Denison. (C.)

The Extension-Windlass Method of Treating Fractures of Long Bones

ESPECIALLY ILLUSTRATED WITH REFERENCE TO FRACTURE IN UPPER THIRD OF FEMUR

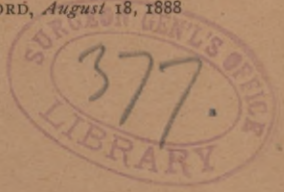
Compliments of

BY

CHARLES DENISON, A.M., M.D.

DENVER, COL.

Reprinted from THE MEDICAL RECORD, *August* 18, 1888



NEW YORK
TROW'S PRINTING AND BOOKBINDING CO.
201-213 EAST TWELFTH STREET
1888

The Extension-Windlass Method of Treating Fractures of Long Bones

ESPECIALLY ILLUSTRATED WITH REFERENCE TO FRACTURE IN UPPER THIRD OF FEMUR

BY

CHARLES DENISON, A.M., M.D.

DENVER, COL.

Reprinted from THE MEDICAL RECORD, *August* 18, 1888

NEW YORK
TROW'S PRINTING AND BOOKBINDING CO.
201-213 EAST TWELFTH STREET
1888

THE EXTENSION-WINDLASS METHOD OF TREATING FRACTURES OF LONG BONES,

Especially Illustrated with Reference to Fracture in Upper Third of Femur.

For some time the writer has been under the impression that there is a decided opportunity for improvement in the mechanical management of certain fractures of long bones requiring extension. Special reference may be made to railroad, marine, or military surgery, or wherever the transportation of the injured to hospitals or their homes is necessitated.

Contrivances for producing extension in the treatment of fractures have been numerous and ingenious; but most of them have been cumbersome, uncomfortable, and not beyond question as to average results.

During his early hospital experience (1870) the writer devised the extension windlass, here illustrated (see Fig. 1), which he believed was the epitome of extension, or the concentration of that power into the smallest possible space for practical uses.[1]

[1] In making extension we cannot expect the muscular power to be overcome, and, at the same time, its relations to the various states of the nervous system to remain *constant;* and yet, with a weight of twenty pounds, a constant force, it is sought to overcome another which naturally weakens. While so great a power may be necessary at first, still, as the opposing power lessens, its influence is really proportionately intensified. In this contest with a man's muscle and nervous system, a bag of sand has undue advantage. Then, too, there may be some uncertainty as to the amount of extension used by the pulley and weight. Some surgeons habitually weigh the sand or material used, instead of guessing at it, and then endeavor to regulate this weight as the case may require. Such are probably the exceptions. Now, if the maximum weight required (as Professor

This little instrument—about the size of an ordinary silver watch—can accomplish everything that may be desired in the way of extension, if properly applied. By this is meant, if it is suitably combined with plaster-of-Paris or silicate of soda bandage-dressing, felt splints, or other appropriate device. Furthermore, because it furnishes a fixed and definable power, it is by so much superior to all unstable or elastic methods of treating fractures requiring extension, heretofore the rule in surgery. It may be claimed that this is an intermittent force because it depends upon the intermittent acts of the attending surgeon. But the slight relaxation between the surgeon's visits is as nothing compared with the unstable conditions which have to be overcome alike by all methods of extension.

In the treatment of fracture of the femur by the pulley and weight, the varying amounts of shortening or lengthening, as you like it, on successive days, with the weight of traction unchanged, has somehow caused the suspicion in the mind of the writer that this *unstable force* (motion) tends to elongate or change those cells into fibrous tissue (non-union), which, in nature's reparative process, were intended to become *bone*. The extension by pulley and weight is considered unstable because it is only opposed by the more or less *flexible* resistance of muscles, tendons, and tissues. Such methods, typified in Buck's extension, are, then, unnatural, inhuman, and unreasonable, and must of necessity give way to the utilization of steadier forces to accomplish the needed extension. The beauty about the screw or windlass method is that it re-

---

Hamilton found in making extension for fracture of the shaft of the femur) is twenty-two pounds, who can give us even an approximate rule for the weight necessary on successive days after the injury, as muscular contraction is gradually weakened, or that would be applicable to the great variety of cases occurring? The nearest to a correct guide would be the *length of the limb;* but this is just as reliable in extension by the windlass, which requires no more of muscles once relaxed, than to keep them under control.—*New York Medical Journal*, May, 1875.

quires nothing further of resisting muscles once relaxed than simply to hold them in position, which is finally an extremely simple affair, when once they have succumbed to just sufficient extension.

Fracture of the neck or in the upper third of the femur.

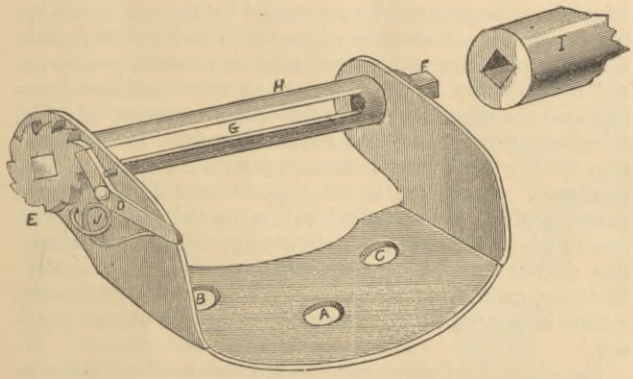


FIG. 1.—The Extension Windlass (diagram nearly the full size), made of brass, each pair of windlasses being rights and lefts, *i.e.*, the key-ends (F) of the winding-rod (H) both project forward on each side of the limb when in use. This winding-rod is firmly held in a bracket by means of which, through the perforations shown for screws or tacks, it is made either stationary (A, B, C) or swivel (A) upon any splint or wooden slat. The usual form of attachment (stationary) is to have the arms of the bracket, which are one and three-fourths inch apart, enclose the end of a pine- or soft wood slat of the same width. The windlass thus placed upon the outside of the slat, and the end of an adhesive plaster threaded through the slat at the winding-rod (G), traction is furnished about on a line with the surface of the limb to which the plaster is applied. The traction is regulated at will by the ratchet (E) and pinion (D) on one end of the winding-rod, the handle of the pinion serving as a means of throwing it off from the ratchet and thus letting up the tension whenever that is desired. The pinion is constantly held against the ratchet by the spring J, unless the handle of the former is purposely depressed. The winding-rod is easily turned by the key I.

—One of the most difficult fractures to treat, in which the surgery of the day is not up to its average success in other directions, is intra- and extra-capsular fracture of the femur, or the two combined. If the ligamentum teres is severed, if the break is intra-capsular, or in old people,

the pain or confinement involved, and the long time consumed in obtaining the possible shortening, non-union, or deformity, are satisfactory *only* because they seem heretofore to have been unavoidable. Even with less serious complications the rule of shortening is perhaps more liberal than it should be. This is a conclusion which, it is hoped, will be supported by the use of the extension windlasses suitably adjusted. There are two methods of application to be mentioned at present, one by the aid of plaster-of-Paris or silicate of soda bandage-dressing, and the other by porous felt-splint material, or a like substitute, properly cut and moulded to fit. The preparation for the first method consists, first, in the plaster-rolled bandages. These are to be applied over a thick pair of drawers, which can be pulled well up on the waist, or (with one to whom flannel may be irritating) silk or fine balbriggan drawers might be substituted, covered with cotton-wadding, canton, or lamb's-wool flannel, cut to fit a space a little larger than that to be enclosed in the plaster bandage.[1]

Fan-shaped adhesive plasters are cut to fit the sides of the leg, reaching from the knee to below the foot, where they can be threaded through the winding-rod, being there one to one and a half inch wide.

Pine-slats are needed, one and three-fourths inch wide, one-fourth inch or less thick above, one-half inch thick below, long enough to reach from below the groin on the inside, and from the trochanter major on the outside of the limb to just below the arch of the foot or to the malleoli, as the surgeon prefers. The upper ends of these slats are thinned and roughened to favor fixation in the plaster bandage. To the lower ends of the slats the windlasses are attached; each windlass enclosing the outside of the end of each slat. It is desirable to spread the up-

[1] If silicate of soda dressing is to be preferred (because it is lighter and less likely to crumble), a thick duck or tent cloth has lately been found by the writer to be best for the bandages.

ward pressure of the plaster bandage over as large a surface as possible, and protect the perineum and gluteal region by fixing in this locality an absorbent cotton or similar pad—perhaps plaited—one-fourth inch thick, five inches wide, and two feet or more long. The turning outward of the upper edge of the bandage-dressing at this point also helps to make a broad impinging surface along the inner and upper border of the inverted and truncated cone, which will be the shape of the dressing as it fits the thigh. The perineal pad and protecting covering to the thigh and waist being in place, the patient is lifted up above the bed, or out from the bed and at a right angle to its side, and a chair is placed under the opposite hip to help support him in this horizontal position. The parts over which the plaster-of-Paris bandage is to be spread are then entirely free and the application can be quickly made, turning the broad bandages from the thigh around the waist by the figure-of-eight movement, and properly enclosing the roughened ends of the side-slats in the middle layer of the bandage.

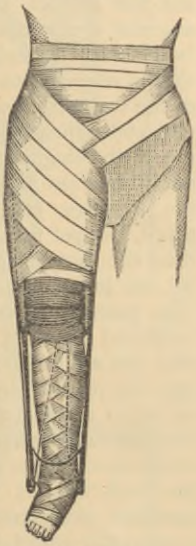


FIG. 2.

Extension had better be begun, by means of the windlass, before the bandage is entirely dry, so as to adjust the same to the swell of the thigh. Care should be also taken that the foot does not turn too much outward, that the thigh is slightly flexed upon the pelvis, and that the knee is a little bent, so as not to leave it in a strained condition. This latter can be accomplished by a broad band running from one slat to the other underneath the knee (see Fig. 2). The slats are held apart and prevented from pressing too much on the limb at their lower ends by a wire hoop

extending over the limb and having sharp ends which stick into the inner surface of each splint, or pads may be tacked to the inner surface of each slat near their lower ends, which will guard the flesh from friction against the windlasses. In a variable time up to two days, after traction is commenced, the limb may be drawn down to the exact length of its fellow, and after that, for a week, turning the ratchet a chick or more a day, and the same amount every other day the second week, will probably be sufficient to hold the limb down in place, this being all that is requisite to neutralize the giving of the plasters and of the counter-extension around the thigh. If properly padded and adjusted, there is no pain from the upward pressure of the thigh-dressing. Care must be taken, however, not to use too much traction by the windlasses when once the muscles, etc., have succumbed to this apparently small, but yet invincible, force. How much better is this than the increasingly uncertain and never-ending traction on the pulley-and-weight principle of Buck's extension! The patient can be turned on to either side, and then be bolstered up in a comfortable way. Not only this, but with the aid of the nurse, who lifts the injured thigh and leg, the patient can move himself at will across the bed or on to a bed-pan. This is accomplished by the aid of the trapeze apparatus (illustrated in Fig. 3) which the writer devised for the use of his first case of fracture of the neck treated by this method. This the patient in question christened the "Fracture Alleviator," and was continually grateful for the comfort and freedom of motion which it afforded.

It consists mainly of a bar, which is made to swing down from a frame behind the head of the bed, so as to be within the reach of the patient, at which point it is made stationary by hinged supports, which fit into slats in the upright beams of this frame. The trapeze portion can be pulled up out of the way by a cord running over a pulley on the frame above. By this apparatus the patient lifts the thorax and head with the hands, and sup-

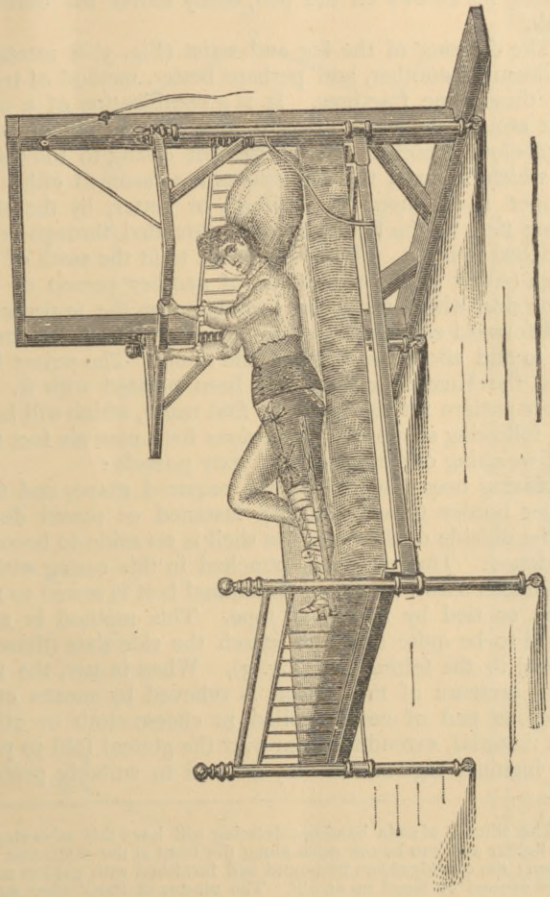


FIG. 3.

ports the body by the sound limb, while the nurse, resting his elbows on the bed, easily moves the disabled limb.[1]

The dressing of the leg and waist (Fig. 3) is intended to illustrate another, and perhaps better, method of treating these same fractures. It is a combination of a wide belt around the waist, made of four thicknesses of thick duck-cloth, attached to a porous felt casing to the thigh, to which, in turn, the side-splints are fastened either by copper rivets (used for belting), or better, by the slats being tied to the felting by tape threaded through holes punched in both. The felting is cut to fit the swell of the thigh (either of the patient or of another person of the same size) with a triangular projection on the upper edge and forward end, so as to form an extension of the dressing to and above the crest of the ilium. The writer has used the Russian felting, and been pleased with it. A paper pattern for this might be first made, which will have the following shape and dimensions for a man six feet tall and weighing one hundred and sixty pounds:

Having been moulded to the required shape, and this upper border turned out and fastened or sewed down to the outside of the cone, the shell is set aside to become hardened. Through holes, punched in this casing with a shoemaker's awl, the broad abdominal belt is sewed to the same or tied by means of tape. This method is also found to be quite suited to attach the side-slats (thinned above) to the felting (see Fig. 3). When in use, the upward pressure of this casing is relieved by means of a generous pad of cotton rolled in cheese-cloth or other soft material, extending from over the gluteal fold to past the inguinal region. It may be well to suitably protect

[1] The silicate of soda bandage-dressing will have this advantage: It is lighter and can be cut open along the front of the thigh and abdomen; the cut edges can be bound and furnished with eyelets so as to be opened or laced up at will. The plaster-of-Paris, after much use, crumbles and irritates the patient, which the lighter bandage will not do.

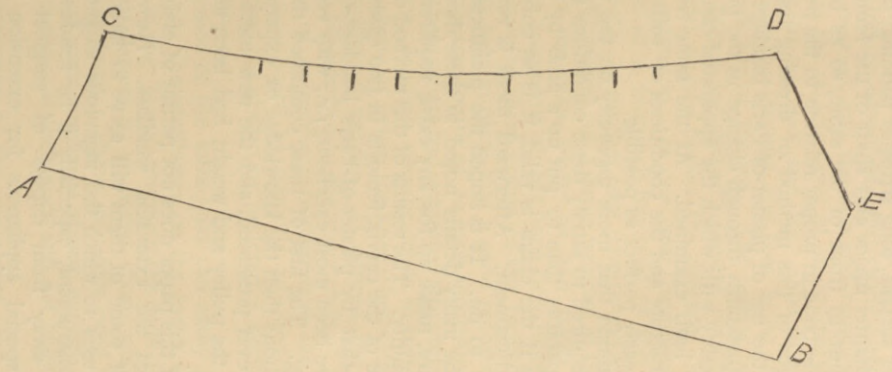


FIG. 4.—A B, distance around middle of thigh; A C, or B E, distance from symphysis pubis to upper border of patella, about twelve inches; B E D, about twice A C. For the right side, A C would be bent backward, and *vice versa* for the left side, A C lapping over B E, and the point D reaching above the crest of the ilium. After softening the felting the middle two-thirds of the upper edge C D is bent outward to form a rolling border, which process may be aided by slitting the edge one-half to one inch deep, every two inches.

the thigh from this stiff covering, and also to secure to the cone, on its inner surface, long strips of padding, one just back of the trochanter major and shaft of the femur, and a smaller one just in front of the same, so as by their pressure to fix the bone in proper relation to the pelvis.

The advantages of this method of dressing the thigh and pelvis over the use of plaster-of-Paris bandage are its lightness, its adjustability through change in the padding, etc., and the facility with which the apparatus can be removed and the limb examined. At the same time, the control of the fracture and the conditions of suitable extension are as nearly perfect as possible.

It may be claimed that more ingenuity on the part of the surgeon is required to satisfy these conditions and adjust such an apparatus than to put up a limb by the old methods. Even if the claim is valid, it is so only in the first accurate adjustment. Afterward there is very little for the surgeon to do. It is hoped the plainness of the drawings, and the many details noted in these directions, may, in a measure, make up for any extra requirement of mechanical ingenuity. The results of this method of treatment of fracture of the cervix femoris in two cases where the first plan—that by plaster-of-Paris bandage-dressing —was used, have been most excellent, *i.e.*, with very little or no shortening. The first of these combined more unfavorable conditions than the knowledge or experience of the writer had ever presented, and the new method was not tried until the pulley and weight had been used and proved a failure.

The length of this paper does not permit of elaboration of other uses of the extension windlass. However, a brief mention of some of them will serve to indicate the wide range of uses to which the ingenious surgeon may put this little instrument, especially if he resides in the country or is away from depôts of surgical instruments where special appliances for extension are to be obtained.

A compound or comminuted fracture of tibia and

fibula requiring extension is most admirably treated by the method illustrated in Fig. 5. The side-slats, like those already described, with windlasses on them, are simply inverted, and the thin and roughened ends are inclosed in the middle layer of an ordinary plaster-of-Paris dressing to the foot and leg. The dressing fits snugly only below the fracture, the foot being at right angles to the centre line of the leg. The pulling of the windlasses on the broad, fan-shaped adhesive plasters (bandaged to the thigh) simply pushes the dressing down to the required extension. In one case (comminuted) the tilting sideways of a four-inch fragment of the tibia was nicely prevented. In another case (compound and comminuted, 1874) the writer cut a large window in the plaster dressing over the tibia, where he had taken away half an ounce in fragments of that bone from its posterior surface. The remaining sharp points of the broken bones were so perfectly held in place that a good recovery was obtained with only one-fourth of an inch shortening. This was in a case where others had suggested amputation. With children, one windlass may be made to answer either for extension above or below the knee; but with adults two are to be preferred usually. If desired, the windlasses can likewise be attached to the upper ends of slats fastened to the sides of an ordinary fracture-box, the foot being held to the foot-board by properly adjusted adhesive strips. The writer has always, by preference, slung these dressings in a coop.

Extension of the knee-joint can easily be imagined by duplicating the windlasses on the lower ends of the slats (shown in Fig. 5) and reversing the ends of the fan-shaped adhesive plasters to represent those which are applied below the knee. These side-slats need not be cumbersome, but must simply be strong enough to stand the required pressure at their ends, and not bulge too much outward.

For extension of the ankle-joint (Fig. 6), notice how slats may be fastened to a foot-piece to which the foot is

fastened by adhesive straps, and any desired angle of the foot to the leg be obtained by producing traction on either the posterior or anterior windlass (on the upper ends of the slats) as the case may require.

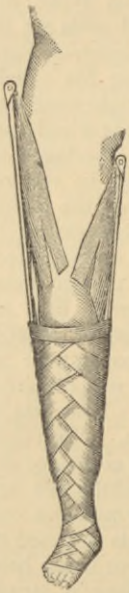


FIG. 5.

Extension of the hip-joint may be obtained by fastening the ends of a perineal band to the upper end of a long, light side-splint, over the lower end of which the extension windlass is made stationary. The fan-shaped adhesive strips are applied to the outside and back of the calf of the leg, converging toward the winding-rod. Or the point of traction could be reversed and two windlasses could be attached (swivel) to the upper end of the side-slat, or on a hip-piece to which this slat is jointed, each one pulling on separate ends of a long perineal band, while the lower end of the side-slat could be embedded in a plaster-of-Paris dressing to the leg; or it could terminate below in a right-angled metal brace fastened to the sole of the shoe under the instep. The perineal pad should have long ends and the inside of the upper end of the side-slat, or of an extra cross hip-piece if used, be properly padded, so that the traction of the windlasses would not produce uncomfortable pressure on the body.

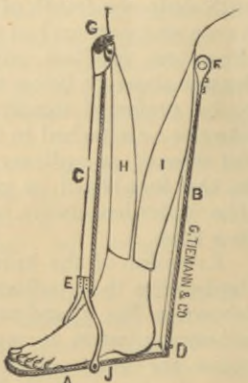


FIG. 6.

In 1870, while an interne in hospital, the writer con-

trived this windlass when treating his first case of fracture of the patella. He put the leg into a box made of half-inch pine-boards. Through the sides, which were higher than the limb, he put the round of a chair with a handle on its end, like the crank on a miner's derrick. The converging ends of adhesive straps, which wholly covered and controlled the quadriceps femoris, were threaded through a slat in this chair-round. The desired extension, thus obtained by turning the crank, was the chief factor in an excellent recovery with bony union. This led to the con-

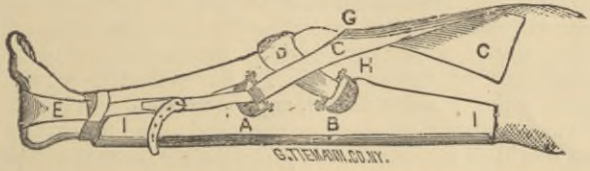


FIG. 7.—Fracture of Patella. A and B, extension and counter-extension windlasses, each fastened by one screw to the raised sides of a wooden posterior splint; C C are fan-shaped adhesive plasters crossing each other at G, and threaded through the winding-rods of A. D, a padded roller in front of ligamentum patellæ, the ends of which are threaded through winding-rods of B; E, reserve counter-extension to relieve D from uncomfortable pressure over the ligamentum patellæ. I I, points at which the posterior splint is bandaged to the limb. The bandaging of the limb, especially over the adhesive plasters, is not shown in this and the two preceding cuts. Brittain & Barber, of Denver, have made some dies to get these windlasses out cheaply; from whom, or from George Tiemann & Co., New York, they can be obtained quite reasonably.

centrating of this power of extension into the small space occupied by the windlass here illustrated. Fig. 7 shows this application on a finally perfected plan. However, the sides of the pine-splint should be raised a little higher than shown in the cut; the knee should be padded well underneath, so as not to be constrained in position, *i.e.*, not to be bent backward at that point, and the use of the limb, by the patient going around on crutches during the first part of the treatment (as was done with the case just mentioned) had better not be allowed.

A word in closing. It is with some apprehension that this paper is given to the press, because of the possible

failure to appreciate the conditions necessary to a successful use of the instrument. It is surprising that a few physicians have at first seemed to experience difficulty in understanding where the extension and counter-extension are obtained, as shown in Figs. 2, 3, and 5. Then, again, too little, too thin, or too weak adhesive plaster might be used (a generous amount of Maw's moleskin, snugly applied without wrinkles, answers best); or the neglect to shave off the hairs where the plasters are to be applied; or to sufficiently protect by padding where much pressure is to be borne; or the mistake of leaving the joints in a constrained position; or of extending the limb longer than its fellow, any of these might lead to discomfort and so disparagement of the method. If, however, the requirements, as they are manifested, are appreciated, and reasonable ingenuity and patience are exercised in the adjustment, then this little instrument will prove itself a boon to others, as it has to the writer, in the treatment of some very difficult fractures of long bones.

April 27, 1888.