INTERLOCKING NAILS IN INTERNAL FIXATION OF FEMORAL SHAFT FRACTURES

THESIS

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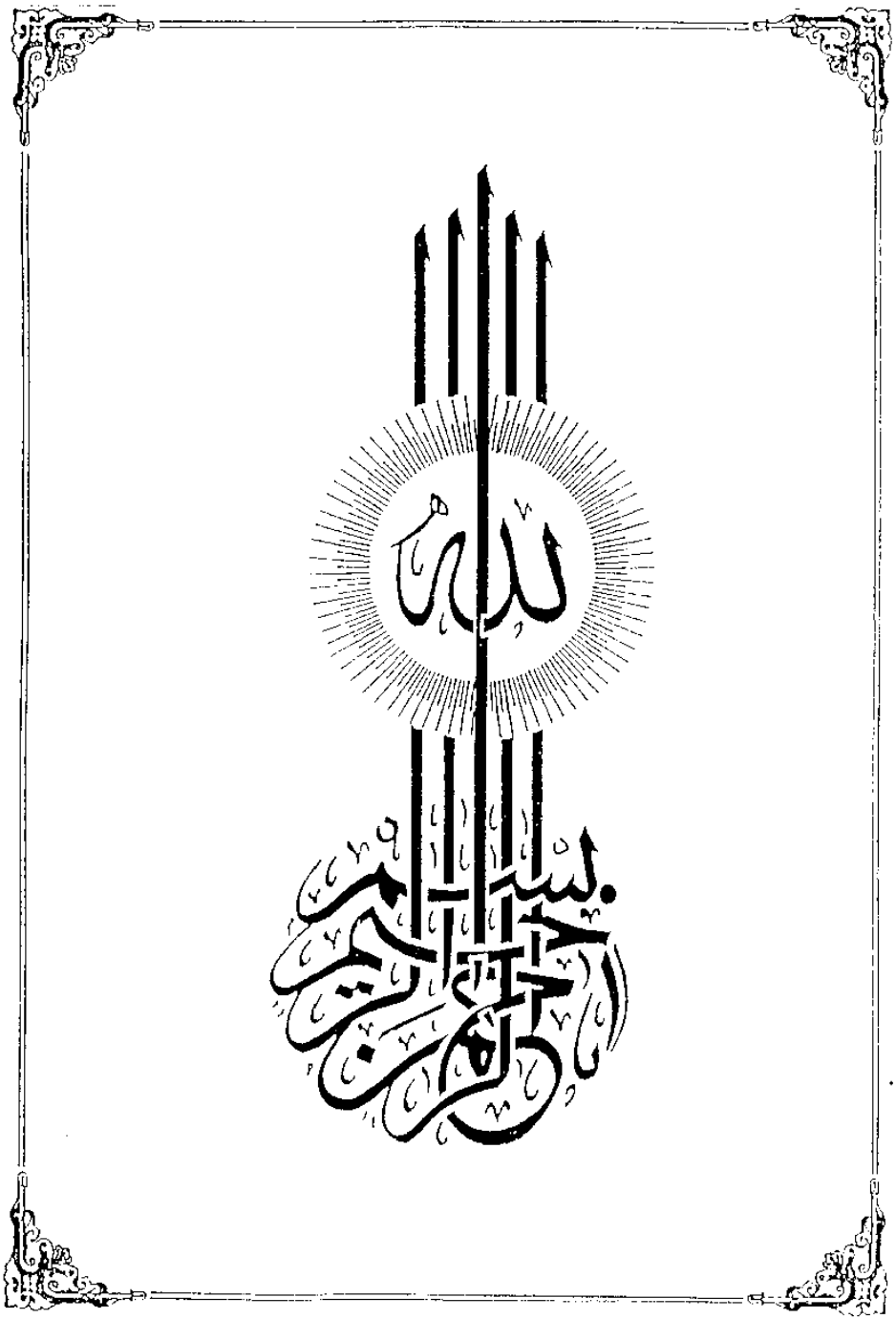

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INTRODUCTION

The femur, being the strongest and longest bone in the body, its fracture represents a traumatic significant event. Because of its length and ambulatory function, the femur must tolerate the most severe combination of axial loading and angulatory stresses.

It is surrounded by large strong muscles groups aiding in displacing fracture fragments if the bone is injured, but also these muscles give a very good chance for bone union. So, the aim in treating this problem is not only achieving bony union but also trying to return the function of the whole limb back to normal within a reasonable period of time.

Since a very long time trials did not stop arising to solve this problem. The arabs, two centuries ago encased the fractured limb in a mound of plaster. The Chineese also used wooden strips or bamboo splints wrapped with leather. The Egyptians used embalmer's bandages stiffened with gum to splints fractured limbs.

The development continued passing from incomporating plaster of Paris in bandages to the external splinting divices and prostheses.

In 1907, the principle of skeletal traction was introduced by Fritz Steinman then improved by Kirschner in 1909. Also the skin traction over a Thomas splint, owing to its simplicity and its ready

availability, has had greater durability and long term acceptance in clinical practice like no device had. **(Mooney and claudi, 1984).**

Nowadays, Many lines of treatment options are used begining from the old fashioned ones, but still giving good results, as the Thomas splint, skeletal traction, skin traction or roller traction. Cast bracing also has its own indications. External fixators and pins incorporated in casts are also sometimes used.

With the late industrial progress and the fine metalologic development, different ways of internal fixation are now marketed such as plates and screws which still have their certain indications.

But the method rapidly developing lately is the intramedullary fixation of fractures for its several advantages. The development of Küntcher nail and the following modifications made by this great surgeons and others had made a revolution in the world of trauma orthopaedic surgery. The use of closed technique of intramedullary nailing is not a new event. It has been tried during the second world war by the Germans, by Küntscher in 1940, also by Waston Jones in 1950 and by Böhler in 1968. Popularity of this procedure has gradually declined as more and more complications started to appear such as over exposure to irradiation, impaction of the nail, failure of reduction and, even vasclar injuries. Recently, the development of image intensifier with television monitor and

fracture table with traction piece helped a great deal and encouraged many authors to try the closed technique with encouraging results. (Quoted from **Mehrez and Maziad, 1988).**

Different nails had developed lately and even the concept of interlocked nailing had faced some controversy with recent advances.

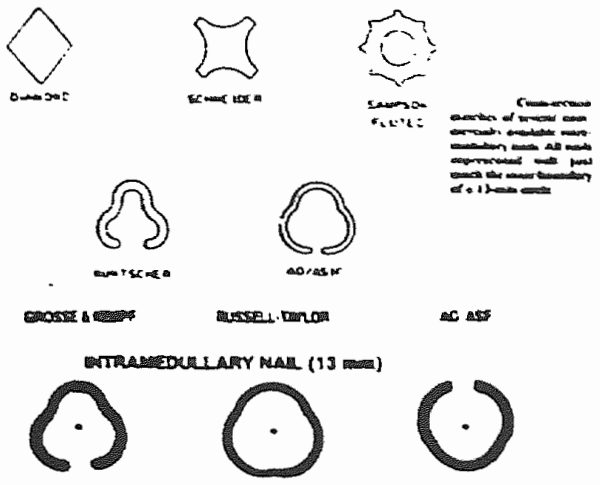
In this thesis different types of interlocking nails have been tried. There is some preferability to certain nails. There are advantages and disadvantages of one nail over the other. Some indications for certain types, with some changes in the general technical principles with some changes in the precautions needed; many of these points should be clear and kept in mind in case of having the choice of using one of the several types of nails appearing now in the market. In this work we have tried to answer some of these questions.

HISTORICAL REVIEW OF THE LITERATURE

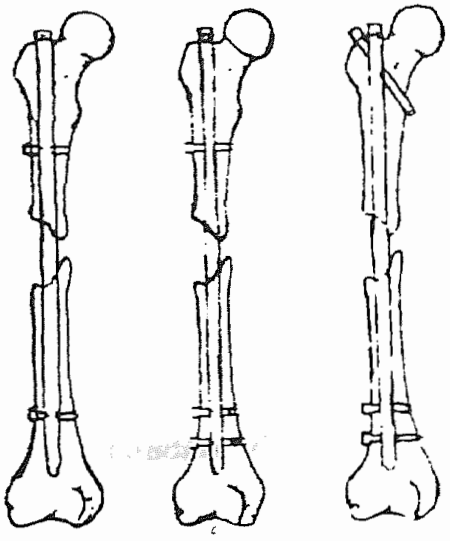
Intramedullary fixation of long bones has been subjected to research work since a very long time. Although there had been some abortive attempts at intramedullary fixation with ivory, the first recorded attempts at internal fixation with metal rods were by Lambotte 1913 of Antwerp and Hey Groves 1918 of Bristol during the first world war. **(Mooney and Claudi 1984); (Adam, 1985).** They were handicaped by the lack of a suitable inert material. In 1936 Leslie V. Rush and H. Lowry Rush were satisfied with their results in treating comminuted open Monteggia fracture dislocation by using an intramedullary Steinmann pin **(Leslie V. Rush and H. Lowry Rush 1986).**

In 1940 Dr. Jerhard Küntcher in Germany reported his experience in fixing fractured femora using a V shaped nail design under radiographic control through a small incision over the greater trochanter without opening the fracture site **(Mooney and Claudi 1984).**

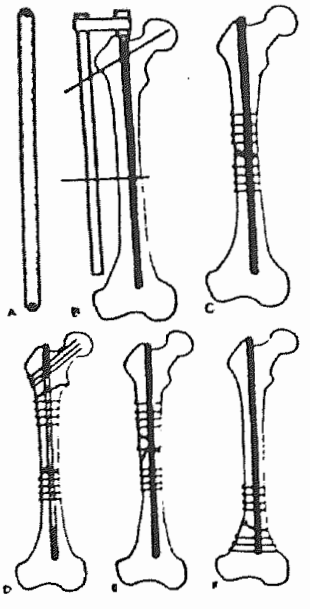
In 1942 the (Time Magazine) aroused american interest in the principle of fracture fixation using longitudinal pins through presenting a medical mystery in a news story of an american soldier who had returned from germany to England. American doctors were surprised to find a long intramedullary bar on x-raying his femur. The soldier's story was that his femur had been fractured and that after it was mended in this manner he wore no cast and was immediately ambulatory **(Leslie V. Rush and H. Lowry Rush 1986).**



(Fig. 1)
Tarr & Wiss,
1986



(Fig. 2.a.)
Klemm 1986



(Fig. 2.b.)
Huckstep, 1986

Since that time several changes and evolutions have occured following better understanding of the femoral anatomy and bone implant biomechanics and also following the great industrial advances improving the material of the implant.

Numerous types of nails have been manufactured based on: 1. Cross-sectional geometry (solid nails, hollow for guide wire control, open sections for internal pressure, fluted for rotational control 2. Length and Shape (anatomic curvature, prebent designs) 3. Surgical techniques (open closed, Reamed, unreamed or self cutting designs) **(Tarr and Wiss, 1986).** (Fig. 1), (Tarr and Wiss 1986).

He was Gerhart Küntcher who developed the concept of an interlocking nail. He called the implant a detensor nail. This novel idea was presented to the Deutsche Gesellschoft Für Chirurgie in 1968 **(Schilden et al., 1990).** (Fig. 2.a) (Klemm, 1986).

In 1971 An australian surgeon described the development of a rigid solid stainless steel nail with holes drilled every 1.5 centimeter along its length. Locking could be achieved through a special jig fixed to the nail which can guide all the locking screws **(Huckstep, 1972).**

(Fig. 2.b) (Huckstep, 1986).

Klemm modified the detensor nail and called it the interlocking nail,. and in 1972 he has introduced his original material **(Klemm, 1986).**

In 1974 Grosse and Kempf introduced another design which was inspired from the A.O. intramedullary nail **(Kempf, 1986).**

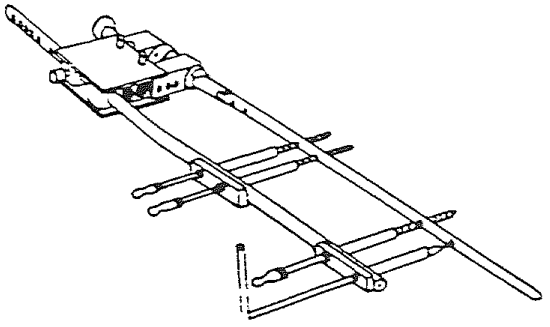
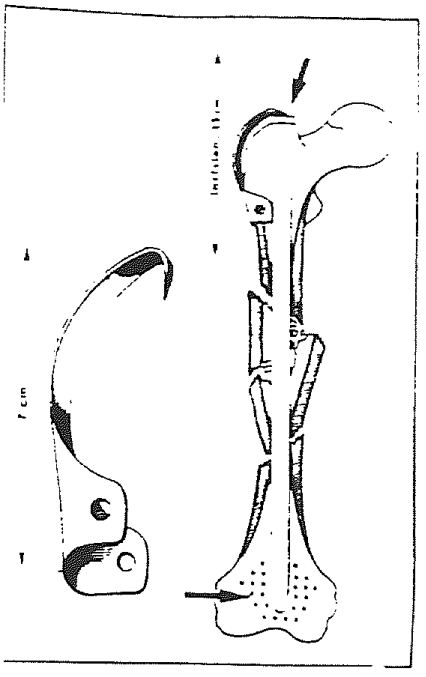


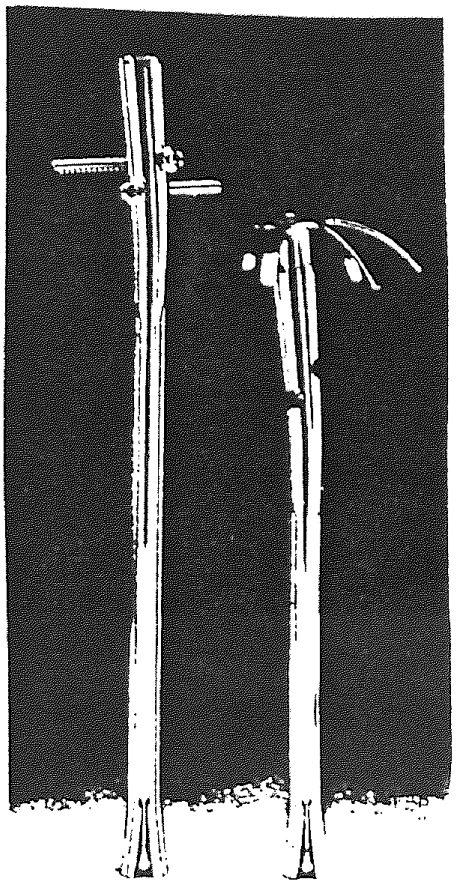
Fig. (3): The Colchero nail. Foucault, 1985.



(Fig. 4)
Lord & Samuel,
1983

The distal ends of the nails studied are shown with their ...sive interlocks in place. The Utah and Brooker-Wills locks ...placed through the nail with the trans-fixation screws of the ...chempf are inserted percutaneously.

(Fig. 5)
Hofman et al.,
1987



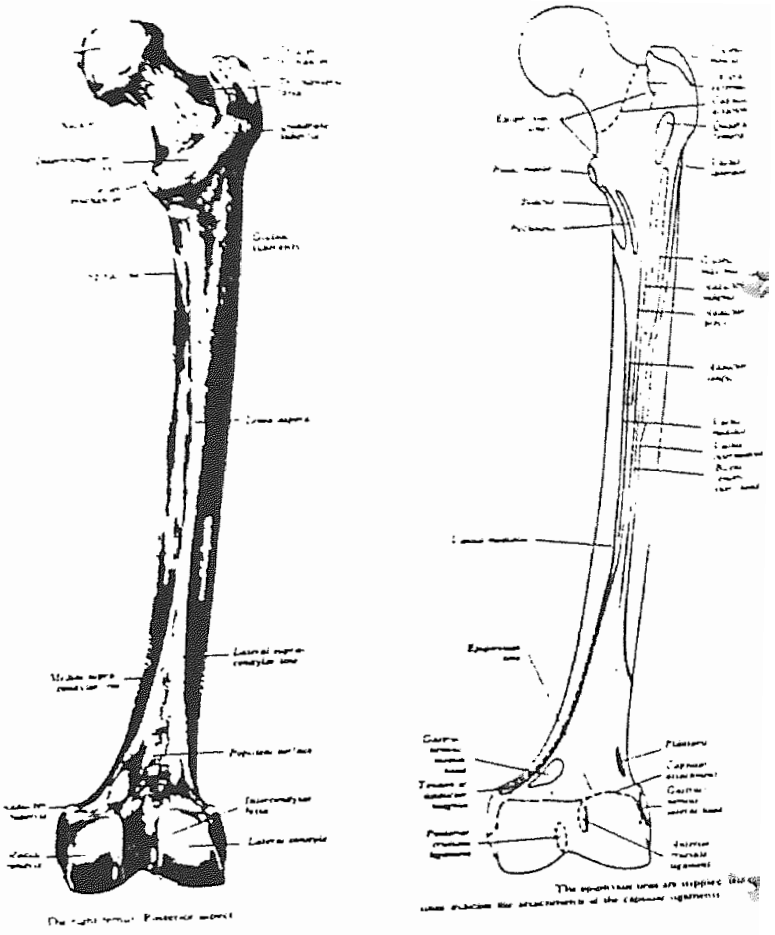
(Fig. 6)
Seidel,
1988

Fernando Colchero, a mexican orthopaedic surgeon started research and clinical work in France and tried to modify the Huckstep nail design with a rigid solid nail rounded in cross section and holed only at three specified distances along the nail length. He published his results in 1983 **(Colchero et al., 1983).** (Fig. 3, Foucault, 1985)

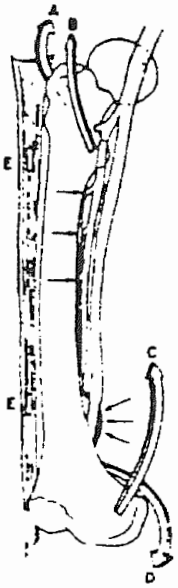
In spite of having all this long research story the idea of interlocking fixation is still posing a rich territory for further research ideas trying to solve the technical problems of locking in a manoeuver to overcome the problem of proximal locking. Geneste designed his spur plate for proximal locking. (Fig. 4) (Lord and Samuel, 1983)

For distal locking different techniques were introduced as nail mounted targeting devices, fluoroscopic mounted targeting devices, hand held targeting devices and free hand technique. **(Bucholz and Browner, 1990).** Also other designs were put to face the same problem as in: Utah nail and Brooker-wills' nail. (Fig. 5) (Hofman et al., 1987)

Seidel has also designed another device which is still restricted to humeral fracture fixation based on a postintroduction widening of the distal nail end. **(Seidel 1988).** (Fig. 6) (Seidel, 1988).
The subject is still a fertile one for further ideas and progress.



(Fig. 7) Warwick & Williams, 1973



Deforming muscle forces on the femur (A) abductors, (B) iliopsoas, (C) adductors, (D gastrocnemius origin. Medial angulating forces are resisted by the tension brace of the fascia lata (E). Sites of vascular threat are at the adductor hiatus and the perforating vessels of the profunda femoris.

(Fig. 8) Mooney & Claudi, 1984

ANATOMY OF THE FEMORAL SHAFT

The femur or thigh bone is the longest and strongest bone in the body. As postulated by Mooney and Claudi 1984, this tubal mechanical structure can resist angulation with the best weight to strength ratio, however it is not the best design to resist torstional forces (**Mooney and Claudi, 1984**).

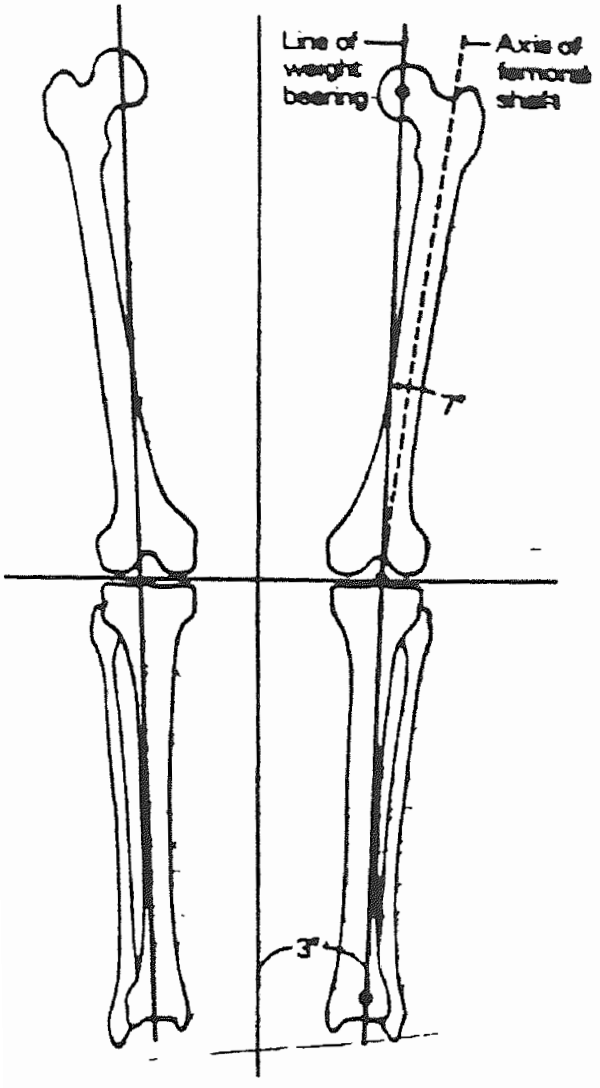
Onoue, et al. 1979 have measured the average length of the whole femur and also the anterolateral curvature of the femoral shaft. They found the former of about 406.2 $\pm$ 26.7 mm and the radius of the later of about 115.9 $\pm$ 12.2 cm. They also studied the size and the site of the isthmus or the narrowest part of the medullary cavity. They found that it is located at 173.6 $\pm$ 20.6 mm from the tip of the greater trochanter with a diameter of 10.9 $\pm$ 1.9 mm. (**Onoue et al., 1979**).

Several forces act on the femoral bone leading to fracture angulation that may make reduction and nailing difficult.

The abductor muscle mass leads to abduction deformity in proximal shaft fractures, in addition the large iliopsoas muscle complex creates a flexion external rotation forces and deformity which is impossible to be corrected by traction in extension. Medially the large adductor muscle group leads to varization deformity accentuated by ambulatory forces on weight bearing but resisted by the lateral thigh muscles and fascia lata as stated by **Inman 1947.** (Fig. 7) (Warwick and Williams, 1973)

(Fig. 8) (Mooney and Claudi, 1984)

Distally the origins of gastrocnemius muscle on the femoral condyles create an unopposed flexion force on the distal fragment in case of



The line of weight bearing should pass through the centre of the hip joint, the centre of the knee joint, and the centre of the ankle joint. In a standing person this line is not quite vertical, because the ankles are closer together than the hips: the deviation from the vertical is about 3 degrees. The long axis of the femoral shaft forms an angle of 6 or 7 degrees with the line of weight bearing.

(Fig. 9) Adams, 1985