HOW TO HANDLE ORTHOPAEDIC PROBLEMS IN A PRIMITIVE SETTING

DISCLAIMER:

These monographs represent the opinion of the author, based on his own personal training, experience, and reading.

In some cases these opinions may be in conflict with standard orthopaedic care.

The monographs have been produced solely in an effort to assist doctors who are practicing in, or will be going to practice in, remote and primitive settings where normal equipment, supplies and referral base may be lacking.

The monographs are in no way any attempt to change or circumvent the usual or typical standards of orthopaedic care and management. Nor are they intended for publication in any books or journals. Rather, they are intended as a "personal" communication from the author to such doctors as described above.

Each doctor receiving and utilizing the data contained herein must carefully exercise his or her own judgment, based on his or her own experience and abilities.

Just because a practice location is primitive and remote does not excuse "mayhem". Each doctor practicing in such a location and under such circumstances must still do his or her very best to provide the finest care possible for the patient, within the constraints and limitations of the location and his or her own abilities.

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Date of production in this revised format: February 15, 2001

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Monograph #1, October 11, 1994

The idea of writing a book to give orthopaedic instruction to non-orthopaedists came about as a result of the need at Memorial Christian Hospital in Bangladesh. After working in that hospital over a period of seventeen and one-half years as an orthopaedic surgeon, interrupted only by furlough years, it was very evident to me that the demand for orthopaedic care was not going to stop when I left the scene. However, the doctors who were taking over the medical work at the hospital had not had much orthopaedic training. Many of the short term doctors I who came from time to time to assist in the work for several weeks or several months, also had not had much orthopaedic surgery training during their residencies. Orthopaedic problems are very common in mission hospitals, especially at Memorial Christian Hospital in Bangladesh, and, like-it-or-not, the doctors are pressed into handling orthopaedic emergencies. Clearly, I thought, there is a need for a simplified treatise on how to handle orthopaedic problems in such a setting. That's when I got the concept of writing such a book. However, realizing that considerable time would be required to write this in book form, and that the need on the field for such information is NOW, I decided to write a series of short monographs, instead of a book. The missionary doctor "on the front line" has little time to read. These short monographs could be more "bite-size" and could be read as they arrived. Then, they could be filed in a loose-leaf notebook for future reference. The articles are very basic, assuming no knowledge of orthopedic terms, equipment, procedures, etc. on the part of the reader. To the experienced surgeon they may be oversimplified, but it is hoped that they will be helpful to some doctors.

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I do not intend to spend much time on elective orthopaedics--that is, reconstructive surgery, or non-emergency work. The big demand on our field, and I suspect on many mission fields, is for knowledge and expertise in the handling of trauma cases. This will be our major thrust. However, many non-emergency orthopaedic problems are quite simple to care for, and I will discuss some of these.

In my own case, when I arrived in Bangladesh, having had a formal orthopaedic residency training, followed by six years of clinical practice of orthopaedics in California, I had been thoroughly indoctrinated in principles of handling various orthopaedic problems. It did not take long for me to realize that these "principles" could not always be applied in the primitive setting where our hospital was located. Cultural, traditional, and environmental factors all require modifying treatment to fit each individual situation. For example, the standard approach in developed countries for treatment of tuberculosis of the knee joint might be considered to be joint fusion. This is good treatment, and often results in a "cure" of the TB. However, Bangladesh has a squatting culture. Squatting is required to use an Asian toilet in anything resembling a comfortable position. A stiff knee

requires one to sit on the bricks on either side of the opening in the floor, and this may be quite messy -- not a pleasant situation! Therefore, your patient with a stiff knee may not be very happy with the final result.

Patients arriving at the hospital for treatment have often had treatment elsewhere, resulting in considerable delay, and often in severe complications. It is not possible to describe the great variety of such complicated problems, but they may be more prevalent in your practice than nice, fresh, clean injuries. They will require special consideration and often special handling. This is where the "tricks of the trade" often come in handy.

When the patient arrives and is seen by the national staff of medics, nurses, or even doctors, one must not assume that the patient has been adequately triaged by these persons. The doctor must do his own triage and assessment, taking nothing for granted.

The expectations of the patient need to be considered. The uneducated patient often expects immediate results. He does not understand the need for "staged" treatment. Do not assume that he or she will follow instructions, and that they will return as requested for further treatment. Often they have come a long way, and have no place to stay around for a few days while you get lab work, x-ray work, and special tests. You are pressed into doing as much as' you can on that first visit.

The patients often know little or nothing about their anatomy or physiology, so detailed explanations only confuse them. Superstition or fear may cause them to reject recommended treatment, even if it may be lifesaving or lifesaving.

With that as an introduction, let us begin by considering some very basic orthopaedic management procedures and techniques. Let's start with TRACTION, since this is the orthopaedist's great "master tool". No matter how complicated a fracture might appear to be, traction will often times pull the fragments into alignment very nicely, and surgery may be avoided. Traction is a two-edged sword, however. It can cause problems as well as treat problems.

SKIN TRACTION:

In a hot climate, skin traction is oftentimes poorly tolerated. Adhesive tape traction strips may cause traction blisters at the edges of the tape. Efforts to wrap the extremity securely enough to prevent the tape from slipping may embarrass the circulation. I have found that the most effective way to apply skin traction is by means of orthopaedic tubular stockinette applied over some sort of "skin glue", such as tincture of benzoin or Ace Adherent. This gives circumferential traction to the skin, avoiding problems at the edges of tape strips. Some sort of spreader must be applied at the end of the limb, to avoid squeezing the tubular stockinette tightly over pressure points, such as the malleoli. This can be a wood block with a hole in it for the rope, or can be a wire spreader.

If tubular stockinette is not available, one might improvise

by applying the "skin glue", and then wrapping the limb snugly but not tightly with cloth strips or bias-cut stockinette, in a circumferential fashion. Then, strips of adhesive tape can be applied in a longitudinal fashion over the cloth layer, and traction applied to the tape strips. This will give circumferential skin traction, without the "shear force" at the edges of the tape strips.

Skin will only tolerate about 8-10 pounds of pull without blistering. If more pull than this is required, you need to go to skeletal traction.

If an elastic bandage is used to wrap around the tubular stockinette to hold it next to the skin, great caution must be used to see that the elastic bandage is not too tight. I think it is better to wrap the extremity with a nonelastic wrap, such as a bandage roll, to avoid excessive tightness. This wrapping should be rewrapped DAILY, or more often if it gets wrinkled into a series of rope-like constrictions.

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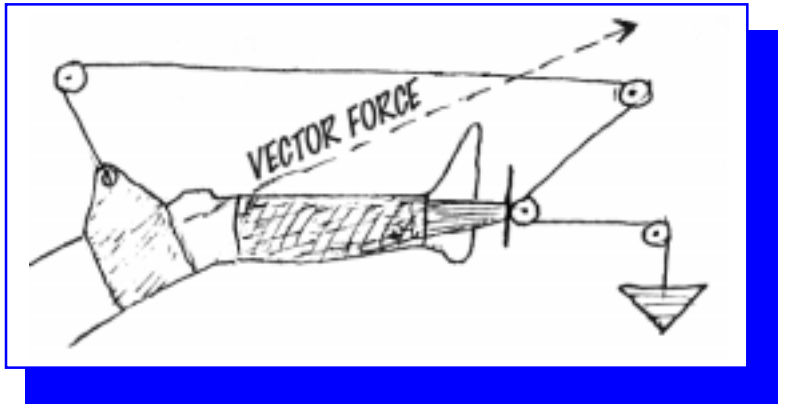
Some types of commonly used SKIN TRACTION:

Buck's traction: This is straight traction to one leg, and is often used in cases of hip fractures, or knee injuries. Traction is applied by applying the tubular stockinette to the leg from just below the knee to the ankle, securing it in place with circumferential wrapping, and then applying a spreader block or wire distally, connected to a rope. Sometimes longitudinal strips of tape are applied to the stockinette and traction is applied to the tape strips. The rope is ideally passed through a pulley at the end of the bed, and connected to a 5-8 pound weight. If no pulley is available, one can simply use the foot of the bed, or a smooth round rod between two chairs, over which to pass the rope. Caution is necessary to see that the traction does not pull the heel down against the bed, as this will result in a bedsore behind the heel. These are very difficult to treat! Be certain to assess the circulation after application of the traction, and check it daily.

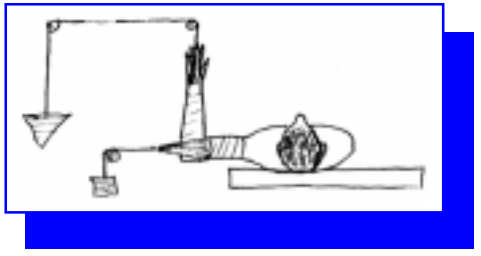
Bryant's traction: This is sometimes used in small children with femur fractures, applying Buck's-type traction to both legs in an upward direction. This pulls the legs straight up, with the hips flexed 90 degrees. Great caution must be exercised in using this form of traction on other than very small children, weighing less than 30 pounds. The circumferential wrapping, together with the elevated position, may cause ischemia to the leg or foot, which can be disastrous! Enough traction is applied to just lift the buttocks off the bed.

Russell's traction: This is an extremely useful form of traction, utilizing a system of pulleys to result in a strong traction force without over-tracting the skin.

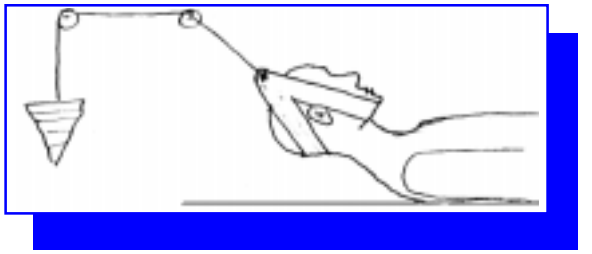


The resultant or vector force between the upward traction and the longitudinal traction is about double the weight applied. Here it is absolutely necessary to use a spreader bar on the sling above the knee, to avoid a constrictive force around the distal thigh.

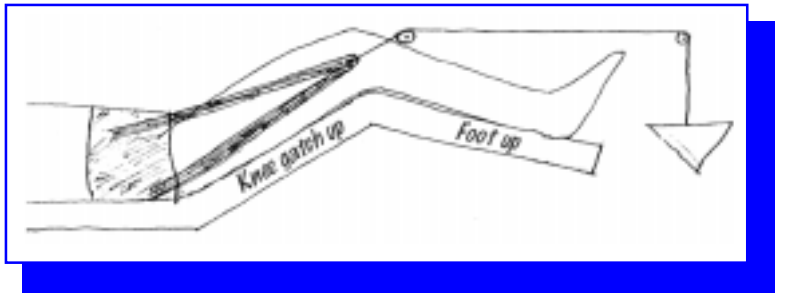
Side-arm traction: This is useful in fractures of the humerus, and may also be useful in some cases of forearm fractures. Again, great caution is necessary to ensure the circulation is not compromised.



Cervical traction: 5-6 pounds of continuous cervical traction can be tolerated via a traction sling beneath the occiput and beneath the chin. This sling should be padded well. In cases of cervical fracture the traction must be in line with the trunk (axial). In cases of suspected herniated cervical discs, the traction should be in about 20-30 degrees upward angulation.



Pelvic traction: Pelvic traction may be used for herniated lumbar discs. In this case the traction should be applied in about 30 to 45 degrees upward direction.



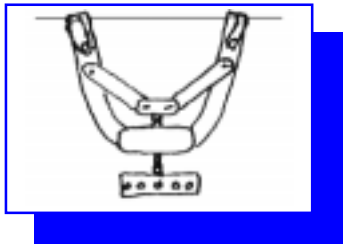
This reverses the lumbar lordotic curve, opening the posterior part of the intervertebral disc space. Pelvic traction may also be used in some cases of spinal fractures. This will be discussed in detail under that category.

As you can see from the foregoing discussion, skin traction is quite limited by the amount of weight that can be applied to the skin without causing problems. When more weight is needed,

one must go to skeletal traction. Or, when traction will be prolonged beyond just a few days, it is usually better to use skeletal traction than skin traction, to avoid skin problems.

Skeletal traction: This is the orthopaedist's great friend, but must be used carefully. There are two main types of pins used for skeletal traction - - Steinmann pins and Kirschner wires. Both of these come in both threaded and smooth, or non-threaded styles. In general, threaded pins or wires should NOT be used for skeletal traction as they may break more easily than the smooth ones. However, in very small children undergoing femoral traction, it may be better to use threaded pins to prevent side-to-side slipping of the pin with subsequent contamination of the pin-sites.

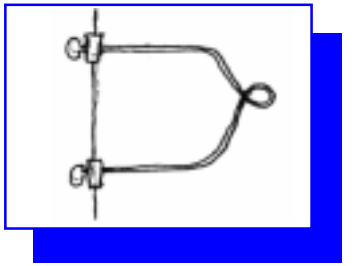
Kirschner wires are usually nine inches long and in three diameters: 1/32", 3/64", and 1/16" (. 035, . 045, and . 062 in. , or 0. 9, 1. 2, and 1. 6 mm). Because of their small diameter, Kirschner wires are only used for smaller bones. Traction on the ends of the wire will cause it to bow. Therefore, Kirschner-wire traction bows are necessary.



When tightened, these change the easily bendable K-wire into a tight-wire, and considerable pull can be applied to the traction bow without bowing the wire very much.

Remember -- because K-wires are relatively fine, they will cut through bone rather easily, just like you cut cheese with a tight wire. This is especially true in osteoporotic bone.

Steinmann pins are thicker than K-wires. They, too, usually come in 9 inch lengths (you can get longer ones on special order). They come in a greater variety of diameters: 5/64", 3/32", 7/64", 1/8", 9/64", 5/32", and 3/16" (2.0, 2.4, 2.8, 3.2, 3.6, 4.0 and 4.8 mm). They come with various kinds of points, and some are pointed on both ends. One very useful modification of a Steinmann pin has suture holes drilled in each end, and can be used for passing suture through bone.



Because of their increased size, Steinmann pins do not require a "wire stretcher" like the K-wire traction bow. Instead, traction can be applied by a simple traction bow.

When drilling skeletal traction pins through bones it is very important to drill SLOWLY, so as to not cause overheating of the bone around the pin with resultant ring-sequestrum. This will also lead to loosening of the pin with prolonged traction, and paves the way for infection. Sites for application of skeletal traction will be discussed under the various uses.

Pins or wires can usually be inserted under local anesthesia. Very careful sterile technique is a MUST. The area should be thoroughly cleansed with soap and water, and then prepped with Betadyne (if available), or other strong germicide. Tincture of iodine can be used, and is usually available. Then, the area is draped with sterile towels. The operator should wear sterile gloves, and all of the equipment must have been suitably sterilized. 1% or 2%

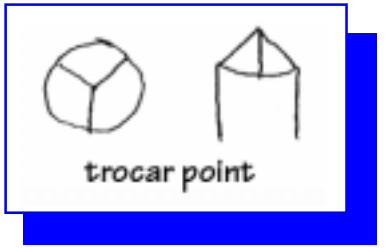
lidocaine is injected at the site of pin insertion, down to the periosteum. The site of pin exit is also injected. The pin or wire is then drilled slowly through both cortices of the bone with a hand drill.

It is important to take good care of the pin-sites, to avoid infection. They should be dressed with a sterile sponge and antibiotic ointment, or left open and cleansed daily with hydrogen peroxide. Care must be exerted to see that the pin does not move from side to side through the bone, which will pull contaminated wire into the traction hole.

Improvisation: Mission hospitals may not be able to afford the luxury of "store-bought" K-wires and Steinmann pins, and the "missionary drums" may not contain a sufficient supply. It is possible to make your own pins and wires from type 316 stainless steel rods and wires available from various sources. Such rods and wires should be sufficiently stiff to allow insertion in bone. Do not use ordinary stainless steel, as it is not well tolerated in the human body. At the same time ask about getting type 316 nuts and washers to use with the threaded pins. Usually nuts and washers are only used on threaded pins of 1/8" diameter and larger. These are very useful, as will be described later.

You can have the wires and rods cut to three-foot lengths for ease in shipping. When you get them, cleanse the grease off with solvent, cut them to desired lengths, sharpen the ends with a file (using a grinder will cause them to overheat and lose their temper), and then polish them with steel wool.

The easiest way to sharpen the ends so that the wire or pin will act as a drill point is to fashion a "trocar point".



Monograph #2, October 31, 1994

We have considered two very important basic tools of the orthopaedic surgeon: Kirschner wires and Steinmann pins. Now, let's look at some other very useful hardware.

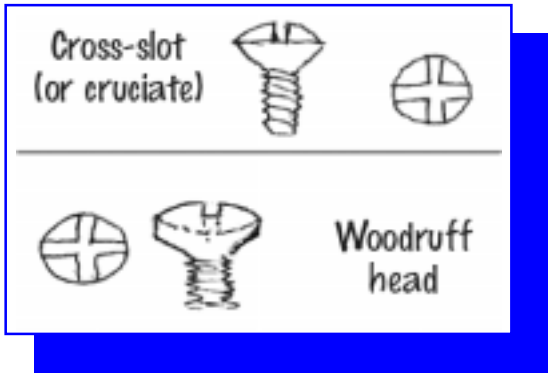
Screws and plates are important in the armamentarium of the orthopaedic surgeon, and they come in a great variety of shapes, styles, and metals. The most commonly used screws and plates are stainless steel, and this is usually an alloy called "type 316", consisting of iron, chromium and nickel. The exact formulation may differ somewhat from one manufacturer to another, and even from one batch to another. Another common alloy is called Vitallium. Other alloys are also in use.

IT IS IMPORTANT TO AVOID PUTTING DISSIMILAR METALS TOGETHER, TO AVOID "BATTERY EFFECT", WITH RESULTANT CORROSION, TISSUE NECROSIS AND LOOSENING OF THE IMPLANT.

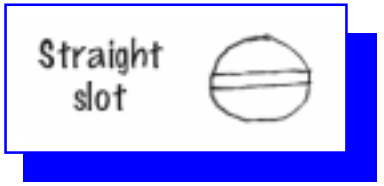
Vitallium usually has a dull finish, whereas stainless steel is usually shiny. Whenever you get a new batch of screws and plates, it is very important to examine them and separate out the vitallium plates and screws from the stainless steel ones. Put them in a separate place, to prevent the CSR crew from mixing them up. Don't mix vitallium and stainless. This battery effect can often cause pain to the patient, as well as the other effects of the corrosion.

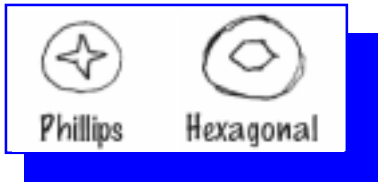
Screws come in a great variety of styles:

Common head styles:



The Woodruff head has the advantage that the slots are concave, deeper in the center than at the edges. This allows the special Woodruff screwdriver bit to engage the head even when held at an angle. This screw type can also be driven with a straight screwdriver.





Other head styles include Straight slot, Phillips and hexagonal.

Threads: Standard screws have 20 threads per inch, and are called "coarse thread". Fine-threaded screws have 32 threads

per inch. In general it is probably best to use the coarse threaded screws as they have better holding power in the bone.

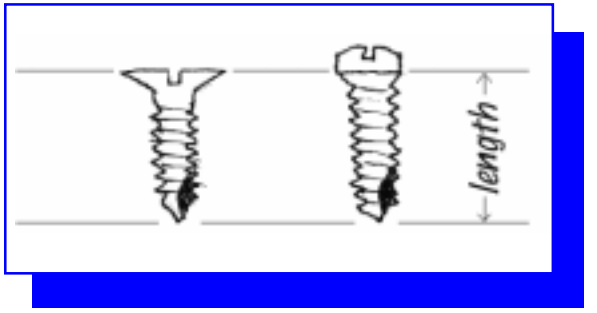
Thickness, or diameter, of screws: The most commonly used thickness is 0.138" (3. 5 mm.), and this requires a 7/64" drill hole. Sometimes it is necessary to use a thicker screw, which is 0.164" (4.2 mm). This screw requires a 9/64" drill hole.

PITFALL! When you are using screws, inspect each one as it is handed to you to see that it is the thickness you want to use, and whether it is coarse-threaded or fine-threaded. Also, be sure you are using the correct size drill for the pilot hole. Try to use the same type head on all the screws -- this makes it more likely that they will be compatible metals, and makes the removal easier later on.

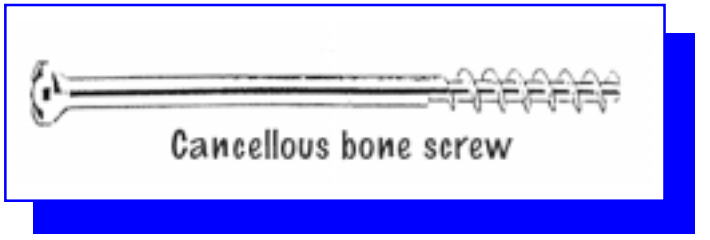
Points: In general, points may be either self-tapping or non-self-tapping. Self tapping points have a cutout at the end, which allows the screw to cut its own threads in the bone:

If the screws do not have this "cutting tip", you must use a correct-size tap. Purists will tell you to use a tap with all screws, and this is fine if you have the tap and the time. It does make a better contact between the threads and the thread-channel in the bone, with greater holding strength. If you do not have the correct tap, you can make an improvised tap by cutting a slot with a file in one side of the tip of one screw and then use it to tap the holes for the other screws.

Length: It is best to use a length that will allow the screw to just protrude from the distant cortex (so that perhaps one thread is visible). If the screw protrudes further than this, there is the danger of damage to the soft-tissues. If shorter than this, there will be inadequate holding power in the far-cortex. Screws should penetrate both cortices of a long-bone. Length is measured like this:



Cancellous bone screws: These have much coarser and deeper threads, to give greater holding power in soft bone. There are only 11 threads per inch. Diameters vary, and required drill sizes vary, so be sure to check these carefully before using them. The partially threaded shaft or shank is useful in applying compression techniques, which will be discussed later.

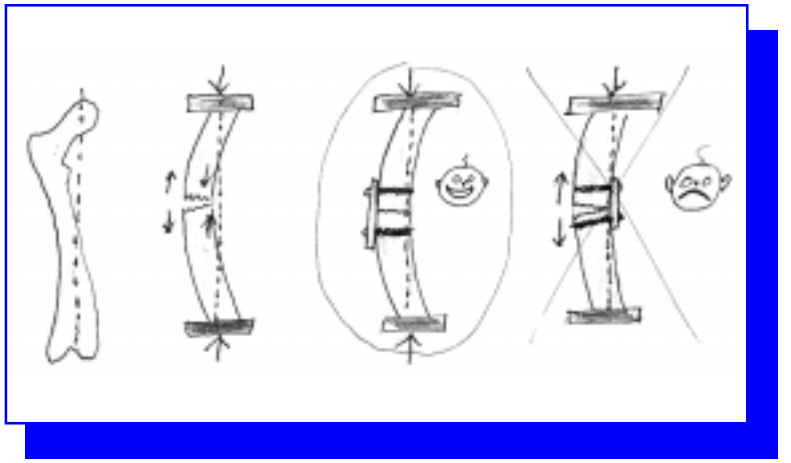


There are many other types of screws for special purposes. Some of these will be discussed later on, as we deal with specific fractures.

Use of Screws: Screws can be used as inter-fragmentary holding devices, or for applying plates or other metal devices to bone. If screws are used to hold two fragments of bone together, the proximal hole should be over-drilled, so that the threads will have purchase only in the distal fragment. Tightening the screw will compress the fragments together. Commonly the pilot hole is first drilled with a 7/64" bit, through both fragments. Then, a 1/8" bit is used to enlarge the hole through the proximal fragment only. When the screw is inserted and tightened it will "slip through" the proximal fragment but firmly engage the distal fragment, and when it is tightened it will draw the proximal fragment down against the distal one.

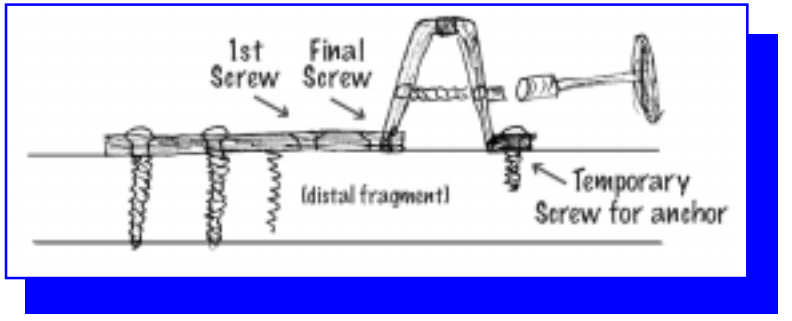
When screws are used with plates, whenever possible, six to eight cortices proximal and six to eight cortices distal to the fracture should be penetrated by the screws. Sometimes only two screws proximal and two distal to the fracture are all that can be used.

Whenever plates are applied to a long-bone fracture, if the bone is "eccentrically loaded" (as is the femur, for example), the plate should be applied to the convex surface of the bone. This will result in a compressive force on the fracture site. Conversely, if the plate is put on the concave site, the normal loading will result in a distractive force on the fracture site.



Compression plating: Compression of fracture fragments together will result in much faster healing. There are basically two ways compression can be applied: (1) Use of a compression plating device, and (2) use of a self-compressing plate.

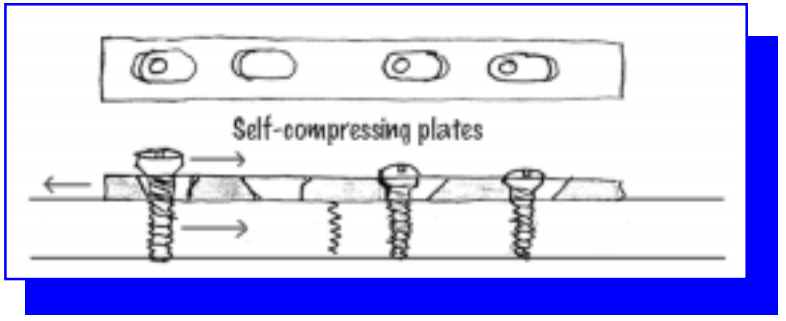
(1) Compression-plating devices involve attaching a plate to one side of the fracture and then drawing it toward the other side of the fracture by pulling against an "anchor" screw in the opposite side. One type of such device is the Meuller device. After the compression has been applied, one screw is placed in



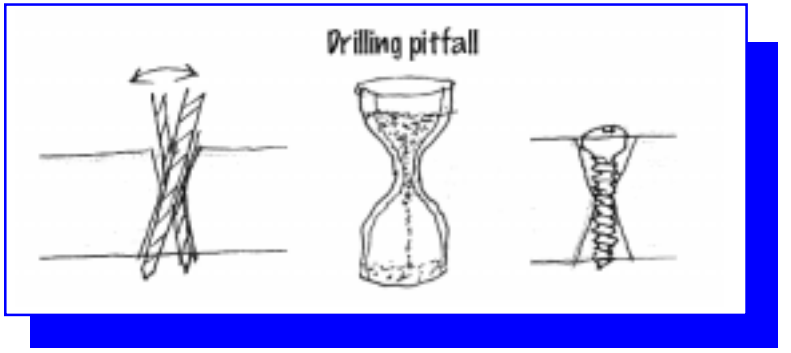
the distal fragment, the compression device removed, and the final screw or screws applied.

Compression can be improvised by partially inserting a screw on each side of the fracture, encircling both screws with a strong wire, and then twisting the wire to draw the two screws toward each other, thereby compressing the fracture. A plate can then be applied beside the wire, and the wire and temporary screws removed.

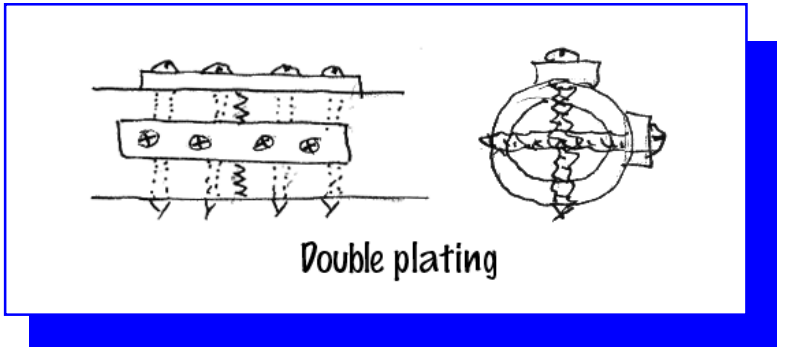
(2) Self-compressing plates: These plates have elongated screw holes. The plate is fastened to one side of the fracture with screws. Then, on the other side of the fracture, screws are driven in the holes at the "far-end" (away from the fracture line) of each elliptical hole. When the screw is tightened, the shoulder of the screw will force the bone to migrate toward the fracture, thereby compressing the fracture site. There are various types of these plates, but the principle is basically the same.



PITFALL: When drilling the pilot holes for screws AVOID THE WOBBLE! Wobbling the handle of the drill while drilling makes an hourglass shaped hole, and the holding power of the screw is decreased. Hold the drill as steadily as possible tile drilling.



Double plating: Sometimes it is necessary to apply two plates to a long bone, 90 degrees apart. This gives increased stability and lessens the likelihood of plate failure. This may be considered in an uncooperative patient, who is likely to use the limb against orders.



Removal of plates: Removal of plates is optional. The patient may request removal. People sometimes don't like the thought of that "thing" that is inside their bodies, and that they can see on the radiograph. Stress-shielding by the plate prevents normal bone remodelling and the bone does not get as strong as it would without the plate. It may be desirable to remove plates for this reason, e. g. in the case of an athlete.

It must be remembered that drilling holes in bone causes stress points and weakens the bone. After removal of the plate and screws the extremity should be protected by a cast or brace until x-rays show restoration of the medullary canal and obliteration of the screw holes. In case of double plating, only one plate should be removed at a time, with a six-month interval before removal of the second one.

Here are guidelines for timing of metal removal:

Malleolar fractures ..... *8-12 months*
Tibial shaft
plate ..... *12-18 months*
medullary nail ..... *18-24 months*
Patella, tension band ..... *8-12 months*
Femoral condyles ..... *12-24 months*
shaft, single plate ..... *24-36 months*
double plate ..... *first at 18 months*
second ..... *6 months later*
Femoral shaft medullary nail ..... *24-36 months*
Hip - trochanteric and neck ..... *12-18 months*
Upper extremity (optional) ..... *12-18 months*

PRINCIPLE: AVOID USING OR SCREWS AND PLATES IN OPEN FRACTURES!! There is a high incidence of infection in such cases, and the fixation device will loosen, losing its effectiveness. Alternatively, see INTRAMEDULLARY FIXATION, USE IN OPEN FRACTURES.

PRINCIPLE: REMEMBER THAT PLATES AND SCREWS ARE ONLY INTERNAL SPLINTS, AND SHOULD NOT BE EXPECTED TO BEAR THE STRESS OF WEIGHT BEARING OR OTHER STRESSES AND STRAINS. PROTECT THE EXTREMITY UNTIL ADEQUATE CALLUS IS VISIBLE ON X-RAY.

These are some general principles regarding screws and plates. We will discuss more details as we consider specific uses.

Monograph #3, February, 1995

In this monograph I would like to discuss intramedullary fixation and external fixation. These are two relatively simple but extremely effective ways of dealing with many fractures, and are well suited to a primitive setting.

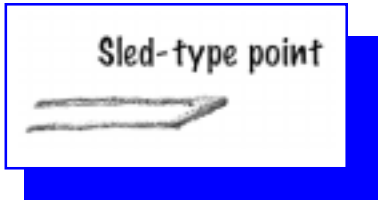
Intramedullary Fixation: One should avoid the use of plates and screws in open fractures. The same used to be felt true in regard to intramedullary fixation, but now it is not uncommon to use intramedullary fixation in open fractures. If infection does occur, the intramedullary fixation can remain and fulfill its function of holding fragments in alignment. Later, after the fracture has healed, removal of the intramedullary fixation is relatively simple. On the other hand, infection involving plates and screws most often results in loosening of the screws and loss of fixation.

For example: Let's consider an open fracture of the forearm with displacement of the fragments. If one treats the wound and leaves the fracture alone, until the wound is healed, going back in to insert plates and screws is a large undertaking. On the other hand, careful debridement, followed by intramedullary fixation, and then leaving the wound open for secondary closure will result in maintenance of alignment while the wound is healing. Also, in a busy schedule, this will reduce the load on the operating room.

Rush rods are very useful in many types of fractures, both open and closed. A similar type rod can be made in your own workshop out of the type 316 stainless steel rods I mentioned before. For femurs and tibias you need 1/4" or 3/16" rods. Forearms usually need 1/8" or 3/32".

First of all you have to fashion a hook on one end, which will prevent the rod from migrating deeper into the bone and will remain superficial to allow later removal. The hook can be fashioned with a vice, vise-grip pliers, channel-lock pliers, etc. and looks like this:

Making the hook on 3/16" and 1/4" stock is more challenging. It is usually necessary to heat the tip with a blowtorch to a glowing red, before attempting to bend it. Then, the hook must be inserted into cold water while it is still hot, to restore the temper.

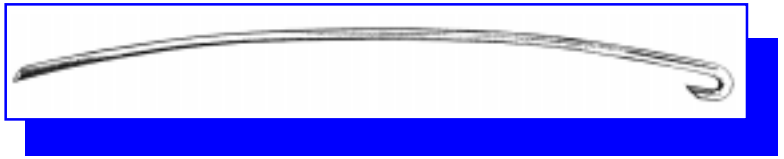


Then a sled-type point is constructed at the other end with the point of the sled on the same side as the hook:

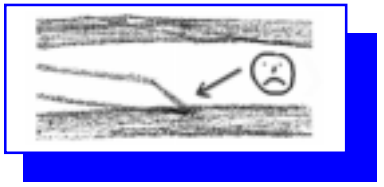
It is very helpful to have a sterile vice, hacksaw, extra blades and files that can be set up in the operating room to enable you to cut long pins down to make shorter ones. Be sure to get a hacksaw with an all-metal handle, so it won't melt in the autoclave. The file will rust and will have to be replaced from time to time. After cutting pins or rods, be sure to wash them thoroughly in sterile water, to remove filings and dust.

After the hook and the point have been constructed, polish the rod with steel wool before sterilizing.

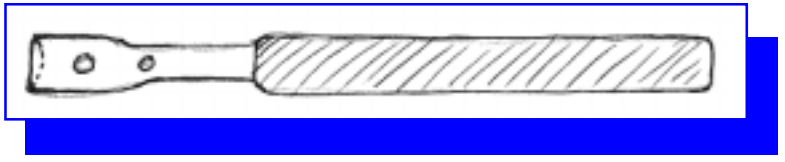
Technique of insertion: The rods should be bent somewhat, like this:



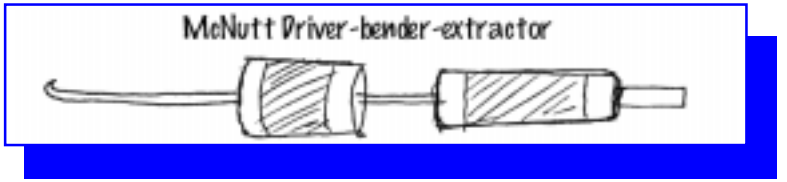
This results in "three-point fixation" within the medullary canal of the bone. Be sure to bend it so that the flat part of the sled-end skids along the interior of the medullary canal. Otherwise the point will dig in and you are in trouble:



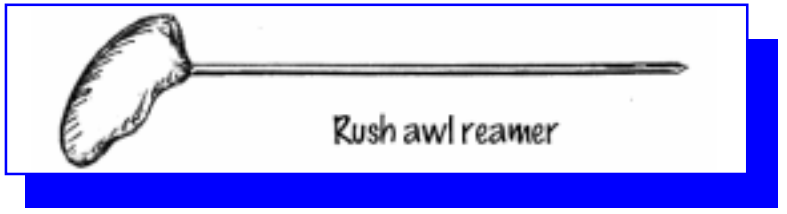
About the only tool you really need besides a mallet is a Rush pin driver. The concave end of this driver allows you to control rotation as the rod is introduced. The hole in the tip is useful for bending the rod. This driver can also be used to extract the rod, by hooking the tip under the hook and driving the rod out in reverse:



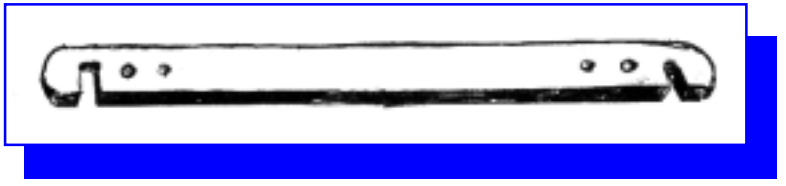
However, removal is much facilitated by an extractor, such as the McNutt Driver-bender-extractor:



It is also helpful to have an awl, to make the original hole. The Rush awl reamer has a channel along one side of the pointed end. After you have made the hole, insert the point of the rod into the channel and slide it down into the hole:



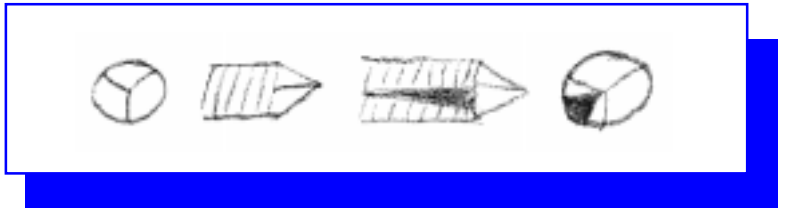
Benders will allow you to shape the rods more easily:



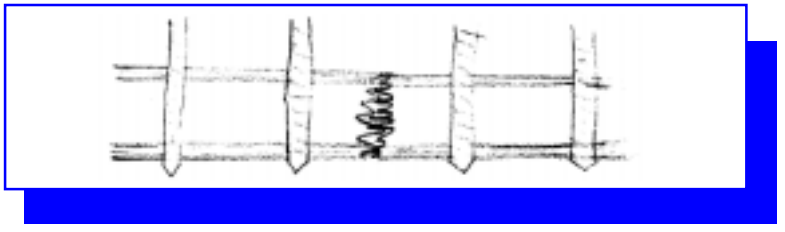
An Atlas of Rush Pin Techniques, by Berivon is available free of charge and is highly recommended-phone 1-800-251-7874.

External fixation: External fixation may be better than internal in some situations, especially in severely comminuted or very dirty fractures. We have tried the various types of external fixation apparatus, and found them hard to use. Moreover, we didn't dare send someone home with one of those erector sets in place, as we knew we would never see it again. We devised a method of our own, based on a technique I first saw in Japanese literature.

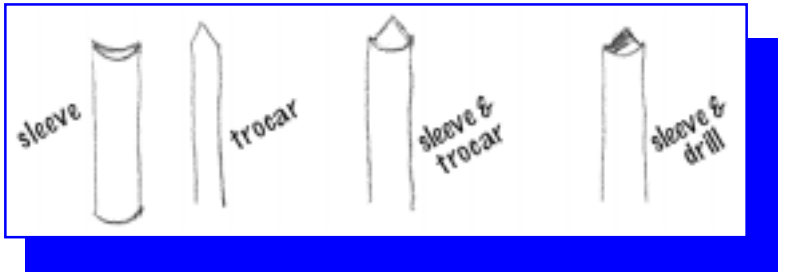
We fashion external fixation pins out of threaded 316 stainless steel stock. First, we sharpen the tip and then cut a channel along one side of the tip, to make it a self-tapping tip:



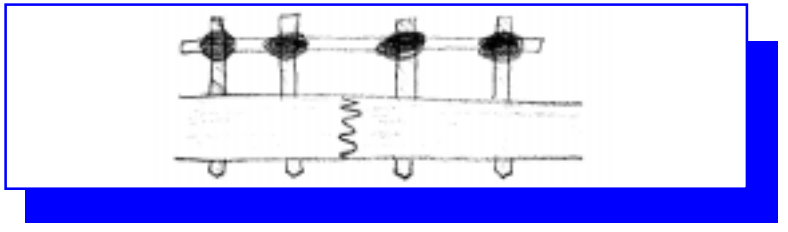
If you are working with exposed bone, all that is necessary is to drill a starter hole in the bone and then insert the external fixation pins, two proximal to the fracture and two distal to the fracture. Be sure that the fixation pin penetrates both cortices of the bone:



If you do not have exposed bone, you can use a drill-sleeve apparatus, to protect the soft tissues, while you drill the hole and drive the external fixation pins:



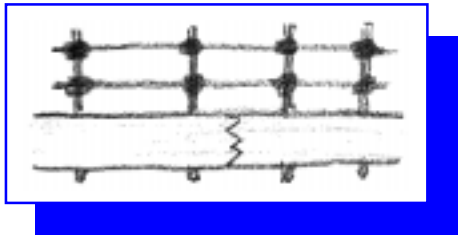
After the pins have been inserted, you then connect them with a rod (we usually used 1/4" galvanized steel, available from a hardware store), tying the junctions with small wire, such as stove-wire, to temporarily hold things in place. Then we used non-sterile dental methylmethacrylate "bone cement". At this point in the procedure, it is necessary for the wound to be partially dressed and protected from the unsterile bone cement, and the operator has to break sterility in order to apply the cement. You can also use sterile bone cement, but it is much more expensive. Sometimes you can get outdated sterile cement from orthopaedic supply places, or from hospitals, and this can be admirably well used in external fixation techniques. A ball of bone cement is placed at each junction:



Be sure to leave enough room between the pins, with bare wire showing, to allow you to later cut the wire between the pins for removal of the pins. You can then strike the cement with a hammer and shatter it, thereby saving the external pins to be used again, and again. The total cost of this method of fixation is very reasonable, if you use the pins over and over. It usually is far less than the cost of plaster.

The fracture is held in approximate alignment while the cement sets (about five minutes). Then, x-rays can be taken. The wire between the two sets of pins can be bent with wire benders to adjust the angulation of the fracture, if necessary. At first we also had a "sliding block" between the two sets of pins, to allow us to let the fracture fragments compress. While theoretically advantageous, we seldom saw the need for this, and eventually virtually abandoned it.

In the case of a large bone, such as the femur or tibia, it may be necessary to place two connecting rods between the fixation pins, for additional strength:



If bone cement is not available you can still use this technique, using plaster of paris at the junctions of the pins with the external wire splint. Use 1" wide plaster bandage and wrap the junction tightly.

The biggest advantage of using external fixation like this is that you still have excellent access to the soft tissue wound. You can immerse the extremity in a whirlpool (providing bone cement has been used at the junctions), or use wet packs, without getting a plaster cast all soggy. You can secondarily close a wound with a skin graft, without removing the ext. fix. apparatus.

Placement of the pins requires knowledge of the anatomy, so as to not injure important structures. It is best to apply the external fixation apparatus on the tension side of the fracture, just as in the case of plates.

This apparatus allows construction of triangle frames for control of complicated fractures, or fractures on both sides of a joint, etc. -- it is extremely versatile.

We have found this technique useful in pelvic fractures, inserting two pins between the tables of the ilium on each side, connecting the pins with a short rod, and then connecting these two short rods with one or more long curved rods crossing from one side of the pelvis to the other. This gives good fixation of "open book" types of pelvic fractures.

Disadvantages and hazards of external fixation:

1. Pin tracts must be carefully cleansed with hydrogen peroxide daily, to prevent pin-track infection.
2. Pins inserted through muscles impale the muscle, and motion is very painful.
3. Prolonged use of the external fixator may "unload" the fracture and result in delayed or non-union.

4. The external fixation pin inserted through a closed compartment may cause a compartment syndrome.

5. There is very little peripheral callus formation, and the fracture site is still weak at the time of removal of external fixator. It must be protected by a cast, brace, crutches, etc. for a few weeks.

6. Care must be exercised that the deep tip of the external fixation pin does not protrude very far beyond the distal cortex, or harm to important structures may result.

"Jungle Orthopaedics" I No. 4.

Since the last monograph was written, I have become aware of four books, that are written for doctors who have not had much, if any, orthopaedic training, and yet are required to manage at least orthopaedlc trauma. There is certainly no need to "reinvent the wheel", so I have recommended that any doctors seriously interested in developing familiarity with orthopaedic principles purchase these four books. I will be referring to these books as I go along. These books are:

"Practical Orthopaedics", by Lonnie R. Mercier, published by Mosby, ISBN 0-8151-5903-X (soft cover), Fourth Edition.

"Emergency Orthopaedics, The Extremities", by Simon and Koenigsknecht, published by Appleton & Lange, ISBN 0-8385-2208-4, Third edition.

"Emergency Orthopaedics, The Spine", by Galli, Spaite, and Simon, published by Appleton & Lange, ISBN 0-8385-2203-3, First Edition.

"Current Diagnosis & Treatment in Orthopaedics", by Skinner, published by Appleton & Lange, ISBN 0-8385-1-009-4, First Edition.

Since these books do not go into surgical techniques in any detail, I will also be referring to Campbell's Operative Orthopedics and other texts.

Another extremely useful manual has been prepared by Dr. Ronald Garst, entitled, *"A guide to management of common problems in orthopaedics and related subjects in developing countries, especially applicable to mission hospitals. "*

Contact Dr. Garst at 2749 Tuckaleechee Pike, Maryville, TN 37803, phone 865-982-1472.

In this monograph I would like to discuss COMPARTMENT SYNDROMES.

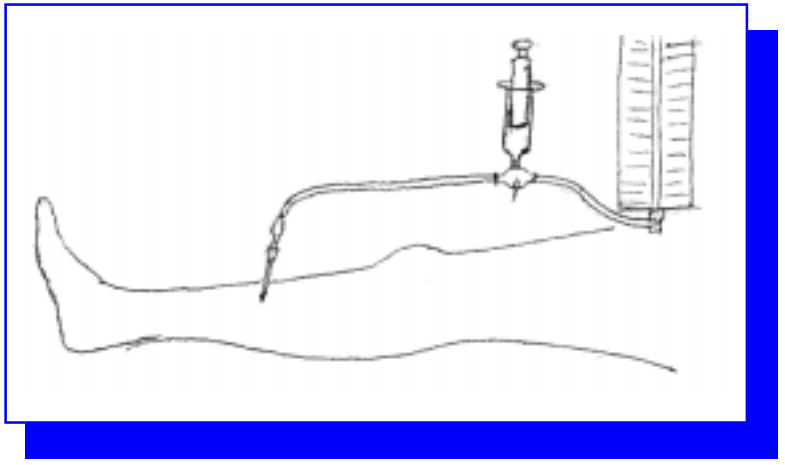
COMPARTMENT SYNDROMES result from increased pressure within a closed compartment, due to hemorrhage or edema. They are frequently seen in the lower leg and in the forearm. Untreated, this increased presssure may result in necrosis of muscles within the compartment. Volkmann's ischemic contracture of the forearm is one example of this. Compartment syndrome should be suspected in all cases of fracture of the leg or forearm, and frequent examinations done to rule out its presence,

There is a good discussion of this topic in "Current Therapy", page 485 & 486.

The outstanding symptom is PAIN OUT OF PROPORTION TO THE INJURY. This pain may be accentuated by passive stretching of the muscles involved. There may also be paralysis of the muscles involved. There is also marked tenderness to presssure over the involved compartment. The pulse may not be involved early. In the leg a very useful sign is the patient's

inability to dorsiflex the great toe. In the forearm, the patient is unable to extend the fingers.

Increased compartment pressure can be determined by an improvised instrument, consisting of a blood pressure manometer, a 20 ml. syringe, two IV extension tubes, a four-way stopcock, an 18 gauge needle, and some sterile normal saline. See diagram:



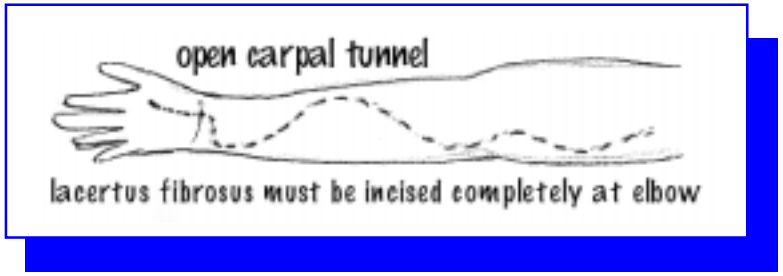
Saline is aspirated into the first extension tubing, for approximately one-half its length. The needle is then inserted into the compartment being tested. The apparatus is kept at the level of this needle. The stop cock Is then opened such that it is open to the syringe, and the IV tubing on either side. The syringe should be filled with air at this point. Slowly compress the piston of the syringe. Watch the end of the fluid in the first tube. When it begins to move, the compartment presssure is measured on the manometer.

Normal compartment pressure is zero to 10 mL. of mercury. Compartment pressures between 15 and 20 mL require careful observation. Pressures over 30 to 40 mL. demand immediate fasciotomy. Prolongation of this sort of pressure for more than a few hours will result in tissue necrosis.

If the compartment pressure is moderately elevated, it is treated by elevation and ice packs, without any constricting dressings. If this does not promptly relieve the situation, fasciotomy must be done.

Prophylactic fasciotomy should be done in cases where there has been ischemia for four hours or more.

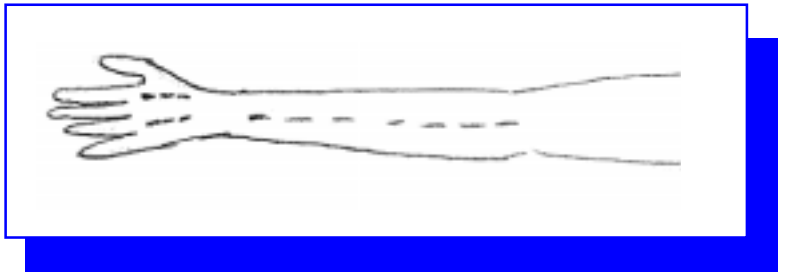
In the forearm the volar compartment is the one most often requiring fasciotomy. The incision should extend into the arm and into the carpal tunnel:



An epimysiotomy of the involved muscle bellies should also be performed. The serpentine incision is used to minimize contracture by scar as the wounds heal. Sometimes the incision can be closed secondarily after the swelling goes down, but

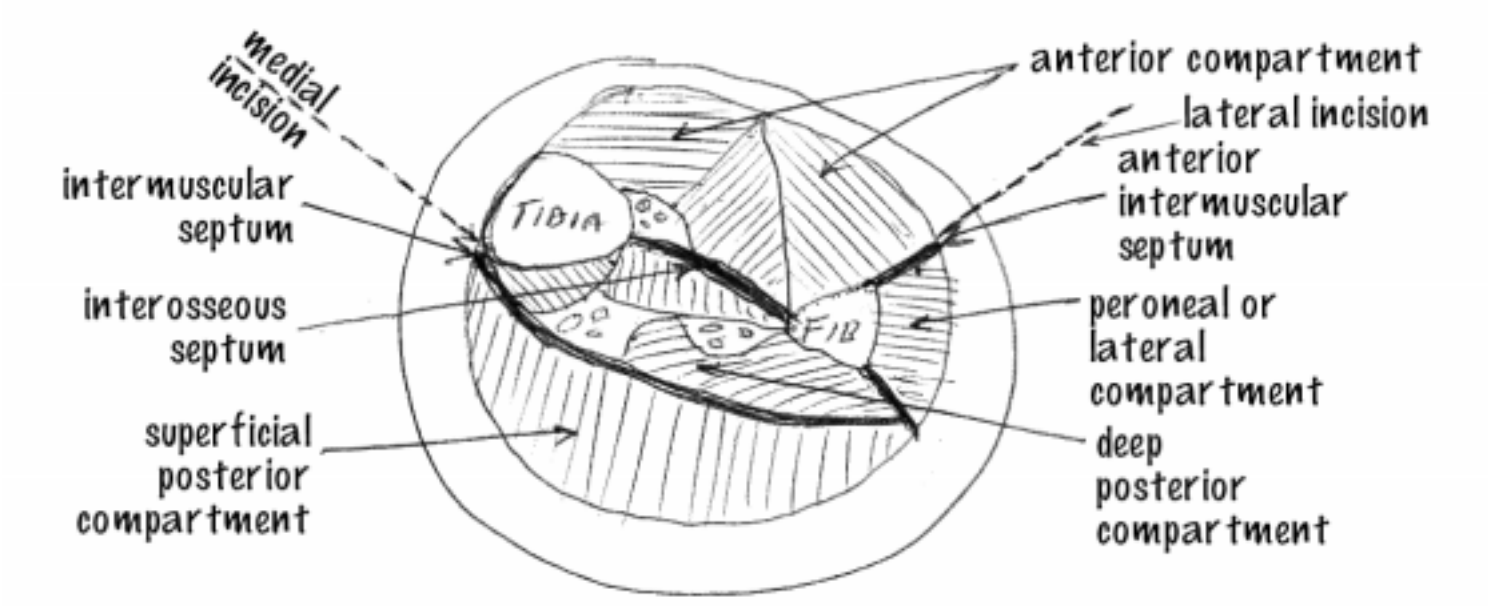
most often a split thickness skin graft is used.

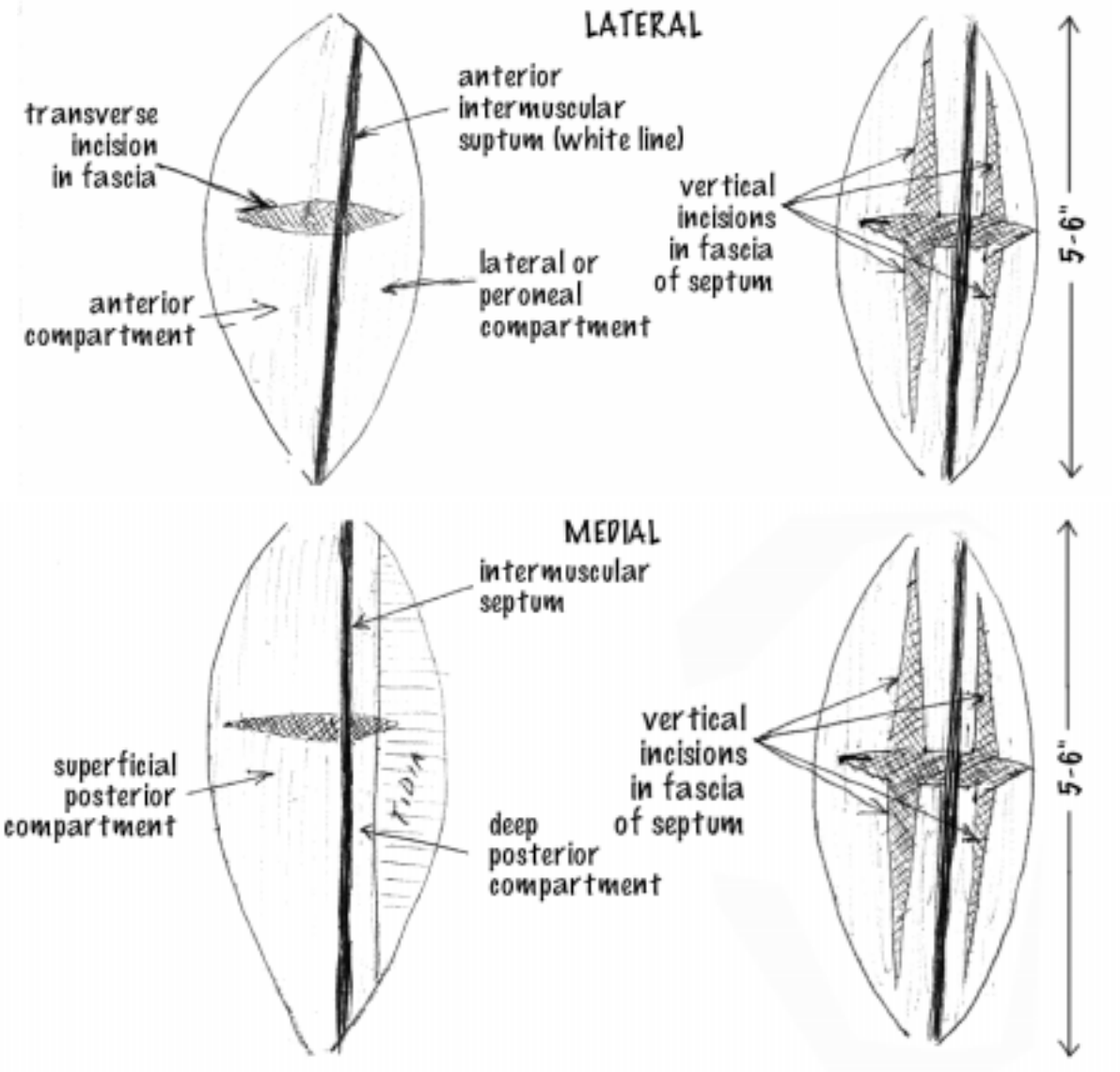
The dorsum of the forearm can be opened with a simple longitudinal incision:



In the hand each compartment must be opened individually. Two longitudinal incisions over the dorsum will provide access to the interosseous muscles. Other compartments will require separate incisions. Fasciotomy of the fingers may be necessary in the case of snake bite or burns, and is performed if the swelling appears to be causing ischemia.

In the leg there is an ANTERI0R compartment between the tibia and fibula, a PER0NEAL compartment lateral to the fibula, and a SUPERFICIAL AND DEEP POSTERIOR compartment. All four of these must be released. This can be accomplished as illustrated in the following diagrams:




LATERAL
transverse incision in fascia
anterior intermuscular suptum (white line)
vertical incisions in fascia of septum
anterior compartment
lateral or peroneal compartment
5-6"
MEDIAL
intermuscular septum
superficial posterior compartment
deep posterior compartment
vertical incisions in fascia of septum
5-6"

JUNGLE ORTHOPAEDICS NO. 5

BONE AND JOINT INFECTIONS IN CHILDREN

SEPTIC ARTHRITIS:

- Typically involves weight-bearing joints
- Generally only one joint involved
- Knee and hip are most commonly involved joints
- Onset--fever, pain, swelling, painful limitation of motion, joint held in position of comfort (in case of hip this is slight flexion, abduction, and external rotation to relax the capsule)
- Lab: CBC, ESR, blood cultures, x-rays
  WBC and ESR often but not always elevated

Hip: - in this joint early diagnosis and treatment is imperative, because the increased intracapsular pressure can compromise the circulation to the femoral head, resulting in avascular necrosis. In other joints the vessels to the physis and epiphysis lie outside the capsule and are not subject to compression.

Pathogens:

- Overall staph aureus is the most common pathogen.
- In about one-third of cases no pathogen can be identified, even with a very thorough bacteriological examination.
- There is an age-predilection regarding the type of pathogens found:

> Newborn:
  Staph aureus
  Group B streptococci--occasionally gonococcus

> Infants under 2 years of age:
  Hemophilus influenza
  Streptococci of various types, including pneumococci

> Children over 2 years of age:
  Staph aureus

> Sexually active teenagers:
  Gonococcus in only about 6% of cases but it is the most common cause of polyarticular disease

Treatment:

Parenteral therapy is indicated for all cases of suspected septic arthritis. Choose the antibiotic on the basis of the gram stain, pending culture results. If gram stain is negative choose antibiotics on basis of most common organisms found in that age group:

- Neonate = ampicillin/gentamycin
- Infant - cefuroxime
- Child- Oxacillin, nafcillin, cefazolin, cephapirin

Usually 5-7 days of parenteral, followed by oral for 3-6 weeks

NOTE: Ciprofloxacin not recommended in children--potential damage to joint cartilage

Surgery: Always drain hip surgically, to decompress it. This must be done early. Posterior approach probably safest in inexperienced hands.

Other joints: can lavage if necessary, but probably best to do incision and drainage to get pus out of joint as quickly as possible. Pus is destructive to joint cartilage. Do not use intra-articular antibiotics as they are quite irritating to the synovium.

SPECIAL NOTE: Infants can have silent meningitis, especially with hemophilus inlluenza. Must either do CSF examination or use antibiotic that will cross the blood- brain barrier.

ACUTE OSTEOMELITIS:

• Early diagnosis is desirable, because decompression of an acute abscess within the bone can minimize the spread of the infection within the bone. X-rays early may show only loss of normally defined tissue planes, due to swelling. The most frequently involved sites are usually long bones, especially femurs, tibias and humeri.

• Fever and other signs of sepsis may or may not be present.

• WBC may be normal at first in many cases.

• Bone scan is useful, but false negative scans are not uncommon.

• Blood cultures may be positive.

• Definitive diagnosis can be made by subperiosteal or metaphyseal needle aspiration. If subperiosteal pus is found, there is no need to decompress the bone. If no pus is found subperiosteally, then the needle should be introduced into the metaphysis, or drill holes made into the metaphysis. If pus is found the bone should be windowed to decompress the abscess.

• In neonates there may be only swelling, flexion contractures and overlying inflamatory reaction. Very commonly neonatal osteomyelitis is multifocal.

• The mainstays of treatment are adequate drainage and antibiotic therapy, guided by the Gram stain and culture results.

• In osteomyelitis of metatarsals following puncture wounds of sole, pseudomonas is often the causative organism.

• Antibiotics usually should be given parenterally for 5-7 days, followed by oral for 3-6 weeks.

LYME ARTHRITIS

Lyme arthritis gets its name from a town in the state of Connecticut, USA, where the disease was first discovered and described. It is caused by a spirochete, which is carried by a tick. When an infected tick bites a person, that person can get Lyme disease.

The earliest sign is an expanding skin lesion, called ERYTHEMA CHRONICA MIGRANS. It is a red area, with a pale center. This lesion comes days to weeks (3-32 days) after the bite, and may be accompanied by flu-like symptoms.

Weeks to months later (up to two years) the patient develops neurologic, cardiac or joint involvement. The arthritis presents as intermittent attacks of asymmetric joint swelling and pain, usually involving large joints, especially knees.

The knees are usually more swollen than painful, often hot, but rarely red. Baker's cysts may form and rupture early. However, both large and small joints may be affected. A few patients have symmetric polyarthritis.

Attacks last a few weeks to a few months, typically recurring for several years, accompanied by fatigue, but few other constitutional symptoms.

Synovial fluid: WBC 500-110,000 -- average 25,000. Mostly polys.

- Protein 3-8 Gms/deciliter
- Glucose level greater than 2-3 times serum level.
- RA negative
- 10% of cases become chronic with pannus and erosion of cartilage.

Treatment for established arthritis:

- Penicillin parenterally - i. m. benzathene penicillin 2. 4 million units weekly X 3 wks. -- or I. V. penicillin

Symptoms:

- asymmetric arthritis of large joints, usually, especially knees
- intermittent attacks
- knees usually not as painful as swollen, often hot, rarely red
- may affect large and small joints
- may be symmetric and polyarthritis
- attacks last weeks to months
- typically recur for several years fatigue with attacks

JUNGLE ORTHOPAEDICS No. 6

More books and Acupuncture & trigger points

Books:

A very excellent and extremely well illustrated book on local anesthesia, including nerve blocks and spinal anesthesia, is:

"Illustrated handbook in local anesthesia" by Eriksson Publisher Saunders, ISBN 0 7216 3399 4

Acupuncture and trigger point therapy are very important adjuncts to the practice of orthopaedic surgery anywhere, and also have application in many other aspects of medicine. A very excellent book on this subject is:

"Acupuncture, Trigger Points and Musculoskeletal Pain" by P. E. Baldry ISBN 0 443 03991-6

An excellent short course in acupuncture is available from:
Felix Mann, MBBS
15, Devonshire Place:
London W1N, 1PB
phone 935 7575

His course is called "Scientific Acupuncture", and is given three times yearly. He admits only doctors to his course, which lasts one week. Dr, Mann is one of the world's leading experts in the field of acupuncture, and has written many books. During the week-long course one learns how to handle many painful conditions, and also some applications to non-orthopaedic conditions. I took his course, and count it one of the most valuable experiences of my professional life. It has proven extremely useful to me in my practice in Bangladesh, and with it I have been able to handle many problems for which them was no other effective solution,

I will not, in these monographs, go into any detail regarding acupuncture, but would like to discuss trigger points a bit. Whenever a trigger point is activated, it can remain "active" long after the inciting cause is gone. It can produce referred pain that can mimic a host of conditions. The trigger point can be identified as a very tender spot to deep palpation. It can be "deactivated" by injection of local anesthesia, or by simply inserting a dry needle into it.

This topic is covered in detail in Dr. Baldry's book.

Just a few of the conditions where acupuncture or trigger point injection is very useful include painful shoulder conditions, headache, low back pains, herniated intervertebral disc, bronchial asthma in children and in some adults , other localized painful conditions, etc,

Jungle Orthopaedics No. 7

SOME HIP PROBLEMS

TRANSIENT SYNOVITIS of the hip is the most common cause of hip pain and limp in children under ten years of age. It frequently follows an upper respiratory infection. Males are more often affected than females.

- Sometimes no pain -- only limp
- Physical examination: Patient has guarded rotation of the hip, plus pain at extremes of abduction and medial rotation. May or may not have elevated temperature.
- X-ray: Widened medial joint space, due to femoral head being forced laterally by synovial fluid pressure.
- Bone density normal
- Laboratory:
  - ESR normal or mildly elevated
  - WBC and differential normal
- Differential:
  - > Septic hip - pain, fever, ESR elevated, WBC elevated.
  - > Rheumatic fever - history of antecedent strep infection, polyarthralgia, other signs of rheumatic fever
  - > Legg Calve Perthes Disease - x-ray changes; bone scan in early stages will show decreased uptake
  - > Slipped capital femoral epiphysis - characteristic x-ray changes
  - > Tumors - osteoid osteoma - night pain, relief by ASA
- Course:
  - Self-limiting - 3-7 days but sometimes prolonged weeks or months
  - 1-3% may develop Legg-Calve Perthes -- observe carefully
- Treatment:
  - > Rest
  - > Maybe traction
  - > Maybe anti-inflammatory medication
  - > Observation

LEGG-CALVE PERTHES SYNDROME:

In this condition the femoral head becomes softened, due to avascular necrosis. The age group affected is approximately 4-10 years, but can occur as early as age 2 and as late as the late teens. Boys are more affected than girls. It is a self-limited condition, with revascularization and reconstitution of the head occurring with time, usually about 18 months.

The prognosis depends on the extent of involvement of the necrotic process in the head, Involvement of the anterior 1/4 of the head is Catterell Class I.

Class II involves approximately one-half of the anterior portion of the head.

Class III involves approximately three-fourths of the head, with some rarefaction of the metaphysis adjacent to the epiphyseal line. Class IV involves the entire head or ephiphysis. Prognosis is best in Class I and worst in Class IV.

The patient presents with a limp that may or may not be

accompanied by pain. Pain, if present, may be referred to the thigh or knee. Every child that presents with "knee pain" should be examined for possible Legg-Calve Perthes syndrome. The patient may also have some restriction of motion in the involved hip, especially in abduction and extension.

There are four stages;

Stage one is synovitis: During this stage the capsule is distended with fluid and the femoral head may be displaced somewhat laterally, Synovitis of the hip is the most common cause of pain and limp in children under ten years of age. Only 1-3% of cases of synovitis progress to LCP Syndrome, but this must be kept in mind and the patient followed.

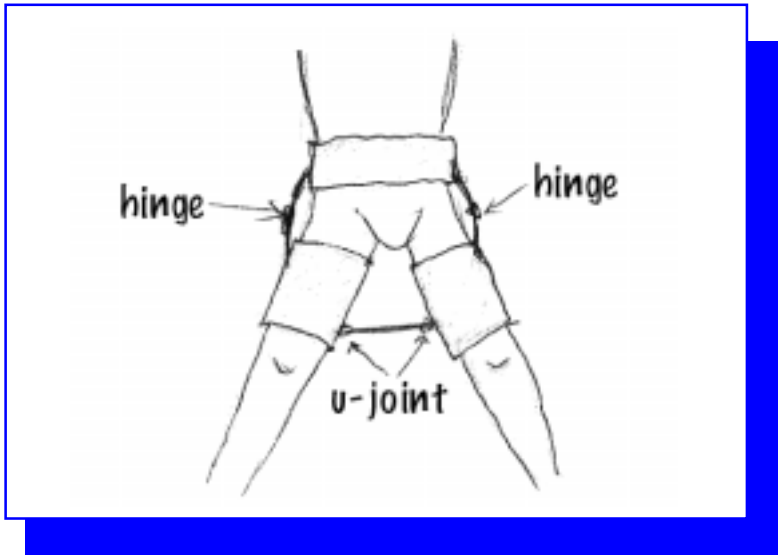
Stage two is the stage of fragmentation: X-rays show fragmentation of the osseous nucleus and areas of increased radiodensity and radiolucency.

Stage three is the reparative stage during which there is restoration of vascularisation of the head, with return to normal densities.

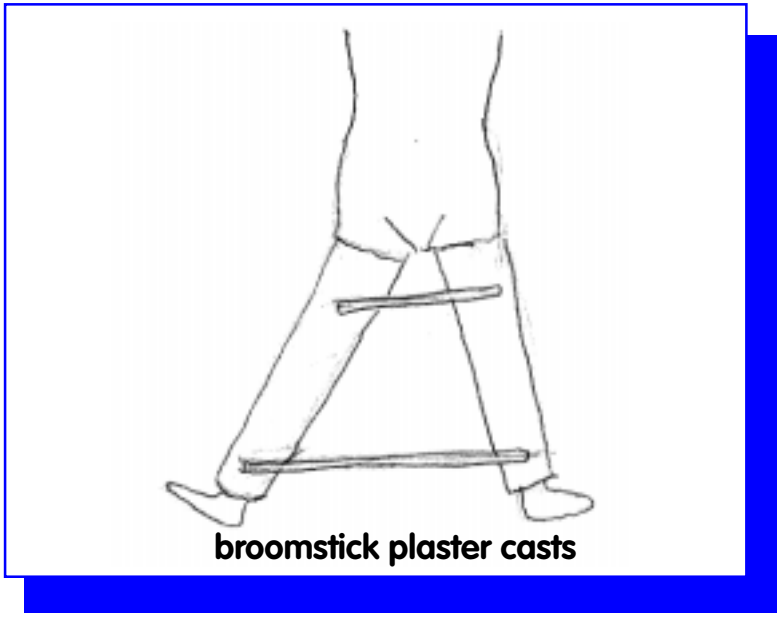
Stage four is the healed stage: The head is completely reossified and has its final shape.

X-ray examination should include anteroposterior views of both hips, and frogleg lateral views of both hips. On the lateral view the extent of involvement of the anterior portion of the head can be ascertained,

The object of treatment is to prevent the head from becoming flattened during the stage of softening. There is considerable controversy in the literature as to how best to accomplish this. Most people feel that if the entire head can be contained within the acetabulum, the acetabulum will act as a molding force, causing the head to retain a round shape. Often this "containment", can be accomplished by simply maintaining the hip in an abducted position, and a commonly used way of doing this is by the use of an abduction orthosis:



Before treatment with the abduction brace can be started, any contractures must be overcome, If the patient can be admitted, abduction Buck's traction can be used, If admission is not feasible, broomstick plaster casts can be used, with the abduction gradually increased until x-rays show the head to be contained in the acetabulum:


broomstick plaster casts

The abduction brace is worn full-time, except for non-weight-bearing baths, and is usually required for eighteen months, The patient is allowed to ambulate in the brace without restrictions.

Bracing should be continued until the previously rarified areas are beginning to reossify, as shown by x-ray. In a primitive situation, I feel it is best to treat all patients, rather than trying to decide which ones are Class I or II and may not require treatment. Better safe than sorry.

If the head cannot be contained in the acetabulum by simple abduction bracing, the patient may require either varus rotation osteotomy of the femur, or pelvic osteotomy to provide coverage, These procedures are beyond the scope of these monographs, but are fully covered in Campbell's Operative Orthopaedics.

Some cases are bilateral, and this must be watched for,

DEVELOPMENTAL DYSPLASIA OF THE HIP:

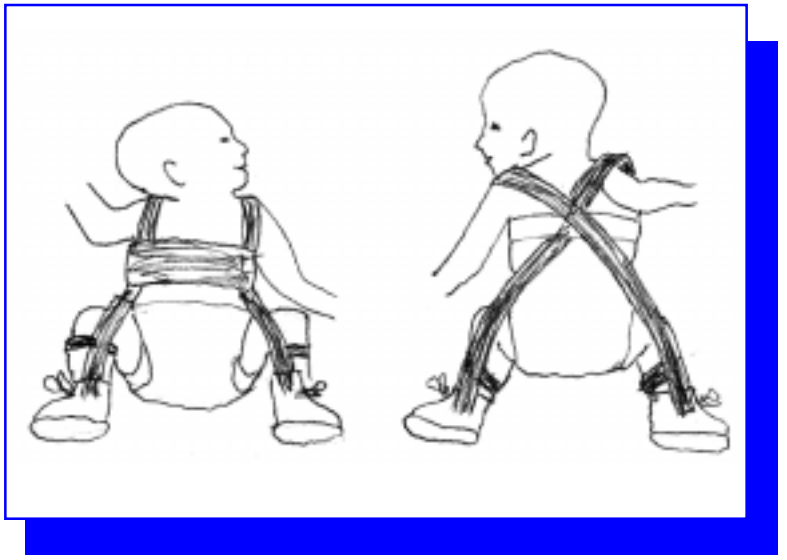
It is now recognized that very few hips are actually dislocated at birth, However, poor development of the acetabulum may result in subluxing hips, in which the femoral head is not properly seated in the acetabulum. Proper development of an acetabulum requires the presence of the femoral head within the acetabulum.

If diagnosed very early, preferably at birth, this condition can be successfully treated in 95% of cases by effective splinting or bracing.

Diagnosis: This is very well discussed in the Current Diagnosis and Treatment in Orthopaedics book, mentioned earlier. Basically it hinges on detection of abnormality of movement of the affected hip. The hips should be examined in the newborn nursery, and then periodically until the child begins to walk. X-rays are not very useful in the newborn, because the ossific nucleus of the femoral head is not yet visible.

Treatment: Treatment depends upon "Containment" of the femoral head within the acetabulum until it develops enough depth and form to hold the head in place by itself. A position of flexion and some abduction is necessary to accomplish this.

Several types of devices are available for accomplishing this. The Pavlick harness is probably the most effective:



DOUBLE DIAPERS DO NOT MAINTAIN THE EFFECTIVE POSITION VERY WELL AND SHOULD NOT BE DEPENDED UPON TO ACCOMPLISH THIS.

The Pavlick harness holds the hips flexed at 100 degrees, and prevents adduction but does not prevent further flexion.

GENERAL TREATMENT GUIDELINES:

- Age 0-6 mos. - Pavlik harness for 6-12 weeks
- Age over 6 months - Pavlik harness not effective
- 6 mos to 2 years - skin traction, and then closed reduction, cast in hip flexion a bit over 90 degrees and 50 degrees abduction. CAUTION: TOO MUCH FLEXION CAN CAUSE AVASCULAR NECROSIS.
- Over 2 years of age - no traction - open reduction with femoral shortening to relax pressure on located head to avoid avascular necrosis.

INSTRUCTIONS FOR APPLICATION AND USE OF PAVLICK HARNESS:

Use in newborn to 6 months of age, only.

1. Fasten chest strap first with child lying on his back. Strap must be loose enough to allow a hand to be passed beneath the strap.
2. Adjust shoulder strap to keep chest strap at nipple level.
3. With feet in stirrups and hips flexed 90-120 degrees, tighten anterior strap to hold in this position.
4. Posterior strap loosely fastened to limit adduction. Knees should be 3-5 cm. apart at full adduction.
5. Do Barlow test -- pressure on long axis of femur to try to dislocate hip.
6. X-ray to confirm reduction -- adjust harness as necessary.
7. If not reduced in 6-8 weeks, abandon this form of treatment and go to traction, closed reduction, and cast.
8. If successful, wear full time until stable on exam (negative Barlow test.

PSOAS ABSCESS (TROPICAL HIP):

A strange malady that is frequently seen in tropical countries is psoas abscess. This is an abscess that develops along or within the psoas muscle. It may point above or below the inguinal ligament.

Most commonly the child presents with fever and pain, and with the involved hip held in flexion and internal rotation. Palpation reveals a mass above the inguinal ligament.

Xrays of the spine should be obtained, because some of these cases are TB of the spine with an abscess extending down the psoas sheath.

Treatment is by incision above the inguinal ligament, with extra-peritoneal dissection down to the psoas muscle as it passes over the brim of the pelvis. Usually the abscess is encountered at this time, but if it is not you should introduce a hemostat into the fusiform swelling of the psoas muscle, and often you will find pus. Insert a drain.

JUNGLE ORTHOPAEDICS #8 -- POT POURRI

CARE OF WOUNDS: This is mainly for non-surgeons who might be reading this monograph, but surgeons may also find some benefit from it, as it pertains to "non-clean" conditions in particular.

The important thing to remember in primitive settings is that wounds sustained in such a setting are usually very dirty. The environment is dirty. Sanitation and personal cleanliness may be poor. The article causing the wound is usually very dirty. Initial wound care at the site of the incident causing the wound may have introduced even more contamination into the wound--such as manure, leaves, urine, caustic chemicals, and various unknowns.

A good policy is to consider practically all wounds dirty and debride them carefully. "Debridement" really means "excision" of the wound, as much as is possible without harming important structures. This must be done under good lighting and must be meticulous, with copious irrigation with normal saline. Gentle scrubbing with a surgical brush may help dislodge sand and small bits of rock. Soap can be used (mild soap), but must be rinsed out thoroughly. When all contaminated or devitalized tissue possible has been excised, the decision must be made whether to close the wound, or to leave it open. If there is ANY doubt as to the cleanliness of the wound, or of the viability of the remaining tissues, the best course is to pack the wound open with saline-soaked gauze, and bring the patient back to the operating room in a few days for secondary debridement. This may have to be done several times before the wound can be considered clean enough to close.

One must also remember that there will be swelling of the tissues around the wound. Any closure will become tighter, due to this swelling, and circulation to the skin may be further compromised. This is particularly true in the lower leg. Closure may be possible after this swelling has run its course, with sal-

vage of much more skin than if primary closure had been attempted.

Wounds that are left open and allowed to heal by secondary intention do surprisingly well. We saw this well illustrated in patients who came in with multiple machette cuts, some of which went very deep into muscles. After debriding these as much as possible, they were left open and allowed to heal by secondary intention, avoiding any risk that might accompany attempts to close them. In most cases these healed with no greater scarring than might have been expected if they had been closed primarily.

Wounds over joints deserve special mention and discussion. A wound that penetrates a joint is a special situation, because the wound may have introduced foreign matter or infected material into the joint. Untreated, this may result in septic arthritis and possible loss of the joint cartilage. If there is any doubt as to whether or not the joint has been penetrated, it is better to open it through a separate incision, and do a thorough inspection and lavage. If there has been penetration, after the lavage it is best to close the joint wound with a small Penrose drain that should remain for several days. Do not instill antibiotics directly into the joint, as they are very irritating to the synovial tissues.

In the case of a wound that exposes a joint, every effort should be made to close the synovium and not leave the joint open. Again, leave a small drain for a few days. You may have to transpose a bit of muscle or other soft tissue to provide closure of the joint.

This same principle is true in regard to major vessels, nerves and tendons--if left open they will dry out and become necrotic. Try to cover them with something.

Many years ago, while in general practice, I used to use a poultice paste called "Osmopak". It was magnesium sulfate paste, with brilliant green dye. This was a powerful poultice. In Bangladesh we decided to use a saturated solution of magnesium sulfate for our wet dressings, to provide a "poultice-like" effect, as well as stimulating granulation tissue formation. The main drawback is that it stings a lot when applied, but it has been very effective in helping soupy wounds to clean up. In my hands it works much better than normal saline. We changed the wet dressings every eight hours (once per shift), and put them on "sloppy wet".

Gentian violet has been a good friend in wound care. It is bacteriostatic, is a good stimulant of granulation tissue growth, and also is an epithelial cell growth stimulant. It also provides some psychological benefit, in that the patient can definitely see that you have applied some medicine (much better than a colorless solution).

Granulation tissue formation can also be stimulated by application of granulated sugar in the wound. This is very effective in bed sores.

It was my routine practice to apply a triple antibiotic oint-

ment to the suture line whenever I closed an incision, even in clean cases. This may be "empirical", but I very seldom saw any suture abscesses. Hydrogen peroxide can be used at the time of dressing changes, or at pin sites, but should not be applied to open wounds as it is too harsh for the tissues.

SOME BASIC PRINCIPLES REGARDING X-RAYS

Any x-ray of a long bone for a suspected fracture should show two joints, one above and the one below the fracture, if at all possible. Many people have missed a fracture of the proximal fibula, for example, in the presence of an ankle fracture--or, a fracture of the proximal ulna in a distal radial fracture. Fractures or dislocations of the hip are not uncommon along with a knee fracture.

Always strive to get two views of any area, preferably a true AP and a true lateral. It is also wise to get a comparison view of the normal extremity, especially in children and infants.

Be aware of the "Mach" effect--a linear shadow on the x-ray caused by tissue overlap, that may be mistaken for a linear fracture. The shadow of the Mach effect, upon close inspection, can be seen to extend beyond the bony margins.

Be aware that non-displaced fractures may not be visible on x-rays taken within a few hours or a few days of the injury. Roentgenograms are basically shadows. If there is no separation of the fragments, no line will be visible in the shadow. If you suspect a non-displaced fracture, it is wise to splint the extremity and repeat the x-ray after ten to fourteen days. At that time there will have been enough bony resorption at the fracture site to make the fracture line visible:

Epiphyseal injuries need to be discussed a bit. A separation can occur through an epiphyseal line, and then spontaneous reduction occur, such that no defect is visible on x-ray. Usually, however, a small fleck of metaphysis at one side or the other of the epiphyseal line will have been displaced along with the epiphysis. When seen, this indicates that there has been an epiphyseal separation, and it should be immobilized. Sometimes such an injury becomes evident during the course of stress x-rays for suspected ligamentous injury of the knee.

Whenever a fracture line crosses an epiphysis there is cause for concern. The healing may cause a bony bridge across the epiphyseal line, with subsequent growth arrest. Even when anatomically reduced, it is well to advise the parents (preferably in writing) that growth problems may occur in spite of any treatment that has been rendered, and that the patient must be followed for several years.

ABOUT TOURNIQUETS

It has been said that trying to debride a wound or do surgery deep in a wound without a tourniquet is like trying to fix a watch that is immersed in an ink well. This is very true. Proper use of a tourniquet can turn a trying ordeal into an orderly, systematic and efficient surgical exercise. Tourniquets can be abused, however, with resulting harm to the tissues.

Generally speaking a tourniquet can be left in place for a maximum of two hours, but there will be some tissue swelling as a result. A good practice is to release the tourniquet for ten minutes after one hour, and then re-apply it for the second hour. This prevents some tissue hypoxia and may reduce the post-operative edema.

Blood pressure cuffs can be used for tourniquets. The extremity can be exsanguinated adequately by simply elevating it above heart level for one minute for an arm and two minutes for a leg. This can also be accomplished by applying a tight wrapping, such as by an Esmarch rubber bandage, which is removed after inflation of the tourniquet. The tourniquet should be wide. No padding is necessary under it, and may even cause problems due to wrinkling of the padding.

A simple tourniquet for a finger can be provided by a 1/2" wide Penrose drain in a "U" around the base of the finger, drawing it tight, and then applying a clamp across the "U" before releasing the traction. Do not use rubber bands or other narrow bands, as these may cause damage to the finger blood vessels or nerves.

POST-OPERATIVE FEVER

Blood in the tissues can cause a foreign protein reaction with a low-grade fever. This is usually seen during the first 24 hours post-op. It is seldom more than 1 degree F. elevation.

Another cause of immediate post-op fever may be atelectasis.

Fever coming on after a lapse of 24 to 48 hours may signify infection, but it may also be caused by:

Gout -- the stress of surgery may precipitate an attack of acute gout. This especially true in developed countries, where gout is common.

Malaria -- many people in primitive situations have chronic malaria, which their immune system is apparently handling all right. The stress of surgery, or of trauma, may upset this immune-system protection and the patient may develop malarial symptoms. There may or may not be a positive MP smear. When this is strongly suspected, we usually treat the patient with a therapeutic dose of Chloraquin, or Fansidar, or sometimes just with quinine. Prompt reduction of the fever indicates a correct diagnosis.

WARNINGS ABOUT LOCAL ANESTHESIA

This is for the non-surgeons: Never use local anesthetic solutions containing epinephrine for anesthetizing fingers, toes, or penises. The prolonged vasoconstriction from the epinephrine may result in gangrene. Use only "plain" Xylocaine, for example.

A FEW COMMENTS REGARDING FRACTURES

I do not intend to discuss each and every fracture--these are well covered in the books I mentioned earlier. I would like to make a few comments in general about some points in closed fracture care, however.

The general aim in fracture care is to get an "adequate" reduction, and hold it there until healing occurs. "Adequate" is different for different fractures:

Fractures in children: In the growing child substantial correction of angular defects in bones can occur near the ends of the bones. It is not essential to get perfect angular alignment of fractures near the ends of growing bones. HOWEVER, ROTATORY MALALIGNMENT WILL NOT CORRECT WITH GROWTH.

Forearm - the interosseous space between the radius and ulna is important for pronation and supination, and should be preserved. "Bayonet" apposition of the shafts of the radius and ulna may be allowable in young children, but not in adults. In adults near-anatomic reduction is the goal.

Wrist: - the proper length of the distal radius is important regarding radio/ulnar deviation; the angulation of the distal radial articular surface is important for flexion/extension.

Fingers: Here the close-anatomy does not allow significant deviation from normal without impairing the proper gliding of tendons. Near-anatomic reduction is the goal. Passive motion of the joints once weekly during the first two weeks will minimize the sticking of the tendons to the fracture-site. Generally immobilization of finger fractures is discontinued at about three weeks--before good callus is evident on the x-ray. This allows for gentle active motion, with the use of protective splinting except during periods of guarded exercise, for another three weeks.

If there is contracture of the small joints after the fractures have healed, rubber bands can be used to slowly overcome these contractures. The patient must be advised NOT to forcibly try to correct the contracture, as this will cause further harm. Steady, gentle pressure from rubber bands will slowly relieve the contracture. The rubber bands should be worn continuously, and exercises done against the resistance of the rubber bands.

REFLEX SYMPATHETIC DYSTROPHY: This can occur in any area, but is especially common in the hand. The symptoms are pain out of proportion to the injury, accompanied by swelling of the hand. The patient is reluctant to exercise the fingers. When this is suspected, immobilization is discontinued and gentle active motion is instituted. A well-healed fracture in a frozen hand is worthless! It is better to forget the fracture and try to get motion back into the hand.

Gravity: Blood behaves just like water -- it runs downhill. In the hand especially, allowing the hand to hang down can result in marked swelling, with resultant loss of motion. It is very important to keep the hand elevated ABOVE HEART LEVEL

for at least the first 24-48 hours after an injury, and then periodically as necessary for control of edema. This is true for other fractures as well, but for most other fractures the edema is not so potentially devastating.

Long bones: In most long bones the goal is axial alignment, length restoration, and reasonable apposition (at least 10%). Excessive traction, to the point of distraction of the fracture fragments, must be guarded against, because it may result in non-union. This is particularly true in the case of humeral fractures.

Humeral shaft fractures: Here a simple plaster cuff around the arm (not the forearm , and a neck yoke around the wrist, holding the elbow at right angles, is usually sufficient. Gravity-traction is usually all that is necessary. Hanging arm casts are often too heavy and result in distraction. If distraction occurs, it is best to immediately put the patient into a shoulder spica cast with the arm in "salute position", to remove any effect of gravity that might prolong the distraction. Angular deformity is not terribly significant in humeral fractures, except at the elbow.

Elbow fractures: There is a great variety of these, and the reader is referred to the above-mentioned texts. Just a word of warning here in regard to the need for extreme attention to circulation, to prevent the dreaded ischemic contracture (Volkmann's). If possible, I like to keep the patient in the hospital overnight, after reduction, so the pulse and circulation can be checked by trained personnel. If this is not possible, some member of the family must be carefully taught what to look for and instructed to bring the Patient back immediately in case of problems.

Femur fractures: In children, up to about age six years, femur shaft fractures can be treated by immediate plaster spica and one-half casting, removal of the sole of the foot part on the side of the fracture to prevent the patient from being able to push down on it, and then x-ray, followed by wedging of the cast as needed for correction of any angulation. Over-riding of about 1 – 1 1/2 cm. is allowed in these young children, because the femur will overgrow due to the fracture-hyperemia. In children over age six years the muscles are powerful enough to cause excessive over-riding, so a period of traction is necessary until the fracture becomes "sticky", and non-tender--then they can be put into a cast and sent home.

Adults with femur shaft fractures, in our institution, are usually treated by skeletal traction for a few days, until their hematocrit stops dropping (supposed to reduce chances of fat embolism) and then internal fixation. When this is not possible, or not indicated by the site of the fracture, we used cast-brace treatment, with protected weight bearing.

Tibia fractures: In our institution these are usually treated by a long leg cast for three weeks first, and then go to a "patellar-tendon-bearing (PTB) cast. In every case, elevation above heart level for the first 24-48 hours is very important. Remember that an intact fibula is like an internal splint, and will greatly stabilize the fracture.

Segmental fractures: These will usually require open reduction and internal fixation, preferably intra-medullary pinning.

Clavicle: The only thing usually necessary here is a simple figure-of-eight bandage or clavicle splint until the fracture is no longer tender. It is best not to rely on x-ray evidence of callus in determining when to discontinue the splint. Commonly this requires eight weeks in the splint.

Ribs: The only thing required here is analgesics for relief of pain. Do not use rib belts or taping, as this will reduce pulmonary excursion and may cause atelectasis. Be alert to the possibility of lung damage with pneumothorax, which may require thorocentesis. Multiple rib fractures, with flail chest, may require traction by means of towel clips into the flail segment.

Spine: The important thing to look for in spinal compression fractures is "rabbit-earing" of the spinous processes. If this is present, it indicates rupture of the interspinous ligament, which makes the fracture unstable. In that case it is best to do a spinal fusion, with inter-spinous process wiring. If this is not possible, the patient should be put into an extension body cast for twelve weeks.

Calcaneus: Fractures of the os calcis are usually caused by a fall onto the extended leg. Look for concomittant spinal fractures, resulting from the compression of the spine. The most important determinant of outcome of calcaneal fractures is the subtalar joint, and every effort should be made to restore the congruity of that joint. If this cannot be done closed, then open reduction and internal fixation is indicated. Again, the reader is referred to the texts for a more thorough discussion of this fracture and its treatment. If the fracture is treated closed, it is very important to not allow weight bearing for twelve full weeks! If closed reduction is successful, or if the fragment position and subtalar joint is adequate, a simple "slipper cast" is applied, and early ankle motion is encouraged, with no weight bearing.

Hip fractures: With the exception of relatively non-displaced intertrochanteric fractures, virtually all hip fractures should be treated by open reduction and internal fixation. In the first mentioned case, a period of three to four weeks of traction, followed by non-weight-bearing crutch ambulation may be adequate. Full weight bearing should not be allowed before eight weeks, or so, until good callus is visible on x-ray.