

Intramedullary Fracture Nailing

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Several years have elapsed since 1940 when Küntscher made known his procedure for the treatment of long bone fractures. Although there is an increasing number of publications on the subject, this method is still the subject of continuing investigation. Our purpose in this paper is to review a series of 66 cases treated in our center and either confirm or reject the criteria laid down by other authors with a view to making an eminently practical contribution.

The first concept that comes to mind is that of the desirability of a perfect method, although perfection is not easily achieved! Professor Böhler said that he found Küntscher's procedure fully satisfactory since fully-fledged osteosynthesis was ideal for containing and immobilizing. But are containment and immobilization always achieved in practice? We believe that for certain bones it does whereas for others only occasionally. For the femur, for example, it is always possible to obtain perfect immobilization and containment. We can easily recognize this if we think of the firm purchase of a nail or a rod on the upper extremity (trochanteric region) and of the cylindrical and regular shape of the medullary canal. A similar situation is obtained for the ulna and to a lesser extent for the radius. However, we cannot say the same thing for the remaining bones that are amenable to instrumentation. Now, if the goal of instrumentation is the one mentioned above, we should be quite content if it allows us to achieve the containment of the reduced fragments more efficiently than with other methods, especially if we take into account that it more often than not makes it possible to reduce, albeit not avoid, the need for supplementary cast immobilization.

Another one of the great advantages of the procedure is that it makes it possible to act without opening the fracture site. Although this is undoubtedly a good thing, open fixation is not a serious problem as open surgery is the norm for all other types of osteosynthesis. Opening the fracture site is

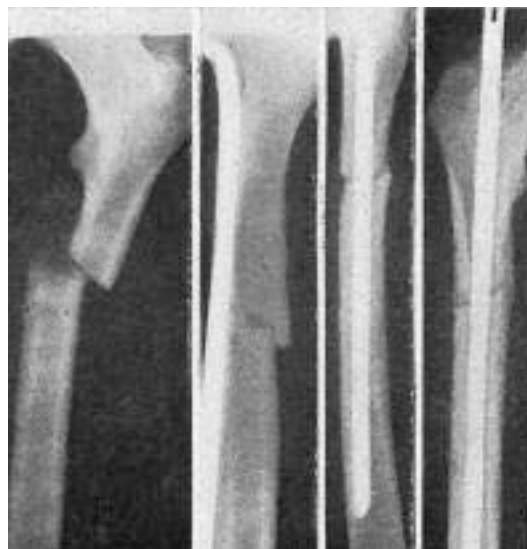


Figure 1. Recent transverse fracture of the upper-third of the femur. Closed nailing. With the nail in place, correct reduction and immobilization permit ambulation without any further immobilization procedure.

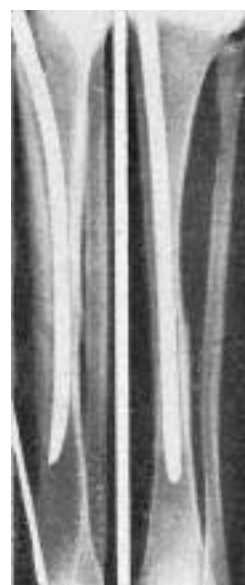


Figure 2. Transverse fracture of the middle-third of the tibia, without displacement. The fibula is intact. Closed nailing was performed. This is one of the first cases we treated. At three months, the patient resumed his work; an single nail afforded a perfect immobilization.

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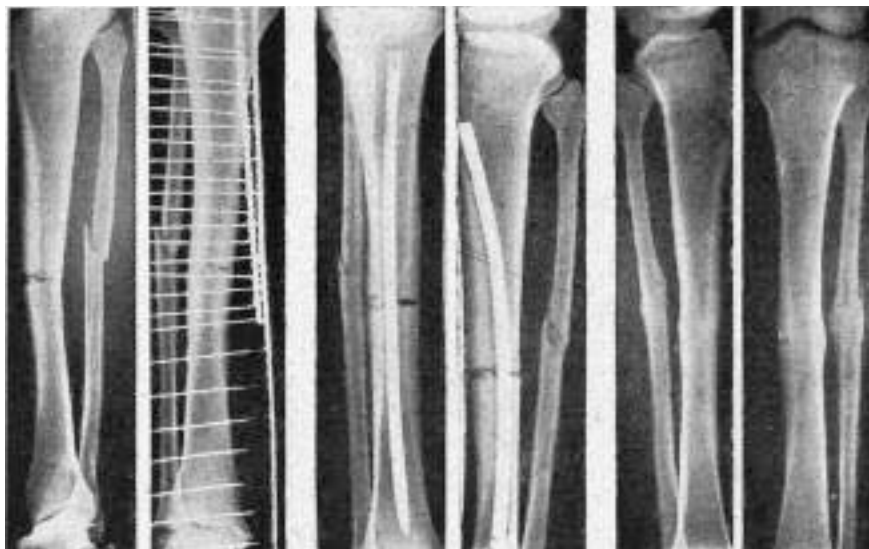


Figure 3. Fracture of middle-third of the tibia and fibula; closed nailing with a single nail; a third fragment prevents an accurate union of the fractures. However, good healing is obtained with a predominance of periosteal callus; note the entry hole for the nail in the upper part.

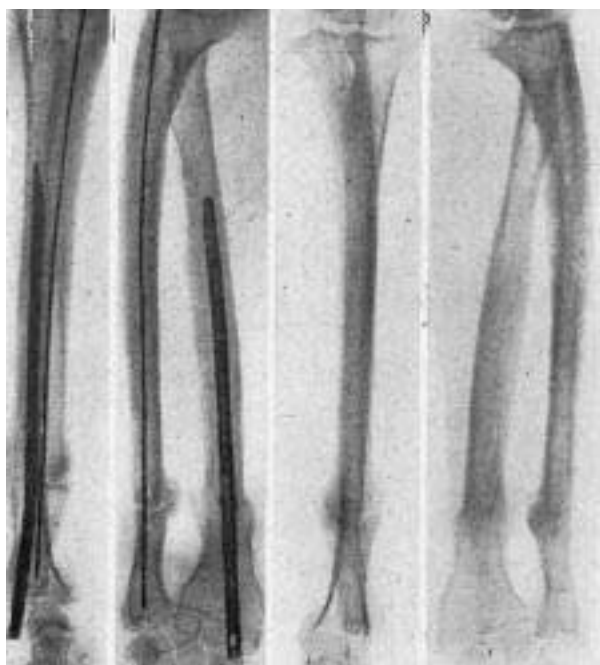


Figure 4. Mixed nailing in a case of ulnar and radial pseudoarthrosis, further to the refreshment of the fragment. Wiring was used for the ulna since we did not have a nail that was long enough. The fracture is also shown once healing was obtained.

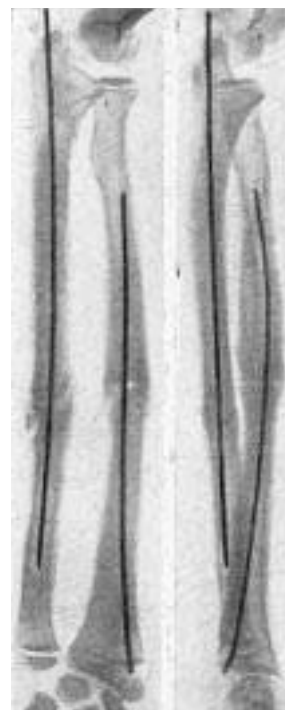


Figure 5. Two-part forearm fracture. Closed mailing reinforced by wiring.

a must in many cases where fixation is indicated: irreducibility of the fragments due to muscle interposition, pseudoarthrosis, fractures healed with displacement, open fractures.

It could be argued that we nowadays have osteosynthesis hardware that in some cases can offer certain advan-

tages over intramedullary nailing, but given the cost and scarcity of the new vitallium alloy, it can only be used in exceptional circumstances. We have had experience of performing osteosynthesis procedures with vitallium plates and we believe that nailing is in many cases more effective.

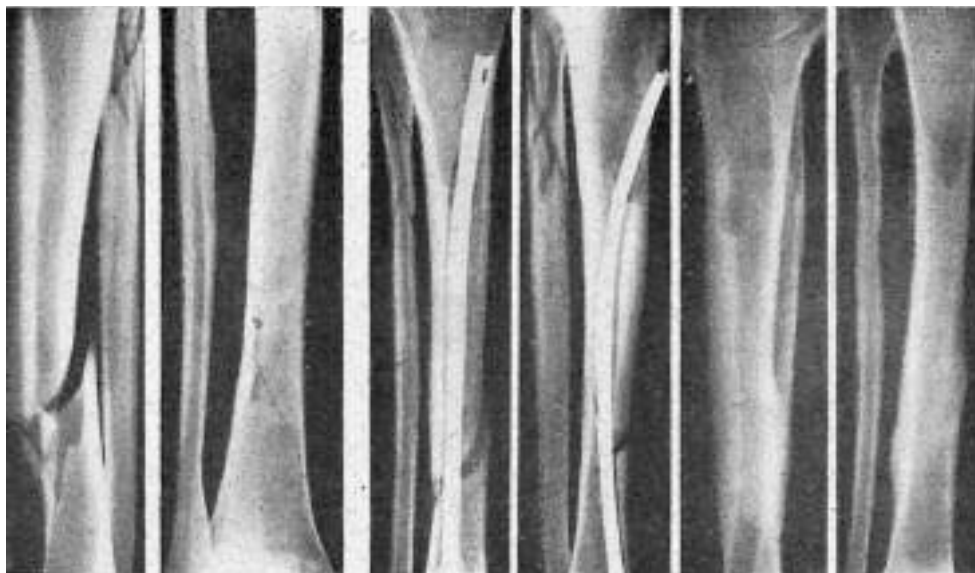


Figure 6. Spiral tibial and comminuted fibular fracture that could not be reduced even by continuous extension. Closed nailing. The fracture is also shown once healing was obtained.

Some authors compare the degree of containment achieved by bone transfixation to that achieved by nailing; but transfixation is neither innocuous nor does it achieve a higher degree of containment than nailing; Nor is it a straightforward technique when performed with Steinmann nails. Not to mention continuous extension in cases of difficult-to-contain fractures that require a long period of bedrest and the use of devices that demand permanent surveillance; all of this can be replaced by a nailing procedure. We would like to make the following remarks about the procedure at hand:



Figure 7. Grossly displaced clavicle fracture; open nailing affords excellent results.

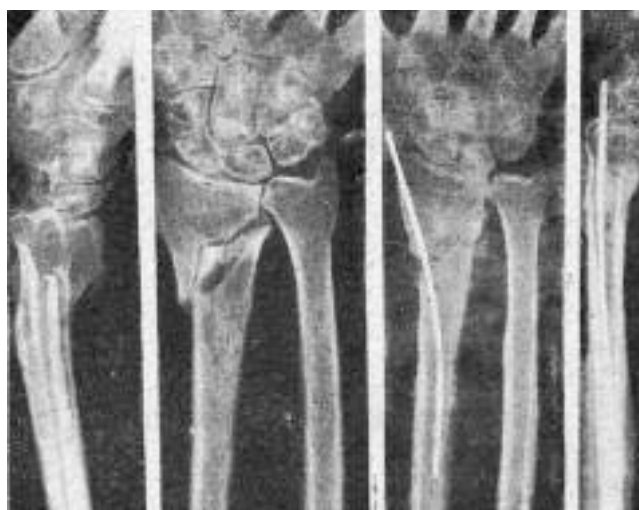


Figure 8. Healed fracture with fragment displacement; osteotomy and atypical nailing; the displacement was corrected.



Figure 9. Pseudoarthrosis of the middle-third of the humerus. After fragment refreshment, an attempt was made at Küntscher nail placement, which failed due to the presence of osteoporosis throughout the humerus. Nailing reinforced by wiring and bone paste led to healing was achieved.

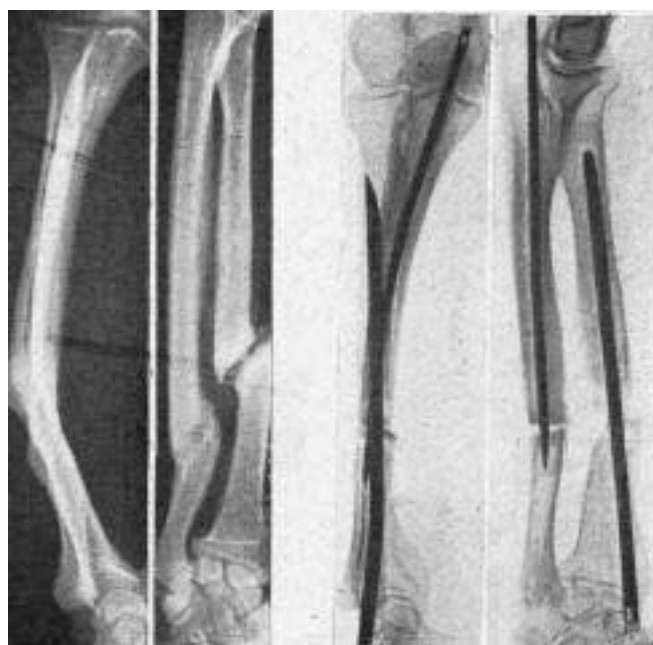


Figure 10. Ulnar and radial pseudoarthrosis further to a flawed nailing procedure. The nail is too short, the purchase on the distal fragment is too weak and there is a gap; the case worsened with a post-operative infection and a ring sequestrum at the radial site; the radial pseudoarthrosis persisted. This was our only infection, which healed when the sequestrum was removed; the infection did not spread to the intramedullary canal.

According to the experience of other authors, we did not find among our cases any significant alterations of the leukocyte count, or pulmonary embolisms or infections, except in a case of an old ulnar pseudoarthrosis that resolved without any noteworthy complications. We do want to un-

derline, however, two important objections to the method. One of these is the significantly delayed healing observed in most of our cases (in general, healing times were higher than those obtained on average with other procedures). This drawback is offset by shorter post-healing treatments. This

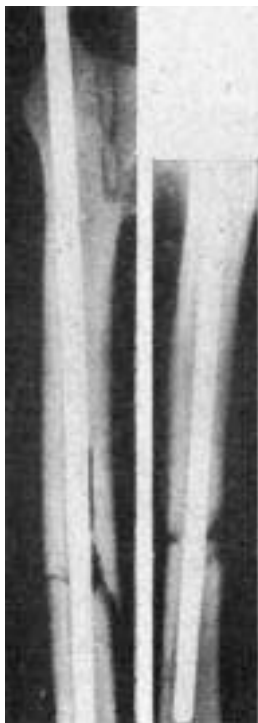


Figure 11. This complication occurred because the nail diameter was not properly selected. Splintering of the proximal fragment.



Figure 12. A further complication of closed nailing; the bust proximal fragment has been impacted by the distal fragment and has caused a wedge-shaped indentation. On observing the situation in the x-rays, the decision was made to explant the nail and reduce the indentation; the case healed uneventfully.

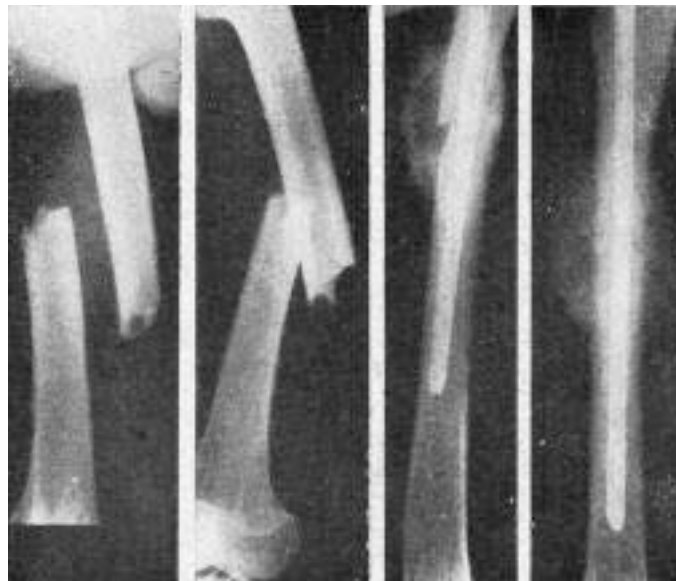


Figure 13. Fracture of the middle-third of the femur with significant fragment displacement. The fracture could not be reduced due to muscle interposition derived from a surgical reduction. We can see the fracture with the nail in place during the healing period; exuberant periosteal callus.

delayed healing is usually fairly easy to account for: if it occurs early it may be due to a poor selection of the cases; if it occurs later it could be due to the patients' characteristics (multiple-fracture patients or poorly immobilized ones). Nonetheless, there are other cases in which although perfect

reduction and immobilization have been achieved this delay is still observed.

The other objection has already been pointed out by Küntscher and other authors and refers to the huge periosteal reaction that occurs in many cases, especially in the

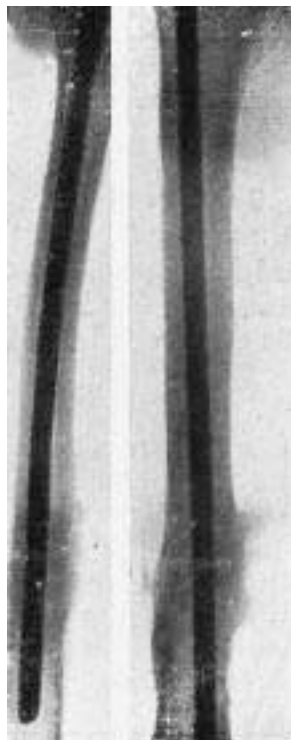


Figure 14. Typical exuberant periosteal callus in a closed nailing procedure.

femur, especially in the fracture site had to be opened due to muscle interposition. Such a periosteal reaction can be explained by the pressure exerted by the intramedullary nail and by the manipulations made during the reduction process. It tends to be rather extense and extremely apparent with all our cases showing a predominance of the periosteal over the endosteal callus, which results in the persistence of a radiographic fracture line in the endosteum. On the other hand, the periosteal callus is so strong that it permits an excellent functional result. This delay in the formation of the endosteal callus resolves gradually once the metal nail is removed, which might be attributable a potential mechanical or chemical irritation caused by the nail.

Only in two cases did we find, on removing the nail, a small area of corrosion on the device; however, this has been inconsequential even in those cases in which the nail was kept in place for a long time (as long as 164 days in one case).

On the basis of what we have said, and taking into account the degree of containment afforded by this procedure, before we had any nails available, we started using intramedullary Kirschner wires for forearm fractures, a technique that has proved successful and that we still use at the present day. We place wires into both bones, or a wire into the radius and a Küntscher nail in the ulna, especially in distal cubital fractures, in order to avoid a «décalage», which a wire would not be able to prevent. We have extended the

wire-based technique to atypical cases in which, when introduced obliquely, the wire's elasticity makes it behave like a bow and is therefore able to maintain reductions that would be difficult to obtain with other procedures.

CASE REPORTS

So far we have performed 66 fixation procedures. All patients have been discharged. We have operated on other patients too, who are still under treatment. The location of the fractures is as follows:

Clavicle	6	
Humerus	1	
Radius	16	} 20 patients
Ulna	13	
Metacarpals	4	} 2 patients
Femur	13	
Tibia	13	
Total	66	nailing procedures in 55 patients

The fact that the amount of fixation procedures that open the fracture site outnumbers those that do not, is not due to the difficulties inherent in carrying out the procedure but rather to the characteristics of the cases treated among which feature a large amount of pseudoarthroses, a series of malunited frac-

	Open	Closed	Wired	Nailed
Clavicle	6	0	6	0
Humerus	1	0	1	0
Forearm	24	5	21	8
Metacarpals	4	0	4	0
Femur	9	4	0	13
Tibia	3	10	0	13
Total	47	19	32	34

tures and fractures with muscle interposition, all of them amenable to opening up the site with any type of osteosynthesis but for which this procedure offers many advantages.

Of the cases treated we have chosen a few radiographs of the procedures performed and of some of the difficulties that we experienced, taking into account that we want to keep this article short.

CONCLUSIONS

1. Our experience, based on 66 cases, confirms the usefulness of this method for selected cases.

2. We consider most cases in which for some reason it is necessary to open the fracture site to be amenable to a nailing procedure.

3. It is not always easy to achieve immobilization, not so much because of the method used but rather because of the delayed healing and the exuberant callus.

4. We had no other significant complications attributable to the method used than delayed consolidations and exuberant calluses.

5. Fixation with K-wires is an easy innocuous procedure.

6. The fixation technique described in this paper is not easy and should be performed by specialized personnel.

Comment

This article was first published in our Journal in 1947, seven years after Küntscher's classic paper. In those early years of intramedullary osteosynthesis the author mentions that «although there is an increasing number of publications on the subject, this method is still the subject of continuing investigation». He could not have been more right since today, six decades later, this procedure still awakens great interest since it constitutes, *per se*, one of the fundamental lines of treatment offered by internal osteosynthesis for the management of long bone fractures.

After the development of his first method, Küntscher's completed his work with the development of closed techniques, a method for intramedullary reaming, the locking nail and the possibility to compress the fracture site among others. Subsequently, many other methods of intramedullary osteosynthesis have emerged. The development of the AO osteosynthesis techniques with a screw-in plate, its emphasis on anatomical reduction and the theory of *ad primam* healing almost condemned intramedullary nailing to oblivion although nowadays both approaches are self-standing fields of research that offer different kinds of solutions. Both of them are supported not only by large series of clinical studies but also by biological studies such as the work on vascularization done by Rhinelander and

Kessler. So this is far from an exhausted field on study as Dr. López de la Garma prophesied.

The article is based on a heterogeneous series of 66 cases of intramedullary osteosynthesis performed on patients that had not been previously selected; this is indeed a study carried out from the vantage point of the experience accumulated with those new and «imaginative» surgical methods. Techniques had to be discovered on a case-by-case basis and patient by patient since as the author says «perfection is not easily achieved.»

The series presented includes all kinds of long bone fractures and pseudoarthroses; the method not only includes Küntscher's well-known intramedullary nailing procedure but it also includes cases of K-wire fixation used to address diaphyseal ulnar, radial and even clavicular fractures. The decision to open the fracture site or not is a function of the degree of difficulty of each case and in most cases the procedure is followed by plaster cast immobilization.

In a sort of discussion of the method presented, Dr. López de la Garma compares it with other procedures such as immobilization with transfixating pins and a plaster cast, continuous extension and other osteosynthesis systems like screw-in vitallium plates (an expensive and