the latter source of error to be so great as to justify the following recommendations:

1. The anteversion angle should not be measured in legs with acute pain in the hip and consequent resistance to movement.
2. Before rotation osteotomy is done, instability of the knee should

be judged clinically or roentgenologically in order to check that the patient does not belong to the type with a marked medial instability of the knee joint resulting in the measurement of a falsely large anteversion angle.

SUMMARY

The author calls attention to two sources of error in measurement of the anteversion angle of the femur, one of which may be of practical importance. When making such a measurement on patients with a painful, fixed hip and/or on patients with marked instability in the knee joint one have to pay attention to this error.

RESUME

L'auteur attire l'attention sur deux sôurces d'erreur dans la mensuration de l'angle d'antéversion du fémur dont l'une peut présenter une importance pratique. Lorsqu'on procède à de telles mensurations chez un malade qui a une hanche douloureuse fixée et/ou chez des malades présentant une instabilité marquée de l'articulation du genou, il faut prendre garde à cette erreur.

ZUSAMMENFASSUNG

Der Verfasser macht auf zwei Fehlerquellen bei der Messung des Anteversionswinkels des Femurs aufmerksam, von denen eine praktische Bedeutung haben kann. Wenn solche Messungen an Patienten mit schmerzhafter, fixierter Hüfte und/oder an Patienten mit ausgesprochener Instabilitet des Kniegelenkes vorgenommen werden, dann muss man diesen Fehler berücksichtigen.

REFERENCES

Billing, L.: Acta Radiol. Suppl. 110, 1954.
Bragard, K.: Zschrift Orthop. Chir., Beilageheft 57, 1935.
Brantigram, O. C. & Voshell, A. F.: J. Bone & J. Surg. *23:* 44–66, 1941.
Hjortsjö, K. H.: Rörelseapparaten, Gleerup, Lund, 1959.
v. Lantz, T. & Wachsmuth, W.: Praktische Anatomi, Springer, Berlin 1938.
Palmer, I.: Acta Chir. Scand., Suppl. 53, 1938.
Platou, E.: J. Bone & J. Surg. *35 A:* 48–54, 1953.
Steels, W. & Mineas, W.: Quart. Bull. Northwest. Univers. Med. School *30*: 43–48, 1956.
Trevor, D.: Proc. Roy. Soc. Med. *51*: 1045–48, 1958.