TYPES OF DISPLACEMENT IN FRACTURES OF THE FEMORAL NECK

and Observations on Impaction of Fractures

PER LINTON, GÄVLE, SWEDEN

From the Service of the Central Hospital, Gävle

In fractures of the femoral neck there may be displacement of different types accounting for the well recognised abduction and adduction fractures with valgus and varus displacement (Nyström 1938). Between these types there is a transitional form that was described by Waldenström (1924) as the "fracture impacted in adduction" and by this author as "the intermediary type" (Linton 1944). The title intermediary fracture, which was intended to emphasize the mid-position of displacement between abduction and adduction, has been criticised because the term "medial fracture" has already passed into general use as an indication of the level of injury in the femoral neck, a medial fracture being the equivalent of an intracapsular fracture. In the German language intermediary fractures would be described suitably as Übergangsfrakturen, but it is difficult to find a comparable term in English. This type of displacement is of great significance, and insufficient attention has been paid to it in the literature. The fact that it does indeed exist calls for emphasis.

Figure 1 illustrates the displacements in five fractures of the femoral neck. It is evident, from this manner of presentation, that they form a graduated series. All radiographs in the upper row have been taken in the frontal plane and they range from the first, which shows no displacement, to the second which shows valgus displacement, the third which shows the intermediary position, the fourth in which there is an incipient varus position, and finally to the fifth in which there is such varus displacement that the fragments have slipped apart. An increasing degree of outward rotation of the femoral shaft is evident in the progressive prominence of the lesser trochanter. The lateral projections, illustrated in the lower row, show clearly how this recurvation has increased steadily as we progress from the first to the fifth type. These radiographs, selected from different patients, and showing in each case the primary displacement, illustrate different stages in the displacing movement beginning with a valgus position and passing, under increasing recurvation, into a varus position.

In adduction fractures the fragments are not actually in varus relationship to each other. The fact is that the peripheral fragment is rotated outwards, round the longitudinal axis of the femur, while the neck is directed forwards so that the femoral head lies on its posterior aspect. This is shown in Fig. 2. All outlines in the upper row show the femoral shaft in an unchanged position; displacement of the femoral head occurs progressively backwards and downwards on the posterior aspect of the neck. This dislocating movement is the same as in Fig. 1, though the projection of the pictures is different. Thus, neither the term "adduction fracture," nor "varus fracture," can be considered adequate if it is intended to denote the mutual position of the fragments.

In a review of 323 fractures of the femoral neck in which the direction of original displacement was known and analysed by this writer (Linton 1944), forty-seven were abduction fractures (14.6 per cent.), twenty-eight were intermediary fractures (8.6 per cent.), and two hundred and forty-eight were adduction fractures (76.8 per cent.). That these three types of fractures, each with different displacement, were due to different types of injury is often assumed, and if we are to judge from the literature such a conception is widely entertained. Nevertheless, it is probably incorrect and the assumption has been made too readily. In support of this contention, which was first discussed in the author's article of 1944, certain observations may now be made.

184 THE JOURNAL OF BONE AND JOINT SURGERY
Types of displacement in fractures of the femoral neck

Fig. 1
Radiographs of a series of fractures of the femoral neck (the upper row frontal plane, the lower row lateral plane), the first two representing "abduction fractures," the third an "intermediary fracture," and the last two "adduction fractures." In fact, each represents an increasing degree of displacement arising from the same type of injury.

Fig. 2
Progressive displacement of the fragments during the dislocating movement.

Type of injury causing fracture of the femoral neck—It is often believed that differences in the position of the bone fragments as disclosed by radiography are due to different forms of injury. But other factors than the direction of force may play a part—namely the degree of violence and the degree of resistance of the skeleton. It is quite conceivable that valgus or varus relationships of the fragments may be attributable much more to the violence of injury, and the degree of resistance of the skeleton, than to the direction of the force of injury.

It is recognised that a direct blow to the hip joint may cause any of the fractures that have been described, and that after such injury the frequency of the various types of
displacement is the same as in the whole series. In other words, the type of displacement does not depend necessarily on the direction or type of violence.

Moreover it is difficult to believe that serious displacement of the fragments should depend essentially on the application of lateral rotation strain. When a patient falls on his hip joint, it is more than likely that the limb will be flexed at the knee joint so that rotation strains may not be transmitted to the hip. Nor, in such circumstances, does the position of the pelvis undergo any noteworthy change by which the trunk would be rotated more constantly in one direction than another. The explanation should be sought in the capacity of the femoral head to move in the acetabulum in response to compression by the posterior corticalis of the femoral neck. It seems probable that the pelvis and shaft of the femur maintain their mutual relationship, and that displacement of the fragments arises solely by reason of rotation of the ball-shaped central fragment of the femur. The fact that the limb lies in lateral rotation when the patient is admitted to hospital is a secondary consequence; and it does not follow that such displacement indicates the type or direction of the initial violence. The terms abduction and adduction fracture, or the equivalent terms valgus or varus fracture, cannot be regarded as suitable.

**Changes in the type of displacement of femoral neck fractures**—Certain abduction fractures, while under observation, have changed in their position and thereafter shown the typical displacement of adduction fractures (Figs. 3 and 4). It is thus evident that one type of fracture may pass readily into the other. Moreover, adduction fractures, at the time of reposition, pass through all the stages shown in Fig. 1 though in the reverse direction. Some patients have been admitted to hospital with a history of being able to move the limb actively, and even to walk for several days after injury, who suddenly complained of increased pain and loss of ability to walk. On admission there has been evidence of a fracture of the adduction type which would not permit easy walking or active movement. It must be assumed that these were cases of abduction or "intermediary" fractures in which displacement increased and thereafter became of the adduction type.
Study of a specimen of intermediary fracture of the femoral neck—The post-mortem specimen of an intermediary fracture in which there was good contact between the femoral head and neck shows that two fragments were broken from the corticalis without being displaced (Fig. 5). Study of this specimen leaves little doubt that the violence must have ceased at that moment, and that incipient displacement of the fragments was never completed. Such breaking of the posterior corticalis of the femoral neck may, conceivably, take place in many cases but pronounced displacement occurs only when splintering and comminution is still more complete. Perhaps this splintered part, which often takes the shape of an inlet in the posterior region of the neck, might be described as a passage delved by the head in the course of displacement of the fragments.

Mean age of patients with abduction, intermediary, and adduction fractures of the femoral neck—The mean age of patients who sustain abduction and intermediary fractures is lower than that of patients who sustain adduction fractures. The difference is fairly marked, and it is statistically significant. This must be interpreted in terms of the greater power of skeletal resistance at younger ages so that at these ages the degree of displacement is arrested at an earlier stage.

Relative stability of abduction and intermediary fractures of the femoral neck—In abduction fractures the position is usually stable, and the degree of displacement does not increase after the initial injury has been sustained. On the other hand, intermediary fractures are less stable; and this is in accord with the thesis that is being put forward. In intermediary fractures the degree of injury is greater than in abduction fractures, and it is not surprising that displacement should often increase until the typical appearance of an adduction fracture is reproduced. Intermediary fractures are therefore seldom seen; they accounted for no more than 8.6 per cent. of this series of 323 fractures of the femoral neck.

Summary—In summing up it may be said that various displacements in fractures of the femoral neck are in fact due to the same injury, and that different types of fracture are due to different degrees of displacement. The displacing movement begins with the femoral head in slight abduction or valgus, and it ends when the head is on the posterior aspect of the femoral neck in adduction or varus; the displacements are the consequence of a single rotatory movement of the head.
THE TRUE SIGNIFICANCE OF SO-CALLED IMPACTION OF FRACTURES

Returning to Figure 1 we see that a series of fractures of the femoral neck with increasing displacement appears to show impaction in the first three cases and failure of impaction in the last two. The question that arises is why the first three types of fracture should ever have been considered to be "impacted." There is, of course, overlap of shadows in the radiographs—the appearance described by Nicole (1939) as Konturüberschneidung. It is often assumed that such radiographic appearances indicate impaction, with hitching of the corticalis into the spongiosa at one or several places. But this is probably untrue. In general, such an appearance indicates no more than close contact between the fragments with limited breaking of bone tissue in one region, so that there is exact correspondence between displacement and compression. These three factors—displacement, compression, and contact, are intimately connected; but the primary factor is displacement.

There is much to be said in favour of the assumption that impaction, in the sense of interlocking of the fragments, does not exist. A valgus fracture of the femoral neck with so-called impaction may be displaced by the simple process of inserting a three-flanged nail. In the specimen shown in Figure 5 there is obviously no real impaction despite the radiographic appearances that suggest it. This is confirmed in the illustrations of the same case, Figures 6 to 8. It is often assumed, because a patient can move his limb actively without pain, or even walk on it, that there is impaction; but this is to jump to a conclusion—and it may well be that the explanation lies in the fact that displacement is not yet sufficient to cause loss of stability.
The assumption that there is impaction depends usually on close contact between the fragments, moderate compression of bone tissue, and reasonable stability in response to physiological demands—all these depending on the fact that the degree of displacement was limited by the resistance of the bone in relation to the degree of injury. The so-called "impacted fracture" differs from no other fracture; it is sustained in the usual manner—but there is some degree of stability because displacement is limited and there is compression of bone tissue with contact between the fragments. In short, an impacted fracture is no more than the first stage in a movement which, if it continues, will give rise to a more displaced fracture.

So-called "impaction" may also be observed in fractures at the upper end of the humerus, lower end of the radius, upper and lower ends of the tibia, and in the vertebral bodies. Limitation of displacement in fractures near the ends of long bones is often due to mobility of the adjacent joint—there is no long lever and, within certain limits, the articular fragment can follow movements of the longer fragment. Since displacement is limited, the characteristics attributed to "impaction" are reproduced.

Such fractures have in common the possibility of treatment with minimal external fixation, or even with early mobilisation and weight-bearing. But it should be borne in mind that an "impacted" stable fracture with but little displacement, after perhaps an unnecessary reposition, can develop into a labile fracture which presents great difficulty in maintenance of reduction (Linton 1949).

SUMMARY

1. Various types of fracture of the femoral neck represent different stages of one and the same displacing movement.
2. The displacement first produces an "abduction fracture" and terminates in an "adduction fracture," passing through the stage of an "intermediary fracture" which is less well recognised.
3. These three types of fracture occur in response to the same injury and they differ only in the degree of displacement.
4. It is a mistake to believe that in "adduction fractures" the femoral head lies medially to the collum: it lies posteriorly.
5. "Impaction" is no more than the first stage of displacement of fractures in which there is limited displacement, with contact still maintained between the fragments.
6. An "impacted fracture" is not necessarily stable—if there is additional strain it may progress to the next stage of a displaced and unstable fracture.
7. These principles apply not only to fractures of the femoral neck but to all other fractures at the ends of long bones.

REFERENCES

LINTON, Per (1942): Stabilitet och labilitet i frakturer (Summary in French). Nordisk Medicin, 13, 891.