SUDAN UNIVERSITY OF SCIENCE AND TECHNOLOGY
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APPLICATION OF BONY SHUTTLE PIN SPLINT FOR DIAPHYSEAL FEMORAL FRACTURES IN DOGS

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بِسْمِ ٱللَّهِ ٱلرَّحْمَٰنِ ٱلرَّحِيمِ

وَضَرَبَ لَنَا مَثَلًا وَنَسِيَ خَلْقَهُۥ ۖ قَالَ مَن يُحْيِ ٱلْعِظَٰمَ وَهِيَ رَمِيمٌ ﴿٧٨﴾
قُلْ يُحْيِيهَا ٱلَّذِىٓ أَنشَأَهَآ أَوَّلَ مَرَّةٍ ۖ وَهُوَ بِكُلِّ خَلْقٍ عَلِيمٌ
﴿٧٩﴾ ٱلَّذِى جَعَلَ لَكُم مِّنَ ٱلشَّجَرِ ٱلْأَخْضَرِ نَارًا فَإِذَآ أَنتُم
مِّنْهُ تُوقِدُونَ ﴿٨٠﴾ أَوَلَيْسَ ٱلَّذِى خَلَقَ ٱلسَّمَٰوَٰتِ وَٱلْأَرْضَ
بِقَٰدِرٍ عَلَىٰٓ أَن يَخْلُقَ مِثْلَهُم ۚ بَلَىٰ وَهُوَ ٱلْخَلَّٰقُ ٱلْعَلِيمُ ﴿٨١﴾
إِنَّمَآ أَمْرُهُۥٓ إِذَآ أَرَادَ شَيْـًٔا أَن يَقُولَ لَهُۥ كُن فَيَكُونُ ﴿٨٢﴾
فَسُبْحَٰنَ ٱلَّذِى بِيَدِهِۦ مَلَكُوتُ كُلِّ شَىْءٍ وَإِلَيْهِ تُرْجَعُونَ ﴿٨٣﴾

صَدَقَ ٱللَّهُ ٱلْعَظِيمُ

سُورَةُ يسٓ

بسم الله الرحمن الرحيم

Dedication

To every one in my family specially you..

My Mother

Haitham

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Haitham

ABSTRACT

Bony shuttle pin splints were obtained from slaughtered camel metacarpal bone and used successfully for repair of induced diaphyseal femoral fractures in small dogs.

Clinical and radiographical follow-up of these cases showed that this type of splint is effective for immobilization of the diaphyseal femoral fractures.

Bony shuttle pin splints, obtained from other sources (bovine) were used for immobilization of the diaphyseal femoral fractures in dogs, but none of these bony intramedullary pins were strong enough to support the fractured femur more than few days due to the process of decalcification of the bony pins at the fracture line.

الخلاصة

استعمال الجبيرة العظمية المكوكية لكسور عمد عظم الفخذ في الكلاب

تم استخدام الجبائر العظمية المكوكية الماخوذه من عظام الإبل المذبوحة بنجاح لشفاء الكسور المستحدثة في عظم فخذ الكلاب. ومن خلال متابعة الحالات سريريا وشعاعيا لوحظ بأن هذه الجبيرة جيدة لتثبيت كسور عمد عظم فخذ الكلاب الصغيرة.

وتمت مناقشة ووصف التقنية الجراحية لاستحداث الكسر وتثبيت هذه الجبائر .

INTRODUCTION

The incidence of femoral fractures in dogs is about 80% (Slatter, 1995). It commonly occurred in the diaphysis of the femur and fractures are mostly simple, transverse and oblique.

These fractures are commonly treated by internal splints mostly Intramedullary Pin splints and some of them with bone splints.

These techniques need special surgical instruments, Pins, Plates, Screws, Pin chuck and Pin cutters that are costly and most of these splints need a second operation for removal of the splint.

Permanent Shuttle pin is easy to apply and efficient for proper alignment and immobilization. (Shnain, Khalid and Markus, 1989).

In this study bony shuttle permanent intramedullary pin splints (Camel metacarpal bone) are used instead of the metallic pins.

Objectives: -

1- This study is planed to find out the possibility of immobilization and fixation of the femoral fracture segments in dogs using bony shuttle pin splints which were obtained from camel metacarpal bone.

2- To reduce the cost of treatment.

3- No need for another operation to remove the splint after healing.

CHAPTER ONE

LITERATURE REVIEW

1.1 Diaphyseal femoral fractures

The incidence of femoral fractures is about 80% in dogs of all ages and probably accounts for half of the fractures that occur in this species (Dingwall *et al*)

These fractures are usually due to direct external violence, in spite of the fact that the femur has the best muscular protection than any other bone in the body (Brinker, 1957).

Clinical signs following these fractures are general signs which are commonly attributable to any injury (loss of function and Shock) and local signs such as, abnormal mobility, deformity, crepitation and pain (Brinker, 1994).

Type of fractures may be simple, compound or complicated depending on the severity of the accident (Brinker, 1994 , Slatter,1995).

1.2 Diagnosis of fractures

The diagnosis of the fractures by clinical examination and radiograph Lateral radiograph should be taken not only to confirm the fractures diagnosis, but to have an idea about the type and direction of the fracture (De Young, 1985, Probst, 1985,Slatter 1995).

1.3 Reduction of the Fractures

Reduction of the fractures refers to the procedure by which the fractured segment is approximately returned to its original position (Brinke, 1957).

1.3.1 Methods of Reduction

1.3.1.1 Closed reduction

In this method, the fracture is reduced without skin incision or exposing the bone (Brink, 1957).

1.3.1.2 Open reduction

In this method, the reduction which will ensure the proper alignment of the fractured segments is done through an incision to expose the bone and manipulate directly the two segments (Brink, 1957).

1.4 Methods of fracture fixation

1.4.1 External fixation:

1.4.1.1 Coaptation:

Coaptation is the oldest method of fracture fixation, dating back to some five thousand years, it still has its place in our modern orthopedic surgery because of its simplicity and effectiveness in certain types of fractures (Hickman1964, Leonard, 1968).

These splints are made from different materials such as the basswood, aluminum sheeting, alufoam and x-ray film (Brinker, 1957, Hickman,1964).

Coaptation should be durable yet as light as possible and least Cumbersome. (Leonard, 1968; Brinker, 1957).

* Mason Metal splints

These are spoon shaped metal splints. Earlier models were made of aluminum. They are available in different lengths and sizes. Nowadays plastics similar in shape are available.

*Plaster of Paris (Gypsum)

This is a solid crystalline mineral which becomes harder after being impregnated with warm water and squeezed gently. It is then applied as bandage or moulded with the limb shape (Hurov *et al*).

* Aircast

This is a plastic coarse woven cloth that hardens into cast when soaked in a catalyst. This material allows air to reach the skin easily. It is applied to the affected part as a bandage after wetting with the catalyst (Leonard, 1971).

Complications of coaptation splint include, delayed and non-union of the fractured segments, pressure and rub sores, edema, dermatitis, restriction of the joint movements which may lead to muscles atrophy, split breakage and refracture.

1.4.1.2 Modified Thomas Splint:

Modified Thomas splints are most valuable for large animals when combined with some other immobilization device, i.e., internal fixation or plaster casting. Modified Thomas splints can be used for radial and tibial fractures that are not suitably immobilized by a cast alone (Oehme, 1986).

1.4.1.3 Kirschner-Elmer splint (half pin splintage):

In this method has several pins are driven into the parts of the fractured bones on either side of the fracture in an angle not less than 35° between each two pins and which are then held in position by an external clamp and a connecting bar (Leonard, 1971 and West, 1995).

1.4.1.4 Full pin splintage: (Eggae andGreenwood, 1985).

All fixation pins penetrate the skin both sides and the bone cortices These pins are attached to connecting bars on both sides.

1.4.1.5 Modified spica splint and lateral splint:

These splints are made from plaster of paris or any other material.

They are applied on the lateral surface of the limb in greenstick or non- displaced fractures (incomplete types of fracture) (Egger and Greenwood, 1985).

1.4.2 Internal fixation:

Internal fixation refers to the immobilization of bone fragments through the use of metal devices exerting restraining forces on the bone wholly from within the body itself (De Young and Probst, 1985).

These metals may cause more inflammation if the soft parts are unduly traumatized during its application (Ehmer, 1974, West, 1995).

According to internal fixation have the following advantages:

Alignment is relatively in normal position, rigid fixation; it decreases the restriction on the joint movement, there is no muscular atrophy and the animal can not remove them because they are buried inside the body (Singlton, 1966; Stoloff, 1983).

Many devices are used for internal fixation and these vary in shape, material and application techniques.

These devices are:

1.4.2.1 Intramedullary pins

This is the most commonly used system of internal fixation in small animals. They are primary used in human and modified for animals (Nunamaker, D.M., 1985).

The devices used in veterinary practice include: -

The Steinman pin (Kirschner intramedulary pin), Kirschner wire, Rush pin, Kuntscher pin and Shuttle pin.

Most of the intramedullary pins are applied by the open reduction method, occasionally, some of the intramedullary are derived by closed reduction (Ehmer, 1974).

1.4.2.1.1 Steinman intramedullary pins: (Hurov, 1978)

The round pins are used more frequently for intramedullary fixation. They differ in length, diameter and shape of their points (Appendix 1a, 1b).

They are also classified as threaded and non-threaded intramedullary pins depending on their points.

Since the Kirschner intramedullary pins are round, the problem of long axis rotation should always be considered, particularly in the smooth Transverse fracture. This can be avoided by applying an external splint for one week as an additional support (Paul and Crumley, 1984).

14.2.1.2 Kuentscher nails:

These nails (Appendix 2) are used for proximal and mid-diaphyseal femoral fractures (De Angiles, 1975).

They are effective if the fracture is smooth transverse or oblique.

The size of K- nail is very important because the femur can be shattered to pieces if the nail is too large, and if is driven through the medullary canal forcefully.

The application of K-nails is best accomplished by open reduction because all parts exposed will be under control

1.4.21.3 Rush pin (De young and Probst, 1985)

Rush pinning as described by Rush has limitations. However in veterinary medicine, rush pins are used in pairs for fractures of the distal part of humerus and femur.

Rush pins (Appendix 3) may also be used to treat fractures of the central third of the diaphysis of both humerus and femur in dogs (Nunamaker, 1985).

They can be inserted either individually or in pairs.

1.4.2.1.4 Shuttle pin (Leighton, 1950)

This is a modified form of permanent intramedullary pinning (Appendix 4).it is a metal, diamond-shaped intramedullary pin with central hole in order to facilitate its traction from the proximal of the fractured bone after alignment. segment

Successful use of this pin has been reported in radiuu,ulna,tibia and the femur of small animals (Shnain and Markus,1995).

In this technique (Leonard, 1971 and Hurov, 1978) Open reduction is performed and the medullar cavity of the bone segments is reamed to facilitate introduction of the pin.

Long silk or wire suture is threaded through the central hole of the pin, then the pin is inserted in the long segment of the bone until a tiny portion of the pin protrudes. The alignment of the fractured bone is done and the thread is twisted to pull the pin across the fracture line (Leonard, 1971 and Hurov 1978).

CHAPTER TWO

MATERIAL AND METHODS

2.1 Animals:

Five local breed dogs, 10-20 Kg in weight were used. All animals were examined clinically and kept for two weeks in cages (1/1/1 M in size) in the Veterinary Teaching Hospital, College of Veterinary Medicine and Animal Production.

2.2 Splints:

(Bony shuttle pins)

Round pins were made from metacarpal bone of healthy and freshly slaughtered camel.

The bones were cleaned properly and cut with an electric saw into proper width slats, and then with an electric grindstone. Different sizes of pins were made with notch in one of its ends. The bony

Shuttle pins were wrapped in papers and autoclaved for 30 min. at 121ċ.

Pins of different lengths and diameters were sterilized and some of these Splints were re sterilized many times and kept in a closed surgical drum ready to be used.

2.3 The procedure: (operation)

A mixture Ketamine and Xylazine was administered intramuscularly as anesthetic agents. Half of the mixed calculated dose (Ketamine Hcl 15mg/kg, Xylzine 5mg/kg BW) was given to make the animal lightly anesthetized in order to prepare the surgical site. (Fig. 1).

The other half of the dose was given before surgical operation.

The preparation of the surgical site was extended high up to the midline of the back and down to the distal third of the Tibia.

The animal was positioned laterally on the surgical table on the opposite side and restrained. (Fig. 2)

The prepared leg was covered with thin layer of cotton impregnated with alcohol, and then the prepared leg was picked up after the surgeon had been ready. (Appendix 4a,4b,4c,4d)

The surgical line extended from the major trochanter down to the lateral condyle of the femur. Skin was incised over the diaphyseal part of the femur along the surgical line. Then, the fascia lata was incised as close as possible to the anterior border of Biceps femoris muscle (Leonard, 1988).

The Vastus lateralis and Biceps femoris muscles were retracted to expose the femur. (Appendix 5,5a,5b).

Fig.1 Surgical site preparation

Fig.2 Animal positioned laterally

Part of the adductor muscle attached to the posterior part of the femur was separated to pass two long curved scissors under the femur, one opposite to the other and kept open to protect the underlying structures from being injured during induction of diaphyseal partial fracture. This was started with gigli wire saw and then completed with a heavy tool to produce an uneven fracture (Appendix 6).

After choosing the proper size and length of the bony pin reaming of the proximal and distal segments of the femur was performed (Appendix 7)

Bony pin was hocked with no 1 nylon thread, held with an artery forceps and then introduced into the proximal segment to about a few Millimeters of the bony pin appears out of the proximal segment, Then reduction and alignment of the fractured femur is done pin is pulled into distal segment to about half of its length estimated from the nylon thread which is hocked into the notch of the bony pin and signed with the artery forceps.

Procaine penicillin powder is sprayed on the fractured area, then the wound closed by simple continuous suture using absorbable suture (cat gut no 2/0) to approximate the fascia lata, and the skin was sutured with simple interrupted stitches using No 2/0 Surgical silk. Postoperative doses of Procaine penicillin were used intramuscularly for five days.

Immediate postoperative mobilization and weight bearing was allowed as soon as it is tolerated by the operated animals.

2.4 Radiographically:

Lateral view radiographs (50 Kv, 0.2 Sec) of the fractured area were made immediately after operation and then at 2, 4, 6, and 8 weeks. Then the healing and reaction to Splints was monthly followed-up.

CHAPTER THREE

RESULTS

Clinical and Radiographical Findings

Clinical examinations and the follow up of the general condition of the operated animals were made to assess recovery and bone healing.

All operated animals were followed until the clinical and radiological Healing is satisfactory.

Case no (1)

A- Clinically:

Adult dog weighting 10-Kg was operated to induce transverse fracture in the midshaft of the femur. Bony shuttle pin splint (camel metacarpal bone) was applied without any external support. The animal stood on his operated leg on the 15th day after operation and walked on the 17th day without any complications.

B- Radiographically:

X-Ray was taken immediately after operation to check the fractured region and the position of bony pin (Fig.3).

Another X-Ray was taken after 20 days (Fig.4), Callus formation started to cover the distal and proximal segments.

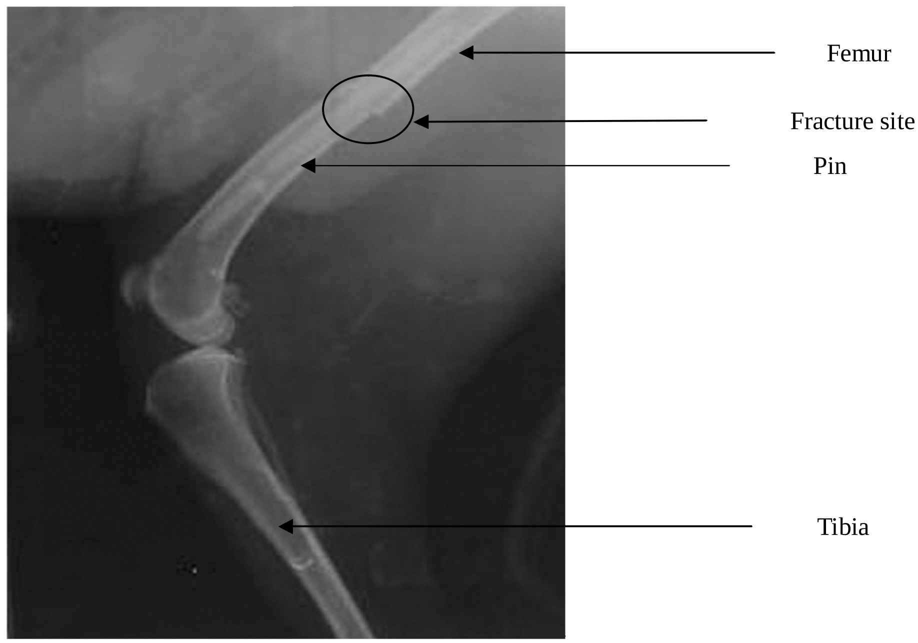


Fig.3 X- Ray immediately after operation

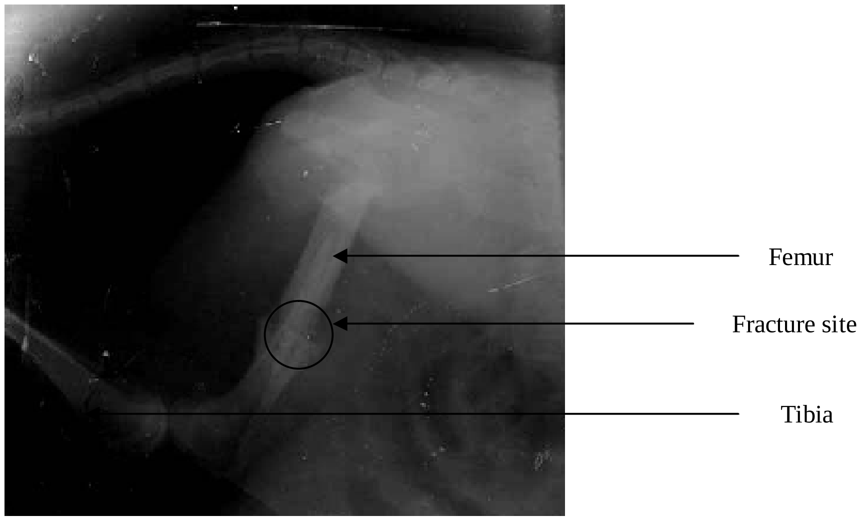


Fig.4 X- Ray 20 days after the operation.

Case no (2)

A- Clinically:

15 kg Adult dog was operated to induce an oblique femoral fracture on the left leg.

Bony intramedullary pin (camel metacarpal bone) was applied without any external splint.

The animal stood on his operated leg on day 10 after operation and walked at the 15^{th} day after operation

No infection or complication appeared.

After one month the animal started to run and jump.

B- Radiographically:

X-Ray was taken on day one after operation to check the fractured region and the position of bony pin (Fig.5).

At 15^{th} day there was callus formation (primary callus), (Fig.6).

After one month further callus formation ((secondary callus)) started to Cover the distal and proximal segments of the Femur (Fig.7).

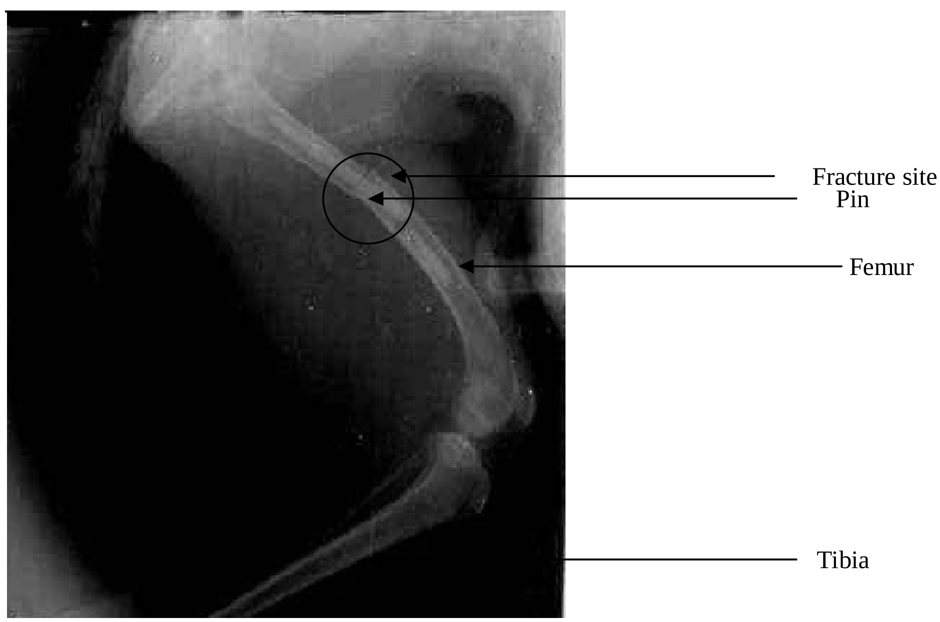


Fig.5 X- Ray one day after the operation.

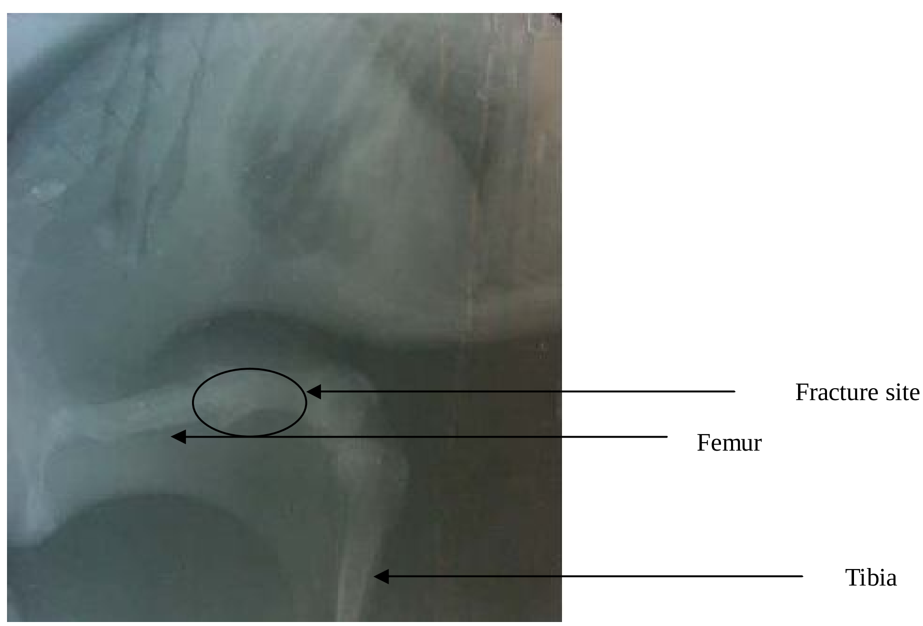


Fig.6 X- Ray 15 days after the operation.

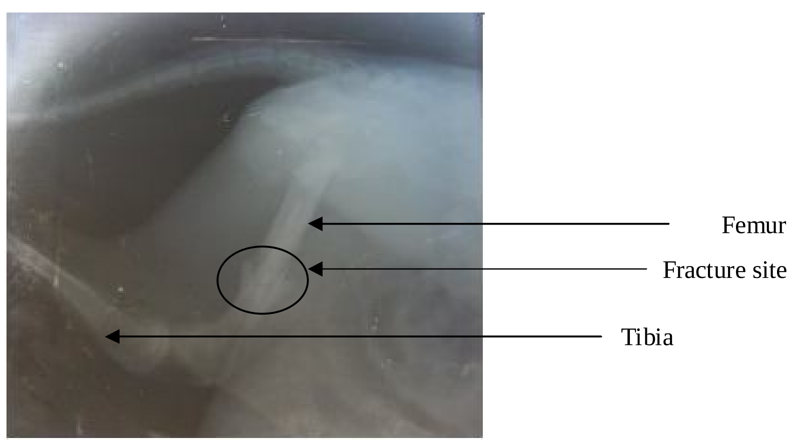


Fig. 7 X- Ray one month after the operation (secondary callus formation)

Case no (3)

A- Clinically:

18 kg Adult dog was operated to induce an artificial oblique femoral fracture and bony shuttle intramedullary pin was applied without any external supports.

Palpation and clinical examination were done one week after operation.

Animal stood on his operated leg on the 7^{th} day after operation.

Primary callus started on second week after operation.

B- Radiographically:

X-Ray was taken immediately after operation to check the pin position, (Fig.8), and another radiograph was taken two weeks after primary callus was formed (Fig.9).

The animal died 30 days after operation due to severe diarrhea.

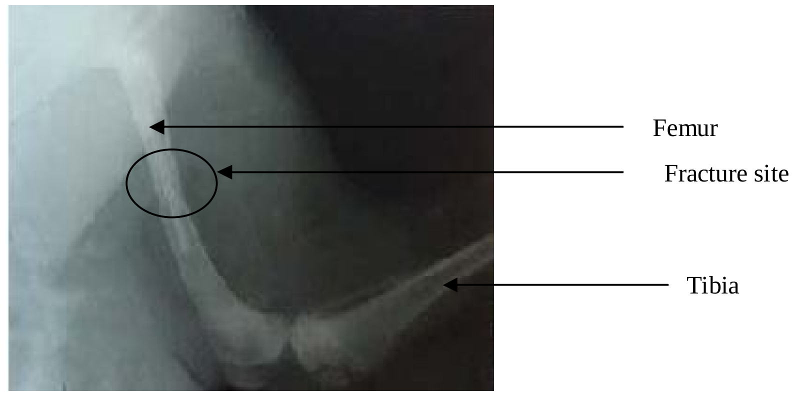
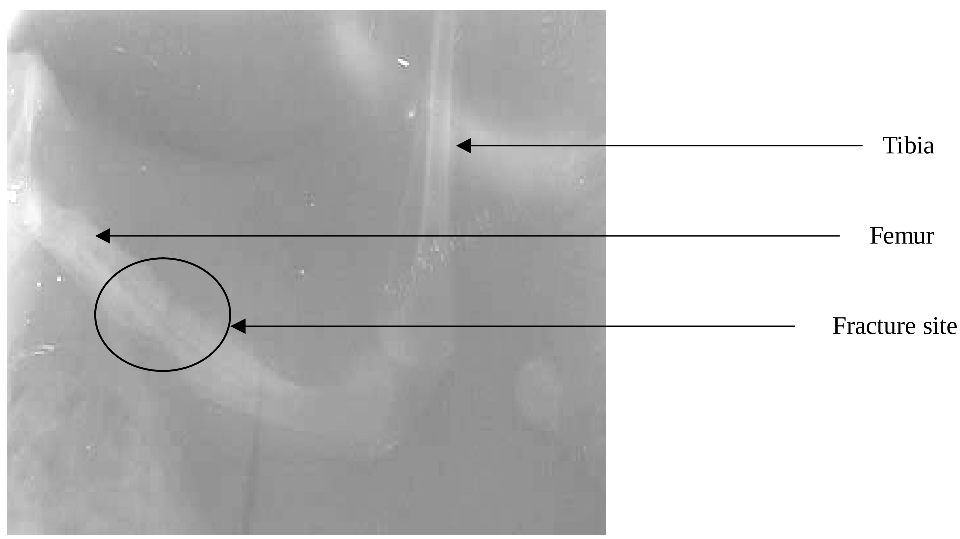


Fig.8 X-Ray immediately after the operation



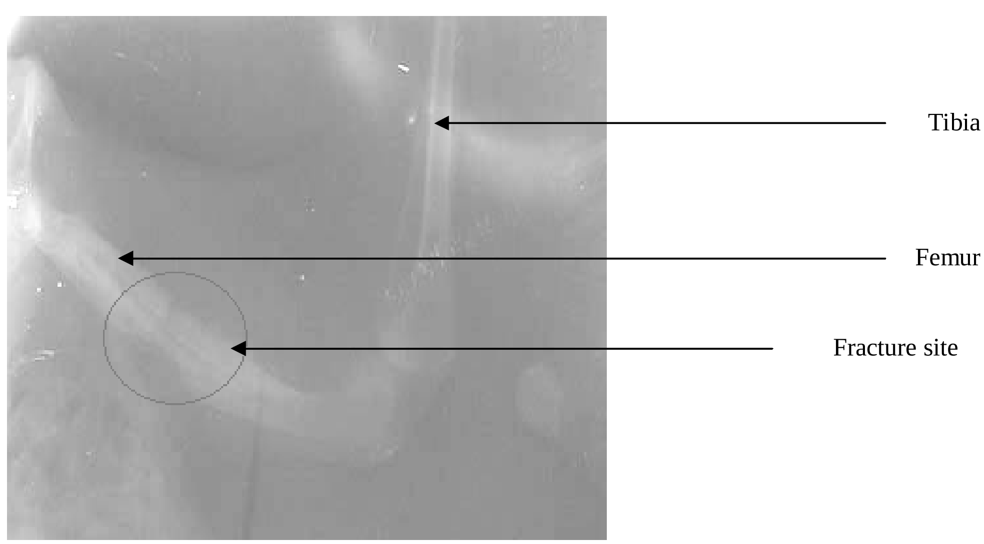


Fig.9 X-Ray 2 weeks after the operation
(After primary callus formation)

Case no (4)

A- Clinically:

20 kg Adult dog was operated to induce transverse femoral fracture and bony shuttle intramedullary pin was applied without any external supports.

Animal stood on his operated leg on the 7^{th} day after operation.

At day 20 after operation the animal walked and suddenly ran, so the primary callus, which was formed, was refractured and for this reason Non union and delayed healing occurred.

B- Radiographically:

X-Ray was taken immediately after operation to check the pin position inside the medulla (Fig.10).

At the 10th day, there was no callus formation but fractured region immobilized properly.

At the 2nd week, the primary callus formation started on the segments of the fractured femur.

The primary callus, which had been formed, was refractured.

At the 20 Non union and delayed healing occurred. (Fig.11).

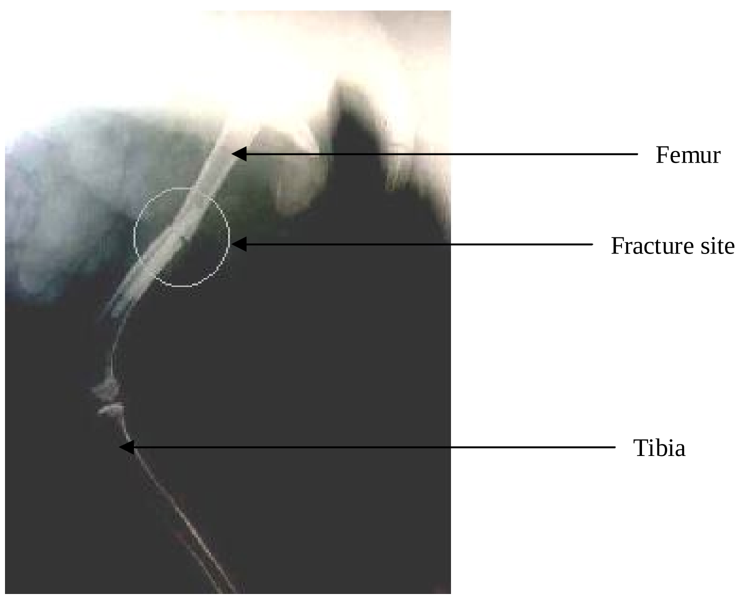


Fig.10 X-Ray immediately after the operation

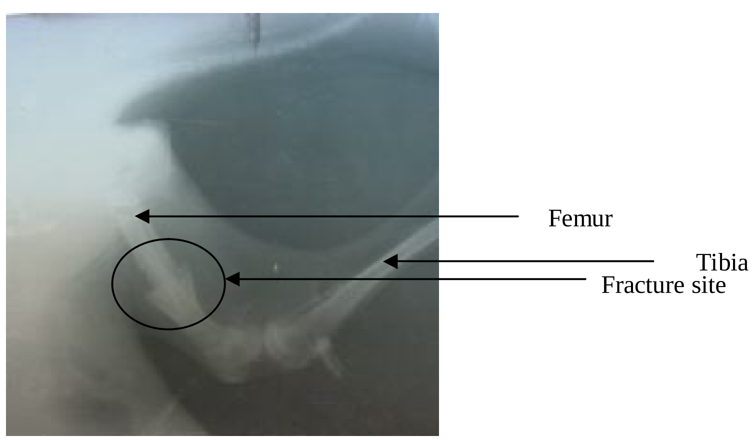


Fig11 X-Ray 20 days after the operation

Case no (5)

A- Clinically:

25-kg cross-breed dog was operated to induce transverse femoral fracture and intramedullary bony shuttle pin was applied without any external supports.

The animal stood on his operated leg on the 3rd day after operation.

Bony shuttle pin splint was broken on the 6th day after operation; the dog showed swelling on the fractured area with painful inflammatory signs.

The animal was unable to put his weight on the affected leg.

B- Radiographically:

X-Ray was taken immediately after operation to check the position of the bony shuttle pin.

Another radiograph was taken on the 6th day after the appearance of swelling and inflammation.

The bony pin was broken and the segments were displaced (Fig.12).

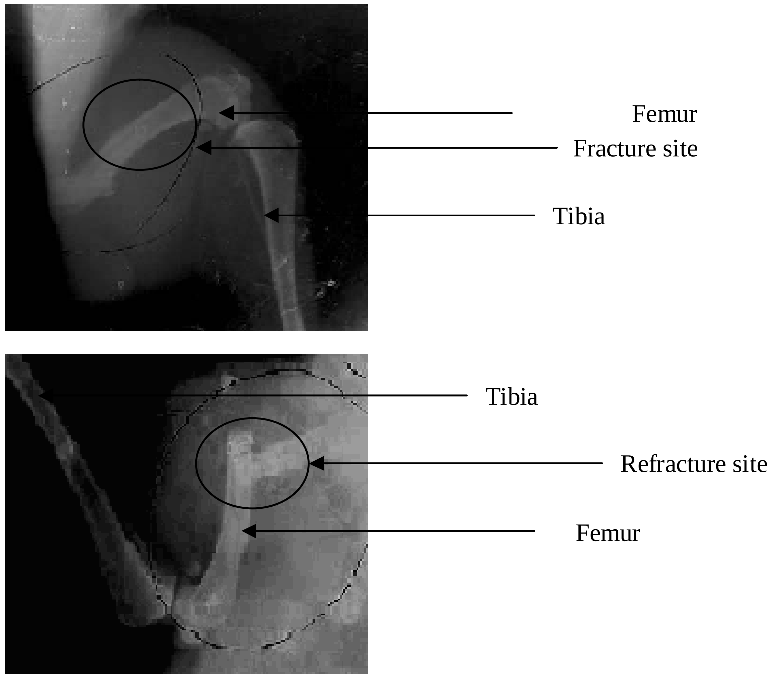


Fig.12 The broken bony pin

CHAPTER FOUR

DISCUSSION

Many external and internal splints are used to immobilize fractures in dogs, but only internal splints are usually suitable for femoral fractures fixation, such as intramedullary pins and bone plates (Leonard, 1971; Slatter, 1995).

The bony intramedullary pins such as bovine bony shuttle pins have been used for immobilization of the distal third fractures of the radius and tibia in dogs (Shnain, Khalid and Markus, 1989; Kadhim, 1989).

The bony intramedullary pins such as bovine bony shuttle pins have been used for immobilization of mid-shaft femoral fractures in dogs, but unfortunately they are not successful. Failure of this type of bony splint could be due to the strong muscular traction of the heavy muscle coating which makes the additional external splint not efficient (Dingwall, 1974).

However the main possible cause of failure is the decalcification of the bony intramedullary pin at the fracture line as result of local inflammatory reaction which enhances decalcification (decrease in the pH at this area). Some has found that the freeze-dried bone-plate allografts were eventually incorporated in the host bone (Malinin, Latta ,Wanger and Brown, 1984),while others find that the absorbable osteosynthesis implants will lose their strength subcutaneously and intramedullary cavity of the femur (in vivo) faster than those in distilled water at 37ċ (in vitro) in the rabbit, (Vasenius,Vainiopaa,Vihtonen and Makela; 1990). Bone healing process is influenced by many factors Including mechanical stress and biochemical stress. The mechanical Stress is the most important factor which is depends on, to use the suitable method for immobilization of fracture area (Mann and Payne, 1989).

In this study, bony shuttle intramedullary pin splint (camel metacarpal bone) has been used instead of metallic splint.

According to the present study this type of internal splint could be recommended for the fixation of diaphyseal femoral fracture in dogs, because it is simple, easy to apply and needs minimal postoperative care. There are no side effects as those associated with the use of the metallic devices, because most of the metallic fracture fixation devices need another operation to remove them and that will increase the cost of the operation, (Bostman, 1996).

Resorption will occur during the remodeling period, because bony shuttle pin splint acts as a bone implant (xenograft) which is used to establishment and/or restoration of normal or maximal mechanical function with minimal compromise of biological function (Schwarz, 1991).

The shuttle pin splint like the xenograft can be a source of calcium for osteogenesis or bone formation and acts as weight-bearing support placed in the cortical bone, (Johnson, 1991).

Metallic devices also block the callus and new bone does not develop from the a vascular cortical ends (Anderson, 1965).

Cost of the bony shuttle intramedullary pin splint, its availability, its preparation and the simple sterilization methods should be taken into consideration, because the sterilization of the bone graft is mostly complicated and expensive in comparison with the other sterilization methods of bone implants, like the use of ethylene oxide 84% at 22ċ and atmospheric pressure and stored at 0 ċ for 2 months (Johnson, Eurell and Schaeffer, 1992).

Boiling or autoclaving is easier, inexpensive but might have little loss of bone strength (Stroosma,Klopper and Van-den-Hooff, 1986).

Autoclaving have been used in sterilization of the bony shuttle pin splint with little effect on its strength until the 7^{th} time of sterilization.

CONCLUSION AND RECOMMENDATIONS

Conclusion:

The results of this study revealed the bony shuttle intramedullary pin splint (camel metacarpal bone) is good splint for immobilization of the diaphyseal femoral fractures in the dogs of light weight with minimal disadvantages and side effects.

The bony shuttle intramedullary pin splint ((camel metacarpal bone)) is inexpensive and easily applied with minimal postoperative care and without need for splint removal like the metallic internal splints.

Recommendations:

Further studies should be done to detect the period needed to absorb these bony shuttle pin splints.

A histological and biochemical study of fracture region in the bony splint is necessary to follow-up the resorption of these bony pins.

Application of the synthetic absorbable tubes as splints is recommended

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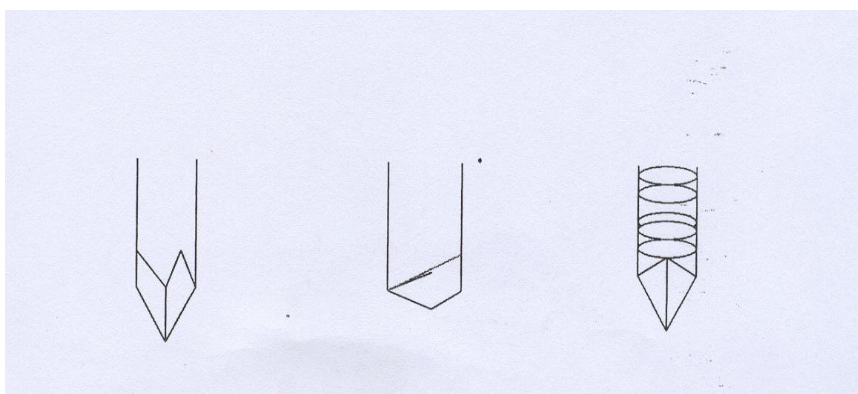
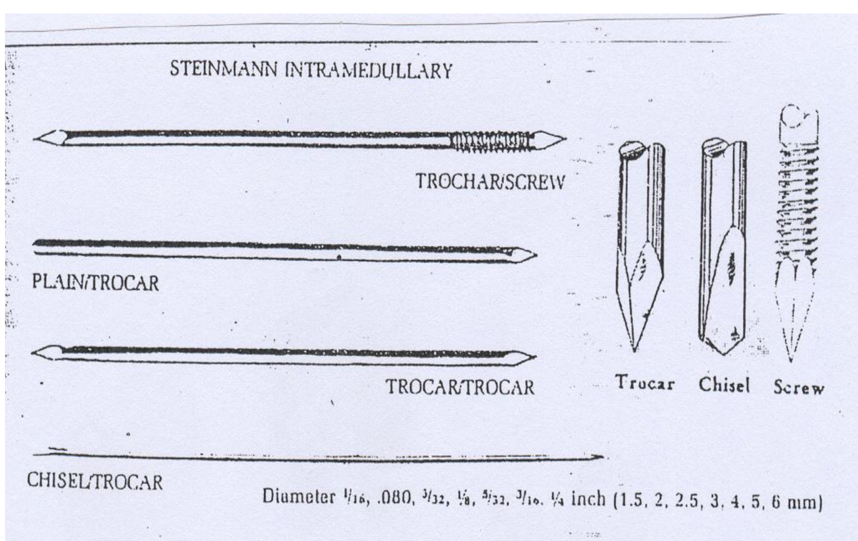
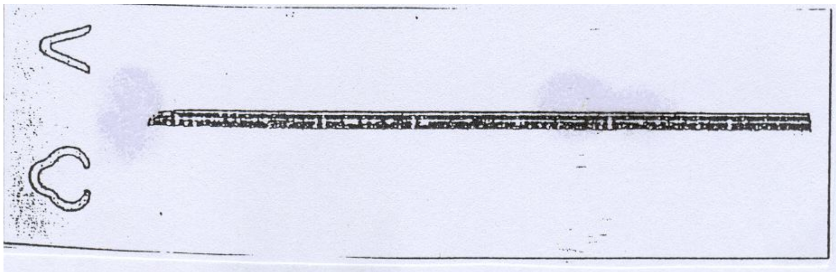


Trocar IChise Trocar Threaded

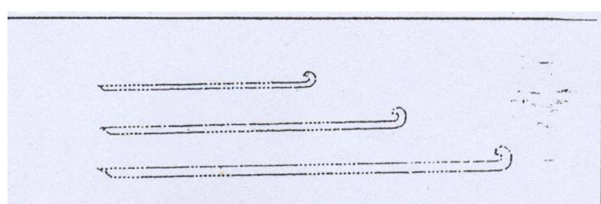
Appendix1a pins intramedullary teimanS


STEINMANN INTRAMEDULLARY
TROCHAR/SCREW
PLAIN/TROCAR
TROCAR/TROCAR
CHISEL/TROCAR
Trocar
Chisel
Screw
Diameter 1/16, .080, 3/32, 1/8, 5/32, 3/16, 1/4 inch (1.5, 2, 2.5, 3, 4, 5, 6 mm)

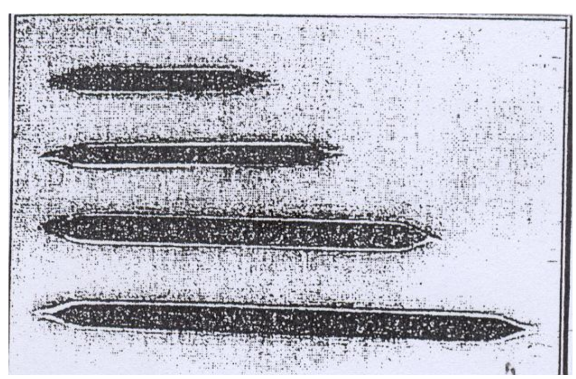
Appendix1b pins intramedullary teimanS



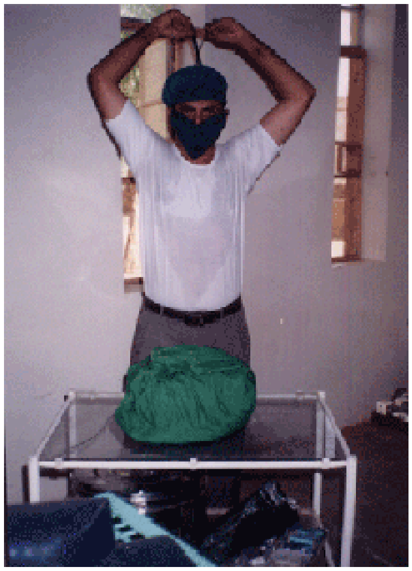
Appendix 2 Kirschner nail

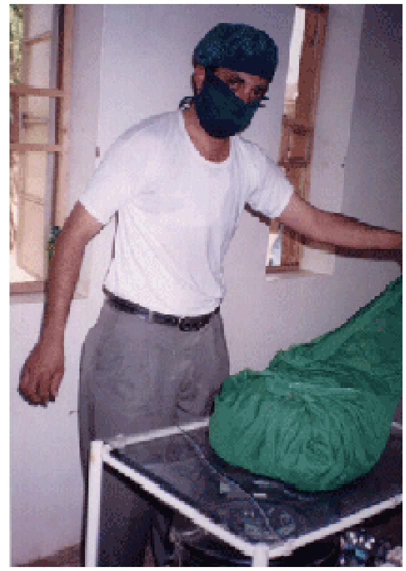


Appendix3pin Rush

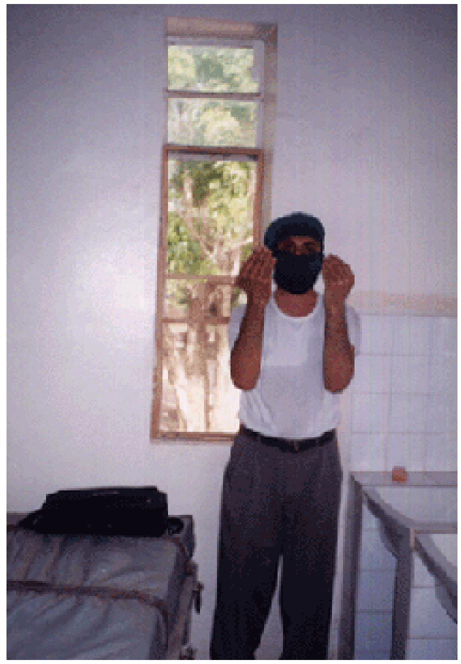


Appendix 4 Leighton shuttle pin

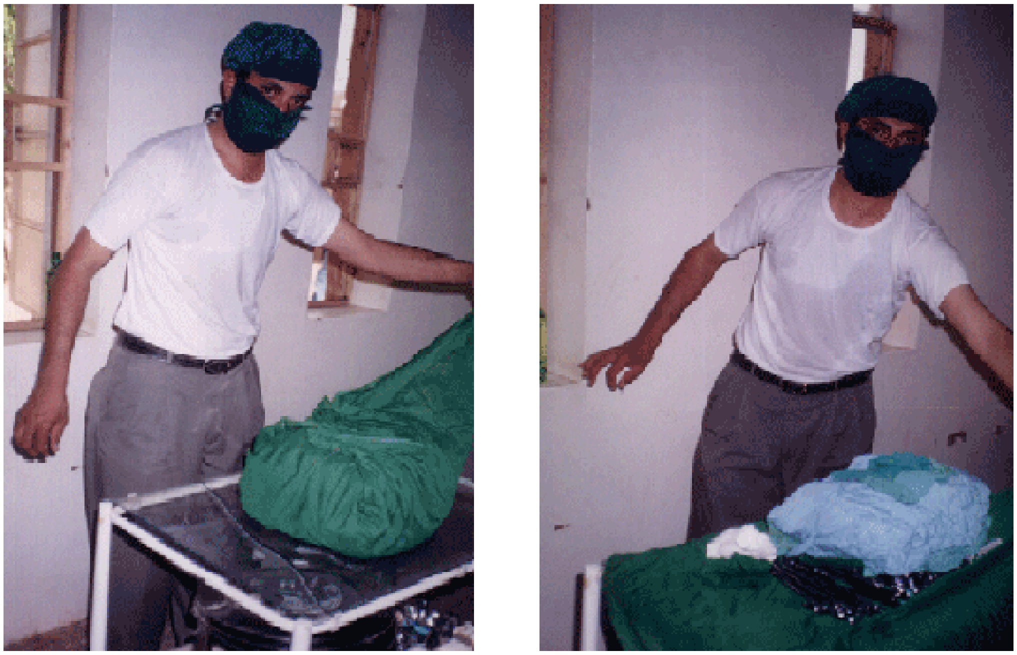




Appendix 5a The Surgeon preparation

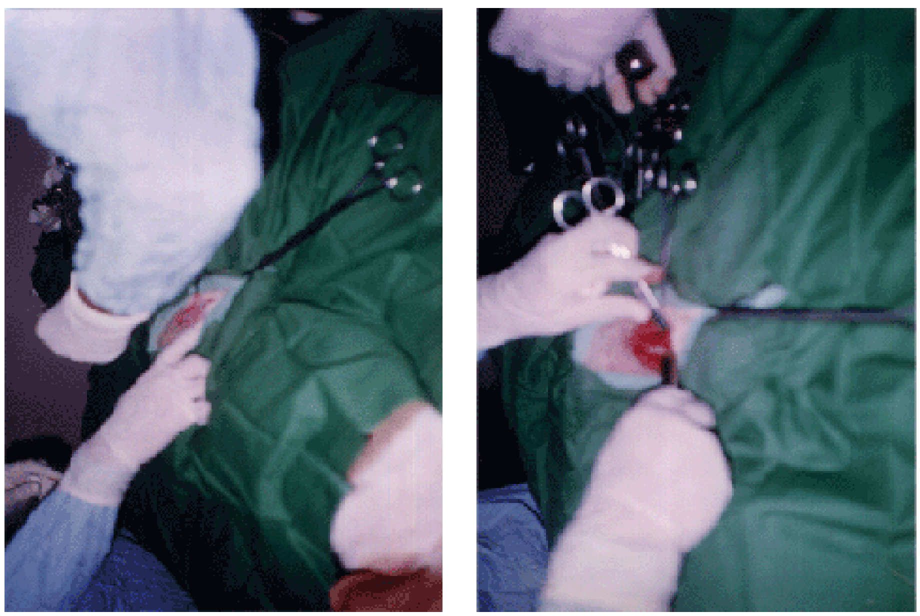


Appendix 5b The Surgeon preparation

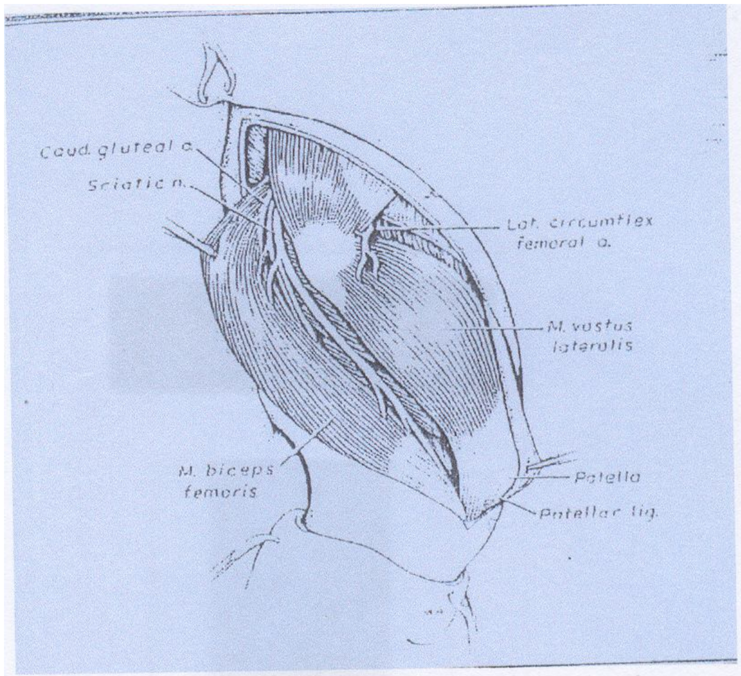


Appendix 5c The surgeon preparation

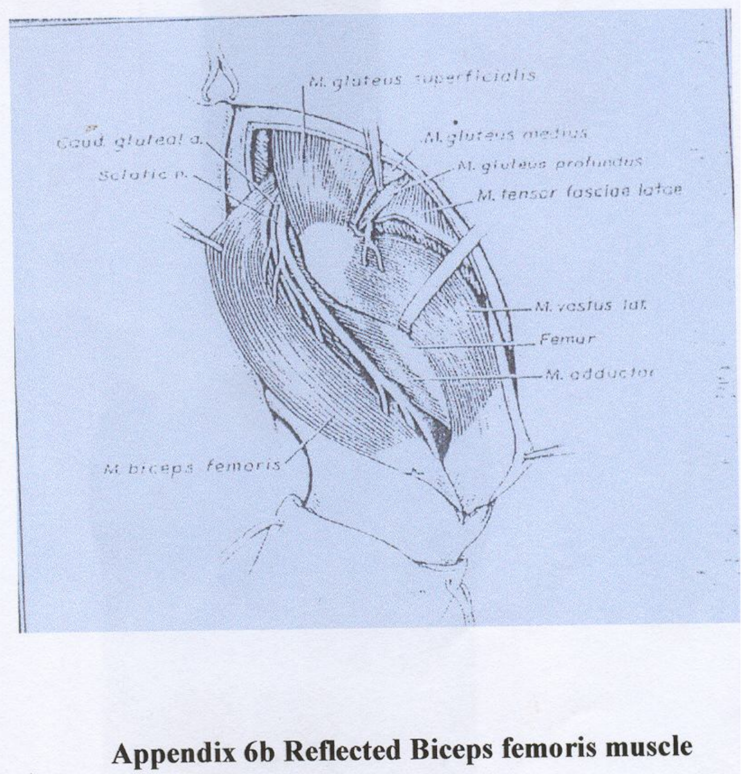
Appendix 5d. Preparations of the operation



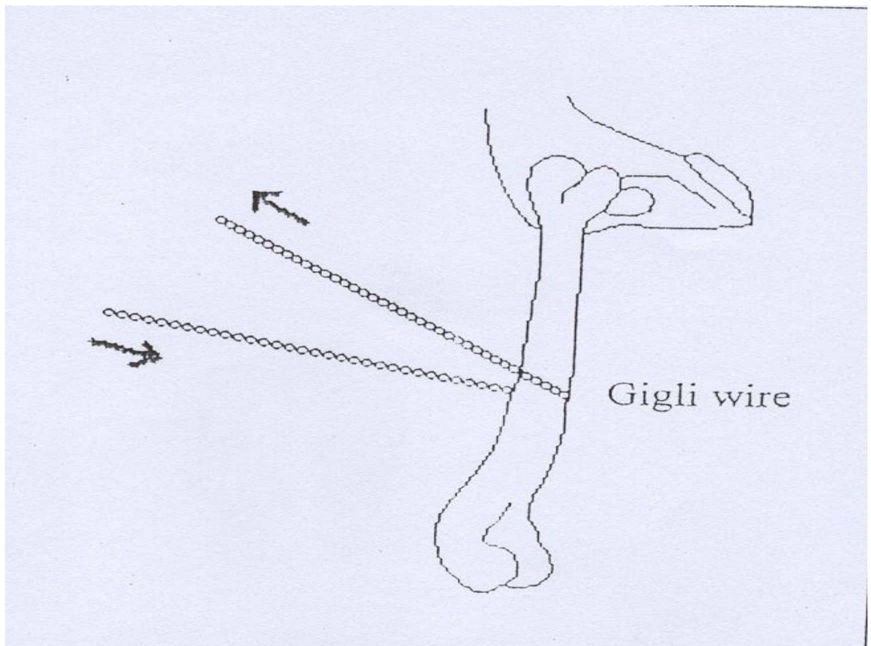
Appendix 6 The Vastus lateralis and Biceps femoris muscles were retracted to expose the femur



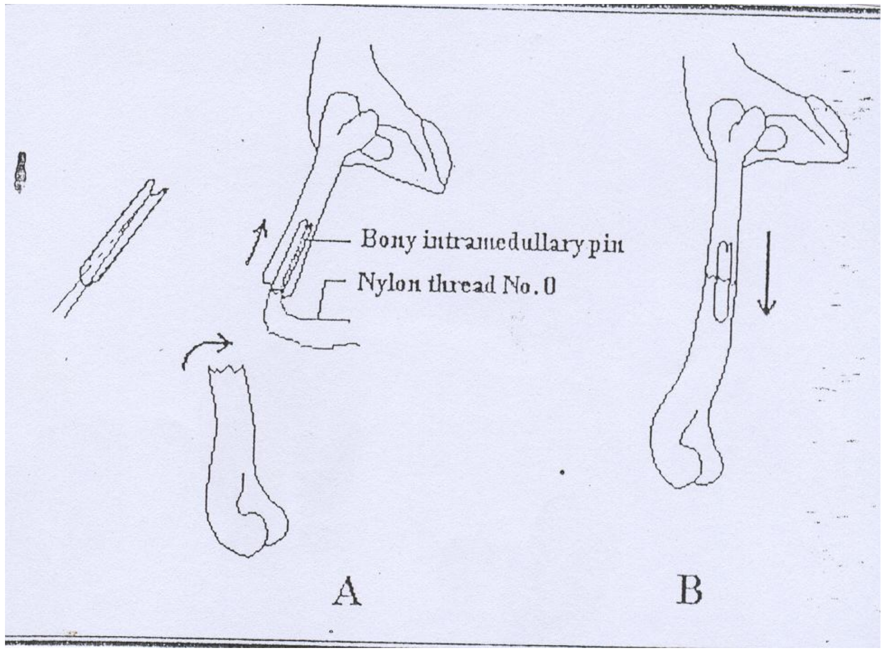
Appendix 6a Reflected vastus lateralis muscle



Appendix 6b Reflected Biceps femoris muscle



Appendix 7. Induced diaphyseal femoral fracture with Gigli wire



Appendix8Insertion of the pin