1903

Modern Surgery - Chapter 19. Diseases and Injuries of the Bones and Joints - Fractures

John Chalmers Da Costa
Jefferson Medical College

—for instance, the clavicle, the tibia, the spine, or the radius. In fact, in some cases the bones of the head do not enlarge at all; but, taking all the reported cases, the skull is affected more frequently than any of the other bones. In some cases, the enlargement of the bones seems to be symmetrical; in others, it is not. In the disease known as leontiasis ossium, the chief enlargement is manifested in the face; in Paget's disease there is no enlargement of the bones of the face, or else these bones are trivially involved. Packard and Steele point out that the diagnosis is extremely difficult when but a single bone is involved; but that if two or more bones are involved, we should think of Paget's disease as the condition, especially if we are able to exclude syphilis, cancer, and sarcoma. In mollities ossium the head is not involved at all; and there is not nearly so much thickening of the bone. The two authors before quoted show that in acromegaly the cranium is a triangle with its base below the lower jaw, the orbital arches being chiefly involved; but that in Paget's disease the involvement is chiefly of the calvarium. In this curious malady there may or may not be pain. The patient actually diminishes in height. The chest becomes deformed. There is angular curvature in the dorsocervical region. The lower extremities are usually bent; and the pelvis, as a general thing, is broadened. In the 67 cases collected by Packard and Steele, 3 suffered with cancer and 5 with sarcoma.

Treatment.—Treatment is practically useless. No known expedient diminishes the size of the bones, although iodid of potassium is said occasionally to mitigate the pain.

2. Fractures.

Definition.—A fracture is a solution, by sudden force, of the continuity of a bone or of a cartilage. Clinically, under this head are placed epiphyseal separations and the tearing apart of ribs and their cartilages.

Varieties of Fractures.—The varieties of fractures are as follows:

Simple fracture is a subcutaneous fracture, or one in which there is no

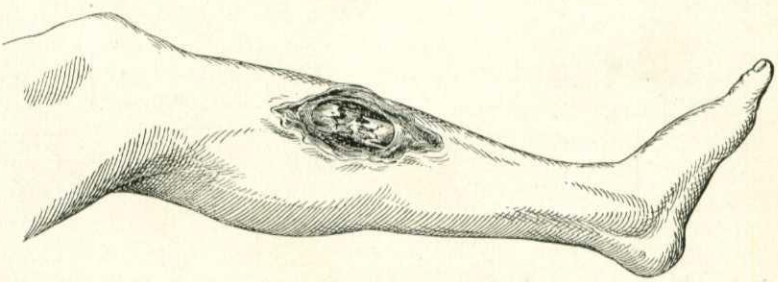


Fig. 146.—Fracture of the leg complicated with wound and comminution of the bone.

wound extending from the surface to the seat of bone-injury. This corresponds to a contusion of the soft parts.

Compound fracture is an open fracture, or one in which an open wound extends from the surface to the seat of bone-injury or in which a wound opens up a passage from the fracture to the surface. This corresponds to a contused or lacerated wound of the soft parts (Fig. 146). The opening may be through

the skin; through a mucous membrane, as in some fractures of the base of the skull and pelvis; through the drum of the ear, as in some fractures of the middle fossa of the base of the skull; through the lung, as when a broken rib penetrates that organ; or through the bowel or bladder, as in some fractures of the pelvis.

A primary compound fracture is one in which the breach in the soft parts

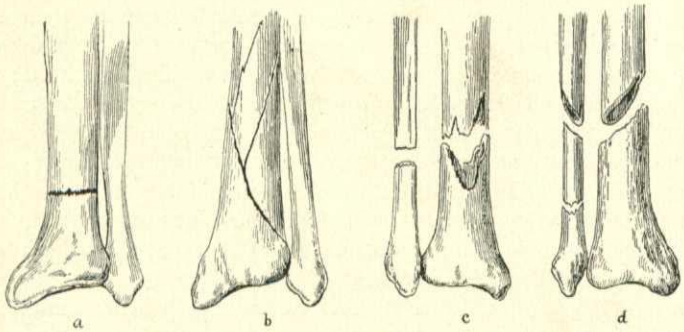


Fig. 147.—Complete fractures: *a*, Transverse; *b*, spiral; *c*, dentated; *d*, oblique or multiple.

is produced at the time of the accident, either by the direct violence of the injury or by the forcing of a bone or bones through the tissues.

A secondary compound fracture is one in which the breach in the soft parts occurs after the accident, either from sloughing of damaged tissues, from ulceration because of the pressure of ill-adjusted fragments, or from the forcing of a bone or bones through the soft parts because of rough handling, neglect, or the tossing of delirium.

Fig. 148. — Longitudinal and oblique fracture.

Complicated fracture is a fracture plus the complication of a joint-injury, arterial or venous damage, or injury to the nerves or soft parts. When a fractured rib injures the lung or when a broken vertebra damages the cord a complicated fracture exists. The term is unfortunate, as it conveys no definite meaning, and ts use is no more justifiable than it would be to speak of "complicated pneumonia" or "complicated typhoid," for the complication should be named in any case. It must be remembered that damage to the soft parts not sufficiently severe to produce a wound reaching from the surface to the seat of fracture does not make the case a compound fracture, but rather complicates a simple fracture. Remember also that even superficial areas of tissue-destruction must be treated antiseptically, otherwise absorption of pyogenic bacteria and their deposition at the seat of injury may cause diffuse osteomyelitis.

Complete fracture is that which extends through the whole thickness of a bone or entirely across it (Fig. 147).

Incomplete fracture is that which extends only partially through the thickness of a bone or only partially across it.

A linear, hair, capillary, or *fissured fracture*, or *a fissure*, is a crack in a bone with very little separation of the edges. This is an incomplete fracture, but may be associated with a complete break.

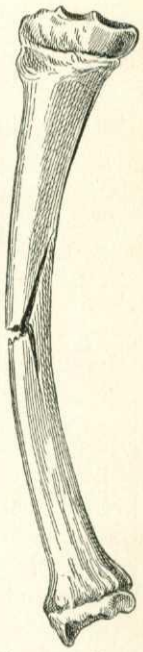


Fig. 149.—Green-stick fracture.

A green-stick, hickory-stick, willow, or *bent fracture* is a true incomplete break (Fig. 149). The bones most frequently broken are the radius, ulna, clavicle, and ribs. It arises from indirect force, and it is very rare after the age of sixteen. In rickets green-stick fractures are very common. It is called "green-stick" because the bone breaks like a green stick when forced across the knee, first bending and then breaking on its convex surface. The bone, being compressed between two forces, bends, and the fibers on the outer side of the curve are pulled apart, while those on the concavity are not broken, but are compressed. In correcting the deformity such fractures are often made complete. The permanent bending of a bone without a break may possibly occur in youth. In children a portion of a bone of the skull may be bent inward, causing depression. In some cases such a depression is permanent: in others it is temporary, the bone returning to its proper level.

Depression-fracture occurs when a portion of the thickness of a bone is driven in by crushing. Fracture by depression is a result of the bending in of a bone (as the parietal), a fragment breaking off from the side toward which the bone is bending. A *depressed fracture* is complete, not incomplete, and by this term is meant an injury in which a fragment of the entire thickness of the bone is driven below the level of the surrounding surface.

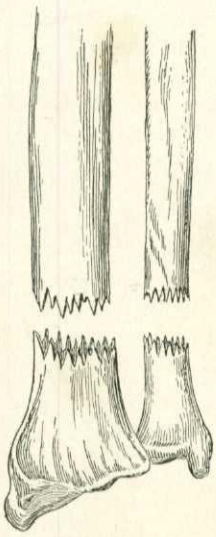


Fig. 150.—Appearances of the ends of fragments.

Splinter- and Strain-fracture. — The breaking off of a splinter of bone (splinter-fracture) or of an apophysis constitutes a form of incomplete fracture. A strain upon a ligament or a tendon may tear off a shell of bone, and this injury is the "strain-fracture" or "sprain-fracture" of Callender.

Longitudinal fracture is a fracture whose line is for a considerable distance parallel, or nearly so, with the long axis of the bone. Such fractures are common in gunshot-injuries (Fig. 148).

Oblique fracture is a fracture the direction of which is positively oblique to the long axis of the bone. Most fractures from indirect force are oblique (Fig. 147, *d*).

Transverse fracture is a fracture the direction of which is nearly transverse to the long axis of the bone (no fracture is mathematically transverse) (Fig. 147, *a*). The cause is often, but not invari-

ably, direct force. The "*fracture en rave*" (radish-fracture, so called because the bone breaks as does a radish) is transverse at the surface, but not within.

Toothed or *dentate fracture* is a form of fracture in which the end of each fragment is irregularly serrated and the fragments are commonly locked together; hence it is difficult to correct the deformity (Fig. 147, *c*, and Fig. 150). Most simple fractures from direct force are serrated.

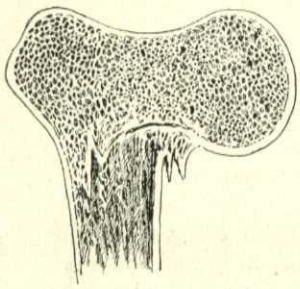


Fig. 151.—Impacted fracture of the neck of the femur.

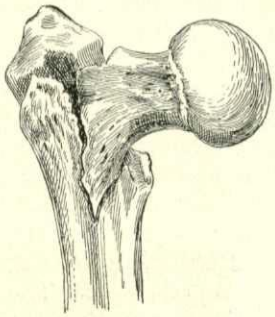


Fig. 152.—Impacted fracture of the neck of the femur.

Wedge-shaped, *V-shaped*, *cuneated*, or *cuneiform fracture* ("fracture oblique spiroïde," "fracture en V" of Gosselin, "fracture en coin") is one the lines of which take the shape of a V, which may be entire or may lack the point. It occurs at the articular extremity of a long bone, and a fissure usually arises from its point and enters the joint. If complete, it is a "comminuted fracture."

T-shaped fracture is a fracture which presents a transverse or oblique line and also a longitudinal or vertical line. It occurs at the lower end of either the humerus or femur, the transverse line being above, and the vertical line (intercondyloid) between, the condyles. If complete, it is in reality a form of comminuted fracture.

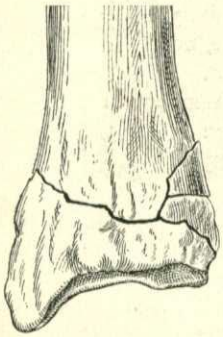


Fig. 153.—Comminuted fracture of the lower extremity of radius.

Multiple or *composite fracture* is a condition in which a bone is broken into more than two pieces, the lines of fracture not intercommunicating, or a condition in which two or more bones are broken. Multiple fractures of one bone are divided into double, treble, quadruple, etc.

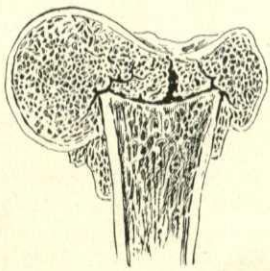


Fig. 154.—Comminuted fracture of the upper part of femur.

Comminuted fracture is a condition in which a bone is broken into more than two pieces, the lines of fracture intercommunicating (Figs. 153 and 154). The bone may be broken into many small fragments, there may be much splintering, or the osseous matter may actually be ground up.

Impacted fracture is one in which one fragment is driven into the other and solidly wedged (Figs. 151, 152, and 155).

Fracture with crushing or *penetration* is a fracture in which one bone is driven into the other, the encasing bone being so splintered that the impacting bone is not firmly held.

Pathological, spontaneous, or *secondary fracture* is one occurring from a very insignificant force acting on a bone rendered brittle by disease.

Ununited fracture is a fracture in which bony union is absent after the passage of the period normally necessary for its occurrence.

Direct fracture is one occurring at the point at which the force was primarily applied.

Indirect fracture is one occurring at a point distant from the area of primary application of force.

Stellate or *starred fracture* (fracture par irradiation) is one in which several fissures radiate from a center. If the fractures be complete, the condition is in reality a form of comminuted fracture.

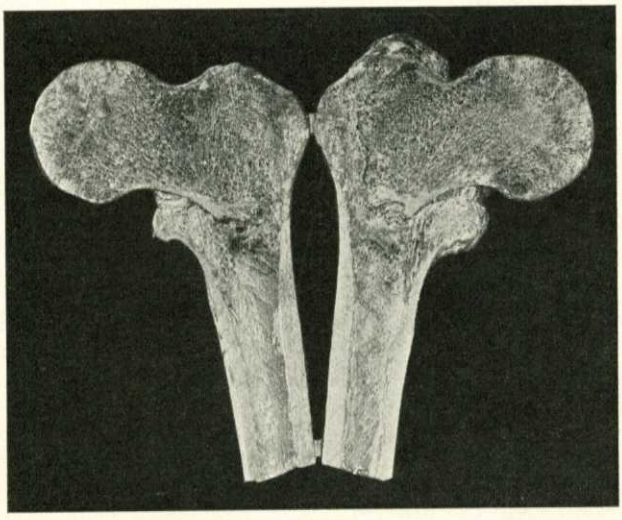


Fig. 155.—Impacted fracture of neck of femur (Conner).

Helicoidal, spiral, or *torsion fracture* is a fracture resulting in a long bone from twisting.

Fracture by contrecoup is a fracture of the skull which is on the opposite side of the head to that which was the recipient of the force.

Epiphyseal Separation or Diastasis.—This injury occurs only before the age of twenty-five. In order of frequency, the bones chiefly subject to epiphyseal separation are: the upper end of the humerus, the lower end of the radius, the lower end of the femur, and the lower end of the tibia (John Poland, in the "Practitioner," Sept., 1901). This injury induces deformity, which is often difficult to reduce, and by damaging the cartilage may retard or inhibit a further lengthening of the limb by growth. Occasionally, after damage to an epiphysis suppuration will occur, sometimes thickening takes place. Non-union is very rare. After a sprain of an epiphysis tuberculous disease sometimes develops, but very rarely after a separation.

Intra-uterine fractures are usually due to injuries of the mother's abdomen sustained toward the end of pregnancy. Some hold that they can arise as a consequence of the force of violent uterine contractions. Many so-called "intra-uterine" fractures are wrongly named, as they result from injury during delivery. In sporadic cretinism the bones are fragile and ill-ossified, and many fractures may occur *in utero*.

Designation According to Seat of Fracture.—A fracture may be designated according to its anatomical seat; for instance, fracture of the upper third of the shaft of the femur, fracture of the olecranon process of the ulna, fracture of the middle third of the clavicle, and fracture of the body of the lower jaw. *Intra-articular* fracture is one extending into a joint; *intracapsular* fracture is one within the capsule of either the shoulder- or hip-joint; and *extracapsular* fracture is one just without the capsule of either the shoulder- or hip-joint.

Causes of Fracture.—The causes of fracture are (1) exciting, immediate or direct, and (2) predisposing or indirect.

Exciting causes are (*a*) external violence and (*b*) muscular action.

External violence is the most usual exciting cause. Two forms are noted: (1) direct violence and (2) indirect force.

Fractures from direct violence occur at the point struck, as when the nasal bones are broken with the fist. In such fractures the soft parts are injured; they may be destroyed at once in part, they may be damaged so severely that a portion sloughs, or they may be damaged so slightly that they do not lose vitality; hence fractures by direct violence may be compound from the start, may become so, or may remain simple. In fractures by direct force discoloration, due to effused blood, usually appears at the point struck soon after the accident. In compound fractures by direct violence the soft-part injury is so great that primary tissue-union cannot occur.

Fractures from indirect force do not occur at the point of application of the force, but at a distance from it, the force being transmitted through a bone or a chain of bones, as when the clavicle is broken by a fall upon the extended hand. Such fractures tend to occur in regions of special predilection. If they are not compound, there is no injury of the surface over the fracture. If they become compound by projection of fragments, primary union may still occur. Discoloration over the seat of fracture is usually not present soon after the accident, but may occur later. Discoloration rapidly appears in soft parts at the point where the force was first applied.

Muscular action is rather an unusual cause. Fractures thus produced result from sudden or violent muscular contraction. Bones so broken are usually diseased. Violent coughing may fracture the ribs; attempting to kick may fracture the femur; saving one's self from falling backward may fracture the patella; throwing a stone may fracture the humerus; and sudden extension of the forearm may fracture the olecranon process of the ulna.

Predisposing Causes.—There are two classes of predisposing causes, namely: (1) physiological, natural or normal, and (2) pathological or abnormal.

Natural Predisposing Causes.—Under this head is considered the liability to fracture possessed by individual bones because of their shape, structure, function, or position. Those predispositions occasioned by special ages are

also considered. In youth epiphyseal separation is commoner than fracture and a fracture is apt to be incomplete. Fractures are commonest between the ages of twenty-five and sixty. From two to four years of age a child is more liable to fracture than later, because he is then learning to walk (Malgaigne). The bones of the old are easily broken, but the normal lack of activity of the aged saves them from more frequent injury. Thus the predispositions of age are in part due to habits and in part to bony structure. The bones of the young, being elastic, bend considerably before they break; the bones of the old, being brittle and inelastic, break easily, but do not bend. In old age the bones become lighter and more porous, though they do not diminish in size. Absorption takes place from the interior of a bone, particularly at its articular head, the medullary canal increases in size, the cancellous spaces become notably larger, and portions of the remaining bone of the interior show a fatty change. There is no increase in the amount of mineral salts present, as was long taught. These alterations occur earlier in women than in men.* The change of age is a diminution in the amount of bone present, and sometimes a fatty change in a portion of what remains. If the atrophy of bone is other than that normal to senility, it constitutes a pathological predisposing cause of fracture. Normal predisposing causes include the person's weight (which determines the force of a fall), muscular development, habits, sex, occupation, and the season of the year.

Pathological Predisposing Causes.—Hereditary fragility, a form of *fragilitas ossium*, is a condition commonest among women, often existing in generation after generation, and in this condition fractures occur from a very slight force. There exists in these cases bony rarefaction—in fact, a premature senility. Fragilitas ossium may result from senility, from wasting diseases, from certain nervous disorders, from rickets, from osteomalacia, and from atrophy due to disuse.

Nervous Diseases.—Bony nutrition is dependent on the spinal cord, and the trophic influence is probably exerted through the posterior nerve-roots (Gowers). In diseases of the anterior cornua bony growth is much interfered with; in diseases of the posterior columns, as in locomotor ataxia, a true bony atrophy bespeaks trophic disorder. Syringomyelia causes brittleness of the osseous structures, and in paralysis agitans bones are thought to break easily. Trophic changes may occur in the bones of the insane, most commonly when insanity is linked to organic disease. About one-quarter of paretic dements show undue brittleness or unnatural softness of bones.† The bones of maniacs are frequently fragile. Fractures among the insane are not necessarily an indication of abuse.

Rickets.—Rickets predisposes to fracture because of altered bone-structure and the great liability to falls.

Osteomalacia predisposes to fracture of the long bones, sternum and ribs.

Atrophy of Bone.—This condition, as has been stated (page 364), is normal in senility. It may arise from want of use, as is observed in the bedfast in the wasted femur of hip-joint disease, and in the bones of a stump. It may arise from pressure, as when an aneurysm compresses the ribs, sternum, or vertebræ. Among other of the pathological predisposing causes are to be

* Humphrey on "Old Age."

† "Manual of Insanity," by Spitzka.

mentioned cancer, sarcoma, hydatid and solitary cysts of bone, caries, necrosis, gout, scrofula, syphilis, mollities ossium, and scurvy.

Symptoms of Fracture.—*History of an Injury.*—In spontaneous fracture there may be no record of violence; for instance, a bone may break while an individual is turning in bed. In investigating the history, not only seek for a record or for evidences of violence, but try to determine exactly how the accident happened.

A sound of cracking is occasionally audible to a bystander at the time of the injury. The patient may have heard it, but very rarely does. A rupture of a tendon or a ligament produces a similar sound.

Pain is usually, but not invariably, present (absent often in rickets). Malgaigne says that in some fractures the pain is slight or absent, in others it is torturing, and in most it is severe for a time after the injury, but gradually abates unless reinduced by movement. Pain developed at the time of the accident is far less important as a symptom than that which can subsequently be produced by movement. In indirect fracture there is an area of pain at the point of application of the force, and another at the seat of fracture. Pain at the seat of fracture can be greatly aggravated by pressure or movement and is rather narrowly localized.

Deformity or *alteration in length or outline* is due in part to swelling and in part to a change in the mutual relation of the fragments (displacement). The deformity due to swelling is no aid to diagnosis, as the same condition occurs in contusion, and often hides some positive symptomatic distortion. The swelling is due first to blood and next to inflammatory products and pressure-edema, and is very great in joint-fractures. The deformity of displacement may be produced by the violence of the injury (as is the depression in a skull-fracture), by the weight of an extremity (as is the falling of the shoulder in a fracture of the clavicle), or by muscular action (as is the pulling upward of the superior fragment of a fractured olecranon process).

The **varieties of displacement** are (1) *transverse* or lateral, where one fragment goes to the side, front, or back, but does not overlap the other; (2) *angular*, the bony axis at the point of fracture being altered and the fragments forming with each other an angle; (3) *rotary*, one fragment rotating in the bony circumference, the other remaining stationary. As a rule, it is the lower fragment which turns on its long axis, the limb below the level of the break rotating with it; (4) *overlapping* or overriding, when the upper level of one fragment is above the lower level of the other fragment. It is usually the lower fragment which is drawn by the muscles above the upper, but in a fracture of the lower extremity the body-weight and sliding down in bed may push the upper below the lower fragment. In overriding the ends are near together and the bones are usually in contact at their periphery. It is obvious that overlapping is associated with transverse displacement, as one fragment must go front, back, or to the side; (5) *penetration* or impaction when one fragment is driven into the other, thus producing shortening; (6) *separation* of the two fragments occurs in fracture of the patella, olecranon, os calcis, certain articulations, and in some breaks of the humerus when the arm is not supported.

It is important to remember that a dislocation as well as a fracture may produce displacement, but these two conditions may be differentiated by

the observation that the displacement of fracture tends to reappear even after complete reduction, while the displacement of dislocation does not reappear after correction. A displacement is difficult of detection in a flat bone and when one of two parallel bones is broken.

Loss of function may be shown by inability to move the limb because of the break, but it is not always markedly present, though some degree invariably exists. It is slight in "green-stick" and impacted fractures (unless the loss of power arises from pain or nerve-injury). A person can walk when the fibula alone is broken, and likewise in some cases of intracapsular fracture of the femur, and can often put the hand on the head in fractured clavicle (Malgaigne). The pain of any injury or the loss of power from nerve-traumatism may cause loss of movement in the limb. This symptom is of slight diagnostic value in most fractures.

Extravasation of Blood.—A contusion of the surface accompanied by skin-abrasion indicates merely the point of application of direct external violence. If contusion is extensive over a superficial bone, as the tibia or parietal, after a few hours it often stimulates fracture by presenting a soft, compressible center surrounded by a ring of hard, condensed tissues and coagulated blood. Direct external violence may merely occasion ecchymosis, and in fracture from indirect force ecchymosis may occur throughout a considerable area. In regard to this symptom, note that even great external violence may occasion no evident contusion or ecchymosis, and in any fracture this symptom may be present or absent. In old people, anemic subjects, alcoholics and opium-eaters, extravasation of blood is frequently marked and persistent. By suggillation is meant an extravasation of blood which slowly invades wide areas of tissue and which appears at the surface only after some time, and then usually as a yellowish discoloration, red hemoglobin having been changed to yellow hematoidin. Linear ecchymosis has been esteemed by some as a sign of fissure, and it is often noted after fracture of the fibula. Linear ecchymosis over the line of the posterior auricular artery was shown by Battle to be a valuable sign of fracture of the posterior fossa of the base of the cranium.

Preternatural mobility is a most important symptom, which is pathognomonic when surely found. The unbroken bone is nowhere mobile in continuity. By preternatural mobility is meant that a bone is mobile in continuity or that there is abnormality in the direction or extent of joint-mobility. In some fractures this symptom does not exist (impacted, green-stick, and locked serrated fractures); in others it cannot be found (fractures of tarsus, carpus, vertebral bodies); in others it is difficult to obtain, but at times can be developed (fractures near or into many joints). To develop this symptom, try, when the case admits, to grasp the fragments and to move them in opposite directions. In a fracture of the shaft of the femur or humerus fix the upper fragment and carry the knee or elbow in various directions to develop bending at the point of fracture. In fracture of the clavicle push the shoulder downward and inward. In fractures of either bone of the forearm grasp the parallel bone with four fingers of each hand and make pressure on the suspected bone alternately with either thumb, and the same procedure can be used in fractures of the leg. In fracture of the neck of the femur the altered rotation-arc of the great trochanter demonstrates preternatural

mobility (Desault). In fracture of the lower end of the radius bend the hand back, and in a break of the lower end of the fibula evert the foot (Maisonneuve). In seeking preternatural mobility, remember that the elastic ribs when forced in give a sense of bending, and that the fibula at its middle is "normally flexible" (Dupuytren). Some rachitic bones may be bent.

Crepitus or *crepitation* is both a sensation and a sound, which indicates the grating together of the two rough surfaces of a broken bone. This symptom is of great value, but it is not always present. It is absent in locked serrated fractures, in impacted fractures, in cases where the broken ends cannot be approximated (as in overlapping), is rare when a fractured surface is against the side, and not the broken face, of the other fragment, and is unusual in incomplete fractures. Crepitus is often absent in epiphyseal separation, in softened bones, and in fractures in or near joints, and it may be prevented from occurring by blood-clot, fascia, synovial membrane, periosteum, or muscle between the broken surfaces. The grating found in tenosynovitis must not be mistaken for the crepitus of fracture: the former is diffuse, large, soft, and moist; the latter is limited, small, harsh, and dry. The clicking of an inflamed or eroded joint and the crackling of emphysema must also be separated from bony crepitus. Crepitus of fracture may be present at one moment, but absent the next. It is often not detected during the time swelling is marked, and cannot be discovered after organization of the callus begins. In but few fractures is it needful to try to hear crepitus with the unaided ear or with a stethoscope upon the part, but in doubtful cases of fractures of ribs and joints this evidence should be sought for.

The above-named symptoms are known as "direct." There are other symptoms known as "circumstantial," such as the flow of blood and cerebrospinal fluid from the ear after some fractures of the middle fossa of the skull; emphysema of the face and epistaxis after fracture of the nasal bones; hemoptysis and emphysema after crushes of the chest; discoloration following the line of the posterior auricular artery after fracture of the posterior fossa of the skull; and subconjunctival ecchymosis after fracture of the anterior fossa of the skull.

Diagnosis.—Examine as soon as practicable after the injury—before the onset of swelling, if possible. Expose the part completely, taking off the clothing, if necessary, by clipping it along the seams. Attentively scrutinize the part and compare it with the corresponding part on the opposite side. If any deformity be present, it must be ascertained that it did not exist before the accident. If the nature of the injury be uncertain, if the patient be very nervous, or if the part be acutely painful, it is better to give ether to diagnosticate, set, and dress. In injuries of the elbow-joint anesthetize before examination, unless an *x*-ray apparatus is accessible to settle the diagnosis, and even then it is usually well to anesthetize in order to facilitate reduction and dressing.

A fracture is distinguished from a dislocation by its preternatural mobility, its easily reduced but recurring displacement, and its crepitus, as contrasted with the preternatural rigidity, the deformity, difficult to reduce but remaining reduced, and the absence of crepitus of a dislocation. Further, in dislocation the bone, when rotated, moves as one piece, whereas in fracture it does not

so move; in dislocation the bony processes are felt occupying their proper relations to the rest of the same bone, while in fracture some of them present altered relations. In dislocation the head of the bone is found out of its socket, but in fracture it is felt in place. It is important to remember, moreover, that a fracture and a dislocation may occur together, and that the rubbing of a dislocated bone against an articular edge, when the joint has been roughened by inflammation, simulates crepitus.

Great contusion, by inducing extreme tumefaction, may mask characteristic deformity and obscure crepitus. When only a contusion exists, pain is apt to be widespread; but if a fracture has occurred, the pain is accentuated at some narrow spot. In many cases, before he can give a certain opinion, the surgeon must wait some days until the swelling has largely subsided. In such a case it is best to assume in our treatment that a fracture exists until the contrary is known. Combat swelling by rest, the use of evaporating lotions, and moderate compression.

In impaction the diagnosis is difficult. The moderate deformity is concealed by swelling; crepitus and preternatural mobility do not exist unless the fragments are pulled apart, and there is not necessarily much loss of function. A conclusion is reached largely by considering the nature, direction, and extent of the violence, the seat of the pain, and by a careful study of the most minute deformity. It is difficult to recognize fissures. They rarely present any evidence of their existence except a localized pain, and possibly a linear ecchymosis appearing after a few days.

In green-stick fractures the age, the deformity, and possibly crepitus during reduction help in the diagnosis, although in many cases no crepitus is obtained. Epiphyseal separations are diagnosticated by the age, the preternatural mobility, the pain, the swelling, the ecchymosis, the deformity, the situation of the injury, and the absence of crepitus or the presence only of a soft crepitus. It is important, however, to remember that an epiphyseal separation is sometimes incomplete, and even when it is complete there may be no displacement. In cases without displacement the *x*-rays will not enable us to make a diagnosis. In many cases of complete separation soft crepitus is obtainable; but in not a few cases it is not to be found. In incomplete separation crepitus is absent. If absent in complete separation, probably some tissue is between the lines. Fractures are often difficult to recognize when occurring in a group of bones (which are firmly joined by dense ligaments) like those of the carpus and tarsus, or in one of two parallel bones. There is not always a certainty that a fracture exists, and when, after a careful examination, there is still an uncertainty, do not prolong the efforts or use great force, but treat the case as a fracture until a cure ensues or the diagnosis becomes apparent.

In a child the diagnosis of fracture is sometimes difficult. Pain may be trivial. Children are liable to a form of fracture in which the periosteum is but slightly torn or is not torn at all, the disability and pain are often slight, and the fracture may be easily overlooked (Cotton and Vose).

We have recently had added to our resources a method of incalculable value in diagnosticating fracture; that is, the use of the force known as the *x*-ray or the Röntgen ray. We can look through a part with a fluoroscope and see the bones as shadows, or we can take a negative of the shadows

and print skiagraphs from it. This method is applicable even when the parts are swollen, and even when a limb is clothed or wrapped in dressings. It is possible to obtain a picture of a fractured skull after long exposure; fractured ribs and vertebræ can be detected; and the process is of the greatest use in detecting fractures of the limbs. It is not infallible. An epiphyseal separation may not be detected, and a slight angling of the plate may give a deceptive appearance of distortion. An *x*-ray picture, to be useful, must be taken by an expert and should be interpreted by a surgeon. This method should, if possible, be resorted to in doubtful cases.

Complications and Consequences.—Some of the consequences and complications of fractures are—sloughing of the soft parts, thus making the fracture compound; extravasation of blood, causing swelling or even gangrene; rupture of the main artery or vein of the limb; dislocation; edema from pressure of extravasated blood, from inflammatory exudation, from tight bandaging, from thrombosis, or, later, from the pressure of callus; stiffness of joints from synovitis with adhesion, from displaced fragments, or from intra-articular callus; stiffness of tendons from adhesive thecitis or from the pressure of callus; paralysis from traumatic neuritis, the pressure of callus upon nerve-trunks, or from division of a nerve; muscular spasm; painful callus; exuberant callus; embolism; fat-embolism; pulmonary congestion; gangrene; shock; septicemia; pyemia; tetanus; delirium tremens; urinary retention; extensive laceration of the soft parts; rupture of large nerves: and involvement of joints. A fracture may fail to unite, fibrous union or cartilaginous union only being obtained. An epiphyseal separation may arrest the future growth of the limb.

Repair of Fractures.—Simple Fracture.—In a simple fracture the bone is broken, the medullary contents are lacerated, the periosteum is torn, and the overlying soft parts are damaged to a considerable degree. The periosteum is stripped more or less from each fragment, but it is rarely completely torn through, an untorn portion known as the *periosteal bridge* remaining. The amount of blood effused is usually considerable, and it forms a decided prominence at the seat of fracture; it gradually gathers because of oozing, and soon clots. This clot lies in the medullary canal, between the fragments, under the periosteum at the ends of the fragments, and in the tissues outside of the periosteum. Very rapidly after the accident the damaged parts inflame (bone, endosteum, periosteum, and the torn periosseous structures). The inflammatory exudate enters into the blood-clot and the leukocytes eat up and destroy the clot. The clot is simply dead material and in no way contributes to repair. The cells of the damaged tissue proliferate and the young proliferating cells (fibroblasts) enter into the spaces in the blood and clot eaten out by the leukocytes. Finally the entire clot is replaced by fibroblasts and much of this cellular mass quickly becomes vascularized (granulation tissue).

The osteoblasts, which exist in the deeper layers of the periosteum and in the tissue of the medulla itself, begin to proliferate actively soon after the fracture has taken place. The fibroblasts have been formed by the proliferation of the ordinary connective-tissue cells, and the proliferating osteoblasts soon enter into and become widely distributed through this mass of fibroblasts. Some maintain that the fibroblasts themselves are directly

transformed into bone; other observers deny this, and think that all bone-formation comes from the osteoblasts. Osteoblasts may form bone directly, or may form cartilage first and then bone. When a fracture takes place, a bridge of periosteum is usually left untorn; and this bridge holds the fragments in contact at some point, just as a strap nailed to a trunk and also to its lid might hold these two objects in contact at some point. The new tissue about the periosteal bridge always becomes cartilaginous for a time; but the rest of the callus rarely shows the development of cartilage, and passes directly into bone. If, however, osteoblasts fail to proliferate with sufficient activity, the mass of granulation tissue becomes fibrous tissue; bone is not formed at all, or is very scantily formed; and fibrous union occurs. If the osteoblasts lack activity, but are more active than in the case just cited, they form cartilage extensively—but cartilage only; consequently, cartilaginous union occurs. During the process of the repair of a fracture the ends of the bony fragments are always softened, and some of the bone is absorbed by the osteoclasts. The osteoclasts are really large osteoblasts that have lost the power of producing bone and that furnish a secretion to absorb bone (the elder Senn). After bony union has been accomplished the osteoclasts absorb the superfluous callus. The mass of new tissue around and between the bone-ends is called *callus*. It will be observed that the name is applied successively to fibroblastic tissue, granulation tissue, fibrous tissue, and bone. Warren tells us that callus has no well-defined outline, and "involves not only the bone and periosteum, but also the connective tissue and some of the surrounding muscular tissue." Within a few days after the injury the inflammatory mass is much firmer than follows inflammation involving other structures, and the bone-ends are deeply imbedded in a dense mass.

During the second week the callus is greatly strengthened by the formation of dense fibrous tissue in and below the periosteum, of less dense fibrous tissue outside the periosteum, and of cartilage from the periosteal bridge. The newly formed tissue contracts decidedly. During the third week ossification begins at the points farthest from the fracture, and in the course of a short time (from three to six weeks) is complete. The mass of ossified callus, or new bone, is spindle-shaped and spongy.

The term *intermediate*, *definitive*, or *permanent* callus is used to describe the material which forms between the ends of the broken bone. The name *provisional* or *temporary* callus is given to the material within the canal (central callus) and external to the bone (ensheathing callus). The amount of provisional callus depends directly on the extent of separation and the amount of motion between the fragments. It is Nature's splint, and when the break is not well immobilized a large amount is formed. The greater the amount of motion, short of a degree sufficient to cause non-union, the larger the amount of provisional callus.

The ensheathing callus is after a time largely absorbed, and the central callus in the course of a long time may also be absorbed, with the restoration of the medullary canal, although this latter result is rare. An excessive amount of provisional callus may ossify nearby tendons, may unite two parallel bones (radius to ulna, tibia to fibula, a rib to its neighbors), may block a joint just as a stone in the crack of a door will block a door, or may

absolutely abolish a joint. Fragments, even if entirely detached, often unite, but they may be surrounded by provisional callus; sometimes they do not cause trouble, but sometimes suppuration takes place. It takes about one year for Nature to remove the temporary callus. The definitive or permanent callus after a time ceases to be porous and becomes very dense bone.

Compound fractures without much destruction or bruising of soft parts, if treated antiseptically, become at once simple fractures and unite as such. If the wound is not drained and asepticized and septic inflammation occurs, pus forms, and union by granulation is the best that can be obtained. Compound fractures by direct violence will not heal by first intention because of the loss of vitality of a large area of the soft parts.

Delayed union is usually due to imperfect approximation of the fragments. This imperfect approximation may result from failure to reduce the fracture (muscle, ligament, or synovial membrane being caught between the ends of the bone); the use of unsuitable splints; too tight application of bandages; and general causes of ill health, for instance anemia, scurvy, Bright's disease, rickets, syphilis, and pregnancy. In delayed union there is pain on passive motion; in non-union there is not. In delayed union there is loss of voluntary motion; in non-union there is power of voluntary motion (A. H. Tubby, in "Brit. Med. Jour.," Dec. 7, 1901). Delayed union is not non-union, but may eventuate in non-union.

Non-union of Fractures.—An ununited fracture is a fracture in which union is not effected at all or in which it is not brought about by bone. Non-union is especially common in fractures of the upper third of the femur and of the middle third of the humerus. The causes are local and constitutional. The *local causes* are (1) want of approximation of fragments (a frequent cause of want of approximation is interposition of soft tissues, especially muscle); (2) want of rest; (3) want of blood-supply (as seen in the heads of the humerus and femur, or when a nutrient artery is torn, or when a thrombus forms in a vein near the fracture); (4) defective innervation; (5) bone-disease; (6) the use of unsuitable splints; (7) tight bandaging. The *constitutional causes* are debility, scurvy, Bright's disease, syphilis, etc. Sometimes union fails to occur for no appreciable reason. In an ununited fracture the broken ends of the bone round off and the medullary canal of each fragment becomes closed by bone. The fragments may not be held together by any material, or they may be held by very thin and much-stretched fibrous tissue (*membranous* union), or by strong, thick, fibrous tissue (*ligamentous* or *fibrous* union). When the ends of the bones come together, are held by a fibrous capsule, and move on each other, there exists a *false joint* or *pseudarthrosis*. Such a joint may after a time secrete serous fluid for lubrication.

Vicious union is union with great deformity, and is often productive of pain and loss of function. It arises from failure to coaptate the fragments, from a recurrence of displacement after reduction, or from yielding of callus after the removal of splints.

Treatment of Fracture.—If a man is found in the street with a fracture, further injury must be prevented by applying, after cutting off the clothing over the fracture, some temporary support. If an ambulance or patrol-wagon cannot be obtained, move the patient by hand. If the lower extremity be involved, an improvised stretcher (a board or a shutter)

is placed on the ground beside the patient, who is laid on the stretcher, the surgeon lifting the injured limb, and the patient is then carried to the hospital and carefully transferred to a fracture-bed, or, if taken home, to a small ordinary bed, several boards being placed transversely beneath a rather hard but even mattress. The temporary appliances are now removed and a diagnosis by the methods before given is proceeded with. After determining the nature of the injury the fragments must be adjusted. This should, if possible, be done at once, because a fracture remaining unreduced may become compound, the fragments may injure important structures, and they are sure to cause intense pain. Reduction is easily effected during shock, as the muscles are in a state of relaxation. If there is great swelling, reduction may be impossible, and the part must then be supported, moderate cold, sorbefacients, and gentle pressure being used, ice and tight bandaging, which predispose to gangrene, not being employed. Set the fracture at the first possible moment. Velpeau's axiom was to reduce fractures at once, regardless of pain, spasm, or inflammation, as reduction is their cure.

If the patient is very nervous, if the pain is severe, or if rigid muscles antagonize the efforts of the surgeon, reduce the fracture under anesthesia. In some fractures (as those of the clavicle) adjustment is effected by altering the position, and in others (as those of the femur) by extension and counter-extension; in some by tenotomy, and in some by kneading, bending, and coaptation. When extension is employed, always endeavor to get a point of counterextension. The extension is to be made on the broken bone (if possible, in the axis of the bone), is to be steady, and neither jerky nor violent. In some cases complete reduction is impossible. This may be due to spasm, to swelling, to the catching of soft parts between the fragments, to the existence of a loose fragment, to locking, or to impaction. An impaction by rotation can generally be released, but it is sometimes undesirable to reduce it. If the fragments cannot be adjusted without violence, retain them in the best attainable position, combat the antagonistic cause, and set them properly as soon as possible.

After adjusting the fragments maintain them in position by some retentive apparatus. Avoid pressure over joints or bony prominences, and particularly guard against tight or improper bandaging. The circulation in the fingers or the toes must be observed as an index of circulation in the limb; hence leave those digits exposed. A retentive apparatus should prevent the redevelopment of deformity, and not be itself productive of pain or harm. For the first few days of treatment of a simple fracture the dressing is removed every day, to make sure that deformity has not recurred, and if it does recur the fragments must at once be reset. The splints should be padded thoroughly, especially when over joints or bony prominences, and they should, if possible, fix the joints immediately above and below the break. A primary roller should *never* be used.

Some surgeons at once apply an immovable dressing. This proceeding is safe in simple fractures without much displacement or soft-part injury. This dressing is valuable in military practice, for the old and feeble whom we fear to put to bed, for the young who are very restless, and for the insane or the delirious. If, however, there is great deformity, much soft-part injury, or marked swelling, immovable dressings may induce sloughing, edema, gangrene

or faulty union. In the above-named cases use splints for the first few days; then, if it is desirable, the immovable dressing can be applied. Plaster-of-Paris bandages are unsafe in very young children, and gangrene may occasionally result from their application. It is dangerous to keep old or feeble persons long in bed, as they are prone to develop bed-sores and hypostatic pulmonary congestion. The period for the artificial retention of the fracture varies with the seat of the fracture and the age and the condition of the patient. Passive motion is to be made in most fractures in from two to three weeks, though it is sometimes made earlier to prevent ankylosis and sometimes later because of risk of non-union. Landerer strongly advocates massage, believing that it hastens union and prevents wasting. He applies it as soon as there is no

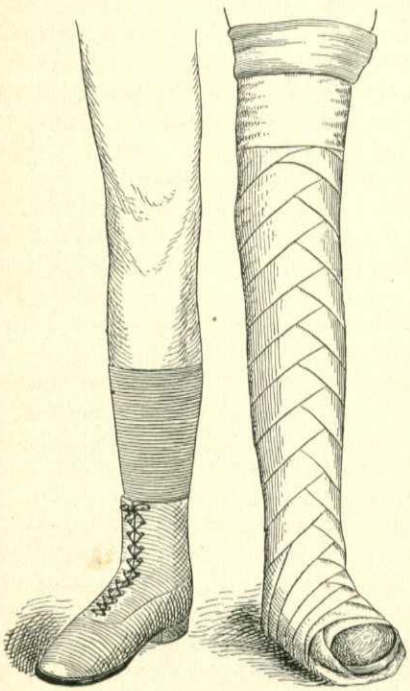


Fig. 156.—Ambulatory dressing of Plaster-of-Paris for fracture of the bones of the leg (Pilcher).

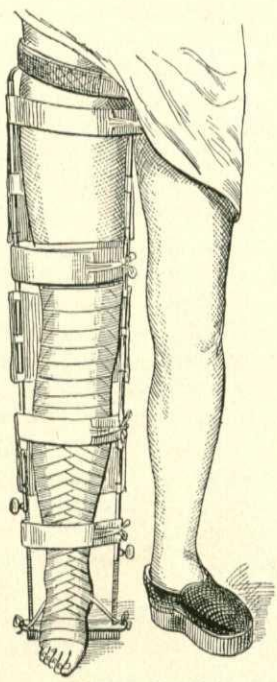


Fig. 157.—Ambulatory dressing apparatus for fracture of thigh (Harting).

danger of the callus bending (in from eight to fourteen days). Massage should not be used when great edema points to the possibility of venous thrombosis. The movements might break up a clot and cause fatal embolism.* Very early massage may cause fat-embolism. In fracture of the patella, Barker and many others believe in wiring, and some surgeons advocate the same procedure in fracture of the clavicle, fracture of the tibia, and fracture of the upper third of the femur. If fragments cannot be approximated or retained, an incision should be made, approximation effected, and the fragments retained by wire, a clamp, or a bone ferrule.

The plan known as the ambulatory treatment of fractures of the lower

* Cerne's case, in "Normandie méd."; Bull. méd., 1895, No. 44.

extremities has many advocates. Its aim is not only to get the patient about on crutches, but also to cause him to use the limb. It is held that this plan of treatment greatly lessens the patient's sufferings and actually favors union by the stimulation of walking. Bardeleben, in his report to the German Surgical Congress, gave the records of 111 fractures of the lower extremity thus treated (77 simple and 12 compound fractures of the leg; 17 simple and 5 compound fractures of the thigh). The patients were gotten about a few days after the accident, were able to attend to business, had excellent appetites, digested their food perfectly, slept well, and were saved from muscular atrophy. Pilcher has warmly advocated the method. It can be used in fractures as high up as the middle of the femur. The apparatus which we should employ in the ambulatory treatment reaches below the sole of the foot, and is supported firmly above the seat of fracture, the weight of the body being transferred from above the fracture to the firm pad below the sole of the foot on which the patient walks (Fig. 157). This appliance in a fractured thigh is put on about one week after the infliction of the injury. While the patient sits on the ischial tuberosities extension is made upon the leg. The seat of fracture is encircled with a thin plaster cast. The sole of the other foot is raised by a cork sole. Albers, when he treats a fractured thigh, uses plaster-of-Paris strengthened by bits of wood, running from *below* the sole of the foot to the iliac crest. Krause says in fracture of the ankle carry the dressing to the head of the tibia; in fracture of the leg carry it to the middle of the thigh; in fracture of the lower end of the femur carry it to the pelvis.* Bradford warmly advocates the use of Thomas's splint often combined with plaster-of-Paris.

Prevention and Treatment of Complications.—In every case of fracture feel for the pulse between the periphery and the seat of injury in order to be sure the artery is not ruptured. If the soft parts are badly contused, try to prevent sloughing by employing rest and relaxation, and by applying heat. If superficial sloughing occurs, treat antiseptically, remembering that even a superficial excoriation can admit bacteria which, carried by the blood or lymph, may infect the bones. If a slough leads down to the fracture, treat the case as a compound fracture. If there be great blood-extravasation, the danger is gangrene, and the foot of the bed is to be elevated, or the extremity, to which splints and bandages are to be loosely applied, is to be raised and surrounded with hot bottles. If a bleb forms, it is to be opened with a clean needle and dressed antiseptically. If gangrene occurs, treat by the usual rules. Frequently after fracture of a bone blebs containing reddish serum form on the skin. The appearance of blebs when the circulation is good does not mean gangrene, and is not of any particular consequence. If blebs are due to gangrene, there are distinct symptoms of circulatory impairment.

Edema may be due to tight bandaging. If it is due to phlebitis, there is danger of pulmonary or cerebral embolism. In phlebitis elevate the limb, remove all constriction, and employ locally ichthyol ointment; do not use massage, and give stimulants by the mouth. In edema due to weak circulation or venous relaxation use daily frictions and firm bandaging. If the fracture involves a joint, carefully adjust the fragments, make passive motion early, and inform the patient that he will probably have a stiff joint.

A dislocation occurring with a fracture is reduced at once if possible. To

* Centralbl. f. Chir., vol. xxii, 1895.

do this, splint the limb and give ether, and try to reduce while the limb is managed with the splint as a handle. Allis is often able to reduce a dislocation accompanied by a fracture. He uses the untorn portion of periosteum as a hinge, pulls upon the lower fragment, and thus draws down the upper fragment and pushes it in place by manipulation. If this fails, it is best to incise and pull the separated end in place by the hook of McBurney and Dowd (Figs. 158–160); but some surgeons say, get the bones in the best possible position, set them, await union, and then treat the unreduced dislocation. A rupture of the main artery of the limb presents the symptoms of absent pulse below the rupture, a tumor which may pulsate, and possibly a whirring sound, or an aneurysmal thrill and bruit. This condition demands that the surgeon should apply an Esmarch bandage, cut down upon the tumor, turn out the clot, and ligate each end of the vessel. If these measures fail or if gangrene appears, amputate at once above the seat of the fracture.

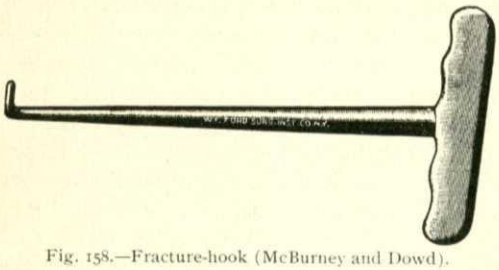


Fig. 158.—Fracture-hook (McBurney and Dowd).

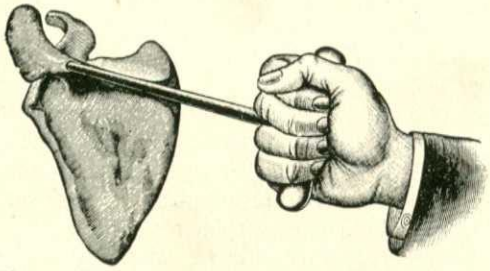


Fig. 159.—Fracture-hook applied at base of acromion process (McBurney and Dowd).

Inflammation is to be treated by compression, rest, moderate cold, and later by a 50 per cent. ichthyol ointment. Muscular spasm requires morphin internally, firm bandaging, or even tenotomy. Fat-embolism is treated by stimulants and inhalation of oxygen, and possibly artificial respiration. Shock, delirium tremens, urinary retention, etc., are treated according to the ordinary rules of surgery.

Treatment of Compound Fractures.—It must first be decided, in a case of compound fracture of a limb, if amputation is necessary, and the *x*-rays are of great value in determining the condition of the bones in a crushed part. Amputation is demanded when the limb is completely crushed or pulpefied through its entire thickness; when extensive pieces of skin are torn off; when the main artery, vein, and nerve are torn through; and sometimes when there is violent hemorrhage from a deep-seated vessel or when an important joint is splintered. What is to be done is to some extent determined by the patient's age and general health. In a healthy young person, if in doubt, give the limb the benefit of the doubt and try to save it; if the artery or vein alone is

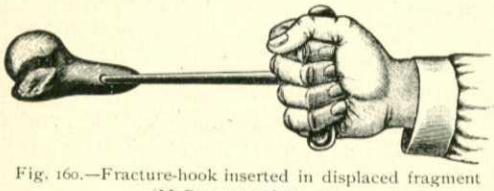


Fig. 160.—Fracture-hook inserted in displaced fragment (McBurney and Dowd).

ruptured, cut down upon it and tie both ends; if the nerve is severed, suture it; if a joint is opened, drain and asepticize. If an attempt is made to save the limb, be ready at any time to amputate for gangrene, secondary hemorrhage (if re-ligation at original point and compression high up fail), extensive cellulitis, and profuse and prolonged suppuration.* When it is determined to try to save the limb, the part must be cleansed thoroughly by the antiseptic method (in no injuries is this more important). If a small portion of bone protrudes, cleanse the skin of the extremity and the protruding bone, push the spicule out a little more and cut it off. If a large piece of bone is protruded, it must not be cut away, but should be thoroughly disinfected, and after the skin wound has been enlarged should be returned into place. Hemorrhage requires a free incision to permit of ligation of bleeding points. In comminuted fractures, fragments which are completely broken off should be removed, but those which are only partially separated should be retained. In all cases a drainage-tube must be carried down to the seat of fracture, and in some cases a counter-opening must be made and the tube be pulled through the limb (Fig. 161).

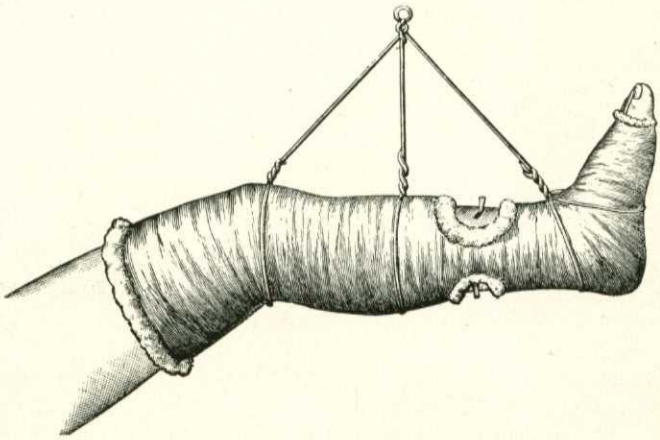


Fig. 161.—Fenestrated plaster-of-Paris dressing.

After inserting the tube the wound is sutured, a plentiful antiseptic dressing is applied, and the extremity is dressed with plaster. The plaster can be applied over a narrow strip of wood, trap-doors being cut in the plaster before it sets (Fig. 161). The wound is then covered with gauze and a bandage.

The bracketed splint is a better dressing than the one just described. After the wound has been dressed with gauze, plaster is at once applied over the ends of brackets (Fig. 162). The above methods not only immobilize the fractured bones, but keep the parts aseptic and afford easy access to the wound. The drainage-tubes are usually removed, if suppuration does not occur, in from forty-eight to seventy-two hours. The wound is treated as any other wound. In some compound fractures there is difficulty in retaining the fragments in apposition (lower end of femur, upper third of femur). In such cases the ends of the bone should be resected and the bones should be fastened together as in a case of united fracture, with silver wire, aluminum wire, chromicized catgut,

* See Howard Marsh on "Fractures," in Heath's Dictionary of Practical Surgery.

or kangaroo-tendon. In a compound fracture of the patella after free incision and disinfection, investigate to determine the gravity of the injury. In an ordinary case in which there are two or three fragments, open the joint, irrigate with saline fluid, drill the fragments, and fasten them with silver wire. Very small fragments should be removed. A tube is carried into the joint, the wound is sutured and dressed, and the limb is immobilized in extension.

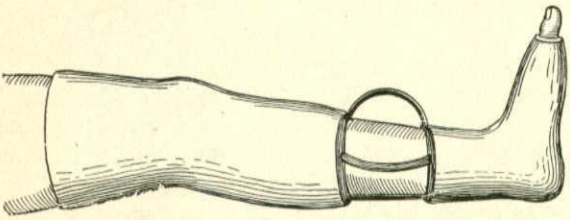


Fig. 162.—Bracketed plaster-of-Paris dressing.

In a case of severe compound comminuted fracture of the patella, after disinfection, the loose piece should be removed and "the remaining portions made smooth with bone forceps and the sharp spoon."* The wound is only partially sutured, is drained and dressed, and the limb is placed on a straight posterior splint. A compound fracture of the skull demands trephining. If a fracture of a rib is compound internally, resect the rib; if it is compound externally, dress antiseptically.

Compound fractures may be followed by gangrene, sloughing, periostitis, septicemia, pyemia, osteomyelitis, necrosis, etc. The treatment of these conditions is by well-known rules.

Treatment of Delayed Union and Ununited Fracture.—When delayed union exists, seek for a cause and remove it, treating constitutionally if required, and

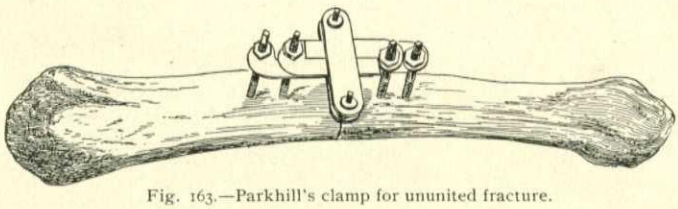


Fig. 163.—Parkhill's clamp for ununited fracture.

thoroughly immobilizing the parts by plaster. Orthopedic splints may be of value. Use of the limb while splinted, percussion over the fracture, and rubbing the fragments together, thus in each case producing irritation, have all been recommended. Blistering the skin with iodin or firing it has been employed. If the union be very long delayed, forcibly separate the fragments and put up the limb in plaster as we would a fresh break. If these means fail, irritate by subcutaneous drilling or scraping, or, better, by laying open the parts and then drilling and scraping at many places. Buechner advocates the induction of hyperemia by a constricting band, just as Bier induces congestive hyperemia in treating tuberculous areas. At first the constriction is permitted to remain but a short time, but the period is lengthened every day, until in a few days it remains almost continuously day and night. He claims that ten days of almost continuous application cures most cases. Helferich devised this method in 1887. Lannelongue and Menard inject a 1 : 10 solution of zinc chlorid between the

* Lilienthal's "Imperative Surgery."

fragments. Leaving acupuncture needles in for days is approved by some, and electropuncture is advocated by others. Cases of ununited fracture must be treated by excision of the bony ends and fibrous tissue, securing the fragments together by periosteal sutures, by pins, by screws and plates, by ivory pegs, by screws, by silver or aluminum bronze wire, by kangaroo-tendon, by Senn's bone-rings or bone-ferrules, or by chromicized catgut. Delorme makes an incision, removes bone-splinters and fibrous tissue, smooths off one end, forces this into the bored-out medullary canal of the other fragment, and sutures the periosteum. Gussenbauer's clamp will often give a good result, and was used for years by Billroth. Parkhill's clamp (Fig. 163) secures absolute immobility and is a very useful instrument (see Osteotomy for Ununited Fracture).

Treatment of Vicious Union.—If angular deformity results from faulty union, it can be corrected by moulding the part into shape while the callus is soft. If the callus has become hard, the bone can be refractured. If faulty union occurs with overriding, an osteotomy can be performed.

Special Fractures.—Nasal Bones.—The nasal bones, because of their situation, are often broken. The commonest seat of fracture is through the lower third, where the bones are thin and lack support. The fracture is usually compound externally or through the mucous membrane internally. The *cause* is direct violence. Displacement may not occur at all, but when present it arises purely from force, and never from muscular action, no muscle being attached to these bones. If the force is from the front, the nose is flattened; if from the side, it is deflected. Displacement is soon masked by swelling. Crepitus can sometimes be elicited by lightly grasping the upper part of the nose with the fingers of one hand and moving it gently below from side to side with the fingers of the other hand. Preternatural mobility is valueless as a sign, because of the natural mobility of the cartilages. Nose-breathing is difficult because of blocking of the nostrils by blood-clot. Diagnosis may be almost impossible when deformity is absent.

The complications that may be noted are cerebral concussion, brain-symptoms from implication of the frontal bone or cribriform plate of the ethmoid bone, and extension of the fracture to the superior maxillary or lachrymal bones. Emphysema of the root of the nose, the eyelids, and the cheeks is common, and means either a rent in the mucous membrane of Schneider or a crack in the frontal sinus. There may be much discoloration because of subcutaneous hemorrhage. Epistaxis is usual, and is recognized from the epistaxis produced by fracture of the base of the skull by the facts that the bleeding in the first condition is profuse, is, as a rule, soon checked, and is not followed by oozing of cerebrospinal fluid, whereas in the second condition it is profuse, continued, and followed by a flow of cerebrospinal fluid. Fracture of the bony septum occasionally complicates nasal fractures, and deviation of the cartilaginous septum often takes place. Suppuration may occur and necrosis of bone or cartilage may follow. The prognosis is usually good.

Treatment.—After cocainizing the nares a careful inspection should be made by means of a mirror and a light to determine if there is any injury of the septum. This point must be determined in order that the deformity of the septum may be corrected at the same time as is the deformity of the nasal bones. When there is no displacement, or when a displacement does not tend to be reproduced after reduction, employ no retentive apparatus of any kind. Order

the patient not to blow his nose for ten days and syringe it daily with a solution of bicarbonate of sodium. If deformity be noted, correct it at once, as the bones soon unite in deformity. If the attempts at reduction are very painful, or if the subject be a child, a woman, or a nervous man, give ether to obtain primary anesthesia. Reduction is effected by a grooved director or steel knitting-needle wrapped in iodoform gauze and passed into the nostril; the fragments are lifted with this instrument, and the fingers externally mould them into place. A rubber dilator can be used in reduction. This is pushed into the nose and inflated by air or water. If the septum is deviated and cannot be pushed in place by a metal sound, it must be twisted into place by means of septum forceps. If bleeding is moderate, check it with cold; if severe, by plugging. "For fractures high up with displacement, gauze packing carried well up will be required to retain the elevated bones. For lower deviations the Asch tube will be needed" (Scudder, on "The Treatment of Fractures"). A hollow vulcanite plug is inserted in each nostril and the nose is moulded into correct shape over the plug. The patient breathes through the hollow plug. A thread runs from each plug and is fastened to the cheek by adhesive plaster. Once or twice a day the plugs are removed, cleaned, and greased with iodoform ointment. The nose is cleared, and the plugs are reinserted. If flattening tends to recur, pass a Mason pin (Fig. 164) just beneath the fragments, through the line of fracture and out the opposite side. Steady the fragments by a piece of rubber externally caught on each end of the pin, or with figure-of-eight turns around the ends with silk. Leave the pin in place for five days. The instrument of Mason is a sharp, strong, nickel-plated pin, with a triangular point.

Fig. 164.—Mason's pin.

If lateral deformity tends to recur, hold a compress over the fracture or fix a moulded-rubber splint over the nose by a piece of rubber plaster one and a half inches broad and long enough to reach well across the face, and use compression for ten days. In neither of the above cases is the nose to be blown, and in both cases it is to be syringed once or twice a day. In fractures rendered compound by tears in the mucous membrane irrigate with normal salt solution or boracic-acid solution, holding the head so that the solution will not run into the mouth; plug with iodoform gauze around a small rubber catheter, which instrument permits nose-breathing; carefully remove the gauze daily and syringe. In fractures compound externally cleanse antiseptically externally, and dress with a film of cotton soaked in iodoform collodion or compound tincture of benzoin, or apply sterile gauze. Fractures of the bony septum, if showing a tendency to reproduction of deformity, require packing as above explained or the use of a special splint within the nostrils (Fig. 165), or the application of vulcanite plugs, so made that the patient can breathe through them, and that threads can be attached to them. Fractures of the nasal cartilages are to be

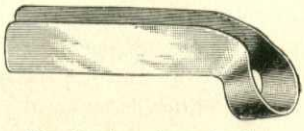


Fig. 165.—Jones's nasal splint.

pinned in place. Fractures of the nose are entirely united in from ten to twelve days.

Fractures of the Lachrymal Bone.—The lachrymal bone may be broken when the nasal bones, a superior maxillary bone, or the lateral plate of the ethmoid are fractured, and union is solid in from three to four weeks. The question of how much deformity is to be expected is always uncertain, and in not a few cases obstruction of the nose follows fracture because of damage to the septum.

Treatment.—Treat the chief injury, which is the fracture of the other bone or bones. Maintain the patency of the lachrymal duct by frequently passing a clean probe.

Fractures of the Superior Maxillary Bone.—Although a fragile bone, the superior maxillary is rarely broken except through the alveolar border. It may be broken by transmitted force from blows on the chin, or on the head when the chin is fixed; but direct violence is the usual cause. The wall of the antrum may be crushed in. Comminution is the rule, and the injury is often compound. These fractures induce great swelling, pain, and inability to chew. Mobility and crepitus may be detected. Deformity is due to the breaking force, and not to the action of any muscle. When a portion of the alveolar arch is fractured, as may occur in pulling teeth, the small fragment is depressed backward, and there exist irregularity of the teeth (some of which may be loosened) and inability to chew food. Fracture of the nasal process is apt to injure the lachrymal duct. When the antrum is broken in there are great sinking over the fracture, depression of the malar bone, and emphysema. Transverse fracture of the upper part of the body of the bone may cause no deformity. The force required to break the superior maxillary bone is so great that fractures of other bones almost certainly occur, and concussion of the brain not infrequently exists. Injury of the infra-orbital nerve is not unusual, causing pain, numbness, or an area of anesthesia involving one-half of the upper lip, the alæ of the nose, and a triangle whose base is one-half the upper lip and whose apex is the infra-orbital foramen. There is also loss of sensation in the gums and upper teeth of the injured side. Fractures of the superior maxillary bone occasionally induce fierce hemorrhage from branches of the internal maxillary artery; and if this occurs, watch for secondary hemorrhage (these vessels being in firm canals).

Treatment.—If the fracture does not implicate the alveolus, or if no deformity exists, apply no apparatus, but feed the patient on liquid food for four weeks. Reduce deformity, if it exists, by inserting a finger in the mouth. If the antrum is broken in, put the thumb in the mouth and push the malar bone up and back. In certain cases of deformity make an incision at the anterior border of the masseter muscle, insert a tenaculum or aneurysm needle, and pull the bone into place (Hamilton). If the malar bone or malar process is driven into the antrum, Weir tells us to incise the mucous membrane above and external to the canine tooth of the upper jaw, break into the antrum with a bone-gouge, insert a steel sound, lift out the malar bone, and pack the antrum with gauze. Loose teeth are not to be removed; they are pushed back into place and held by wiring them to their firmer neighbors. Hemorrhage is arrested by cold and pressure. If hemorrhage is dangerously profuse or prolonged, tie the external carotid.

If the line of the teeth, notwithstanding the wiring, is not regular, mould on an interdental splint. The usual splint for the upper jaw is the lower jaw held firmly against it by the Gibson, the Barton, or the four-tailed bandage. There is a great amount of dribbling of saliva during the treatment, and a dressing must be used to catch this fluid. Every day remove the bandage and dressing, and wash the face with ethereal soap. The patient, who is ordered not to talk, is to live on liquid food administered by a nasal tube or by pouring it into the mouth back of the last molar tooth by means of a tube or a feeding-cup. Never pull a tooth to obtain a space; but if a tooth is lost, utilize the vacant space for this purpose. After every meal wash out the mouth with peroxid of hydrogen followed by chlorate of potassium, boracic-acid or normal salt solution, and thus prevent foulness and the digestive disorders it may induce. Dispense with the dressings in six weeks, and let the patient gradually return to ordinary diet.

In fractures compound externally do not remove fragments, antisepticize, arrest bleeding as far as possible by ligature, by pressure, or by plugging, wire the fragments if feasible, dress with gauze, and wash the mouth with great

Fig. 166.—Hard-rubber splint; wire arms and chin-piece held together by metal rods and nuts.

frequency. Fractures compound internally are treated as simple fractures, except that the mouth is washed more frequently.

The **malar bone** is rarely broken alone. Hamilton says no uncomplicated case is on record. The malar is a strong bone resting on a fragile support, and hence it may become a wedge to break other bones and yet itself be unfractured. The *cause* of fracture is violent direct force. A fracture of the orbital surface of this bone causes subconjunctival hemorrhage like that encountered in fracture at the base of the skull, and may produce irritation of the infra-orbital nerve. Protrusion of the eye may result either from hemorrhage or from crushing in of the malar bone. There is a hollow below and to the inner side of the orbit. Occasionally the line of fracture is detectable. but mobility and crepitus are very rarely discoverable. Chewing is apt to cause pain, and often the motions of the lower jaw are limited, the coronoid process being pressed upon by a depressed malar bone, an associated fracture of the zygoma, a blood-clot or swollen tissue. (See Scudder, on "The Treatment of Fractures.")

Treatment.—If no deformity exists, there is practically nothing to be done. If deformity exists, try to correct it as in fractures of the superior maxillary bone. If correction is impossible by ordinary methods and the movements of the lower jaw are impeded by the displaced bone, make a small incision and through this insert an instrument and endeavor to lift the bone into place. As these cases are almost invariably complicated by fracture of the upper jaw, they are treated in the same manner as the latter injury. The union is complete in three weeks.

Fractures of the zygomatic arch are very rare. The *causes* are (1) direct violence; (2) indirect force (from depression of the malar); and (3) forcing foreign bodies through the mouth. Direct violence is the usual cause. Direct violence causes inward displacement, and indirect force may cause outward displacement. The usual seat of fracture is at the smallest portion of the process—that is, on the temporal side of the temporomalar

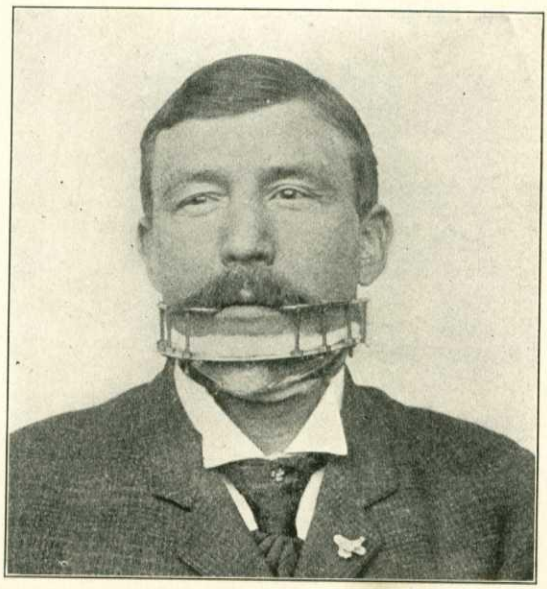


Fig. 167.—Front view of splint (figure 166), with mouth closed (Moriarty).

suture (Matas). The symptoms are pain, ecchymosis, swelling, displacement, and difficulty in moving the jaw (because of injury to the masseter muscle).

Treatment.—In simple fracture give ether and try to push the arch in place. Many surgeons do not make an incision, as depression will do no harm and the functions of the jaw will be restored. Simply dress with a compress, adhesive strips, and the crossed bandage of the angle of the jaw. Union will take place in three weeks. Matas* advises operation. An anesthetic is administered, and the parts are asepticized. A long semicircular Hagedorn needle is threaded with silk, is entered one inch above the middle of the displaced fragment, is passed well into the temporal fossa, and is made to

*New Orleans Med. and Surg. Jour., Sept., 1896.

emerge half an inch below the arch. The silk is used to pull a silver wire around the fracture, and this wire is employed to pull the bone into position. A firm pad is applied externally and the wire is twisted over the pad. Antiseptic dressings are applied, and on the ninth or tenth day the wire, splint, and dressings are removed permanently. I have employed this plan in two cases with perfect satisfaction.

Fractures of the inferior maxillary bone may, and most usually do, affect the body, although they occasionally occur in the rami. Any part of the body may be fractured, the most usual seat being near the canine tooth or a little external to the symphysis (Pick). A portion of alveolus may be broken off. In fractures of the ramus either the angle, the condyloid neck, or the coronoid process may be broken. In fractures of the body the posterior fragment generally overrides the anterior. Fractures of the lower jaw are often multiple and are almost always compound, because the oral mucous membrane and alveolar periosteum are torn. The *cause* is usually direct vio-

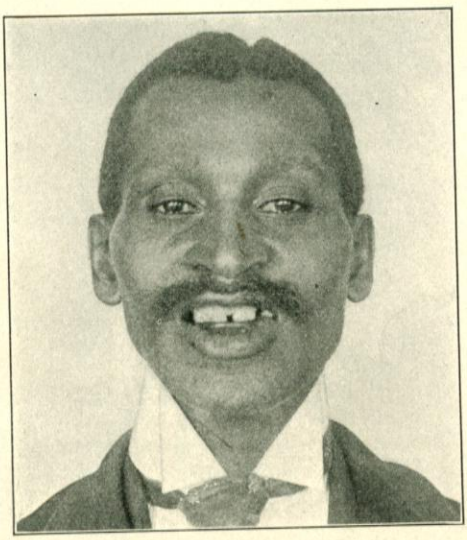


Fig. 168.—Hard-rubber splint in position, upper teeth resting upon it (Moriarty).

lence. Indirect violence (lateral pressure) may fracture the body anteriorly. Fractures near the angle are always due to direct violence. Indirect violence may fracture the condyle (falls on the chin), and so may direct violence. Fractures of the coronoid process are very rare, and they arise from great direct violence (usually a gunshot-wound or some other penetrating force).

Symptoms.—In fracture of the body preternatural mobility and crepitus generally exist. The gum over the fracture swells rapidly and decidedly. There is bleeding because of laceration of the gum; saliva dribbles constantly; after two or three days some of the cervical lymph-glands enlarge; when the fracture is open through the mucous membrane suppuration is usual; the odor of decomposition soon becomes marked; the patient supports the jaw with the hand; great pain exists (possibly from injury of the nerve); and deformity

is present, shown by inequality of the teeth if the fracture is anterior to the masseter, the anterior fragment going downward and backward and the posterior fragment going upward and forward. The downward displacement is due to muscular action (action of the digastric, geniohyoid, and geniohyoglossus). The backward displacement is due to the violence. The temporal muscle draws the posterior fragment upward and to the front. In fracture of the neck of the condyle the jaw is drawn toward the injured side, and the condyle is pulled inward and forward by the action of the external pterygoid muscle. In fracture of the coronoid process the temporal muscle pulls the small fragment upward.

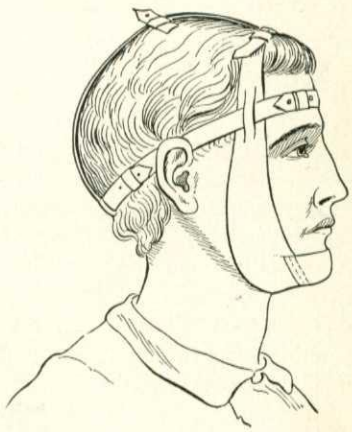


Fig. 169.—Hamilton's bandage.

Complications.—The complications are—digestive disorders and diarrhea from swallowing foul discharges; loosening of the teeth; lodgment of loosened teeth between the fragments; bleeding (usually only oozing from the gum, but there may be hemorrhage from the inferior dental artery); and suppuration. Necrosis may follow these fractures, an abscess of the neck may develop, or a sinus may form.

Treatment.—Remove a tooth if it lies between the fragments, but replace it in its socket after reducing the fracture. Correct deformity with great care and be sure to bring the teeth into normal alinement. As a rule, push loose teeth into place and put back detached ones; but occasionally a tooth obstinately prevents perfect approximation, and if it does it must be removed. Wash the mouth with hot water to clean it and to check bleeding. If bleeding is very severe, compress the carotid artery for a time. The fracture can be dressed with a pad of lint over the chin and Hamilton's four-tailed bandage (Fig. 169). A common plan is to take a splint of pasteboard, felt, or gutta-percha; pad it lightly with cotton, mould it to the part, and hold it in place with a Barton or a Gibson bandage. If apposition of the fragments cannot be maintained by the above methods, fasten the teeth together with wire, wire the fragments together, or have a dentist apply an interdental splint (Figs. 170, 171). Fracture of the lower jaw can often be most satisfactorily treated by Angle's bands. These bands are of great value in complicated cases, in which two or more fractures exist. Each band consists of thin metal and a screw and a nut to fit the screw. The band is adjusted around a firm tooth and a nut is applied so as to hold the band tightly. Several bands are placed

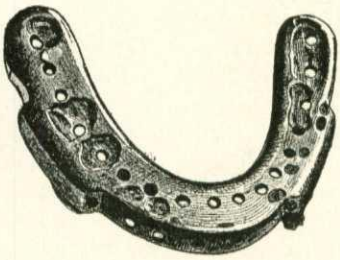


Fig. 170.—Vulcanite splint with boxes vulcanized on each side. If the jaw is fractured in the region of the molars, considerable pressure is required to get the parts in position; therefore it is best to vulcanize on to the sides of the vulcanite splint boxes into which wire arms can be inserted (Pilcher).

upon teeth in both jaws. Silver wire or silk is thrown around the pins of the bands so as to catch, and the jaws are thus held firmly together. The patient is to be fed on liquid food (see Fracture of the Upper Jaw), the mouth is to be washed frequently with peroxid of hydrogen, followed by boric-acid solution or normal salt solution, and the dressings are to be changed every second day. The union should be complete in five weeks. Though these fractures are usually compound, they do not endanger life.

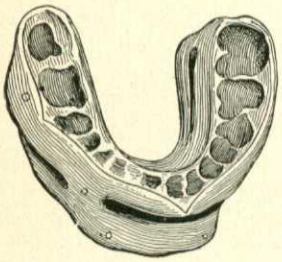


Fig. 171.—Interdental splint.

Fractures of the Hyoid Bone.—These fractures are uncommon injuries, and are caused by hanging, by throttling, and by falls in which the neck strikes some obstacle. If the bone breaks by throttling, it is its body which fractures (indirect force). Fractures by muscular action are most unusual.

Symptoms.—The symptoms are—a sensation of something breaking; bleeding from the mouth if the mucous membrane be lacerated; pain, which is worse on opening the jaws or on moving the head or tongue; difficulty in swallowing; muffled, hoarse voice or aphonia; swelling, and frequently ecchymosis, of the neck. There are observed occasionally, though rarely, harsh cough and dyspnea, irregularity of bony contour, and crepitus. Always look into the mouth and see if there can be detected ecchymosis or laceration of the mucous membrane or projection of a bony fragment. The displacement is due to the middle constrictor of the pharynx contracting. A fracture of the hyoid bone may destroy life.

Treatment.—For dyspnea, be ready to perform intubation or tracheotomy at a moment's notice. Edema of the glottis is a great danger. Try to restore the fragments with one hand externally and with a finger in the mouth. Put the patient to bed and have him lie back upon a firm rest so that his shoulders are elevated. His head is to be placed between extension and flexion, a pasteboard splint or collar is moulded on the neck, and a bandage is applied around the forehead, neck, and shoulders to keep the head immobile. The patient must not utter a word for a week; he must at first be fed by enemata, and then for some time on liquid diet, which is given through a tube early in the case. Endeavor to control the cough by opiates. A fractured hyoid bone requires about four weeks to unite.

Fractures of laryngeal cartilages are caused by direct violence, as throttling, blows, or kicks. They are rare in young persons, and are commonest when the cartilages have begun to ossify. They are very grave injuries, death tending to occur from obstruction to the entrance of air.

Symptoms.—The symptoms, which are severe, are pain, aggravated by attempts at swallowing or speaking; swelling, ecchymosis it may be, and emphysema of the neck; cough; aphonia; intense dyspnea; and bloody expectoration if the mucous membrane is ruptured. There can be detected inequality of outline (flattening or projection) and perhaps moist crepitus. The usual seat of the injury is the thyroid cartilage.

Treatment.—Cases without dyspnea require quiet, avoidance of all talking,

feeding with a stomach-tube, the application of compresses and adhesive strips over the fracture, and the use of remedies to quiet cough. The surgeon must be ready to operate at any moment. In most cases dyspnea exists, due to projection of the fragments or submucous extravasation. When there is dyspnea, emphysema, or spitting of blood, at once practise intubation, or, if unable to do this, open the larynx or trachea below the seat of fracture. If laryngotomy or tracheotomy is performed, try to restore to proper position displaced fragments. If the fragments will not remain reduced, introduce a Trendelenburg cannula or a tracheotomy-tube, and pack gauze around it. Take out the packing in four days, and remove the tube as soon as the patient breathes well, when the opening may be allowed to close. In these cases feed with a stomach-tube and keep the patient absolutely quiet. Union takes place in four weeks.

Fractures of the Ribs.—The ribs, owing to their shape, elasticity, and mode of attachment, readily bend and as readily recover shape, and thus withstand considerable force without breaking. Notwithstanding these facts, the situation of the ribs so exposes them that in 16 per cent. of all cases of fractures noted by Gurlt these bones were involved. In children fracture of a rib seldom occurs and is usually incomplete; it is common in adults and the aged, and in them is generally complete. It is more frequent among men than among women. The ribs commonly broken are from the fifth to the ninth, the seventh being the one that most frequently suffers. Fracture of the first rib alone is an excessively rare accident. The eleventh and twelfth ribs are seldom broken. A rib may be broken in several places, and several ribs are often broken at the same time. Fracture of a single rib is not nearly so common as fracture of several ribs. These fractures may be compound either through the skin or through the pleura, a damaged lung permitting pneumothorax. Compound fractures are very rare, however, except from bullet-wounds.

Causes.—Direct force, as buffer accidents, kicks, blows with heavy instruments, or being jumped on while recumbent, may produce these injuries. A fracture from direct violence occurs at the point struck, and the ends, projecting inward, may damage a viscus. *Indirect* force, as great pressure or blows which exaggerate the natural bony curves, tends to produce fractures near the middle of the ribs or in front of their angles and to force the ends outward. A number of ribs are apt to be broken. Muscular action, as in coughing or parturition, occasionally, but very rarely, is a cause.

Symptoms.—In connection with the history of the accident the symptoms are: acute localized pain (a stitch) on breathing, increased by pressure over the seat of pain, pressure backward over the sternum, cough, and forcible inspiration or expiration; respiration is largely diaphragmatic, the patient endeavoring to immobilize the injured side; cough is frequent and is suppressed because of pain. Crepitus is often but not invariably found. The surgeon seeks for it, first, by resting the palm of his hand over the seat of pain while the patient takes long breaths; second, by placing a thumb before and one behind the seat of pain and making alternate pressure; and third, by auscultation. It should be remembered that incomplete fractures are the rule in children; hence in them do not expect crepitus. Deformity is usually trivial unless several ribs are broken, because shortening cannot occur and the

intercostal attachments prevent vertical displacement. Preternatural mobility may occasionally be elicited, when the region is not deeply covered with muscles, by pressing on one side of the supposed break and observing that a part of, and not the entire, rib moves. If air gathers in the subcutaneous tissue and there is no wound of the surface, it is proof of rib fracture with lung damage. In such a case the lung has been penetrated by a fragment, and air has been forced out into the tissues. This condition is recognized by great and growing swelling, which crackles when touched. Such a collection of air is known as *cellular emphysema*. Bloody expectoration suggests lung injury; bloody expectoration and cellular emphysema, without an external wound, prove injury of the lung. A simple, uncomplicated case of fracture of a rib or ribs in a young person gives a good prognosis.

The *complications* are: additional injury, making the fracture externally or internally compound; laceration of the pleura, pericardium, heart, lung, diaphragm, liver, spleen, or colon; rupture of an intercostal artery; hemothorax; cellular emphysema; pulmonary emphysema; pneumothorax; pyothorax; traumatic pleurisy; pneumonia; bronchitis; congestion or edema of the lungs.

Treatment.—In an uncomplicated case the patient is not kept in bed, as breathing is easier when erect than when recumbent. Angular displacement outward is corrected by direct pressure. Displacement inward is soon corrected, as a rule, by the expansion of ordinary respiratory action; but if it is not thus corrected, etherize, the deep breathing of the anesthetic state almost always succeeding. If ether fails, and dangerous symptoms come on, incise under strict antiseptic precautions, elevate, and drain, or sometimes resect a portion of the rib.

After correcting any existing deformity immobilize the injured side. Direct the patient to raise his arms above his head, to empty his chest of air by a forced expiration, and to keep it empty until a piece of rubber plaster (two inches wide) is forcibly applied seven or eight inches below the fracture and from the spine to the sternum. The patient is now allowed to take a breath and is directed to empty the chest again, another piece of plaster being applied, covering the upper two-thirds of the width of the first strip. This process is continued until the side is strapped well above and well below the fracture (Pl. 6, Fig. 13). Over the plaster light turns of a spiral bandage of muslin are carried, or a figure-of-8 bandage of the chest is applied, the turns crossing over the seat of injury. About once a week the plaster is removed and fresh pieces applied after rubbing the chest with soap liniment, drying, and anointing excoriations with an ointment of oxid of zinc. The dressing is worn for three or four weeks. The patient avoids cold, damp, and draughts. The diet must be nutritious but non-stimulating, and any cough should be treated by opiates and expectorants. A person with this injury who has reached the age of sixty must take stimulant expectorants (ammonii carb., gr. x, in infus. senegæ, ℥ss, *t. i. d.*) or employ a steam-tent several times a day. The old method of treatment, in which the chest was included in a forcibly applied broad rib-roller, is not to be used except as a temporary expedient; it compresses the entire chest, causes pain and dyspnea, and tends to loosen and slip.

Fracture of the ribs complicated with visceral injury is highly dangerous,

and requires confinement to bed. The treatment is that of the visceral injury. If there be bloody expectoration, apply adhesive strips as above indicated, put the patient to bed reclining on a bed-rest, keep him quiet, subdue the circulation, and employ opium, diaphoretics, and expectorants (a good mixture consists of squill, ipecac, ammonium acetate, and chloroform; opium is given separately). Inflammations of the lung or the pleura, fortunately, are apt to be localized, and are treated as are ordinary inflammations of these parts. If signs of pulmonary injury are severe from the start or become worse under medical treatment, incise, resect a rib, arrest hemorrhage, and drain the pleura. In laceration of an intercostal artery incise and try to ligate; if unable to ligate, resect a rib and apply a ligature. If the signs point to internal bleeding, resect a rib, search for the bleeding point, and ligate. Emphysema usually soon disappears; but if it does not, make many small incisions in the cellular tissue, dress antiseptically, and employ pressure. When there arises a sudden attack of dyspnea, which is prone to happen in these cases, and in which the face becomes blue, the heart labors, and suffocation seems imminent, bleed the patient almost to syncope.

Fractures of the costal cartilages are not common, even in the aged. Such fractures occur either through the cartilages or through their points of junction with the ribs. These injuries generally arise from direct violence, the cartilage of the eighth rib being most prone to suffer. Indirect force (such as a blow upon the shoulder) is occasionally the cause, but when it is the cause some other injury besides the fracture of the cartilages is apt to be noticed. Muscular action is a possible cause.

Symptoms.—Displacement is often absent; but if present, it is forward or backward of either fragment, and is due chiefly to the force of the injury, but partly, it may be, to muscular action. When displacement is absent, crepitus will not often be found; in fact, crepitus is usually absent in these injuries. Localized pain, swelling, and ecchymosis are noted. Preternatural mobility may or may not be detected. Union by bone is to be expected.

Treatment.—If displacement exists, try to reduce it. If the fragment is displaced backward, reduce by deep inspirations; if the fragment is displaced forward, reduce by pulling back the shoulders. In this attempt failure is the rule, and the surgeon may then adopt Malgaigne's expedient of applying a truss over the projection for a day or two. Dress and treat the case as if a rib were broken, removing the dressings in four weeks.

Fractures of the Sternum.—The sternum may be broken, along with the ribs and spine, from great violence. Fractures of the sternum alone are infrequent, because the bone rests on a spring-bed of ribs. Fractures of the sternum may be simple or compound, complete or incomplete, single or multiple. The most usual injury is a simple transverse fracture at or near the gladiomanubrial junction, at which point dislocation may also occur. Both fracture and separation of the ensiform cartilage are very rare. The sternum may be broken along with the ribs or clavicle.

Causes.—These are: *direct* force, as by a fall of an embankment or of a wall, by a car-crush, or by the passing of a cart-wheel over the body; *indirect* force, as by a fall upon the head, thus driving the chin against the chest; by a fall upon the feet, the buttocks, or the shoulder; by forced flexion or extension of the body over an edge or angle (as may occur during labor-pains).

Symptoms.—In fracture of the sternum displacement is not always present, but when it does occur the lower fragment is apt to pass forward; displacement may, however, be transverse or angular, or there may be overriding. The posterior periosteum, which rarely tears, limits displacement, but some deformity can, as a rule, be detected. The history of the nature of the accident has a valuable bearing upon the question of diagnosis. The position assumed by the patient is with the head and body bent forward, as attempts to straighten up cause much suffering. There is fixed and localized pain, increased by deep respiratory action, by body-movements, or by cough. Crepitus is sought for by auscultation and by placing the hand over the injury and directing the patient to make quick respirations. Mobility may become manifest on external pressure, during respiration, or while attempts are being made to bring the body erect. Respiration in these cases is usually much interfered with. It is not important to separate diagnostically diastasis from fracture.

Complications.—Other fractures generally complicate fracture of the sternum, and laceration of the pleura or pericardium and hemorrhage into the anterior mediastinum may exist. Abscess of the mediastinum and necrosis of the sternum may appear as late consequences. The *prognosis* is good in uncomplicated cases.

Treatment.—The deformity attending fracture of the sternum is to be corrected, if possible, by external pressure. If overriding is found, effect reduction by bending the body back over a firm pillow and ordering the patient to respire deeply; if this method fails, give ether and then bend the body backward. The deformity, after reduction, tends to recur, but the bones unite well even in deformity, and no great harm results. The fragments need not be cut down on or be hooked up unless there be internal injury. After reducing the deformity, cover the front of the chest with adhesive strips extending laterally from one axillary line to the other, and covering a region from above the fracture down to the ensiform cartilage. Place over this covering an anterior figure-of-eight bandage of the chest. In some cases, where deformity recurs after reduction, a circular bandage of the chest is applied and the shoulders are pulled strongly back with a posterior figure-of-eight bandage. The plaster is to be reapplied once a week. Some surgeons treat these cases by means of a large compress held by adhesive plaster and a broad tight roller.

The patient goes promptly to bed, and reposes erect, or semi-erect, on a bed-rest. This position favors easy respiration and antagonizes the tendency to displacement. The diet should be light, nutritious, and non-stimulating. Convalescence is established in four weeks, and the plaster should be permanently removed in five weeks. When the ensiform cartilage is so bent in as to cause intense pain or to injure the stomach, it should be exposed by incision and resected. Edema of the skin and fever, if they appear, indicate pus, in which case an incision should be made at the edge of the sternum and the pus-cavity should be irrigated and drained.

Fractures of the Pelvis.—In some of the indicated fractures serious injury of the pelvic contents is apt to be found.

Fractures of the False Pelvis.—Fractures of this region are seldom dangerous unless comminuted. There may be fracture of the iliac crest

or of the anterior superior spine, or the line of fracture may traverse the entire length of the flanged-out ilium, or the bone may be comminuted with the association of grave visceral damage. The anterior superior and posterior superior spines may be broken off.

Causes.—The cause of fracture of the false pelvis is generally violent *direct* force, as the passage of a wagon-wheel, the fall of a wall, the kick of a horse or mule, or the force of car-crushes. Violent contraction of the rectus muscle may tear off the anterior inferior spine of the ilium.

Symptoms.—In fracture of the false pelvis the history of violent force is noted. The patient leans toward the injured side. Pain exists, which is aggravated by movements (particularly by bending forward), by coughing, or by straining to empty the bowels or the bladder. Ecchymosis and swelling are manifest. Crepitus and preternatural mobility are detected by moving the iliac crest. Deformity is very rarely present. Cases uncomplicated by visceral injury make good recoveries.

Complications.—The fracture may be, but rarely is, compound, as the parts are well protected with muscles. The colon may be injured when comminution has taken place.

Treatment.—If there are symptoms of injury of the colon, perform laparotomy, search for the injured region, and suture it. In treating an ordinary fracture of the false pelvis put the patient on a fracture-bed, raise the shoulders, and apply a canvas binder about the pelvis, or encase the pelvis with broad pieces of rubber plaster, or employ the belt or girdle. The pressure of the binder, girdle, or plaster must not be so great as to force the fragment of ilium inward. Place the knees over two pillows so as to semiflex the legs and thighs, and tie the knees together. To restrain thigh-movements it may be necessary to encase a restless patient with splints or bind him to sandbags. If the pelvic binder displaces the fragments or causes pain, abandon it and trust to position. If the fragment cannot be retained in place, wire it. The dressings can be removed in six weeks, and the patient is allowed to get up in eight weeks. In simple, uncomplicated fracture of the false pelvis the prognosis is good. In compound fractures of the false pelvis asepticize, drain and dress, put on a binder, and direct the same position to be maintained as for simple fractures.

Fractures of the True Pelvis.—The most usual seat of these fractures is through the obturator foramen, the ascending ischial and horizontal pubic rami being broken. A fracture may occur near the symphysis pubis, the symphysis may be separated, a break may run near to or into the sacroiliac joint, the same fracture may occur on each side of the body of the pubis, and there may be multiple fractures. Fractures of the acetabulum and of the tuberosity of the ischium may occur. Before the seventeenth year the innominate bone may be broken into its three anatomical segments. Fractures of the true pelvis are highly dangerous because of the damage which is apt to be inflicted on the pelvic contents. There may be rupture of the bladder or membranous urethra and injury of the vagina, the rectum, the uterus, or the small gut. The *cause* of pelvic fracture is violent force, direct or indirect. Front force tends to produce direct, and side force indirect fracture. The acetabulum may be broken by falls upon the feet.

Symptoms.—In pelvic fracture there is a history of violent force. There

are great shock, ecchymosis which is possibly linear, swelling, and intense pain increased by attempts at motion, coughing, and straining. There is also inability to sit or to stand. Mobility becomes obvious on grasping an ilium in each hand and moving the hands. Crepitus may be noticed by this maneuver or by moving an ilium with one hand, a finger of the other hand being inserted in the rectum or vagina. In making movements for diagnostic purposes be very gentle, as rough manipulation may cause injury by sharp fragments. There may be doubt as to whether crepitus is to be referred to pelvic fracture or to fracture of the neck of the femur; in this case follow the rule of John Wood: "The surgeon grasps the femur with one hand and places the other firmly upon the anterior superior iliac spine or crest or upon the pubes; then, on moving the femur and abducting it freely, if a crepitus be detected, it will be felt the more distinctly by that hand which rests on or grasps the fractured bone."

Rupture of the bladder is made manifest by pain in the hypogastric region, an intense desire to micturate, an inability to pass urine in quantity although a few drops of bloody urine may be voided, great shock, sometimes dulness on percussion in the loins, and evidences of extravasation in the prevesical space. The condition is proved to exist by practising the maneuvers suggested under Rupture of Bladder. The symptoms of ruptured urethra are set forth later. Bleeding from vagina or rectum points to laceration of the part by a fragment. The vagina may be badly lacerated and the bowels may emerge from the laceration (Maurice H. Richardson's case). Intestinal injury is apt to induce septic peritonitis. Fracture of the brim of the acetabulum permits dorsal dislocation of the femur to occur, which dislocation will not remain reduced, and causes shortening, which at once recurs when extension is abandoned—inversion and adduction, although the power of eversion and abduction is preserved (Stokes). There is crepitus, and the head of the bone goes with the fragment upward and backward (Stokes). If the head of the femur be driven through the acetabulum into the pelvis, the injury is very grave; there are then found shortening, adduction, and semiflexion of the thigh, absence of the prominence of the great trochanter, and more capacity for movement than is noted in dislocation. Fracture of the ischium rarely occurs alone.

Treatment.—Examine carefully to determine if the bowel, the bladder, the urethra, or the vagina is injured. If such an injury exists, radical operation is of course demanded. Always use a catheter to see if the urine is bloody. Bloody urine suggests, but does not prove, the existence of a ruptured bladder. It may be due to simple contusion of the bladder or to contusion of the kidney. In treating a pelvic fracture endeavor to restore the parts to a normal position, employing external manipulation and inserting a finger in the rectum or in the vagina. If reduction is difficult, administer ether. The pelvis should be encircled with a canvas binder and the patient should be placed upon a Bradford frame. If this is done he can be cleaned readily and the bed-pan can be easily used. If movements of the thighs distort the pelvic bones, each thigh should be bound to the frame. In fracture with separation of the pubic bones, the bones should be wired together. If urinary extravasation occurs, perform perineal section. If there are signs of bowel injury or intraperitoneal rupture of the bladder, perform laparotomy; and if the bladder is found to

be torn, apply sutures. All visceral injuries are treated by general rules. Remove the dressings in six weeks and allow the patient to get about in twelve weeks. In fracture of the acetabulum, if the limb is shortened, give ether and reduce by extension and counterextension. Treat these fractures in the same way as intracapsular fractures of the femur. Fractures of the ischium are best treated by the application of a pad and adhesive plaster, and rest in bed.

Fractures of the Sacrum.—This bone may be broken by direct force, such as a kick, but the injury is rare. The sacral plexus is usually injured, and if it is paralysis is observed in the territory of its branches.

Symptoms.—The symptoms of fracture of the sacrum are pain, frequently incontinence of feces and retention of urine, irregularity of the sacral spines, ecchymosis, and crepitus. Crepitus may be sought for with one hand externally and a finger of the other hand in the rectum. The lower fragment passes forward and may obstruct or may tear the rectum. Paralysis may be found in the area of distribution of the sacral plexus.

Treatment.—In any case of fracture of the sacrum if there are evidences of pressure upon nerves by displaced bone, incise and elevate the depressed bone. If the rectum is lacerated sutures must be inserted. In many cases of fracture of the sacrum the older conservative treatment is sufficient. The conservative treatment is as follows: Press the fragments into place with a hand externally and a finger in the rectum. Do not plug the rectum. Put a pad over the upper fragment, hold it with plaster or a binder, place the patient recumbent on a fracture-bed, and insert a large cushion underneath the pad. Some surgeons give opium to induce constipation, and allow a fecal support to accumulate in the rectum. Use a clean catheter regularly, and guard against bed-sores. Union occurs in about four weeks, when the dressing can be removed. The patient can get about again in six weeks. If urinary retention persists or if intractable bed-sores form after eight or ten weeks, cut down on the seat of injury and elevate or remove the portion of bone causing pressure.

Fractures of the Coccyx.—The coccyx may be broken or be separated from the sacrum by a fall, a blow, a kick, or the straining of parturition. Its mobility is so great, however, that it does not often break.

Symptoms.—The chief symptom of fracture of the coccyx is pain, which is much aggravated by sitting, walking, or straining at stool. If the index finger is inserted into the rectum, the displaced bone is felt; if the thumb of the same hand is also placed externally, a rocking motion will develop crepitus and preternatural mobility.

Treatment.—In treating fracture of the coccyx reduce by external pressure and by the manipulations of a finger in the rectum and put the patient to bed. In four weeks the fracture should be united. If union does not take place, defecation and all movements of the coccyx will cause excruciating pain by pressure on the last sacral nerve. This condition, known as "coccygodynia," demands a subcutaneous division of the nerve or of the muscles which move the coccyx, or a resection of the bone.

Fractures of the Vertebra. (See page 648.)

Fractures of the Skull. (See page 608.)

Fractures of the Clavicle.—The clavicle is more often fractured than any other bone. The fracture may occur at any age, but is commonest

before the sixth year (Hulke says one-half of the recorded cases). It may be simple, multiple, comminuted, oblique, transverse, complete, incomplete, or, very rarely, compound. Both clavicles may be broken. Fractures are most apt to occur just external to the middle, at the point where the inner or large curve meets the outer or small curve, at which junction the bone is at its smallest diameter. Fractures of the acromial end are more frequent than fractures of the sternal end, and less frequent than fractures of the shaft. The *causes* of fracture of the clavicle are direct violence, indirect violence, and, very rarely, the contractions of "the deltoid and clavicular fibers of the great pectoral" (Treves, from Polaillon).

Fractures of the shaft are usually due to indirect violence, as falls upon the shoulder or upon the outstretched hand. In the latter accident, which is the usual mode of origin, the concussion of the fall travels up and the body-weight travels down, and these two forces compress the bone, which snaps at its weakest point. Fractures from indirect force are oblique, and in children are of the green-stick form. Fractures from direct force are usually transverse, and are occasionally comminuted. Fractures from muscular action have been recorded (Rubini the tenor, recorded by Melay).

Symptoms.—In fracture of the shaft of the clavicle the attitude of the patient is peculiar. He supports the elbow or wrist of the injured side with the hand of the sound side, and also pulls the extremity agaisnt the chest; the head is turned down toward the shoulder of the damaged side, as if trying to listen to something in the joint, thus relaxing the pull of the sternocleidomastoid muscle upon the inner fragment. The shoulder is nearer the sternum, on a lower level, and farther front than that of the sound side. Loss of function is shown by inability to abduct the arm, and in many cases by inability to place the hand on the top of the erect head. Considerable pain exists, which is increased by motion, by pressure, and by hanging down the extremity without support.

The deformity above noted is described by stating that the shoulder goes downward, inward, and forward (D. I. F.). The *downward* deformity is chiefly due to the weight of the extremity, which pulls down the unsupported outer fragment, and is contributed to by the action of the pectoralis minor muscle. The *inward* deformity is chiefly due to the contraction of the pectoralis minor and subclavius muscles assisted by the action of the pectoralis major. The *forward* deformity is due to rotation of the outer fragment, which is brought about by the serratus magnus muscle carrying the scapula forward. In this deformity, the inner end of the outer fragment is below and behind the outer end of the inner fragment, which overrides it. The inner fragment, though pulled on by the sternocleidomastoid muscle and relatively higher than the outer fragment, is really but little, if at all, elevated, marked elevation being prevented by the attachment of the rhomboid ligament. After noting the deformity, detect with the finger the irregularity of bony contour. Examine for preternatural mobility and crepitus by raising and throwing back the shoulder. In looking for these signs in children it is to be remembered that the fracture is probably incomplete. The prognosis is good, the bone uniting, but always with some shortening and inequality.

Complications.—Fractures of the shaft are rarely compound, because the sharp end of the outer fragment passes backward and because of the free

play the skin makes over the bone (Pickering Pick). Both clavicles may be broken. One or more ribs may be fractured at the same time. In fractures from direct force deeper structures may be injured by fragments. Thus, injury of the brachial plexus will induce paralysis. There are 11 recorded cases of simple fracture of the clavicle complicated by laceration of a large vessel. Eight of these cases died. The vessel ruptured may be the subclavian vein, the subclavian artery, or the jugular vein. After a rupture a huge blood-clot forms (Gallois and Piollet, in "Rev. de Chir.," July and Aug., 1901).

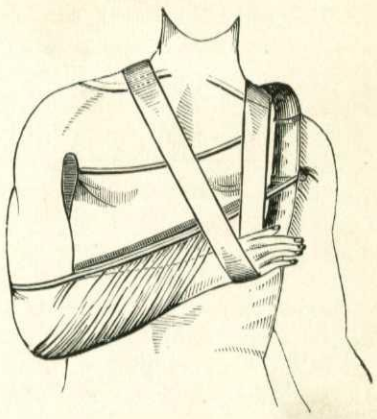


Fig. 172.—Fox's apparatus for fractured clavicle.

Treatment.—In treating a fracture of the shaft of the clavicle correct the deformity as soon as possible by throwing the shoulder upward, outward, and backward. If the patient is a girl, it is desirable to minimize the deformity. Place her upon her back upon a hard bed, with a small pillow under her head, a firm and narrow cushion between the shoulders, a bag of shot resting over the seat of fracture, and the forearm lying on the front of the chest, the arm being held to the side by a sandbag. In three weeks there will be union, practically without deformity. In a child with an incomplete fracture a handkerchief sling for the forearm, worn three weeks, is all that is needed. In a fracture of the collarbone of an adult the Velpeau bandage is efficient. Before applying it, place lint around the chest and cotton over the elbow. Change the bandage every day for the first week, and after that period every third day. Each time it is changed rub the skin with alcohol, ethereal soap, or soap liniment, dry carefully, and examine for excoriations; if any are found, they are anointed with zinc ointment before the dressing is reapplied. The dressing is permanently removed at the end of four weeks, the arm being carried in a sling for another week. The classical apparatus of Desault is now rarely used. The posterior figure-of-eight bandage associated with the second roller of Desault, some turns being made from the elbow of the injured side to the shoulder of the sound side, can be used in cases in which the forward deformity is apt to return. The apparatus of Fox, which is very useful, consists of a pad for the axilla, a sling for the forearm, and a ring for the opposite shoulder, to which ring are tied the tapes from both the pad and the sling (Fig. 172).

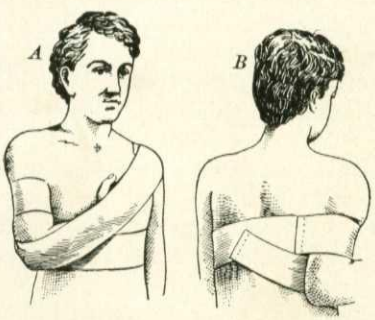


Fig. 173.—Sayre's adhesive-plaster dressing for fracture of the clavicle (Stimson): *A*, First piece; *B*, second piece.

The dressing of Moore, of Rochester, is valuable in an emergency. It consists of a piece of cotton cloth, two yards long, and folded like a cravat until it is eight inches in width at the middle. The center of the bandage rests upon the elbow, the posterior tail is carried across the front of the shoulder of the injured side. The forearm is at an acute angle with the arm, and the other end of the bandage is carried across the forearm, across the back over the opposite shoulder, and around the axilla, where the extremities are stitched together. The forearm is suspended in a bandage sling (S. D. Gross). The four-tailed bandage is preferred by Pick. Sayre's dressing has many advocates (Fig. 173). For this there are required two pieces of rubber plaster, each piece being three inches wide and sufficiently long to go around the chest one and a half times. The end of one piece encircles the arm of the injured side just below the arm-pit; the plaster strip is pulled across the back to the other side, to the front of the chest, and returns again to the middle of the back. This procedure pulls the elbow back and throws the shoulder out. The hand of the injured side is placed on the breast of the opposite side, cotton being interposed, and the second strip of plaster runs from the elbow of the injured side and the opposite shoulder, front, around, and back, pressing the elbow forward, upward, and inward. In children, if it is found difficult to immobilize the parts, the most satisfactory result is obtained by the application of the Velpeau bandage, which is to be overlaid by a thin plaster-of-Paris bandage. If the fragments cannot be coaptated, sterilize the parts, administer ether, incise, clear away the muscle from between the fragments, saw the ends, bore each end and hold them in contact by means of kangaroo-tendon or silver wire. The same procedure should be pursued when a fracture is compound or threatens to become so, or if signs indicate pressure upon vessels or nerves. If a large vessel has been injured, the operation is imperatively necessary. If a patient suffering under a fracture which threatens to become compound refuses the aid of operation, keep him in bed and hold the arm in abduction. In three cases in the Jefferson Medical College Hospital the author wired the fragments with excellent results.

After a broken collar-bone has united, if the shoulder is found to be stiff, make passive movements daily; if these fail, move the joint forcibly, first giving ether or nitrous oxid.

Fractures of the acromial end of the clavicle are due to direct force. If the fracture is between the two coracoclavicular ligaments, deformity is very slight, crepitus is elicited by manipulating with the fingers, and pain exists, but loss of function is not markedly manifest unless it is due to pain. These fractures are treated by interposing cotton between the arm and the side, binding the arm to the side with the second roller of Desault, and hanging the hand in a sling. In fractures external to the ligaments crepitus is manifest on moving the shoulder, the outline of the bone is irregular, severe pain is developed by movement, and deformity is pronounced. The deformity is due to the serratus magnus muscle rotating the scapula forward, the inner end of the outer fragment of the clavicle often coming in contact with the anterior surface of the outer portion of the inner fragment. Fracture of the acromial end of the clavicle is reduced by pulling both of the shoulders strongly backward, and it is kept reduced by the use of a posterior figure-of-eight bandage. In fracture

external to the ligaments the displacement frequently cannot be corrected by position and manipulation. Such cases demand incision and wiring. In either variety of fracture the dressings are worn for four weeks.

Fractures of the sternal end of the clavicle are very rare. They are caused by either direct or indirect force. In such a fracture there are found crepitus, projection at the seat of fracture, rigidity of the sternocleidomastoid muscle, and shortening of the clavicle. The inner end of the outer fragment always passes forward, and often also downward and inward. Reduce these fractures by pulling the shoulders back, and treat them by means of the posterior figure-of-eight bandage worn for four weeks. Wiring may be necessary.

Fractures of the Scapula.—This bone is not often broken, as it rests upon thick muscles and elastic ribs; it is freely movable, and it has attached to it a bone which easily breaks.

Fractures of the Body of the Scapula.—These are due to direct violence. The *symptoms* are pain (which becomes agonizing on attempting to rotate the shoulder-blade), ecchymosis, and swelling. Crepitus is sought for by placing the hand over the bone and making movements of the arm; also by holding the point of the shoulder and lifting up the lower angle of the bone. The latter plan may develop mobility. The spine of the scapula is uneven only when it is itself fractured. Examine for unevenness of the vertebral border of the shoulder-blade. In fractures of the body of the scapula a shoulder-cap is applied, a gutta-percha splint is moulded over the scapula, the arm is bound to the side, and the hand is carried in a sling. The apparatus is worn for four weeks.

Fractures of the spine of the scapula are treated as are fractures of the body of the bone, and for the same time.

Fractures of the Neck of the Scapula.—Fracture of the *anatomical neck* has not been proved to exist. Fracture of the *surgical neck* is evinced by flattening of the shoulder, prominence of the acromion, and the presence of a lump in the axilla, crepitus being developed by pressing the axillary prominence upward and backward. The deformity is reduced with ease, but it at once recurs. The condition is treated by placing a pad in the axilla, a shoulder-cap on the shoulder, applying the second roller of Desault, and supporting the forearm and elbow in a sling. A Velpeau dressing can be used, associated with the application of a folded towel in the axilla. The dressing is to be worn for five weeks.

Fractures of the glenoid cavity are not very unusual, and may occur with or without dislocation. Fracture of this region arises from direct force applied to the shoulder. The existence of this fracture is determined by excluding fractures of other bones and by detecting crepitus when the arm is at a right angle to the body and the humerus is pushed against the glenoid cavity, the crepitus not being found when the arm hangs by the side.

Treatment is by the second roller of Desault and a forearm sling worn for four weeks; careful passive movements limit ankylosis. If ankylosis occurs, adhesions must be broken up while the patient is under ether or nitrous oxid.

Fractures of the acromion process are often met with as the result of direct violence. The existence of fracture of the acromion is indicated by pain, by inability to abduct the arm, by flattening of the shoulder, by

sudden lowering of the point of the shoulder, by mobility, and by crepitus. To treat a case of this kind, put a large pad in the axilla with the base down, bind the arm over the pad with the second roller of Desault, lifting the elbow with turns of the roller carried over it and the opposite shoulder, thus splinting the bone in place by the head of the humerus pushing against the coraco-acromial ligaments. The dressing is to be worn for four weeks.

Fractures of the coracoid process rarely happen alone, and may arise from direct force or from muscular action. But little displacement is found. Crepitus and mobility are usually detected. Inability to shrug the shoulder inward was pointed out as a symptom by Byers. Such a case is well treated by a Velpeau bandage, which is to be worn for four weeks.

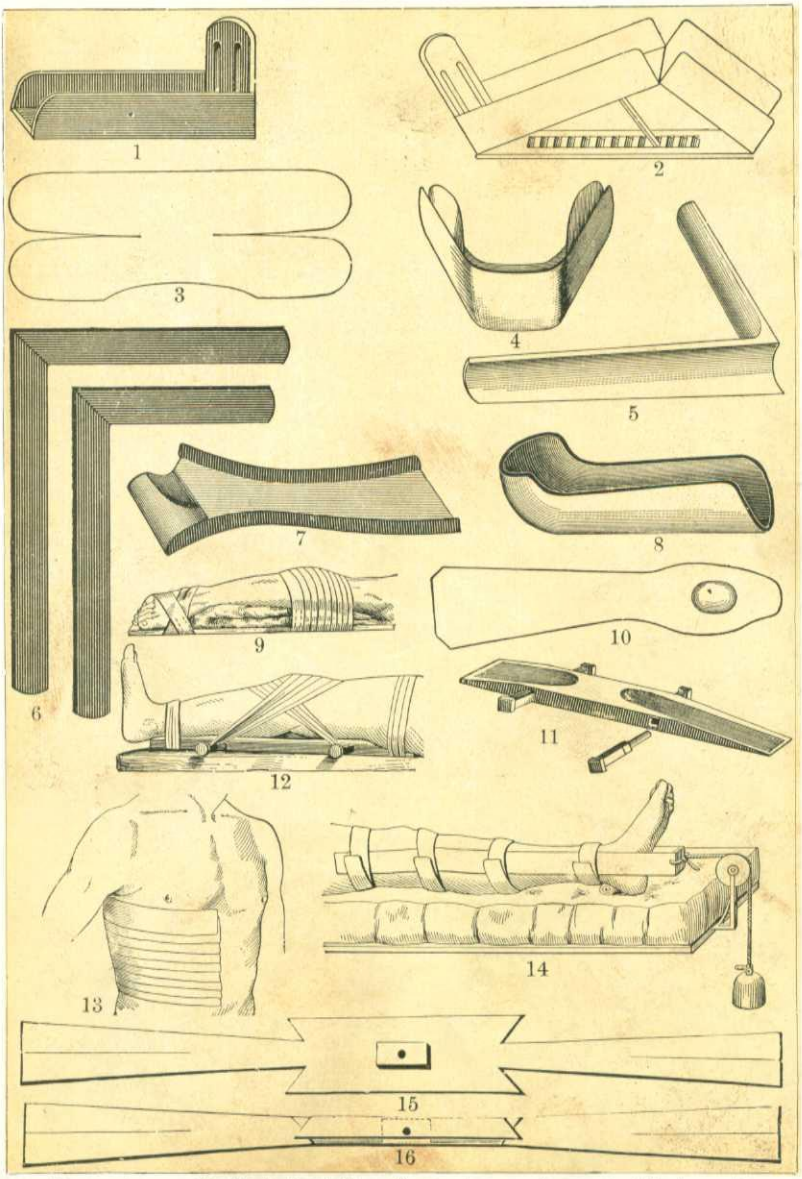
Fractures of the humerus are divided into (1) fractures of the upper extremity; (2) fractures of the shaft; and (3) fractures of the lower extremity. In examining any fracture of the humerus, feel at once for the pulse, so as to ascertain if the artery has been torn; in any fracture near the head of the humerus be certain that dislocation does not exist.

Examination of the Shoulder.—In some cases ether must be administered. Compare the injured shoulder with the sound shoulder, the patient, if not anesthetized, being seated in a chair or stool. The direction of the axis of the arm is noted. The surgeon grasps the flexed elbow with one hand and the shoulder with the other; he thus can move the extremity and palpate the joint and adjacent points. The shoulder is moved gently in every direction, and the surgeon notes if the head of the bone moves with the shaft. Examination shows if the head of the bone is in place or if the glenoid cavity is vacant—if the head of the bone is in an abnormal situation, if it is altered in contour, if there is crepitus or preternatural mobility, and if any movement is impaired. The acromion process, outer end of the clavicle, coracoid process of the scapula, and neck of the scapula are also investigated. The length of the arm is obtained by measuring from the apex of the acromion process of the scapula to the apex of the external condyle of the humerus, and it is compared with the length of the sound extremity.

1. **Fractures of the upper extremity of the humerus** include (*a*) fractures of the anatomical neck; (*b*) fractures of the surgical neck; (*c*) fractures of the head, oblique and longitudinal; and (*d*) separation of the upper epiphysis.

Fractures of the Anatomical Neck of the Humerus.—The anatomical neck is the constricted circumference of the articular surface, and fractures of it, though rare, do occur, especially in the aged. The line of fracture in some cases follows the insertion of the capsule, in others it is entirely within the capsule, but in most it is without the capsule above and within the capsule below; hence the term "intracapsular" is rarely correct as a designation. Such a fracture may be impacted. The *cause* is direct violence or a fall or a blow upon the elbow when the arm is abducted. Polloson, of Lyons,* has reported a case due to muscular action. The patient died in eclampsia, and at the necropsy it was found that both humeral heads were fractured and impacted. The fractures must have been produced by the muscles throwing the heads of the bones violently against the glenoid cavities, probably by adduction.

* Rev. de Chir., vol. viii, 1888.



1. Fracture-box. 2. Double Inclined Plane Fracture-box. 3. Jaw-cup (unfolded). 4. Jaw-cup (folded). 5. Anterior Angular Splint. 6. Internal Angular Splint. 7. Bond Splint. 8. Shoulder-cap. 9. Dupuytren Splint in Pott's Fracture. 10. Agnew Splint for Fracture of the Metacarpus. 11. Agnew Splint for Fracture of the Patella. 12. Agnew Splint applied. 13. Strapping the Chest in Fractured Ribs. 14. Extension Apparatus in Fracture of the Femur. 15, 16. Adhesive Strips for Extension Apparatus.

Symptoms.—The symptoms in fracture of the anatomical neck are pain, swelling, ecchymosis, slight irregularity of the shoulder (which irregularity is soon hidden by tumefaction), and inability to actively abduct the arm. Deformity, as a rule, is slight or is absent, because the capsule is rarely entirely torn from the lower fragment. If deformity exists, it is due to the muscles inserted on the bicipital groove and to the coracobrachialis, which pull the lower fragment inward and forward. Treves says that a tear of the reflected fibers of the capsule leads to subsequent necrosis, because this joint has no ligamentum teres. In unimpacted cases there is crepitus, and mobility of the shaft can be detected near the head of the bone. In some cases impaction occurs, the upper fragment impacting into the lower. In this condition there are very slight shortening and trivial shoulder-flattening,

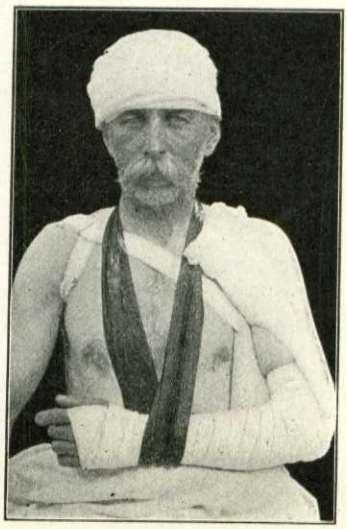


Fig. 174.—Fracture at upper end of the humerus. Note hand, forearm, and elbow bandaged; axillary pad and strap, plaster-of-Paris shoulder-cap, sling (Scudder).

Fig. 175.—Fracture at upper end of the humerus. Arm and elbow bandaged. Axillary pad and shoulder-cap in position. Application of circular bandage to trunk and shoulder. Sling not shown (Scudder).

no crepitus unless the tuberosity is broken off, no mobility, and, as Erichsen says, the head of the bone, while it can be felt through the axilla, is not in the axis of the limb.

The *prognosis* of fracture of the anatomical neck is usually good for bony union (Hamilton, Pick, and R. W. Smith), but a stiff joint is apt to result.

Treatment.—Feel the pulse to be sure the artery is untorn. In most cases an anesthetic should be given in order to examine with ease and dress with satisfaction. Sometimes the fragments are readily coaptated; occasionally they are not. In a case reported by Carl Beck the axes of the fragments were at right angles and they could only be kept in contact by holding the arm at a right angle to the body ("New York Med. Jour.," April 5, 1902). Some surgeons treat this fracture by simply hanging the wrist in a sling

and suspending a bag of shot from the elbow to make extension. The usual plan of treatment is as follows: flex the arm to a right angle with the body, and carry up from the base of the fingers to above the elbow the turns of a spiral reversed bandage made of flannel. Interpose lint between the arm and the side, and place a V-shaped pad with the apex upward in the axilla. tying the tapes over the opposite shoulder. A shoulder-cap made of pasteboard (Pl. 6, Fig. 8) or plaster-of-Paris (Fig. 174), moulded to fit and well lined with cotton, is applied. The plaster-of-Paris cap is the most satisfactory. It is applied "so as to cover the whole shoulder, the anterior and posterior aspects of the chest and the outer side of the upper arm down to the external condyle of the humerus" (Scudder, on "The Treatment of Fractures") (Fig. 174). The arm with the shoulder-cap is fixed to the side by the second roller of Desault, and the wrist is hung in a sling (Fig. 175). The edges of the bandage should be stitched together. This apparatus is changed daily for the first few days, the body and arm being rubbed at each change with alcohol, soap liniment or ethereal soap. After this period a change every third or fourth day is often enough. Massage is begun at the end of one week, but rotation and motion of the joint are not employed until after three weeks. The dressings are removed at the end of four weeks, the forearm being carried in a sling for two weeks more. In impacted fracture do not pull apart the impaction, do not use a pad, but apply a cap to the shoulder and fix the arm to the side for five weeks. The fracture unites with deformity.

Fractures of the Surgical Neck of the Humerus.—The surgical neck is the constricted portion of bone between the tuberosities and the upper line of the insertion of the muscles on the bicipital groove. Fractures in this region are usually transverse, but they may be oblique. The *causes* are: direct force almost always; indirect force occasionally; and muscular action in rare instances.

Fig. 176.—Internal angular splint and shoulder-cap in fracture of the surgical neck of the humerus.

Symptoms.—The symptoms in fracture of the surgical neck are: pain running into the fingers from pressure upon the brachial plexus; crepitus and mobility on extension; and flattening, which differs from the flattening of dislocation in that it occurs farther below the acromion and that this process is not so prominent. Shortening to the extent of an inch is noted. The head of the bone can be felt in the glenoid cavity, but it does not move on rotating the arm. The upper end of the lower fragment is felt and moves on rotating the arm. The displacement is pronounced. The lower fragment is pulled upward by the deltoid, biceps, coracobrachialis, and triceps; inward by the muscles of the bicipital groove; and forward by the great pectoral; thus, the upper end of the lower fragment projects into the axilla, and the elbow lies from the side and backward. Péan holds that the violence drives the lower fragment forward. The upper fragment is abducted and rotated outward, which position is due, it is generally taught, to the action of the supraspinatus, infraspinatus, and teres minor muscles. In some cases displacement is for-

ward, and in other cases it is not obvious. The lower fragment may impact into the upper, in which case the symptoms are obscure and the diagnosis is made by exclusion. If the impaction is solid and complete, there are the history of direct force, the impaired movements, the slight deformity, and the absence of crepitus. In all fractures of the upper end of the humerus the distinction can be made from dislocation by feeling the head of the bone under the acromion and by noting that it does not move on rotating the arm.

The *prognosis* of fracture of the surgical neck of the bone is good.

Treatment.—Some surgeons treat a fracture of the surgical neck in exactly the same manner as a fracture of the anatomical neck. We prefer the following plan: In many cases give ether in order to examine and dress. Feel the pulse to see that the artery has not been damaged. Reduce by traction and manipulation; if there is an impaction, pull it apart. Take an internal angular splint (Pl. 6, Fig. 6) and pad it well, putting on extra padding at the points that are to rest against the palm, the inner condyle, and the axillary folds. Lay the arm and pronated forearm upon the splint. Apply a padded shoulder-cap. Fix the splint and cap in place with a spiral reversed bandage terminating as a spica of the shoulder, and hang the hand or forearm in a sling (Fig. 176). The dressing is to be worn for four weeks, and the rules to be followed in changing it are the same as in fracture of the anatomical neck. Massage is used after one week and passive motion after four weeks to amend stiffness. In rare cases—those with strong anterior projection of the lower end of the upper fragment—apply an anterior angular splint. In some cases where the deformity strongly tends to recur support by a plaster-of-Paris trough on the back and sides of the arm and shoulder (Fig. 177), or maintain extension by weights and pulleys, the patient being kept in bed (Stimson).

Fig. 177.—Apparatus for fracture of the humerus at any point above the condyles.

Longitudinal and Oblique Fractures of the Head of the Humerus.—By this term may be designated separation of the great tuberosity, or separation of a portion of the articular surface, together with the great tuberosity, from the shaft and lesser tuberosity (Pickering Pick, Guthrie, and Ogston). The *cause* is direct violence to the front of the shoulder.

Symptoms.—The symptoms in longitudinal and oblique fracture of the head are broadening and flattening of the shoulder with projection of the acromion. The upper fragment passes upward and outward, and the lower fragment passes upward and inward to rest on the margin of the glenoid cavity below the coracoid process. The elbow is drawn from the side, there

is some shortening, and the patient cannot abduct his arm. If the surgeon grasps the patient's elbow and holds it to the side and rotates the arm while with his other hand he grasps the upper fragment, crepitus is very positive. Examination develops wide separation of the fragments. The deformity cannot be entirely corrected, because the biceps tendon usually gets between the fragments (Ogston), but a useful limb can usually be obtained.

Treatment.—The plan which gives the best result in treating longitudinal and oblique fracture of the head of the bone is to place the patient on his back upon a hard bed with a small, firm pillow under his head, abduct the arm above the head, rotate it outward so that the back of the hand rests on the bed, and hold it in place by sand-bags. This position should be maintained for three weeks, at the end of which period the fracture can be treated for three weeks more as is a fracture of the anatomical neck. If the patient refuses to go to bed, treat the injury as a fracture of the anatomical neck, padding well over the tuberosities. The dressings should be worn for five weeks, passive motion being made after four weeks. In the above injury feel at once for the pulse, to see if the artery has been torn.

Separation of the Upper Epiphysis of the Humerus.—The epiphysis is united during the twentieth year. Separation is a rare accident and is produced by direct force.

Symptoms.—The chief symptom in separation of the upper epiphysis is projection of the upper end of the lower fragment inward, forward, and upward beneath the coracoid, and consequently a projection of the elbow backward and from the side. If the lower fragment passes forward and not inward, the elbow simply passes back. The upper end of the lower fragment is smooth and convex. Rotation of the shaft develops soft crepitus when the fragments are in contact.

The *prognosis* is good for bony union, though the future growth of the limb may be impaired.

Treatment.—The treatment for separation of the upper epiphysis is a pad in the axilla, a shoulder-cap, binding the arm to the side, and hanging the hand in a sling. Wear the dressing for four weeks, and begin passive motion as directed when dealing with fracture of the upper end of the humerus.

2. **Fractures of the Shaft of the Humerus.**—Fracture of the shaft of the humerus is a very common accident. The *cause* is usually direct violence, such as a blow. The fracture may arise from indirect violence, such as a fall upon the elbow. Muscular action is not rarely also a cause, as in throwing a ball, in catching a tree-limb while falling, or in turning another's wrist as a test of strength (Treves).

The *symptoms* of fracture of the shaft of the humerus are pain, swelling, ecchymosis, inability to move the arm, mobility, and distinct crepitus. Shortening to the extent of three-fourths of an inch occurs. The displacement varies with the situation of the fracture and the direction of the force. If the fracture is above the insertion of the deltoid, the lower fragment is pulled up by the triceps, biceps, and deltoid, and pulled out by the deltoid, and the upper fragment is pulled inward by the arm-pit muscle. In fracture below the deltoid this muscle is apt to pull the lower end of the upper fragment outward, while the lower fragment passes inward and upward because of the action of the biceps and triceps. Injury of the *musculospiral nerve*

sometimes occurs. The nerve may be contused, producing pain at the seat of bruising, and tingling and numbness in the region supplied by the nerve.

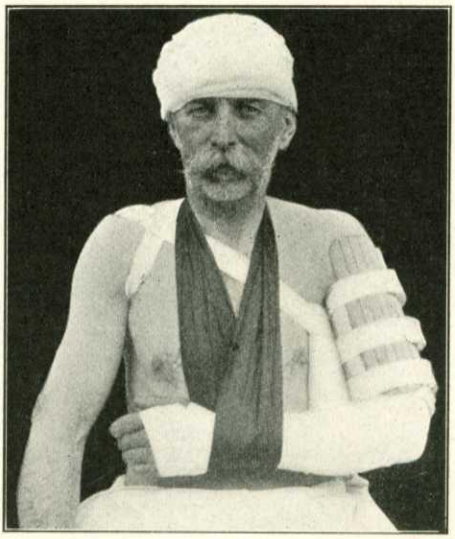


Fig. 178.—Fracture of the shaft of the humerus. Note bandage to hand, forearm, and elbow; axillary pad and strap; coaptation splints and sling. Bandage does not cover fracture (Scudder).

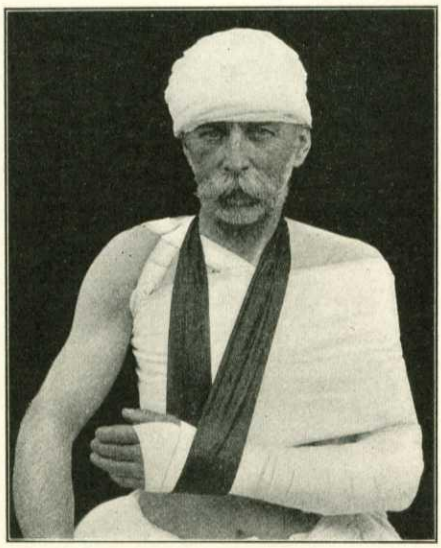


Fig. 179.—Fracture of the shaft of the humerus. Note bandage to hand, forearm, and elbow; adhesive-plaster swathe holding arm upon axillary pad and covering coaptation splints. Sling (Scudder).

In most cases the symptoms soon pass away, but sometimes neuritis ensues. A severe contusion produces not only pain, but paralysis of the muscles

supplied by the nerve, and surface anesthesia. In most cases this condition is recovered from in a few weeks, but sometimes it lasts a long while or even permanently. In musculospiral paralysis the patient is unable to extend the wrist and fingers or to supinate the forearm. There is "complete loss or impaired sensation in the lower half of the outer and anterior aspect of the arm and in the middle of the back of the forearm as far as the wrist" (Scudder, in "The Treatment of Fractures"). The nerve may be divided by a sharp fragment, paralysis of motion and anesthesia resulting at once. In some cases the nerve is caught in and compressed by callus, scar-tissue, or fragments, motor and sensory disturbances resulting.

The *prognosis* is good, but the fact should always be remembered that ununited fractures are commoner in the humerus than in any other bone. Treves believes this to be due to entanglement of muscle between the fragments, lack of fixation of the shoulder-joint, and imperfect elbow-support. Hamilton believes that it is due to the facts that the elbow soon becomes fixed at a right angle, and that any movement of the forearm moves the seat of fracture, and not the elbow.

Fig. 180.—Internal angular splint in fracture of the shaft of the humerus.

Treatment.—It is rarely necessary to anesthetize unless the patient be a nervous woman or an excitable child. Feel the pulse, to be certain the artery has not been lacerated. Reduce the fracture by extension, counter-extension, and manipulation. Apply an internal angular splint without the shoulder-cap (Fig. 180). If this splint does not maintain coaptation of the fragments, associate with it three short humeral splints instead of the shoulder-cap used in fractures near the shoulder-joint. Splints are to be worn for five or six weeks, and after the removal of the splints the wrist is hung in a sling. The sling is dispensed with eight weeks after the infliction of the injury. Passive movements are not to be made until the fracture is well united (after five or six weeks), for, if made too soon, they predispose to non-union, and, as no joint is involved, genuine ankylosis will not occur. Many surgeons treat these fractures by applying plaster-of-Paris to the forearm and the arm (the elbow being flexed to a right angle), binding the arm to the side and hanging the wrist in a sling. Others apply a trough to the arm and forearm (Fig. 177). Scudder prefers to bandage the hand, forearm, and elbow, and apply an axillary pad, coaptation splints, a swathe of adhesive plaster holding arm to the side, and a sling (Figs. 178, 179). In any case in which it is impossible to obtain and maintain correct apposition of the fragments, cut down upon them, and apply sutures. If the nerve is divided, an incision must be made, and the nerve sutured and the bone wired. If the nerve is caught in the callus, after repair has taken place the nerve must be liberated by chiseling the callus away. Neuritis is treated by blisters over the nerve, the use of the descending galvanic current, and the administration of salicylate of ammonium and the bromids.

3. **Fractures of the Lower Extremity of the Humerus.**—These fractures are spoken of as fractures in, or in the neighborhood of, the elbow-joint, and they include (*a*) fractures of the external condyle; (*b*) fractures of the internal condyle; (*c*) fractures of the internal epicondyle; (*d*) fractures at the base of the condyles; (*e*) T- or Y-shaped fractures; (*f*) epiphyseal separation; and (*g*) fractures of the capitellum and trochlea. There may be more than one fracture, or there may be also a dislocation of the humerus, of the ulna, or of both bones. Rarely the fracture is compound. These fractures are frequent injuries in childhood, and are not uncommon in adults.

Method of Examination.—A fracture of the elbow is rapidly followed by great swelling, and the diagnosis is often very difficult. In most cases, when possible, the *x*-rays should be used in arriving at a diagnosis. In every case in which the *x*-rays are not used, and in most cases in which they are, the surgeon examines the parts carefully while the patient is under ether. If swelling is very great, it is necessary to abate it in order to reach any conclusion as to the condition. We can bandage the arm, rest it semiflexed on a pillow, and apply evaporating lotions or even an ice-bag for a day or two, or, what is better, temporarily diminish the swelling by Gerster's plan, which is as follows: Apply an Esmarch bandage from the hand to well above the seat of fracture; this will drive away extra-articular swelling and permit of thorough examination. It is a great advantage to have the patient anesthetized, for then not only can we make an accurate diagnosis, but we can reduce the fracture satisfactorily and apply a careful first dressing.

Compare the injured with the sound elbow. Note swelling and local ecchymosis. Feel the radial pulse. Note the "carrying angle" (Fig. 182). Measure each arm from the tip of the acromion process of the scapula to the tip of the external condyle of the humerus. Feel each prominent body-point and note if it is mobile (condyles, olecranon, head of ulna). Feel the shaft just above the condyles. Mark with ink on each elbow the tip of the external condyle, the tip of the internal condyle, and the tip of the olecranon, and observe the relation between these points of each elbow in flexion and in extension. In an uninjured elbow a straight line transverse to the long axis of the limb with the joint in extension will pass through the condyles and leave the tip of the olecranon just a shade above it. "When the elbow is at a right angle, these three points will be found in the same plane with the back of the upper arm" (Scudder, in "The Treatment of Fractures"). Rotate the radius while a thumb is held against the head of the bone. Make flexion and extension of the elbow and determine if there is any lateral motion. Test for mobility just above the condyles. The above maneuvers will determine the presence or absence of crepitus, preternatural mobility, deformity, etc.

Fractures of the External Condyle of the Humerus.—A fracture of the external condyle runs into the joint and the capitellum is usually broken off. Such an injury occurs oftenest in children, being due to falling on the hand; but it may occur from direct force, and may happen to adults.

Symptoms.—The symptoms of fracture of the external condyle are severe pain, great swelling, and crepitus (found on pressing or moving the condyle and on rotating the radius). Mobility may also be discovered. A projection

is felt on the outer and posterior surface of the elbow. The forearm is semi-flexed and supinated. The patient cannot use the joint.

Fractures of the Inner Epicondyle of the Humerus.—The inner epicondyle is an epiphysis which unites during the seventeenth year. It not infrequently breaks from muscular action or from direct violence, and the fracture does not involve the joint. Crepitus and mobility can be detected. Displacement is slight. The *outer epicondyle* is never fractured alone.

Fractures of the Internal Condyle of the Humerus.—The line of fracture after a break of the internal condyle runs into the joint, to the trochlear surface of the humerus. The *cause* is always direct violence.

Symptoms.—In fracture of the internal condyle the fragment, accompanied by the ulna, goes upward and backward, and when the forearm is extended

Fig. 181.—Loss of carrying function after fracture of inner condyle of the humerus.

the ulna projects posteriorly, the lower end of the humerus being felt in front. The fragment forms a projection back of the elbow. Crepitus and preternatural mobility can be found if swelling is not too great. Crepitus is detected by flexing and extending the forearm. The space between the condyles is broader than normal, and the forearm takes a bend toward the ulnar side, the "carrying function" of the forearm being lost (Fig. 181). When a person carries a heavy object, such as a bucket, he instinctively rests the inner condyle upon the pelvis, and the normal deviation of the forearm outward keeps the bucket from striking the leg. This deviation outward when the inner condyle rests against the ilium gives us the carrying function. In fracture of the inner condyle the broken condyle ascends and the "carrying function" is lost (Fig. 182).

Fractures at the Base of the Condyles of the Humerus.—A fracture in this region is just above the olecranon and is on a higher level behind than in front. The *cause* is direct force acting upon the olecranon.

The *symptoms* are loss of function and pain from injury of the median or ulnar nerve. Crepitus and mobility are readily found. The lower fragment is drawn backward and upward by the action of the triceps, biceps, and brachialis anticus muscles. The lower end of the upper fragment projects in front of the joint. This lesion may be mistaken for dislocation of the bones of the forearm backward. In fracture the limb is mobile; in dislocation it is rigid. In fracture the deformity is easily reduced and strongly tends to recur; in

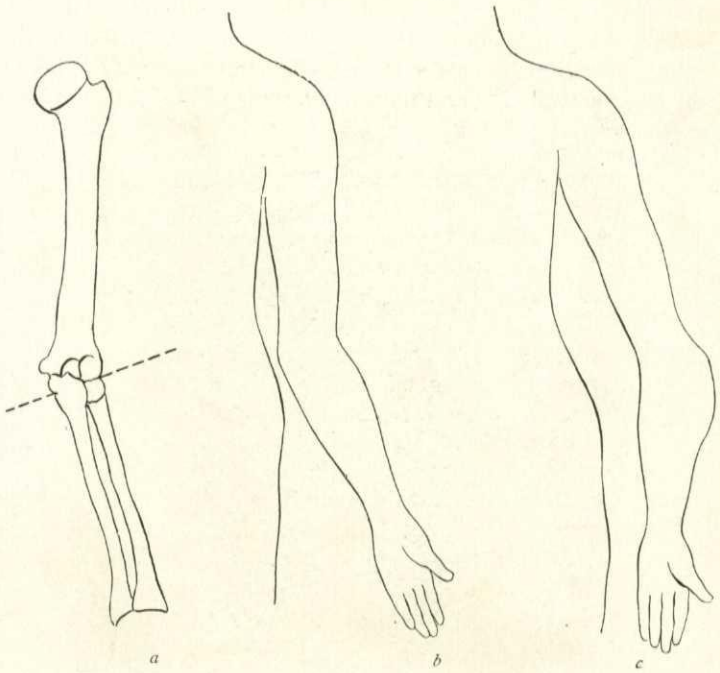


Fig. 182.—Diagram to exhibit the "carrying function" of the forearm, and the loss of this function in fracture of the inner condyle of the humerus: *a* and *b* show the normal relation of the parts when carrying; *c* shows the alteration of axis of the forearm when the inner condyle is fractured, what is known as gunstock deformity resulting (after Allis).

dislocation the deformity is reduced with difficulty and does not tend to recur. In dislocation there is shortening of the forearm, but not of the arm; in fracture there is shortening of the arm but not of the forearm. In dislocation there is a smooth, large projection below the crease in front of the elbow; in fracture there is a sharp projection above the crease. In fracture there is crepitus; in dislocation there is no crepitus.

The *diagnosis* can usually be settled by the Röntgen rays.

T-fractures of the Humerus.—A T-fracture consists of a transverse fracture above the condyles plus a vertical fracture between them. The *cause* is violent direct force applied posteriorly.

Symptoms.—The symptoms are increase in breadth of the joint (Fig. 183), preternatural mobility, crepitus, pain and swelling, mounting up of the inner condyle back of the elbow on the inner side, and of the outer condyle back of the elbow on the outer side. The forearm is semiflexed and supinated, and the carrying function is lost.

Prognosis of Fractures in or near the Elbow-joint.—In many fractures it is difficult or impossible to obtain reduction, and in some it is impossible to maintain reduction. Stimson is undoubtedly right when he says that "in intercondyloid fracture with marked separation there is no practicable means merely to maintain reduction."* The prognosis for complete restoration of function is bad, and in most of these fractures some deformity and considerable stiffness are inevitable. Ankylosis partial or complete is a not unusual sequence. Ankylosis may result from prolonged immobilization, the muscles contracting and becoming fibrous, the fascia and ligaments about the joint shortening, the capsule shrinking and thickening, some of the cartilages becoming

Fig. 183.—Deformity following fracture of the humerus between the condyles.

fibrous, and the joint being partly obliterated. It may result from extravasation of blood into the joint and tendon-sheaths with subsequent formation of fibrous tissue. It may arise from organization of inflammatory exudate within and about the joint and in the sheaths of muscles and tendons. It may arise from the formation of an excess of callus. Bruns claims that in fracture in the joint excess of callus rarely forms, and that masses of callus form chiefly in the line of fracture near but not in a joint.† Excessive callus-formation is sure to take place if reduction is not thoroughly accomplished or if the fragments are not well immobilized but move upon each other. A mass of callus in or about a joint limits or prevents motion.

* Transactions American Surgical Association, vol. ix.

† Max Oberst, in Volkmann's "Sammlung Vorträge."

Treatment of Fractures in or near the Elbow-joint.—Thoroughly set the fracture while the patient is under ether. It is advisable, when it can be done conveniently, to use the *x*-rays to confirm the diagnosis and to use them again after dressings have been applied, to be sure that the bones remain in good position. If swelling is very great, it may be necessary to delay setting for two or even three days, the arm being bandaged and laid upon a pillow or lightly supported on an anterior angular splint during the waiting period.

In all cases except transverse fracture above the condyles reduction is best effected by drawing upon the forearm, supinating it, extending it, and then bending it slowly into a position of acute flexion, the degree of flexion being in inverse ratio to the amount of swelling.

In transverse fracture above the condyles reduction is effected by drawing the forearm and the lower fragment downward and forward and at the same time pushing the upper fragment back.

Some surgeons advocate dressing the fracture on an anterior angular splint, the forearm being fully supinated. The advantage claimed for this splint is that if ankylosis occurs the joint is in a position to be useful, which it is not if ankylosed in extension. Some deformity is usually apparent after treating a case with this splint; the deformity following fracture of the inner condyle is not corrected by it, but if the splint is carefully applied the result is usually a useful extremity in all cases except fracture of the inner condyle. In transverse fracture of the shaft of the humerus above the condyles the anterior angular splint is the best method of treatment, as it prevents displacement. The splint must not be applied when there is great swelling, and swelling must be removed by resting the extremity on a pillow, the elbow being semiflexed, applying evaporating lotions or even an ice-bag, employing massage, and gently compressing by bandaging. In some cases the joint should be aspirated. In order to apply this dressing, take a right-angled splint and pad its outer surface, being careful to place thick, soft pads over the convexity which will press in front of the elbow and over each end of the splint. Fasten the upper end to the arm, then make extension of the forearm, and if the fracture is found to be well reduced, fasten the hand and forearm to the splint (Fig. 184). If the hand and forearm are first fixed to the splint, there will be no extension from the elbow and deformity will result. If posterior projection exists, a pasteboard cup is moulded over the elbow. The extremity is hung in a triangular sling. At night the extremity is kept in the sling or laid on a pillow. Every third or fourth day, while the extremity is carefully steadied, the splint is removed, the arm and forearm well rubbed with alcohol, massaged, and the splint reapplied. The splint is worn between five and six weeks. At the end of the third week, after removing the dressings, slightly flex, slightly extend, and slightly pronate the forearm, and reapply the splint. At the end of the fourth week repeat

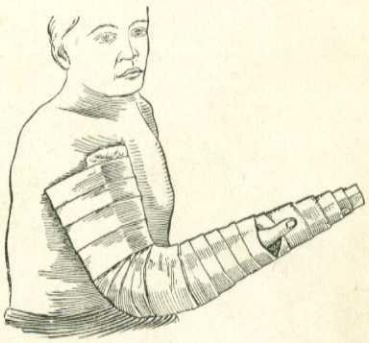


Fig. 184.—Anterior angular splint for fractures in or near the elbow-joint.

this maneuver, making movements of greater range. In the middle of the fifth week and at the end of the fifth week do it again, and flex and extend as much as possible. Very early and very frequent passive motion is objectionable, as it leads to overproduction of callus and ankylosis, but passive motion as above described is imperatively necessary. Many surgeons at the end of the second week apply a Stromeyer splint, which permits the patient and the surgeon to make some motion by means of the screw without removing the dressings. In very stout people an anterior angular splint will not stay in place. In such a case the forearm may be placed at a right angle to the arm and plaster-of-Paris be used. After the dressings are removed employ passive motion, massage, hot and cold douches, inunctions of ichthyol or mercurial ointment, iodin locally, corrosive sublimate and iodid of potassium internally, and direct the patient to systematically use the arm. If in any case after four weeks non-union exists, put up the arm in a plaster splint for three or four weeks more. Some surgeons use a posterior right-angled trough instead of an anterior angular splint (Fig. 177).

Fig. 185.—Frazier's modification of Jones's dressing for injuries of the elbow-joint.

Allis warmly advocates treatment in extension. He holds that the extended position secures the best circulation, and if either condyle is unbroken secures the benefit derivable from a natural splint. Furthermore, in fractures of the inner condyle, it restores the carrying function, which the flexed position does not do. For one week after the accident the patient stays in bed, with his arm extended upon a pillow. After swelling subsides the limb is wrapped firmly in a spiral flannel bandage and plaster is rubbed in or the bandage is covered with adhesive plaster.

Some surgeons extend the limb and apply an ordinary plaster bandage, and in about three weeks substitute an anterior angular splint. The trouble with treatment in extension is that if ankylosis ensues the limb is nearly useless. Furthermore, treatment by extension requires confinement to bed.

Jones, of Liverpool, thinks that splints and bandages are largely responsible for the stiffness which so commonly ensues upon an elbow injury. He advocates treatment by acute flexion in all elbow injuries except fracture of the olecranon. It has been demonstrated that the position of acute flexion forces the fragments into place and holds them firmly between the coronoid process of the ulna, the trochlear surface of the ulna, the fascia, and the triceps tendon. The surgeon must be certain that the radial pulse is perceptible *after* the elbow has been flexed. Flexion is maintained by fastening a bandage around the wrist and neck. The bandage around the neck passes through a rubber tube, which serves to protect the neck. The ball of the thumb should rest against the neck. The bandage is fastened to a leather band around the wrist. The most convenient dressing to maintain Jones's position was devised by Frazier; it is shown in Fig. 185.

After the dressing has been applied certain precautions are to be observed. For the first week or ten days look at the arm daily. If the swelling grows worse, diminish the degree of flexion, and do the same if there is severe pain. If the radial pulse disappears, diminish the flexion until free circulation is obtained. This position is maintained from three to six weeks.* Passive motion and massage are applied as if an anterior splint were being used. The author has treated a number of cases by Jones's method, and now prefers it to any other plan in all fractures of the elbow except fracture of the olecranon and transverse fracture above the condyles. The former injury must be dressed in extension and the latter requires an anterior angular splint.

If it is found impossible to reduce the fragments or to maintain reduction we should follow the advice of John B. Roberts, make an incision and nail the fragments in place. A comminuted fracture requires operation.

In *young children* the anterior angular splint must not be used. It will become loosened, and motion will inevitably take place at the seat of fracture. Such cases can be treated satisfactorily in Jones's position with Frazier's sling, or we can treat them in extension. Bertomier's plan is very useful in young children.† The extremity is dressed without pressure in extension and supination. This can be effected by flannel bandages. In from four to eight days a silicate of sodium bandage is applied in order to prevent pronation. About the sixteenth day the bandage is cut so as to form two troughs. From this period every third day the splints are removed and gentle passive motion is made. The splints are removed permanently at the end of four weeks.

If *false ankylosis* follows fracture of the elbow, the adhesions should be broken up under ether, and for some time the hot-air apparatus should be used daily and massage, passive motion, and the hot and cold douche should be employed. In *true ankylosis* an operation should be performed and the interlocking callus or the interposed tissue or fragment removed, if a skiagraph shows that operation promises success. If gunstock deformity results and produces marked disablement, it should be operated upon. An osteotomy is performed on the inner condyle. The arm is set in the extended position, plaster-of-Paris applied, and is not removed for six weeks.‡

Separation of the lower epiphysis of the humerus is a not unusual accident. The inferior extremity of the humerus may be separated, or the condyles may be separated from each other and from the shaft of the bone.

Symptoms.—The symptoms are prominence in front of the joint, caused by the lower end of the shaft of the humerus; projection backward of the olecranon; the forearm rests midway between pronation and supination. Epiphyseal separation may retard growth and produce deformity.

Treatment.—Jones's position or an anterior splint as above directed.

Fractures of the ulna comprise the following varieties: (1) fracture of the coronoid process; (2) fracture of the olecranon process; (3) fracture of the shaft; and (4) fracture of the styloid process.

Fractures of the coronoid process of the ulna are rarely observed, and practically occur only as a complication of backward dislocation of the ulna or in association with other fractures.

* Provincial Medical Jour., Dec., 1894, and Jan., 1895.
† Révue de Chir., vol. viii, 1888.
‡ G. G. Davis, Phila. Med Jour., May 13, 1899.

Symptoms.—When fracture of the coronoid process is associated with a dislocation, crepitus is appreciated on reduction, and it is found that the deformity of the dislocation promptly returns on cessation of extension. The upper fragment may be pulled upward by the brachialis anticus muscle, and there exists an inability to flex the forearm completely. The position is one of extension with posterior projection of the olecranon. The broken piece is felt in front of the joint.

Treatment.—The treatment is by an anterior splint the angle of which is less than a right angle. Jones's position may be used in treating such a case. A stiff joint may follow.

Fractures of the olecranon process of the ulna occur not uncommonly in adults. Hulke states that such a fracture never occurs before the age of fifteen, but the writer has seen in the Jefferson Medical College Hospital a girl aged fourteen with a fractured olecranon. The *cause* is direct violence or muscular action. Only a small fragment may be torn away, or the entire olecranon may be broken off, and the break may be comminuted or may even be compound.

Symptoms.—The symptoms of fracture of the olecranon are: swelling; partial flexion of the forearm; separation of the fragments, the upper piece being pulled up from half an inch to two inches by the triceps; the space between the fragments is increased by flexion at the elbow, and lessened by extension at the elbow; and there is inability to extend the arm. Bulging of the triceps above the fragments and crepitus on approximating the fragments are observed. In some few cases there is no separation, the periosteum being untorn or the fascial expansions from the triceps holding the fragments in apposition. In such cases crepitus can be elicited by rocking the upper fragment from side to side.

The *prognosis* is fair, fibrous union being the rule. Some joint-stiffness usually occurs, and much ankylosis may be unavoidable.

Treatment.—Fracture of the olecranon is treated with a well-padded anterior splint almost, but not quite, straight. A perfectly straight splint is uncomfortable, and by opening a retiring angle between the fragments and into the joint, favors non-union and ankylosis. The splint should reach from a level with the axillary margin to below the fingers. If the upper fragment does not come in contact with the lower, pull it down by adhesive plaster and fasten the strips to the splint. The author in one case employed a glove to which strings from the adhesive plaster were attached. After applying the splint keep the patient in bed for three weeks. The danger of ankylosis in this fracture is very great, and, in case it occurs in the position of extension, an almost useless arm results. Follow the rule of T. Pickering Pick, and at the end of three weeks anesthetize the patient, press the thumb firmly down upon the top of the olecranon, put the forearm at a right angle, and apply an anterior angular splint and direct it to be worn for two weeks. When the anterior splint has been applied, passive motion should be made every other day, or every third day, and massage should be used at the same time. When the splint is removed, try to increase the range of motion as previously directed. If it is found impossible to secure apposition of the fragments after fracture of the olecranon, incise and apply wires. A compound fracture and a comminuted fracture require operation. Non-union requires wiring of the fragments.

Fractures of the shaft of the ulna alone are most usual near the middle of the bone, are always due to direct violence, and are not infrequently compound. An injury which breaks the ulna is very apt to break the radius also.

Symptoms.—By running the finger along the inner surface of the bone there are detected inequality and depression; crepitus and mobility are easily developed; there are pain and the evidence of direct violence. The long axis of the hand is not on a line with the long axis of the forearm, but is internal to it. If

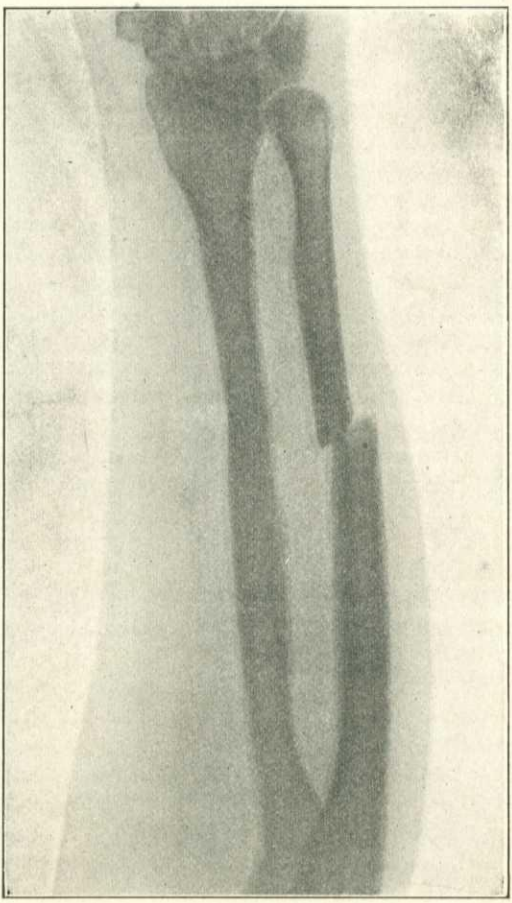


Fig. 186.—Fracture of the shaft of the ulna (case in the Pennsylvania Hospital; skiagraphed by Dr. Gaston Torrance).

deformity exists, it is due to the lower fragment passing into the interosseous space because of the action of the pronator quadratus muscle; the upper fragment, acted on by the brachialis anticus, passes a little forward (Fig. 186). The forearm at and below the seat of fracture is narrower and thicker than normal.

Treatment.—In treating fracture of the shaft of the ulna place the forearm midway between pronation and supination, so as to bring the fragments

together and to obtain the widest possible interosseous space, and thus limit the danger of union taking place between the radius and ulna. The position midway between pronation and supination is obtained by flexing the forearm to a right angle with the arm and pointing the thumb to the nose. Take two well-padded straight splints, one long enough to reach from the inner condyle to below the fingers, the other from the outer condyle to below the wrist; place a long pad of lint over the interosseous space on the flexor side of the limb, and another on the extensor side; apply the splints and hang the forearm in a triangular sling (Fig. 187). Passive motion is to be made in the third week, and the splints are to be worn for four weeks. Fractures of the ulna can be treated very efficiently with plaster-of-Paris.

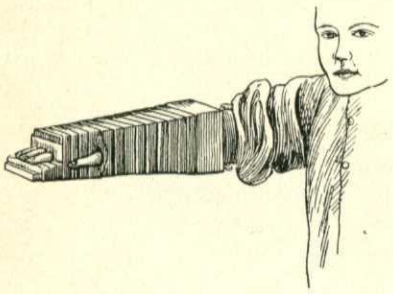


Fig. 187.—Two straight splints in fracture of both bones of the forearm.

Fractures of the styloid process of the ulna are due to direct force. The displacement is obvious.

Treatment.—In treating fracture of the styloid process push the fragment back into place and use a Bond splint with a compress for four weeks, or a plaster-of-Paris dressing.

Fractures of the radius include the following varieties: (*a*) fractures of its head; (*b*) fractures of its neck; (*c*) fractures of its shaft; and (*d*) fractures of its lower extremity.

Fracture of the head of the radius very rarely occurs alone, but it may complicate backward dislocation of the radius.

Symptoms.—The symptoms of fracture of the head of the radius are crepitus on passive pronation and supination, and loss of voluntary pronation and supination.

Treatment.—The treatment of a fracture of the head of the radius is the same as for a fracture in or near the elbow-joint, namely, an anterior angular splint, or placing the extremity in Jones's position.

Fracture of the neck of the radius very rarely occurs alone.

Symptoms.—In this fracture the forearm is pronated and the patient is found to have lost the power of voluntary pronation and supination. Under forced pronation and supination it will be noted that the head of the radius does not move and crepitus is felt. The lower fragment, being pulled upward and forward by the biceps, can be felt in front of the elbow-joint.

Treatment.—The treatment for fracture of the neck of the radius is the same as for fracture of the elbow-joint—namely, an anterior angular splint or Jones's position.

Fracture of the shaft of the radius is far commoner than fracture of the shaft of the ulna. It may occur above or below the insertion of the pronator radii teres muscle. It may arise from either direct or indirect force. Fracture of the shaft of the ulna may coexist as a result of the same accident.

Fracture of the Shaft of the Radius above the Insertion of the Pronator Radii Teres Muscle.—*Symptoms.*—The upper fragment is drawn

forward by the biceps and is fully supinated by the supinator brevis. The lower fragment is fully pronated by the pronator quadratus and pronator radii teres, and its upper end is pulled into the interosseous space. There are crepitus, mobility, pain, narrowing and thickening of the forearm below the seat of fracture, and loss of the power of pronation and supination. The head of the bone is motionless during passive pronation and supination. The hand is prone.

Treatment.—In treating this fracture do not put the forearm midway between pronation and supination, as this position will not bring the fragments into contact, the upper fragment remaining flexed and supinated. To bring the lower fragment in contact with the upper, flex and fully supinate the forearm. Apply an anterior angular splint to the extremity for four weeks, and make passive motion in the third week.

Fracture of the Shaft of the Radius below the Insertion of the Pronator Radii Teres Muscle.—In this variety of fracture the upper fragment is acted on by the biceps, the supinator brevis, and the pronator radii teres, and it remains about midway between pronation and supination, passing forward and also into the interosseous space. The lower fragment is acted on by the supinator longus and the pronator quadratus, the latter being the more powerful of the two, hence the lower fragment is moderately pronated, its upper extremity being drawn into the interosseous space. Other symptoms are identical with those of fracture above the insertion of the pronator radii teres.

Treatment.—In treating fracture below the pronator radii teres the forearm is flexed and is placed midway between pronation and supination; two interosseous pads and two straight splints are applied as for fracture of the ulna (Fig. 187). The splints are worn for four weeks, and passive motion is made in the third week. Plaster-of-Paris is a most satisfactory dressing.

Fracture of the shafts of both bones of the forearm is not frequently seen. It is caused by either direct or indirect force.

Symptoms.—After fracture of both bones of the forearm the hand is pronated and the two lower fragments come together and are drawn upward and backward or upward and forward by the combined force of flexor and extensor muscles, shortening being manifest and the projection of the lower fragments being detected on either the dorsal or the flexor surface of the forearm. The upper fragment of the ulna is somewhat flexed by the brachialis anticus; the upper fragment of the radius is flexed by the biceps and is pronated and drawn toward the ulna by the pronator radii teres. The forearm is narrower than it should be (the ends of the fragments having passed into the interosseous space) and is thicker than normal from front to back (the contents of the interosseous space having been forced out). Crepitus, mobility, pain, and inequality exist, the power of rotation is lost, and on passive rotation the head of the radius does not move. The forearm is prone and semiflexed.

Treatment.—The treatment consists in the application of two straight splints and two interosseous pads, the forearm being flexed to a right angle and placed midway between pronation and supination (Fig. 187). The splints are worn for four weeks, and passive motion is made in the third week. Instead of these splints, a plaster-of-Paris dressing can be used.

Fractures of the Lower Extremity of the Radius.—*Colles's fracture* is a

transverse or nearly transverse fracture of the lower end of the radius, between the limits of one-quarter of an inch and one and a half inches above the wrist-joint, the lower fragment sometimes mounting upon the dorsum of the upper fragment. An oblique fracture beginning within half an inch of the joint and passing into the joint is known as *Barton's fracture.* Colles's fracture was first recognized as a fracture by Colles, of Dublin, in 1814. Before his time the injury was called backward dislocation of the wrist. It is a very common injury, is met with most frequently in those beyond the age of forty, and oftener in women than in men. It is due to transmitted force (a fall upon the palm of the pronated hand). Some think that the force is received by the ball of the thumb and passes to the carpal bones and the edge of the radius; a fracture beginning posteriorly rather than anteriorly and the force driving the lower fragment upon the dorsal surface of the radius, the carpus and lower fragment moving upward and outward. It is much more likely that this fracture is due to cross-strain on the bone. There is sudden traction upon the anterior ligaments, which drag upon the bone and break it at a point where the cancellous end of the radius joins the compact shaft (Fig. 188). The fragments are not unusually impacted. In the author's experience dislocation of the lower end of the ulna is a not unusual complication, which arises from a fracture of the ulnar styloid or tearing off of the internal lateral ligament of the wrist.

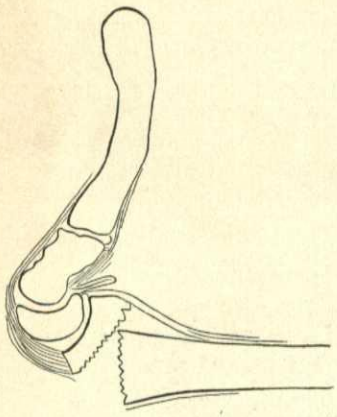
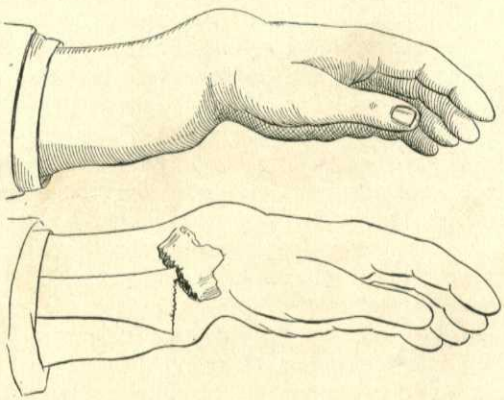


Fig. 188.—Effect upon the lower end of the radius of the cross-breaking strain produced by extreme backward flexion of the hand (Pilcher).



Figs. 189, 190.—Deformity at the wrist consequent upon displacement backward of the lower fragment of the radius after fracture at its lower extremity (Levis).

Symptoms.—In Colles's fracture the hand is abducted (drawn to the radial side of the forearm) and pronated, the head of the ulna is prominent, the styloid process of the radius is raised, and the lower fragment may mount on the back of the lower end of the upper fragment, causing a dorsal projection, termed by Liston the "silver-fork deformity" (Figs. 189 and 190). The lower end of the upper fragment can be felt beneath the flexor tendons above the wrist. The position in deformity is produced by the force. Some consider it is maintained by the action of the supinator longus and the flexor and

extensor muscles, but particularly by the extensors of the thumb. Pilcher has demonstrated the fact that in this fracture a portion of the dorsal periosteum is untorn, and this untorn portion acts as a binding band to hold the fragments in deformity. Pronation and supination are lost. In this fracture the hand can be greatly hyperextended (Maisonneuve's symptom). Crepitus, which is best obtained by alternate hyperextension and flexion, can be secured unless swelling is great or impaction exists. Crepitus on side movements is rarely obtainable. Impaction may greatly modify the deformity, though displacement generally exists to some extent, and the fragments do not ride easily on each other. The styloid process of the ulna may be broken, or the inferior radio-ulnar articulation may be separated. This latter complication allows the lower fragment to roll freely upon the upper, and the characteristic silver-fork deformity does not appear. If the styloid process of the ulna is

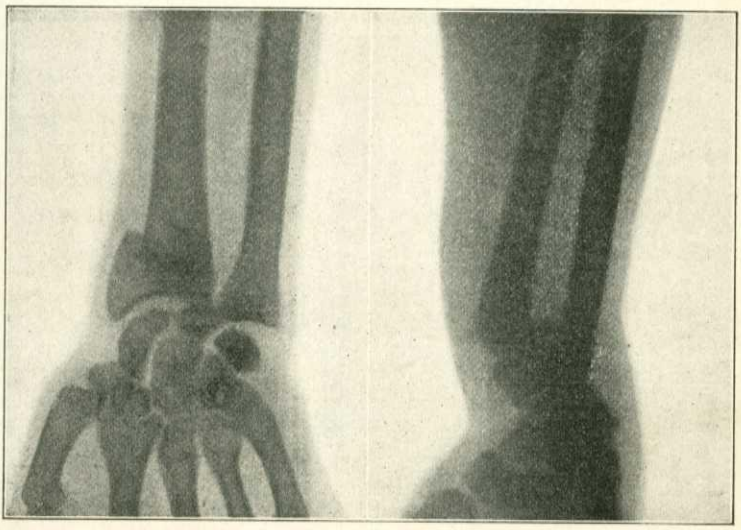


Fig. 191.—Colles's fracture of the radius (Pennsylvania Hospital case; skiagraphed by Dr. Gaston Torrance).

broken, pressure over it causes great pain. If a person in falling strikes the back of the hand and a fracture of the radius occurs, the lower fragment is driven upon the front surface of the upper fragment and is felt under the flexor tendons at the wrist. An elaborate study of fracture of the radius with forward displacement of the lower fragment has been published by John B. Roberts.*

Treatment.—In treating Colles's fracture reduce the deformity by hyperextension to unlock the fragments and relax the dorsal periosteum, and follow by longitudinal traction to separate the fragments, and forced flexion to force them into position. This formula was introduced many years ago by the late R. J. Levis. It is of the first importance to thoroughly reduce this fracture, and very often it is not thoroughly reduced. Imperfect reduction means permanent deformity, stiffness of the tendons and wrist, and possibly an almost useless hand. The extremity can be placed upon a Levis splint (Fig. 192), the posi-

*Am. Jour. Med. Sci., Jan., 1897.

tion maintaining reduction and the tense extensor tendons giving dorsal support. Some surgeons use Gordon's pistol-shaped splint. The favorite splint in Philadelphia practice in the past has been Bond's (Pl. 6, Fig. 7). It places the hand in a natural position of rest (semiflexion of the fingers, semi-extension of the wrist, and deviation of the hand toward the ulna). Two pads are used: a dorsal pad which overlies the lower fragment, and a pad for the flexor surface

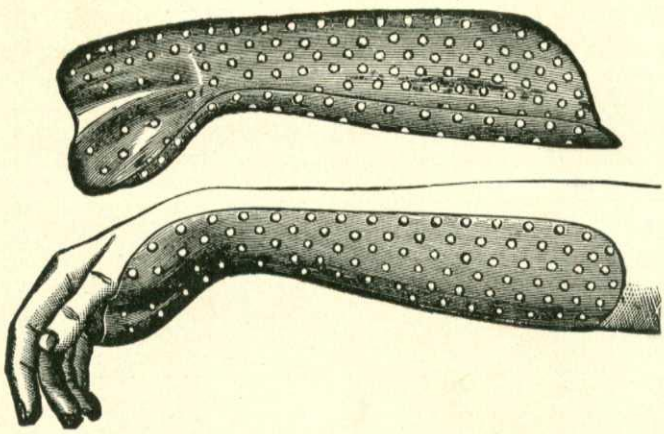


Fig. 192.—Levis's radius-splints, right and left, for fracture of the lower end of the radius.

which overlies the lower end of the upper fragment. A bandage is applied, the thumb and fingers being left free (Fig. 193). Passive motion is begun upon the fingers in three or four days, and upon the wrist during the second week. The splint is removed in three weeks, and a bandage is worn for a week or two more because of the swelling. In applying the Bond splint, do not pull the hand too much up on the block, or the fracture will unite with a projection upon the flexor surface of the extremity and the tendons of the wrist will be apt to be caught in the callus. The most satisfactory dressing is the straight dorsal splint advised by Roberts (Fig. 194). I use it almost invariably. It prevents the recurrence of deformity and is mechanically the proper mode of treatment. It should be worn for three weeks. Undoubtedly more or less stiffness often follows Colles's fracture, and some very able surgeons have been so impressed with the frequency of its occurrence that they have dispensed with the use of a splint. Sir Astley Cooper long ago spoke of placing the arm in a sling as proper treatment for fracture of the radius. Moore, of Rochester, applied a cylindrical compress over the ulna, held in place for six hours with adhesive plaster, then cut the plaster, placed the forearm in a sling, and let the hand hang over the edge of the sling. Pilcher applies a band of adhesive plaster around the

Fig. 193.—Bond's splint in Colles's fracture.

wrist and supports the wrist in a sling, but, as Storp says, dispensary patients are apt to disarrange this dressing. Storp wraps a piece of rubber plaster four inches wide around the wrist, and places a second piece around the first so arranged as to form a fold over the radius; an opening is made through the fold for the passage of a sling. In ten days the plaster is removed and the forearm is carried in a sling. If a stiff joint and limited tendon-motion eventuate from the fracture, use massage, frictions, sorbefacient ointments, tincture of iodin, electricity, hot and cold douches, and the hot-air apparatus, or give ether and forcibly break up adhesions. If reduction was not thoroughly effected and too great a length of time has not elapsed, and the hand is helpless and painful, the bone should be refractured. In a young or middle-aged person, in whom a useless hand has followed an ill-reduced fracture, osteotomy is justifiable.

Fracture of both the Radius and Ulna near the Wrist.—Colles's fracture may be complicated by a fracture of the ulna other than of its styloid process.

Symptoms.—In fracture of the radius and ulna near the wrist the lower ends

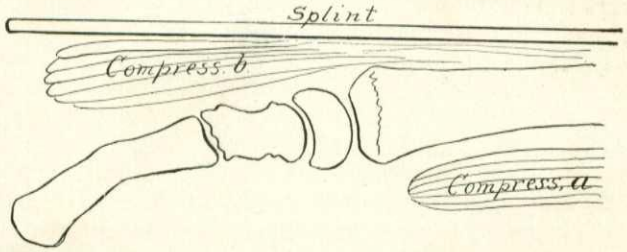


Fig. 194.—Diagram showing the arrangement of compresses and splint best adapted to retain fragments in proper position after reduction (Pilcher).

of the upper fragments come together, the upper fragment of the radius is pronated, and the lower fragment of the radius is drawn up. Pain, crepitus, mobility, shortening, and loss of function exist.

Treatment.—Fracture of the radius and ulna near the wrist should be treated with the straight dorsal splint, as in Colles's fracture.

Separation of the Lower Radial Epiphysis.—This accident occurs in children from falling upon the palm of the hand. It never happens after the twentieth year.

Symptoms.—In separation of the lower radial epiphysis the lower fragment mounts upon the upper and produces a dorsal projection like Colles's fracture, but the hand does not deviate to the radial side. The deformity resembles that of a backward carpal dislocation, but is differentiated from dislocation by the unaltered relation in the fracture between the styloid processes and the carpal bones.

Treatment.—The treatment in separation of the lower radial epiphysis is the same as for Colles's fracture.

Fractures of the carpus are not frequent, and they are usually compound. The *cause* is violent direct force.

Symptoms.—Fractures of the carpus are indicated by pain, swelling, evi-

dences of direct force, sometimes crepitus, loss of power in the hand, and a very little displacement.

Treatment.—Many compound comminuted fractures of the carpus require amputation. In an ordinary compound fracture, asepticize, drain, dress with antiseptic gauze and a plaster-of-Paris bandage, cutting trap-doors in the plaster over the ends of the drainage-tube. In a simple fracture dress the hand upon a well-padded straight palmar splint (Pl. 5, Fig. 10) reaching from beyond the fingers to the middle of the forearm, and place the hand and forearm in a sling. The splint is worn for four weeks, and passive motion of the wrist is begun in the second week.

Fractures of the Metacarpal Bones.—Fracture of the metacarpus is very common. One or more bones may be broken. The first metacarpal bone is oftenest broken; the third is rarely broken (Hulke). The *cause* is direct or indirect force.

Symptoms.—The signs of a metacarpal fracture are—dorsal projection of the upper end of the lower fragment or the lower end of the upper fragment; pain; crepitus; and often evidences of direct violence.

Treatment.—To treat a fracture of a metacarpal bone reduce by extension; place a large ball of oakum, cotton, or lint in the palm to maintain the natural rotundity, and apply a straight palmar splint like that used for fracture of the carpus (Pl. 6, Fig. 10). It may be necessary to apply a compress over the dorsal projection. The duration of treatment is three weeks, and passive motion is begun after two weeks. A plaster-of-Paris dressing is often used.

Fractures of the Phalanges.—The phalanges are often broken. The fracture may be compound. The *cause* usually is direct force.

Symptoms.—Fracture of a phalangeal bone is indicated by pain, bruising, crepitus, and mobility, with very little or no displacement.

Treatment.—If the middle or distal phalanx is broken, mould on a trough-like splint of gutta-percha or of pasteboard, which splint need not reach into the palm. If the proximal phalanx is broken, carry the splint into the palm of the hand. Make the splint of gutta-percha, pasteboard, wood, or leather. The splint is worn three weeks. A sling must be worn, otherwise the finger will constantly be knocked and hurt. Some cases require a dorsal as well as a palmar splint. These cases are dressed most satisfactorily with a silicate of sodium or plaster-of-Paris bandage.

Fracture of the femur is a very common injury. The divisions of the femur are (1) the upper extremity; (2) the shaft; and (3) the lower extremity.

1. **Fractures of the upper extremity of the femur** are divided into (*a*) intracapsular; (*b*) extracapsular; (*c*) of the great trochanter; and (*d*) epiphyseal separation (either of the great trochanter or the head).

Examination of the Hip.—It is sometimes though rarely necessary to give ether. Remove all the patient's clothing and place him recumbent upon a table. Note the position. Feel with care the great trochanter and femoral neck. Very gradually and gently make movements to determine if there is impairment, undue mobility, or crepitus. Never make sudden or violent movements in looking for crepitus. The diagnosis can be made even if crepitus is not obtained, and rapid or violent movements may tear apart an impaction. Measure the sound extremity and the injured extremity. The measurement is made from the anterior superior spine of the ilium to

the inner malleolus. Other symptoms to be looked for are set forth on pages 440–442.

Intracapsular Fracture of the Femur.—Intracapsular fracture of the neck of the femur is transverse or only slightly oblique (Fig. 195), and is not unusually impacted (Figs. 151, 152, 155). Stokes follows Gordon, of Belfast, in classifying fractures of the femoral neck. He divides them into intracapsular and extracapsular, and subdivides intracapsular fractures into fracture with penetration of the cervix into the head; fracture with reciprocal penetration; intraperiosteal fracture at the junction of the cervix and head; intraperiosteal

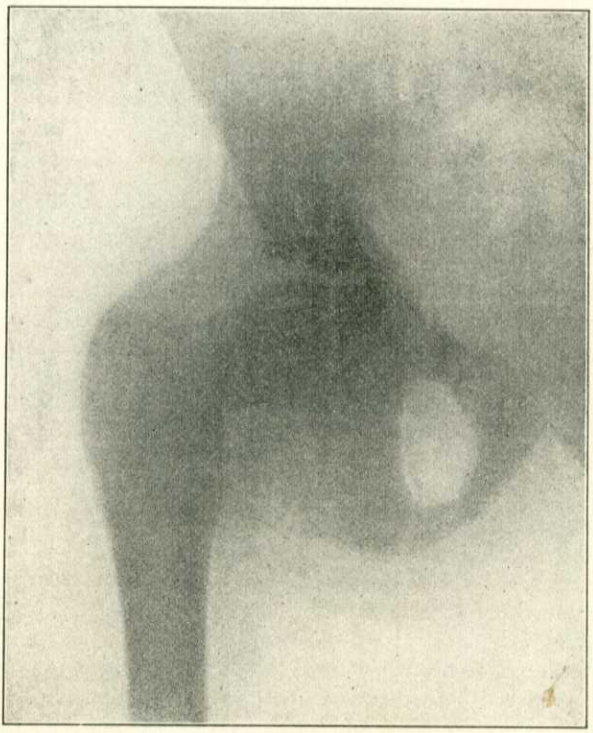


Fig. 195.—Intracapsular fracture of the hip (Pennsylvania Hospital case; skiagraphed by Dr. Gaston Torrance).

fracture of the center of the cervix; extraperiosteal fracture, with laceration of the cervical ligaments. The last-named fracture is the most common. The first four forms may unite by bone, the fifth form will not because of non-apposition, lack of nutrition, effusion of blood, synovitis, or interstitial absorption.* Stokes claims that we may have penetration, but not impaction. The *cause* is often slight indirect force, of the nature of a twist, acting upon a person of advanced years (more often a woman than a man), but not unusually a fall upon the great trochanter is the cause. A fall upon the knees, a trip, or an attempt to prevent a fall may produce this fracture. It often happens that the fall is due to the fracture rather than that the fracture

* Stokes, in Brit. Med. Jour., Oct. 12, 1895.

arises from the fall. Intracapsular fracture is never caused by direct force unless it is due to gunshot violence. The aged are more liable to intracapsular fracture than the young or the middle-aged, because, first, the angle which the neck forms with the axis of the femur becomes less obtuse with advancing years, and may even become a right angle; this change is more pronounced in women than in men; secondly, the compact tissue becomes thinned by absorption, the cancelli diminish, the spaces between them enlarge, the bony portions of the cancellous structure are thinned and destroyed, and the cancellous structure becomes fatty and degenerated. Sutton has shown that in rare cases this fracture may occur in the young, even before the union of the epiphyses.

Symptoms.—In intracapsular fracture there is usually shortening to the extent of from half an inch to an inch; but in some cases no shortening can be detected. Shortening of a quarter of an inch does not count in making a diagnosis, for one limb is often naturally a little shorter than the other. If the reflected portion of the capsule is not torn, the shortening is trivial in amount or is entirely absent. In some cases shortening gradually or suddenly increases some little time after the accident. This is due to separation of a penetration, tearing of the previously unlacerated fibrous synovial reflection, or restoration of muscular strength after traumatic paresis has passed away. A gradually increasing shortening arises from absorption of the head of the bone. Shortening is due chiefly to pulling upon the lower fragment by the hamstring, the glutei, and the rectus muscles.

Pain is usually present anteriorly, posteriorly, and to the side. The area of pain is localized, and motion or pressure greatly increases the suffering.

Eversion exists, spoken of as "helpless eversion," though in a very few instances the patient can still invert the leg. This eversion is due to the force of gravity, the limb rolling outward because the line of gravity has moved externally. That eversion is not due to the action of the external rotator muscles, as was taught by Astley Cooper, is proved by the fact that when a fracture happens in the shaft below the insertion of these muscles the lower fragment still rotates outward. This is further demonstrated by the considerations that the internal rotators are more powerful than the external, that some patients can still invert the limb after a fracture, and that eversion persists during anesthesia.* In some unusual cases *inversion* attends the fracture. Inversion, if it exists, is due to the fact that the limb was adducted and inverted at the time of the accident, and after the accident it remains in this position (Stokes). Besides shortening and eversion, the leg is somewhat flexed on the thigh and the thigh on the pelvis, the extremity when rolled out resting upon its outer surface. Abduction is commonly present.

Loss of power is a prominent symptom: the limb can rarely be raised or inverted; although in rare cases, when the fibrous synovial envelope is untorn, the patient may stand or even take steps. Pain is not commonly severe except upon motion, when it may be localized in the joint. In some cases the pain is violent. Crepitus often cannot be found, either because the fragments cannot be approximated, because penetration exists, or because the bone is greatly softened by fatty change. To obtain crepitus the front of

* Edmund Owen: "A Manual of Anatomy."

the joint must be examined while the limb is extended and rotated inward. But why try to obtain crepitus? The diagnosis is readily made without it; in many cases it cannot be detected, and the endeavor to obtain it inflicts pain and may produce damage. These fractures offer a not very flattering chance of repair, and efforts to find crepitus may produce serious damage.

Altered Arc of Rotation of the Great Trochanter (Desault's sign).—The pivot on which the great trochanter revolves is no longer the acetabulum, and the great trochanter no longer describes the segment of a circle, but rotates only as the apex of the femur, which rotates around its own axis. It is needless to try to obtain this sign; to do so inflicts violence on the parts.

Relaxation of the fascia lata (Allis's sign) simply means *shortening*. The fascia lata is attached to the ilium and the tibia (iliotibial band), and when shortening brings the tibia nearer to the ilium this band relaxes and permits one to push more deeply inward on the injured side, between the great trochanter and the iliac crest, and near the knee above the outer condyle, than on the sound side. In this examination each limb should be adducted. Allis has pointed out another sign: when the patient is recumbent the sound thigh cannot be raised to the perpendicular without flexing the leg; the injured thigh can be.

Lagoria's sign is a relaxation of the extensor muscles.

Ascent of the Great Trochanter above Nélaton's Line.—This line is taken from the anterior superior iliac spine to the most prominent part of the ischial tuberosity (Fig. 196). In health the great trochanter is below, and in intracapsular fracture it is above, this line.

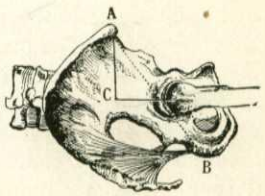


Fig. 196.—A C D, Bryant's ilio-femoral triangle; A B, Nélaton's line (Owen).

Relation of the Trochanter to Bryant's Triangle (Fig. 196).—Place the patient recumbent, carry a line around the body on a level with the anterior superior iliac spines, draw a line from the anterior iliac spine on each side to the summit of the corresponding great trochanter, and measure the base of the triangle from the great trochanter to the perpendicular line to determine the amount of ascent. The difference in measurement between the two sides shows the amount of ascent of the trochanter; that is, shows the extent of shortening.

Morris's measurement shows the extent of inward displacement. Measure from the median line of the body to a perpendicular line drawn through the trochanter on each side of the body.

Diagnosis.—The *x*-rays are a valuable aid to diagnosis (Fig. 195). Intracapsular fracture without separation of fragments may be mistaken for a mere contusion, and the diagnosis may continue obscure unless the fragments separate. Loss of function in contusion is rarely complete or prolonged, although occasionally the head of the bone is absorbed. Early after a contusion, and usually throughout the case, there is no alteration between the relation of the spine of the ilium and the trochanter, and no shortening. Some little time after a severe contusion the head of the bone may be absorbed. Contusion of a rheumatic joint leads to much difficulty in diagnosis. Intracapsular fracture may be confused with

extracapsular fracture or with a dislocation of the hip-joint. Extracapsular fracture, which is common in advanced life, but is met with in middle life or even occasionally in the young, results usually from great violence over the great trochanter; if non-impacted, there are noted shortening of from one and a half to three inches, crepitus over the great trochanter, and usually, but not invariably, eversion; if impacted, there is less eversion, crepitus is almost or entirely absent, and the shortening is limited to about an inch. Great tenderness exists over the great trochanter in both impacted and non-impacted fractures. The extensor muscles are relaxed. In dislocation on the dorsum of the ilium the patient is usually a strong young adult. There is a history of forcible internal rotation. There are inversion (the ball of the great toe resting on the instep of the sound foot), rigidity, ascent of the great trochanter above Nélaton's line, and shortening of from one to three inches. The head of the bone is felt on the dorsum of the ilium, and the trochanter mounts up toward the spine of the ilium, and pressure upon it causes no pain. In dislocation into the thyroid notch there is possibly eversion, but it is linked with lengthening.

In *fracture of the brim of the acetabulum* there is shortening, which occurs on the removal of extension, inversion, abduction, flexion of the knee, the head of bone is drawn upward and backward with the acetabular fragment, and there is retention of the power of eversion and of adduction (Stokes). Crepitus is most distinctly appreciated by a hand resting on the ilium. In fracture of the fundus of the acetabulum there is shortening, and the head of the bone enters the pelvis (Stokes).

Prognosis.—The prognosis is not very favorable. Some aged patients die in a day or two from shock. Not a few perish later from hypostatic congestion of the lungs, kidney failure, or exhaustion. The majority of cases recover with a little shortening, some stiffness, and a permanent limp. There is a much better chance for firm union if the fracture is impacted than if it is not. Even if non-union results after an intracapsular fracture, and it is not unusual, a patient may get about fairly well with a proper support. In some cases after intracapsular fracture rheumatoid arthritis develops. Many surgeons have maintained that bony union never occurs, but it certainly does sometimes take place. Stokes holds that bony union is possible in fractures with penetration, and even in fractures without penetration when the fracture is within the periosteum.*

Treatment.—In treating a very feeble person for intracapsular fracture make no attempt to obtain union. Keep the patient in bed for two weeks; give lateral support by sand-bags; tie around the ankle a fillet, attach a weight of a few pounds to the fillet, and hang the weight over the foot-board of the bed. When pain and tenderness abate, order the patient to get into a reclining-chair, and permit him very soon to get about on crutches. If hypostatic congestion of the lungs sets in, if bed-sores appear, if the appetite and digestion utterly fail, or if diarrhea persists, abandon attempts at cure in any case, and get the patient up and take him into the sunshine and fresh air, simply immobilizing the fracture as thoroughly as possible by means of pasteboard splints or plaster-of-Paris. In the vast majority of cases, no matter how old the patient may be, undertake treatment. We may be forced

* See the masterly paper of Stokes, before quoted.

to abandon it, but should at least attempt to obtain a cure. If it is determined to treat the case, place patient on a hair mattress, several boards being laid under it transversely in order to prevent unevenness and the formation of hollows. A fracture-bed is a valuable adjunct to treatment.

Treatment by the extension apparatus of Gurdon Buck: Extend the knee, and place the leg in a natural posture, and put a pillow beneath the knee. Combine extension with lateral support by means of sand-bags. The extension should be gentle, never forcible. It is not wise to pull apart a penetration in an old person, but it should always be done in a young or middle-aged person. Place the subject on a firm mattress. If the patient be a man, shave the leg. Cut a foot-piece out of a cigar-box, perforate it to admit the passage of a cord, wrap it with adhesive plaster as shown in Plate 6, Figs. 15 and 16, run the weight-cord through the opening in the wood, and fasten a piece of adhesive plaster on each side of the leg, from just below the seat of fracture to above the malleolus (Pl. 6, Fig. 14). The plaster is guarded from sticking to the malleoli by having another piece stuck to its under surface opposite each of these points. Apply an ascending spiral reversed bandage over the plaster to the groin (Fig. 197), and finish the bandage by a spica of the groin. Slightly abduct the extremity. Put a brick under each leg of the

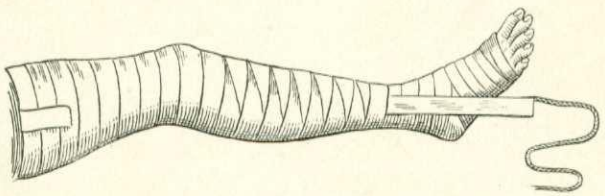


Fig. 197.—Adhesive plaster applied to make extension.

bed at its foot, thus obtaining counter-extension by the weight of the body. Run a cord over a pulley at the foot of the bed, and obtain extension by the use of weights. In an adult from fifteen to twenty pounds will probably be necessary at first, but after a few days from eight to ten pounds will be found sufficient (remember that a brick weighs about five pounds). Dawbarn's rule as to the proper weight to be attached is one pound for every year up to twenty. When the foot of the bed is raised and the weight to make extension is applied, very gently rotate the extremity, put the foot at a right angle with the leg, and make a bird's-nest pad of cotton or oakum to save the heel from pressure. Take two canvas bags, one long enough to reach from the crest of the ilium to the outer malleolus, the other long enough to reach from the perineum to the inner malleolus. Fill the bags three-quarters full of dry sand, sew up their ends, cover the bags with slips, and put the bags in place in order to correct eversion. The slips may be changed every third or fourth day. Keep the bed-clothing from coming in contact with the foot by means of a cradle (Figs. 198, 199). The bowels are to be emptied and the urine is to be voided in a bed-pan, unless using a fracture-bed. For two weeks the patient remains recumbent, after which time he can be propped up on pillows. Maintain extension for three weeks, then

simply maintain support by sand-bags or mould pasteboard splints upon the part, and keep up this support three to five weeks more. After removing the extension he can be transferred daily to a couch. In from six to eight weeks after the infliction of the injury he can be moved about in a wheeling-chair, the leg being extended or the knee flexed in accordance with the dictates of comfort. After a week or so of such movement a thick-soled shoe is placed on the sound foot and the patient is allowed to use crutches; but weight is not put upon the injured extremity until from ten to twelve weeks have elapsed from the time of the accident. For many months, at least, and possibly permanently, he walks with the aid of a cane. Union, if it takes place, is

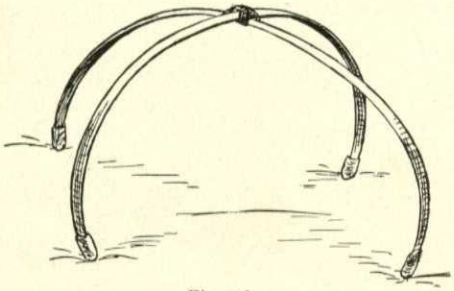


Fig. 198.

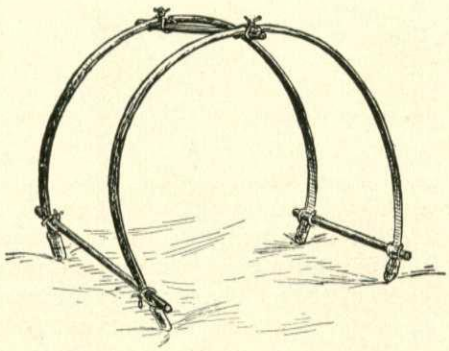


Fig. 199.

Figs. 198, 199.—Cradle to keep clothing from leg, made from two barrel-hoops (Scudder).

usually cartilaginous, but is sometimes bony, and there will surely be some shortening and also some stiffness of the joint. Passive motion is not made until at least eight weeks have elapsed since the accident. Treatment by the extension apparatus is far from satisfactory, as it does not afford sufficient immobilization.

Senn's method: Senn claims that by his method of "immediate reduction and permanent fixation" bony union is obtained in fractures of the neck of the femur within the capsule. He "places the patient in the erect position, causing him to stand with his sound leg upon a stool or box about two feet

in height; in this position he is supported by a person on each side until the dressing has been applied and the plaster has set.

"Another person takes care of the fractured limb, which in impacted fractures is gently supported and immovably held until permanent fixation has been secured by the dressing. In non-impacted fractures the weight of the fractured limb makes auto-extension, which is often quite sufficient to restore the normal length of the limb; if this is not the case, the person who has charge of the limb makes traction until all shortening has been overcome as far as possible, at the same time holding the limb in position, so that the great toe is on a straight line with the inner margin of the patella and the anterior superior spinous process of the ilium. In applying the plaster-of-Paris bandage over the seat of fracture a fenestrum, corresponding in size to the dimensions of the compress with which the lateral pressure is to be made, is left open over the great trochanter.

"To secure perfect immobility at the seat of fractures, it is not only necessary to include in the dressing the fractured limb and the entire pelvis, but it is absolutely necessary to also include the opposite limb as far as the knee and to extend the dressing as far as the cartilage of the eighth rib.

"The splint (Fig. 200) is incorporated in the plaster-of-Paris dressing, and it must carefully be applied, so that the compress, composed of a well-cushioned pad with a stiff, unyielding back, rests directly upon the trochanter major, and the pressure, which is made by a set-screw, is directed in the axis of the femoral neck. Lateral pressure is not applied until the plaster has completely set. Syncope should be guarded against by the administration of stimulants.

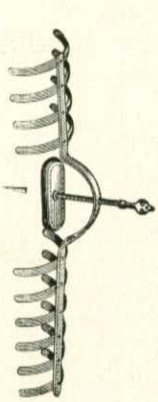


Fig. 200.—Senn's apparatus.

Fig. 201.—Senn's apparatus applied.

"As soon as the plaster has sufficiently hardened to retain the limb in proper position, the patient should be laid upon a smooth, even mattress, without pillows under the head, and in non-impacted fractures the foot is held in a straight position and extension is kept up until lateral pressure can be applied.

"No matter how snugly a plaster-of-Paris dressing is applied, as the result of shrinkage it becomes loose, and without some means of making lateral pressure it would become necessary to change it from time to time in order to render it efficient. But by incorporating a splint in the plaster dressing (Fig. 201) this is obviated, and the lateral pressure is regulated, day by day, by moving the screw, the proximal end of which rests on an oval depression in the center of the pad."

Treatment by Thomas's splint: Scudder, in his valuable treatise on "The Treatment of Fractures," advocates in intracapsular fracture the use of Thomas's hip splint. If the bones are unimpacted, the fragments are brought into apposition by extension, inversion, and pressure upon the great trochanter, and the Thomas splint is bent to fit, is padded, and is

applied (Figs. 202, 203). When the bed-pan is to be used or the bed is to be smoothed, the patient can be lifted without disturbing the fracture. He can be turned on the sound side. If hypostatic congestion is developing raise the head of the bed and tie the splint to the iron of the head of the bed. In addition to the use of the splint Scudder advocates the making of lateral pressure over the great trochanter by a graduated compress and a bandage. The splint is worn for six or eight weeks. It is then removed, the patient remaining in bed four weeks longer without any apparatus (Scudder, from Ridlon).

Extracapsular Fracture (*Fracture of the Base of the Neck of the Femur*).—The line of extracapsular fracture is at the junction of the neck with the great trochanter, and is partly within and partly without the capsule, the fracture being generally comminuted and often impacted. The *cause* is violent di-

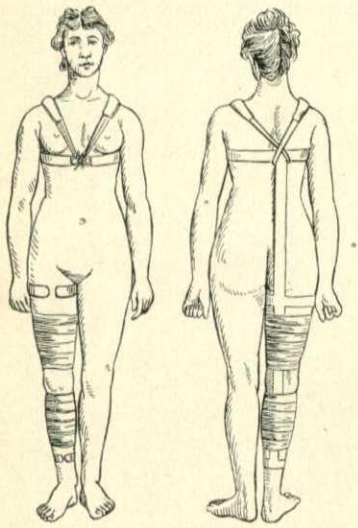


Fig. 202.—Thomas's single hip-splint in position (Ridlon).

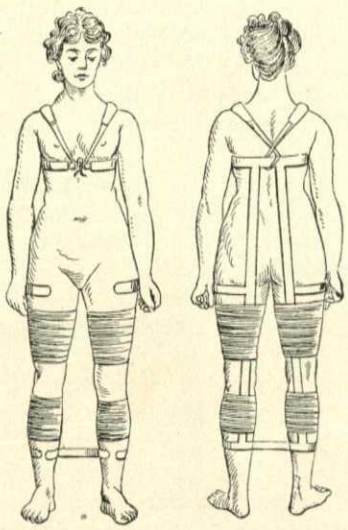


Fig. 203.—Thomas's double hip-splint in position (Ridlon).

rect force over the great trochanter (as by falling upon the side of the hip). This fracture is most usual in elderly people, but is not very uncommon in young adults. Stokes has described six forms of extracapsular fracture: extracapsular fracture with partial impaction posterior; fracture with complete impaction; fracture with partial impaction above; fracture with partial impaction below, the shaft being split; splitting of the neck longitudinally without impaction; comminuted non-impacted fracture.*

Symptoms.—When impaction is absent there is marked crepitus on motion, which is manifested most distinctly when the fingers are placed upon the great trochanter; there is severe pain, pressure upon the great trochanter is very painful, swelling and ecchymosis are marked; there is absolute inability on the part of the patient to move the limb, and passive

* Brit. Med. Jour., Oct. 12, 1895.

movements cause violent pain; there is shortening to the extent of at least one and a half inches, and sometimes to the extent of three inches, which shortening is made manifest by noting the ascent of the trochanter above Nélaton's line, by a comparison of measurements of the injured limb and the sound limb, and by measuring the base-line of Bryant's triangle on each side. Absolute eversion usually exists with slight flexion both of the leg and the thigh. In some rare cases there is inversion. This happens if at the time of the accident the limb was inverted and adducted (Stokes). Lagoria's sign, Desault's sign, and Allis's signs are present. All these symptoms follow violent direct lateral force. In the *impacted* form of extracapsular fracture, in addition to the aid given the surgeon by the history, there is severe pain, which is intensified by movement or pressure; shortening to the extent of one inch at least, which is not corrected by extension; great loss of function; and whereas the limb may be straight or even inverted, it is usually everted. The trochanter is above Nélaton's line, the base-line of Bryant's triangle is shortened, but not so much as in the unimpacted form; there is no crepitus unless the impaction is pulled apart, and the arc of rotation of the great trochanter is larger than in a non-impacted fracture.

Treatment.—In impacted extracapsular fracture it is best to pull apart the impaction if the patient is in good physical condition. Southam, of Manchester, in an impressive article, has recently insisted on the absolute necessity of pulling apart an impaction. He gives ether, and when the patient is anesthetized unlocks the fragments.* In treating non-impacted extracapsular fracture make extension, raise the foot of the bed, and apply the extension apparatus with sand-bags for three weeks; then apply a plaster dressing. Get the patient up on crutches after the plaster has been in place for two weeks. Remove the plaster at the end of four weeks. Thomas's splint may be used instead of Buck's extension.

Fractures of the Femoral Neck in Children.—Fracture of the femoral neck in children can scarcely be regarded as very unusual, and is certainly more often encountered than is separation of the upper epiphysis. The accident results from a fall rather than, as in an adult, from a twist, and it is the product of considerable violence rather than of slight force. Many such fractures are impacted and most of those which are unimpacted are of the green-stick variety. The disability is not nearly so great as in an adult; in fact, it is not unusual for the victim of such an injury to be able to hobble about a few days afterward. The symptoms are shortening, some eversion, impairment of joint-movements, and a limp when the patient gets about. Fractures of the hip in children are often unrecognized and lead frequently to permanent impairment because of the development of coxa vara. The *x*-rays should be used in making the diagnosis.

A green-stick fracture is treated with Thomas's splint, and after four weeks in bed "the child may be allowed up, wearing a traction hip-splint for several months until union is so firm that the danger from coxa vara is practically eliminated. A light plaster-of-Paris spica bandage from the calf to the axilla will maintain immobility after the splint is omitted" (Scudder, on "The Treatment of Fractures"). An impacted fracture is treated exactly as is a green-stick fracture. In a case of acute disability in a child,

*Lancet, Dec. 21, 1895.

following fracture of the femoral neck, make a careful differentiation from tuberculous disease of the joint and apply a traction splint to support the body and give rest to the joint. If coxa vara becomes marked and causes great disability, osteotomy is justifiable.

Separation of the upper epiphysis of the femoral head is a very rare result of accident; it occurs most often from disease. It is met with in early youth, results in considerable permanent shortening and perhaps in coxa vara.

Symptoms and Treatment.—The symptoms are like those of fracture of the neck, except that the crepitus is soft. The *treatment* is as above directed.

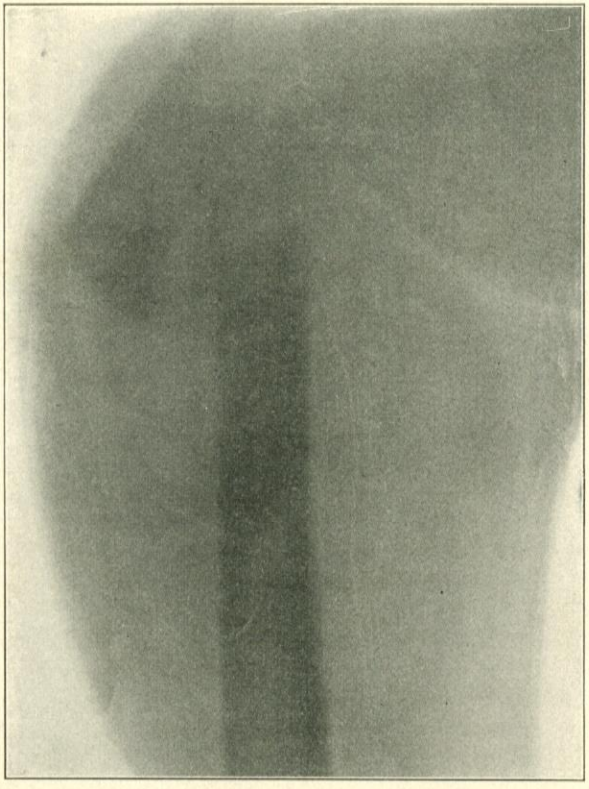


Fig. 204.—Deformity following fracture of upper third of femur.

Fractures of the Great Trochanter.—This process may be (1) broken off without any other injury, but in most cases (2) the line of fracture runs through the trochanter, and leaves one portion of the trochanter attached to the head and neck and the other part attached to the shaft of the femur. The *cause* is violent direct force over the great trochanter.

Symptoms and Treatment.—The symptoms of the second form are similar to those of extracapsular fracture. On rotating the femur the lower part of the trochanter moves with it, but not the upper. The lower fragment goes upward and backward and projects by the side of the sciatic notch.

There are shortening, eversion, crepitus, and altered position of the trochanter. The symptoms of the first form resemble those of epiphyseal separation. The *treatment* of the second form is like that in extracapsular fracture, and the first form is treated like separation of the epiphysis of the trochanter.

Separation of the epiphysis of the great trochanter is a very rare accident. The *cause* is direct violence, and the injury occurs only in youth.

Symptoms.—The trochanter is found to have ascended and passed posteriorly; there is no shortening of the thigh; all the motions of the hip-joint can be obtained; if the thigh is flexed, abducted, and rotated externally, and the fragment is pushed downward and forward, crepitus is obtained—soft in epiphyseal separation, hard in fracture.

Treatment.—In treating separation of the epiphysis of the great trochanter flex the leg on the thigh and the thigh on the pelvis, place the extremity upon its outer surface, keep it fixed by some form of retentive apparatus, and try to draw the trochanter downward and forward by adhesive strips or by a pad and bandage. Some degree of lameness is inevitable, even after Bryant's extension. Bryant's extension directly upward may admit of the trochanter being pulled into place upon the bone (Fig. 209). Extension must be applied for four weeks, and crutches and pasteboard splints should be used for four weeks more.

2. **Fractures of the shaft of the femur** may affect any portion of the shaft, but especially the middle third, and may occur at any age. Fracture of the upper third is a rare accident. Allis estimates that each year in Philadelphia there is 1 case of fracture of the upper third of the femur to every 100,000 inhabitants. Separation of the lower epiphysis occasionally occurs. The *cause* of fractures in the upper third is usually indirect force; fractures in the lower third are due to direct force; and in fractures of the middle third these two causes are about equally potential. Fracture from muscular action occasionally occurs. Oblique fracture is the usual variety. In many cases the soft parts are badly lacerated and sometimes a great vessel is torn.

Symptoms.—The chief symptom in fracture of the shaft of the femur is great displacement, except when impaction occurs, when the break is due to direct force, or when the injury is in a child. In a child the line of fracture is often transverse and the periosteum may be untorn. Green-stick fractures occur in children. As a rule, in fracture of the shaft of the femur the lower fragment is drawn upward and the upper end of the lower fragment is found posterior and somewhat to the inside of the lower end of the upper fragment, and the lower fragment also undergoes external rotation (the drawing up is due to the rectus and hamstrings; the passing inward is due to the adductor muscles; the rotation outward arises from the weight of the limb). If a fracture of the lower two-thirds of the shaft is produced by direct force, there is usually but little deformity, because the line of fracture is nearly transverse. If produced by indirect force, there is often great deformity, the line of fracture being oblique. In fracture of the lower third of the shaft the gastrocnemius pulls upon the condyles and tilts the lower fragment, so that its upper end projects into the popliteal space and may damage the vessels. In fracture of the upper third the upper fragment is apt to be thrown strongly forward and outward (Fig. 204).

Some attribute this to the action of the psoas, iliacus, and external rotator muscles, but Allis thinks it is due chiefly to the lower fragment pushing the upper fragment into this position, a part of the tendon of the gluteus maximus acting as a hinge for the fragments.* In rare cases the angular deformity is backward. In fracture of the shaft of the femur there is complete loss of function, the thigh and leg are slightly flexed and usually everted. In some cases the leg and lower fragment are inverted. There are shortening to the extent of two or three inches, pain on movement, preternatural mobility, crepitus, and obvious deformity, and the ends of the fragments

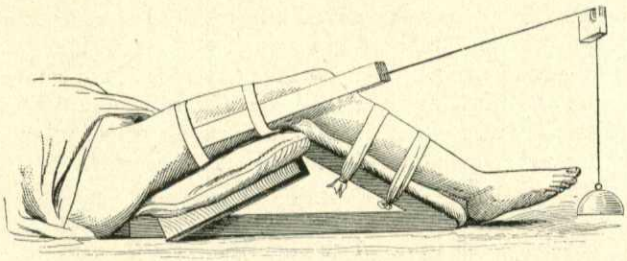


Fig. 205.—Dressing of fracture of the femur in the upper third with extension upon a double inclined plane (Agnew).

can be felt by the surgeon. In impaction there is alteration of the axis of the limb and some shortening. Always feel for the pulse below the fracture.

Treatment.—In setting and dressing a fracture of the thigh ether should be given and the parts must be handled with great care to prevent a sharp end from tearing the soft parts and puncturing the skin. The surgeon always feels for the pulse below the seat of fracture to see if the artery is damaged. In fracture of the shaft of the femur, if impaction exists, the fragments must be pulled apart, when the case should be treated exactly as is a non-impacted fracture. After a fracture of the shaft of the femur some amount of permanent shortening is almost inevitable. In fracture of the upper third treatment is usually unsatisfactory, and there is permanent shortening from angular union or from overlapping. Horizontal extension fails to correct the displacement of the upper fragment in fracture of the upper third. The double inclined plane will not correct the tilting of the upper fragment while shortening exists. Agnew used a double inclined plane and corrected shortening by the use of extension in the axis of the partly-flexed thigh (Fig. 205). This plan is the most serviceable of those usually employed, but it too fails

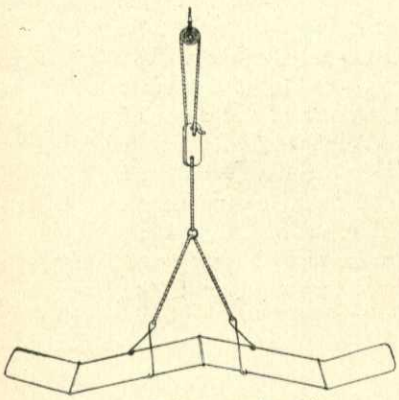


Fig. 206.—Smith's anterior splint.

* "Fracture in the Upper Third of the Femur Exclusive of the Neck," by Oscar H. Allis, Medical News, Nov. 21, 1891.

to completely correct the displacement. If, notwithstanding position and extension, the upper fragment projects, it should be pushed into place and be retained if possible by short splints bound upon the thigh. Extension should be continued for four weeks, a plaster-of-Paris bandage being used for four weeks more, the patient being then allowed to go about on crutches. Some surgeons, in fracture of the upper third, apply a plaster-of-Paris bandage

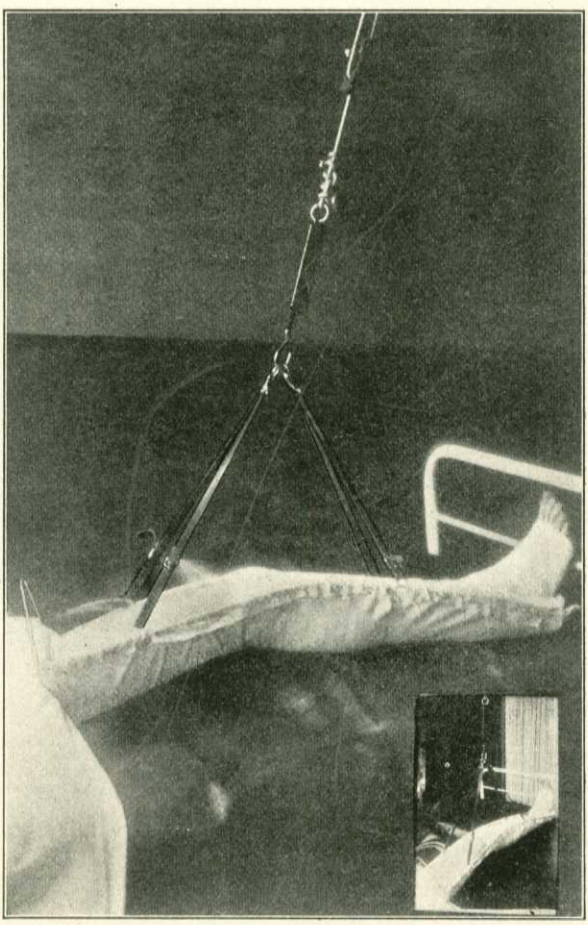


Fig. 207.—Hodgen's apparatus as applied by Dr. George S. Brown.

to the leg, thigh, and pelvis, extension being made from the foot while the dressing is being applied. This method does not give good results because such extension will not correct the tilting of the upper fragment. The anterior splint of Nathan R. Smith is used by some in treating fractures of the upper third of the femur (Fig. 206). It is bent to the desired shape, fastened to the anterior surfaces of the leg and thigh, and hung to a gallows, the limb being suspended at the desired height. This splint is open to the same objection as the double inclined plane. In fact, in many fractures of the

upper third of the shaft of the femur no apparatus will maintain reduction. In such cases it is advisable to incise, separate the muscles from between the fragments, and fasten the ends of the bone fragments together with bone ferrules, silver wire, kangaroo-tendon, steel screws, steel pins, or a bone-clamp. This radical treatment has certain dangers of its own, but it is the only plan which promises to secure a thoroughly good limb. In fracture of the middle third or upper part of the lower third of the shaft of the femur, the extension apparatus and sand-bags will usually secure a satisfactory result (Pl. 6, Fig. 14). The strips of adhesive plaster are carried to just below the seat of fracture, and the turns of the roller bandage should be taken to a little above this point. Extension should be continued for four weeks, when the plaster-of-Paris bandage ought to be applied. The plaster is kept in place for four weeks. Many surgeons use Hodgen's splint in treating fractures of the thigh. The limb is suspended in a cradle and extension is obtained by strapping the foot to the cross-bar of the frame and pulling upon the frame by cords (Fig. 207). Hodgen's apparatus as applied

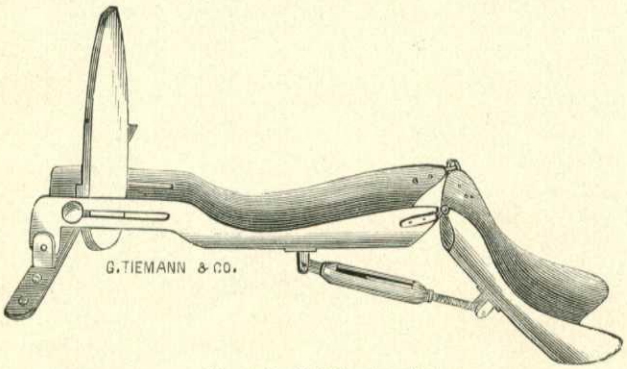


Fig. 208.—McIntyre's splint.

by Brown, of Birmingham, Ala., is one of the most satisfactory methods of treatment in fractures below the upper third. The extremity can be raised or lowered at will without disturbing the approximation of the fragments, extension to the required degree can be obtained, and the patient can be moved in bed. I consider this apparatus the most comfortable appliance which can be worn and excellent results are obtained by its use. In fracture of the middle third or upper part of the lower third of the shaft if the line of fracture is transverse and there is little deformity, as is seen often after a fracture by direct force, and often in children, immobilization in an immovable dressing may be all that is required; but if shortening exists, extension must be used. If extension is used, continue it for four weeks and then substitute a plaster-of-Paris dressing for four weeks. The amount of weight required is pointed out by Dawbarn: one pound for each year up to twenty.* In fracture near the knee-joint it may be impossible to effect reduction by horizontal traction. In such a case make traction, and while it is being made gradually bring the leg to a right angle. Place the limb in a double inclined plane (Pl. 6, Fig. 2). A McIntyre splint (Fig. 208) is a useful form of double

* Annals of Surgery, Oct., 1897.

inclined plane. After four weeks of the use of a double inclined plane apply a plaster-of-Paris dressing, which is to be worn for four weeks.

Fractures of the Shaft of the Femur in Children.—In children under three years of age the extension apparatus will not satisfactorily immobilize the fragments. Fractures of the thigh in children are reduced by extension and counter-extension; a well-padded splint reaching from the axilla to below the sole of the foot is applied to the outer side of the limb and body. This splint is held in place by bandages which are overlaid with plaster-of-Paris. It is worn for four weeks, at which time it is removed and a plaster bandage, applied so as to include the entire limb, is worn for four weeks more.

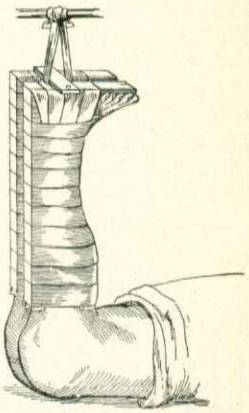


Fig. 209.—Bryant's extension for fracture of the thigh in a child.

Bryant's extension is very satisfactory in treating a child (Fig. 209). Both the injured limb and the sound limb should be flexed to a right angle with the pelvis, fixed by light splints, and fastened to a bar above the bed. The weight of the body produces counter-extension and the child can be easily cleaned.*

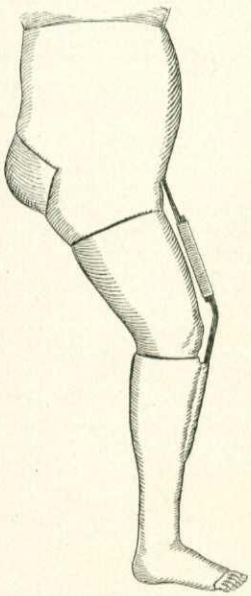


Fig. 210.—Dunham's apparatus for treating fractures of the thigh in infants and children.

Another plan is that of Theodore Dunham.† The child is placed upon a table, and the knee and thigh are partly flexed. After first applying flannel rollers, plaster-of-Paris bandages are applied from the roots of the toes to the spine of the tibia, and as a spica about the upper part of the thigh and pelvis. Two pieces of iron, suitably bent, are used to anchor the two plaster bandages together. One end of one iron is attached to the plaster over the groin and one end of the other iron is attached to the plaster over the front of the leg. The free ends of the irons overlap. At the points over the joints and the front of the leg where the irons are to rest masses of plaster are placed. The iron is sunk into the plaster and supported at each spot by several turns of a plaster bandage. While the irons are being adjusted the thigh is so held as to prevent bending or rotation, and the hip and knee are semi-flexed. When the plaster has set, an assistant makes extension on the leg and another assistant makes counter-extension by pressing on the pelvis. Any shortening is thus reduced and the two irons are lashed together with strong cord (Fig. 210).

Van Arsdale's triangular splint is a very useful appliance. It is made of binders' board. A. Ernest Gallant ‡ describes its preparation and application as follows: Measure the length of the sound thigh from the middle of

* Bryant's "Practice of Surgery." † Phila. Med. Jour., April 23, 1898.
‡ Jour. Amer. Med. Assoc., Dec. 18, 1897.

the groin to the end of the femur. Draw upon cardboard an outline of a double spade (playing-card spade), Fig. 211. Each of the four sections (*A*, *B*, *C*, *D*) must be equal to the length of the child's thigh, the flanged portions being equal to the widest part of the thigh. The figure is then cut out. The cardboard is moistened on one side and folded on the dotted line, section *A* being lapped over *D*, so as to form a triangle. It is fastened together by adhesive plaster. The thigh is flexed and the triangle is applied so that one flanged portion embraces the thigh and the other flanged portion rests on the abdomen. The triangle is fixed in position by bandages, figure-of-eight turns being made around the knee and around the thigh and body. Plaster or starch bandages are then applied to fix the splint firmly. The leg should be bandaged from the toe to the knee to prevent swelling (Fig. 212). This splint is worn for three weeks. A child wearing this splint can sit on a chair, nurse, play on the floor and crawl about, may sleep on either side, and the dressing is not soiled by the evacuations.

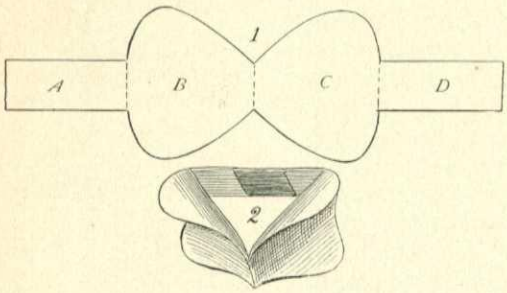


Fig. 211.—1, Diagram showing outline of Van Arsdale's splint; the end band to be folded on the dotted lines; each section to equal the length of the child's thigh. 2, Diagram, splint folded, fastened by rubber plaster, flanges bent to embrace the thigh and abdomen, ready for adjustment (Gallant).

If a thigh is fractured during parturition, or during the first few weeks of life, Wyeth's dressing is very serviceable. It is applied as follows: The leg is flexed on the thigh and the thigh on the abdomen. A flannel bandage is applied so as to include the leg, the thigh, and the body from the axilla to the pelvis. Plaster-of-Paris is applied over this; the dressing is worn for four weeks.

Fig. 212.—Showing Van Arsdale's triangular splint in position. Note the wide space between the dressings and the excretory passages (Gallant).

Fractures Just above the Condyles of the Femur.—The *line* of fracture above the condyles is well above the epiphyseal line. The femoral artery is in danger from the fragments. The *cause* of the break, as a rule, is direct violence. Indirect force is sometimes responsible (falls upon the feet). The knee-joint may be opened. The fracture is sometimes compound.

Symptoms.—The upper end of the lower fragment is drawn upward and backward, because of the action of the rectus, hamstrings, gastrocnemius, and popliteus. The upper fragment passes inward, and the deformity is

very manifest. There are shortening, crepitus, and mobility. The ends of the fragments can be felt by the surgeon. If the force has been very great, a T-fracture results. In T-fracture the knee is broadened and crepitus is obtained by moving the condyles, one up and the other down. Always feel for the pulse below the fracture.

Treatment.—In treating fracture above the condyles, reduce the deformity by horizontal extension. If this fails, make traction at the same time, gradually bringing the leg to a right angle with the thigh. Place the limb on a double inclined plane for five weeks, then begin passive motion once every other day, restoring the limb to the splint after the movements are completed. At the end of eight weeks after the accident remove the dressings, and, if the knee-joint be stiff, use for some time massage, passive motion, hot and cold douches, ichthyol inunctions, etc. Bryant treats this fracture in extension, cutting the tendo Achillis, if necessary, to amend deformity. It is occasionally necessary to wire the fragments. Some cases demand amputation because of injury to the structures in the popliteal space.

Fracture Separating Either Condyle.—The *cause* is direct force.

Symptoms and Treatment.—The broken piece is drawn upward, the leg bends toward the injury, crepitus exists, the knee is much broadened, there is no shortening, and considerable swelling is sure to arise. In treating a fracture separating either condyle, use a double inclined plane as directed above.

Longitudinal fractures run upward from the knee-joint. The *cause* is a fall upon the feet or the knees.

Symptoms and Treatment.—The symptoms of longitudinal fracture are often obscure. The femur is broadened when the knee is flexed. The split may be detected between the condyles. The *treatment* is the straight position in plaster for eight weeks.

Separation of the lower epiphysis occurs only before the twenty-first year. It is not a very rare accident even in children.

Symptoms.—The symptoms in separation of the lower epiphysis are like those of transverse fracture, but crepitus is moist. The lower fragment is tilted, so that the articular surface looks forward. The lower end of the upper fragment projects into the popliteal space. There is danger to the structures in the popliteal space and that the growth of bone will be stunted. Feel for the pulse in the leg or foot.

Treatment.—Reduction may be effected in some cases by horizontal extension. Occasionally this is impossible.* In such a case adopt the plan of Hutchinson and Barnard, make extension, and while it is being made gradually place the leg at a right angle to the thigh. This is effected by an assistant making traction on the leg, while the surgeon clasps his hands beneath the lower part of the thigh and draws upward. The treatment for separation of the lower epiphysis is the use of a double inclined plane as above directed. In some cases replacement is impossible without incision.

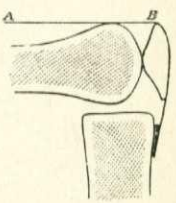


Fig. 213.—Mechanism of fracture of the patella by muscular action (after Treves).

Fracture of the patella is a very common accident. The *cause* is direct

*See the case reported by Jonathan Hutchinson, Jr., and Harold L. Barnard, Lancet, May 13, 1899.

force (producing vertical, star-shaped, or oblique lines of fracture) or muscular action (producing a transverse line of fracture).

Transverse fractures of the patella: The knee-cap is more often broken by muscular action than is any other bone. When the knee is partly flexed the middle third of the patella rests upon the condyles of the femur and the upper third of the knee-cap projects above them; when in this position a contraction of the quadriceps may easily cause a fracture near the center of the bone (Fig. 213). The accident may be caused by sudden flexion of the knee when the quadriceps is contracting. The most usual cause is a fall or an attempt of the patient to save himself from a fall. Both patellæ

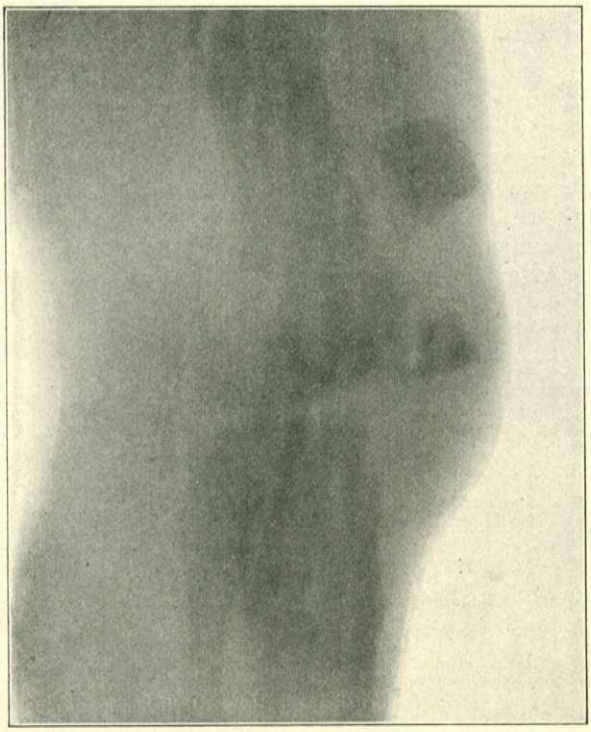


Fig. 214.—Fracture of the patella (Pennsylvania Hospital case; skiagraphed by Dr. Gaston Torrance).

may be broken at once. In fracture of the patella the joint, and often the prepatellar bursa, is opened. Fractures by muscular action are transverse. The injury is more common in males than in females, and is extremely rare in the very young and the old. It is an injury of active manhood and middle life.

Symptoms.—When the accident happens there is often an audible crack. As a rule, the patient will not try to use the limb, although it is possible for him to stand, to walk backward, and to move slowly forward when the extremity is kept straight. After the accident there is rapid and enormous swelling, due to the effusion first of blood and then of synovia and inflammatory products into and around the joint. The patient is

absolutely unable to raise the limb from the bed. The fragments are movable and usually widely separated (Fig. 214), this separation being distinctly manifest to the touch unless swelling is great. The separation is accentuated by flexion of the leg. The separation may be to the extent of one inch or even more. In cases in which the lateral fibrous expansions and periosteum are but slightly torn, there may be slight separation or no separation. Separation is due in part "to the retraction of the quadriceps and the tension of the fascia lata, and in part to distention of the joint by blood and exudate." * If fragments are not approximated and union does not occur, the separation becomes gradually greater because of the progressive

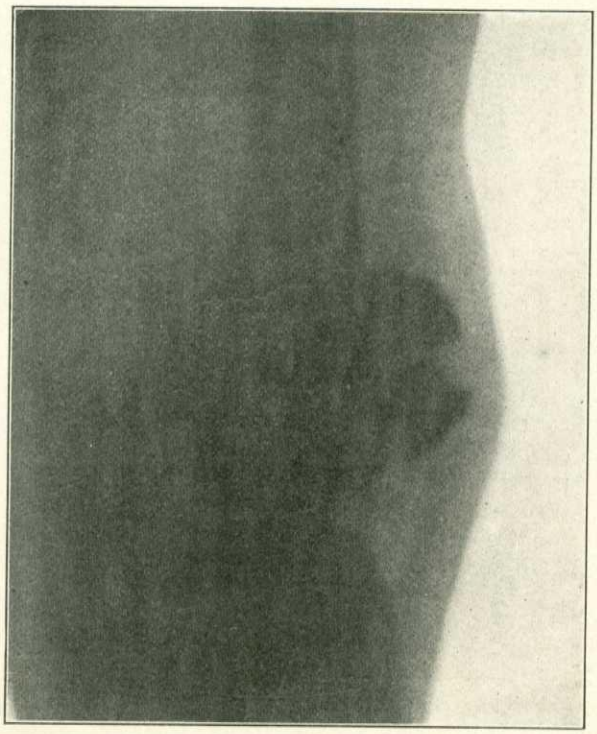


Fig. 215.—Fracture of the patella (Pennsylvania Hospital case; skiagraphed by Dr. Gaston Torrance).

shortening of the muscle and the retraction of the ligamentum patellæ (Stimson). In some cases an anterior angular displacement occurs because of the intra-articular distention (Fig. 215). It may be produced by the pressure of bandages or strips of plaster when the fragments have been brought together. Crepitus is detected if the upper fragment can be pushed down until it touches the lower piece; but if swelling is great, or if fibrous tissue is interposed between the bones, crepitus cannot be elicited. It is useless to seek for it, as the diagnosis is obvious without this sign. The anterior fibro-periosteal layer is torn, and the tear does not correspond exactly with the

* Stimson's "Treatise on Fractures and Dislocations."

line of fracture. A portion of this torn fibroperiosteal layer may, as Macewen pointed out, drop between the fragments and prevent union (Fig. 216). The lateral expansions of the capsule are usually extensively torn. If union occurs after a transverse fracture it will probably be ligamentous, and if the patient gets about too soon, even apparently well-united fragments will by degrees stretch far asunder.

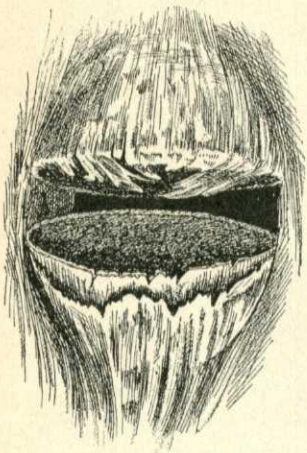


Fig. 216.—Transverse fracture of the patella; fractured surface partially covered by irregular flaps of torn aponeurosis (Hoffa).

Treatment of Transverse Fractures of the Patella.—If in transverse fracture of the patella the swelling is so great as to prevent approximation of the fragments, reduce it by bandaging for a day or two, by using ice-bags, or by aspirating the joint. As a rule, the blood does not coagulate for several days. After it coagulates it cannot be withdrawn by aspiration, but only by incision. When the swelling diminishes, bring the two fragments into apposition, pull them together by adhesive plaster, and put on a well-padded posterior splint. Carry a piece of adhesive plaster over the upper end of the upper fragment, draw the bone down and fasten the plaster behind and below the joint. Carry another piece of plaster over the lower end of the lower fragment, draw the bone up, and fasten the plaster behind and above the joint. Carry a third piece over the junction of the fragments to prevent tilting. Agnew's splint admirably accomplishes this approximation (Pl. 6, Figs. 11, 12). A bandage holds the splint in place, and may be carried around the knee by figure-of-eight turns. The heel is sometimes raised upon a pillow so as to extend the leg and to semiflex the thigh, but this is not essential. Remove and reapply the dressing every few days, as it inevitably becomes loose. At the end of three

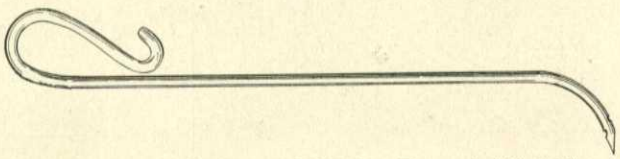


Fig. 217.—Needle specially designed to carry a thick wire. The eye is drilled obliquely, and should receive only a little loop on the end of the wire; this loop should be made previously.

weeks remove the splint permanently and apply a plaster-of-Paris dressing from just above the ankle to the middle of the thigh, and get the patient about on crutches. The dressing is to be worn for five weeks. After eight weeks of treatment allow the patient to walk with canes, the joint being kept fixed for four weeks more by pasteboard splints or by a light plaster-of-Paris bandage. For one year after removing the splints and plaster a lacing knee-cap of leather should be worn in the daytime to support the joint. The plan of prolonged immobilization renders more or less joint-stiffness a certain occurrence, but this is less of an impediment than the wide separation of the fragments that inevitably attends an early use of the joint. Bryant, of New York, has devised an ambulatory dressing.

Malgaigne's hooks are practically obsolete.

It is said that John Rhea Barton wired an ununited fracture of the patella in 1843. In 1877 Hector Cameron wired an ununited fracture of the patella, and a few months later Lord Lister operated on a fracture of the kneecap two weeks after the accident. The question of the advisability of suturing a recent fracture is very much disputed. The ordinary non-operative plans of treatment do not endanger life and generally give a good functional result. The operative method will usually succeed, and is capable of obtaining a better functional result and of obtaining it more rapidly. There is some danger of infection, and if infection should occur the results will be most disastrous. Some cases obviously cannot be treated by the ordinary method with any chance of success; cases, for instance, in which a flap of fibroperiosteum intervenes between the fragments, or cases in which from some other cause the bones cannot be approximated. Such cases should, of course, be operated upon. But in the great majority of cases a good result will follow conservative treatment, and conservative treatment should be trusted to unless the case is in the hands of a surgeon and in a place where every antiseptic precaution can be taken. We agree with Stimson when he says that operative methods can be used with confidence when surrounded with every protection; he habitually uses them, but he never teaches them as proper routine practice, and strongly advises against their use except by those who have had experience in operating, who have formed the habit of taking precautions, and who have the aid of skilled assistants.*

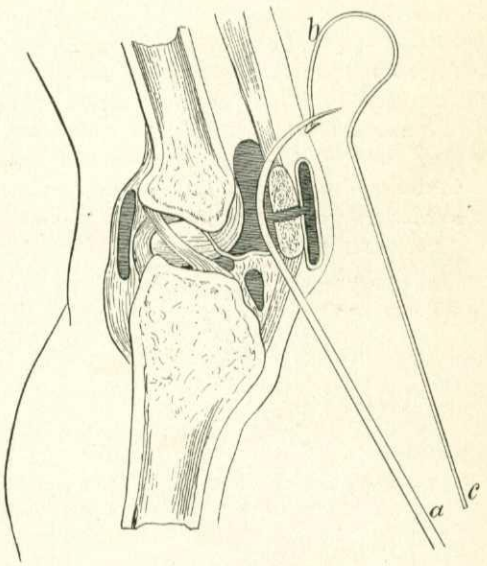


Fig. 218.—Needle (*a*) introduced behind the fragments, and receiving one end (*b*) of the silver wire (*b*, *c*) (Barker).

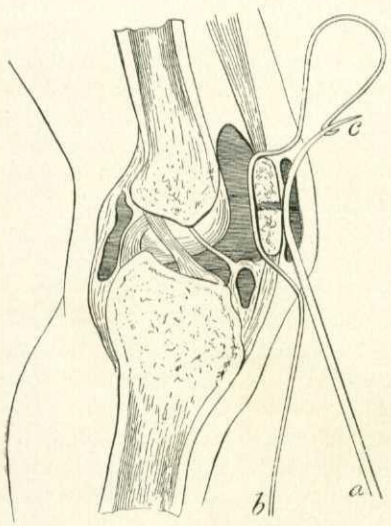


Fig. 219.—Needle (*a*) passed in front of the fragments and receiving the other end (*c*) of the silver wire (*b*, *c*) (Barker).

* Annals of Surgery, Aug., 1898.

Operation should only be performed on healthy persons of suitable age, when the separation is over one-half an inch or when there is much laceration of the capsule.* Barker believes strongly in wiring recent transverse fractures. He does it with antiseptic care soon after the accident, and permits passive motion or even slight active motion immediately after the operation. Massage is begun the day after the operation, and is practised daily for two weeks.

Barker† uses a special needle (Fig. 217) and silver wire of the thickness of a No. 1 English catheter. This wire is straightened and softened in a spirit-flame. He rubs the fragments together in order to dislodge blood or fibrous material, and when marked grating occurs introduces the wire. A puncture with a small knife is made through the middle of the upper attachment of the patellar ligament. The needle, not carrying any wire, is made to enter through this opening into the joint, is passed back of the fragments, pierces the tendon of the quadriceps at the upper edge of the upper fragment, and its point is cut upon with a knife. The wire is inserted into the eye of the needle and the needle is withdrawn and unthreaded. The empty needle is pushed through the lower opening, is carried in front of the joint, is made to emerge at the upper opening, is threaded again and withdrawn (Figs. 218, 219). The wires are threaded into bars and twisted (Fig. 220). There are objections to Barker's operation: It does not allow us to remove blood-clots from the joint; if a bit of tissue intervenes between the fragments, it cannot be removed; and a foreign body is left permanently in the joint.‡ If an operation is thought advisable, we deem it best to do an open operation, making a central incision, freeing the joint from blood-clots by irrigation with hot salt solution, removing all tissue from between the fragments, drilling the fragments, passing silver wire, twisting the wire and drawing the fragments together, and closing the wound (Fig. 221). Instead of wire, silk may be used. In cases in which there is no very strong tendency to separation the fragments can be held together by several catgut sutures through the periosteum at the fractured edges or by a strong catgut suture passed through the ligamentum patellæ and the quadriceps tendon and carried in front of the fracture (Stimson). The limb should be placed on a

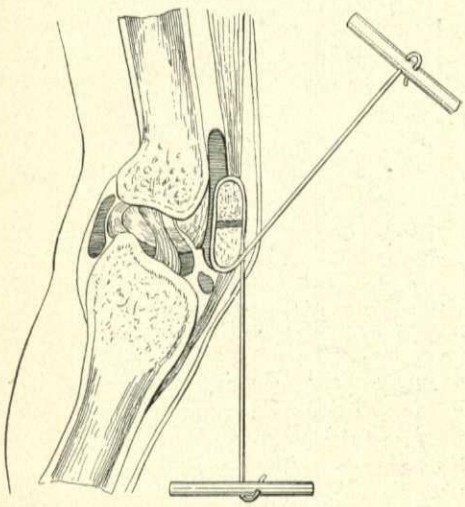


Fig. 220.—Wire in position round fragments and threaded through metal bars. The lower and posterior wire runs upward to the left of the upper, ready for twisting (Barker).

* Powers, in Annals of Surgery, July, 1898.

† See the objections of Sir William Stokes to Barker's method, in Brit. Med. Jour.; Dec. 3, 1898.

‡ Brit. Med. Jour., April 11, 1896.

posterior splint. In seven or eight days the superficial sutures are removed and a plaster-of-Paris splint is applied. In a few days the patient gets about on crutches. In a month the dressing is cut down the front and worn only in the daytime, and passive motion is begun. The splint is discarded at the end of the third month.* Among other operative procedures we may mention the following: Encircling the fragments with a silk suture (the circumferential suture). This suture may impair bone nutrition and retard union. Ceci drills

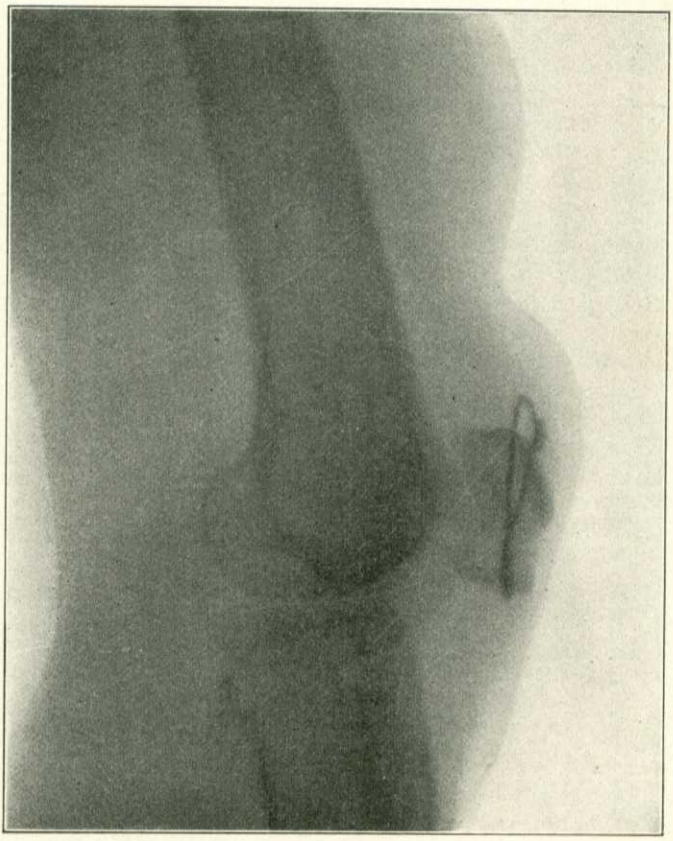


Fig. 221.—Wired fracture of the patella (St. Joseph's Hospital case; operated upon and skiagraphed by Dr. Nassau).

the bones subcutaneously and passes wire through the drill-holes in the form of a figure-of-eight. Passing subcutaneously a ligature around and over the fragments (Butcher). Incision and approximation of the fragments by fixation-hooks or metal pins.

Fractures of the patella by direct force are vertical, stellate, oblique, or V-shaped, are often incomplete and occasionally compound or comminuted.

Symptoms.—Fractures of the patella by direct force are followed by discoloration, swelling, great difficulty in movement, and much pain. There may

* Stimson, Annals of Surgery, Aug., 1898.

or may not be crepitus. The degree of separation of the fragments depends upon the direction of the line of fracture, and the extent of bone involved. Bony union is apt to occur after such a fracture.

Treatment.—A fracture resulting from direct force may often be treated with a posterior splint and the application of a bandage. If there is any separation, the fragments should be approximated by adhesive strips, bandages, and compresses. At the end of three weeks remove the posterior splint, apply a plaster-of-Paris splint, and get the patient about on crutches. The danger in these cases is ankylosis rather than non-union; hence, in the fourth week, cut the plaster splint down the front and begin passive motion of the knee-joint. At the end of six weeks cease wearing the dressing in the daytime, and at the end of three months discard it entirely. In those rather unusual cases, in which an oblique fracture with wide separation arises from direct force, treat as advised for transverse fracture from muscular action. The question of operation is practically the same as for transverse fracture from muscular action. In every compound fracture of the patella, if amputation can be avoided, incise, irrigate the joint with hot saline fluid, suture the fragments, and drain for twenty-four to forty-eight hours.

Ununited and Badly United Fracture of the Patella.—There is usually a band of union, but it may be very thin and the fragments may be far asunder. It is commonly taught that the degree of functional impairment depends directly on the amount of separation. This is not strictly true. There may be great separation, and but little impairment of function, the fragments being firmly united with a dense fibrous band. There may be little separation and yet lameness, stiffness of the joint, and imperfect power of extension. The reason of this has been pointed out by Bruns, of Tübingen.* He says there may be complete failure of union, even when the separation is trivial, and failure of union produces impaired function. If separation is considerable, the fragments are apt to tilt and tissue is often interposed between them. Functional difficulty is more often met with when the fragments are far apart than when they are near together, because non-union is more common. Even if non-union occurs, in some cases the quadriceps is still able to act upon the tibia by means of the fascia lata, ligaments at the sides of the joint, or bands from the vasti to the lower fragment. Besides non-union, functional impairment may be due to anchoring of the upper fragment to the femur. The upper fragment is anchored to the femur by the interposition of the fibrous investment of the knee-cap, which covers the fractured surface of the upper fragment and grows fast to the capsule of the joint (Bruns).

The *treatment* of ununited and badly united fracture is discussed on page 396.

Fractures of the Leg.—In leg-fractures both bones or only one bone may be broken.

Fractures of the tibia are divided into (1) fractures of the upper end; (2) separation of the upper epiphysis; (3) fractures of the shaft; (4) fractures of the lower end; and (5) separation of the lower epiphysis.

Fractures of the upper end of the tibia are uncommon. They may be transverse, oblique, or vertical, running into the joint. The *cause* is direct violence.

* "Beiträge zur klinischen Chirurgie," "Mittheilungen aus der chirurg. Klinik zu Tübingen," Bd. iii, Heft 2, 1888.

Symptoms.—In fracture of the upper end of the tibia there is contusion of the soft parts. In a *transverse* fracture there are mobility and crepitus, but there is little displacement. In *oblique* fracture crepitus and mobility are marked, the axis of the limb is altered, and the fragment may be displaced. In fractures entering the joint there is great swelling of the knee-joint. In *comminuted* fractures, which exhibit marked signs, union is readily obtained, but if the joint has been damaged stiffness is sure to ensue.

Treatment.—Reduce displacement by extension and manipulation. The special apparatus used depends on the case. In some cases extension is required, in some a posterior splint is applied and the limb is suspended from a gallows, in some a double inclined plane is employed, and in some a plaster-of-Paris splint is used.

The double inclined plane in the form of McIntyre's splint is frequently employed, or a double inclined plane in the form of a fracture-box may be preferred. The extremity should be immobilized for four weeks, when passive motion should be begun. Passive motion is to be made daily, the dressing being reapplied after each séance. In five or six weeks the dressings are removed and the patient allowed to go about on crutches. The crutches are soon abandoned for a cane, and later all support is dispensed with. If a fracture extends into the knee-joint and the ill-adjusted fragments block the articulation, the joint should be opened and the fragments placed in proper position.

Separation of the tubercle of the tibia is due to violent contraction of the quadriceps, and occurs only in those under twenty years of age. The fragment is drawn up and can be felt, and the patient is unable to use the limb. In a case in which the tibial spine has been torn off, the limb should be placed on a posterior straight splint and the fragment should be pulled down into place by adhesive strips and bandages. The splint should be worn for five weeks.

Separation of the Upper Epiphysis of the Tibia.—This is an injury of extreme rarity. It does not seem to occur after the sixteenth year. It is caused by a twist or by violent abduction or adduction of the leg. It may lead to lessened growth of the limb. The *treatment* is as for a fracture of the upper end.

Fractures of the Shaft of the Tibia.—The *causes* of these fractures are direct force, indirect force, or torsion. A fracture in the upper part of the bone is usually transverse; in the lower part it is usually oblique (Pickering Pick).

Symptoms.—In transverse fracture of the shaft of the tibia there is no deformity, and the support of the fibula may even permit of walking; there is fixed pain; there may or may not be inequality of the fragments felt by the finger; and there are crepitus, mobility, and often linear ecchymosis. In oblique fractures there usually exist crepitus, a little mobility, and distinct deformity. The deformity depends on the direction of the line of fracture, and, as this line is usually from above downward, inward, and a little forward, the lower fragment usually passes behind the upper fragment and rotates inward.

Treatment.—In treating fractures of the shaft of the tibia, effect reduction by making extension from the foot and counter-extension from the knee, the knee-joint being in partial flexion. If there is much swelling, put the limb

in a fracture-box (Pl. 6, Fig. 1; Fig. 222), swing the box from a gallows, and apply an ice-bag for a day or two. A silicate of sodium or a plaster-of-Paris dressing is applied when the swelling subsides, or the dressing is used at once if swelling is slight. As soon as the limb is immobilized in a silicate or plaster dressing the patient gets about on crutches. The dressing is removed after five weeks, and the patient goes about for one week on crutches, lightly using the foot, and then for a time with a cane. At the end of eight or nine weeks the cane may often be dispensed with, the amount of use of the leg being daily augmented.

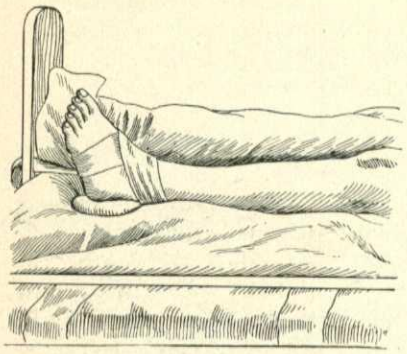


Fig. 222.—Fracture-box in fractures of the bones of the leg.

Fractures of the Lower End of the Tibia: Fracture of the Inner Malleolus.—The *cause* of fracture of the inner malleolus is direct force or traction upon the internal lateral ligament.

Symptoms and Treatment.—The *symptoms* of fracture of the inner malleolus are some downward displacement, depression above the ends of the fragments, mobility, and crepitus. The *treatment* is to push the fragments into place and use side-splints or a fracture-box for two weeks, when a plaster-of-Paris or a silicate dressing may be substituted and the patient be ordered to use crutches. Remove the plaster four or five weeks after it is applied, and direct the patient to gradually bear his weight upon the leg, as outlined above.

Separation of the lower epiphysis of the tibia is a rare accident, but is commoner than separation of the upper epiphysis. The *treatment* is a fixed dressing for six weeks.

Fracture of the fibula alone is commoner by far than is fracture of the tibia alone. Fractures in the upper two-thirds, which are rare, are usually due to direct force. Fractures in the lower third are frequent, and arise from indirect force.

Fractures of the Upper Two-thirds of the Fibula.—In these fractures the *cause* is direct force.

Symptoms.—In fracture of the upper two-thirds of the fibula the patient is frequently able to walk. The bone is deeply situated, and displacement cannot often be detected. There is a fixed pain, which is intensified by movement and by pressure. Pressure upon the lower fragment does not move the upper fragment. Crepitus is sometimes obtained, and a linear ecchymosis is apt to appear. The bone is normally elastic, hence slight mobility is of no value diagnostically.

Treatment.—In treating a fracture of the upper two-thirds of the fibula apply a plaster-of-Paris or a silicate bandage and direct that it be worn for five weeks. Weight is not to be put upon the foot for six weeks after the accident.

Fractures of the Lower Third of the Fibula.—In these fractures the *cause* is indirect force, especially twists of the foot. Forcible inversion of

the foot pulls upon the external lateral ligament and the external malleolus, forces the fibula outward, and tends to break it, the lower fragment being displaced outward. Forcible eversion pulls the internal lateral ligament off from the inner malleolus (often breaks the malleolus) and fractures the fibula above the ankle, the bone being displaced inward.

Pott's Fracture.—By the term Pott's fracture is meant a fracture of the lower fifth of the fibula produced by eversion and abduction of the foot. Stimson points out that the production of Pott's fracture is often aided by the weight of the body. The lesions which arise depend upon whether the chief force is eversion or abduction. "If eversion is the sole, or main, movement, the force is exerted through the internal lateral ligament and breaks the internal malleolus squarely off at its base; then it presses the external malleolus outward, rupturing the tibiofibular ligament, and breaks the fibula close above the malleolus. Sometimes instead of pure rupture of the tibiofibular ligament there is avulsion of the portion of the tibia to which it is attached."* Stimson further points out that if abduction is the preponderating force there is an oblique fracture of the anterior portion of the internal malleolus or more frequently rupture of the anterior portion of the internal lateral ligament. There is, as in the former case, rupture of the tibiofibular ligament and an oblique fracture of the fibula several inches above the external malleolus. It is evident that the degree of injury produced by eversion and abduction depends on the time at which the force is arrested. It may be arrested after the inner malleolus has been separated or the anterior fibers of the deltoid ligament torn, and in this case the tibiofibular articulation remains intact and the fibula is not broken. It may cease after separating the tibiofibular articulation, and in this case too the fibula escapes. It may be continued until the fibula breaks. In this fracture the astragalus passes outward, somewhat backward and also upward, the later deviation being due to separation of the tibiofibular articulation.

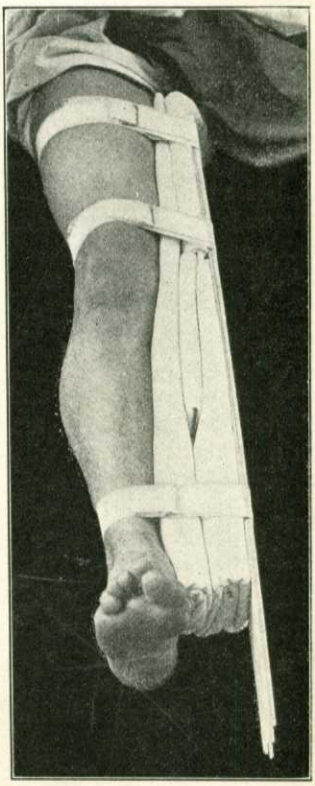


Fig. 223.—Pott's fracture. Dupuytren's splint. Note length of splint; position of straps; arrangement of padding; space between foot and splint (Scudder).

Symptoms.—The foot is displaced outward, and a little backward and upward, and the inner malleolus or the tibia from which it was torn, is extremely prominent. There is great lateral mobility and often anteroposterior mobility at the ankle-joint. Stimson points out that there are three points where pressure is certain to provoke pain: in front of the tibiofibular ligament,

*"A Practical Treatise on Fractures and Dislocations," by Lewis A. Stimson.

at the base or anterior border of the inner malleolus, and over the seat of fracture through the fibula.

Treatment.—Thorough reduction is of the greatest importance. If thorough reduction is effected, a good result will probably be obtained; but if thorough reduction is not effected, the patient will be permanently crippled to a greater or less extent. In order to effect reduction it may be necessary to anesthetize the patient. The deformity is corrected "by pressing the calcaneum forward and inward; the hand is placed against the back and outer side of the heel and pressed forward and then forcibly inward."*

Some surgeons, at once after reduction, apply a plaster-of-Paris bandage. This treatment is objectionable because the deformity may be partially reproduced after the application of the dressing, the surgeon being unable to see it, and unable to correct it.

If there seems to be no strong tendency to a recurrence of deformity, a fracture-box can be used. After reducing displacement in such a case, place the limb in a fracture-box containing a soft pillow. A bird's-nest pad of cotton or oakum is made for the heel (Fig. 222). A fillet around the ankle fastens the foot to the foot-piece of the box; a pad of oakum rests between the foot-piece and the sole. A compress is placed below the outer malleolus and another one above the inner malleolus. Close the sides of the box and tie them together with a bandage, and swing the box on a gallows. Every day let down the sides of the box and rub the leg, the ankle, and the foot with alcohol. In ten days apply a plaster-of-Paris bandage and let the patient get about on crutches. Remove the plaster at the end of the fifth week after the accident, and let the patient go about with crutches for one week and with a cane for a week longer.

I am accustomed to dress most cases of Pott's fracture with a Dupuytren splint. This is a straight splint (Pl. 6, Fig. 9, and Fig. 223) which reaches from the head of the tibia to below the sole of the foot. This splint is padded, and a pyramidal pad with the base down is laid upon the inner surface of the leg, above the inner malleolus, the splint being put upon the inner surface of the leg, over the pad. The splint is fastened as shown in Plate 6, Fig. 9 (and Fig. 223). If the short splint shown in Plate 6 is used, the leg is semiflexed upon the thigh and is laid upon its outer surface on a pillow. After ten days apply the plaster-of-Paris bandage, which is to be worn as above directed. Bryant treats Pott's fracture with a posterior splint, two lateral splints, and a swing. Stimson uses a posterior and lateral splint of plaster-of-Paris. This splint does not slip, as may Dupuytren's dressing, and does not hide the seat of fracture from view as does complete encasement with plaster-of-Paris. It is a most useful dressing. The fracture may be compound, a portion of the inner malleolus or of the tibia projecting through the wound. If it is necessary to introduce through and through drainage, the foot must be placed and kept at a right angle to the leg. If a compound fracture exists, it may be possible to wire the malleolus in place. In a reported case the wire was passed through the joint and around the fragment, and the result was good.† It would be better in most cases to nail the fragment in place.

* Stimson's "Practical Treatise on Fractures and Dislocations."

† Rev. de Chir., vol. viii, 1888.

Fracture of both bones of the leg is a very common injury, is often compound, and is not unusually comminuted. Fractures by direct force, such as blows or kicks, are commonest in the upper half of the leg. Fractures by indirect force, as by falls, are commonest in the lower half of the leg. In fractures from indirect force the tibia breaks first, and then the fibula breaks at a higher level. The point of greatest liability to fracture from indirect force is the junction of the lower and middle thirds. Fractures of the leg are usually oblique, but they may be transverse if arising from direct force. Spiral, torsion, or V-shaped fractures and longitudinal breaks sometimes occur. In oblique fractures, as a rule, the line of fracture runs from behind, downward, inward, and a little forward.

Symptoms.—Fracture of both bones of the leg is easy of recognition. The fibular fracture is detected as before described. By running the finger along the crest of the tibia displacement will be found, except in transverse fractures, when it may not occur. The common displacement is for the lower fragment to ascend and pass behind the lower end of the upper fragment and to rotate a little outward, and for the upper fragment to project in front. The ascent of the lower fragment is due to the action of the gastrocnemius and soleus muscles. If the line of fracture is in a direction the reverse of that which is usual, the lower fragment ascends in front of the lower end of the upper fragment. In fracture of both bones of the leg there are marked mobility and crepitus, severe pain, and inability to walk. In fractures from direct force there is more or less damage to the soft parts. A fracture of the shaft of the tibia near the ankle is distinguished from a dislocation by the fact that the deformity is easily reduced, but tends to recur in the fracture, and, further, that in a fracture the relations of the malleoli to the tarsus are unaltered, whereas in a dislocation they are altered.

Treatment.—If the fracture is near the ankle-joint, the action of the tendo Achillis may maintain deformity, and in such cases the tendon must be divided. In treating a simple fracture of the lower two-thirds of the bones reduce by extension and counter-extension, and use a fracture-box (Pl. 6, Fig. 1) as in Pott's fracture (Fig. 222), though the compresses are not required. If the soft parts are bruised, use an ice-bag for a day or two; if they are abraded, apply antiseptic dressings. The fracture-box should be swung upon a gallows. After three weeks apply a plaster-of-Paris or silicate of sodium dressing and let the patient sit up in a chair daily for one week; at the end of this time the patient may get about with crutches. At the end of six weeks after the accident remove the plaster, and let the sufferer get about on crutches for two weeks and with a cane for two weeks more. Brinton dresses a fracture of both bones of the leg for two weeks in a fracture-box, for two weeks in side-splints made of metal, and for two weeks in an immovable dressing, allowing the patient to get about on crutches as soon as the plaster is put on. Instead of the fracture-box, we may use a posterior splint, two lateral splints, and a swing. Nathan R. Smith's anterior splint is used by some in the treatment of fractures of the leg. Many surgeons apply plaster-of-Paris in the form of an ambulatory dressing. In this dressing a solid apparatus reaches to the lower third of the thigh and below the sole of the foot. When the patient walks the weight is transmitted to the thigh (Fig. 227). In fractures of the upper third of the leg the McIntyre splint

or the double inclined plane is used. If the fracture is compound, asepticize thoroughly, make a counter-opening, insert a drainage-tube, dress with bichlorid gauze, apply a plaster bandage, and cut trap-doors over the openings of the tube (see Fig. 161), or dress with the bracketed splint and plaster-of-Paris (Fig. 162). Remove the tube, as a rule, in about forty-eight hours; but the patient's temperature is a better guide than time.

Fractures of the bones of the foot are rather rare accidents. Owing to the number of the bones and to the elasticity of their connections, the force of blows and falls is spread and dissipated. Fractures from direct force are often compound. The *cause* of fracture of either the scaphoid, the cuboid, or one of the cuneiform bones is direct force. Fractures of the os calcis and astragalus arise, as a rule, from indirect force, such as falls, but the calcaneum may be broken by direct violence. In rare instances the os calcis has been broken by contraction of the great calf-muscles.

Symptoms.—In fracture of the os calcis there are severe pain, swelling, crepitus, mobility, often an apparent widening of the bone, and not unusually a loss of the arch of the foot (Pick). In some cases the posterior fragment is drawn up by the calf-muscles, and in other cases there is deformity. In fracture of the astragalus displacement may occur which resembles that of a dislocation. Crepitus may or may not be detected. It can be elicited, as a rule, by rotating the foot while the heel is firmly held. If crepitus cannot be detected, it is not certain that a fracture is present, though the patient may be unable to stand and there may be swelling and pain on pressure. The *x*-rays will make the diagnosis certain. Fractures of the other bones are difficult of detection. There may or may not be crepitus, which, if it exists, is hard to localize; there is pain on standing and on pressure, and there is bruising of the soft parts.

Treatment.—To treat a fracture of the os calcis when no deformity exists, use a fracture-box for two weeks, maintaining the foot at a right angle to the leg; then put on an immovable dressing, and let it be worn for four weeks. In fracture of the os calcis with drawing up of the posterior fragment flex the leg upon the thigh, extend the foot, and maintain this position by means of a band around the thigh, the band being fastened by means of a cord to a slipper (Pl. 7, Fig. 5), the leg resting upon its outer side. At the end of two weeks apply plaster-of-Paris, and let it be worn for four weeks. Many cases require incision and nailing or wiring of the fragments together. If the projecting fragment of the os calcis cannot be forced into place, and if it makes dangerous pressure upon the skin, excise it; if it does not make pressure which threatens sloughing, place the joint in a position favorable for ankylosis, and immobilize. In a fracture of the astragalus use a fracture-box and then an immovable dressing, as in fracture of the os calcis without deformity. Fractures of the other bones of the tarsus are almost invariably compound, and the injury may require drainage and immovable dressing, excision of bones, or even amputation.

Fractures of the metatarsal bones are almost invariably due to direct force and are almost always compound. Robert Jones has published skiagraphs of a fracture of the fifth metatarsal bone from indirect force. Crepitus may be absent because of impaction or fixation by interosseous ligaments. Jones says such a fracture may be produced by the pressure of the body-

weight on an inverted foot the heel of which is raised ("Annals of Surgery," June, 1902). When only one bone is broken, displacement is slight, there is severe pain on motion and pressure, and crepitus can generally be obtained. Pain is produced by flexing the toes, putting weight upon the toes, as in walking, and by inverting or everting the foot. A simple fracture of a metatarsal bone is treated by an immovable dressing for four weeks. Fractures from crushes usually demand excision or amputation.

Fractures of the phalanges of the toes are due to direct force and are often compound. They may require immediate amputation.

Treatment.—In a compound fracture where amputation is unnecessary, drain with strands of catgut for forty-eight hours and dress antiseptically; at the end of this time apply over the bichlorid gauze a gutta-percha or a pasteboard splint extending from beyond the end of the toe to well up upon the sole of the foot, and fix the splint in place with a spiral bandage of the toe and instep. The splint is to be worn for four weeks. In a simple fracture fasten the injured toe to an adjacent toe or toes by a plaster bandage and wear the dressing for three weeks.

3. Diseases of the Joints.

Synovitis is a primary inflammation of the synovial membrane alone. If other structures besides the synovial membrane are involved, the condition is known as "arthritis." Two forms of simple synovitis exist—namely, *acute* and *chronic*. Some surgeons speak also of *subacute* cases.

Acute Simple Synovitis.—The *causes* of acute simple synovitis are contusions, sprains, twists, and overuse. The causative influence of exposure to cold or damp has been much debated. It seems probable that in some cases cold produces vasomotor paresis of the vessels of the synovial membrane, a condition which may be followed by inflammation. In synovitis the synovial membrane is red and swollen, and the joint contains an excess of turbid fibrinous fluid. If the inflammation advances, arthritis arises and sometimes blood is effused.

Symptoms.—A prominent symptom of acute synovitis is pain, which is increased by motion of the joint, by pressure upon the articulation, and by a dependent position of the limb, and which is worse at night. Pressure upon the cartilage does not cause pain, but friction of the synovial membrane at once develops it. The patient places the limb in the position which gives the greatest ease, and in this position the part becomes more or less fixed as the muscles about the joint are rigid. A fluctuating swelling is noted in a superficial joint, most marked between the ligaments, which swelling bulges out the synovial area and hides or obscures the articular heads of the bones. The swelling is due early to extensive secretion of synovia, and later to effusion of liquor sanguinis. Bulging takes place at points where the capsule is thin, and at such points fluctuation may be detected. Fluctuation in the elbow is sought for posteriorly. Fluctuation in the knee is sought for on either side in front. A large effusion in the knee floats the patella up from the condyles. A small effusion in the knee can be detected by Fiske's plan, which is as follows: Tell the patient to bend forward at the hips, resting