FROM THE ORTHOPAEDIC CLINIC OF KAROLINSKA INSTITUTET. STOCKHOLM. CHIEF: PROF. S. FRIBERG

ON COMPLICATIONS FOLLOWING NAILING ARTHRODESIS OF THE HIP-JOINT

BY

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Arthrodesis of the hip-joint is constantly one of the most gratifying operations, which is extensively used in severe cases of arthritis deformans. At first mainly intra- and juxta-articular arthrodesis were performed, but more recently an increasing variety of nailing arthrodeses has been devised and practised. It was hoped that absolute fixation would both relieve the uncomfortable postoperative symptoms and encourage earlier and firmer bony consolidation.

In order to reach a proper understanding and a reliable evaluation of the results of the different nailing procedures, a study has been made of cases operated on over the years 1938-46. Table 1 shows the distribution of the cases. (Table 1.) It includes cases which in the same period had partial or total intra-articular arthrodesis combined with juxta-articular arthrodesis.

The nailing arthrodesis have been followed by both early and late complications, and an attempt is made in the present paper to estimate the incidence of these from a study of the postoperative courses of the cases who had nailing arthrodeses during the period 1938-46: cases operated in the second half of 1946 and in 1947 have been excluded from the series in order to allow a minimum period of 6 months for observation.

90 patients have had 95 operations; 5 patients had a second operation. At the beginning of the series simple transarticular nailing arthrodesis was used, but the frequent occurrence of gradual slipping of the nail had to be recognised. These cases

usually had only a short period of immobilisation, or none at all. In order to prevent the nail from slipping we began, during

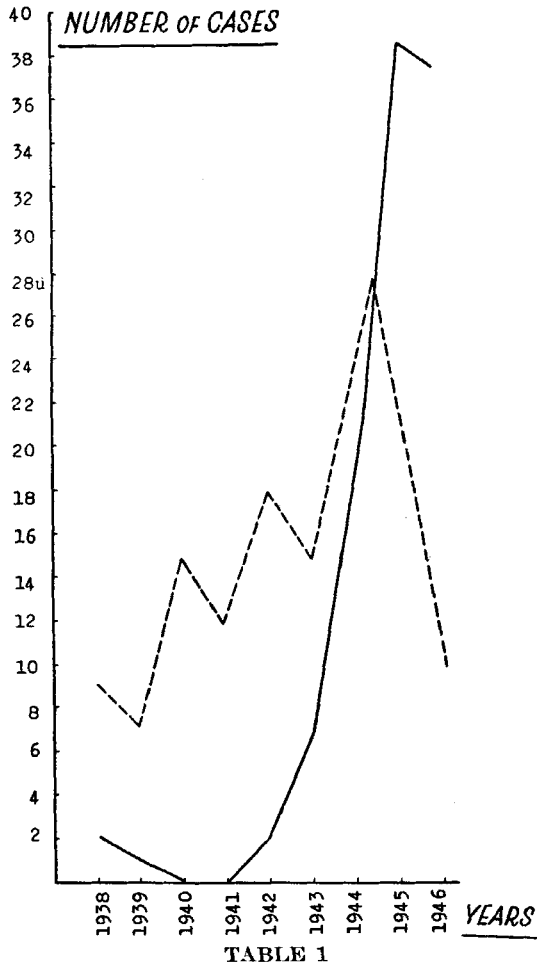

TABLE 1

——— Nailing arthrodeses.

..... Partial and Total Intra-articular Arthrodeses combined with Juxta-articular bone-grafting.

the latter half of 1944, to use indented or fenestrated nails, whose length varied from 14-17 centimetres. (Fig. 1.) This device

certainly counteracted the tendency of the nail to slip, but it introduced another complication, namely fracture of the nail. Consequently simple transarticular nailing arthrodesis has been advocated and practised less and less, and has been replaced by

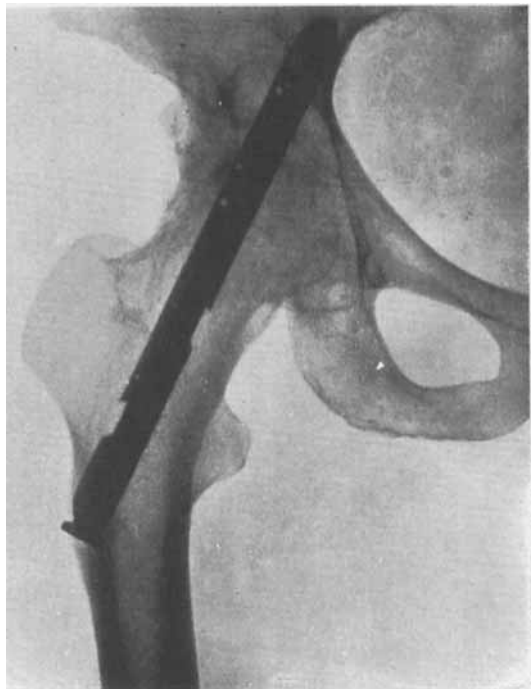

Fig. 1.
Roentgenogram taken 11 months after combined hip-nailing, showing total bony ankylosis obtained with indented and fenestrated nail.

transarticular nailing combined with intra-articular arthrodesis, except in rare instances in which there was either very bad position of the hip, or poor general condition of the patient, when subtrochanteric osteotomy combined with intramedullary transarticular nailing was used. (Fig. 2.) The former procedure must be considered as a major operation, while the latter is relatively minor.

The following complications have occurred:—death, thromboembolism, infection, paralysis, slipping of the nail, fracture of the nail and fracture of the femur.

Death was the more or less direct result of operation in

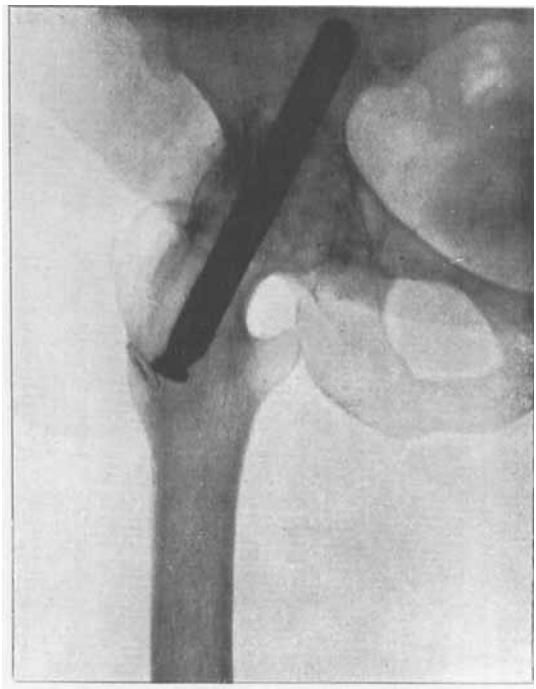

Fig. 2.
Bony ankylosis after subtrochanteric osteotomy + intramedullary transarticular arthrodesis.

5 cases; one had had a simple transarticular nailing arthrodesis, and 4 had had transarticular nailing combined with total intra-articular arthrodesis. In the first case death was due to pulmonary embolism, which occurred less than a month after operation; of the other 4 deaths, one was due to fat embolism, one to pulmonary embolism, and two to circulatory failure (combined in one case with an infected haematoma). This represents a mor-

tality rate of 5.3 % of operations (5/95) or 5.6 % of patients (5/90).

Thrombus embolism occurred in 9 cases, with death by pulmonary embolism in two: thus the frequency of this complication

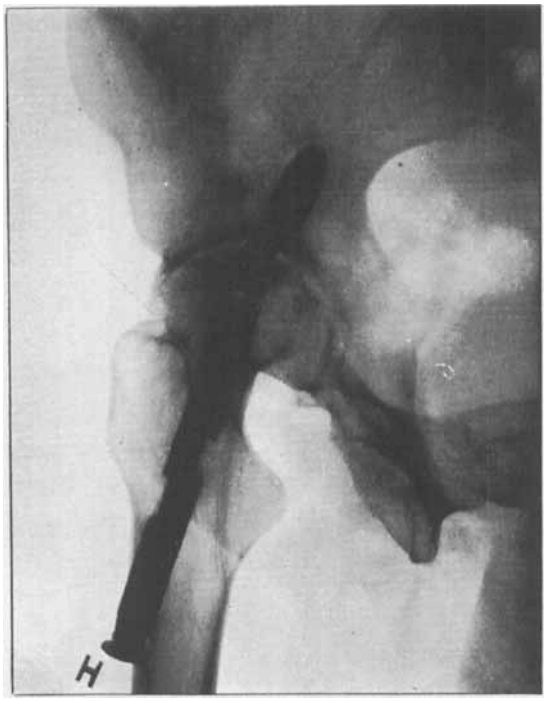

Fig. 3.

Transarticular nailing arthrodesis by means of an indented nail which fractured near the centre of the Caput 3 months after opeartion, during plaster immobilisation. Fracture of the nail at the level of the indented portion. End-result: No ankylosis.

was 10 % of patients or 9.5 % of operations. One of these cases was operated upon in the period before prophylaxis against the onset and spread of thrombosis was adopted; while in the remaining 8 cases either preliminary antithrombotic measures had not been prescribed, or the AP treatment (which was the method

used) was unsuccessful as judged by the fall obtained in the plasma prothrombin concentration.

Infection occurred in one case after transarticular nailing with intra-articular arthrodesis. The nail was removed and,

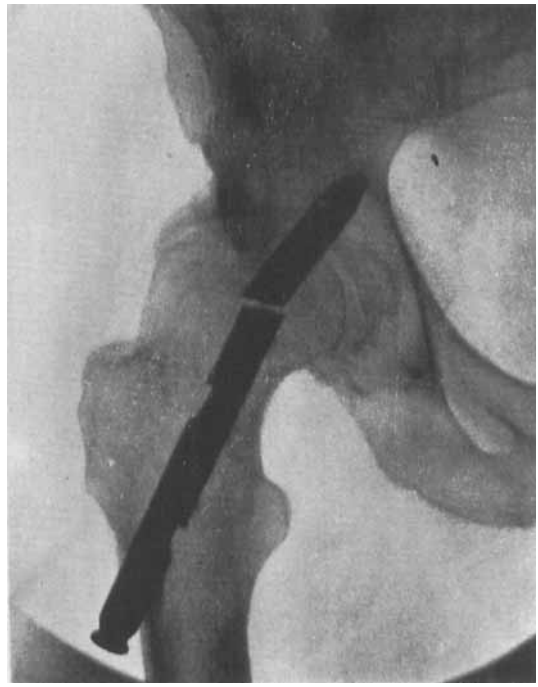

Fig. 4.

Transarticular nailing arthrodesis by means of an indented and fenestrated nail. Fracture of the nail near the centre of the Caput, 6 months after operation. The nail is fractured at the level of one of its small fenestrations. End-result: Fibrous ankylosis.

after a final sequestrectomy, there was fibrous ankylosis of the hip-joint at the last examination.

Peroneal paralysis was seen at follow-up examination in 2 patients: in 1 the paralysis was bilateral and temporary, in the other it was unilateral and left a permanent paralysis of the tibialis anterior.

The local complications inherent in nailing arthrodesis, i.e. slipping of the nail, fracture of the nail, and fracture of the femur, are of greater interest than are the more general complications. As already stated the arthrodeses in the first part

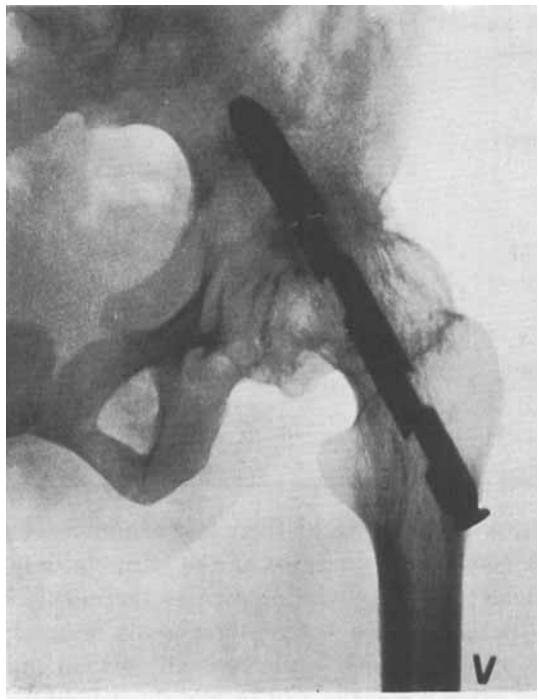

Fig. 5.
Bony ankylosis 23 months after combined nailing arthrodesis. The operation had produced a gap of 1 centimetre. Fracture of the nail at the level of the joint line in spite of bony ankylosis.

of the period covered by this investigation were simple transarticular nailing arthrodeses, followed by little or no postoperative splinting or rest in bed. In this technique stainless steel 3-flanged nails, 14-17 centimetres long, were driven through the neck of the femur up into the acetabular roof, where a penetration of 3-4 centimetres was aimed at, when the nail was hammered home. After 18 such operations, no less than 8 showed

TABLE 2

Results with Respect to ankylosis in 94 Nailing Arthrodeses Performed.

Operative method	Number of Operations	Results			
		Bony Ankylosis	Fibrous Ankylosis	No Ankylosis	Deaths
Transarticular Nailing Arthrodesis:	46	14	20	11	1
Intra-articular Arthrodesis + Transarticular Nail (Long):	23	16	3	3	1
Intra-articular Arthrodesis + Transarticular Nail (Short):	17	9	4	1	3
Osteotomy + Intramedullary Transarticular Nail:	8	7	1	—	—
	94	46	28	15	5
		48.9 %	29.8 %	16 %	5.3 %

slipping of the nail. However, at their last examinations, 3 of the cases showed bony union in spite of the slipping, and 1 had a fibrous ankylosis; in the remaining 4 cases there was no ankylosis. In 1 of the cases with bony union more than a year had elapsed after operation before the nail slipped, in another the same occurred after 3 months and in the third between 2 and 4 months after operation. In the 5 cases, with slipping of the nail and without bony union, the interval before slipping could be detected varied from ½ to 3 months; in 4 cases it occurred while the hip was still immobilised in plaster.

As already mentioned, steps were taken to prevent the nail from slipping out of its track by indenting the nail flanges, and later by fenestration with small holes gouged out in such a way as to weaken the nail as little as possible. But, as has already been stated, though these devices entirely achieved their object, i.e. prevented the nail from slipping, they gave rise to another complication, namely, fracture of the nail. Indented nails, and

TABLE 3

Results with Respect to Ankylosis in 89 Cases treated by Nailing Arthrodesis. In the Cases Re-operated upon, the Patient is Graded as Belonging to the Late Operation Used.

Operative method	Number of Operations	Results			
		Bony Ankylosis	Fibrous Ankylosis	No Ankylosis	Deaths
Transarticular Nailing Arthrodesis:	43	14	20	8	1
Intra-articular Arthrodesis + Transarticular Nail (Long):	21	16	3	1	1
Intra-articular Arthrodesis + Transarticular Nail (Short):	17	9	4	1	3
Osteotomy + Intramedullary Transarticular Nail:	8	7	1	—	—
	89	46	28	10	5
		50.6 %	31.5 %	11.2 %	5.7 %

fenestrated nails, and nails with both indents and fenestrations were used in 40 cases; 27 of these had simple transarticular nailing, and 13 had transarticular arthrodesis combined with intra-articular arthrodesis. The nail broke in no less than 12 cases. (Figs. 3-4.) 4 of these cases developed bony union, 3 have a fibrous ankylosis, and 5 show no ankylosis at all. In 3 of the cases with bony ankylosis in spite of fracture of the nail, the approximate date of fracture could be estimated and appeared to be respectively 7, 9, and 12 months after operation. In the 4th case there were no radiographs between the 2nd and 9th months and no accurate estimate was possible. In the 3 cases with fibrous ankylosis the nails fractured 2, 6, and 16½ months after operation, and in the 5 cases without ankylosis the interval was 2, 3, 4, 4, and 4½ months. In all the cases with either bony

TABLE 4

Results with Respect to Ankylosis in 53 Cases Subjected to Partial and Total Intra-articular Arthrodesis Combined with Juxta-articular Bone-Grafting.

Operative method	Number of Operations	Results			
		Bony Ankylosis	Fibrous Ankylosis	No Ankylosis	Deaths
Partial Intra-Articular Arthrodesis with Juxta-Articular Bone-Grafting:	21	17	2	2	—
Total Intra-Articular Arthrodesis with Juxta-Articular Bone-Grafting:	32	29	1	1	1*
	53	46	3	3	1
		86.8 %	5.7 %	5.7 %	1.8 %

or fibrous ankylosis brace treatment had been discontinued some time before the nail broke, and while there was still no sound bony union at the hip-joint. It is thus evident that too great a strain was being sustained by the nail. However, complete bony union, confirmed radiologically, does not entirely obviate the risk of fracture of the nail. This statement is based on one case in this series and on one case operated since. (Fig. 5.) In 4 of the 5 cases which showed no ankylosis, the nail broke during plaster immobilisation, while in the fifth case no accurate immobilisation had been possible on account of the patient's excessive obesity. In 4 cases the nail broke at the joint line, at which level there was either an indent or a fenestration, and in the remaining 8 cases the fracture occurred near the centre of the head of the femur, again at the site of a fenestration or indent. In 9 of the cases the nail broke following simple nailing used either as a primary treatment or as a secondary treatment on cases with preceding slipping of the nail. Fracture

* Died of Bronchopneumonia 2½ months after operation.

of the nail occurred in 9/27, or 33.3 % cases of simple transarticular nailing, and in 3/13, or 23.1 % of cases of transarticular nailing combined with intra-articular arthrodesis. One of the factors responsible for the higher incidence of nail fracture in cases with simple transarticular nailing may be found in their considerably shorter period of postoperative rest in bed. When one considers how sclerotic the adjacent bony surfaces often are and the pseudo-arthrosis-like type of cicatrical tissue which is found between the surfaces at operation it is obvious that the conditions are not favourable to the desired union and consolidation. Further, the fixation during the long postoperative period depends entirely on the nail, and on it is thrown the increased strain. Thus should the operation continue to be used, it might be advisable to lengthen the period of rest in bed in these cases. But then the operation would fail in one of its main purposes. Among the cases which had the combined operation the fracture of the nail could be attributed in one case to a gap of 1 cm. which appeared at operation and impaired subsequent union, and in another case fracture was attributed to too short a period in bed: in the remaining patient the records were inadequate to determine the cause of fracture.

It was not possible to discover whether there were common local conditions present in the cases with fracture of the nail, and absent from the others, and no support could be found for the theory that fracture might result from certain differences of angle between the line of the nail, and the line of gravity. It seems most reasonable to attribute the fractures to a combination of factors such as the local condition, the general constitution, the use of plaster immobilisation and others.

Of the list of complications given earlier, there remains only fracture of the femur. This occurred in 9 cases: in 3, during the operation, and in 6 during the aftertreatment. The 3 fractures which occurred at operation may have been due to the size of the nail, to forcible bending, or to failure in technique: they were, respectively, fracture of the neck of the femur, fissure of the neck, and subtrochanteric fracture. 3 of the 6 fractures, occuring during the aftertreatment, could be classed as directly

traumatic, and 3 as "insufficiency fractures". Of the former 3, 2 were fractures of the neck of the femur, and each followed a fall, and one was a subtrochanteric fracture produced by a violent movement of the patient in whom immobilisation had had to be discontinued for a sudden attack of acute cholecystitis. The 3 "insufficiency fractures" were detected 2, 4 and 16 months respectively after operation, and could not be attributed to any particular factor. All of them were subtrochanteric fractures originated at the lower end of the nail.

In order to avoid if possible the above complications shorter nails were adopted for the combined intra-articular arthrodeses, and the period of rest in bed was prolonged. In some cases coarser nails were still used, but the period of rest in bed was prolonged to 3 months. 25 patients had a combined nailing arthrodesis using shorter nails. The nail slipped in two, the slipping being detected 8 and 10 months after operation: both cases developed bony ankylosis.

These numerous complications must of course rouse interest in the end results of the different operations. They are given in Table 2, which shows the end results of 94 operations (Table 2). One result could not be judged as the patient was discharged to his local hospital and adequate information of his case could not be obtained. As the table shows, fibrous ankylosis (i.e. clinical, not radiographic, ankylosis) occurred in a large proportion of cases. This type of ankylosis can be attributed largely to the simple transarticular nailing arthrodesis, which had been used in 20 of the 28 cases of fibrous ankylosis. The reason for the high incidence of fibrous ankylosis after this operation probably lies in the extreme local sclerosis which is often present, and which is not affected by the operation, which also leaves the remains of the articular cartilage. Both these factors will discourage the formation of solid bony trabeculae across the joint and will greatly delay bony ankylosis. The observation period might therefore be extended, and one would expect then that the majority of these cases would later reveal bony union. Finally Table 3 shows the end-results of 89 cases, that is, of all cases operated on apart from the one who was transferred to

his local hospital (Table 3). This table shows the same striking fact, namely, the high incidence of fibrous and the low incidence of bony ankylosis. However, when these 2 groups which both have clinical ankylosis free from pain are put together, one finds a satisfactory clinical end-result in 82.1 % of cases.

How do these results compere with those obtained from the earlier operations, i.e. partial and total intra-articular arthrodesis combined with juxta-articular bone-grafting? The results of 53 cases treated by the latter methods have already been published in "A Clinical Study on Arthrodesis for Arthritis Deformans of the Hip-Joint" (Acta Chir. Scand., supp. 96, table 10) and are shown in Table 4.

The table shows that the earlier operations secured a higher proportion of bony ankylosis than all the nailing operations together (86.8 % compared with 50.6 %). Of the combined nailing arthrodesis (see Table 2) 25 (62.5 %) showed bony ankylosis. Thus, judging by the results of the arthrodeses, the results of nailing arthrodeses are less satisfactory than those of the earlier operations. If the cases which ended in either bony or fibrous ankylosis are grouped together in one series, one finds that ankylosis occurred in 94.2 % of the cases who had partial and total intra-articular arthrodesis combined with juxta-articular bone-grafting, and in 82.1 % of the hip-nailings in toto, and again in 82.1 % of the combined nailing arthrodeses alone. However it is worth nothing that fibrous ankylosis does not eliminate the possibility of yielding to later strain, and that bony ankylosis is the desired end result.

The mortality rate is far from discrediting the earlier operations. Only one patient of the earlier group died, from bronchopneumonia after a long postoperative interval (2½ months)—giving a death rate of 1.8 %. The corresponding figures for the nailing arthrodeses are 5, or 5.7 %, i.e. three times higher. The patient who died of bronchopneumonia after total intra- and juxta-articular arthrodesis was aged 57 years, while the ages of the patients dying after nailing operations were 43, 47, 61, 66 and 66 years, giving an average age of 56.6 years. The average age of all the patients in the first group was 45, and in the

second group 53.3. The average age of patients treated by combined nailing arthrodesis was 48.2 years and this was the method with the highest contribution to the mortality.

One of the reasons for adoption of nailing operations was to reduce the long period of postoperative recumbency. This result was obtained even by simple transarticular nailing, for which the average period was 3.2 weeks. However it must be remembered that this operation resulted in a large number of fibrous ankyloses. For the combined nailing arthrodeses the average period of postoperative rest in bed was 9.9 weeks and for the partial and total intra-and juxta-articular arthrodeses 11.4 weeks, a difference of about 1½ weeks. Since in these last cases the period can be reduced to 10 weeks without evidence of adverse effect, there is no significant difference between the last 2 figures, and the analysis shows that nothing has been gained by the introduction of combined nailing operations.

Nor apparently does bone ankylosis occur earlier after combined nailing, which shows an average time of 7.64 months, in contrast with 5.26 months after the earlier operations. Obviously those cases of combined nailing, which have both a favourable position of the nail, and extensive contact between the apposed bony surfaces, show ankylosis sooner than the average figur for this group; but that period is not shorter than the shortest periods found amongst the group treated by the earlier methods. In addition it is worth stressing that in certain cases, especially those in which there are marked slerotic changes of the acetabular surface a gap appears between the resected surfaces. A displacement of the hip into ab- or adduction during the nailing may rarely appear.

As is shown in Table 2 subtrochanteric osteotomy combined with transarticular intramedullary nailing gives satisfactory results, although, so far, too few such operations have been done for definite estimation of its value. Bony ankylosis occurred in 7 out of the 8 cases, in which it has been used; the remaining case showed fibrous ankylosis. Further this operation has the advantage that it is fairly simple and less severe than the others. The average period for bony ankylosis was 7.8 months.

SUMMARY

The conclusions from this investigation must be that the introduction of the combined nailing arthrodesis has neither hastened nor rendered more certain a satisfactory end-result. Further, combined nailing has had a higher mortality than the earlier operations. Although restriction of operation to simple transarticular nailing reduces the number of bony ankyloses (32.6 %) on the other hand 79.1 % showed clinically stable hip-joints with relief of pain (bony and fibrous ankylosis). In this connection it may be argued that fibrous ankylosis always carries a slight risk that it may lead to later strain. But the procedure is a relatively simple one, and it should find application among the elderly in whom for various reasons a minimal degree of surgical trauma may be indicated.

ZUSAMMENFASSUNG

Als Schlussfolgerung aus dieser Untersuchung ergibt sich, dass die Einführung der kombinierten Bolzungs-Arthrodese ein befriedigendes Endergebnis weder beschleunigt noch sicherer gemacht hat. Die kombinierte Bolzung hat ausserdem eine höhere Sterblichkeit als die früheren Operationen. Obwohl eine Beschränkung der Operation auf eine einfache transartikulare Bolzung die Anzahl der knöchernen Ankylosen (32,6 %) reduziert, zeigten andererseits 79,1 % der Fälle klinisch versteifte Hüftgelenke mit Milderung der Schmerzen (knöcherne und bindegewebige Ankylose). In diesem Zusammenhange mag eingewendet werden, dass bei bindegewebiger Ankylose immer ein geringes Risiko einer späteren Schädigung vorhanden ist. Aber das Verfahren ist relativ einfach, und es eignet sich daher zur Anwendung bei älteren Patienten, bei denen aus verschiedenen Gründen ein Mindestmass von chirurgischer Traumatisierung angezeigt ist.

RÉSUMÉ

1) L'arthrodèse combinée de clouage n'a amené ni consolidation plus rapide ni résultat fonctionnel meilleur.

2) La mortalité est plus élevée qu'avec d'autres techniques. Quoique le clouage transarticulaire simple réduit le nombre d'ankyloses osseuses à 32,6 % on trouve néanmoins un résultat fonctionnel satisfaisant avec disparition des douleurs dans 79,1 % (ankylose fibreuse) il est vrai que celle-ci comporte toujours un certain risque de contracture antérieure.

La technique est simple et mérite d'être prise en considération chaque fois qu'il s'agit de personnes âgées où pour plusieurs raisons un traumatisme chirurgical important doit être évité.