COMMONLY ASKED QUESTIONS ON THE PRACTICE OF INTRAMEDULLARY NAILING

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INTRODUCTION

Intramedullary Nailing (IMN) of the extremities has taken many twists and turns in its odyssey to its current status as the gold standard in the management of long bone fractures. Here in East Africa, we are a long way off the pace of the Western World and have our peculiar circumstances and practice, and our own questions regarding any surgery including IM nailing. There have been many questions regarding the history, concepts, applications of and recent developments in the field of IMN, and it is the purpose of this article to elucidate some of the gray areas.

Q1) Who started the practice of IMN?

A) The practice of IMN was introduced and popularized by a German scientist and doctor called Gerhard Kuntscher (1). He did his first experiments on IMN on animals, and extended this to humans, and first presented his findings in a meeting in Berlin. His work was initially treated with a lot of skepticism, but eventually accepted. His book "The Practice of Intramedullary Nailing" is available as an English translation (2) and is a must-read for anyone wanting an insight into the subject.

Q2) What are the indications of IMN?

A) IMN is indicated for any shaft fractures- transverse, oblique and comminuted- of long bones. This may be extended to some of those with intraarticular extensions. Complex fractures around the hip joint may also be treated using an intramedullary device with a screw into the femoral neck.

Regarding the specific bones, IMN has traditionally been applied to the femur, but is now commonly used in the tibia and humerus. Radius and ulna fractures are also being treated by this method now.

IMN is also being used in the fusion of the knee and ankle joints for indications such as failed arthroplasty, infections, severe osteoporosis in rheumatoid arthritis.

Q3) *What are the advantages of IMN over conventional plating?*

A) Closed nailing has the advantage of preserving the fracture biology as opposed to plating. Even done open, IMN may be done with minimal to no periosteal stripping as opposed to plating in which the periosteum is stripped and bone cortex devascularised. Thus nailing enables better fracture healing by preserving the biology,and risk of infection is also minimized (3).

The biomechanics of callus are strongly in favour of IMN as opposed to plating. Removal of a plate requires careful timing, and done too soon may leave an inadequately healed fracture, whereas left too late may lead to peri implant stress , shielding and eventual implant failure with refracture.

Q4) *What are the different types of IM nails available?*

A) Nails may be broadly categorized into two: the locked nails and the unlocked nails.The Kuntscher nail is an unlocked nail, and is the only one of its kind now available.The locked nails may be used in the unlocked form if so decided by surgeon. Locked nails have also developed over the years.

The Grosse Kempf nail was one of the first locked nails available. The Russel Taylor nail was developed later, and incorporates a bend in the nail to accommodate the anterior bow of the femur. The third generation nails such as the Trigen and AO Sigma nail are designed with an anterior bow as well as a mediolateral curve to accommodate the trochanteric entry. A special mention is made of the SIGN nail and the Huckstep nail.

Q5) *What is the difference between solid and hollow nails?*

The principle biomechanical property of the IM nail is its rigidity, that is, its bending stiffness.The rigidity of a cylindrical structure is proportional to the fourth power of the radius (3).

In the case of a hollow structure the thickness of the wall determines the rigidity of the structure.

Doing some quick calculations one finds that there is actually not much difference between the two structures, and since the hollow tube allows for the use of a guide wire over which it maybe threaded then, it is preferred over the solid tube.

The hollow nail does have the disadvantage of an increased surface area, increasing the area for biofilm formation, and therefore increasing susceptibility to infection.

Q6) What materials are used to make IM nails?

A) The first IM nails were made of stainless steel, and this has been the principle material in use since then. Stainless steel, despite being very strong, doesn't quite match bone in its mechanical strength and portrays a strong element of stress shielding.

The development of titanium now gives us a material with biomechanical property much closer to that of bone, and has the other added advantage of being repulsive to infection by a yet to be understood mechanism.

Silver coated nails are also being used by certain groups. These too are useful in preventing infection and therefore applicable in compound fractures.

Q7) How does locking work?

A) Locking involves placement of a screw or two proximally and distally transfixing the nail in the bone. This gives the construct axial, rotational as well as angular stability.

Q8) Locked nailing or unlocked nailing?

A) Indications for locked nailing were well explained by Winquist *et al*. The difficulty with locking is well known to any surgeon who practices nailing. This is what presents as the main technical difficulty in nailing, and takes up considerable amount of time of the surgeon, as well as theatre space etc. It would therefore make some economic sense to leave an unlocked nail in those fractures where the decision to lock is unclear such as in the midshaft fracture of the femur.

Q9) What is the phenomenon of stress risers in IMN and how may it be prevented?

A) Most IM nails have two proximal and two distal locking holes. These are static holes in most designs. The two proximal and distal locks prevent fracture translation after fixation, but have the disadvantage of converting the fracture into a rigid frame. The desired motion at the fracture site is therefore lost, and the proximal and distal screw holes therefore become points of increased stress.

The solution to this involves a repeat operation whereupon the distal interlocking screws are removed. This allows motion at the fracture site and also removes the stress riser point.

Q10) Reamed nailing or unreamed nailing?

A) When initially developed by Kuntscher, nailing was strictly meant to be done after reaming. This was and still is recognized to enable a larger sized nail to be inserted, offering better mechanical property of the nail inserted, and less likelihood of failure. Reaming also enables a better fit of the nail so inserted.

The disadvantages of reaming are: disruption of the endosteal blood supply and emboli into the vasculature from the reaming. Despite these problems, reamed nailing is preferred to unreamed nailing as the standard operation.

Unreamed nailing has specific applicability in the following scenarios: In multiple injured patients in whom one desires a quick operation; in segmental fractures to avoid devascularising the middle fragment; and sometimes in compound fractures of the tibia.

Q11) Doesn't reaming interrupt the endosteal blood supply and so disturb fracture healing?

A) In an experiment on dogs, James *et al* (5) studied endosteal blood supply and found that reaming disturbed the endosteal supply. This however returned to normal after 14 days, and remained higher than that for plating thereafter.

These findings would have different applicability in relation to the tibia and femur. In the case of the tibia, a largely subcutaneous bone, endosteal blood supply might be the only supply to the fracture site. Disruption of this would theoretically disrupt all supply to the fracture site and significantly delay healing. In the femur, however, the periosteal blood supply is rich. Temporary disruption of the endosteal blood supply would not be a problem since the periosteum takes over.

In compound fractures of the tibia therefore, unreamed nailing is preferred to reamed nailing by some authors.

Q12) *What are the indications of IMN in compound fractures?*

A) IMN is currently used in the treatment of Gustilo

I,II, and even IIIA and IIIB fractures of the extremities. The adequacy of initial debridement and repeated debridement are two important features that make this application workable.
Infection prevention in compound fractures revolves around stability and adequate vascularity. IMN provides stability without disrupting the periosteal blood supply.

Q13) *What are the entry points in antegrade femoral nailing?*
A) the trochanteric vs. piriform fossa entry points each have their merits and demerits (6). For those surgeons who do open reduction of fractures, and ream retrograde from the fracture site, the piriform entry point is the automatic choice.This entry point enables one to use a nail that is straight in the sagittal plane. It has the disadvantage of potentially disrupting the trochanteric anastomosis which is the main source of blood supply to the femoral head. For closed reduction and nailing, the trochanteric entry point is usually easier to locate. However, it needs a nail that has been bent in the sagittal plane, that is, mediolaterally, if difficulties in distal locking are not to be encountered. Another limitation of the trochanteric entry is the likelihood of getting varus anguation at the fracture site. This is especially notorious in fractures of the proximal third of the femur. The trochanteric entry does not disrupt the anastomosis.

Q14) *What is the concept of exchange nailing and when is it used?*
A) Exchange nailing is done when an IM nail has been used on a patient and the fracture site is found to exhibit nonunion or delayed union. This is usually accompanied by metal fatigue of the nail in situ. The failed nail is then removed and a larger nail placed in after reaming further.In doing this operation, Kuntscher recommended removing the nail via the trochanteric incision used at the time of initial operation without disrupting the fracture callus. Reaming is done via the same incision and a larger nail placed. In Kenyatta National Hospital the author has observed the practice of straightening the leg of the patient while under GA to straighten the nail inside.This makes the process of removing an otherwise bent nail an easier one. For the broken nails one has to remove them via the fracture site. This necessitates going through the fracture callus.

Q15) *What is the role of bone grafting in IMN?*
Bone grafting may be done in 2 stages. At the primary operation, bone grafting may be done if one does open reduction and finds a large piece of bone missing. If closed reduction is done, the reaming procedure has been found to deposit about 25% of the reamings at the fracture site. These reamings have been found to contain potent osteogenic cells that would help in the healing process. In event of delayed or nonunion which is atrophic, bone graft may be used to stimulate bone healing.

Q16) *What is the role of IMN in patients with fragility fractures?*
A) In severely osteoporotic patients the decision is difficult in any case. IMN offers a biomechanical advantage in that the load bearing nail is located within the medullary canal. The placement, entry and locking of such a nail are more difficult than one would suppose. Any bending or shear stresses on the bone while performing reduction of such fractures lead to further fracturing. The concept of hybrid fixation is worthwhile considering whereby one can cement the locking screws to support them. In patients who have end-stage metastatic disease, one may consider cement in the medullary canal to support the fixation. The presence of the cement may prevent fracture healing but that may not be of much consequence.

Q17) When to mobilize a patient after nailing, and when to move from nonweight bearing to Partial Weight Bearing to Full Weight Bearing?
This question hs no clear answer, but varies depending on number of factors including: the patient's build vis-a-vis the nail size; stability achieved after fracture fixation; patient demand; available resources; presence of multiple fractures; and the general state of the patient.

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