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ON THE

TREATMENT OF UNUNITED FRACTURE,

BY

"PRESSURE AND MOTION,"

WITH CASES.

BY

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WITH FOUR WOOD-CUTS.

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TREATMENT OF UNUNITED FRACTURE

BY

"PRESSURE AND MOTION."

CASE I. *Oblique Fracture of the Right Femur with Oblique Fracture of both Bones of the Right Leg; non-union after six months' treatment; cured in five months whilst walking about.*—I am indebted to Dr. Wm. R. Blakeslee, of Coatesville, Pa., for the following notes of this case:—

On the 1st of July, 1873, H. W., aged 33 years, being on a freight train going at ordinary speed, attempted to get off from the front platform of a "house-car" (last of train), when a rod of iron, to which he held, became detached, causing him to fall backwards and strike against a coal car, thus whirling him partially around off the platform on to the ground between the tracks, he lighting on his feet, and falling immediately forward in the same direction as the train was running, producing bodily concussion, lacerations, and contusions, with an oblique fracture of the middle third of the *right* femur as well as an oblique fracture of both bones of the *right* leg.

The limb was dressed by extension and straight splints with such modifications as seemed expedient during the first six months of the patient's illness, without any union occurring either in the bones of the leg or in the femur. No effort was spared to promote the welfare and comfort of the patient during this treatment as regards room, bed, ventilation, and nutrition. His appetite was good, and pain not excessive, requiring anodynes only during the first few days after the accident. On November 21st, it was decided to treat the case by "Smith's artificial limbs for ununited fracture," Fig. 1, but owing to various circumstances their application, with an attempt by the patient to walk, was not made until Jan. 1, 1874, six months after the injury. It was so long since his muscles had been exercised that in his first attempts he seemed like a child beginning to walk alone, was compelled to use crutches, and also have assistance from a friend to give him confidence. This being also the most inclement part of the year, his exercise was limited to the house until April, when he was out of doors most of his time. He continued the use of the apparatus until the middle of May (four and a half months), when he took it off occasionally. Soon afterwards he laid it aside entirely, and is now (May 5, 1875) walking well, and with but trifling lameness, this being apparent especially on ascending stairs.

CASE II. *Comminuted Ununited Fracture of the Right Femur of nineteen months' standing; extreme mobility of the fragments; inability to stand or use the limb; immediate ability to walk with only a cane, as soon as the apparatus was applied.*—Col. Jno. W. T., of Iowa, aged 56 years, was thrown from his wagon on May 20th, 1873, breaking his right femur at the union of the middle and superior third, and also just below the trochanter major, thus making a comminuted fracture, of which the middle fragment was nearly the entire upper third of the shaft of the bone. The soft tissues were not much bruised; there was no discoloration of the skin, nor was there any appearance of inflammation in the soft parts during the treatment of the fracture. The limb was immediately dressed with a long, straight splint, and extension made, the patient being kept at perfect rest for nine weeks, when the splint was removed, and he was allowed to sit up in bed. At this time there appeared to be partial union at the upper end of the intermediate fragment near the trochanter, but there was no union at the lower end of it where it joined the inferior third of the shaft, near the middle of the thigh. At a consultation of surgeons about the eleventh week after the accident, it was decided to introduce a seton between the fragments in the middle of the thigh. This was done, but on the eighth day subsequently, owing to the violent inflammation of the thigh, high fever, and general constitutional disturbance, the seton was removed. Ten days after this, when these symptoms had subsided, the limb was again dressed with the straight splint, and the patient confined to bed on his back for seven weeks more. At this time, twenty weeks after the injury, there being no indication of the slightest union, and his general health being much impaired by confinement and suffering, he was permitted to move about on crutches, the limb being bandaged, and partially supported by splints. This gentleman had always enjoyed unusually good health; never had any disease likely to retard the union; had led a very active life, especially during the war, when he was on a prominent general's staff, and was unable to explain his condition.

Dec. 9th, 1874, he consulted me in Philadelphia. At the examination made at this date it was evident that there was no union in the middle of the thigh, as the leg and knee, and lower third of the thigh *could be bent laterally at a right angle with the axis of the limb*, whilst the muscles, etc., could be so twisted on the axis of the femur, that the *calf and heel could be turned upwards whilst the patient lay on his back.* The upper fracture was also ununited, but adhesions, etc., rendered it firmer. The point where the seton had passed was also quite plain. Of course the limb was useless as a support, and dangled loosely on attempts to walk. After being well fitted with the apparatus by E. Spellerberg, of No. 105 South Tenth Street, he could *at once* walk with only a small cane—used more for confidence than support—the fracture and weight of the body being firmly supported by the artificial limb. This patient was carefully examined by members of the Philadelphia County Medical Society when shown to that body. The uselessness of the limb as a support was very apparent to all, as well as the ability of the patient to walk the entire length of the Society's hall, as soon as the apparatus (Fig. 1) was adjusted, thus immediately illustrating one of the points claimed for this mode of treatment, viz., that amputation for an ununited fracture was unnecessary, the patient's limb with the apparatus on, being more useful for support and progression than the stump could be after an amputation.

With such an injury there was little hope entertained of union, yet the usefulness of the limb with the apparatus was entirely satisfactory to the patient, his progression being impossible without it.

Whilst penning these notes I received a letter from Col. T., dated Iowa, Oct. 15th, 1875, in which he says: "My poor, broken thigh remains as when I left you (Dec. 18th, 1874), eleven months since. Your apparatus enables me to walk about readily for short distances, but when I wish to go a mile, I take my crutches or mount an old riding horse that is perfectly gentle. There has been a little shortening, which will require a slight addition to the heel of my shoe. My general health and strength have considerably improved since I saw you."

Case III. *Simple Oblique Fracture of both Bones of the Left Leg; non-union at the ninth week; cured in twelve weeks whilst walking about and attending an office.*—Mr. D. L., aged 74, whilst bathing in the surf on the shore of Rhode Island, was upset by a heavy wave, and fractured both bones of the leg, the fibula being broken near its lower fifth, and the tibia obliquely near its middle. There was nothing unusual in the injury, except the *slight* pain after the accident. Being at a seaside hotel, he was temporarily dressed with a "fracture-box" for about fourteen days, and then a plaster of Paris bandage applied, after which the patient was permitted on the third week to sit up and move a little on crutches. During the eighth week union was nearly firm in the fibula, but a false joint was apparent in the tibia, permitting considerable lateral motion. The leg was also shortened about three-fourths of an inch, and there was marked angular deformity anteriorly and internally, the sharp point of the spine of the upper end of the lower fragment projecting so as to inflame the skin, and threaten ulceration. On the ninth week after the injury, he was moved by his physician to Philadelphia, with the plaster bandage on, and placed in my charge. On removing the dressing, the want of union in the tibia and the angular deformity caused by the sinking of the heel in the bandage were very apparent. The general health was good. After making as much extension of the fragments as was possible, the measurements for an apparatus were accurately taken, and the "artificial limb" (Fig. 2) made and applied. Considerable difficulty was at first experienced in making pressure by the apparatus at the seat of fracture in the tibia, owing to the projection of the sharp point of the displaced lower fragment which threatened to inflame the skin, but by hollowing the front splint at this point, this was accomplished. Soap plaster spread on kid was also applied, to protect the skin from too much pressure, and the patient was at once able to walk with crutches. Being directed to wear the apparatus night and day, and walk constantly about his chamber, he was enabled in about two weeks to come down stairs and move about more freely. After eight weeks of this exercise, *being out of bed all day*, union had evidently become firmer, and on December 16th, twelve weeks after the application of the apparatus, union was perfect.

On February 2d, 1875, he was able to walk without a cane, and since then has the free use of the limb, a high heel to his shoe overcoming the shortening.

The advanced age of this patient, his nervous temperament, his fretfulness at confinement to bed, and his despondency at the failure of the first treatment of his fracture, all illustrated the great comfort and success

derivable from a mode of treatment which gave him the benefit of fresh air and exercise.

CASE IV. *Ununited Fracture of both Bones of the Right Leg; failure of the operation of perforation, etc., of the bone; patient able to walk freely on the "Artificial limb."*—Mr. J. W., aged 40 years, was thrown from his buggy in Batavia, New York, on August 2d, 1873, and received a compound fracture of both bones of the leg. He was treated at his home for nine weeks with a "starch bandage," and the fragments being supposed to have united, he came to Philadelphia on business. Eight months subsequently, as union was imperfect, he consulted a surgeon, who operated by "drilling the bones" and refracturing the fibula, in February, 1874. Under this treatment, he was confined to bed six weeks, and then dressed with a silicate of soda bandage and tin splints. Although able to move in this with the assistance of crutches, and his general health improved, union was not obtained, and progression being unsatisfactory to the patient, he obtained, on his own judgment, from a cutler an imperfect form of "Smith's apparatus," which he commenced to wear January 1, 1875. When I first saw him his weight was 275 pounds. There was no union in the tibia, and he could not walk without assistance. Directing him to obtain a well-fitted artificial limb, he was soon able to walk with only a cane and attend to active business. To-day (Nov. 1st, 1875), the patient reports the bone as firmer but not healed, and that he can walk to his satisfaction without a cane, though using one for confidence. The amount sustained by the apparatus on this ununited tibia may be understood by reference to the patient's weight as before stated (275 pounds).

CASE V. *Fracture of the Tibia through the Internal Malleolus and of the Fibula in its lower Fifth; laceration of the internal lateral ligament of the ankle, and partial luxation outwards of the foot; patient able to sit up and travel on the fourth week after the accident with the apparatus.*—Mrs. K., aged 30 years, in good health, and weighing 180 pounds, fell, July 30th, 1875, on a waxed floor, and fractured both bones of the right leg at the ankle, breaking the tibia obliquely through the internal malleolus up into the shaft, and the fibula obliquely two inches above the joint, lacerating the internal lateral ligament of the ankle, and partially luxating the foot outwards. She was immediately carried to bed; extension made so as to reduce the luxation and fracture, and the limb dressed with a fracture box and cold water clothes. The sharp point of the lower end of the upper fragment nearly penetrated the skin, and swelling and marked bloody effusion around the ankle promptly followed. The inflammation being subdued, she was dressed on the 18th day with side splints, and the suspensory frame of Salter of England. On August 24th the limb was placed in the apparatus for ununited fracture, and to give a correct idea of the patient's frame, it may be stated that the circumference of her calf was 17½ inches, and of the middle of the thigh 22½ inches.

This lady was enabled to sit up out of bed as soon as the apparatus was applied, and on August 29th, travelled by carriage and steamboat to Newport, Rhode Island, and the next day, four weeks after the injury, rode about the hotel entries in a wheel chair. On September 30th, eight weeks after the injury, she travelled nine hours, with two changes of cars, to her home in Vermont, where she arrived safely, and was able to walk with the apparatus.

A letter from Mrs. K., dated Oct. 27th, says: "After my safe arrival on the tenth week after my injuries, I started with two canes and began walking on my injured limb. The fracture seems all right, and I do not feel any pain except in the ankle, which yet feels sprained. I am able to walk about the house and up and down stairs without any assistance, and I only use the canes out of doors. I commenced to leave the apparatus off at night on the tenth week. I have only ventured on walking a few steps barefoot without the apparatus to see whether both limbs were of the same length, but the limb is yet so weak that I dare not attempt walking without the splint."

In the varied plans recommended for the treatment of ununited fracture, the greatest confidence is apparently felt by surgeons in an operative treatment, such as the seton, resection, drilling, pegs, etc., yet this is hardly justified by the result, the failures after such operations being numerous, and the suffering, confinement to bed, and risk to life, such as frequently to excite serious apprehension, whilst amputation has been resorted to, in order to get rid of an apparently useless limb. Impressed with similar results in a case in which I performed resection with caustic, etc. (the patient barely escaping with her life), and recalling the influence of pressure on the periosteum in developing new bone, as shown in the formation of a new acetabulum by pressure of the head of a luxated femur on the dorsum of the ilium, or the head of the humerus on the neck of the scapula, I suggested, in the *American Journal of the Medical Sciences*, N. S. vol. xv. p. 84, 1848, the advantage of treatment by an apparatus which, whilst sustaining the weight of the body and enabling the patient to walk and obtain the benefit of exercise in the open air, yet made such friction on the periosteum of the adjacent fragments as would lead to the formation of an ensheathing callus.

After an experience of twenty-seven years, this method of treating ununited fracture yet retains my confidence, and I have felt justified, on the occurrence of these recent cases, in again recommending it to the consideration of the profession. The lady previously referred to (*Amer. Journ. Med. Sci.*, vol. xv. N. S.) on whom the apparatus was first applied, still enjoys excellent health—twenty-eight years after her accident—has had a second family of children, and walks well, although union never became firm enough to enable her to move without the "artificial limb." In the *American Journal of the Medical Sciences*, January, vol. xxi. p. 106, 1851, also vol. xiv. N. S. p. 117, I illustrated the results of this treatment as far as I could obtain returns from surgeons who had employed it, as well as from my own practice. I also reported in my work on the *Principles and Practice of Surgery*, Phila. 1863, a case of false-joint in both bones of the leg of 18 months' standing, cured in five months whilst the patient was walking about; another of both bones of the leg of 4 months' standing, cured in 19 weeks—both by Dr. Waters of Maryland; one of the femur of 5 months' standing, cured in 17 weeks; another of the femur of 6 months, cured in 9 weeks under my own care; "false joint" of the femur of 20 weeks' standing, cured in 6 weeks by Dr. Levis of Philadel-

phia; and "false-joint" in the humerus of 6 months' standing, cured by Dr. Dock of Harrisburg, in 3 months, whilst the limb was freely used in "setting type." Another of the humerus by Dr. Ashby of Alexandria, which enabled the patient to use the limb at the time, with several others as there mentioned. Cures have also been frequently shown to the students in attendance on the surgical clinics of the University of Pennsylvania.

Since 1862 I have frequently heard from cutlers of orders given for the apparatus, but have been unable to obtain a satisfactory report of the treatment from the surgeon ordering it. Sufficient evidence has, however, been presented to show that the results of the treatment by "Pressure and Motion" should not be forgotten, nor its advantages overlooked by the profession.

Experience having led to some slight modifications of the original apparatus, and many of the cutlers having failed to manufacture it as described by me, often spoiling it in attempts to modify it to their taste, I here offer drawings clearly showing the forms now applied to the femur, tibia, and humerus, in all of which it has been successfully employed.

Fig. 1. *Artificial Limb for Ununited Fracture of the Femur.*—*A.* Pelvic band. *B.* Hip-joint. *C.* Conical thigh piece which supports the weight of the body and makes pressure on the fractured ends of the bone, permitting sufficient friction to excite periosteal action. *D.* Knee-joint in side irons. *E.* Support at calf. *F.* Laced shoe and ankle-joint.

Fig. 2. *Artificial Limb for Ununited Fracture of the Tibia.*—*A.* Support at middle of thigh. *B.* Knee-joint in side irons. *C.* Main support of the body by accurate adjustment below the tubercle of the tibia. *D.* Ankle-joint and boot.

Fig. 3. *Artificial Limb for Ununited Fracture of the Humerus* fitting close over the rotundity of the shoulder and forearm, and accurately jointed at the elbow.

Fig. 4. *Artificial Limb for Ununited Fracture of the Forearm.*—*A.* Piece accurately embracing the arm. *B.* Joint for flexion and extension of forearm at elbow. *B.* Pivot-joint permitting rotation of head of radius in semi-pronation and supination. *C.* Ensheathing piece for forearm. *D.* A thick pad to press on styloid processes of ulna and radius at their carpal surfaces—so as to preserve the parallelism of these bones.

In the manufacture of all these limbs the cutler should use for the side *bars*, that are the main support, "cased steel," $\frac{1}{2}$ inch wide and $\frac{1}{8}$ of inch thick, which is strong enough to sustain any ordinary weight. For the back and front splints that surround the limb, and act as a ferule at the seat of fracture, take galvanized sheet-iron, No. 6, stuffed with wool, covered by buckskin on the inside of the splint and morocco on the outside. The attempts of some cutlers to make lighter limbs, by using stiff leather and steel half rings, has not proved advantageous—the failure of the artificial limb thus made being proved in Case IV. of this paper. The following measurements, if accurately taken, will suffice for any good instrument maker: First, state the limb required, viz., femur or tibia, and whether for the *right* or *left* side. Second, for the femur (Fig. 1), give the *length* in inches from sole of foot to perineum—from foot to ankle-joint—ankle to centre of knee-joint—knee-joint to trochanter major—hip-joint to crest of ilium. State also the *circumference* above crests of ilia; of thigh close to groin; of middle of thigh above knee; around middle of knee-joint; around tubercle of tibia; middle of calf; below the calf; around ankle-joint; around point of heel and ankle; around instep; around ball of toes.

Fig. 1.

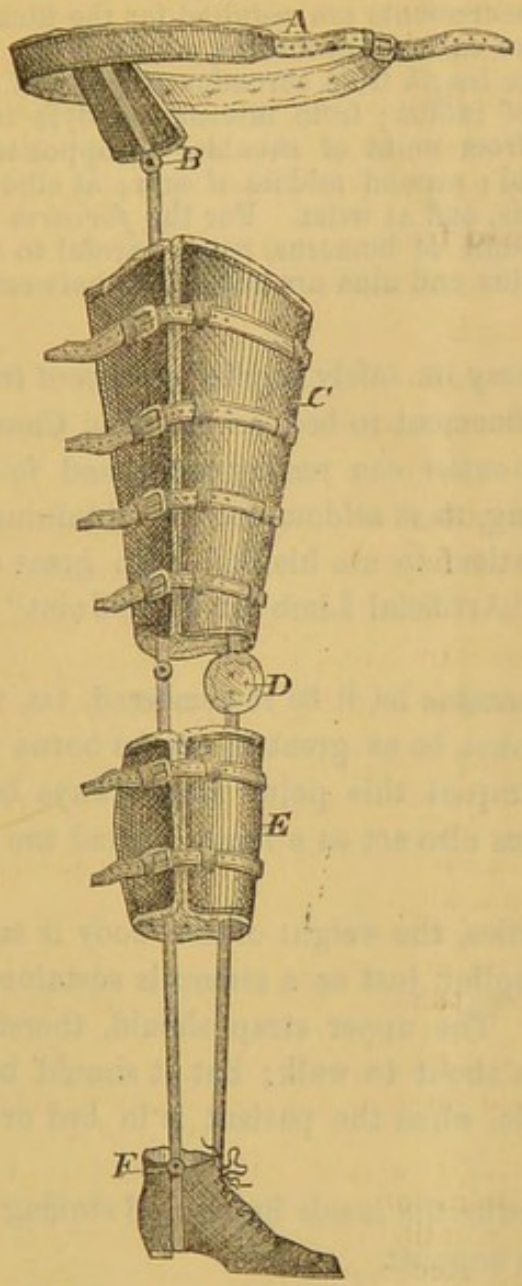


Fig. 2.

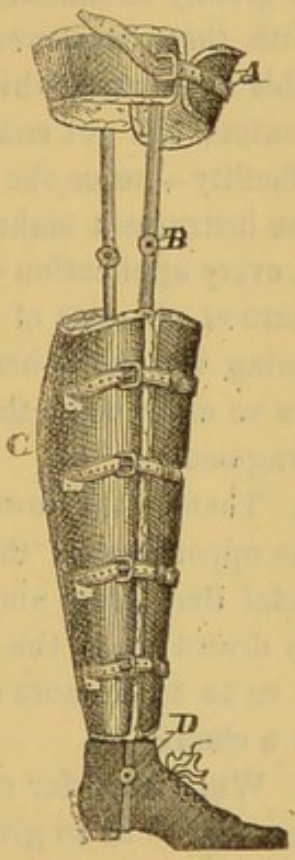


Fig. 3.

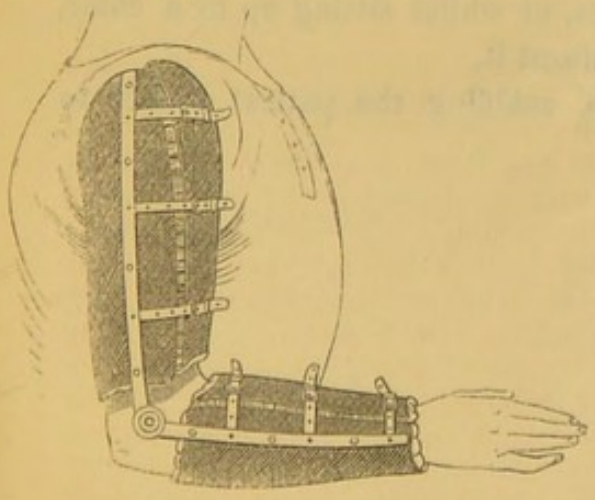
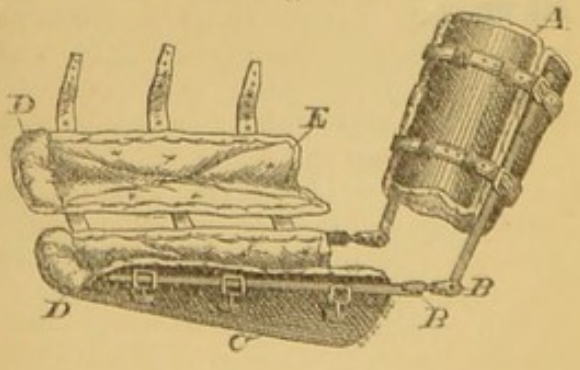


Fig. 4.



The length of the foot should be given for a loose shoe, which should be slit *entirely* down the front, and made to lace. The heel depends on the shortening from the fracture. Similar measurements are required for the tibia, except that the apparatus (Fig. 2) need not extend beyond the middle of the thigh.

For the humerus (Fig. 3) give the *length* from acromion to point of external condyle; from condyle to styloid of radius; from internal condyle to styloid of ulna; and the *circumferences* from point of shoulder to opposite axilla; around top of shoulder over deltoid; around middle of arm; at elbow-joint; upper end of forearm, also its middle, and at wrist. For the *forearm* take the same measurements as high as middle of humerus, being careful to take circumference at wrist, whilst the radius and ulna are parallel or between pronation and supination (Fig. 4).

When obtainable, these limbs may be safely applied to *recent* fractures, so as greatly to diminish the confinement to bed, as shown in Case V.

With these measurements any cutler can readily make and forward a suitable apparatus, which, if failing, as it seldom does, in obtaining a perfect union, will yet enable the patient to use his limb with great comfort and facility—hence the name of "Artificial Limb for False Joint" applied by the instrument makers.

In every application of the apparatus let it be remembered, 1st, that the pressure at the seat of fracture must be as great as can be borne without inflaming the skin—hence the strap at this point must always be firmly drawn so as to make the apparatus also act as a ferule around the ends of the fragments.

2d. That in the lower extremities, the weight of the body is sustained by the upper part of the hollow splint, just as a stump is sustained in an artificial limb after amputation. The upper strap should, therefore, be firmly drawn when the patient is about to walk; but it should be slackened, so as to be more comfortable, when the patient is in bed or sitting up in a chair.

3d. When worn for several months the inside lining and stuffing should be renewed, so as to give accurate support.

4th. When from union occurring it is proposed to lay aside the splint, let it be taken off at night for ten days, or whilst sitting up in a chair, before any attempt is made to walk without it.

5th. It is useful in recent fractures, enabling the patient sooner to sit up.