Locked itramedullary nail for fracture shaft of femur Without (or with very low) fluoroscopic control

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Abbreviations:
LIMN= locked intramedulary nail
RTA = road traffic accident

Abstract:

A review of 48 patients sustained a fracture shaft of femur for different mechanism of injury ;RTA ,direct blunt trama ,blast and shell injury, gun shot injury , and pathological fractures .all were operated on by ante grade reamed LIMN Targon aesculap design at al diwaniya teaching hospital from December 2009 to October 2010. the LINM were applied and used without fluoroscopic guidance or very little use , in order to minimize or eliminate the ionizing radiations to surgical staff as well as the patients and it's hazards which may occur due to excessive x ray exposure throughout surgery with mini invasive small incision and open reduction and good perioperative templating

Aim of the study:

Using of locked intramedullary nail for fixation of fracture shaft of femur without (or with very low) imaging intensification guidance

Introduction:

An intramedullary rod, also known as an intamedulary nail or inter-locking nail or Küntscher nail (without proximal or distal fixation), is a metal rod forced into the medullary cavity of a bone. IM nails have long been used to treat fracture of long bones of the body. Gehard kuntscher is credited with the first use of this device in1939[1,2] during World War II , for soldiers with fractures of the femur. Prior to that, treatment of such fractures was limited to traction or plaster, both of which required long periods of inactivity.

IM nails resulted in earlier return to activity for the soldiers, sometimes even within a span of a few weeks, since they share the load with the bone, rather than entirely supporting the bone[3].

Although stainless steel was used for older IM nails, titanium has several advantages, including lower mechanical failure rates and improved biocompatibility[4]. However 1939[1,2] during World War II, for soldiers with fractures of the femur , the biggest problem with the earlier designs was the failure to prevent collapse or rotation in inherently unstable fractures. This was addressed by the introduction of the concept of 'locking' of the nails using bolts on each end of the nail (thus fixing the nail to the bony cortex and preventing rotation among the fragments), leading to emergence of locked IM nailing, which is the standard today[3].

Locked intramedullary nailing is the treatment of choice not only in diaphyseal fractures of long bone but also in most metaphyseal and periarticular fractures.[5]

Locked intramedullary nailing has transformed the management of long bone fractures. Intramedullary nails act as loadsharing devices in fractures and are subjected to smaller bending loads than plates [1],thus, they are less vulnerable to fatigue failure and patients can be mobilized as early as the first postoperative day. Additionally, stress shielding with resultant cortical osteopenia, commonly seen with plates and screws, is avoided with intramedullary devices [1]. Therefore, refracture after implant removal is rare with the use of this device. There is also lower infection rate and higher union rates with minimum scarring with intramedullary nailing [2] , this is because extensile exposures required in plate fixation are not necessary and with image intensifier both fracture reduction and implantation of the device can be done as a closed procedure.

In most cases, especially in advanced countries, an image intensifier is a prerequisite for the procedure. This permits minimal access surgery where closed reduction is possible while the nail is inserted with the aid of a guide wire. the risk of radiation exposure has made the researchers over time to develop techniques of interlocked intramedullary nailing that is possible without an image intensifier or little use regarding time and dose exposure[5]

During the use of intraoperative imaging intensification , surgical staff and patients are exposed to both direct and scatter radiation. Direct radiation is the radiation absorbed from the beam as it projects from the source. Direct radiation is the predominant source of radiation exposure for the patient and surgeon. Scatter radiation is radiation from the source that is deflected off of a surface, typically the patient in an operative setting. Scatter radiation exposure is the primary form of exposure for operative staff who stand further away from the surgical table. While many different types of radiation exist, the most concerning in regards to the development of pathology is ionizing radiation. Ionizing radiation from intraoperative imaging leads to cellular damage through the induction of direct or indirect DNA lesions and production of reactive oxygen species[6,7]]. The ensuing cellular stress response can lead to cell death *via* replicative or apoptotic mechanisms[6]. Conversely, if cell death does not occur, the risk of neoplastic proliferation may be increased due to the persistence and replication of cells with DNA lesions and subsequent genomic instability[7].and the gonads and thyroid are the most affected organs as well as eyes and hands for the surgeons .

Patient and method

The study included 48 patients with femur bone fractures , 34 males and 14 females aging from19 -63 years were admitted to emergency unit at al diwaniya teaching hospital from December 2009 to October 2010 .

The causative mechanism as follows :

30 patients by RTA

8 building workers underwent blunt trauma

5 with shell and gun shot injury

3 pathological fractures

2 were non union old fracture

39 of them were closed fractures and other 9 were compound The compound fractures were simple compound from within by the bone itself and the other gun shot or shell injury were inlet without outlet and 2 of them were inlet and outlet

3 fractures were segmental; 2 of them the fracture was at shaft level and 1 in form of shaft and subtrochantric fractures ,11 of them were multiply traumatic patients in form of fractures femur associated with other bone injuries like tibia and fibula , radius , ulna and humorous which had been dealt with them separately ,

7 of patients associated with different types and degrees of head injury and brain concussion.

All of them admitted to casualty and fully evaluated by live saving measures : care about respiration ,heamodynamic status and consciousness level ,i.v lines , complete exposure ,abdomen and chest , pelvis and limbs examination and stabilization of legs by Thomas splint to prevent movements at fracture site.

All of patients were received blood transfusion and iv solutions thoroughly specially the RTA and gun shot and shell injury cases and iv dose of cephalosporin for compound fractures and full examination by general ,neuro, vascular and uro surgeons and thorough saline irrigation for wounds.

After improvement of general conditions all patients were transformed to orthopedic word except head trauma patients were transformed to neurosurgery word where managed there and put under observations until their conditions in respect to head injury and consciousness level was improved then transformed back to our unit.

Skin tractions with suitable weight were applied to injured limbs and saline irrigation and wound care day and night for the compound fractures

All operations done at the second or third days after the injury due to limitation of facilities but the cases with head injury after 5-7 days from time of injury

Operative technique:

All operations done under spinal anesthesia except 9 patients were general anesthesia was used instead .

At the orthopedic table (except cases of non union at simple surgical table) all operations had been done with adduction of both affected limb and trunk at supine position where preliminary traction started to achieve muscles stretching .

small incision about 3-5 cm(but larger in non union cases) and by direct joystick we grasp and expose the fracture ends without striping(saline irrigation for compound fractures and simple tissue debridement).

retrograde reaming and penetration of proximal femoral fragment by simple rigid small sized reamer (9 mm) .

remove the reamer and insert the distal ball end guide wire instead retrogradly, pushed it up out of femur gently in the soft tissue until it's end felt subcutaneously at gluteal region , make incision over it's head (1cm) .

pull out the guide wire until it's distal ball end matching the fracture level .

reduction of fracture by 2 joysticks or small bone clamps with interdigitation ,push the guide wire into distal fragment for a length which ascertain pre and intra operativly by direct templating and measurement from the level of proximal end of distal fragment until the prominence of lateral condyle of femur without using x -ray guidance .

release the traction and compress the fracture site

reaming the canal with graduated sized flexible reamers on the guidance of wire until seating takes place.

inserting a suitable sized nail and pullout the guide wire

inserting the proximal locking screw with the aid of proximal locking screw guide handle and leave the sleeve attached.

compress the fracture site again and ascertain the length of the nail from fracture level to proximal hole of distal locking screws by tape measure as near as possible

ascertain the point by awl pit ,drill the lateral cortex at the awl pit by 4.5mm reamer .

by a thin awl or small size k wire handled by the hand ,we look for the lateral nail hole then the medial one.

if we find difficulty to locate the lateral hole we can use the flouroscopy for this step , and drill a k wire only to piers the lateral cortex of the femur , drill the lateral cortex of the bone by a same canulated reamer over the wire to widening the hole ,remove the c arm and wire ,and by the same thin awl handled by the hand we locate the nail holes .

drill a k wire through nail and cortices , then canulated reamer over the wire to drill the medial cortex of the bone and inserting the locking screws

close the incision with the usual ways.

Results:

follow up was continue 1-2 years.

2 of patients of pathological fracture were dead during first month after surgery due to tumor metastasis .

Other patient of pathological fracture show delayed union.

As the cause of delayed union due to the defect at the bone it's self and the death due to the poor medical condition so we exclude the pathological cases from the study

No infection ,all fractures were readily united and no delayed union .

Bone grafts were used in both non united cases from ipsilateral iliac crest chips .

weight bearing by sitting on the chair and flexion of the knee at first week (end of second week to cases with bone graft) and standing with partial weight bearing with aids at second week.

Wallking and full weight bearing with crutches at the third week .

No need for dynamization in all cases

Time needed from incision until the guide rod crossing the fracture site was 5-10 minutes with mean time of 7.5 minutes

Time needed to locate the distal lateral locking hole without fluoroscopic control was 5-10 minutes with mean time of 7.5 minutes.

Time needed to locate the distal lateral locking hole with fluoroscopic control was 5-8 minutes with mean time of 6.5 minutes.

Step of technique	Time needed	Mean time
From incision to guide rod cross fracture site	5-10 minutes	7.5 minutes
locate lat. Hole without C arm	5-10 m	7.5 m
locate lat. Hole with C arm	5-8 m	6.5m

31 case we could locate the lateral hole without fluoroscopic control in a 64.6 %

17 cases need fluoroscopic control in percent of 35.4% and all of them were obese or high muscular mass with large diameter of the thigh .

Lat hole locating	No. of cases	percent
Without C arm	31	64.6%
With C arm	17	35.4%

Discussion:

Interlocked intramedullary nailing is a standard technique for internal fixation of femoral fractures. It has the capacity to prevent malrotation, shortening and angulation of comminuted femoral fractures [8].

During the use of intraoperative imaging intensification , surgical staff and patients are exposed to ionizing radiations and many cases of gonads , thyroid ,eyes and hand neoplasias among the surgical staff , imaging intensification was blamed[6,7] .

Locked nail of fracture femur itself need more x ray usage than other bones due to great muscle mass around.

X ray guide in locked nail of fracture femur use in many steps throughout procedure as follows : in reduction, entry point localization , driving a guide wire in the entry point then inside the distal fragment to cross the fracture site , ascertain the distal level of nail ,checking the fracture site during reamer insertion through distal fragment and the highly demanding step is the challenging free hand locking screws .

Achieving reduction by closed way need sometime massive traction through the knee joint particularly in young sport men and obese patients which may affect the restraint of knee ligaments while this complication can be overcame following our way of small and mini invasive incision and open reduction as well as less time and interdigitation reduction which enhance perfect alignment ,rotation controlling , bone length restoration and primary callous formation .

Retrograde insertion of guide wire will ease the difficulty of antegrade entry ,little gluteal tissue dissection and distraction, abbreviate surgical time and leaving tinny neglected scar .

Almost always in closed reduction guiding the guide wire crossing the fracture site through distal fragment spend a lot of time and fluoroscopic usage.

Distraction at fracture site and fragments displacement could be encountered again in closed reduction during reaming specially for type II winquist system of classification which needs another x ray checking .

All these steps are time consuming and need more x ray guidance hence more radiations.

At the end ,the most challenging ,time consuming and high x ray requirement step is the free hand distal locking screw , where first instance is to make a circular hole appearance by pure lateral view which spend allot of C arm shots ,then the tip of the awl must be appear inside the hole at 45 degree which mean another set of radiation followed by reaming the hole by positioned the reamer to appear as a dot at the centre of the hole which requires additional x ray shots and time consuming.

By our modified bashful way we will spend less time and no x ray (or little) usage ,and by time we found that the location of the hole is not as challenging as thought .

By measuring the length of the proximal half of the nail from it's top to fracture level we can ascertain the length of the lower half and hence the distal hole level direct at the femoral condyle at primarily prepared bone cortex by small 1-2 cm stab wound and using an awl to make a clear pit corresponding to templating point at the mid way of lateral cortex at sagital plane and drill a thin k wire in .

by good and accurate templating , about 2\3 of the cases we located the lateral hole without need x ray aid ‘ another 1\3 were failed and calling for c arm aid just to find the lateral hole where most of them were obese or with mass muscular thigh.

The steps to locate the lateral hole without c arm as follows :

drilling the lateral cortex at the awl pit by 4.5 mm reamer and positioned the drill at the plane of sleeve of the proximal locking screw and perpendicular to the long axis of the bone , then handle a thin awl or a k wire in the hole easily up and down ,forward and backward to locate and pass inside the nail hole ,then to feel the medial hole and piers the medial bone cortex which can felt by the tip of awl .

if we found a difficulty to locate the lateral hole we can use the c arm in limited time and put in mind that almost always that we are so close to the hole by accurate templating the fracture site hole distance ,arrange the c arm to take a lateral view with the drill and wire and bring the drill parallel and in line with the fluoroscopic beam. Take care to maintain constant pressure to avoid movement of the drill tip. The trick point is once we correspond the awl pit to the level of the hole at the length of the bone ,we haven't any need to use the x ray guidance again by enlarging the lateral cortical hole and handling a thin sharp awl to look for and locate the nail hole.

Conclusion :

=Purely closed LIMN of shaft femur fracture need high imaging intensification using and hence high radiation for the surgical staff and patients

=high radiation represent a real hazard

=meni invasive incision for open reduction and wire guide insertion will abbreviate the x ray using and shorten the operative time

=good and accurate length templating measurement at the nail will locate the distal locking hole in LIMN of femur in more than 70% without the aid of c arm .

=rate of union of reamed LIMN of shat femur is great and it is the implant of choice

Recommendations:

- restriction of using x ray guide in theater is recommended which can be achieved by good pre , and itraoperative templating and plane .
- LIMN is the implant of choice in fixation of fracture shaft of femur.
- training and experiance is crucial.
- We encourage research to find another tool rather than x ray aid in LIMN

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