Notes on Military Orthopaedics.

VII.—THE MECHANICAL TREATMENT OF FRACTURES UNDER WAR CONDITIONS.

BY

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The methods employed must be both efficient and simple; they must allow easy and painless access to the wound, and ensure immobilization of the limb during transport. The following notes are a contribution towards the attainment of these needs, but it must be understood that modifications of them may be rendered necessary by the severity of the wounds, or by the necessity of providing for the transport of the patient, should early evacuation be necessary.

Plaster-of-Paris, so often used in the treatment of simple fractures, becomes a filthy method where suppuration has occurred. Despite every precaution for the exposure of the wound the plaster mops up discharges, and becomes horribly offensive,

FIG. 1.—Thomas's double frame.

FIG. 2.—Thomas's double frame applied.

adding to the infection of the wound. I would urge my young colleagues at the front to discard it altogether.

FRACTURES THROUGH THE LOWER SPINE AND PELVIS.

Fractures through the lower spine and pelvis are, in my opinion, best treated on the double Thomas frame. (Figs. 1, 2, 3.) All that is needed is to place the patient on the frame, bandage the limbs, and press the body and leg wings into position to prevent side movement. If there is any wound on the posterior surface that requires dressing the pad can be shaped accordingly to allow of access.

Thomas's Double Frame.

Measurements Required: Nipple to external malleolus.

Splint Measurement: 4 in. less than above measurement.

Application.—Place the patient on the splint with the buttocks on either side of the horseshoe-shaped gap in the back pad, which has been left for nursing purposes. The wings of the splint should then be moulded round the patient's chest and ribs, care being taken to turn them up

acutely enough from the back pad to prevent side movements of the body. A 5 in. thick pad is placed under each knee to prevent genu recurvatum, and the ankle grips, which reach just above the malleoli, must be well padded. The knees are now bandaged firmly to the splint, and

FIG. 3.—Method of lifting patient on Thomas's double frame.

constant pressure of bedclothes on the feet avoided during treatment.

Double Frame too Short.—Place the patient as high up on the splint as the lesion will allow. Posterior knee splints firmly bandaged to the knees will be found to supply the deficiency at the foot of the splint quite well.

Double Frame too Long.—Place the patient on the splint with chest band at the nipple line as usual. Readjust the back pad sufficiently high up the splint to allow for nursing purposes. The pads under the knees will require to be larger, and the heels must be protected with rectangular foot splints or plaster-of-Paris, as they will be lying on the leg bars of the splint—otherwise, proceed as usual.

Hints for Nursing a Patient on Double Frame.

The patient should never be turned for nursing purposes, or the spine and limbs will sag laterally. Place a block underneath the bar between the ankles to avoid pressure on the heels, increasing the height of the block when necessary to insert a flat bed-pan beneath the splint. In this raised position all necessary washing of the buttocks can be done. The patient is never taken from the splint, nor are the bandages removed for any purpose, but only the exposed skin washed.

FIG. 4.—Left abduction frame.

The feet should be supported at right angles, and protected from the weight of the bedclothes.

FRACTURES OF THE LOWER LIMB.

HIP AND UPPER THIGH.

Fractures through the hip joint and those just below the trochanter are best treated by a modification of the Thomas splint, which I have described as an "abduction frame" (Fig. 4). It is a splint upon which the patient lies and can be carried (Figs. 5 and 3), extension is easily applied, maintained, and need not be relaxed for any purpose. The patient is placed upon this splint, and any

displacement should be overcome by immediate extension in the abducted plane. The limb should be rotated inwards slightly until the foot is at right angles to the table and be fixed in this position on the frame. It will

FIG. 5.—Left abduction frame applied.

be seen by the illustration that both limbs are controlled and that extension is secured by strapping on the injured limb with counter extension by means of a smooth leather groin strap on the opposite side of the pelvis. This groin strap should not be slackened by the nurse under any pretext, but in order to avoid pressure sores she should be instructed to alter the area of skin subjected to it over the adductor muscles by moving it to and fro. This method of "fixed extension" in abduction secures the lower limb in relation to the pelvis in a manner which can never be satisfactorily achieved by weight and pulley, where reliance is placed on the weight of the body for counter extension. It is by reflex nervous impulses, induced by changes of tension in the muscle, that muscular spasm is produced. A patient lying in bed with a fractured femur—high up or lower in the shaft—cannot avoid constantly changing the state of tension of the muscles of his thigh if a weight and pulley are attached to his limb. The counterpoise is the weight of his body. Every time he tries to shift the position of his shoulders by digging his elbows into the bed he alters the tension of his muscles, calling forth a reflex spasm. When he falls asleep and his muscles relax; when he moves in his sleep; when he is lifted upon a bedpan or moved slightly by the nurses to have his bed put straight, there is apt to recur this reflex contraction due to sudden change in tension.

FIG. 6.—Left abduction frame, limbs parallel for transport.

are desired. One of the objections to the old abduction frame was the difficulty of transport. The abducted limb proved difficult both on the boat and in the train. To obviate this, the splint is now made so that

the patient may be put up for transport with both limbs parallel. As soon as the patient arrives at hospital the limb is abducted without disturbing him in any other way (Fig. 6).

The patient who lies on an "abduction frame" can be lifted and moved without pain, without disturbing the fracture or relaxing the extension, and the dressing can be changed without interfering with the mechanism of fixation. If the wound is through the buttock and the discharge takes place there, the splint can be modified

FIG. 7.—Modified abduction frame for pelvic wound; only to be used while wound discharges, as shown in the illustration (Fig. 7). The abduction frame can be applied in a few minutes.

Abduction Frame.

Measurements Required: Nipple to external malleolus.

Splint Measurement: From chest band to ankle grip, 4 in. short or above measurement.

Application.—A strip of adhesive plaster, to which a strong loop has been sewn at one end, is applied to each side of each leg.

The adhesive plasters should reach from as near the lesion as possible to the malleoli—the loops lying at each side of the heel. Bandage these on firmly. The patient now lies on the splint (see "Double frame"), but before bandaging down the knees lay the body of the groin strap along the gluteal fold of the sound limb, securing it by means of its perforated ends to the pegs on the splint wing. Next apply the traction required to the injured limb, maintaining it by tying the external loops to the end of the splint by means of bandage which has previously been passed through the loops. The groin strap remains stationary. Further traction of the limb is obtained by means of

FIG. 8.—Strapping extensions applied to leg. Suspension slings to splint to support limb.

this extension. The sound limb should have very slight traction applied to avoid pelvic tilting.

FIG. 9.—Introducing limb through ring of Thomas's knee splint.

this raised position all necessary washing of the buttocks can be done. The patient is never taken from the splint nor are the bandages removed for this purpose, but only the exposed skin washed. The feet should be supported at right angles, and protected from the weight of the bedclothes. Remove the groin strap for five minutes four-hourly during the first twenty-four hours; twice daily is usually sufficient afterwards. Rub area with spirit and powder during these intervals, replacing strap in same hole as before, but as much as possible over a different adductor skin surface.

UPPER MIDDLE AND LOWER THIGH.

For all other fractures of the thigh the Thomas knee splint is incomparably the simplest and best (Fig. 8). I have often fixed a fractured thigh in this splint and sent the patient home in a cab. By reason of its construction, it automatically secures a correct alignment, as any surgeon with a mechanical mind can see if he examines the illustration. I am in the habit of using this splint for the treatment of all fractures of

If Abduction Frame too Short.—Place patient on abduction frame allowing only about 6 in. of space between the heels and the extension loops of the splint. Move the back pad higher up the splint fitting the gap between the patient's buttocks for nursing purposes. Having fitted the groin strap to the patient's gluteal fold, tie the perforated ends over the chest band of the splint at the axilla and proceed as usual.

If Abduction Frame too Long.—Place patient on abduction frame, fixing the groin strap in the usual manner. If the chest band will not mould down sufficiently to lie comfortably in each axilla, it may be turned back flat with the bed and ignored. Heels that do not reach beyond the leg piece of the splint must be protected from pressure with a rectangular foot splint or plaster-of-Paris, and proportionately thicker pads placed under the knees (see "Double frames").

Nursing Hints for Patient on Abduction Frame.

The patient should never be turned for nursing purposes, or the spine and limbs will sag laterally. Place a block underneath the bar of the ankles to avoid pressure to heels, increasing heel block when necessary to insert a flat bedpan beneath the splint. Also in

FIG. 10.—Knee splint in position, traction applied.

the middle and lower third of the thigh, fractures through the knee-joint, and fractures through the upper and upper middle portion of the leg.

The application of the Thomas bed splint is quite easy. Strapping of adhesive plaster is applied in the usual way to the sides of the limb. At the lower end of the extension strapping there is a loop of webbing to which is attached a length of strong bandage (Fig. 8). The ring of the splint is passed over the foot (Fig. 9) and up to the groin till it is firmly against the tuber ischii. The extensions are then pulled tight, the ends turned round each side bar (Fig. 10) and tied together over the bottom end of the splint, which

FIG. 11.—Sheet iron splints moulded by hand for various uses.

should project 6 or 8 in. beyond the foot. Care must be taken to avoid internal or external rotation of the limb, the foot being kept at right angles. Local splints can then be employed, and are made of block tin or sheet iron. They can be moulded by the hand to fit the limb, and yet, being gutter-shaped, they are rigid longitudinally (Fig. 11). They can be disinfected by fire or water. A couple of transverse bandage slings suspend the limb from the side bars of the knee splint. A straight splint is placed behind the suspensory bandages of the thigh and knee. On the front of the thigh another sheet iron splint is applied, and the femur is thus kept rigid. The alignment from the hip-joint to the ankle is perfect, being dependent on a straight pull (Fig. 12).

One may prefer to use a screw extension instead of bandage in some cases, when there is difficulty in maintaining the full length of the limb (Fig. 13). This splint allows the patient to raise his shoulders, or even sit in bed. His other leg can be moved freely without altering the tension on his thigh muscles, and there is no reflex spasm. Even if the muscles try to contract they cannot, for the ring of the splint is firm against the tuber ischii. The muscles therefore do not remain on the alert but become quiescent, and starting pains do not occur. Such is the difference between "fixed" and "intermittent" extension.

In using this splint a little attention is necessary to prevent soreness of the perineum. The ring of the splint, being covered with smooth basil leather, can easily be kept clean, so can the skin. The dressings can be applied without in any way interfering with the action of the splint. When the fracture has occurred through the knee or upper tibia the splint is applied in the same way.

It is often a matter of astonishment to

FIG. 13.—Screw extension which may be used with Thomas's knee splints or abduction frames.

FIG. 12.—Thomas's bed knee splint with local splints applied.

me that so simple and effective a splint has not been universally employed. It can be applied in a few minutes, usually without an anaesthetic, and one is always sure of good length and good alignment. The fractured limb can be moved in any direction without giving pain, so that transport is easy and safe. I have

FIG. 14.—Skeleton splint for injuries near the ankle-joint.

never yet had to plate or wire a femur in a recent case, and this I ascribe to using the Thomas splint.

Thomas Bed Knee Splint.

Measurements Required: Horizontal circumference of thigh at groin, length of leg from fork to base of heel.

Splint Measurement: Add 1½ in. to circumference measurement to allow for obliquity of ring. Add 6 in. to 8 in. to length of leg measurement to allow for extension pull.

Application.—Apply a strip of adhesive plaster, to which

a loop has been sewn at one end, to each side of the leg with the loop lying at the heel. These should be firmly bandaged on and reach from the heel to as near the lesion as possible. Slide the ring of the splint over the foot and

FIG. 16.—Splint to keep the arm abducted slightly forward, and slightly rotated inwards.

up the leg, pushing the ring well into the groin and applying the necessary counter-extension on the limb. This counter-extension is maintained by tying the extension loops to the end of the splint by means of bandage which has been previously passed through the loops.

A posterior knee splint, short enough to just avoid the gluteal fold at the upper end and the heel at the lower end, is then slung between the side bars of the bed splint to support the limb. Local splints can be applied if required, and the whole bandaged compactly together. Sling or support the foot of the splint to prevent pressure of the heel on the bed.

If the Splint is too Large in the Ring.—Fix a sufficiently large soft pad in the ring at its junction with the outer bar to prevent the inner portion of the ring slipping from the groin across the perineum.

If the Splint is too Small in the Ring.—Saw through the ring just in front of its junction with the outer bar; open as necessary.

FIG. 18.—Splint immobilizing the elbow-joint but allowing access to it.

Nursing Hints for Patient with Thomas Bed Knee Splint.

This is usually applied when extension of the limb is required; therefore pressure over the ischium may be great, but this can be relieved by raising, lowering, or abducting the limb from time to time. The skin surface

FIG. 15.—Skeleton splint applied.

lying under the ring should frequently be changed and kept dry and well powdered. The foot end of the splint must be either slung or supported to prevent pressure under the heel, and if the foot has been left free it should be supported at right angles by a pillow or otherwise.

LEG.

Fractures of the lower portion of the tibia or fibula, and fractures through the ankle-joint, I treat in a skeleton splint, such as I have illustrated (Fig. 14). It allows of

easy access to the wound, and can without difficulty be modified to suit a special case. Fortunately, in gunshot wounds, the spiral fracture is rare, and, generally speaking, one bone remains unbroken. The treat-

FIG. 17.—Splint applied to keep the arm abducted slightly forward, and slightly rotated inwards.

ment, therefore, of fractures of the leg does not present so much difficulty as that of the thigh. For transport, however, and for general comfort, the splint should immobilize the knee (Fig. 15).

A Skeleton or a Rectangular Foot Splint.

Measurements Required for Skeleton Splint: Tread of great toe to heel.

Measurements Required for Rectangular Foot Splint: Tip of great toe to heel.

Splint Measurements: The same, but any adult size is easily adapted.

These splints are usually applied to feet which are, or are required to be, held at right angles. When this is not the case, it is advisable to alter the splint's angle, or a pressure sore may result to the heel which is not lying in its appointed place.

Rectangular Foot Splint too Large.

Of no consequence unless marked, when a pad will be required above insertion of the tendo Achillis to prevent pressure on the heel; and a skeleton splint

FIG. 19.—Elbow splint applied.

will require a local splint or its substitute to the sole of the foot.

FIG. 20.—Thomas's knee splint, modified, used to maintain extension of the humerus in the abducted position.

Skeleton Splint too Short.—The foot-piece of the splint can be lengthened by a local flat splint or its substitute.

FIG. 21.—Extension arm splint applied.

Nursing Hints for Patient with Skeleton Foot Splint.

This splint should be supported on a graduated pillow which is thicker under the knee.

FRACTURES OF THE UPPER LIMB.

ARM.

Fractures through the shoulder-joint and through the surgical neck of the humerus require no splints.

FIG. 22.—Modified Thomas's humerus extension splint.

FIG. 23.—Modified Thomas's humerus extension splint applied.

position need not be adopted if the patient has to be transported, as it can be established after the arrival home. Fractures through the elbow or immediately above the condyles are best treated without splints. If possible, the

arm should be kept flexed well above a right angle. Suppurating cases in the adult will not admit of the very acute flexion which we insist upon in the case of children. If, for a rare reason, a splint has to be applied, the internal wooden angular splint must be avoided, because it is always clumsy and often causes deformity, and a splint as illustrated used (Figs. 18 and 19).

Fractures of the middle and lower middle portions of the shaft of the humerus, where dressings have to be frequently changed, require very gentle handling, and I illustrate two splints which may be found very useful. One is a modified Thomas knee splint used to maintain extension in the abducted position, the patient being recumbent (Figs. 20 and 21). The other is a modified Thomas humerus extension splint (Figs. 22 and 23), to be used when the patient can walk about or sit up in bed. Either splint permits of easy dressing, and maintains adequate fixation. As so much destruction of bone may be produced by modern shrapnel, and even by rifle bullet, great care must be taken to prevent over-extension, otherwise non-union will ensue.

FOREARM.

The chief disability to be feared in fractures of the shafts of the bones of the forearm is inability to supinate the forearm completely. The trouble usually arises where both bones are broken, but it may occur where the radius alone is involved. We must remember that the whole length of the posterior border of the ulna is subcutaneous and is practically straight. On this straight ulna the curved radius rotates like the handle of a bucket. We must therefore attend to two points. First, we must keep the ulna straight; second, we must not interfere with the natural curve of the radius. That is to say, there must be no lateral pressure of bandage or splint on the middle of

the shaft of the radius. In dealing, therefore, with these fractures, whether one or both bones be broken, the position of supination should invariably be maintained. This is even more important in septic compound fractures than where no complication exists. Neglect of this important point will often result in a locking of the bones in pronation. We must remember that in nearly all neglected fractures of the forearm, supination and not pronation is defective, the arm being usually fixed in the pronated position.

WRIST AND HAND.

Gunshot wounds through the wrist are very common, and far too many have been treated with the hand in line with the forearm—that is, midway between palmar and dorsiflexion. This is fatal to good function. All injuries of the wrist-joint should be treated in the dorsiflexed position, as shown in the illustration,

FIG. 24.—Hyperextension hand splint.

FIG. 25.—Hyperextension hand splint applied.

FIG. 26.—Skeleton hyperextension hand splint.

FIG. 27.—Skeleton hyperextension hand splint applied.

FIG. 28.—Skeleton hyperextension hand splint applied.

FIG. 29.—Long hand splint.

FIG. 30.—Long hand splint,
with thumb-piece.

FIG. 31.—Long hand splint applied.

in order that the fingers may maintain their grasping power (Figs. 24, 25, 26, 27, and 28). Fractures of the hand may be immobilized as shown (Figs. 29, 30, and 31).

Care must be taken to fit the wrist flexion accurately to the splint flexion, thus avoiding any possible strain of the carpal joints.

RETENTION OF LOOSE PIECES OF BONE.

I do not intend to deal with the surgical considerations

involved in the treatment of the suppurating wound. Many distinguished surgeons are devoting themselves to this problem. It may be well, however, to offer a word of warning against the destruction of loose pieces of bone removed from the wound. If quite loose they can be taken out, cleaned, and replaced. Suppurative compound fractures unite well if time be given them; a common source of failure is due to the removal of bone.

THE USE OF CRUTCHES TO PREVENT PRIMARY CONTRACTION.

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CRUTCHES are commonly used by patients after the loss of one of the lower limbs or after injury before complete recovery. The latter, using them in the same way as the former, lift the injured limb when walking; we frequently see them walking with the knee lifted and bent, or the thigh hanging straight with a bent knee, according to the position of the wound, as in cases of wounds of the soft parts of the thigh, etc.

This method of holding the leg in walking, if it is continued over ten to twelve days, makes a bent knee and extended ankle-joint immobile. The contraction thus caused by injuries of the lower limb is merely reflex; this reflex primary contraction is easily cured; the secondary cicatricial contraction may get worse with time—for instance, after loss of muscular substance. To prevent pain from the injury of the muscle, the ends of it are approximated and fixed by the other flexors. The patients acquire this crooked position of the limb before they begin to use crutches, from the first day after the injury. A fortnight later the knee can scarcely be extended without force.

If the surgeon waits for the healing of the wound, and does not take precautions to prevent the contraction by splinting, and lets the patient walk with crutches with a lifted leg, shortening of the ligaments of the joints follows the muscular contraction; extension apparatus is required, and time is lost before the harm can be undone.

This can be prevented if crutches be used as follows: It is not enough to give crutches to a patient; the surgeon must teach him how to use them. The presence of the surgeon is necessary to give the patient assurance that he is going the right way without the least danger to his injured limb. His presence is desirable at the first trial to watch the patient. After lying in bed for several days the patient may feel giddy in the upright position, and may fall. Not many patients can walk at once with crutches as if they had never walked without them. Many require teaching.

Give the patient his crutches in the way in which they have to be used. Put the ends of them at a near and equal distance in front and aside of him, and let him take two steps, putting the wounded leg with the sole, as far as he can, flat on the floor, like the healthy one; then put both crutches at a rather greater distance in front of him, and so on. Care should be taken to let the patient put his feet symmetrically, not putting the bad one in abduction as he is inclined to do, nor the toes of the bad one pointing inward. In the absence of the surgeon the nurse must see that the patient learns his lesson thoroughly.

A light lateral splint, applied during the first days, can

be removed, and the patient will not feel inclined to bend the knee, nor to keep the ankle-joint in an equinus position.

There is no need to wait for the use of crutches till the wound has entirely healed or the suppuration has ceased. There is no danger whatever in using the lower limb for walking as soon as the wound is granulating. The crutches must not be merely a support of the weight of the body, as in cases of amputation; they ought also to be a means of helping the physiological graduated use of muscles and bones.

To decide the time for using both crutches, or only one, or a stick, there is a simple method. Reach both hands to the patient instead of crutches, and let him take a few steps. If the pressure on both your hands is rather heavy, he must continue to walk with both crutches; if your hand feels the pressure of the hand on the bad side, he can walk with one crutch; if the pressure be slight on both your hands, he can walk with a stick.

Another important point for the same purpose is the length of time that the patient takes over touching the floor in making a step with the injured limb. If the time be very short he must use crutches. The more the difference of time between the steps of the two lower limbs diminishes the sooner he will be able to use a stick.

The length of crutches must exceed by $1\frac{1}{2}$ to 2 inches the vertical line from the armpit to the ground.

Patients brought into hospital ten or more days after injury are many of them unable to straighten the leg at the knee-joint. Judicious forcible straightening, with fixation by means of a plaster-of-Paris bandage, with graduated movements and use of crutches, will remove the deformity. I have never had, either in civil or in war practice, to resort to physio-therapeutic measures to restore a recent contraction, if taken in time.

These remarks chiefly refer to cases of wounds of the soft parts of the leg; but the crutch *cliquette* is much wider than that. I will give the approximate times at which to begin the use of crutches in different cases of injuries of the lower limb. Allowance must be made for individuality.

1. Small wounds of the soft parts of the leg, scarcely discharging; light splint: Crutches on fifth to seventh day after injury.

2. Larger and more actively discharging wounds, with splint: Crutches on tenth to fourteenth day from commencement of granulating.

3. Wounds of the knee or ankle joint, penetrating the joint; splinted with a suitable plaster-of-Paris bandage; opening into joint closed: Crutches two to three weeks after the injury. If the joint has not been opened and the cartilages are uninjured, crutches on the fifth to seventh day after injury.

4. Special care must be taken over the use of crutches in cases of suspected or existing lesions of blood vessels.

5. Compound fractures of tibia or fibula or both: at the