FROM THE ORTHOPEDIC CLINIC (VANFÖREANSTALTEN) in GÖTEBORG
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NAILING IN SITU OF SLIPPED PROXIMAL EPIPHYSIS OF THE FEMUR

By

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In 1938 *Wilson* published his method of nailing a slipped epiphysis in the hip joint. As he pointed out, closed reduction had given poor results, improving the situation only slightly if at all in most cases and incurring considerable danger of injury to the joint. *Waldenström* also warned against this form of treatment, stating that attempts at closed reduction caused necrosis of the epiphysis in one out of five cases. It is the general experience that mild displacement of the epiphysis in relation to the femoral neck causes only insignificant functional disturbance. For this reason *Wilson* concluded that it was best in the mild cases to confine treatment to the prevention of further slipping. In his opinion, the deformity could be accepted without any misgiving for the future as long as the epiphysis had not slipped farther than a third the diameter of the femoral neck. In nine cases in which the slipping had not exceeded this limit, he drove a nail through the femoral neck until its point entered the epiphysis, and thereby attached the epiphysis to the neck. He used a three-flanged *Smith-Petersen* nail for this purpose. The results were good in all nine cases, the first of them treated three years prior to his report. Nailing has the advantages of being an extra-articular method of fixation and, in *Wilson*'s experience, it also accelerated the fusion of the epiphysis with the neck without causing any significant shortening of the limb.

The nailing method was introduced into Sweden the same year (1938) by *Waldenström*. *Waldenström* said that if experience showed that two years after operation the patients limped only slightly, that movements in the hip were painless and restricted only by the deformity itself and that roentgenograms revealed no injury to the joint, the treatment should be adopted generally. Further trials showed that

the method fulfils the requirements of *Waldenström*, provided it is carried out with the proper technic.

Today nailing seems to be the routine treatment for mild slipping of the upper femoral epiphysis in most places. In Sweden, *Johansson*'s method with a cannulated nail and a guiding wire is generally used. *Wiberg* has described in detail how this method can be employed for the nailing in situ of a slipped epiphysis. *Wilson*'s limit for applying the method, viz., that the epiphysis must be in contact with at least two-thirds the width of the femoral neck, is still valid. *Waldenström* recommended the same in 1938, i.e., nailing of grades I and II according to his classification.

However, though *Wilson*'s method is generally accepted in principle, the actual technic of operation still admits of improvement in several respects.

Howorth used his "pegging operation" in many cases with good results. Comparing it to nailing he said that nailing incurred a greater danger of damage to the hip "especially if the nail has to be driven in more than once, if it is driven in too far, or if it does not remain wholly within the neck in its course to the head." This gives a good idea of the difficulties of nailing, and to his list can be added a fourth point: if the epiphysis is driven away from the neck by the nail.

The disadvantages of the broad three-flanged nail are obvious. In the case of fractured femoral neck the whole transverse area of the neck is at the disposal of the surgeon for inserting the nail, but only the dorsal section of it in the case of slipped epiphysis (*Waldenström*). The farther the epiphysis has slipped, the smaller the transverse section of the neck in contact with the femoral head. This disadvantage can be counteracted to a certain degree by introducing the nail farther ventralward on the femur. When this is done, however, the nail has to be inserted obliquely through the cortex, and then it is more difficult to direct.

The point of the nail should be directed toward the thickest part of the epiphysis, where it gets the best hold and where there is the least risk of it perforating into the joint (Wiberg). Then it can easily happen, however, that the broad three-flanged nail comes against the posterior cortex of the femoral neck on its way through it. When this happens the nail is apt to veer off in another direction than the guide, with the result that the guide is bent in front of the point of the nail and becomes difficult or impossible to draw out in the ordinary way. Conflict between the guide and the nail (Fig. 1) may arise for other reasons, too, as for example when the hole of insertion runs extremely obliquely through the cortex. It may be difficult to extract the nail

from this position. Worse still, once a *Smith-Petersen* nail has gone astray in the limited area available for good nailing, it is very difficult to get it on the right path. When this broad nail has to be inserted more than once, the spongy tissue is damaged and likewise the blood supply to the epiphysis (*Wilson*).

In two of *Wiberg*'s cases the femur fractured on a level with the head of the nail some time after the operation. Our series of 23 hips

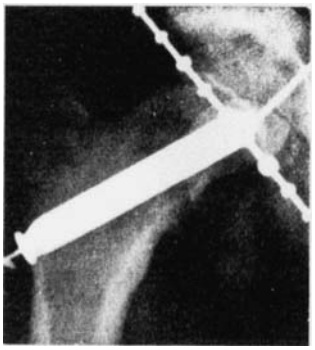

Fig. 1.
Nailing of slipped epiphysis in a 15 year old boy. The cannulated three-flanged nail went its own way, bending the guiding wire, which could not be extracted until the nail had been withdrawn.

nailed with three-flanged nails contains another instance of this post-operative complication. It is true that all three fractures occurred in connection with considerable trauma, but there is no question that the femur was weakened by the nailing. Probably too much of the cortex had been chiselled away by the insertion of the three-flanged nail.

Wiberg observed avascular necrosis of the epiphysis around the point of the nail in 1 out of 36 hips nailed with the three-flanged nail. He wondered whether it had been caused by the femoral neck having been damaged by the nail which first took the wrong direction into the posterior cortex, or by the point of the nail having come too near the articular cartilage on the renailing. He left the question open. The same case was mentioned by *Jerre*. One thing is certain, that partial necrosis of the epiphysis often occurs around the point of a nail which has been driven in too far. The roentgenographic methods usually used to guide the nail are not exact enough and have often caused mistakes.

Another occasional sequel of nailing is the separation of the epiphysis from the femoral neck. As far as I can make out, the first instance of this complication was described by *Wilson* (1949). In a series of over seventy cases of „minimal deformity" he had one case of ava-

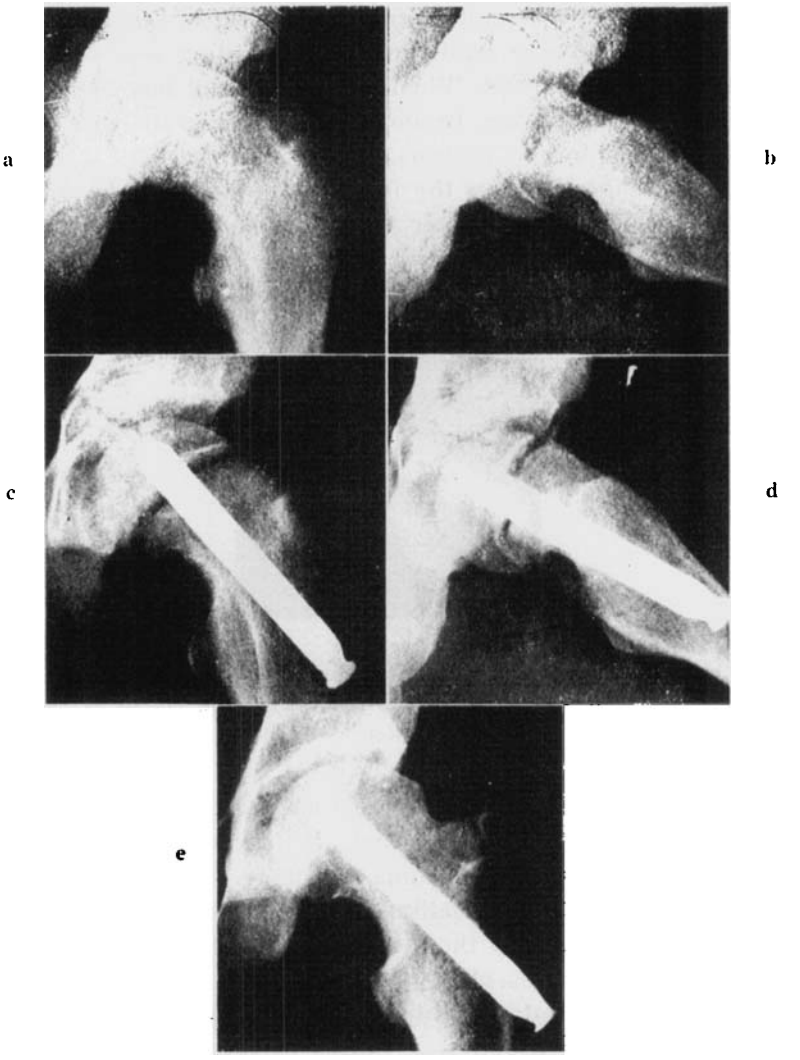

Fig. 2.
a–b. Slipped epiphysis in a 15 year old boy. c–d. Separation of the epiphysis from the femoral neck by nailing. e. Three years later. The epiphyseal line is closed. No necrosis of the head.

scular necrosis due to the epiphysis having been driven away from the neck when the nail was introduced. In one of *Jerre*'s five cases a diastasis one centimeter wide occurred on the nailing; nothing was done about the separation in this case, and the epiphysis did not become necrotic. Diastasis occurred in one (Fig. 2) of our 23 nailed cases. Study of the cases of nailed slipped epiphysis from the Children's Hospital (Barn-

sjukhuset) in Göteborg revealed that separation of this kind occurred in 3 out of 17 hips. A three-flanged nail was used in these cases[1]. Adding the aforegoing figures, we find that the epiphysis was driven away from the neck in no less than 6 of approximately 115 hips nailed with the three-flanged nail. Even though the epiphysis became necrotic in only one of these 6 cases, the others healing without incident, there is obviously a large risk of the epiphysis becoming malnourished when this happens.

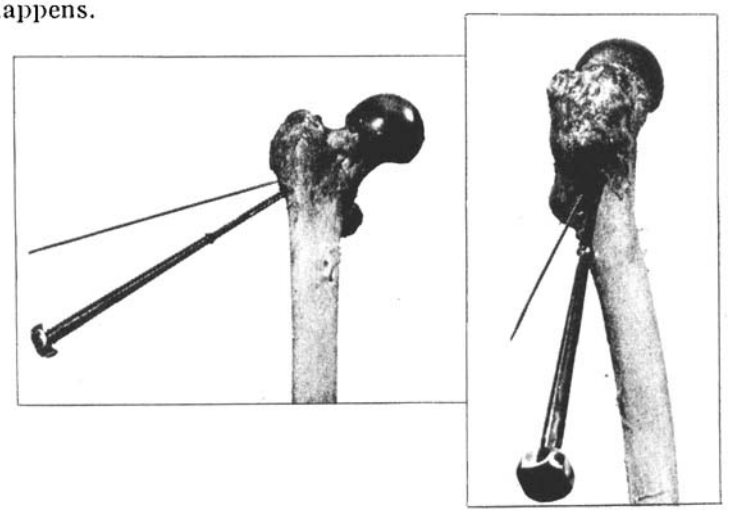

Fig. 3.
Fixation with a *Nyström* nail. A guiding wire and a *Nyström* nail are inserted. The handle can easily be unscrewed from the nail.

Separation of this nature must come from the fact that the point of the nail has difficulty in penetrating the epiphyseal plate and the hammer blows cause the neck to slide out onto the nail instead. The chances of this can be reduced by making the nail thin and sharp. The risk of separation is a strong argument against the use of coarse nails for fixing the epiphysis. Should separation occur, it is best to close the gap by driving in the nail farther until its tip reaches the desired place in the epiphyseal plate. Then it should be drawn back the width of the space with a screwing extractor. When the extractor presses on the femur the diastasis is closed before the point of the nail begins to retract from the epiphysis.

The aforementioned drawbacks are mostly due to the coarse type of nail used and to the difficulty in obtaining reliable roentgen pictures during the operation.

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[1] I was permitted to make this study through the courtesy of the head surgeon at the Children's Hospital, Dr. *G. Pettersson* and the roentgenologist, Dr. *H. Larsson.*

At both *Waldenström* and *Wiberg* pointed out, only slight force is necessary to keep a slipped epiphysis in a certain position. The opposing surfaces of bone in question are large and uneven. Consequently, it should be possible to use a less clumsy type of nail with a smaller contacting surface than the *Smith-Petersen* variety. Other surgeons have advocated various kinds of pins and wires. We use the *Nyström* nail. This nail has several advantages. It is slender but inflexible and is sharply pointed. It requires only a small hole in the cortex to insert it and it is shaped so that it is easy to hammer in. This reduces the risk of bruising the epiphysis and likewise the risk of driving the epiphysis away from the femoral neck. The nail is so slender that there is good room for it in the section of the neck most suitable for nailing. Finally, it has a long handle firmly screwed on which makes it easy to direct. If it is hammered in wrong, there is plenty of room left to insert it again.

Nailing of slipped epiphysis in the hip joint requires a roentgenographic method which tells exactly what path the nail is taking through the neck and where the point of the nail is in the epiphysis. The roentgenographic method usually used for nailing is not satisfactory (*Billing*). This is especially true when it must be decided at the operating table whether the tip of the nail has penetrated far enough to perforate the epiphyseal cartilage, i.e., the cartilaginous plate between the head and neck, but not so far that it touches the surface of the femoral head. The difficulty has been to get good lateral pictures in which the epiphysis is projected free and clearly visible throughout its width. This difficulty has been surmounted by a method worked out by *Billing*. Billing takes the views of the head and neck perpendicular to one another, both with the rays directed ventro-dorsally. For taking the lateral view it is necessary to have the leg outwardly rotated and the knee flexed. This can be done safely in the case of epiphyseal slipping if the surgeon guards himself from entering the joint with the guiding wire or nail. *Billing*'s projections, which are mathematically defined, are selected so that the rays enter parallel with the plane of the epiphyseal cartilage in the lateral picture. This brings the cartilage into sharp relief and the position of the nail in relation to the cartilaginous plate can be judged with complete certainty.

Surgical technic (Figs. 3, 4, 5).— The patient is placed on a traction table with his hip rotated slightly inward, generally about 20 degrees, so that the femoral neck lies on a horizontal plane. The lateral surface of the trochanteric area is exposed. A small hole is made in the cortex and through it a guiding wire is introduced three or four centimeters. To prevent it from getting in the way of the nail afterward, it is wise

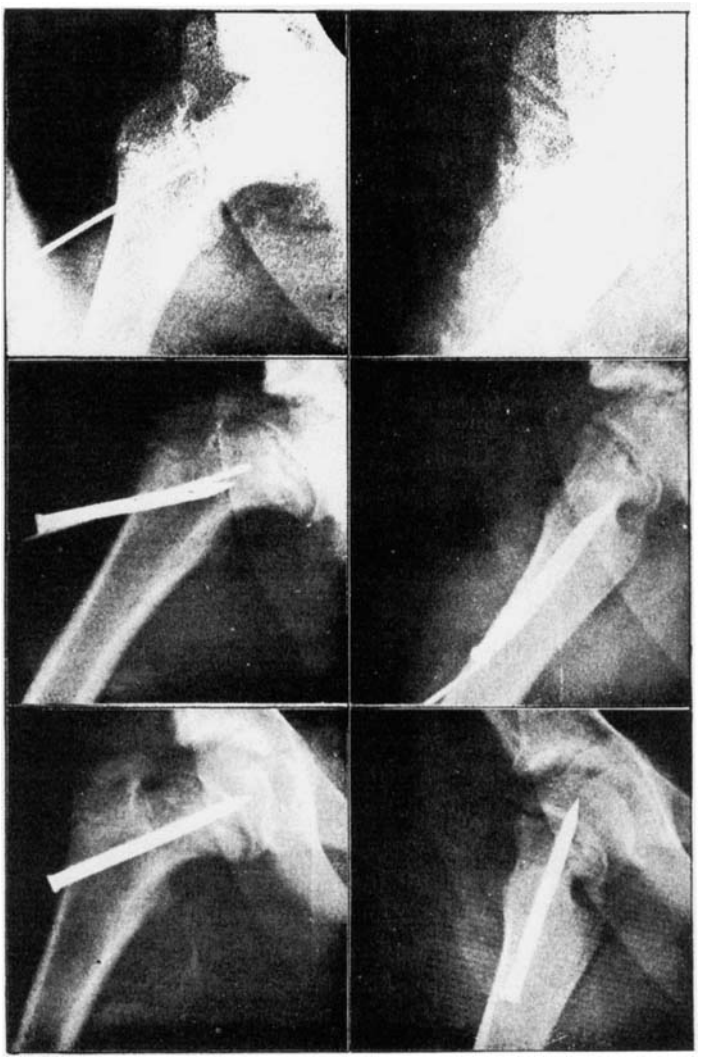

Fig. 4.

a–b. Nailing of slipped epiphysis in an 11 year old girl. The guiding wire is located too far dorsally in the femoral neck. c. The nail is driven in pointing more caudally than the guiding wire and d. ventral to the wire. e–f. It is driven home penetrating the epiphyseal cartilage but not reaching the articular surface of the epiphysis.

to insert it about a half a centimeter cranial or distal to what is considered to be the ideal position. If the epiphysis has slipped to the extent where nailing is just possible, the nail should afterward be introduced more ventrally than for the nailing of fracture of the femoral neck, so that it can reach the center of the epiphysis without coming into conflict with the dorsal cortex of the femoral neck. When the wire

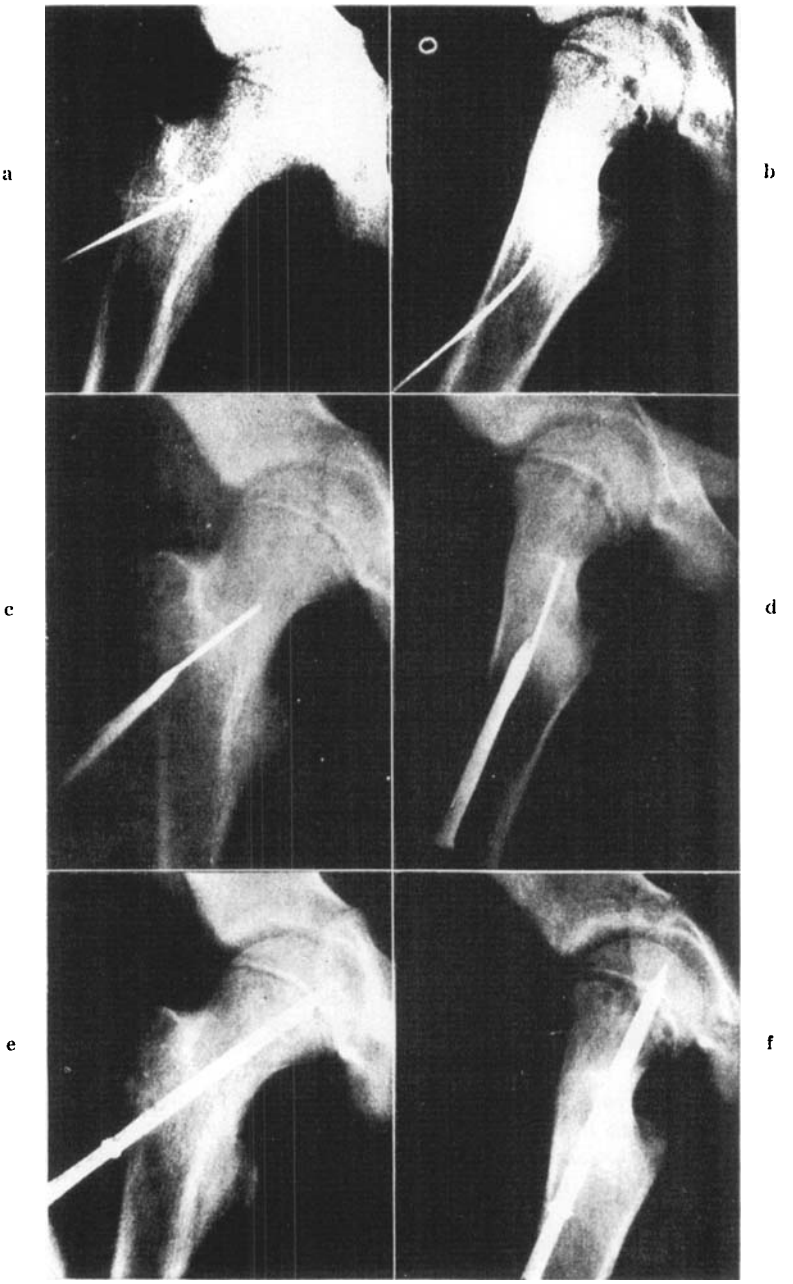

Fig. 5.

a–b. Nailing of slipped epiphysis in a 15 year old boy. The guiding wire points too far caudalward but is otherwise well situated. c. The nail is driven in pointing more to the center of the epiphysis. d. Lateral view where it is still parallel with the wire. e–f. The nail has been driven home into a good position. It has penetrated the epiphyseal cartilage but not reached the articular surface.

is inserted, roentgen pictures according to the *Billing* method are taken. As mentioned, provided the wire has only been inserted three or four centimeters, the leg can be moved to the position necessary for the lateral picture without any risk. It can be seen at once from the pictures exactly how long a nail is required and in what direction it should be inserted. If the wire is inserted satisfactorily, a *Nyström* nail is driven in parallel with it. If a change is needed in the direction, the angles of correction can be measured directly on the roentgen pictures and transferred to the field of operation where the projecting part of the guide and the nail with its long handle form two easily measured sides of an angle. The nail is then driven in until it is reckoned that its tip is about one centimeter from the goal. Two more roentgen pictures are then taken to check the position and the nail is driven home. If the surgeon is experienced, the operation can be shortened by driving in a *Nyström* nail directly, leaving out the preliminary insertion of a guiding wire. The position of the nail is checked after it has been inserted three or four centimeters and, if it is correct, the rest of the operation is performed without delay. If it is necessary to alter the position of the nail, a guiding pin is screwed on in place of its handle, and this first nail is used as a guide during the rest of the operation.

We used this method of nailing in ten cases of slipped epiphysis and found it so advantageous that we intend to continue testing it. Time will show whether the slender *Nyström* nail provides sufficient fixation. As yet we have not observed any postoperative slipping. Nor has there been any separation of the epiphysis from the femoral neck or any epiphyseal necrosis. However, our cases are few in number and have only been observed a short time, the first having been nailed a year ago. In one case the nail had moved 7 mm. laterally three months after the operation, though it did not lose contact with the epiphysis. It was driven in again and the fixation ensured with a screw inserted across its head. It may have been a technical fault that caused it to slip, for first a nail was driven home in the right direction but it proved to be too long and was exchanged for a shorter one. If the *Nyström* nail shows a tendency to slip in other cases, we shall have to consider measures to ensure its fixation.

SUMMARY

A good method for treating slight slipping of the epiphysis in the hip joint is nailing *in situ*. The broad three-flanged nail generally used for this purpose has a number of disadvantages which can be reduced

or eliminated by using a slender and more pointed nail. One nail of this type, the *Nyström* nail, gave such good results in ten cases that further trial is recommended. The author describes his method of nailing. The nailing must be done under reliable roentgenographic guidance, and the method worked out by *Billing* is advocated for the purpose.

RESUME

Une bonne méthode de traitement du léger glissement de l'épiphyse dans l'articulation de la hanche est l'enchevillement *in situ*. Les clous à 3 larges ailes généralement utilisés dans ces cas présentent un certain nombre d'inconvénients qui peuvent être limités ou éliminés par l'emploi d'un clou plus mince et plus pointu. Un clou de ce type est le clou de *Nyström* qui a donné de tels résultats dans un petit nombre de cas qu'il est recommandé de suivre cette piste. L'auteur décrive la méthode d'enchevillement. Celui-ci doit se faire sous contrôle roentgenographique sûr et la méthode élaborée par *Billing* est avantageuse à cet égard.

ZUSAMMENFASSUNG

Eine gute Methode der Behandlung eines leichten Abgleitens der Epiphyse im Hüftgelenk ist die Nagelung *in situ*. Der breite dreilamellige Nagel, der zu diesem Zwecke meist angewendet wird, hat gewisse Nachteile, die man verringern oder ausschalten kann, indem man einen schlankeren und mehr zugespitzten Nagel verwendet. Ein Nagel dieser Art, der *Nyström* Nagel, gab so gute Resultate in einigen Fällen, dass weitere Erprobung anbefohlen wird. Der Verfasser beschreibt seine Nagelungsmethode. Die Nagelung muss unter verlässlicher röntgenologischer Überwachung ausgeführt werden. Die von *Billing* entwickelte Methode wird für diesen Zweck anbefohlen.

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