Acta orthop. Scandinav. *XXXV*, 164–169, 1964.

From the Department of Surgery II, Sahlgrenska Sjukhuset, University of Gothenburg, Sweden. (Head: Professor Ragnar Romanus, M.D.)

ERRORS IN TECHNIQUE AND COMPLICATIONS SPECIFIC TO INTRAMEDULLARY NAILING

A Study Based on 459 Nailed Femoral Shaft Fractures

By

HANS DENCKER

Special errors in technique and complications can occur at intramedullary nailing of femoral shaft fractures. These have been considered closely by *Böhler* (1948), *Lauritzen* (1949), and *Palmer* (1951).

Among the more common errors in technique are the use of too short or too thin a nail, impaction, nail perforation of the proximal or distal fragment or into the knee joint, splitting of the femur, and nailing with a gap between the fracture ends. Bending and breaking of the nail are the most important complications specific to the method.

These errors in technique and complications vary appreciably in incidence in different series. In *Lauritzen*'s material (1949) "technical difficulties of an unpleasant nature were encountered only when the calibre selected was incorrect, *i.e.* when the nail was too thick", but their frequency was not specified. The nail bent in 7 of 46 cases. *Lottes* (1951) reported 11 technical errors among 51 nailing operations. In 4 instances the nail bent and in 1 it broke. In *Key & Lottes'* series (1951) breaking of the nail occurred in 9 of 684 femoral fractures.

MATERIAL

The present series of femoral shaft fractures is collected from practically all Swedish hospitals during 1952–1954. The designation femoral shaft fracture denotes here a fracture situated in its entirety on the shaft itself. The upper limit on the shaft is taken at 5 cm. below the distal margin of the lesser trochanter, and the lower at 6 cm. proximal to the most distal point of the medial femoral condyle, as measured on available roentgen films (see *Dencker* 1963).

Intramedullary nailing was performed in 435 fractures. The method was given a trial in a further 24 cases but failed owing to technical errors and another method was used. For this reason the percentage of technical errors is estimated on the basis of 459 cases, while the percentage of postoperative complications is calculated for 435.

TECHNICAL EPRORS AT NAILING OPERATIONS

Technical errors which have been rated as sufficiently important to be noted were in 63 cases (14 per cent) recorded in the surgeons' reports or discovered on reexamination of the roentgen films.

The use of too short a nail was the most common technical error, occurring at 25 operations. In about one third of the cases this was due to the lack of a suitable nail during the operation. The causes are not known in the remaining instances.

In fractures of the upper and middle thirds of the femoral shaft, the nail was considered too short if it failed to reach at least 10 cm. beyond the fracture. When a fracture implicated the lower third of the shaft, the length of the nail was thought to be inadequate if it did not reach to within approximately 4 cm. of the most distal point of the medial femoral condyle. These definitions are selected as in one third of the above 25 cases displacement occurred postoperatively most probably because the nail was too short. In the cases in which a longer nail was used, postoperative fracture displacement was probably due to other factors.

Impaction of the intramedullary nail was recorded at 24 operations. The surgeon succeeded with difficulty in with-drawing the nail in 12 cases, but he failed in 12. In 11 of the latter cases the nail was sawn off, and in 1 its projecting end was buried under the skin at the greater trochanter.

In 4 of the 12 cases in which it was possible to withdraw the nail, a new one of smaller calibre was employed. Three of the fractures were instead treated with a plate, 2 with bone suture, and 2 with open reduction without internal fixation. In 1, the guide pin was left in position to fix the fracture.

Open reduction without internal fixation was employed in 5 of the 12 cases in which the nail could not be extracted. Encircling wire was used in 3 fractures, an intramedullary pin in 1, and bone suture in 1. In 2, the guide pin was left to fix the fractures.

Splitting of the femur occurred at 6 nailing operations. As a rule a bone fragment was dislodged measuring around 3 cm. in frontal and lateral projections on the roentgen films. This complication was in every instance probably due to the use of a nail of too large a calibre.

The nailing operation was completed in 5 of the latter 6 cases, but the fixation was not stable and external fixation was therefore applied. One of the fractures was instead treated with bone suture.

Nail perforation into the knee joint—approximately 0.5 cm. into the intercondylar fossa—was noted in 3 cases. This was due to inaccurate estimation of the lenght of the femur.

The surgeon failed completely to drive the nail into the medullary cavity in 3 cases. Two of the fractures were instead treated with encircling wire, and 1 with bone suture.

The nail was driven out into the soft tissues around the fracture in 2 cases. In neither instance was the error detected at the operation as no roentgen check was made. Both fractures were reoperated upon shortly after with a new intramedullary nail.

COMPLICATIONS SPECIFIC TO INTRAMEDULLARY NAILING

Bending and breaking of the nail were the complications specific to intramedullary nailing of the greatest significance. The incidence of bursa formation at the proximal end of the nail cannot be ascertained. This complication was not usually recorded at extraction of the nail, and roentgen examination of the hip was seldom made at that time.

The nail bent in 68 cases (16 per cent). The degree of bending, as measured on the roentgen films and therefore representing a minimum value, was in 43 cases less than 15°, in 19 between 15° and 25°, and in 6 over 25°.

The bending of the nail occurred within the first month in 22 cases, during the second to fourth months in 26, and later after the operation in 20.

In 3 cases the nail was bent between 5° and 10° at application but was left in position. In 9 the bending occurred when the patients were confined to bed. The nail bent on loading the limb in 48 cases, and in 8 by trauma at an accident.

The nail broke in 10 cases (2 per cent).

DISCUSSION

Technical errors at intramedullary nailing were recorded in 14 per cent of the 459 cases. If it is borne in mind that the operations in this series were performed by a large number of different surgeons, the in-

cidence is not particularly high. *Palmer* (1951), for instance, who is much interested in intramedullary nailing reported 7 technical errors among 52 such operations for femoral fractures. However, it seems likely that more occurred in the present series. It may well be that all of them were not noted in the surgeons' reports or detected on reexamination of the roentgen films.

The most common error was the use of too short a nail. This was often due to the lack of a suitable one, which suggests that the planning of the operation had been imperfect. If the control of the available internal fixation material had been better, the erroneous procedure might have been avoided. The intramedullary nailing operation could not be completed in 24 cases (5 per cent) and other methods had to be employed instead. The cause was usually impaction.

Several writers have emphasized the need of the experience and skill for good results at intramedullary nailing (*Böhler* 1948, *Luck* 1951, *Smith* 1951, *Key* 1955, among others). Thus, a comparison has been made here of the surgeons' length of training and the incidence of technical errors, but this revealed no significant difference (Table). The

TABLE

Incidence of Technical Error at Nailing Operations in Relation to the Surgeon's Training.

Length of training	No. of operations	Technical error no.
<2 years	16	0
2–5 years	92	12
>5 years	313	49
Unknown	14	2

fact that no errors were attributed to surgeons with less than 2 years' training was probably due to their calling in a more experienced surgeon when they got into difficulties, and that the operation was then recorded in the latter's name.

Bending of the nail was the most common postoperative complication specific to intramedullary nailing, occurring in 68 instances (16 per cent). In two thirds of the cases the bend was less than 15 degrees. Nails V-shaped in cross-section were generally employed in the present series. Nowadays, however, clover-leaf nails are in wide use (*e.g. Palmer* 1957, *Küntscher* 1958), which should lead to a fall in the incidence of

bending. The complication usually occurred within 4 months of the operation. I seems that it might have been prevented in several cases if the limb had not been exposed to weight bearing until somewhat later.

The nail broke in 10 cases (2 per cent). Most authors believe a break to be the result of metal fatigue or trauma (*Fischer-Wasels & Schünemann* 1953, *Lottes & Key* 1953). In the present investigation metal fatigue was probably the cause of the break in 9 cases, and trauma in 1. The case records contained no mention of signs of corrosion of the nail, so this factor was probably of no importance.

SUMMARY

Errors in technique at intramedullary nailing operations were observed in 14 per cent of the 459 cases which were treated at Swedish hospitals between 1952 and 1954. The nail bent in 16 per cent and broke in 2 per cent. The causes and possible preventive measures are discussed.

RESUME

Des défauts techniques dans les opérations d'enclouage intramédullaire ont été observés dans 14 pour cent des 459 cas traités dans les hôpitaux suédois entre 1952 et 1954. Le clou s'est courbé dans 16 pour cent et s'est cassé dans 2 pour cent des cas. Il est discuté des causes de ces accidents et de dispositions préventives qu'il est possible de prendre.

ZUSAMMENFASSUNG

Fehler bei der intramedullären Nagelung wurden in 14 Prozent der 459 Fälle, die an schwedischen Krankenhäusern zwischen 1952 und 1954 behandelt wurden, beobachtet. Der Nagel beugte sich in 16 Prozent und brach in 2 Prozent. Die Ursachen und möglichen vorbeugenden Massnahmen werden besprochen.

REFERENCES

Böhler, L.: Medullary Nailing of Küntscher. The William & Wilkins Co., Baltimore, 1948.

Dencker, H. M.: Fractures of the Shaft of the Femur. A Clinical Study Based on 1,003 Fractures Treated in Swedish Hospitals During the Three-Year Period 1952 to 1954. Orstadius boktryckeriaktiebolag, Göteborg, 1963.

Fischer-Wasels, J. & Schünemann, H.-B.: Zur Frage der Marknagelfrakturen. Arch. orthop. Unfall-Chir. *46*: 207, 1953/1954.

Key, J. A.: Indications on Contraindications for Medullary Nailing of Fractures. J.A.M.A. *158*: 1001, 1955.

Key, J. A. & Lottes, J. O.: Medullary Fixation of the Femur. Complications and Errors in Technique. Am. Acad. Orthopaedic Surgeons, Instructional Course Lectures *8*: 27, 1951.

Küntscher, G.: The Küntscher Method of Intramedullary Fixation. J. Bone Jt Surg. *40–A*: 17, 1958.

Lauritzen, G. K.: Medullary Nailing. A Clinical and Critical Study. Acta chir. Scandinav. Suppl. 147, 1949.

Lottes, J. O.: Treatment of Fractures of the Femur with a Heavy, Large Cored, Three-Flanged Medullary Nail. Surgery *29*: 868, 1951.

Lottes, J. O. & Key, J. A.: Complications and Errors in Technic in Medullary Nailing for Fractures of the Femur. Clin. Orthop. *2*: 38, 1953.

Luck, J. V.: Medullary Fixation of the Femur. Advantages, Limitations, and Indications. Am. Acad. Orthopaedic Surgeons, Instructional Course Lectures *8*: 2, 1951.

Palmer, I.: On the Complications and Technical Problems of Medullary Nailing. Acta chir. Scandinav. *101*: 484, 1951.

Palmer, I.: Märgspikning vid femurfrakturer. Granskning av ett material vid Södersjukhusets kirurgiska klinik I. Nord. Med. *57*: 101, 1957.

Smith, H.: Medullary Fixation of the Femur. Am. Acad. Orthopaedic Surgeons, Instructional Course Lectures *8*: 1, 1951.