ANTEVERSION OF THE NECK OF THE FEMUR

A Method of Measurement

D. M. DUNN, BLACK NOTLEY, ESSEX, ENGLAND

In congenital dislocation of the hip it is always desirable to be able to determine how much the neck of the femur is anteverted; it is important because some of the poor results after successful reduction of the dislocation in infancy are due to excessive anteversion leading to redislocation. This might be avoided by a timely rotation osteotomy. Radiographic examination by antero-posterior views with the femur in full medial rotation, neutral position

FIG. 1

Figure 1—Photograph showing the construction of the model used in the experimental radiographs. The angle of anteversion can be altered by twisting the head and neck of the femur on the shaft. The wire seen entering the femoral head indicates the axis of the neck.

Figure 2—Showing how the experimental radiographs were made. The X-ray tube is centred over the upper end of the femur, which is held in any desired position by a clamp. The metal pointer seen on the protractor indicates the true angle of anteversion. The apparent angle of anteversion is shown by the shadow of the wire within the femoral neck. The angle between this and the shadow of the metal pointer indicates the degree of error.

FIG. 2

and full lateral rotation, and by lateral views of the femoral neck, give a very poor idea of the angle of anteversion; in fact clinical examination of the hip is sometimes more accurate. It has been said that the only certain way of determining the angle of anteversion is by operative exposure of the hip.

On studying a femur stripped of its muscles it is soon clear that the angle of anteversion can be judged accurately by directing the eye along the shaft, for other factors, such as length of neck and the neck-shaft angle (coxa vara or valga) which complicate the estimate in antero-posterior and lateral radiographs, are eliminated. The more the eye deviates from the line of the shaft the less accurate the estimate becomes. Unfortunately, in the living patient it is not possible to take radiographs with the ray exactly along the shaft because of overlap of the condyles and soft tissues. Nevertheless, it is possible to take views with the femur only slightly out of line if the thigh is flexed through a right angle, and experiments have been undertaken to determine how accurate these radiographic estimations can be.

EXPERIMENTAL RADIOGRAPHS

A model was made from the right femur of a three-year-old child. The shaft was divided transversely at the base of the neck and a wooden rod was drilled down the long axis of the shaft on which the head and neck could be rotated, a scale graduated in degrees being attached to the shaft to measure the anteversion (Fig. 1). A short wire was driven down the centre of the femoral neck to indicate the axis of the neck in radiographs of the model. Radiographs were made with the neck in various positions of anteversion and the findings were correlated with the true measurements made on the model.

Experimental technique—Lead markers were placed on the film cassette to give horizontal and vertical base lines, and a pointer (seen in Figure 2 and, as the thin line on the films, Figures 3 to 6) was adjusted to indicate on the film the amount of anteversion actually present in the neck in each case. The guide wire in the femoral neck shows as the shorter, wider line (Figs. 3 to 6). The angle between the shadows of the pointer and of the wire in the femoral neck indicates the inaccuracy in the stated positions of the femur. This angle

FIG. 3
Experimental results. Effect of variations in centring.

is the only significant thing in the interpretation of these experimental radiographs. Lateral displacement of the lines only indicates that the marker was placed too far to the left or right on the cassette. There is an appreciable experimental error because of the difficulty in deciding what is the long axis of the curved femoral shaft. In all cases the central ray was vertical and the film horizontal beneath the femur; the head of the femur was towards the film, and the condyles towards the tube (Fig. 2).

Effects of varying specific factors. *Centring*—With the femur vertical, exposures were made with the tube centred: 1) over the head; 2) two inches medial to the head; and 3) four inches medial to the head. In each case films were made first with 30 degrees and then with 60 degrees anteversion (Fig. 3). Centring two inches medial to the head makes little difference to the film; this indicates that it is reasonable clinically to centre over the midline and to examine both hips together.

Abduction—With the tube centred two inches medial to the head views were taken with the femur upright, abducted 10 degrees and abducted 20 degrees—in each case with increasing degrees of anteversion (Fig. 4). It will be seen that with no abduction the method is accurate and that even with 20 degrees abduction a fair estimate can be made. With the femur abducted 30 degrees or 45 degrees the error is gross, especially when the angle of anteversion is great.

FIG. 4
Experimental results. Effect of minor variations in abduction.

FIG. 5
Experimental results. Effect of wide abduction.

FIG. 6
Experimental results. Effect of variations in flexion.

FIG. 7

FIG. 8

Clinical method. Photographs showing position of tube, cassette and hips. It is important that the tibiae and the edge of the cassette be held parallel with the midline of the body.

FIG. 9

FIG. 10

Clinical radiographs. Figure 9—Congenital dislocation, with 80 degrees anteversion, left hip. (The crescentic dark shadow represents opaque fluid injected into the joint.) Figure 10—After rotation osteotomy, left femur; note overcorrection. (Because of the depth of the superimposed soft tissues contrast in the clinical radiographs is inevitably poor.)

Thus with 90 degrees anteversion the film indicates anteversion of only 55 degrees (Fig. 5). These views are equivalent to lateral views of the femoral neck.

Flexion—If the femur is flexed more than a right angle the apparent anteversion is diminished; if it is flexed less than a right angle the apparent anteversion is increased (Fig. 6).

Conclusions—Centring medially to the head of the femur and abducting the shaft make the amount of anteversion appear less than it actually is, an effect which is more marked the greater the actual degree of anteversion. Too much flexion has a similar effect, especially in the smaller ranges of anteversion. Too little flexion is the only error in positioning which would give an apparent increase in anteversion, again mainly in the smaller ranges.

CLINICAL METHOD

Radiographic technique—The following method is based on the experimental findings, and can be expected to be reasonably accurate. The child lies supine with the hips and knees flexed 90 degrees, the legs being held by an assistant. The film cassette is placed beneath the pelvis, the tube centred over the upper border of the symphysis pubis and each leg abducted 15 degrees from the midline, as measured with a protractor. It is important to make sure that

TABLE I
CONVERSION TABLE

Angle measured on radiograph (degrees)	Addition needed (degrees)	True angle (degrees)
30	0	30
40	5	45
50	10	60
60	15	75
70	20	90

the film cassette, the pelvis and the tibiae are parallel to the long axis of the body before the exposure is made (Figs. 7 and 8). If the tibia is not parallel to the side of the cassette the femur, and with it the femoral neck, is rotated, and there will be no base line from which to measure the anteversion on the radiographs. It is easier to be sure the cassette is in line with the tibiae than to get the pelvis exactly placed.

Interpretation of the radiographs—On the dried film the midline of the femoral neck is marked and the angle this makes with the lower edge of the film is measured. This is the uncorrected angle of anteversion of the neck of the femur. The angle the neck shadow makes with the shaft shadow is of no significance. With the method described the apparent angle of anteversion as measured on the radiograph will be slightly less than the true angle: as the true angle increases the error increases. The additions shown in Table I should, therefore, be made to the angle as measured on the radiograph to obtain the true angle.

I wish to thank Mr Ruddick for the clinical photographs and Miss Alice Huber for unfailing patience in making the experimental radiographs.