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KNEE INSTABILITY

An Orthoradiographic Study

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An orthoradiographic method for preoperative assessment of mediolateral instability and varus/valgus deviation in gonarthrosis is presented. A special definition of the varus/valgus deviation is given. The examination technique has been tested on 15 young, healthy subjects with no clinical signs or symptoms in their knee joints. To test the accuracy of the method, seven of the subjects were re-examined at a later date.

Key words: knee instability; measurement; orthoradiographic method; normal subjects

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In the operative correction of valgus or varus deformities in gonarthrosis by means of wedge osteotomy, the size of the wedge is generally determined by some form of preoperative radiographic examination. A common technique is to take a frontal view of the knee on a large film, usually 40 cm in length. The exposure is usually made with the patient standing so as to obtain a picture of the leg in a "functional" position. Normally there is a valgus deviation between the axes of the femur and tibia of approximately 7° and the aim of corrective osteotomy is to restore this value (angle). This method is open to criticism on several counts, the most serious of which is that the film does not show the whole leg. This is likely to introduce errors in the measurement due to inaccurate placing of the axes of the femur and tibia and to inexactness in the estimation of the normal angle between the femur and tibia in the individual patient.

There is a better method which uses a special film (usually 90 cm in length) long enough to include the whole leg from the hip joint to the ankle with the patient standing (Leger 1960, Weinreich 1961, Oest & Sieberg 1971, Spirig 1967). A line can now be drawn on the film from the centre of the femoral head to the centre of the ankle joint. It is generally believed that this hip-ankle line should pass the centre of the knee in the middle of the intercondylar eminence. Any deviation from this is recorded as a varus or valgus deviation according to whether the line passes medially or laterally to the centre of the knee. This method enables a more accurate evaluation to be made, but it is necessary to use a technique that will ensure a correct exposure for the various thicknesses of

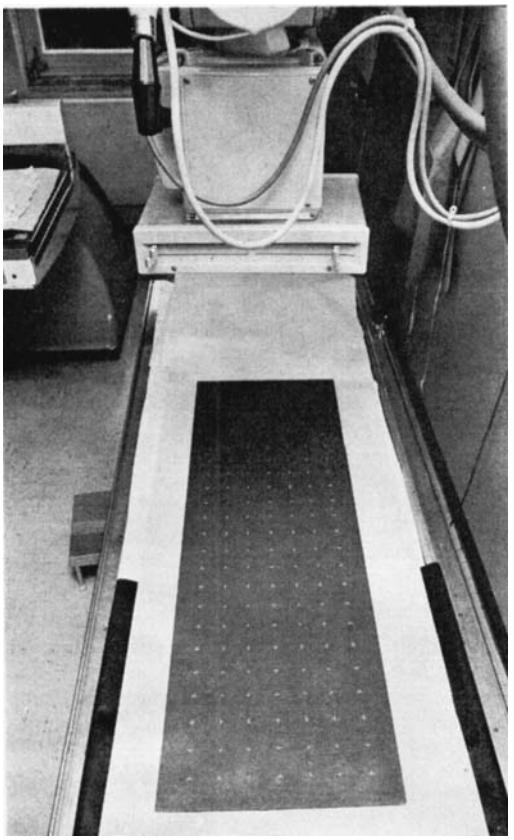


Figure 1. The co-ordinate grid placed on the investigation table.

the leg. For this purpose some kind of compensating filter has to be used.

Both methods suffer from the disadvantage that if there is medio-lateral instability of the knee, the joint will not always assume the same position when loaded. Moreover, no impression of the magnitude of the medio-lateral instability is obtained. Therefore, we have worked out a method for preoperative examination in gonarthrosis, that includes determination of both the varus/valgus deviation and the medio-lateral instability.

METHOD

In true orthoradiography the image should be produced by parallel rays. This has the advantage over the usual divergent projections that distances parallel to the plane of the film are not enlarged and can therefore be measured directly on the film. In radiographic projections an attempt is usually made to reduce the divergence of the rays as much as possible by using as large a focus-to-film distance as is consistent with the conditions for the examination. Another advantage of the orthoradiographic projection is that the image of three-dimensional objects does not suffer from the distortion present in images produced by divergent projections. A number of techniques have been designed that are in some respects orthoradiographic, but none gives a truly orthoradiographic projection.

The aim of our method is to obtain orthoradiographic projections of individual points on the leg by using three ordinary projections, centred over 1) the centre of the femoral head, 2) the centre of the knee and 3) the centre of the

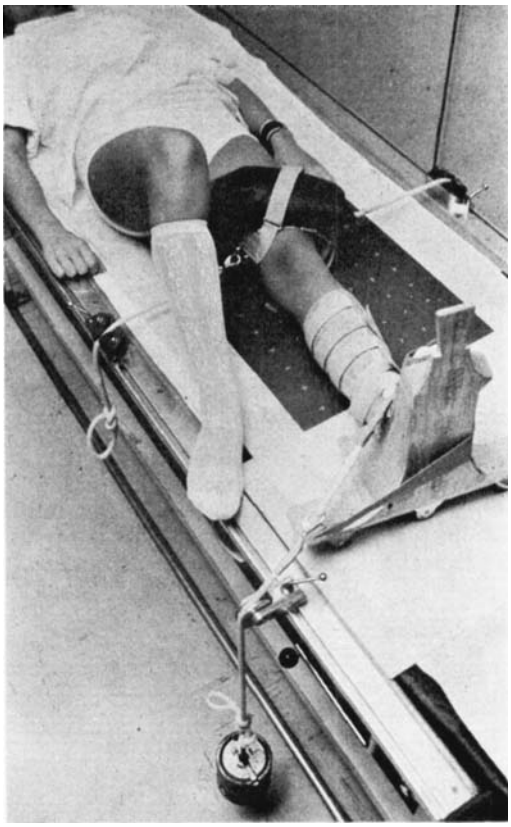
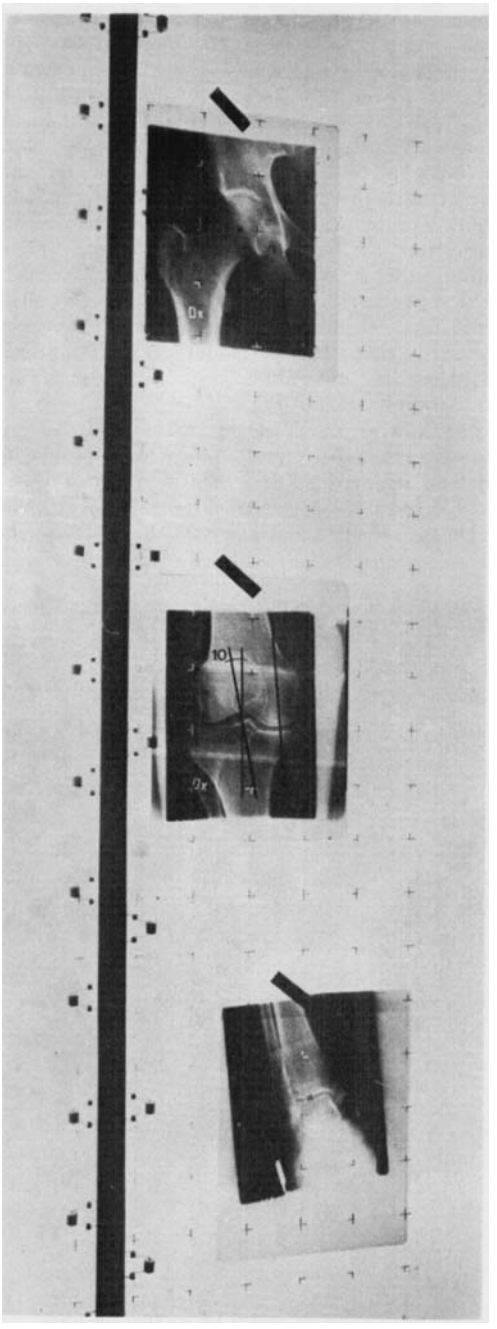


Figure 2. The patient in place on the co-ordinate grid. The foot is placed in the boot-like device and the varus position is induced with a 5 kg weight seen in the lower part of the picture.



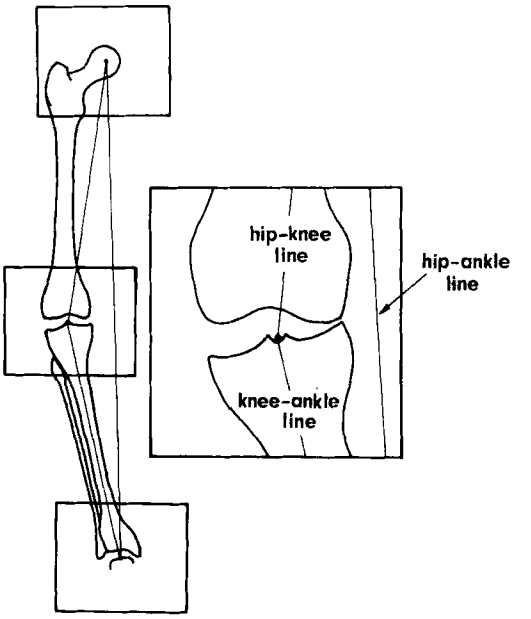


Figure 3. Left. The three films from the varus-induced position in place on the model of the grid for measurement. Above. Drawing showing the three lines between the three reference points.

ankle joint. Each projection is recorded on a separate film. A co-ordinate grid made of radio-translucent material with readily identifiable symbols has been constructed (Figure 1). This grid is placed under the patient's leg and is depicted at the same time as the points of measurement on the separate films. We have called our technique three-point measurement and it is performed in the following manner.

The patient is placed on the grid on an examination table. The knee is bound to the table with a tight bandage round the lower part of the thigh, and the thigh is secured with two cords that are fastened to sheet clips fixed to the edges of the table. A 10 kg weight is placed over the knee to keep it in the extended position. The foot and lower leg are held in a boot-like device mounted on a movable plate, furnished with wheels, which allows varus and valgus deviations of the knee joint. Under this plate a sheet of glass is placed to reduce friction. A cord from the boot is placed medially over a pulley and loaded with a 5 kg weight in the varus-inducing position (Figure 2). In this position three separate projections are taken with the orthoradiographic technique, one each over the centres of the femoral head, the intercondylar eminence and the ankle joint. The weight and the cord are then moved to the lateral side, the valgus position is induced and three more films are exposed. The two sets of three films are then placed on a full-scale

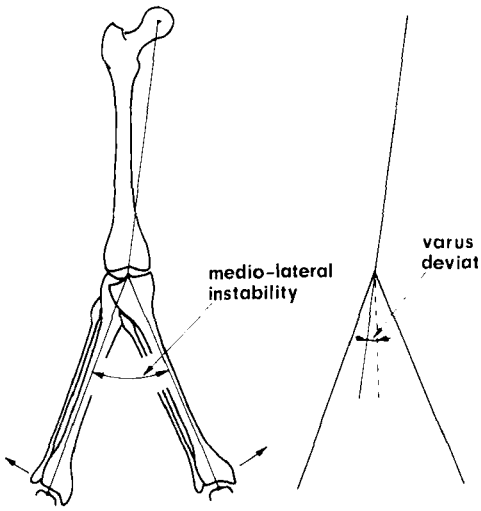


Figure 4. Drawing showing the measurement of the medio-lateral instability and the deviation of the knee.

model of the grid, and lines are drawn between the three reference points (Figure 3). On each of the two films of the knee three lines are drawn: *the hip-ankle line* from the centre of the femoral head to the centre of the ankle, *the hip-knee line* from the centre of the femoral head to the centre of the tibial eminence, and *the knee-ankle line* from the centre o fthe eminence to the centre of the ankle. The medio-lateral instability is measured as the angle through which the knee-ankle line has moved in relation to the hip-knee line between the two measurements. The varus or valgus deviation of the knee is defined as the angle between the hip-knee line and the middle position of the knee-ankle line, i.e., the bisector of the instability angle. If this bisector makes a medial deviation, it is regarded as a varus deviation, and if it makes a lateral deviation, it is a valgus deviation (Figures 4 and 5). The value of this deviation is used when determining the size of the wedge for corrective osteotomy (Edholm et al. 197?).

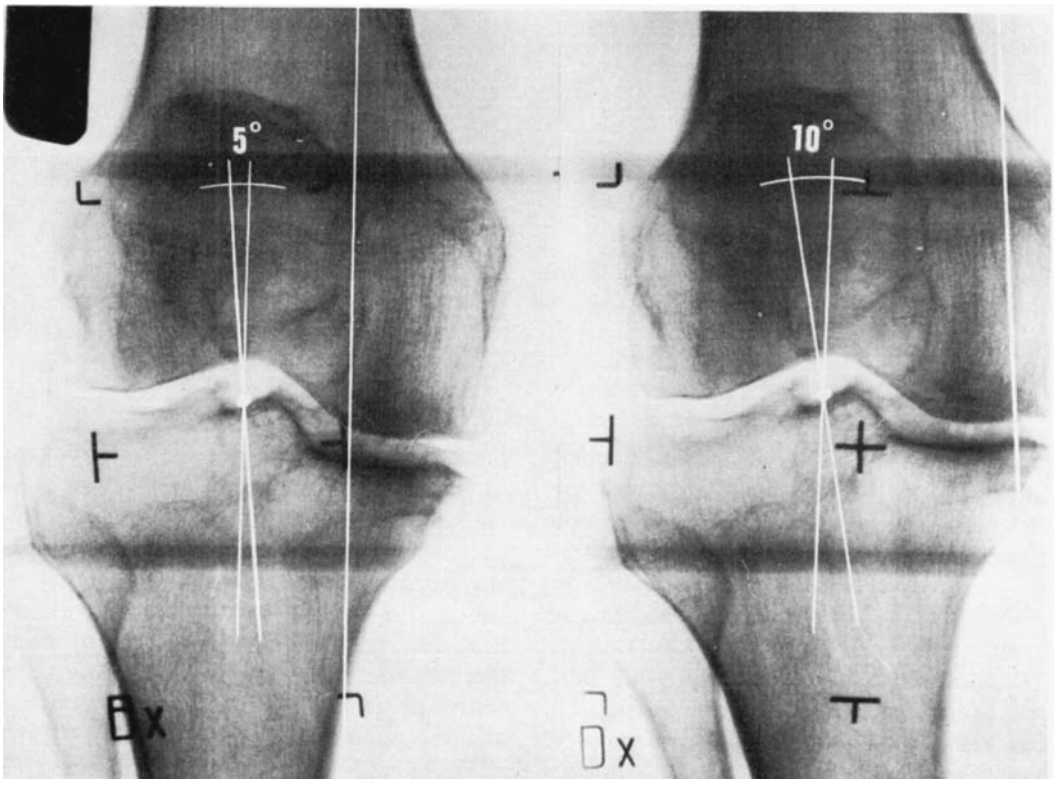


Figure 5. The knee films with the lines drawn. The medio-lateral instability is 5°. The deviation is 7.5° varus.

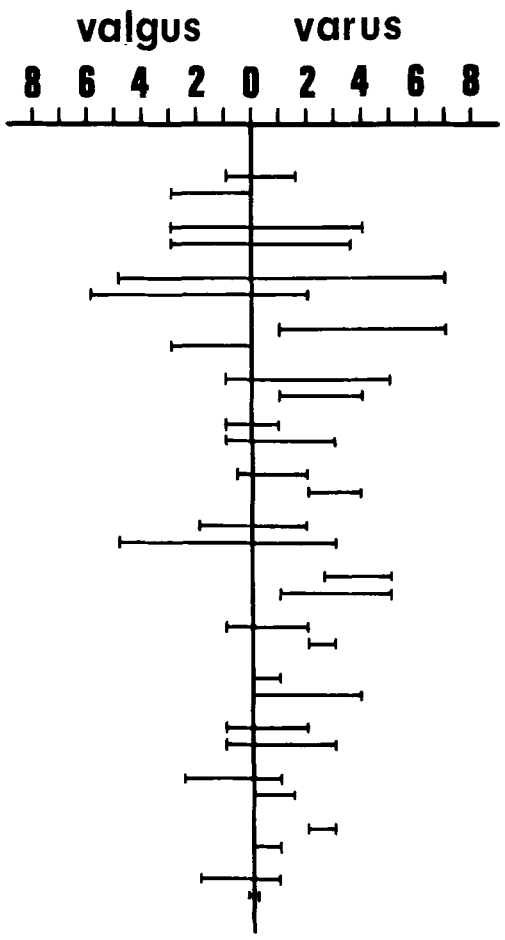


Figure 6. The medio-lateral instability of the 15 subjects.

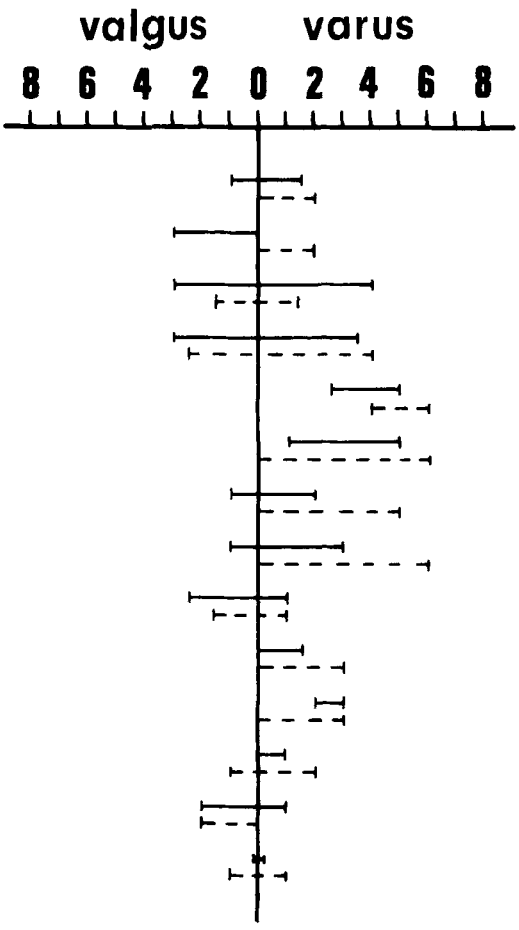


Figure 7. The medio-lateral instability of 14 knees examined on two different occasions. The second examination is represented by broken lines.

SUBJECTS AND RESULTS

In order to test 1) the examination technique, 2) the normal instability of the knee and 3) the hypothesis that the hip-ankle line normally passes through the intercondylar eminence, 15 young healthy subjects with no clinical signs or symptoms in their knee joints were examined with this technique on both knees, i.e., 30 knees were investigated. The results are presented in Figure 6. The results showed that the medio-lateral instability varied between 0° and 12°, with a mean value of 3.7° (standard deviation 2.6°, standard error of the mean 0.5°). The varus/valgus deviation as defined above varied between 1.5° valgus and 4.0° varus with a mean value of 0.9° varus (standard deviation 1.5°, standard error of the mean 0.3°). This small mean value of 0.9° varus means that the hypothesis that the hip-ankle line on the average passes through the centre of the eminence may be considered as confirmed.

To test the accuracy of the method, seven of the subjects (i.e. 14 knees) were re-examined at a later date. The results

of the two examinations are compared in Figure 7. The greatest difference in medio-lateral instability was 4°. The mean differnce in instability between the two occasions was 1.5°. The greatest difference in the measurement of the varus/valgus deviation between the two occasions was 2.5° with a mean value of 0.9°.

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