DISTAL MIGRATION OF THE FEMORAL INTRAMEDULLARY NAIL

Report of Seven Cases

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This paper describes the distal migration of femoral intramedullary nails in seven patients, in two of whom it occurred within the first year and in the others at intervals up to five years after operation. Symptoms were caused by the nail penetrating the articular cartilage of the knee.

Since its reintroduction by Küntscher (1940) intramedullary nailing has become so well established that Roberts (1962) described it as the most commonly used method of treatment throughout the world and, for many surgeons, the treatment of choice when open reduction and metallic fixation were selected for femoral shaft fractures. The development, indications and complications of the technique are now well documented (Soeur 1946, Böhler 1948, Street 1950, 1951, Watson-Jones *et al.* 1950, Symposia in *American Academy of Orthopaedic Surgeons* 1951, *Clinical Orthopaedics* 1953, Küntscher 1958, 1965, Smith 1963a).

Although Küntscher asserted that the medullary nail was anchored so firmly that migration never occurred, Fischer and Maatz, as early as 1942, referred to proximal migration of two tibial nails and distal migration of a humeral nail. Böhler (1948) attributed this complication to faulty selection and technique, and insisted that migration was never seen with a nail of correct dimension.

Proximal migration of a femoral nail is usually an early complication presenting before consolidation of the callus and has been ascribed to a loose fitting nail permitting repetitive movement at the fracture site (Böhler 1951, Stuck and Thompson 1951) or to positive expulsive forces arising in the medulla from the products of ionisation and foreign-body reaction (Watson-Jones *et al.* 1950). Pavlik (1957) claimed that any nail would loosen eventually and travel proximally and he introduced a nail with distally opening jaws to prevent this from happening.

Distal migration of the nail has received little attention in the literature (Table I). Mostly it was noted in abnormal bone. Thus Sofield and Millar (1959) and Williams (1965) reported it in osteogenesis imperfecta, Böhler (1951) in a tabetic patient, MacAusland and Eaton (1963) after sepsis and delayed union with shortening, Haebler (1950a) after nailing a patient with a chronically infected pseudarthrosis, and a second (1949a) in a femur after using too short a nail. The complication was not described, however, in several series of patients with extensive osteomyelitis after nailing reviewed by Thompson (1951, 1953), Key and Reynolds (1954), Weber and Hirtzman (1964) and Wilson (1966).

Bèzes, Zinsou and Goudoté (1965) reported 200 femoral nailings and mentioned four patients in whom the nail migrated distally over five centimetres; the knee was involved in only one. In the few cases encountered by Street (1958) the nail had been driven into the knee at the time of operation and, although withdrawn immediately, had drifted down subsequently along this track. Apart from these reports distal migration of the nail has been described in the early period after operation only in association with oblique fractures of the lowermost third of the femoral shaft and on premature weight-bearing through an extensively comminuted fracture (Soto-Hall 1951a and b, Lottes and Key 1953, O'Brien 1963).

CASE REPORTS

Case 1—A man aged thirty years sustained a comminuted fracture of the upper part of the femoral shaft in July 1959. Intramedullary nailing was done two weeks later and there were

no complications after operation. Three and a half years later he returned to hospital complaining of increasing pain, stiffness and swelling of the knee. Flexion was through only 40 degrees from full extension. Radiographs showed the nail to have migrated distally and to have penetrated the knee joint (Fig. 1). A thin sclerotic margin surrounded the nail track (Fig. 2). A small cavity with an adjacent zone of rarefaction existed in the upper part of the fracture area and the cortex showed areas of patchy sclerosis. The nail was removed through the knee joint which contained a large quantity of faintly turbid fluid, sterile on culture. There was much thickening of the synovial membrane. Six months later the range of knee movement was 100 degrees.

Case 2—A man aged twenty-nine years sustained multiple injuries in May 1961. A compound comminuted fracture of the upper femoral shaft was treated by delayed primary suture and, one month later, Küntscher nailing. The operation, technically difficult, was followed by wound infection. A sinus persisted for two months. The fracture united and almost full knee movement was regained. Twenty months later he returned with pain and swelling in the knee, which now moved only through 100 degrees. Radiographs revealed distal migration of the nail to involve the articular cartilage of the knee. A zone of rarefaction enclosed the length of the nail; a small sequestrum occupied a cavity at the fracture site. The nail was extracted through the knee joint. The synovial membrane was hypertrophied and an area of fibrillary degeneration on the intercondylar articular surface indicated the position of the nail.

Case 3—A man aged thirty-three years sustained a comminuted fracture of the upper part of the right femur in 1960 and was treated elsewhere by intramedullary nailing. Five years later he developed increasing pain and stiffness in the knee and a small sinus on the outer aspect of the lower thigh. No information about the operation could be obtained. Radiographs showed a nail to have migrated about eight centimetres (Fig. 3), and to have involved the femoral articular cartilage. The widened nail track was expanded at each end and low grade chronic osteitis was suggested by the appearance of the bone around the fracture site. The nail was removed through the knee; the synovial membrane was grossly hypertrophied and ragged but the small quantity of turbid fluid contained no micro-organisms.

Case 4—A man aged forty-five had had a comminuted fracture of the uppermost third of the femur nailed five years previously. He presented with pain, stiffness and swelling of the knee, and radiographs showed distal migration of the nail to the intercondylar region of the knee. There was much absorption around the nail, particularly at either end. Cortical erosions were present on the anterior femoral surface and on the medial tibial condyle. The joint cavity was narrowed and synovial thickening present. The irregular sclerotic pattern of the greatly thickened cortex of the healed fracture indicated chronic osteitis. In spite of these appearances no pus was encountered when the nail was removed through the knee (Figs. 4 and 5).

Case 5—A man aged thirty-five sustained a comminuted fracture of the junction of the uppermost and middle thirds of the femur in 1959. It was treated by open reduction and Küntscher nailing. Five years later he returned to hospital with a painful lump below a stiff knee. Radiographs (Figs. 6 and 7) showed the nail to have traversed the knee and to have emerged at the antero-medial aspect of the upper leg. There was a wide zone of rarefaction with an outer sclerotic margin around the nail. There was much synovial thickening and the healed bone bore changes consistent with chronic osteitis. The nail was easily removed but no record is available of the functional end-result.

Case 6—A woman of seventy-eight sustained an oblique fracture of the lowermost third of the femur in October 1965. Two days later the fracture was reduced at operation when, because of the wide medullary cavity, two Küntscher nails were stacked inside the shaft to achieve stability. Four months later the fracture had united and painless knee movement

FIG. 1

FIG. 2

Case 1. Figure 1—Three years after insertion the nail has entered the knee. There is a small zone of absorption around the nail at the fracture site and there is patchy cortical sclerosis which suggests infection. Figure 2—Although of adequate length the nail did not fill the medullary canal.

FIG. 3

FIG. 4

FIG. 5

Figure 3—Case 3. Five years after nailing migration has occurred. The nail was too slender. Figure 4—Case 4. Five years after operation the nail track has widened round the top part of the nail. Figure 5—Absorption around the distal part of the nail has resulted in a series of confluent cavities. There was much marked synovial thickening, narrowing of the joint space and an erosion on the medial tibial condyle.

FIG. 6

FIG. 7

Case 5—A Nigerian patient five and a half years after nailing. Figure 6—Distal migration has occurred and there is much widening of nail track. Figure 7—The patient's complaint was of a stiff knee.

FIG. 8

FIG. 9

Case 6. Figure 8—A radiograph after operation on an elderly patient in whom two nails were stacked in the femoral canal. Figure 9—Four months after operation one of the nails has entered the knee, because the fixation was inadequate and telescoping of the fragments had occurred.

from 10 to 130 degrees had returned. There had, however, been some overlap of the fragments and one of the nails had penetrated the articular cartilage of the knee (Figs. 8 and 9). In spite of this the joint was trouble-free when the patient was readmitted to hospital six months later with a Pott's fracture on the same side. This case demonstrates how quickly local mechanical factors will allow a nail to pass through osteoporotic bone.

Case 7—A man aged twenty-five was admitted to hospital two hours after sustaining multiple fractures, including a compound fracture of the midshaft of the right femur. The proximal shaft projected through a clean wound. Primary intramedullary nailing was performed. The selected nail proved too short and too slender. Infection of the bone occurred and took

FIG. 10

FIG. 11

Case 7. Figure 10—Eight months after primary nailing of a compound fracture with a nail that was too short and too narrow the fracture was still mobile and local osteitis was evident. The nail has penetrated the femoral cortex but the patient refused further surgery. Figure 11—Thirteen months after injury and after five months in a spica, the fracture has united, but the nail has migrated farther.

several weeks to resolve. Eight months after injury the nail had eroded the lateral femoral cortex, a sequestrum was forming and the fracture was not united. The patient declined replacement of the nail and autogenous bone grafting, so a hip spica was applied. Three months later the fracture had united, and two months after this he was admitted for removal of the nail which had migrated farther and now presented by the side of the knee joint (Figs. 10 and 11).

DISCUSSION

The first five patients were encountered during three years' work at the Military Hospital, Accra, Ghana. It was not unusual for the patient to return to his village after discharge from hospital and not be seen again unless a complication ensued. It is of interest that the series of 200 femoral nailings containing four instances of distal migration mentioned above

was also reported from West Africa (Bèzes *et al.* 1965). These authors gave no details of the site or type of fracture or details of nail size in relation to the medullary cavity.

Reaction of knee—The nail penetrated the knee joint through the intercondylar area. A notable feature was the gross reaction of the synovial membrane even when only the deeper part of the articular cartilage had been involved. No micro-organisms were identified in the synovial fluid and cultures were sterile. Nails were removed without technical difficulty and the synovitis settled with some improvement in the range of knee movement in most patients.

Site of fracture—One patient had a subtrochanteric fracture, and another a transverse fracture of the midshaft. Four patients presented with fractures of the upper half of the diaphysis

TABLE I
INCIDENCE OF NAIL MIGRATION IN PUBLISHED SERIES OF INTRAMEDULLARY NAILING OF FEMUR

Author	Year	Number of femurs	Nail migration	
			Proximal	Distal
Soeur	1946	23	0	0
Haebler	1949 ^a	133	0	2
Hucherson	1950	74	2	0
Böhler	1951	253	2	1
Key and Lottes	1951	684	1	0
Lloyd-Roberts	1951	41	0	0
Palmer	1951	46	0	0
Soto-Hall	1951 ^a	35	0	0
Street	1951	100	5	0
Deyerle	1953	66	0	0
Stevens and Turney	1957	41	3	0
Brown	1958	232	6	2
Walker	1959	49	0	0
Ramey	1960	19	1	0
O'Brien	1963	53	2	1
Bèzes, Zinsou and Goudoté	1965	200	1	4
Total		2,049	23	10

and because of comminution all involved the isthmus. All fractures had united without undue delay, and the patients returned to hospital complaining of knee symptoms at intervals between twenty months and five and a half years (Table II). By way of contrast another patient presented with early and symptomless migration into the knee joint of a nail used for an oblique fracture of the lowermost third of the femur.

Infection—Of two patients with compound fractures, one was nailed when the wound had healed a month after injury but low-grade wound infection followed, with a sinus that took two months to close; the other, after primary nailing, followed a similar course and the nail, of inadequate size, eroded the femoral cortex eight months after operation. A third patient returned with a sinus of unknown duration. The radiographic appearances in all femora, except in Case 6, were consistent with local chronic osteitis at the fracture site and infection

along the nail track (Murray 1966). When a slender nail was used some of the medullary changes could have resulted from movement of the bone fragments before consolidation of the callus. The nails had travelled from three to twelve centimetres within the widened nail tracks and the amount of bone resorption varied from a small zone of rarefaction at the fracture site to extensive cavitation around the distal part of the nail (Fig. 5). The femoral cortical erosions seen in Case 4, associated with gross synovial thickening and narrowing of the joint space, closely resembled changes seen in tuberculosis or rheumatoid arthritis.

Size of the nail. *Length*—There is general agreement that the distal end of the nail should reach the epiphysial region of the bone. In only two patients was this achieved. In two patients the nail was more than four centimetres and in another over seven centimetres from the femoral articular surface. This factor is unlikely to be of significance in the initiation of nail migration.

TABLE II
SUMMARY OF THE PRESENTING FEATURES OF THE PATIENTS DESCRIBED IN TEXT

Case number	Age (years)	Sex	Site and type of fracture	Distance nail migrated (centimetres)	Position of nail end	Interval before extraction of nail
1	39	Male	Comminuted; upper shaft	3	Within knee	3½ years
2	29	Male	Compound, comminuted; upper shaft	5	Within knee	2½ years
3	33	Male	Comminuted; upper shaft	8	Femoral articular cartilage	5 years
4	45	Male	Comminuted; subtrochanteric	5	Just through articular cartilage	4½ years
5	35	Male	Comminuted; upper shaft	12	Antero-medial aspect of leg	5½ years
6	79	Female	Lowest third of shaft; oblique	2½	Just within knee	
7	25	Male	Compound, transverse; midshaft	9	Outer side of knee	13 months

Width—O'Brien (1963) regarded any nail as too loose when its diameter was more than two millimetres less than that of the medullary isthmus. Applying this criterion to standard radiographs after operation, he showed a significant incidence of delayed and non-union when this "nail-to-canal ratio" was unacceptable. In the seven cases reported above no nail fitted the medullary isthmus tightly, and none showed less than two millimetres between the diameters of canal and nail (Table III).

Reference has already been made to the tendency of a loosely fitting nail to travel proximally before union has been attained and it is reasonable to infer that, in an ambulant patient, any nail would tend to migrate distally once its hold on the cortex loosened. The cloverleaf nail was designed to allow for compression of its margins during insertion, and a nail that fails to occupy the medullary cavity has not been inserted in accordance with the principles of Küntscher. None the less distal migration is encountered infrequently and it therefore appears that inadequate width is not the only factor concerned.

Reaction of bone to the intramedullary nail—In their studies on the rabbit's radius Trueta and Cavadias (1955) demonstrated that intramedullary nailing was followed by uniform thickening of the outer diaphysial cortex. Once the fracture had united, gradual absorption of the endosteal bone took place so that the final thickness of the cortex equalled that of the normal femur. These changes were described in both young and adult animals although were more pronounced in the former. In addition, necrosis of as much as the inner two-thirds of the cortex

was shown to persist for at least eight months after nailing. It is probable that similar endosteal necrosis and partial absorption occurs in the nailed human femur, but no published studies on this aspect of the operation have been found.

Biological resorption around the implant is a slow process but would be hastened by infection. Comminution of the bone fragments and involvement of the medullary isthmus would combine to prevent the nail from securing a rigid purchase on the bigger bone fragments. It seems likely therefore that all these factors might contribute to loosening of the nail.

Removal of the nail—It is evident that this complication would not have occurred in most cases had the nails been removed as soon as the fractures united. Divided opinions have been expressed about extraction of the nail. Unless the patient complained of local symptoms Watson-Jones (1955) felt that the nail could be left “ indefinitely, or at least for several years,” and this view was upheld by Nickel (1951) and Cave (1958) and has been recently expressed

TABLE III
POSSIBLE FACTORS RELATING TO MIGRATION OF NAILS IN THIS SERIES

Case number	Damage to isthmus	Nail dimensions		Radiographic signs of infection
		Distance from knee after insertion (centimetres)	Ratio of width of nail to canal	
1	+	1	9:12	Small zone of absorption at upper part of fracture site
2	+	4.5	10:12	Sequestrum in small cavity at fracture site
3	+	7.5	7:12	Low-grade osteitis limited to fracture
4	+	4.5	10:12	Much medullary cavitation; erosions on femoral and tibial cortices
5	+	2	9:12	Chronic osteitis around fracture area
6	—	2	12:16	None. Absorption around distal end of nail from mechanical factors
7	—	10.5	9:12	Osteomyelitis at and above fracture

by Küntscher (1966). On the other hand, Lloyd-Roberts (1951) advised removal as “ the permanent retention of so large a piece of metal within the medulla may have its own dangers,” and this attitude has been shared by many other surgeons (Böhler 1951, Stuck and Thompson 1951, Key and Conwell 1961, Smith 1963b).

It is suggested that, although of uncommon occurrence, the possibility of late onset distal migration lends additional support for the routine recovery of the nail as soon as union of the fracture is radiographically established.

SUMMARY

1. Distal migration of a femoral intramedullary nail is described in seven patients. Previous reports of proximal and distal migration are reviewed.
2. Factors predisposing to this complication are infection, incorrect nail size, comminution of the fracture and involvement of the medullary isthmus.

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