

بسم الله الرحمن الرحيم

الحمد لله رب العالمين والصلاة والسلام على رسول الله صلى الله عليه وسلم

**Sudan University of Science and Technology
College of Graduate Studies**

**Dual Effects of Camel Bone (Bony Shuttle Pin) as Splint for Femoral
Fractures and the Bone Marrow of Goats**

**الأثر الثنائي للجبيرة العظمية المأخوذة من عظام الإبل في معالجة
كسور عظم الفخذ و تأثيرها في نخاع العظم في الماعز**

By

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بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَضَرَبَ لَنَا مَثَلًا وَنَسِيَ خَلْقَهُ قَالَ مَنْ يُحْيِي الْعِظَامَ وَهِيَ رَمِيمٌ ﴿٧٨﴾
قُلْ يُحْيِيهَا الَّذِي أَنْشَأَهَا أَوَّلَ مَرَّةٍ وَهُوَ بِكُلِّ خَلْقٍ عَلِيمٌ
﴿٧٩﴾ الَّذِي جَعَلَ لَكُم مِّنَ الشَّجَرِ الْأَخْضَرِ نَارًا فَإِذَا أَنْتُمْ
مِّنْهُ تُوقَدُونَ ﴿٨٠﴾ أَوَلَيْسَ الَّذِي خَلَقَ السَّمَوَاتِ وَالْأَرْضَ
بِقَادِرٍ عَلَىٰ أَنْ يَخْلُقَ مِثْلَهُمْ بَلَىٰ وَهُوَ الْخَلَّاقُ الْعَلِيمُ ﴿٨١﴾
إِنَّمَا أَمْرُهُ إِذَا أَرَادَ شَيْئًا أَنْ يَقُولَ لَهُ كُنْ فَيَكُونُ ﴿٨٢﴾
فَسُبْحَانَ الَّذِي بِيَدِهِ مَلَكُوتُ كُلِّ شَيْءٍ وَإِلَيْهِ تُرْجَعُونَ ﴿٨٣﴾

صَدَقَ اللَّهُ الْعَظِيمُ

سُورَةُ الْأَنْبِيَاءِ

Dedication

To every one in my family specially you..

My Mother

Haitham

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Declaration

I hereby declare that the thesis entitled (**Dual Effects of Camel Bone (Bony Shuttle Pin) as Splint for Femoral Fractures and the Bone Marrow of Goats**) is an original work and was carried out by me with the use of sources listed in bibliography.

This thesis is submitted for the fulfillment of the degree of Doctor of Philosophy and has never been submitted to any university or institute all over the world before.

June 2015

ABSTRACT

Bony pin splints were obtained from slaughtered camel metacarpal bone and used successfully as intramedullary shuttle pin splint for repair of induced femoral fractures in 12 Goats without any additional external splint.

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 121°C.

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.

After choosing the proper size and length of the bony pin, reaming of the proximal and distal segments of the femur was performed.

Bony pin was hooked with no 1 nylon thread, held with an artery forceps and then introduced into 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 hooked into the notch of the bony pin.

Procaine penicillin powder is sprayed on the fractured area, then the wound closed by simple continuous suture using absorbable suture

(Catgut no 2/0) to approximate the fascia lata, and the skin was sutured with simple interrupted stitches using No 2/0 Surgical silk.

The healing of femur fracture was evaluated on the basis of clinical, radiographic and hematological observation. The clinical observations such as rectal temperature, heart rate and respiratory rates were recorded for 7 consecutive days, and found within the normal range in all goats.

The surgical wounds healed by primary intention in all the operated animals.

The partial weight bearing by operated limb was obtained in 7 ± 3 post-operative days and the complete weight bearing was recorded in 28 ± 3 post-operative days.

The radiograph made after the operation and then at (2, 4, 6, and 8) weeks intervals showed a well-organized external bridging of fracture gap by a firm callus in all goats.

The hematological studies such as hemoglobin level, total erythrocyte count, total leucocyte count, PCV, eosinophils, monocytes and basophils count were within the normal range.

The bony shuttle pin splints did not elicit any untoward reaction at the site of fracture during the period of the healing process.

Clinical and radiographical follow-up of these cases showed that this type of splint is effective for immobilization of the diaphyseal femoral fractures in goats without any detrimental effects on the bone marrow.

الأثر الثنائي للجبيرة العظمية المأخوذة من عظام الإبل في معالجة كسور عظم الفخذ و تأثيرها في نخاع العظم في الماعز

تم استخدام الجبائر العظمية المأخوذة من عظم مشط الإبل المذبوحة بنجاح لشفاء الكسور المستحدثة في عظم فخذ الماعز بدون استخدام اي جبيرة خارجية مساعدة.

تم استخدام هذا النوع من الجبائر العظمية في عدد 12 رأس من الماعز وذلك بعد اجراء معالجات خاصة لعظم مشط الابل متمثلة في تقطيع مشط الابل الي جبائر عظمية مختلفة الأطوال والأقطار والأحجام مستخدما المنشار الكهربائي, ثم بعد ذلك تعقيم الجبائر العظمية لمدة نصف ساعة في درجة حرارة 121 درجة مئوية مستخدما جهاز التعقيم .

بعد اختيار الجبيرة المناسبة من ناحية الطول والقطر والحجم يتم ادخالها الي داخل نخاع عظم الفخذ المكسور للماعز , واجراء التثبيت لطرفي العظم المكسور وذلك بعد التأكد من التقاء طرفي العظم المكسور بشكل سليم .

بينت النتائج والمتابعات الاكلينيكية والمعملية بالاضافة الي الصور الاشعاعية أن هذا النوع من الجبائر العظمية المأخوذة من عظم مشط الابل جيدة لتثبيت كسور عمد عظم فخذ الماعز وبدون تأثير علي نخاع العظم.

وتمت مناقشة ووصف التقنية الجراحية لاستحداث الكسر وتثبيت هذه الجبائر .

INTRODUCTION

In Sudan goats are estimated to be about 42.5 million head which is a very large population compared to other African countries (Yousif, 2006). This population composed of four major local breeds, Nubian, Desert, Nilotic and the Dwarf, distributed throughout the country (Wilson, 1991).

People in Sudan are not caring much to keep animals inside pens, this expose them, especially goats to car accident which result in fractures (Awatif et al. 2006).

The majorities of these fractures occurred in the mid-shaft as simple, transverse and oblique fractures or comminuted fractures (Slatter, 1995).

These fractures were treated by internal fixation such as intramedullary pins, plates and screws, and some of them treated with bone splints (Ramadan et al. 1991).

Intramedullary fixation (IM) include Steinmann pin, Kirschner wire, Rush pin, and Kirschner nail (Nunamaker, 1985).

These metals may cause more inflammation if the soft parts are unduly traumatized during its application (Leonard, E.P., 1971).

Additionally, using internal fixators needs special surgical instruments such as pins, plates, screw, pin chuck and pin cutters which are

expensive. Moreover, these implants have to be removed in a second operation after complete healing of the fracture

In recent times biodegradable splints were used (Shnain et al, 1989). These splints were inexpensive and can easily be tolerated by the animal. Such permanent shuttle pins are easy to apply and efficient for proper alignment and immobilization (Haitham et al, 2006).

The aims of this study were:

I- To use camel metacarpal bone as a sole permanent shuttle pin splints for (bridging) treating femoral fractures in goats without external support (splint). Thereafter to access the effect of such bony shuttle pin on the bone marrow.

II- To reduce the cost of treatment

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

CHAPTER ONE

LITERATURE REVIEW

1. BONE MORPHOLOGY AND BONE CELLS

The mechanical properties of bones are determined by its structure; the knowledge of bone structure is therefore essential for understanding the bone function.

1.1. Bone morphology

1.1.2 Gross morphology structure

There are two types of bone tissue at the macroscopic level. Cortical (compact) bone and trabecular (cancellous) bone. Distribution of these two major bone types varies throughout different regions of bones. Trabecular bone is mainly found in short bone and at the metaphyses of long bones, whereas cortical bone is dominant in diaphyseal areas. (Rogers 2011).

The femoral bone (on which the thesis is based) and the major bones of the hand and foot are called long bones (fig. 1). They have a tubular central region (*diaphysis*) expanded on one or both terminations (*metaphyses*) and the bones terminate with articular surfaces (*epiphyses*).

The bones of the cranial vault, shoulder, pelvis and rib cage tend to be flat while the bones of the ankle, wrist and spine are less slender and

irregular. Despite this variety of external shapes, the makeup of bones at both gross and microscopic level is remarkably constant (White and Folkens 2005).

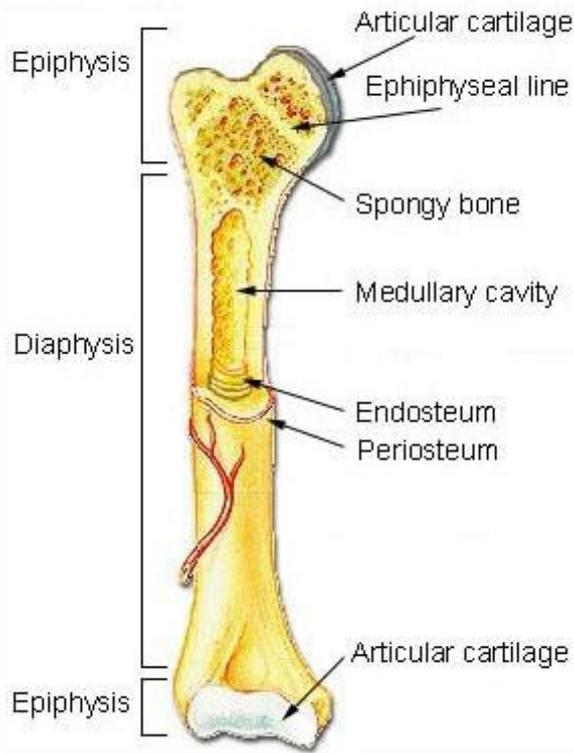


Figure 1: Morphology of along bone (web 1)

1.2 Bone cells

There are three special types of cells that are found only in the bone. (Fig 2). These cell names all start with "OSTEO" because that is the Greek word for bone.

***OSTEOCLASTS** are large cells that dissolve the bone. They come from the bone marrow and are related to white blood cells. They are formed from two or more cells that fuse together, so the osteoclasts usually have more than one nucleus.

They are found on the surface of the bone mineral next to the dissolving bone. (Rogers 2011 and Turner 2003).

***OSTEOBLASTS** are the cells that form new bone. They also come from the bone marrow and are related to structural cells. They have only one nucleus. Osteoblasts work in teams to build bone. They produce new bone called "osteoid" which is made of one collagen and other protein. Then they control calcium and mineral deposition. They are found on the surface of the new bone.

When the team of osteoblasts has finished filling in a cavity, the cells become flat. They line the surface of the bone. These old osteoblasts are

also called **LINING CELLS**. They regulate passage of calcium into and out of the bone, and they respond to hormones by making special proteins that activate the osteoclasts.(White and Folkens 2005).

***OSTEOCYTES**originate as osteoblasts that have become embedded in bone matrix secreted by surrounding osteoblasts. They are smaller and have fewer protein-forming *organelles* because they are no longer involved in matrix formation. The osteocytes comprise approximately 90% of all cells in mature bone (Ortner and Turner-Walker 2003, Currey 2002).

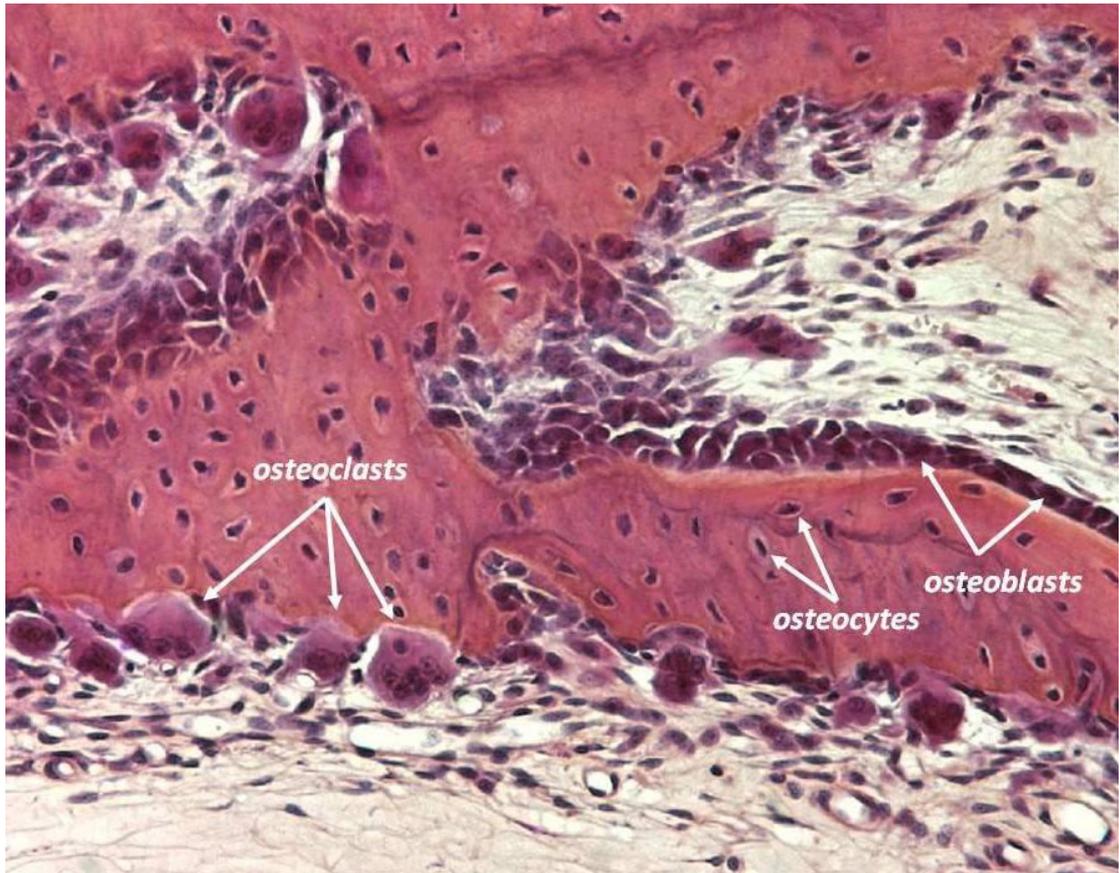


Fig 2 : Bone cells (web 2).

2. Bone Functions

Bones have the following functions

- * Structural support for heart, lungs and marrow
 - * Protection for brain, uterus, and other internal organs
 - * Attachment sites for muscles allowing movement of limbs
 - * Mineral reservoir for calcium and phosphorus
 - * Defense against acidosis
 - * Trap for some dangerous minerals such as lead
- *The [marrow](#), located within the [medullary cavity](#) of long bones and interstices of cancellous bone, produces blood cells in a process called [hematopoiesis](#). (Vunjaket *al*, 2009).

3. Bone fractures

A fracture is dissolution of bony continuity with or without displacement of the fragments. It is always accompanied by soft tissue damage of varying degrees; there are torn vessels, bruised muscles, lacerated periosteum, and contused nerves. Sometimes there are injured internal organs and lacerated skin. The trauma to soft tissue must always be taken into consideration and is often vitally more important than the fracture itself.

The incidence of femoral fractures is about 80% in small animals of all ages and probably accounts for half of the fractures that occur in this species (Ding wall.1974).

3.1 Etiology of Fractures

3.1.1 Extrinsic and direct Causes.

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, 1965).

3.1.2 Indirect Violence

Fractures due to indirect trauma are more predictable than those due to direct trauma. Generally a force is transmitted to a bone in a specific fashion and at a "weak link" within the bone, causing a fracture to occur.

3.2 Classification of fractures

There are multiple ways of describing fracture, usually related to the severity, the type of stress causing the fracture and conditions that increase the fracture. Fractures observed as simple or multi-fragmented and further classified according to its geometric properties (i.g. spiral or linear), the position or location of the fracture (long bone or skull fractures), the orientation of the fracture relative to the bone long axis (i.g. linear or transverse) or the completeness of the break (Kimmerle and Baraybar 2008).

3.2.1. Completeness

If the break does not go through the entire bone and bone fragments are still partially joined, it is called an *incomplete fracture* (e.g. *fissure fracture* that affect only one cortical surface of bone or “*greenstick fractures*” in children bone where the breakage and bending of bone is combined (fig. 3). If the break passes entirely through the bone and separate fragments completely, it is known as a *complete fracture* (Ortner 2003).

3.2.2. Outline

A complete break that separates the bone just in two pieces is called a *simple fracture* whereas a break that results in three or more bone fragments is called a multi-fragment or *comminuted fracture* (fig. 3). An individual fracture lines are interconnect in that fracture and may have transverse, oblique or spiral character (Rogers 2011).

The *linear fractures* run parallelly to the long axis of the bone, thus along the cylindrical osteon tubes while *transverse fractures* run across the bone axis at a right angle (fig. 3). These fractures are caused mostly by bending forces. Transverse fractures may be relatively smooth or rough, sometimes have a deep teeth on the fracture surface (Kimmerle and Baraybar 2008, Newton 1985).

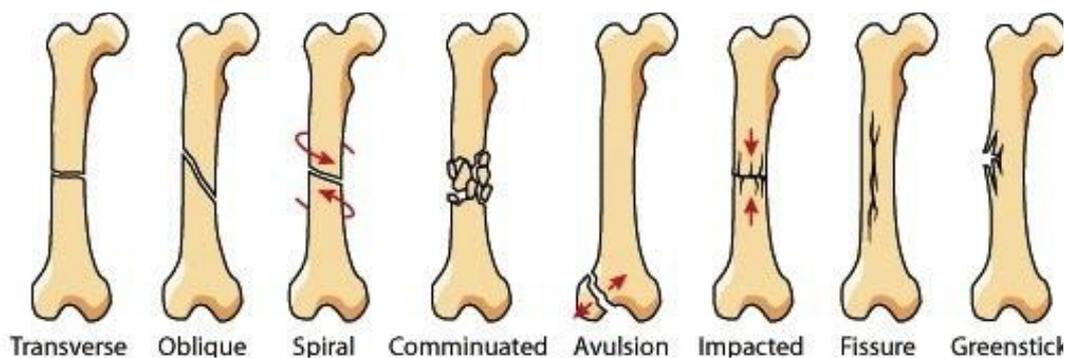
The *oblique fracture* goes diagonally and crosses the long bone axis at approximately a 45° angle (fig. 3). The edges of an oblique fracture are usually smooth; the cortical edges are rather flat than sharp. These fractures generally result from bending with superimposed axial compression. A *spiral fracture* is characterized by a helical break that spirals along the long axis of the bone (fig. 3). It is usually caused by torsional twisting or rotational forces when at least one part of the bone has been twisted or rotated (Newton 1985).

The *impacted fracture* (fig. 3) is caused when bone fragments, generally cortical, are forced or impacted into cancellous bone or into each other.

This type typically occurs at the ends of long bones. *Compression fractures* are similar to impacted ones, but the term is usually used to describe fractures in which cancellous bone collapses and compresses upon itself, typically in vertebral bodies following trauma to the spine (Newton 1985).

The *avulsion fracture* occurs when a fragment of bone is separated from the main mass (fig. 3).

Figure 3: Different types of long bone fractures (web 3)



3.3 Clinical signs of Fractures

In most instances the clinical signs associated with fracture make diagnosis uncomplicated. Although the owner of an animal often will have observed the fractured bone, locating a fracture can at times be difficult. In these instances, the practitioner needs a systematic, logical approach to diagnose the fracture. (Nunamaker, D. M.1985).

Miscellaneous signs associated with fracture include the following:

3.3.1 Dysfunction

Dysfunction is most commonly exemplified by lameness. In the orthopedic examination the focal site of the lameness must be found and the diagnosis pursued. Dysfunction may also includes paralysis with spinal fracture, unconsciousness accompanied by cranial fracture, or masticatory dysfunction with mandibular fracture.

Impairment or loss of function is a constant sign of complete fracture and is the result of pain or loss of mechanical support. Only in cases of incomplete or impacted fracture may some weight be borne by the animal. (Newton, C. D. 1985)

3.3.2 Pain

If there is a break in the continuity of the shaft, pressure will cause pain at the fracture site that is quite distinct from the pain of injured soft tissue parts. If an animal is examined during the state of local tissue shock, that

is, within 20 to 30 minutes after the accident, pain may not be a conspicuous sign. (Nunamaker, D. M.1985).

3.3.3 Local trauma

Immediately after injury the swelling may be sharply outlined as a result of bleeding from the bone and the soft parts. An indistinctly outlined swelling that occurs later is caused by edematous infiltration. Generally the swelling increases for 24 to 48 hours, and then gradually subsides. When applying bandages and splints immediately following fracture, it is important to bear in mind that swelling will subside. (Newton, C. D. 1985)

3.3.4 Abnormal posture or limb positioning

Deformity from the normal anatomical structure may be caused by displacement of the bony framework as in a fracture or dislocation, but it may also be caused by changes in configuration due to a neoplasm. The displacement of bone fragments that produces deformity in a fracture may be angular, longitudinal, or rotational. Longitudinal displacements may cause shortening, referred to as overriding, or may result in separation of the fragments; termed distraction (e.g., fractures of the olecranon). In most cases the primary displacement is determined by the direction and force of an injury and is maintained and often increased by the contraction of muscles. If in doubt about positioning, comparison with

the opposite limb or side of the body part is advised (Nunamaker, D. M.1985).

3.3.5 Crepitus

Crepitus is a sign of fracture that is considered pathognomonic. Bony crepitus is the gritting sensation transmitted to the palpating fingers by the contact of the broken bone ends on each other. There are other forms of crepitus (pseudocrepitus) such as occurs in some cases of arthritis, partial luxations of the patella, or luxations of the coxofemoral joint. The absence of crepitus does not necessarily indicate the absence of a fracture. The interposition of a piece of soft tissue between the fragments will prevent crepitus. It is also absent when the ends of the bones are so far apart that they cannot be brought into contact, or when they are impacted. Crepitation should be elicited with the utmost precaution because of the danger of causing further damage to bony fragments and surrounding soft tissue. Vigorous palpation, which may turn a routine closed fracture into a contaminated open one, should be avoided. (Newton, C. D. and Nunamaker, D. M.1985).

3.3.6 Abnormal mobility

A false point of motion is also pathognomonic. It occurs if there is a complete fracture of the shaft of a long bone; it does not occur in an

incomplete or impacted fracture. Mobility near a joint may be difficult to differentiate from normal or abnormal mobility of the joint itself. In order to avoid additional trauma, the same precaution should be taken in eliciting this symptom as in eliciting crepitus. (Brinker, 1998).

3.4 Pathology associated with fracture

Many specific fracture types have soft tissue injuries associated with them. Pelvic fracture may result in laceration of the bladder, prostate, pelvic urethra, or major vessels and nerves. Fractured ribs routinely accompany hemothorax, pneumothorax, or laceration of the lung parenchyma. Fracture of the axial skeleton can be expected to compromise the brain, brain stem, or spinal cord. There may also be associated injury to the surrounding soft tissue produced by the trauma that caused the fracture. It is important to remember that skin, muscles, periosteum, tendons, nerves, and vessels over the fracture absorbed the same force as the fractured bone. Any or all of these structures may be severely damaged at the time of impact. (Newton, C. D. and Nunamaker, D. M.1985).

3.5 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).

3.6 Complications of fractures

- Delayed union
- Non- union
- Avascular necrosis
- Shortening
- Infection

3.7 The fracture healing process

Fracture healing is a complex process which involves many biological events. There are two categories of bone healing which depend on the size of the fracture gap and the stability at the fracture site during the healing process (McKibbin, 1978, Ito and Perren, 2007).

3.7.1 Primary bone healing

Primary healing (direct healing) requires absolute stability of fracture fixation (Jagodzinski and Krettek, 2007). Fractures treated with compression plating heal by the primary healing process. Here, bone regenerates without external callus. Cartilage and fibrous tissue formation at the fracture gap does not occur.

3.7.2 Secondary bone healing

Most fractures are repaired by secondary bone healing, since some level of mechanical instability exists at the fracture site.

Four stages of fracture repair have been described (Schindeler, McDonald et al. 2008).:

- 1) The first response when a fracture occurs is inflammation associated with soft tissue and vascular damage.
- 2) Chondrocytes and fibroblasts within the fracture site provide temporary mechanical stabilization through the formation of a soft callus
- 3) A hard callus is formed by active osteoblasts that mineralize the callus matrix
- 4) The irregular hard callus is remodeled by osteoclastic resorption and osteoblastic deposition of new bone.

3.8 Principles of fracture treatment

The ideal objective of fracture treatment is to provide a completely rehabilitated patient as quickly as possible. Successful fracture treatment comprises a perfectly aligned bone of full length that has solidly united joints that are freely movable to their fullest range, and musculature, innervation, and integument surrounding the site of the previous fracture that are completely normal. This idealized concept can rarely be achieved in a clinical situation. It is important that the surgeon strive to meet these

Criteria using all avenues of treatment by means of operative and non operative management of the fracture ([Allgower M, 1979](#)).

The objectives to be strived for include the following:

- Sufficient reconstruction or restoration of normal form to meet the requirements expected of the limb
- Immobilization of bone fragments until fracture healing has occurred.
- Mobilization of all joints involved during the process of fracture healing to prevent joint stiffness, fracture disease, and muscle atrophy. (Salter RB, 1980).
- Rehabilitation of the patient.

***The treatment of fracture includes Reduction and Fixation (immobilization) of the fracture.**

3.8.1 Reduction of the Fractures

Reduction of the fractures refers to the procedure by which the fractured segment is approximately returned to its original position (Brinker, 1998).

3.8.1.1 Methods of Reduction

3.8.1.2 Closed reduction

In this method, the fracture is reduced without skin incision or exposing the bone (Brinker, 1998).

3.8 1.3 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 (Brinker, 1965).

3.8.2 Methods of fracture fixation

3.8.2.1 External fixation:

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, 1965, Hickman, 1964).

Coaptation should be durable yet as light as possible and least Cumbersome. (Leonard, 1968; Brinker, 1965).

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.

*** 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, 1978).

*** Aircast**

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).

***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 castalone (Oehme, 1986).

3.8.2.2 Internal fixation:

Internal fixation refers to the immobilization of bone fragments through the use of metal devices exerting restraining forces on the bone 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 cannot remove them because they are buried inside the body (Singleton, W.B. (1966); Stoloff, 1983).

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

3.8.2.2.1 Intramedullary pins

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

The devices used in veterinary practice include: -

The Steinman pin (Kirschner intramedullary 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).

3.8.2.2.2 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. 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).

3.8.2.2.3 Kuentscher nails:

These nails 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.

3.8.2.2.4 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 may also be used to treat fractures of the central third of the diaphysis of both humerus and femur in small animals (Nunamaker, 1985). They can be inserted either individually or in pairs

3.8.2.2.5 Shuttle pin (Leighton, 1952)

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

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

In this technique, 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).

4- Bone marrow examination

Bone marrow is soft, gelatinous tissue that fills the medullary cavities - the centers of bones. There are two types of bone marrow: red bone marrow (also known as myeloid tissue) and yellow bone marrow (fatty tissue).

Both types of bone marrow are highly vascular and enriched with numerous blood vessels and capillaries.

Examination of the bone marrow is helpful in diagnosing certain diseases, especially those related to blood and blood-forming organs.

The common sites for bone marrow (BM) collection are the sternum and tuber coxae (Smith, Korda et al. 2003; Toupadakis, Wong et al. 2010).

The site for aspiration from the tuber coxae is localized from the ventral third of the iliac wing, approximately 4 cm axial to the tuber coxae (Toupadakis, Wong et al. 2010).

BM contains both hematopoietic and mesenchymal elements. The BM-MSCs have the ability to differentiate into multiple cell lineages including bone, cartilage, muscle, ligament, tendon and adipose tissue (Wakitani, Goto et al. 1994; Young, Butler et al. 1998; Pittenger, Mackay et al. 1999; Pittenger, Vanguri et al. 2002; De Bari, Dell'Accio et al. 2003).

BONE ANATOMY

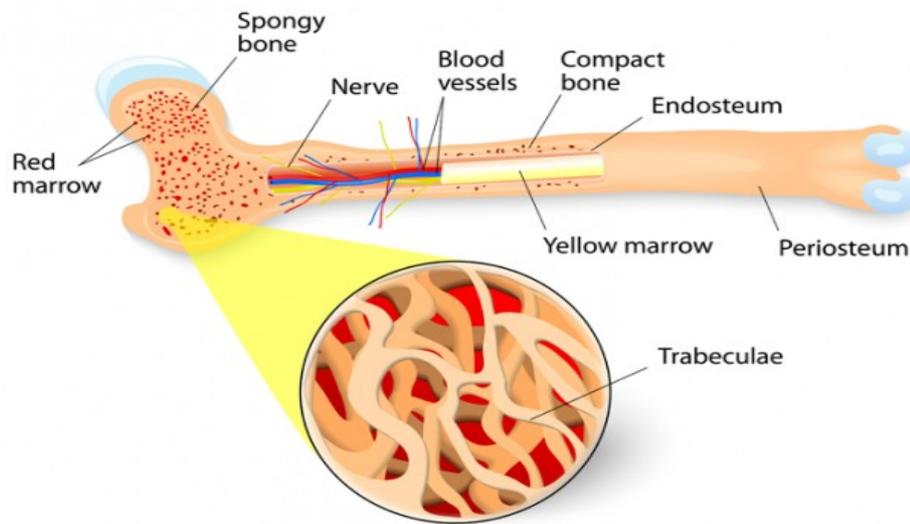


FIG. 4: Long bone cross-section showing both red and yellow bone marrow.(web 4).



Fig 5. A needle used for bone marrow aspiration, with removable stylet