

Fixation of femoral fractures with retrograde intramedullary nail

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Abstract

Retrograde intramedullary nail has been increasingly used as a biological method for fixation of the middle and distal part femur fractures. This method can be used also for fixation of simple intraarticular fractures. Locking screws prevent rotational deformities and length discrepancies. Intramedullary nail offers good angle stability. Procedure is relatively rapid and simple. In comparison to other methods earlier weight bearing and faster fracture healing could be achieved.

Introduction

The main causes of fractures of the distal part of femur are strong forces in traffic accidents and falls, direct or indirect. People with weak bone structure, especially older people, can suffer from such fracture even under the influence of weak forces. The most common ways to injure the femur are by hitting the dashboard with the patella stuck between the condyles of the femur, falling on the knee or by jerkily falling forward with the firm distal part of the femur. Indirect injuries are caused by longitudinal action of forces over the stretched knee or upper part of femur. Over 70% of distal femoral fractures are associated with additional injuries (*arteria poplitea*, ischiadic nerve) or are open fractures (1-3).

Indications for use of locking retrograde intramedullary nail

Locking retrograde intramedullary nail is usually used for fixation of fractures of distal femur including intraarticular. In some cases it can also be used for the fixation of femoral shaft fractures. Most fractures are treated surgically, with the purpose to reposition the bone particles as rapid and as good as possible, especially in the case of articular fractures, and achieve the best possible fixation to allow the patient to rehabilitate rapidly.

One of the methods of fixation is fixation with locking retrograde intramedullary nail. It is used in fractures type A1, A2 and mainly A3, where this kind of fixation is especially recommended, and in fractures type C1 and C2 in the AO (Arbeitsgemeinschaft für Osteosynthesefragen) division (picture 1) (1, 4).

Longer locking retrograde intramedullary nail can be used to fixate fractures, combined of distal and middle femoral fractures, or in fractures of the middle and lower parts of the femur, where access with a locking antegrade intramedullary nail is not possible (e. g. in patients with total hip arthroplasty, in non-union proximal femur fractures with implanted osteosynthetic material).

The method is very good for fixation of fractures in older patients with a weak bone structure, in cases of pathological fractures, and in poly-traumatized patients whose condition allows complete treatment. Locking retrograde intramedullary nail is also used for fixation of correc-

tive supracondylar osteotomy and for fixation of supracondylar fractures in patients with total knee arthroplasty (5, 6).

Contraindications

Contraindications are local and general. The most common **local** contraindications are:

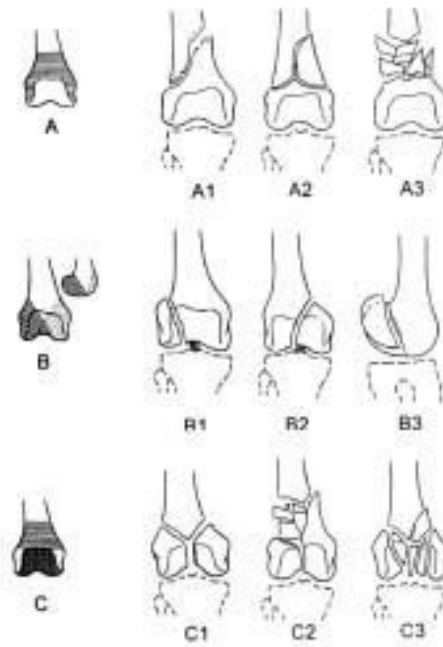
- inflammatory changes in the surgical field (infected scrubs or wounds, skin infections),
- open fracture type IIIIC,
- fractures type B1, B3 and C3

General contraindications are all conditions that do not allow surgery. In poly-traumatized patients not only general condition, but also additional injuries do not allow surgical treatment. The locking intramedullary nail is also not to be used where the growth cartilage is still present in the epiphysis.

The surgical technique

Position of the patient

Operation is performed under general or local anaesthesia. The patient is laid on their back on an X-ray transparent operation table. After preparing the operative field, the knee is bent at an angle of 60-90° over the cover. This way exact access and easier reposition of the bone particles are allowed.



Picture 1. AO classification of distal femoral fractures.

Approach

In intra-articular fractures of the distal femur, where open reposition of the particles is necessary, we perform arthrotomy of the knee at the medial side of patella. We reposition the particles, fixate them with individual nails, and then insert the locking retrograde intramedullary nail.

In fractures that do not require open reposition of the intra-articular particles, we make a short incision directly above the centre of the patella ligament, split the ligament of the patella longitudinally, perform the arthrotomy and display the entry of the intramedullary nail. After completing the surgical procedure, the knee is drained with sub-pressure.

Entry and opening of the intramedullary canal

The entry point for the locking retrograde intramedullary nail lies in the lower part of the inter-condylar fosa in front of the growing of anterior cruciate ligament (picture 3). The opening into the intramedullary canal can be made over the coiled wire, with a cannulated drill or with a bent bodkin.

Reposition of the particles

We must reposition the bone particles before reaming the intramedullary canal. First we try to perform closed reposition. The achieved suitable position must be held during the whole reaming process. We must anatomically reposition intra-articular particles. Simple and unmoved intra-articular fractures often allow closed reposition and fixation, but if not, open reposition is necessary.

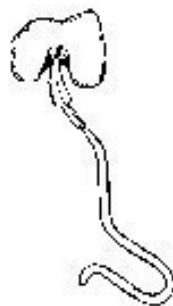
Some extra-articular fractures also require open reposition. Here, minimal approaches should be applied so that we do not remove the periost off the particles. We must monitor the position of bone particles with an image intensifier at all times (7).

Reaming

We insert the guiding wire with a thickened end into the intramedullary canal through the entry, over which we gradually widen the canal with 0,5 mm drills, until it is 1 - 1,5 mm wider than the diameter of the chosen intramedullary nails.



Picture 2. Position of the patient.



Picture 3. Entry point for the nail.

Insertion of the locking intramedullary nail

We insert the locking retrograde intramedullary nail and the locking handle over the guiding wire without the thickened end. The nail must be sunk 1 - 2 mm under the joint cartilage.

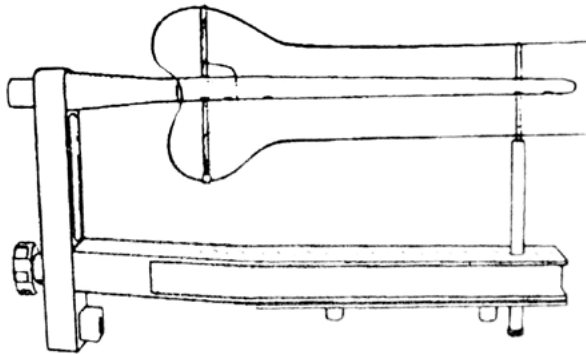
Locking

Locking screws prevent rotation and longitudinal movement of the bone particles. We lock them at the lateral side, with a handle through short skin incisions (picture 4). The number of locking screws depends on the type of fracture, type of intramedullary nail, and the quality of the bone. We should place at least two distal and two proximal locking screws. Special added pieces on the medial side of the screw are used on osteoporotic bones to increase stability. We decide on the length of the screw with the help of a special measure. Proximal locking of the retrograde intramedullary nail requires help of an image intensifier, with the "free hand" technique or with a special reamer.

Post-operative treatment

After the operation, we must support the leg with pillows or with a Braun's brace in a lifted and slightly bent (in the knee) position. We must immediately cool it with cold packs and the patient must do static muscular exercises. After 48 hours the drains are removed, we begin passive exercises on a motorized knee brace. The patient should start assisted active exercising as soon as possible. The patient is encouraged to use crutches from the second day after the operation. In type A1 and A2 fractures, we recommend weight-bearing of 15-20 kg for 6-8 weeks soon after the operation, whereas in type A3 and C fractures, only partial burdening is recommended for 12 weeks or even longer (4, 7).

We take X-ray films of the operated extremity immediately after surgery and before releasing the patient from the hospital. Then X-rays are done after 4, 8, 12, 16 weeks and later if necessary. Patients usually require 10 to 14 days of hospital care, they continue with exercises to improve flexibility of the knee and to prevent atrophy at home or in physical therapy. We usually do not release the patient until they are able to bend the knee at an angle of 90° and stretch it almost completely. The post-operative treatment is individual, depending on the quality of the



Picture 4. Locking the nail with a handle (drill guide).

bone and surrounding soft tissues, the patient's age, and any associated injuries or diseases. We only remove the nail if it causes any problems.

Complications

Intra-operative complications

- problematic position of the bone particles during reposition,
- vessel and nerve damage can occur during reaming of the medullary canal, especially in comminute fractures, fractures with bone defects or in additional surgeries under altered anatomic conditions, or during indirect reposition of major dislocations,
- deviations between the openings on the handle and on the nail can occur when locking the screws, esp. in muscular or over-weight patients,
- angular, axis or length deviations can occur, esp. in comminute fractures,
- the grip of the locking screws is weaker in osteoporotic bones, which must be considered during post-operative treatment (1),
- risk of additional fractures if we do not place the intramedullary nail gently enough,
- system complications during surgery can occur because the content of the medullary canal is embolized. Most common among these are thromboembolism and fat embolism.

Post-operative complications

Most common **early local** complications are:

- uncontrolled bleeding from the fracture area and the medullary canal into the surrounding tissues,
- compartment syndrome,
- infection (mainly depends on the extent to which the surrounding soft tissues have been damaged).

Most common **late local** complications are:

- fracture of the locking screws,
- fracture of the intramedullary nail (usually around the openings for the locking screws),
- loosening of the locking screws,
- non-unions,
- posttraumatic arthritis (depending on the type of fracture).

Most often **early post-operative systemic** complications that can threaten the patient's life are thromboembolism and fat embolism. In rare cases, they can also occur later.

Conclusion

Osteosynthesis of femoral fractures with locking antegrade intramedullary nail is a biological method of fracture fixation. It allows fixation of fractures above the condyles, by-articular and femoral shaft fractures. The main **advantages** are minimal blood loss during surgery, preservation of the periosteal circulation, small operative wound, easy and rapid placement of the nail, good stability, early rehabilitation and rapid bone repair. The main **disadvantage** is the possibility of repeated arthrotomy if the nail is removed.

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