Hip pinning...

An historical perspective

By Kim Cable, R.N.

"We come into the world under the brim of the pelvis and go out through the neck of the femur".[1] This quotation conveys the pessimism regarding treatment of hip fractures. There have been a number of important milestones in hip-pinning as a method of dealing with hip fractures. This submission will take a look at these milestones, as well as examine the various catalysts which initiated the procedure and subsequent improvements.

Hip fractures

There are two main types of hip fracture (Fig. 1):
- Neck (intracapsular) fracture.
- Trochanteric (extracapsular) fracture.

Conservative treatment

Prior to the advent of hip-pinning, there were few reliable choices available to successfully treat a hip fracture. Immobilization was often fatal because elderly people died within weeks of the fracture due to cardiac, renal or pulmonary problems exacerbated by the enforced inactivity.[2] Unfortunately, eighty percent of these fractures occur in people over age sixty.[3]

Non-surgical intervention

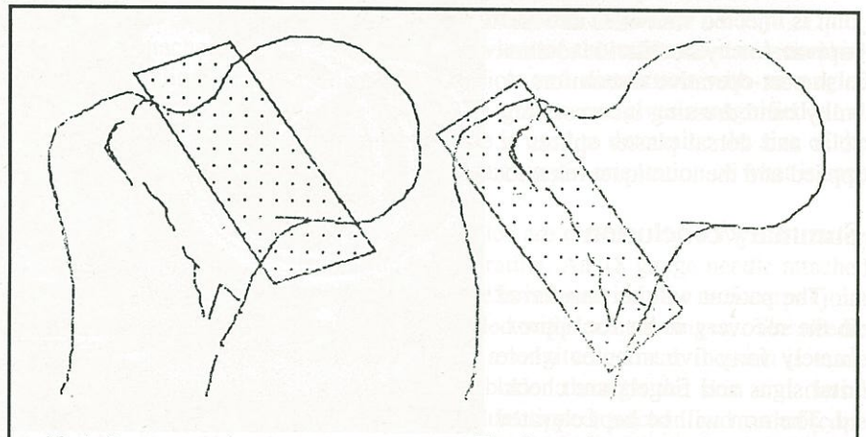
Non-surgical intervention took three basic forms:

1. Prior to the turn of the century, simple traction was the common method of treatment. An orthopaedic textbook printed in 1901 recommended placing the patient on a "comfortable, firm, hair mattress" in conjunction with traction. This method however, did not efficiently immobilize unstable bone fragments.[4]

2. The Thomas hip-splint (Fig. 2a and 2b) was used with traction to afford greater immobilization.

3. The third method was made popular in the early 1900's by Whitman. The fracture was reduced under X-ray observation, and a hip-spica cast was then applied from the lower chest to the toes. This cast remained for six months.[6] "Cotton advocated artificial impaction of these fractures by a blow of a heavy mallet against the padded trochanter as an adjunct to cast treatment."[7]

Casting was routine procedure at that time. It was thought that about thirty percent of those who survived had successful union of the fracture.[8] Casting was better than traction or splinting, but there was a substantial failure rate, which wasn't evident until after the plaster had been endured.[9]



Neck fracture region — Trochanteric fracture region

Fig. 1: Main types of hip fractures

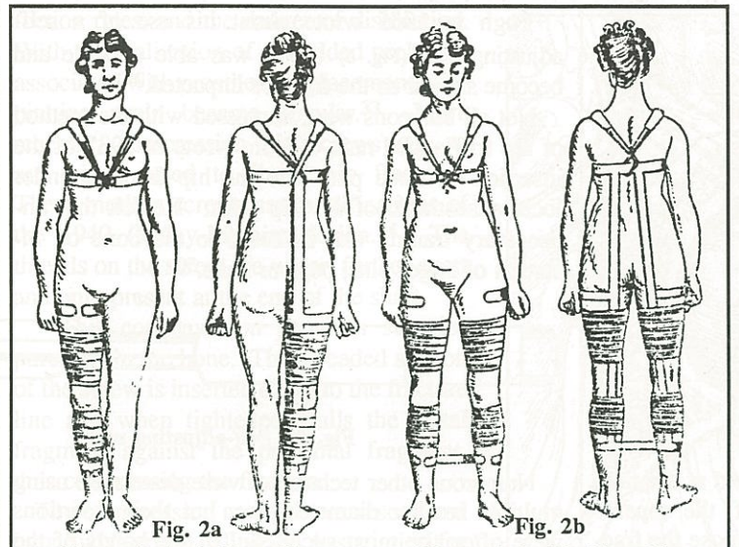


Fig. 2a Thomas' single hip-splint — **Fig. 2b** Thomas' double hip-splint

There is little wonder that with the limited choice of treatment and disappointing results, surgeons were attempting to develop alternate means of treating hip fractures. At the turn of the century, one author grimly wrote: "Slight shortening with a little deformity, some limitation in the movements of the hips, a limp, but a fairly useful limb are to be hoped for."[10]

Disadvantages

- High mortality rate of the predominantly elderly patients who were treated with forced recumbency and immobility.
- Permanent disability after improper union in cast, splint or traction.
- Potential for development of pressure sores.
- Discomfort of long term cast wear.
- Atrophy of soft tissue and absorption of bone, including at neck of femur due to prolonged immobilization.
- Delayed weight bearing for six months or more.
- Expensive, lengthy hospital stay.[11]

Operative treatment

The existence of hip fractures was first documented by Ambroise Pare about four hundred years ago.[12] "Internal fixation of this fracture by nails, screws and (bone and ivory) pegs is by no means a new procedure."[13]

The first reported pinning of this fracture was in 1850 by Langenbeck.[14] Silver or platinum devices were used in the late 1800's because it was "thought that silver was antiseptic or self-sterilizing when implanted".[15] In 1883, Senn achieved a higher success rate in uniting femoral neck fractures in dogs by use of internal fixation.[16] Nicolaysen in 1897 developed a nailing technique, and like his predecessors, without the advantage of X-ray.[17]

Until the late 1920's, other methods were used, including long carpenter screws which proved inadequate because of poor purchase in cancellous or spongy bone. Bone pegs cut from the patient's tibia were also used. These were thought to have better hold and the ability to be incorporated in the healing process.[18] In 1922, steel woodscrews were used with very few reports of satisfactory results. They fell out of favour due to numerous failures.[19]

It was not until 1931 when Smith-Peterson published the results of his work with the tri-flanged nail (Fig. 3) that hip-pinning regained popularity.[20]

Smith-Peterson was not the first to develop a flanged nail. Hey-Groves had devised an earlier quadri-flanged nail, but the metals available at that time proved unsatisfactory to make the device a success.[21] Indeed, the first nail Smith-Peterson developed was quadri-flanged, but three flanges were soon found to be adequate. The earliest tri-flanged nail was made from alloys which caused much tissue reaction. They were also made from two different metals, ie., the flanges made of steel and ends made of brass.[22]

Unsatisfactory metals had plagued the developers of internal fixation devices and doomed them to failure until 1931. Smith-Peterson was fortunate with respect to the timing of the introduction of the tri-flanged nail because the physics of metallurgy had progressed to the discovery of stainless steel and other satisfactory metals.[23]

Advantages of tri-flanged nail:

- made of stainless steel and less likely to break under strain and caused virtually no tissue reaction
- the design of the tri-flanged shape helped it remain solid due to superior purchase in the bone.[24]

The main disadvantage of the early Smith-Peterson nail was the method employed to insert it: "At first

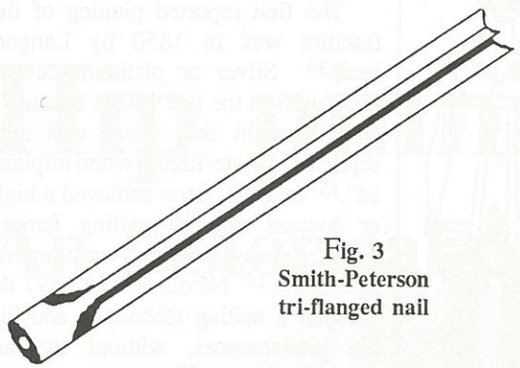


Fig. 3
Smith-Peterson
tri-flanged nail

these three-flanged nails were introduced at the time of an operation on the fracture itself, the capsule being divided and reflected so as to expose the fractured surfaces..."[25]

An important improvement was made in the Smith-Peterson nail in 1932 to remedy the problem of having to open the hip joint in order to nail the fracture.[26] Closed reduction of the fracture and nailing using X-ray control to improve accuracy was suggested by Wescott/Johansson cannulated the nail so that a guide pin could be passed up its centre. This proved important because it allowed the nail to be inserted through an incision over the trochanter at the lateral thigh, and dispensed with the need to open the hip joint itself.[27]

In 1937, Thornton developed a plate which attached to the tri-flanged nail and was fixed to the lateral femur to increase stability. Further development by Jewett in 1941 involved welding the plate to the tri-flanged nail (Fig. 4) to provide greater strength.[28]

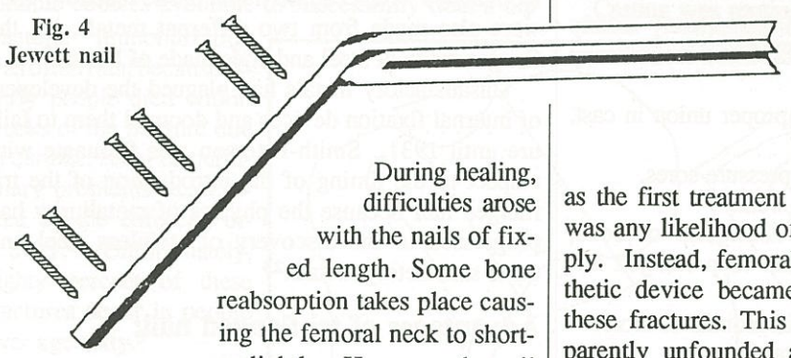


Fig. 4
Jewett nail

During healing, difficulties arose with the nails of fixed length. Some bone reabsorption takes place causing the femoral neck to shorten slightly. However, the nail length remains constant, without the ability to back out laterally due to the femoral plate or one piece Jewett construction. Therefore, the nail would sometimes penetrate the femoral head into the acetabulum.

Pugh in 1955 wrote about his use of a self-adjusting nail (Fig. 5) which was able to slide and become shorter as the fracture impacted.[29]

Not all surgeons were impressed with the method of the tri-flanged nail. Moore wrote in 1937 of the insertion of three pins into the hip fracture under local anaesthetic of the hip joint. He felt that unnecessary trauma was inflicted to the bone on insertion of larger pins, pegs or nails.[30]

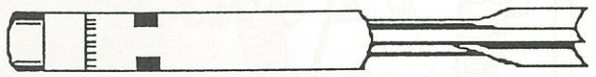


Fig. 5 - Self-adjusting nail

Numerous other techniques were developed using multiple smaller diameter pins, but their insertions were often the most successful in the hands of the originators themselves. The relatively simple technique of inserting a single nail has proven itself more effective in general use.[31]

Regardless of the impressive number of devices available for hip-pinning, there was still a distressing complication that occurred after internal fixation of some hip fractures. Femoral neck fractures and trochanteric fractures differ in their healing capacity. Trochanteric fractures unite more easily due to the wider area of bone involved, the cancellous nature of the bone, and the superior blood supply of both fragments. In neck fractures, however, the narrow area of bone involvement and lower percentage of cancellous bone, along with a compromised blood supply especially in the distal fragment, may lead to avascular necrosis. Avascular necrosis is the death of the head of the femur, in this case, due to restricted blood supply.[32]

In the 1970's, the prospect of the femoral head developing avascular necrosis, even after accurate and successful hip-pinning, caused many surgeons to abandon hip-pinning as the first treatment for neck fractures where there was any likelihood of an impediment of blood supply. Instead, femoral head replacement by a prosthetic device became popular in the treatment of these fractures. This response, however, was apparently unfounded as shown by a study of 500 patients. Sixty percent of the patients had successful union of their fractures, and of those who did develop avascular changes, not all needed further surgical intervention. Prosthetic replacement also has serous complications associated with it when compared to hip-pinning. These include higher mortality and infection rates, and the danger of dislocation. With the realization of the added problems associated with prosthetic replacement, hip-pinning again became popular.[33] More recently, compression hip screws (Fig. 6) are widely used to fixate hip fractures. These modern screws are modifications of the 1940 Godoy-Moreira design.[34] The threads on the screw are wider, further apart and only present at the end of the shaft.

This configuration provides superior purchase in the bone. The threaded section of the screw is inserted distal to the fracture line and when tightened, pulls the distal fragment against the proximal fragment, thus compressing the fracture.

The compression method was researched by a Swiss group called the Association for the Study of Internal Fixation. (ASITF) It was founded in 1958.[35]

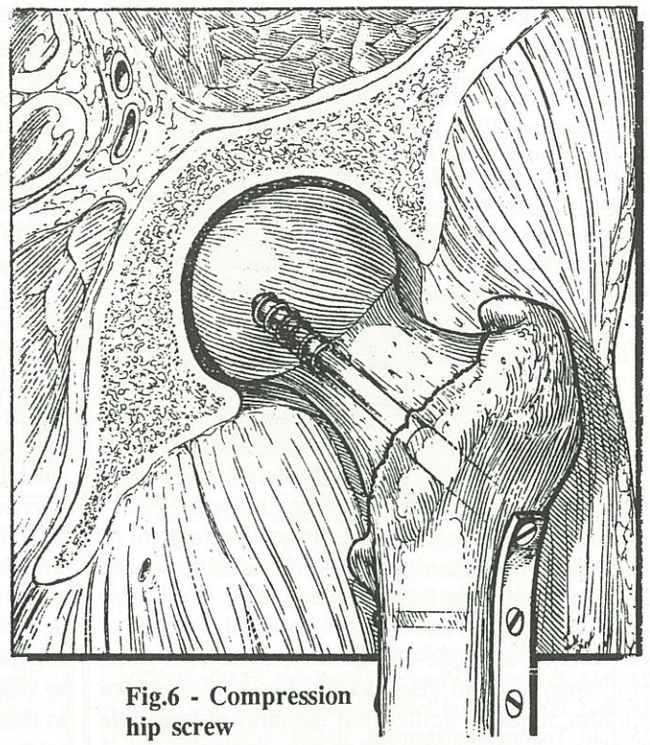


Fig.6 - Compression hip screw

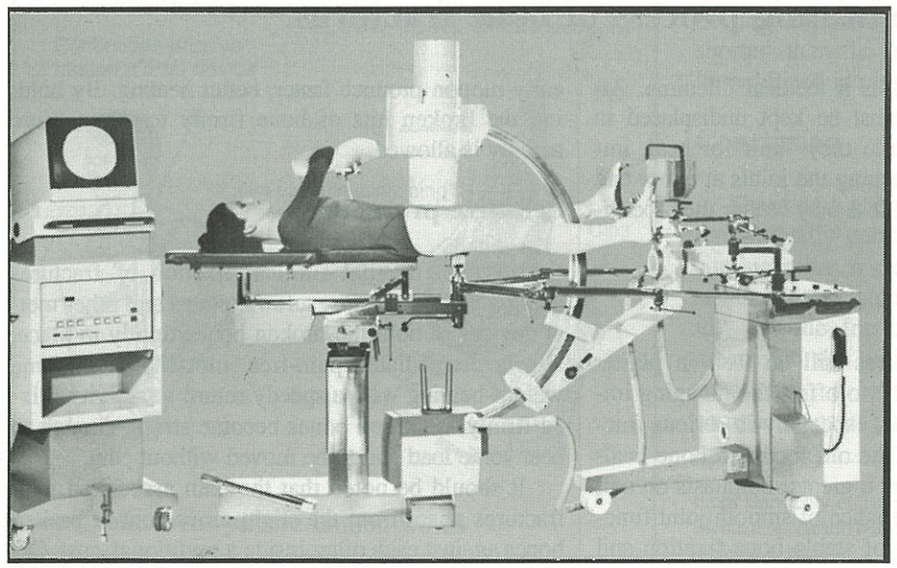
Interfragmental compression

They stressed that stability is of paramount importance to the successful outcome of internal fixation. This stability is achieved through interfragmental compression.[36]

Modern techniques have improved the accuracy of pin placement. The orthographic-orthopaedic and fracture table (Fig. 7) permits easy use of an image intensifier throughout the procedure.

The historical development of hip-pinning has depended upon the need for improved methods of treating hip fractures as well as technological innovations, especially in X-ray and metallurgy. With further advances in technology, no doubt hip-pinning procedures will continue to improve. ■

Fig. 7: Orthographic/orthopaedic and fracture table (AMSCO)



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Canadian hip fracture statistics...

Estimated number of hip fractures in Canadians over age 50 in 1987:
Women - 13,193
Men - 4,610
Predicted increase in hip fractures in Canada in next 20 years, 70%:
Women - 22,922
Men - 7,846

Source: University of Manitoba's Sport and Exercise Science Research Institute, Winnipeg

See pg. 22 for description of study

Continuous passive motion, an innovative concept enhancing the healing process of bone fractures

Bone healing presents a medical dilemma. Although broken bones must be kept undisplaced in the correct position while they "knit" or heal, immobilizing them and keeping the joints at either end of the bone shaft motionless may render them permanently stiff or arthritic.

The new focus

While many fractures still do well in plaster casts, modern experts try to offset the ravaging impact of prolonged disuse, especially in serious fractures involving joints. The old focus on bone healing has been replaced by a greater emphasis on soft tissue repair and maintenance of smooth joint function. The new methods of stable bone fixation and early motion produce faster, better healing. By holding the broken bits of bone firmly together, more activity is allowed.

Selective procedures

Stable, internal surgical fixation of fractures using a variety of pins, screws, plates and other metal devices to hold the broken bones tightly in place, allows immediate, pain-free mobility and some weight-bearing with a speedy return to activity. Fixed firmly, fractured bones become strong enough to bear some load and to be moved without pain.

It should be noted that the pain associated with fractures arises from the slight movement of broken bones against each other inside a traditional cast. Orthopaedic surgeons are much more selective today about which broken bones are set in plaster and which are treated by alternative methods.

"Gate control"

Continuous passisve motion (CPM) is one such alternative in fracture care. Pioneered at the orthopaedic biomechanics laboratory at the University of Toronto, this innovation in fracture care uses a machine instead of the injured person's own muscles to provide motion - motion that is needed to stimulate the healing of damaged joints and tissues.

Over the past 18 years, a team of surgeon-scientists at the University of Toronto has demonstrated by numerous experimental investigations that if damaged joints are continuously, gently and passively moved, the cartilage may regenerate. Contrary to formerly accepted views, the concept of CPM for diseased and injured joints is an excellent stimulus for healing and regeneration of tissue. Experimental investigations on animals confirm that CPM, for about one week, day and night, right after injury or reconstructive surgery, promotes the regeneration of cartilage within an injured joint. It also promotes the repair of ligaments and tendons. Continuous motion devices that gently rock the healing part can painlessly and dramatically improve the rate of tissue repair and the ultimate strength of a healed joint.

Continuous passive motion

The absence of pain reported by people whose healing joints are moved may be explained by the "gate control" theory of pain: the propagation of nerve impulses to the brain from the continuously moving injured joint "closes the gate," blocking the transmission of pain impulses.

After eight years of animal research, CPM was tried for human fracture care, using specially constructed motorized devices to move the damaged joint continuously back and forth in a slow, rhythmic motion, mimicking its natural movement.

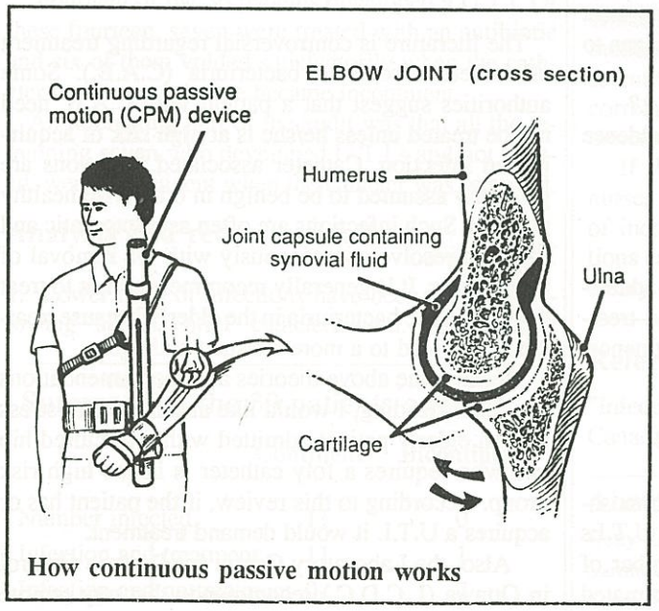
The device is attached to the affected part of the leg or arm, hand or finger putting it through a predetermined range of motion. This motion is quite slow, one cycle per 45 to 60 seconds. Since it is mechanical, the patient is not required to work to move the joint. He or she can lie in bed, eat, read or sleep while the healing part is gently moved.

CPM devices are always set up immediately after an injury or an operation while the patient is still under anaesthetic. The therapy is usually maintained from 1 to 3 weeks, with day and night treatment.

This revolutionary method can be used for ankle, knee, hip, finger, elbow and shoulder injuries, or following reconstructive surgery of these parts. It is also used to promote the healing of septic arthritis (joint infection), synevectomy (surgical removal of the diseased joint lining), replacement or repair of torn ligaments and repair of tendons.

Enhanced healing

The greatest advances of CPM are enhanced healing of joint tissues, maintenance of early post-operative mobilty and prevention of the joint stiffness that usually follows prolonged immobilization in plaster. Wounds heal normally, the involved joints are less swollen and do not become stiff, resulting in a hospital stay shorter than is usual for the patients immobilized in plaster.



How continuous passive motion works

Conclusion

These new approaches to bone healing are gradually gaining acceptance and becoming more widely used. The accepted standard for fracture care in 1989 is to rigidly fix the fracture, often by surgical means, so the patient can ambulate and function at a level that minimizes the complications of disuse. ■

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