Notes on the modern treatment of fractures / by John B. Roberts.

NOTES ON THE

MODERN TREATMENT OF FRACTURES

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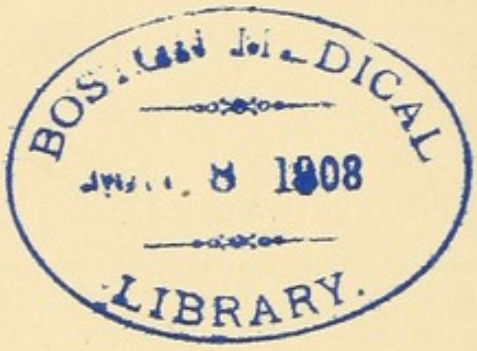

PREFACE.

No injuries require more careful and judicious treatment than fractures; and in no branch of surgical therapeutics is the exercise of common sense followed by more satisfactory results than in the treatment of these lesions. A blind reliance upon therapeutic dogmas and the adoption of routine measures, without due consideration of the mechanical and pathological problems presented, have led to many disasters in this department of surgery. The essays brought together in this little volume represent the views announced at various times by the author, who has always believed that independent thinking leads to the abandonment of false theories, and aids in the search for truth. Some alterations have been made in the papers to bring them into accord with the author's present views.

J. B. R.

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THE MODERN TREATMENT OF FRACTURES.

I.

EXPLORATORY INCISION IN THE TREATMENT OF CLOSED FRACTURES AND DISLOCATIONS.

Complete reduction, exact restitution of contour, and perfect retention are the conditions of full success in the treatment of fractures. Deformity, impairment of articular movement, non-union and neuralgic pains are remote results of failure to obtain these desirable conditions. Since aseptic surgery has made possible the prevention of infective inflammations in most open fractures, it is quite probable that better reduction, coaptation and retention result in open than in closed fractures of the same grade and character of bony lesion.

The recent application of skiagraphy to surgical diagnosis has proved that fractures seemingly well reduced and properly dressed with splints may be the seat of considerable deviation from the normal skeletal relations. At the Polyclinic Hospital recently, for example, a fracture of the middle of the radius, supposed to be well reduced and dressed, was shown, by the use of the Roentgen ray, while the splints were in position, to have its fragments overlapping to the extent of about half an inch. In another case a painful swelling at the seat of a former injury to the fibula was discovered to be due to unrecognized non-union at that point. The rigidity of the tibia prevented the lack of union of the smaller bone being detected, but skiagraphy showed it plainly.

Nearly fifteen years ago I advocated conversion of closed fractures of the cranium into open fractures by incision of the scalp, whenever uncertainty as to the character of the cranial lesion was prejudicial to intelligent treatment.* As part of my argument I said that no surgeon would hesitate to convert a closed recent fracture of the thigh or leg into an open one if it were impossible to replace fragments which were threatening life. I admitted that closed wounds are less serious than open ones, but asserted that, with modern surgical methods, open wounds are preferable to closed wounds having inherent dangers that cannot be recognized without opening them. Further consideration and experience convinced me that this method should be extended to fractures in the limbs, even when life was not threatened, if obscurity of lesion or difficulty in reduction jeopardized function. Accordingly, a few years later,† I gave it as my opinion that recent fractures of the lower end of the humerus might with propriety be subjected to exploratory aseptic incision, if satisfactory coaptation was not obtainable under anæsthesia; and that such action, though it involved opening the elbow joint, was as legitimate in properly selected cases as the recognized exploratory incision made in obscure abdominal conditions.

My belief in the propriety and value of exposure of the fragments in a certain limited number of closed fractures has been strengthened as years have passed. The method, which I do not claim as novel, has, however, not been sufficiently impressed upon the profession to cause its adoption by surgeons in general. Allis of Philadelphia has advocated it ‡ in rebellious fractures of the upper third of the shaft of the femur, in order to apply steel screws for retentive purposes. In England, Lane has employed it § in oblique fractures of

* "Transactions American Surgical Association," vol. iii. (1885), pp. 6 and 105.

† "Transactions American Surgical Association," vol. x. (1892), p. 58.

‡ *Medical News*, November 21, 1891, p. 590.

§ "Transactions Clinical Society of London" (1894), p. 167.

the tibia and fibula near the ankle, for the same reason. McBurney * and others have resorted to it in fracture of the upper end of the humerus complicated with dislocation. Dennis † and Ricard ‡ also approve of it in cases where there is difficulty in obtaining correct apposition of fractures. Other writers may have mentioned the subject, and cases may have been occasionally reported; but, except in fractures of the cranium and patella, I think that most surgeons are more apt to be satisfied with imperfect results than to advise immediate exposure of the fragments before the patient comes out of the anæsthesia induced for the purpose of examining and reducing the fracture.

This attitude of the profession in general has been evident in societies at which I have incidentally mentioned my views,§ and is due to conservatism bred by the fear of open fractures felt by all in the pre-antiseptic period of surgery. The method has suggested itself to many practical surgeons, but it needs to be ever before our minds as a legitimate procedure.

My advocacy of cutting down upon closed fractures is limited to cases in which ignorance of the exact lesion, impossibility of reduction, imperfect immobilization, or failure to deal efficiently with complicating lesions makes the incision the less of two evils. An aseptic incision is almost devoid of risk, even if it opens a joint; but that slight risk should not be added to the patient's burdens unless the probability of deformity, of interference with joint movements or other functions, of pain, of paralysis, or of non-union justify it. Here, as in all departments of surgery, it is the surgeon's duty to exercise care and good judgment in selecting the method of treatment. To illustrate my meaning I cite fracture of the

* *Annals of Surgery*, May, 1890.

† "System of Surgery," vol. i.

‡ "Traité de Chirurgie," Duplay and Reclus, ii., 376.

§ *Annals of Surgery*, April, 1895, p. 457, and *Philadelphia Polyclinic*, August 21, 1896.

patella, which I have never treated by incision and suture of the bone, because I have thus far always been able to satisfactorily bring the fragments together by hooks, subcutaneous suture, or splint. In one or two instances I have almost decided to lay open the overlying tissues in order to obtain approximation by direct appliances, but I have finally not been obliged to do so. The open operation I believe to be legitimate, and probably needful in a very few selected cases, but I am opposed to it as a routine treatment.

It is self-evident that the wound exposing a fracture must be aseptic, and that the operator who adopts incision must be familiar with the steps to be pursued at the inception of infective inflammation. A man who will hesitate to reopen the wound or drain the joint, at the moment septic premonitions show themselves, should associate a more energetic surgeon with himself in such operative treatment of fractures. The risk of incising muscles and opening joints, if done in an aseptic manner by an operator familiar with truly aseptic and antiseptic surgery, is unquestionably very slight. Primary union without disturbance of joint-function will be almost universal.

If it once be admitted that the seat of a fracture can be exposed by incision, with little or no risk to life, there are many advantages that will at once suggest themselves:

1. The exact lines of separation can be seen, and the significance of lines of comminution in relation to subsequent reconstruction can be fully appreciated.

2. Coaptation need no longer be guessed at by the sensations imparted to the examiner's fingers, separated as they are from the bone by varying thicknesses of muscle, fat and skin; nor need it be dependent upon the possibility of having conveniences for taking a skiagraph.

3. The fragments can be accurately fitted together, torn periosteum replaced, and muscular and facial bands, nerves and muscles disentangled from undesirable positions between

the pieces of broken bone. This prevents deformity by permitting restoration of normal contour of the limb and lessens occurrence of non-union, neuralgia, atrophy, and anchylosis.

4. When the osseus, muscular, and vascular relations have been restored, they can be perfectly maintained by the application of sutures, pegs, nails, screws or ferrules to the bone, and sutures or ligatures to the muscles, nerves, and vessels.

5. The pain, due to extravasation of blood, rapid inflammatory exudation, or traumatic synovitis, is relieved by the removal of the clots and leaking out of exudation and synovial fluid. The interstitial pressure caused by extravasated blood and exudate has often heretofore caused surgeons to split the skin and deep fascia by long incisions, in very bad fractures, in order to avert threatened gangrene. A similar relief of tension in less urgent cases will undoubtedly lessen pain and suffering, though such operative treatment would ordinarily not be adopted. The incisions employed to uncover the fractures are therefore indirectly of value as relievers of pain.

6. Pain is also lessened, in the few cases requiring direct retentive apparatus, because the sutures, nails or screws prevent motion between the fragments better than external splints. Muscular spasm or incautious movement has therefore little opportunity to cause suffering.

7. Fat embolism is probably less likely to occur in fractures liable to its occurrence, if early escape of the fatty débris is permitted by incision.

8. Anchylosis from faulty position of fragments, irregular formation of callus due to stripped-up periosteum, and gluing down of tendons, will seldom occur after the fracture has been disclosed to the scrutiny of a competent surgeon.

9. Repair of the broken bone and functional restitution of the surrounding tissues occur more rapidly than when coaptation is imperfect, or when damaged muscular and other structures are left to the unaided efforts of nature. Impairment of digital movements after fractures is probably often due to

coincident rupture or laceration of muscles, which might have been repaired by suturing with catgut, if the surgeon had known of the existence of the complication. The aseptic wound affords him this opportunity; and afterward usually heals so rapidly that it is of no disadvantage to the patient's period of convalescence. This early restoration of wage-earning capacity is of great value to many patients.

10. It not infrequently happens that a closed fracture seems to have been well set, and to have little deviation from the normal; and yet the patient has lost some of his availability as a machine. This is most likely to occur in the lower limb which, during locomotion, carries the entire weight of the man. A slight change in the axis of a bone or in the plane of an articulating surface may perhaps throw the weight upon the hip, knee, or ankle in an abnormal way, and induce a considerable and ever increasing disability. This contingency is usually avoidable after the accurate inspection of the injured bone permitted by uncovering the fracture by an incision.

In vicious union of fractures due to absence of treatment, or to injudicious treatment, I believe that it is sometimes much better to expose the seat of deformity and divide the deformed bone with an osteotome than to refracture subcutaneously by an osteoclast or the surgeon's hand. Many cases can indubitably be well treated by refracture without incision or by subcutaneous osteotomy; but if there be a reasonable doubt as to one of these methods enabling the surgeon to accomplish relief of the deformity, free exposure, such as I have just been advocating in recent fractures, is the proper treatment.

A similar method of dealing with luxations which are not readily reduced by manipulation under anæsthesia is, in my opinion, preferable to a long continuance of unsuccessful manipulations, the application of great power by apparatus, or the relinquishing of the attempt to restore the integrity of the joint. It is true that in all dislocations, except that of the spinal column and the backward luxation of the second

phalanx of the thumb, reduction is usually readily accomplished by skillful manipulation under anæsthesia, provided the attempt is made while the injury is recent. My contention is that in recent dislocation, when this is not the case, and in old dislocations, arthrotomy should be promptly done. No surgeon would recommend allowing the displacement to remain without attempting reduction; and I believe that compound pulleys or other methods of applying great force are usually more risky than prompt and thorough exposure by incision. Immediately before making the incision it would be well in most cases to make a final effort to reduce by manipulation; but this should not be carried to a sufficient extent to cause much bruising or muscular laceration. The presence of such traumatism would increase the liability to septic processes, if imperfect asepsis allowed germs to gain access to the wound during the operation.

Arthrotomy for irreducible dislocations is not a novel suggestion, for it has been repeatedly done by many surgeons in old injuries. It has not, however, I think, been often adopted until after vigorous efforts have been made to subcutaneously replace the articular surfaces. Its use in luxations a few hours or a few days old, except perhaps in the fingers and toes, is probably almost unknown as an accepted surgical procedure. I believe it ought to be the approved treatment in a small number of cases. The advantages of the open method will at once be patent when the accidents that occasionally follow the employment of the older method are recalled. Fracture of the bone or laceration of artery, vein, or nerve is only likely to occur when the region is not exposed to the operator's eye. In case of impossibility to properly reduce the dislocation, moreover, the end of a luxated bone can be excised. This will probably nearly always give a better functional result than to allow the previous condition to persist. Excision is not infrequently required after attempts to reduce old luxations without incision having proved unavailing. In an at-

tempt to reduce an old luxation of the humerus I have displaced the head of the bone in such a way that it rested on the brachial plexus and caused more trouble than the original deformity. This would not have been the result, I think, if I had exposed the luxated bone by arthrotomy. If the open treatment is to be adopted it is evident that the patient will receive the greatest advantage if it be instituted before the head of the bone is altered in shape, the socket changed, and muscle and fascia contracted or adherent to surrounding tissues. The open method in addition gives opportunity to divide any ligaments, tendons, fascias, and muscles which restrain reduction, to scrape out any material filling the socket, and to make provision for preventing recurrence of dislocation by retrenching the capsule or other plastic measures.

Skiagraphy may have a field in this department of surgery, as in fractures, by indicating the character of the luxation before the incision is made. It may, perhaps, be urged to this plea for a more general employment of exploratory incision in closed fractures and dislocations that there are great objections to making a closed lesion of the osseous system an open one.

I know of no objection except the risks inherent in anæsthesia, the possibility of infection, the occurrence of serious bleeding, and the production of anchylosis. The objections are of no force when the injury is one requiring exploratory incision. Anæsthesia will have been used in such instances for diagnosis or attempted reduction. Its moderate prolongation for the necessary time will add practically nothing to the risk. Bleeding is no contra-indication, except in that rare condition, hemorrhagic diathesis. Anchylosis is more liable to occur from displaced fragments of articular surfaces, irregular callus due to stripped-up periosteum, and interference with articular contact, than from aseptic incision into the joint and readjustment of the joint structures. The possibility of infection is, then, the only factor that requires consideration.

Fifteen or twenty years ago, even subcutaneous tenotomy at the heel, recommended by the surgeons of the Pennsylvania Hospital in cases of marked displacement after fracture of the tibia, was undertaken with some hesitation. Now operative infection in muscular and osseous lesions is so preventable and so readily managed by prompt action that it is no longer a valid objection to incision in a closed fracture or dislocation, if functional disability is liable to occur unless this operation is performed. For some years it has been the practice of surgeons to incise open fractures freely in order to thoroughly cleanse the deep recesses, obtain an antiseptic condition of the lesion, and get rid of the effused blood. An extension of operative surgery is, in my opinion, now warranted in closed fractures and dislocations in which ordinary methods of reduction prove unavailing or unsatisfactory.

II.

SUBCUTANEOUS NAILING IN FRACTURES WITH UNUSUAL TENDENCY TO DISPLACEMENT.

The safety with which fractures may be explored by aseptic incisions and the success of direct fixation, obtained by mechanical devices, have begun a revolution in the treatment of complicated injuries of bone.

My attention has recently been directed, as a result of reading, experience and some experimental work, to the value of fixation of closed fractures by subcutaneous nailing. All surgeons use at times wires, screws, pegs, or nails to hold fragments together after adjustment of an open fracture or the operation of resection.

It is now pretty well conceded that it is entirely proper to lay open the soft parts, and accurately examine with the fingers and eyes an obscure fracture which is difficult to reduce or to keep reduced; provided that the surgeon is familiar with the exact details of aseptic surgery and knows how to promptly meet the first evidences of septic contamination. I believe that it is similarly proper for a surgeon, with the same qualification and a sufficient knowledge of regional anatomy, to deliberately nail together the fragments of a broken bone with an aseptic wire nail, driven through the unbroken skin as a tack or nail is driven through a carpet into the boards of the floor.

This operation will naturally be found most serviceable in oblique fractures of superficial bones like the tibia, and in fractures without comminution. It will be adopted with less safety in fractures involving joints, because of a greater risk of faulty asepsis; but even there a skillful and conscientious

surgeon with a rigidly aseptic technique will find no reason to reject the method. The careless surgeon who calls himself an aseptic or antiseptic operator, but continually breaks the simplest rules of aseptic surgery, has no real right to operate in serious cases, and must be considered as debarred from operative undertakings of this kind.

In comminuted fractures it may be impossible to employ satisfactorily subcutaneous nailing, because the exact reposition of the pieces is impossible through the overlying swollen tissues; and because the avoidance of nerves and blood-vessels may be difficult, when driving the two or three nails which will be needed to fix the fragments firmly in place. In these cases an exploratory incision will disclose the nature and extent of the fracture line and permit the nails to be driven with accuracy. They should be so used, of course, only when their use is shown to be better than indirect fixation by splints applied externally.

Ordinary wire nails and a hammer are the only instruments needed in fixing fragments by the method here advocated. As wire nails are not tempered and often are not pointed, and as the exterior of the bone consists of compact tissue, it is rather better to have tempered steel nails or drills of various lengths made for the purpose; but this refinement is not at all necessary. Surgical needles, if long enough, will answer the purpose. I have had made slender steel nails of different lengths with drill-shaped points and long square heads. These fit into a common handle which is used while forcing the nail through the soft tissues and compact outer layer of bone. As soon as the hard bone has been perforated, the handle is detached and the nail driven into the fragments, held in correct position by the fingers; the long head is allowed to protrude. At the end of two, three, or four weeks, the nail is seized by the head with a pair of forceps and withdrawn.

During the time the nail is in position the small wound of entrance is dressed with aseptic or antiseptic gauze; and a

slight additional support is given to the broken bone by any form of dressing which will prevent strain at the seat of fracture. A very light metal, wooden, paper, or gypsum splint may be employed for this purpose.

This manner of dealing with fractures is by no means recommended as a routine procedure, but is a legitimate and valuable adjunct in dealing with broken bones having an unusual tendency to displacement, whether the displacement be due to great obliquity of the line of fracture or to exceptional muscular contraction.

Its advantages are simplicity of technic, effectiveness in meeting the mechanical requirements, and the ease with which the instruments required can be universally obtained. The only objection to the method in cases requiring such active treatment is the necessity for absolutely aseptic materials, and the observance, on the surgeon's part, of the same conscientious care, as to sterility of hands and skin, as is required in a successful intra-abdominal operation.

Subcutaneous nailing will probably be found very valuable also in certain dislocations, such as dislocations of the clavicle from the sternum and the scapula from the clavicle.

III.

THE PREVENTION OF DEFORMITY IN FRACTURES OF THE EXTREMITIES.

The deformity following broken bones is a frequent cause of litigation because the disability and unsightliness of the condition are readily apparent to the patient and his friends. For the same reason the surgeon is more often subject to unfavorable criticism than the physician, whose failure to do the best possible is often unknown to the public.

So annoying is the sight of a deformed limb and so great are the responsibility and anxiety assumed in taking professional care of a bad fracture that some practitioners feel glad to have such cases fall into the hands of other physicians or to receive treatment at hospitals.

Mistaken diagnosis is a common cause of deformity after fracture. It is necessary not only to know that a fracture exists, but also to be acquainted with the situation and general character of the lines of separation, if the surgeon is to obviate deformity. Many physicians fail in this important part of the treatment because they neglect to compare the injured with the uninjured limb; because they have forgotten the anatomical outlines of the region and do not take the trouble to look at the dry bones of the part while studying the injury; or, because they fail to examine the patient under general anæsthesia which prevents pain and relaxes the muscles.

I have seen fractures overlooked because these precautions have been omitted. This is perhaps most often the case in fractures near joints where the normal mobility of the part and the irregular contour of the bones obscure the deformity

and preternatural mobility due to the fracture. It has at times surprised me to find a peculiar curve in a bone of an injured limb existent also in the skeleton of the opposite side, proving that, which I at first supposed was an abnormality due to fracture, to be natural configuration peculiar to the patient. Every doctor should have in his office the parts of a human skeleton. At times nothing so clearly straightens out an obscure diagnosis as a moment's inspection of the bare bones. An articulated skeleton is not necessary, and is rather expensive. The separated bones can be obtained through any medical student at very little cost from a dissecting room. Finer and more costly preparations, but no better for study, can be bought from the surgical instrument makers.

General anæsthesia is not employed as often as it should be in obscure injuries. A few inhalations of ether will relax the tightened muscles and permit the surgeon to freely manipulate the injured limb. The freedom from pain thus obtained is also desirable and prevents the unwise hurry which sometimes is the cause of erroneous treatment at the hands of skillful and careful medical men.

When it is impossible to make out the exact character of the fracture even under etherization and there exists bony deformity which the surgeon is unable to correct, it may, in my opinion, be wise to make an aseptic incision down to the broken bone. This clears up the diagnosis, permits proper readjustment of the fragments, and only converts a closed fracture into an open one. With our present aseptic and antiseptic methods of operating, the incision adds little risk to the case; and may be of incalculable value in overcoming displacement and preventing premature deformity and disability. If the practitioner having charge of the case is not familiar with aseptic surgery, he should seek the aid of a modern surgeon familiar with aseptic details. Suppuration must, of course, be avoided, and energetic relief measures must be promptly instituted if septic contamination occur. The wound, even if it look well

superficially, must be opened and drained if septic process begin in it.

The Roentgen ray now gives us an almost perfect method of discovering the lines of fracture without incision. It is unfortunately not always available.

When the diagnosis of fracture has been made, complete reduction of the fragments should be promptly accomplished. This is usually not a difficult task if the medical man is acquainted with the normal outline of the bone, compares the injured limb with the normal one and uses the skeleton of the arm or leg as a test of accuracy. The swelling which sometimes obliterates the outlines may often be greatly diminished by elevating the limb for a few minutes, rubbing it with the hands from the fingers or toes toward the body, and encircling it for a few minutes with a rubber or flannel bandage firmly applied by spiral or spiral and reverse turns. These manipulations urge the serum upwards toward the heart and lessen the distention of the subcutaneous cellular tissue. The bandage must not be allowed to remain on the limb for more than a few minutes, lest it cause gangrene. It usually cannot be applied unless the patient be etherized, as it gives pain.

In the green-stick fracture of childhood much force may be demanded to bring the bone into its normal shape. This should usually be done, even if the fracture is thereby made complete. The exception I make to this rule is in green-stick fractures of the clavicle. Complete fractures of the clavicle are often difficult to keep in perfect apposition. I therefore frequently desist from applying force sufficient to cause complete separation of the fragments in little children with green-stick fractures of this bone. I believe that the slight deformity which is left after partial restitution of the normal outline by moderate force, is likely to be less conspicuous than that which may result if I carefully separate the fragments and unavailingly try to keep the ends in perfect coaptation. If the child is very young, the deviation in shape will probably

diminish as the bone grows in length and thickens. If the child is nearly full grown, I am much more apt to attempt complete reduction, even if the bone does give way under the pressure of my fingers.

In impacted fractures, considerable force is frequently needed to disentangle the interlocked ends. Unless this is accomplished, reduction is incomplete, and deformity will persist. I think, at present, of but one instance in which it is unwise to attempt to separate the impacted fragments. Fractures of the neck of the femur in the aged have a characteristic indisposition to repair by bony union. Hence the interlocked ends of the broken bone should not be pulled apart in the attempt to make a diagnosis or to obtain perfect restoration of the bony outline of the femoral neck. The deformity that will occur from the impaction is far less important than the disability certain to remain after treatment, if the fragments are separated and non-union occurs. If the bony entanglement is undisturbed, osseous or cartilaginous union becomes more probable.

This advice to avoid meddlesome activity applies only to fractures of the femoral neck in the aged. Under other circumstances the impaction should be overcome and careful coaptation of the fragments sought.

The fracture which probably most often gives rise to deformity is that of the lower end of the radius, with backward displacement of the lower fragment. In this injury the lower fragment is very often impacted or caught upon the dorsal edge of the upper fragment. It requires force suddenly applied with all the power of the surgeon's hands to drive the lower fragment forward into its proper relation with the shaft of the bone. This is neglected, I fear, by a great majority of practitioners. Deformity much greater than necessary and a protracted convalescence, with pain and stiffness of the fingers are the consequences of the error. Immediate and thorough reduction will usually result

in a rapid cure with little or no noticeable deformity. I have sometimes bent the lower end of the radius across my knee before I could disentangle the fragments and bring the lower one into place. This is not often necessary unless the fracture is some days old when first subjected to treatment.

Deformity after unsuccessfully treated fractures may be prevented or relieved by refracturing the callus which unites the fragments. This is occasionally necessary in instances where no treatment has been given. The bone is bent across the edge of a padded table or over the surgeon's knee, and, after the bond of union has been ruptured, is treated as a recent accidental fracture. This may be done with success at the expiration of even six months since the seat of fracture remains weaker than the rest of the bone for a long time. There are various methods of applying the power of the surgeon who wishes to refracture such vicious union of a fracture; and the bone may be weakened or divided by drills, the osteotome, or the saw; but these matters are foreign to the present discussion.

To obviate the occurrence of distortion after reduction and coaptation of a fracture have been accomplished, some sort of retentive apparatus is required. In fractures of the thigh I usually employ permanent traction by means of a weight attached to the limb with adhesive plaster. This overcomes the tendency to overlapping. Any tendency to lateral displacement I antagonize by sand-bags laid along the sides of the thigh and leg or by molded splints. The molded splints may be made of bookbinders' pasteboard wet with water and applied to the limb before becoming dry or of gauze saturated with plaster of Paris and water.

The best, and probably the cheapest, splints for fractures of the extremities are molded gypsum splints. Plaster of Paris, or gypsum, is obtainable in every region from storekeepers or druggists and costs but a few cents a pound. When added to water it forms a creamy mixture, which, as

everybody knows, soon "sets" or hardens into the familiar plaster used for covering the inner walls of our houses. A few strips or layers of cheese-cloth or mosquito-netting, saturated with a moderately thick solution of plaster and laid upon the broken limb after the fracture has been set, soon stick together and harden, forming a splint which accurately fits every inequality of the limb's surface. The rigidity of the hardened gauze and plaster splints may be made as great as the surgeon pleases by placing more layers of gauze saturated with the plaster mixture upon the outside of the first layers, before the plaster in them has "set." If there is a tendency for any fragment to become displaced, the surgeon's fingers pressed for a few minutes on the outside of the splint so as to hold the piece of bone in position, makes a permanent prominence on the inside of the splint which acts as a substitute for his finger and does the same service as long as the splint is worn.

These molded splints are held in place by a roller bandage and are far better than any carved or manufactured splint ever made. They fit as a man's skin fits and need no padding to prevent bedsores. One splint may be applied on each side of the limb, or a single splint may be made so as to encircle the whole or nearly the whole of its circumference. Neighboring joints may be covered and therefore supported by the splint; or openings may be made in the splint where a wound needs frequent dressing or inspection. A little common salt added to the plaster mixture or the use of hot water for the mixture hastens its "setting"; borax or cream of tartar makes it harden more slowly.

Such splints when applied as a first dressing should never be made to entirely encircle the limb; since the swelling incident to the fracture may make them too tight and cause much pain and even gangrene. If the plaster dressing is applied so as to encircle the limb, it should be cut open on one side its entire length before the surgeon leaves the patient.

To prevent late deformity the surgeon must insist that no strain be put upon the newly formed callus until it is hard enough to bear the burden. This is particularly important in fractures of the femur and tibia, which in locomotion carry the entire weight of the patient's body. Oblique fractures of these bones are especially liable to bend at the seat of union, if the patient walks on them to early, without proper artificial support. It often requires very little additional support, but that amount may be essential.

Quite recently I saw a gentleman with a deformed hand because he had insisted upon rowing shortly after being treated for fracture of a metacarpal bone. The callus was too soft, and he now has a curved bone instead of a normally shaped one.

The so-called ambulant treatment of fractures of the lower limb is very valuable in selected cases; but requires the gypsum splint to be adjusted in a special manner. It must be made so thick and firm as to carry the weight of the patient in walking and at the same time allow none of the weight to come upon the broken bone.

IV.

SUBCUTANEOUS TENOTOMY AS AN AID IN THE REDUCTION OF FRACTURES.

The treatment of fractures has received much consideration in recent years and many suggestions of value have been made. Some practitioners, however, seem to regard fractures as injuries belonging to a department of surgery in which no advances have been made, and continue the routine measures of the last generation. It is this conservatism, or want of progress, in surgical practice that leads me to call attention to tenotomy as an aid in the reduction of fractures with displacement.

The suggestion was made a good many years ago by someone; and has been used by many surgeons with great satisfaction. It is not employed as often as it should be, because its simplicity and effectiveness have received such scant recognition. Its adoption by every physician who knows how to perform an aseptic subcutaneous division of a tendon would, I am convinced, result in lessening the number of cases of deformity after fractures—especially of the tibia and fibula. Surgical specialists are well aware of its usefulness in oblique fractures of the leg near the ankle; but I am not sure that even they adopt it as often as is desirable in fractures of the shafts of the tibia and fibula. One who has cut the tendon of Achilles in tibial fractures in which the ordinary fracture dressings seemed unavailing in preventing overriding and deformity, will be pretty sure to adopt it in subsequent cases. The ease with which reduction is obtained and coaptation maintained is a source of much satisfaction, after such an operation.

It is essential that the skin and tendons be made aseptic and that the whole tendon be cut. If a few fibers are left undivided, the heel will still be drawn up by the calf muscles and the operation will fail of its object. If the operator can feel through the skin a distinct gap between the cut ends of the tendon, showing that the whole width and thickness of the tendon has been severed, the fragments will be easily adjusted and will lie in proper position with any simple form of retentive fracture dressing he may prefer. The pain due to spasmodic contraction of the calf muscles will be absent after such a tenotomy and the patient's comfort thereby greatly increased. The puncture made by the tenotome is to be covered by a compress of aseptic gauze or sealed with a little aseptic cotton or gauze held in place with collodion.

This little operation, to which I have been resorting for years in selected cases, does not appear to impair the subsequent power and usefulness of the foot. It obviates the necessity for complicated fracture appliances, to overcome spasm of the calf muscles which are causing pain and displacement of the ends of the broken bone.

I have, so far as I recollect, only employed tenotomy in this manner for aiding the reduction of fractures of the leg. It would probably be available in fractures of the upper part of the femoral shaft, when the iliopsoas muscle flexes and everts the upper fragment. The operation here would probably require open incision and inspection of the parts, in order to devide the tendon without injuring important structures in its neighborhood. Tenotomy would perhaps take the place of cutting down upon and wiring the fragments in these troublesome fractures.

The tilting up of the inner fragment in some fractures of the clavicle could probably be avoided by subcutaneous tenotomy of the clavicular portion of the sterno-cleido-mastoid muscle. The upward displacement of the olecranon after

fracture might be managed in the same way, if it were difficult to obtain and maintain coaptation.

There is a possibility that intra-articular operations for bringing together the fragments in transverse fracture of the patella may be avoided by a free tenotomy and myotomy of the four-headed extensor muscle of the thigh.

V.

FALSE DOCTRINE IN THE TREATMENT OF FRACTURES.

It is my desire to call attention to some points in connection with the treatment of fractures which I believe to be errors, but which I think are accepted as axiomatic truths by many members of the profession.

The idea is entertained by many that every fracture of the extremities should be treated by a special splint or apparatus. The simplicity with which fractures are treated by us in the Philadelphia hospitals has caused surprise to those practitioners who come to us for post-graduate instruction. Their previous teaching or reading has evidently created the mistaken impression that complicated special devices are essential for each variety of broken bone. The fact that treating a fracture is a simple mechanical problem capable of solution by any device that will secure correct apposition and immobilization, while at the same time inflammatory conditions are prevented, is not recognized.

The quite frequent use of a bandage, next to the skin, before the splint is applied to the extremity is due to false teaching, and is fraught with danger because of the possibility of its causing unexpected constriction in the event of rapid inflammatory swelling. This primary bandaging has been advocated to prevent swelling and muscular spasm. That it does either to any beneficial extent is doubtful. We possess other and less dangerous methods that are more effectual for such purposes.

It is quite commonly believed that ensheathing callus is one of the essentials of proper union after fracture, while the truth seems to be that ensheathing callus is seldom found except in

fractures of the ribs and other fractures where immobilization of the fragments is imperfectly accomplished. A fracture so held in proper coaptation that motion cannot occur heals without ensheathing callus in nearly all instances. Cicatrization goes on in bone wounds essentially as it does in wounds of soft parts.

Early institution of passive motion during the treatment of fractures near joints or involving joints is still insisted upon by many practitioners. One of the greatest sources of anxiety to the young and inexperienced doctor is to know when to begin passive motion. He fears to begin too early lest he disturb the process of union; he dreads to leave it too late lest he have an anchylosed limb as the result of his tardiness. The proper course, it seems to me, is something like this: If the joint is involved in the line of fracture passive motion at an early stage will not prevent anchylosis, but may increase it by causing a greater degree of arthritis; if the joint is not invaded by the fracture line early passive motion is not needed, because anchylosis will not occur unless violent inflammation of the soft parts arises, which inflammation passive motion is more likely to increase than to decrease. In accordance with this view no vigorous passive motion should be made earlier than two or three weeks in any case. The adoption of such motion earlier than this has often in energetic but injudicious hands given much unnecessary pain, and perhaps in many cases increased the arthritis and subsequent stiffness. The degree of restoration of function possible after articular fractures is only determinable after many weeks. Passive motion should certainly not be commenced while arthritis is acute, and not as a rule until union of the fracture is pretty well accomplished. When it is attempted the occurrence of arthritic reaction is an indication that it must be still longer postponed.

The permanent stiffness of articulations after fractures involving the joint surfaces is nearly always due to imperfect reduction of the fragments or to infective synovitis. Passive

motion will not lessen the rigidity resulting from these causes. Massage and passive motion are, however, useful in nearly all fractures, by hastening absorption of effused blood and exudate, stimulating the nutrition, and keeping the muscles supple. They may be instituted immediately after the coaptation of the fracture, and be kept up during the entire period of treatment. Pain is an evidence that the passive motion or massage is doing harm, because arthritis exists or the movements are too vigorously employed.

Splints and dressings are often continued too long, and thereby the disability of the patient for attending to his business is prolonged. In uncomplicated fracture of the tibia and fibula the patient should be able to go on crutches to his store or office in two or three weeks; provided that a silicate of sodium or a gypsum dressing has been applied. After fracture of the fibula of ordinary severity one week's confinement to the house is sufficient, provided that some supportive dressing be thereafter worn and crutches used. The usual uncomminuted fracture of the lower end of the radius needs no splint after ten days or two weeks. Although, of course, function is not perfectly restored, the hands and fingers can be used for many purposes involving little muscular effort. While not wishing to advocate rapid convalescence when caution requires a few days' additional confinement, I hold that it is improper to keep a patient from pursuits that need his attention, merely because of the traditional idea that a fracture means six weeks' enforced idleness. Loss of money, mental anxiety, and continued disappointment of business connections are penalties too great to endure because of a tardy convalescence insisted upon by routine practice.

It is false doctrine that still insists upon the great risk incurred when a closed fracture of the cranium is converted by the surgeon into an open one, in order to explore supposed dangerous characteristics which, if present, threaten life from probable secondary encephalic inflammation.

The possibility of septic infection is increased, I admit, but so little that the danger of obscurity in diagnosis and consequent erroneous treatment is often much greater.

Fractures of the nose have long been, and still are, often treated by useless dressings. The conventional application to broken nasal bones is a strip of adhesive plaster placed across the bridge of the nose with the idea that it will by its adhesion to the skin hold the broken fragment upward, and prevent depression of the nasal arch. That it is quite impossible for a flexible tissue like adhesive plaster to act in this manner will be recognized with the mere statement. If comminution tends to allow displacement, the plaster will not give sufficient rigidity to obviate the tendency. If it does no good, why disfigure the patient by making him wear it? The proper method of retaining fragments in position when great tendency to displacement exists, is by transfixing pins; but as the object of this paper is not to deal with plans of treatment, I will not discuss the procedure at this time. Another custom quite prevalent is to put tubes in the nostrils after nasal fractures or operations, when we would all prefer mouth breathing to wearing nasal canulas, which are unsightly, uncomfortable, dirty, and which as a rule soon become clogged. Breathing through the mouth for a few days is easily borne when an acute nasal catarrh is contracted; therefore its performance after nasal injuries is not intolerable. If a plug is required in the nostril to maintain position of the fragments let it be introduced, and let it be a tube if you choose; but it will usually become clogged and offensive. A solid plug will in most instances be more cleanly.

Deformities of the nasal bones and cartilages often become permanent after fracturing injuries because it is believed that there is little relief for the displacement. Properly conducted surgical treatment at the beginning or operative measures afterward will relieve much of the unhappiness resulting from unseemly lateral deviations and irregular contortions of the

nose. The importance of this feature in the facial lines renders defects in conformation so noticeable that in hypersensitive persons mental characteristics are often due to nasal deformity in childhood. It may be remembered that a commander of ancient times gave the order " aim at their noses " knowing that the enemy feared facial disfiguurement more than actual death. The false doctrines prevalent concerning nasal fractures should therefore meet an early overthrow. It is more important to treat a broken nose well than a broken leg.

The use of the axillary pad in treating fractured clavicle is of little or no value. The important factor in the treatment is to so fix the inferior angle of the scapula that the scapula cannot slide forward upon the lateral wall of the thorax, as it tends to do, because the clavicle, which is its only bony attachment to the trunk, is broken.

Displacement of the fragments in broken clavicle is to be prevented by steadying the lower end of the scapula; and not by an axillary pad, which is ineffectual as a fulcrum against which to use the humerus as a lever to throw the acromial end of the clavicle outwards and backwards. The axillary pad is useless unless large and hard; if large and hard it cannot be worn without discomfort, that would usually be accompanied by danger of injurious pressure to soft parts.

The employment of an internal angular splint for fractures in the vicinity of the surgical neck of the humerus is founded on false premises. The axillary muscles prevent the upper end of the splint extending high enough into the axilla to control the upper fragment. Hence the splint does not keep the upper fragment at rest, and, by its projection beyond the elbow or hand, gives more leverage by which unexpected blows may cause motion of the lower fragment. It is better to use the thorax as a splint, and bandage the arm to the chest with perhaps a small amount of packing such as absorbent cotton or lint, in the axilla to steady the upper fragment.

The fallacy of treating fractures of the condyles of the humerus by anterior or posterior rigid angular splints, and thereby causing deformity and disability by impairing the external angular deviation of the axis of the upper extremity, was shown by Allis some years ago.* Yet this is probably the method by which such fractures are treated by most of the members present to-day. The loss of the carrying angle of the arm after treatment of condyloid fracture by such splints, is, I have no doubt, a common experience, though many may not have recognized the cause.

In fractures at the middle of the forearm, interosseous pads are seldom, if ever, required if the fragments are molded into proper position and the forearm is put in a position midway between pronation and supination. The interosseous space cannot easily be preserved by the use of an interosseous compress, if the molding and the position mentioned will not do it. The bones are too much enveloped in muscles to be controlled by a superficial pad, even if it is long and narrow and hard. At least such will be found the case in most instances. A lamentable practice, founded on false doctrine, is the use of a straight—that is, flat—splint for the ordinary fracture of the lower end of the radius. The palmar surface of the lower end of the radius is concave, therefore the splint must be curved. Yet the practice of employing a Bond splint or some other form of flat splint is common. A convex splint or a splint with a hard pad, with a convex upper surface, is the only form of splint proper to use on the palmar aspect of the fracture. A straight splint will do well on the dorsal, but not on the palmar surface. Use, therefore, either a curved palmar or a straight dorsal splint if you desire cure with the least possible deformity. The stiffness of fingers and deformity, so frequently seen after these fractures, are due to imperfect reduction of the fragments and improper splints. In some cases reduction without the application of any splint will give better results than reduction with the use of a flat splint.

* "Transactions of Medical Society, State of Pennsylvania," 1881.

The teaching that fractures of the shafts of metacarpal bones should be treated by palmar splints may not be universal, but it is very common. In oblique fractures the deformity can often be overcome best by continuous extension adjusted to the finger by means of adhesive plaster, as it is done in fractures of the femur. Strips of adhesive plaster attached to the finger and an extending cord, preferably of rubber, fastened to a splint, placed under the wrist and palm and extending beyond the finger tips, is a serviceable dressing for correcting overriding in metacarpal fractures.

The habit of measuring the length of the lower extremities in suspected fracture of the femur is founded on a mistaken impression that the legs are of the same length. The frequent asymmetry in length of normal limbs has been so often demonstrated that it is surprising to see surgeons constantly employ this method of diagnosis. Even if the legs were known to be of equal length, the measurement would probably be inaccurate, because of the difficulty of avoiding tilting of the pelvis and of applying the tape to exactly similar points on each side. When it is known that normal legs differ in length, the folly of placing any diagnostic dependence on the figures obtained is apparent.

The disability liable to follow fractures of the femoral neck in patients beyond middle life is not as great as it is often stated to be. Whether this is due to a mistaken diagnosis between intracapsular and extracapsular fracture, I know not; but I am convinced that the impression prevails to a great extent among the profession, that fracture of the neck of the femur in an old person means almost helpless lameness. Such is not the case. Very good use of the limb quite frequently happens.

In oblique fractures of the legs with overlapping, reduction can at times be facilitated by tenotomy of the tendo Achillis. This means of overcoming displacing muscular action is perhaps not as often resorted to as it should be.

Extension by traction applied to the head and legs should be better known, I think, as a possible method of reducing fractures of the vertebræ. In many cases it will do no good, but in others it may.

The aversion to applying coapting hooks to the patella and olecranon, when apposition is otherwise impossible, is, in my opinion, the result of false teaching and observation.

There are many points of this character upon which I might dwell, but I have said enough to indicate my disbelief in many of the popular traditions of surgical practice. I shall now wait to hear in the discussion that will follow, what justification for my beliefs or disbeliefs I can get from the practical men here present.

VI.

RECENT ADVANCES IN THE TREATMENT OF FRACTURES OF THE EXTREMITIES.

Surgeons have recently made notable advance in the investigation of fractures by the employment of the Roentgen rays, which by means of the fluoroscope or photographic plates show the exact condition in obscure cases of fracture. In other instances, fractures which were supposed to have been properly reduced have been shown by the use of the Roentgen rays to be still the seat of deformity.

Another improvement is the freedom with which obscure fractures may be investigated by aseptic incision of the soft parts, which discloses the exact nature of the bony lesion.

The treatment of fractures has been much improved in recent years by the more extensive adoption of plastic splints made of gauze and plaster of Paris. These should substitute to a great extent the manufactured splints of metal and wood, which instrument makers sell at a high price for use upon fractured limbs which they seldom fit. It is possible to properly pad a wooden splint or successfully adjust a metal or felt one to the injured limb. It is, however, far better to make a splint out of plastic material like gauze filled with gypsum, which will absolutely correspond with all the inequalities of the surface of the patient's limb.

Ambulant splints which permit patients with fractures of the leg to get out of bed and walk upon the injured member at a comparatively early period are also the result of the advance in fracture treatment that has come by study of the imperfections of older methods. The employment of massage during the entire period of treatment of a fracture will be found to lessen the rigidity of muscles, stiffness of joints, and

inflammatory infiltration around the seat of fracture which so often retard the patient's full recovery of function. Massage should be used with discretion, but may be employed with much satisfaction to the patient every time the splint is removed for the inspection of the seat of fracture. The desirability of this method of establishing a healthy condition of the soft parts makes it desirable to remove the splints much more often than used to be thought necessary.

Tenotomy of the tendon of Achilles to prevent muscular displacement in fractures of the leg near the ankle is another accessory of treatment often neglected. This little operation will probably be found of avail in some cases of fracture of the olecranon, and perhaps in other regions where muscular contraction leads to difficulty in maintaining reduction of fragments. The surgeon should not forget that where accurate coaptation of the broken bone cannot be readily accomplished, an aseptic incision will add practically nothing to the patient's risk. Such an incision not only gives a better understanding of the condition of the parts which may be essential to proper treatment, but permits disentanglement of fragments of bone from lacerated muscles, thereby averting nonunion of the fracture. It also permits the use of wire or catgut sutures in cases demanding such direct methods for maintaining apposition.

It is probable that few surgeons, and perhaps almost no general practitioners, realize how easy it is to keep a fractured bone in position when the surgeon sees the exact line of break. Much of the deformity of many fractures would be overcome and the anxieties of the period of treatment lessened, if the medical attendant after finding the line of fracture simply drove a nail through the soft tissues into the broken bone in such a manner as to hold the pieces together. It is not improbable that the time is near at hand when many fractures will be treated by some such direct method. Ordinary wire nails or long tacks made aseptic can be driven through

aseptic tissues into the bone without disadvantage. This could be done in closed fractures as well as in open ones. An ordinary straight surgical needle does very well for this purpose. If necessary, an ordinary brad-awl may be used to drill the bone.

Refracture or osteotomy of deformed union after fracture should be used much more frequently than it is. It is probable that much of the difficulty in fractures about joints comes from imperfectly apposed fragments. Investigation of such cases by free incision, and the use of nails or sutures in the bone to hold the fragments in proper position, would probably lead to more perfect restoration of function than is usual in fractures involving the joints. Many surgeons who fearlessly investigate fractures associated with wounds experience unreasonable hesitation in making aseptic incisions down to the seat of fracture in obscure and troublesome cases.

The recent advances here outlined in the treatment of fractures of the extremities have brought about the following results: The restoration of the patient to a condition of health, permitting him to transact business in much less time than formerly; the establishment of this desirable end with little or no pain during the period of treatment; and the much less frequent occurrence of troublesome anchylosis after fractures involving joints.

VII.

SIMPLICITY IN THE TREATMENT OF FRACTURES.

The essential factors in the treatment of broken bones are, undoubtedly, the early replacement of fragments, the prevention of recurrence of displacement, attention to the condition of the soft parts and due consideration of the patient's general health. After the reduction has been satisfactorily accomplished, displacement may occur through the action of gravity, muscular contraction, or restlessness of the patient, and the surgeon must guard against such recurrence by applying some form of fracture dressing which retains the fragments in proper position. The best form of dressing will, as a rule, be that which corrects the tendency to displacement and at the same time steadies and immobilizes the limb. Special tendency to displacement varies with the line and position of the fracture, and should be recognized by the surgeon before he decides upon a form of dressing.

Fracture dressings may be classed under three divisions: First, those which give moderate continuous traction or maintain the extension which was applied when the fracture was first adjusted; second, those which by virtue of their rigidity or fixedness resist retraction; and finally, those which by virtue of their inflexibility prevent angular or lateral displacement by furnishing lateral support to the fracture.

These statements, which are almost axiomatic, will probably meet the approval of all the members of the society; but it is more than likely that in a general discussion of the subject there would be advocated a dozen different ways of treating the same fracture. It seems to me that surgeons often lose sight of the fact that simplicity in fracture dressing is as much

a surgical virtue as simplicity in the form of instruments used in surgical operations.

Simplicity in the treatment of fractures is often neglected because of an obsequious reverence for the names of former surgical teachers, which have become attached to a splint or method of dressing. It is stated that legends and traditions, connected with historical places, never die; it is, unfortunately, true that surgical traditions have a similar lasting and often deleterious influence upon the progress of surgery. Illustrations of this are seen in the present use of Bond's splint for fracture of the lower end of the radius, an appliance founded upon an erroneous understanding of the nature of the injury, and one of the worst splints which can be used in its treatment. Physick's long splint for fracture of the femur is still used in this injury by many surgeons, who fail to realize that a more modern method of dressing is less troublesome to the attendant and more comfortable and safe for the patient. Desault's dressing for fracture of the clavicle has now no value except as a puzzle with which to entangle unhappy students under examination; yet it is probably still employed.

Many books are filled with elaborate descriptions of fracture dressings, whose number seems to be limited only by the patience of the author. Hamilton's " Treatise on Fractures " is so full of these complicated splints and devices that the young practitioner is hopelessly lost in selecting a method for treating a fracture under his immediate care. Individuals, as well as races, are born with mental characteristics which drive them to invent and advocate complicated methods in all the pursuits of life. The English and German surgeons perhaps illustrate this tendency to an extreme degree. Some American surgeons, partly from individual traits and partly from overdeveloped imitative faculties, are led in the same direction.

A truly wonderful illustration of this perversion of the

mind is found in Bardenheuer's "Guide to the Treatment of Fractures." I show a single illustration taken from his book in proof of my statement. Could anything be more preposterous than the method by which a patient with an ordinary fracture of the lower end of the radius is here treated. He is shown confined in bed, with weights and pulleys attached to his arm and hand so as to make traction in five different direc-

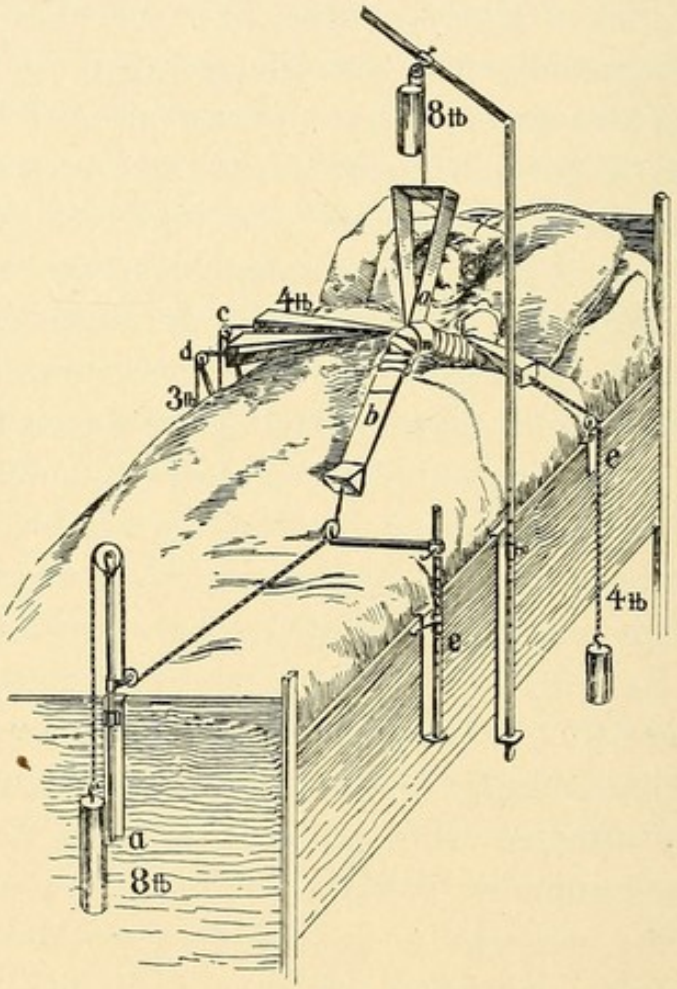

FIG. 1.

Bardenheuer's dressing for the usual fracture of the radius.

tions. Such a method of dealing with an injury, which ordinarily needs scarcely any splint, is a travesty of modern surgery. That even an American can accept such complicated dressings is shown by a visit to the wards of some of our large metropolitan hospitals. I recently saw in a hospital in a neighboring city a patient with fracture of the thigh. The

dressing was a Physick's long splint, combined with the extension apparatus of Buck and, I think, a plaster of Paris encasement: that is, this afflicted patient had about as much apparatus applied for his single fracture as would be required for the treatment of three patients with a similar injury. Any one of the appliances would be sufficient for an ordinary fracture of the femur.

Physicians coming to Philadelphia are, I think, often surprised at the simplicity of the dressings used in some of our hospitals. It is certainly gratifying to know that we do work in a less complicated manner than is the case in some other cities.

Another reason for a want of simplicity in fracture dressing is that students are often taught during their pupilage that each fracture has its special splint; hence they do not realize that the same form of dressing with very slight alteration will often answer for fractures in different parts of the body. I have never forgotten an expression used by Professor Chiene of Edinburgh, who told me that he disliked ready-made splints as he did ready-made trousers; they never fitted.

Few will dispute the desirability of simplicity, provided that simple measures meet the indications and fulfill the surgical objects. Simple dressings are always attainable, they are cheap, and are usually much more comfortable to the patient than more elaborate appliances. The latter are much more liable to become displaced and cause discomfort, and their intricacies are much less likely to be understood by the patient's friends or the hospital resident. The complication also tends to make the surgeon hesitate about removing the dressings, since much time, considerable assistance and no little skill are demanded in their replacement. For this reason complicated dressings are apt to be changed less frequently than simpler ones, and the progress of the fracture less often noted. I am quite convinced that simple appliances, which are readily removed and easily adjusted, tend to give better results, because

of the more frequent examination and inspection given the injured limb.

I would obtain simplicity by disregarding all the unnecessary portions of dressings, and by selecting simple articles for retaining the fragments in apposition. The primary bandage, often applied to the limb before the splint is adjusted, is unnecessary and sometimes harmful; it is seldom used by practical surgeons of to-day. Embrocations of lead water and laudanum and of similar drugs, supposed to lessen the amount of inflammation at the seat of fracture, should be disregarded, as they have no potent influence in lessening the inflammatory exudate, and may perhaps by maceration of the skin lead to blebs on the surface of the limb. Proper coaptation and freedom from muscular contraction are the factors most needed in the treatment of the inflammatory condition. With omission of the primary bandage and the embrocations, which some surgeons cling to as a sort of fetich, there is nothing to be applied to the fracture but the retentive apparatus. This should be of the simplest description. The surgeon who has sufficient individuality to refuse to pay for a carved or molded splint of metal offered by an instrument maker, will seldom have difficulty in dressing a fracture in a simple manner.

The form of displacement and the character and seat of the fracture will give a hint to an observant surgeon as to the kind of apparatus to be used. Any form that tends to maintain the proper contour of the bone after reduction is the one needed. If wooden splints are used, they should be very light and seldom thicker than the lid of an ordinary cigar box. Heavy splints with much padding are uncomfortable to the patient because of their weight and heat. In most fractures comparatively little strain is likely to be thrown upon the broken bone during treatment; hence a splint with a moderate degree of rigidity is all that is needed to prevent displacement.

There is no question that the best splints in use are those

which are molded to the limb after reduction of the fracture. These fit any inequality of the surface without padding, and therefore can be very light and worn with comfort. Molded splints are most readily made from butter-cloth or cheese-cloth dipped in plaster of Paris, paste, or glue. They are readily prepared, and can be molded to the form of the limb without giving the patient pain. In some cases almost no apparatus is needed because the parts may be put in the position which places the displacing muscles at rest and which insures proper coaptation of the fragments; for example, a fracture of the

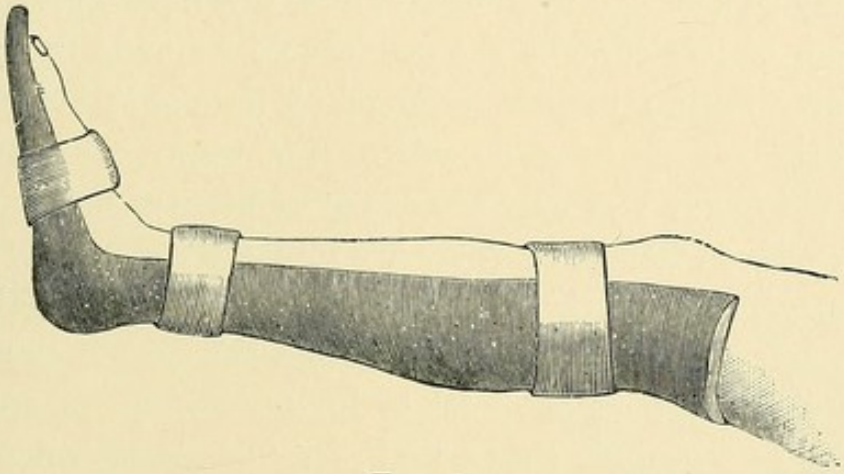

FIG. 2.

Splint made of layers of gauze stiffened with plaster of Paris.

fibula, in which there is very little tendency to displacement, may be treated by simple bandaging, or even this may be dispensed with, because the parallel tibia makes an efficient splint. In some fractures of the phalanges an adjoining finger or toe acts as a good splint, or the finger of a glove made rigid will keep the parts in good position. A little additional firmness can be given to the glove finger by painting it with glue or mucilage. In the same way a stocking may be used as a splint by making it a little more rigid with starch, plaster of Paris, or other hardening material.

The rapidity with which plaster of Paris mixed with water solidifies, makes it, by all odds, the best material for molded splints. Felt or guttapercha may be softened, by dipping it

in hot water, and then molded to the part; but these materials are not so easily obtained as gypsum or plaster of Paris, which is always to be found in any country store. Strips of gauze or other woven fabric may be converted into excellent splints by saturating them with plaster of Paris and water. Eight or ten of these strips applied to a limb soon become hard and hold the fragments in position. Lateral, anterior, or posterior splints of any shape may thus be made and are to be held in place by a roller bandage. The plaster of Paris must be kept dry, for if it has absorbed moisture it will not set. The setting may be retarded by adding a little dissolved glue or borax or cream of tartar, or by the use of cold water in making the mixture. Setting may be hastened by the use of hot water or by adding a little common salt to the water. It takes very little skill to cut V-shaped pieces out of the gauze and to overlap the edges when the corners are to be turned; a moderately good surgeon can make a splint of this kind fit perfectly. In compound, or open, fractures, openings can be left or made in such splints. Strips of metal to further stiffen the splint, or metal rings for supporting a limb, may be incorporated in the layers of gauze and gypsum.

Sometimes we can use another part of the body to maintain apposition of the fragments. Thus in fractures of the upper part of the humerus the thorax is used as a splint when the arm is bound by a bandage to the chest. Fractures of the lower jaw are usually treated by using the upper jaw as a splint.

In the treatment of open, or compound, fractures, less simplicity is possible in the first dressing; but the surgeon who is fully imbued with the doctrines of antiseptic surgery will usually be able to convert fractures of this kind into what are practically closed ones. Thoroughly laying open the injured regions, scraping out all particles of dirt, scrubbing the parts well with soap and water and a nail brush, and providing for removal or asepticity of all accumulations of blood will enable

him to put a dry antiseptic dressing and a splint upon the injured extremity, with the conviction that the wound will probably go on to recovery with very little variation from the clinical course of uncomplicated fractures in the same region.

It perhaps will aid in the discussion of this subject if I give illustrations of simple methods of treating common fractures. It will be understood, of course, that my personal preferences are shown by these illustrations; but naturally there are many

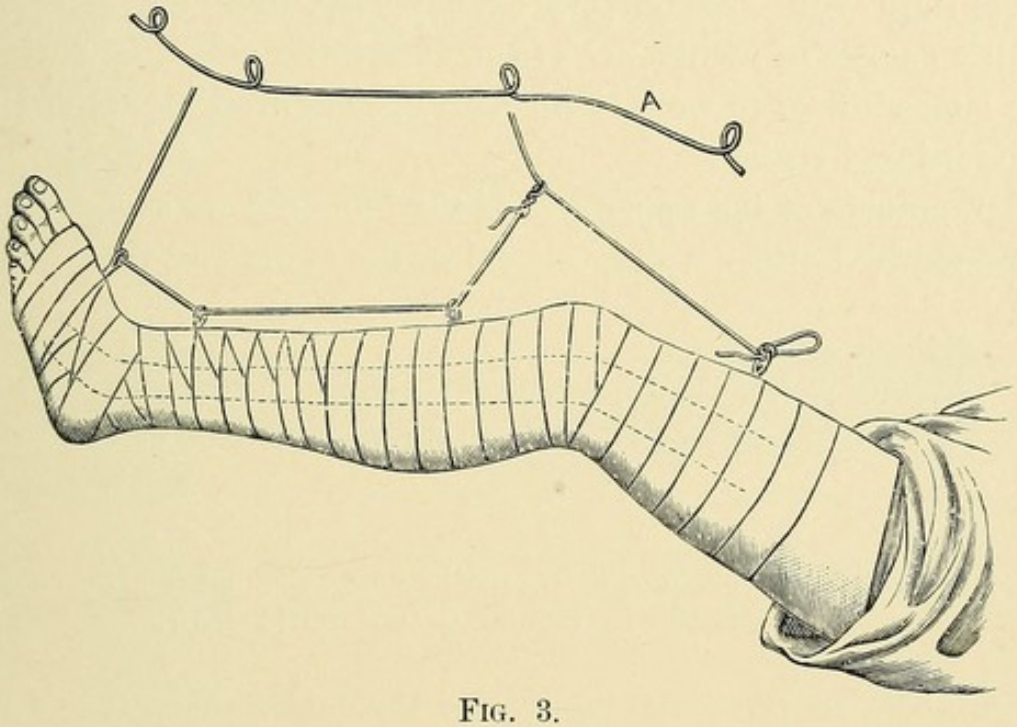

FIG. 3.

Leg dressed with anterior and posterior molded splints, with rings for suspension incorporated in the layers of gauze. Splints are indicated by dotted lines on the bandage. *A* shows form of wire in which rings are made. (From Stimson.)

other equally simple methods of treating the same injuries which may be adopted by other surgeons. Necessarily these descriptions refer to such fractures of bones as are ordinarily seen, and not to cases of unusual severity.

Fractures of the clavicle are usually satisfactorily treated by Sayre's adhesive plaster dressing, consisting of two long strips of plaster, which acts by drawing the upper part of the humerus backward, fixing the lower angle of the scapula, and

pushing up the elbow. Fractures of this bone unite with less deformity, as a rule, if the patient is kept upon his back for a week or ten days, so that the scapula is held in position by the weight of the body pressing against the hard smooth mattress. This supine position, with arm and forearm thrown across the patient's chest, usually allows the fragments to fall into proper position. Such recumbency for a few days gives a chance for the tissues surrounding the seat of injury to become more or less rigid with inflammatory exudate, and there is, therefore, little danger of recurrence of the deformity, when the patient is later allowed to walk about with Sayre's dressing applied to the injured region.

Fractures of the upper end of the humerus are successfully treated by putting a single towel in the axilla and then band-

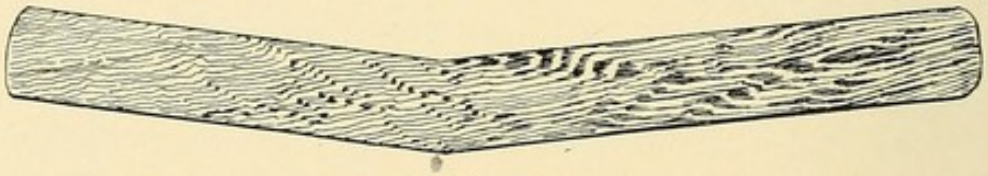

FIG. 4.

Anterior splint with axes of the two portions such as will preserve the carrying function in fractures of humerus at elbow.

aging the upper arm to the side of the chest, having the forearm, which is otherwise free, carried in a sling.

Fractures of the middle of the shaft of the humerus are well managed by an internal angular splint, preferably made of gauze and plaster of Paris. Fractures of the lower end of the humerus are best treated with the elbow in the extended position so as to retain the carrying function of the arm. I prefer holding it in position by a splint of wood having the obliquity of the normal axes of the arm and forearm or by means of a gypsum splint.

Fractures of the forearm require an anterior and posterior straight splint, which should be neither too wide nor too narrow. Fractures of the lower end of the radius usually require

nothing but a wristlet or band of adhesive plaster carried around the lower end of the bone to restrict the movements of the wrist joint after reduction. Where there is unusual comminution of the fragments, a straight wooden splint about six inches long and an inch wide placed on the back of the wrist is all that is required. Fracture of the olecranon demands scarcely more than a wooden splint about eight inches long and one inch wide in front of the elbow to prevent flexion.

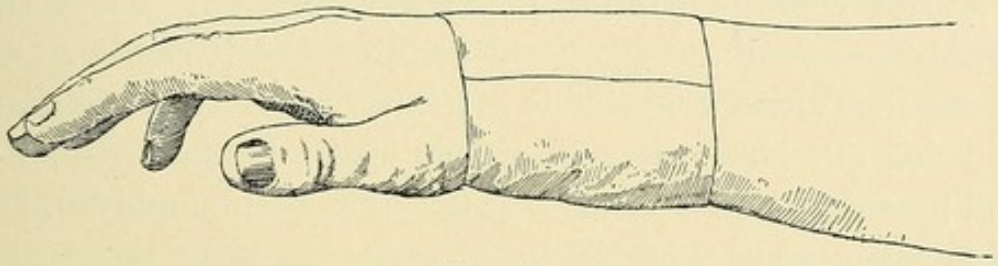

FIG. 5.

Fracture of lower end of radius dressed with a wristlet of adhesive plaster.

Fractures of the femur, whether of the neck or shaft or above the condyles, can generally be well treated by permanent traction made by attached adhesive plaster and a weight fastened to a rope going over a pulley at the foot of the bed. By altering the direction of the traction, the surgeon will find this method satisfactory in all ordinary cases. Sand-bags at the sides of the femur to prevent displacement or a short splint of binder's board around the thigh at the seat of fracture is the only additional apparatus likely to be needed. Sometimes this can be omitted. For fractures of the tibia and fibula a fracture box, or plaster of Paris splint, meets all the ordinary indications.

VIII.

REFRACTURE FOR THE RELIEF OF DEFORMITY AFTER FRACTURE.

Refracture, or rupture of the callus, is only one of the methods of dealing with the deformity, but it combines the advantages of being available in a large majority of cases, and of being attended with a minimum risk. Gradual extension and pressure at the seat of deformity has been employed, but, as is easily seen, this will be of service only at the earliest stages of solidification, and in truth should constitute the treatment of the fracture from the very start, if there is tendency to angular displacement or overlapping. When cases present themselves for the relief of distorted limbs the union is too firm to be affected by any such methods as this, which can only mold soft or semi-solid callus.

In addition to pressure and extension, tenotomy may not unfrequently be of service in the early weeks of fracture by weakening the power of displacing muscles upon the broken fragments. It may also be needed as an assistant to refracture, when the surgeon chooses that method of managing the troublesome bones; but of itself it is, of course, valueless in meeting any deformity dependent on deposition of callus. By the term refracture I mean causing a separation of the fragments at the original site, which may be done by the application of external force alone, or by introducing, as a preparatory step, a perforator to weaken the union due to the large mass of callus usually deposited about fractures when the apposition is not good. The latter method makes, in many instances, a compound fracture, but still comes under the appellation of a subcutaneous operation. I see no reason why

a narrow saw or a chain saw might not be introduced in the same way, and subcutaneous osteotomy done, as in cases of anchylosis; but I do not know that this method has been used to any extent in separating badly consolidated fractures.*

The more serious operations, such as excision of the ends of the displaced fragments and amputations of the limb, which may occasionally be adopted in instances of very great deformity and inability to use the extremity, must be very seldom justifiable, and should only be employed when other means have failed. With these procedures the present paper has nothing to do, but shall be restricted to the consideration of refracture as described above.

The first question in regard to this operation that must be discussed is: What are proper cases to be subjected to refracture? This query can only be answered by investigating the matter in three directions, viz., the amount and character of deformity that demands operative measures, the locality of the original fracture, and the length of time after the primary injury that refracture of the malunion can be accomplished. By far the most frequent reason for having recourse to this operation is shortening of the lower limbs, preventing to a greater or less extent locomotion. A large protuberance of callus situated upon the femur or tibia would be a matter of little moment if the patient had perfect power of progression; but it is because this mass of callus is present as a result of overlapping or angularity of the fragments, both of which circumstances cause shortening of the extremity, that the case calls for surgical attention. There is, of course, no algebraic formula to tell us how much shortening shall be considered equivalent to an operation; and it is well known that a considerable amount of shortening, at times nearly an inch, exists without inconvenience in many persons with uninjured legs.†

* See Dr. Lente's suggestion under the modes of refracturing mentioned below.

† W. C. Cox, *American Journal Medical Sciences*, April, 1875, and Jarvis Wight, *Archives Clinical Surgery*, February, 1877.

The most favorable cases for operation are those where, on account of imperfect treatment, the fragments have united at their extremities, but not in the same line, and thus cause angular deformity and consequent shortening. The union in such instances is more readily ruptured, because the surfaces united are somewhat limited in extent, and the angularity of their position gives a good opportunity for disruption, by applying pressure at the salient angle. In addition to being more amenable to separation, it is evident that the prevention of a recurrence of the deformity is more easily met by after-treatment than if the distortion were dependent upon overriding of oblique smooth surfaces. Such cases, then, are eminently proper ones for treatment by refracture. Shortening, resulting from lateral apposition of the cylinders of bone, caused by want of attention to overcoming muscular displacement during the original treatment of the fracture, appertains to many cases; and such cases have by some been considered unsuitable for operative interference. They, however, believed that in these cases the bond of union, though firm enough to support the weight of the body in walking, was, at least for a long time, fibro-osseous in its nature, and therefore could not be successfully ruptured.* In attempting to dissever the fragments in instances of this nature, the force should, of course, be applied so as to bring transverse strain upon this uniting bone. If the bones are opposed with anterior surface to posterior surface, the power should be exerted laterally; if side to side, the surgeon must use his force in an antero-posterior direction. Hamilton seems to think that there is little hope of gaining anything in length in cases of shortening caused by overriding, because the muscles have become permanently contracted by adjusting themselves to the new condition of things; † while George W. Norris ‡

* "Medico-Chirurgical Transactions," xlii., p. 26 (1859).

† "On Fractures and Dislocations," 4th ed., p. 475.

‡ "Contributions to Practical Surgery," p. 120 (Philadelphia).

doubts whether re-union would occur, owing to the rounded and smooth condition of the ends of the bones in such cases. This is, it seems to me, not a valid objection, because it is not probable that the bones could be placed end to end after refracture, and they would therefore lie alongside of each other with portions in apposition which had previously been united by the now ruptured callus. The shortening would be diminished, but not so entirely overcome as to allow end-to-end apposition. Hence union would occur as in other cases.

It must not be thought, however, that shortening preventing locomotion is the only indication pointing to refracture. In the upper extremity, especially, shortening is of little moment compared with freedom of motion in regard to flexion and rotation. Hence we see that the propriety of operation depends not only on the amount of deformity, but also upon its character. A distortion of the leg involving osseous deposition between tibia and fibula would be a small inconvenience, while the same condition in the forearm would be a lamentable result of a badly managed fracture of the radius or ulna. Hence deformity which has allowed approximation of the bones of the forearm, and has given rise to restriction in rotation as a sequence, may very properly be looked upon as a fair indication for operation. Replacing the bones in perfect relation with each other, and the subsequent absorption of unnecessary callus, may restore the functions of the parts to their normal standard, provided the time of operation be not too remote from the original injury. So also in fracture about the joints, where the deformed condition of the limb militates against flexion and extension, or the callus causes loss of muscular power, benefits may be derived from rupture of the callus and readjustment of the ends of the broken bones. Skey has operated also in cases where there has been persistent pain from pressure of nerve trunks in the callus, or entanglement of muscular or fibrous tissue in the same substance. Again, if the distortion be great, it may at times be justifiable

to operate for cosmetic reasons, just as benign tumors of unsightly appearance are daily subjected to operative treatment. The general rule to govern the selection of cases may be formulated somewhat in this wise: When the deformity is attributable to causes incidental to the first fracture, but avoidable in the second, and is of sufficient degree to interfere with perfect motion or cause persistent pain or great unsightliness, refracture is to be employed as a means of relief. Unfortunately, cases presenting themselves for relief are usually those that have not been under observation during the treatment of the fracture. It is therefore difficult to appreciate the causes of the deformity, whether it be due to great obliquity and smoothness of the fracture's surfaces, to great muscular irritability, to the unwillingness of the patient to submit to restraint or to the inefficiency of the original attendant. Consequently it is at times a question whether the displacing causes can be avoided in the after-treatment, and the surgeon has to operate without knowing exactly what agents are to give him most trouble. The mere matter of great muscular development certainly should not deter us as much as formerly, for with the improved method of extension and counter-extension it is possible to tire out any muscular masses that tend to produce displacement, and in certain cases tenotomy may be called upon as an adjuvant to extension.

The locality of the fracture has some bearing on the propriety of the operation and the exact manner of performing it. A slight amount of shortening or even a decided crook in the humerus or clavicle is of little detriment to a man, while the distortion occurring in a woman or in the lower extremity of either sex, would perhaps be sufficient cause for undertaking an operation. Again, a degree of displacement of little moment in the shaft of a bone may be a serious impediment to the free use of a ginglymoid articulation, or may interfere greatly with the tendons as they lie upon the expanded extremity of the bone. This matter of location is also of

importance respecting the feasibility of refracture, for it is easily seen that it is exceedingly difficult to apply the rupturing power when the deformity is close to the hip or shoulder joint, for the upper fragment is not readily steadied during the manipulative processes.

Another desideratum is the determination of the time after the original fracture that it is possible to tear asunder the united fragments. This necessarily must be variable, as solidification in fractures depends on sex, age, character and situation of lesions, and a host of other contingencies. Dupuytren, in a series of some fifteen cases, says * the period of resetting varied from twenty days to six months, and that, as a rule, the reunion was more rapid in the instances where readjustment was done early. It is well known that the greater the displacement the larger the amount of callus deposited; hence it is more than probable that, in instances requiring readjustment, the callus is longer than usual in becoming perfectly firm and bony. Skey believes that after four or five months the bone is often still fibro-osseous.† Nelaton believes ‡ that it may be attempted as late as a year after the injury in adults, and even later than this in the case of children. Velpeau goes further, and says that angular deformity may be broken at any period if there be much interference with the function of the limb. Mr. Gay, at the Royal Free Hospital, London, refractured the femur for angular deformity about twelve months after the original injury.§ In truth, it may be said that absolute time has nothing to do with the matter, but that the surgeon must be guided by the practicability of refracturing the callus uniting the displaced ends, and this cannot be determined until trial has been made in each individual case. The only limit would seem to be

* "Diseases and Injuries of Bones," Sydenham Translation, p. 70.

† "Medico-Chirurgical Transactions," vol. xlii.

‡ "Lectures on Clinical Surgery" (Atlee), p. 184.

§ *Lancet*, 1850, vol. ii. p. 455.

the injury of the soft parts that might result from applying great power. This is fortunately giving us a wide range, since it is astonishing how much the surrounding tissues will tolerate without resenting the rude handling. Looking at the cases reported from the Pennsylvania Hospital, we find that severe inflammatory reaction occurred in none of them. If we recollect that high inflammation subsequent to ordinary fractures, that are not compound, is comparatively rare, and that, when found as a sequel, it is in great part due to the sharp spiculated fragments forced into the soft parts at the time of accident or during transportation, we can understand its conspicuous absence after refracture, where the ends are more or less smooth and rounded and the bones are placed at once in proper retaining apparatus. An interesting case is reported * by Dr. Walters of Pittsburg, where he made, without success, protracted and vigorous efforts to refracture a femur at the end of about three months, and yet the patient got up the next day and complained only of soreness. At a later period he operated by cutting down upon the deformity.

Skey operated on a fracture of both bones of the leg in a boy, where the union did not seem perfectly firm, at a period of thirteen months after the injury, and obtained a good result, reducing the shortening from two inches to three-quarters of an inch, and enabling his patient to walk with scarcely a limp. The time, then, at which it becomes useless to attempt refracture cannot be fixed, but let the operation be tried in appropriate cases at any time, and let the surgeon be governed in regard to amount of power only by the dangers to the soft parts, for, as far as the bone itself is concerned, it will break, if he can break it at all, at the seat of the former lesion. This question, however, will be discussed under the various objections that have been urged against the procedure as a treatment for deformity after fracture.

It may be asked whether an operation would be justifiable

* *Medical and Surgical Reporter*, Philadelphia, January 13, 1866, p. 28.

in deformity resulting from fractures that have been carefully watched and treated on the most approved principles from the beginning. The majority of cases that offer for treatment by refracture are, of course, maltreated or untreated fractures which have not been seen before by the surgeon who is to operate. Should the same surgeon be willing to undertake refracture in a patient whom he had treated in the best manner from the time of original injury? I think this question should be decided affirmatively, if he thinks the experience gained in regard to the individual characteristics of this particular fracture renders it probable that he can overcome the displacing elements by some alteration in the manner of treatment, or by some additional co-operation on the part of the patient.

Having discussed the subject of selection of cases, I must turn now to consider the various procedures and appliances employed in effecting the desired rupture of the bond of union. The most simple method, when it is possible, is to bend the distorted limb into position with the hands, as is done when it is desired to straighten partial fractures occurring in childhood. This is only practicable when the union is of recent date or the bone small.

I had written that any preparatory softening of the callus by poultices and fomentations was impracticable, when the following case reported by B. W. Switzer * met my eye. A Hindoo boy, aged four years, after sustaining a compound fracture of the right humerus, had received no treatment. Dr. S. saw him eight months subsequently, and found a large mass of callus without any motion or crepitus, and ordered inunctions twice daily, with 100 grains of iodide of potassium and 10 grains of iodine to the ounce of lard. Internally, the patient was given one grain of iodide of potassium twice daily. About three weeks subsequently crepitus was detected, and the mass of callus was found to be breaking up, which

* *Medical Times and Gazette*, September 19, 1868, p. 352.

process continued until all the callus was absorbed and the fragments were movable. The medication was then stopped, splints were used, and reunion occurred in good position. This seems to give weight to the opinion of Dupuytren, who believed that certain applications had a softening action upon callus. In regard to the application of the force, Skey says, "It must be persistent, because the rupture is a species of slow laceration or tearing, and occurs gradually." To this I must take exception. Although the callus in its early stages is fibrous and capable of being molded into shape by slow laceration, yet, in the majority of cases presented to the surgeon, the bond of union is firm, and, when ruptured, gives evidence of its solidity by a sharp snapping sound. When this is once heard, the problem is solved, and restitution can usually be effected. Hence it is that by a sudden force the uniting bond can be ruptured easier than by a gradual strain brought to bear upon it, just as a boy breaks by a sudden bend a stout stick that he could not tear apart by continuous pressure. When the fracture is too firmly consolidated to allow replacement by mere bending and rotation with the hands, it becomes necessary to use some method that gives a better opportunity of utilizing the strength of the operator. Thus, he can make a fulcrum by bringing the limb across the end of a table, or by placing a hard block or pad under the convexity of the angular displacement. Again, he can bind a straight splint along the limb from the seat of fracture to or beyond the distal extremity, and thus control the joints and gain leverage; and, at the same time, by placing a similar support upon the limb above the point to be fractured, can render the occurrence of fracture at a new situation impossible. This, however, is probably never necessary. Another device of a mechanical kind is a screw-press or clamp by which great pressure can be exerted to break down the arch formed by the bones. Bosch of Augsburg, Pormann, and Oesterlen employed a

machine of this description, and, recently, Mr. Butcher adopted this method very successfully in a case of fractured femur of five months' duration where there were nearly five inches shortening and great angular deformity.* These methods are especially adapted to cases where the fragments have united at an angle. When the deformity depends upon lateral application of the two bony cylinders, rupture must be attempted by flexion across the bond of union, combined with rotation in the axis of the limb and strong extension and counter-extension. As has been stated, these cases are less appropriate for treatment by refracture than the former variety. Indeed, in some cases of this kind, as well as in others where the shortening is great, it may be well to keep the patient etherized and continue the excessive extension for an hour or so after rupture, in order to gain as much length as possible before dressing the fracture.

In order to obtain a firm hold upon the limb when making extension by the compound pulleys, and yet to distribute the

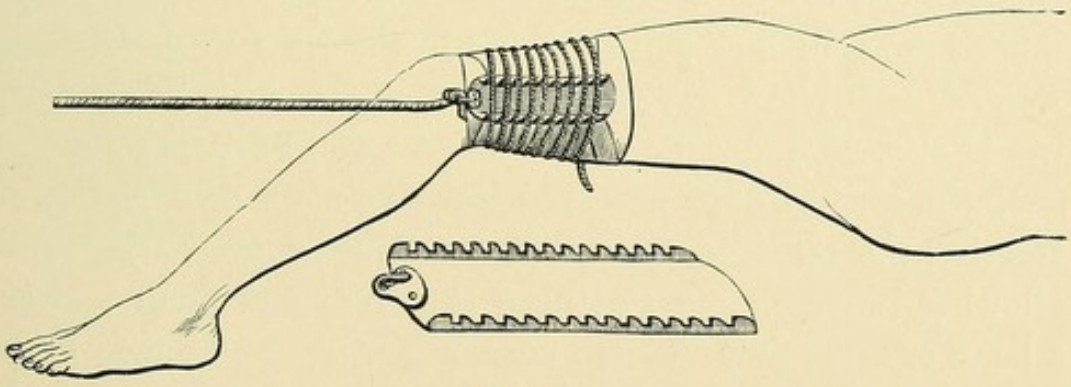

Fig. 6.

pressure so as not to bruise the tissues, Dr. Levis devised a serrated plate for the thigh to give attachment to the pulley rope. It consists of a strong iron hook, the upper part of which expands into a flat plate about seven inches long and two wide. This plate is slightly curved transversely to apply itself to the limb, and is roughened. On the upper surface

* Dublin *Journal of Medical Science*, vol. lviii., 1874.

of this plate, at each side, there extends a longitudinal ridge serrated by deep notches cut into it. The appliance is adjusted in the following manner: After a bandage has been applied to the limb at the point selected, the plate and hook are laid upon it, then a strong cord is carried around the limb circularly and over the plate, catching in the sawlike teeth on the ridges above. This binds the hook and plate firmly to the limb just as sailors splice two spars together by a rope. Finally, the compound pulleys are applied and extension made as required without danger of the skin and muscles being lacerated by the rope, since the pressure is distributed over a large surface.

The osteoclast devised by Dr. C. F. Taylor of New York for producing a transverse fracture at any selected point with ease, certainty, and safety from after-complications would, I should think, be applicable to refracturing the callus in deformed union, though the instrument was invented for fracturing the femur in cases of anchylosis of the hip in which fracture was desired in preference to osteotomy. A description of the appliance will be found in the New York *Medical Record*, vol. xii., 1877, p. 241. The osteoclast of Rizzoli would also, no doubt, be applicable in certain instances.

Brainard, in 1853, proposed introducing a drill and perforating the callus in various directions subcutaneously, then allowing inflammatory softening to occur; and finally, after a lapse of some time, say ten days, restoring the crooked limb to its normal condition by force. His case was very successful, and may be condensed as follows: A boy, aged three years, had sustained a fracture of the tibia and fibula, two years and nine months previously, which had left great angular deformity and shortening of three inches. Perforation was done, and force applied ineffectually to refracture; the case was left ten days, and a further attempt at straightening was successful, though only a moderate degree of force was employed. The cure was very satisfactory, and the patient was

able to walk.* A similar operation was performed by Dr. Stephen Smith, in 1860, upon a boy who had deformity, resulting from a partial fracture that had not been straightened.† Suppuration occurred in one of the two punctures made in the skin, but the distortion was improved. Nussbaum has proposed to cut through three-quarters of the bone with a chisel, allowing the external wound to heal, and then to fracture the remaining fibers. This method does not leave sawdust or chips, as does the method which uses the perforator or saw.‡ Dr. Frederick D. Lente of New York has suggested that the surgeon may accomplish the object by using a drill of very small size for perforating the center of the callus through a mere cutaneous puncture, and following this with an instrument, which he calls a subcutaneous saw, consisting of a narrow blade with a rounded point and saw teeth upon it for an inch from the end. This, being smaller than the drill, can be worked backwards and forwards inside the mass of callus, and thus weaken it in any direction.§ He had not employed this operation at the time the article was written.

What are the objections urged against refracture as a means of relieving deformity from mal-union, and what are the dangers that may be encountered? The first objection to be suggested to anyone would be the possibility of the bone giving way at a point more or less distant from the original fracture. This, however, is to be considered almost impossible, unless the bone be diseased and softened. It is a very different condition of things from that where strong efforts, employed for the rupturing of an anchylosed joint, are followed by fracture of the shaft of the bone. In the latter case, we have two large expanded articular surfaces firmly bound together by adhesions, which have been deposited by a chronic inflammation, that has at the same time perhaps caused more

* *American Journal of Medical Sciences*, 1859, vol. xxxvii., p. 577.

† *American Medical Times*, New York, 1860, vol. i., p. 310.

‡ Dublin *Journal of Medical Science*, October, 1875.

§ New York *Medical Record*, vol. ii., 1867, p. 101.

or less disintegration of the neighboring bone. In the case under discussion, there are two overlapping fragments much smaller as a rule than the articular ends, and generally united at an angle by fibro-osseous matter. This must be much weaker than the normal bone above or below, even if a large amount of irregular callus has been thrown out around the seat of fracture. In fact, to one who has not made the experiment, it will be surprising to find how much force is required to break even so small a bone as the radius across the knee, when the bone has been divested of all the tissues and dried. Much more strength is requisite to fracture one of the bones of the extremities when it is surrounded by periosteum and buried in the muscular masses surrounding it. In order to test this matter I made some experiments on the cadaver where there had been no fracture. I drew the leg of the subject over the end of a table, and while an assistant steadied the thigh and knee as well as he could, endeavored to fracture the tibia by the manipulations that would be employed in refracturing a deformed union of the leg. I repeatedly threw all my weight, over 150 pounds, with sudden force upon the leg, but only succeeded in fracturing the fragile fibula, which being posterior and superficial, was brought in direct contact with the edge of the table without any muscular cushion. My assistant, who was stronger than I, failed also in his attempts to break the tibia. The only method which would avail to cause fracture of the tibia was to turn the subject on its face, in order to bring the subcutaneous surface of the tibia downwards; then by suddenly striking this portion of the bone powerful blows on the sharp edge of the *iron* table, I succeeded in producing an oblique fracture at the lower part of the middle third. These experiments show what a tremendous force would be required to fracture a sound bone by the manipulations used for refracturing deformed callus; for in that operation no one would ever think of selecting a sharp iron edge on which to strike the subcutaneous surface of the tibia. My

efforts fully convinced me that there was no possible chance of my succeeding in fracturing the femur, buried as it is in a large mass of muscles. The radius and ulna were only broken by the same kind of sudden blow over the table edge.

It is a long time before the permanent callus becomes as firm and compact as the original bone, as is shown by the fact that, after once sustaining a fracture, the patient in falling is exceedingly liable to refracture at the seat of original injury. A rather remarkable case bearing on this subject came under my notice a few weeks ago. The boy, who was eighteen years old, had a distorted forearm resulting from fracture about four and one-half inches below the point of the olecranon. His history was as follows: When eight years of age, he fell out of a tree and sustained a fracture of left forearm near the elbow. One year later he fell downstairs and broke it again in the same region, but says he thinks only one bone (?) was broken at that time. Three years subsequently, or when he was about twelve years of age, he fell into the hold of a boat, and sustained a third fracture, but does not know whether both bones were broken or not. After this, he thinks the arm was as straight as the other, and straighter than it had been *previous to this third accident;* but there was some impairment of rotating power. Eight or nine weeks before these notes were taken, or nearly six years from the time of the third fracture, he fell from a coal-wagon, which, however, was not in motion, and sustained a fourth fracture, which from the present appearances must have involved both bones. Here then is a case where refracture occurred in the same position, as near as may be, four successive times at intervals of one, three, and six years, due evidently to the natural weakness of the bond of union, for the fractures resulted from injuries that would probably have been productive of other fractures if there had been any constitutional predisposition to fracture in the patient's skeleton; moreover, they occurred in a young person when solidification is supposed to occur rapidly. This

liability to fracture at the original lesion has been repeatedly noticed, and is said to be equally true in animals.*

The period required to give the bond of union the solidity of original bones—if, indeed, that ever occurs—must therefore be looked upon as indefinitely long. Suppose, however, it were possible to have the bone give way above or below the seat of deformity, would it not give the surgeon an opportunity of making a compensatory cure that would be advantageous to the patient?

The objection to refracture, advanced by some, that erysipelas, abscess, necrosis, or pyæmia may result, can be dismissed in a few words. Everyone knows the extreme infrequency of these occurrences in non-complicated simple fractures. The original injury has, in nearly all these cases, been attended with more disturbance of the tissues than is caused by the operation of refracture. Moreover the patient is in good condition, the bones have rounded ends and do not lacerate, and the fracture is dressed without suffering the jarring and jolting of transportation. From the cases that I am cognizant of, I am inclined to believe that inflammation of a character sufficient to cause swelling and tension of the parts is exceedingly rare.

I have mentioned above, when speaking of the time after injury that refracture may be attempted, the case of Dr. Walker, where his strong, though unsuccessful, efforts were followed by so little inflammation that the patient was up on the following day. Skey has reported a similar case.

There seems also to be no real danger of rupturing vessels that have become shortened by reason of the decreased length of the limb. A much more important topic remains. Is there not danger of non-union after refracturing a firmly united bone? Though we must admit the possibility of such an event, since Dr. Whitridge has reported † an instance sub-

* Holmes' "System of Surgery," vol. ii., p. 96.

† *New England Medical Review and Journal*, vol. i., 1827. Quoted by Norris in "Contributions to Practical Surgery."

sequent to refracture of the radius and ulna, I believe it to be about as unlikely as non-union of the soft parts after incision through an old cicatrix, provided, of course, that the fracture receives proper treatment. Velpeau states that these new fractures consolidate, as a rule, more readily and easily than the primitive fractures. This may depend on the fact that there is required much less repair of muscular tissue and less absorption of blood, which processes are preparatory steps in the union of fractures of an ordinary variety. Oesterlen gives seventeen cases of rupture, and in no case did union fail to occur.* Moreover, ununited fracture, unless there be constitutional reasons, is rare in any event except as the result of imperfect treatment, which has allowed mobility of the fragments, or of the presence of portions of tendon or muscle between the ends of the bone. These factors are eliminated in the case under discussion where you have selected a favorable time as to the health of the patient, have dressed the limb with appropriate apparatus, and where there is little or no opportunity for tissue to become entangled between the ends of the bone. The great infrequency of non-union in well-treated fractures is shown by the statistics of Norris. The number of fractures of all bones treated in the Pennsylvania Hospital from 1830-50 was 2190, among which there occurred, says Norris,† no instance of artificial joint. The only cases of ununited fracture observed during that period were those sent to the hospital from distant parts. Of course some of these 2190 patients died, and some were removed by friends (about 400 altogether), and it is impossible to say what would have been the result if they had remained; one or two, perhaps, might have been examples of ununited fractures. Again, in Bellevue Hospital, New York, from 1865 to 1873 inclusive, there were 128 fractures of the shaft and condyles of the femur, of which the result was known, and in this number there occurred only two examples of non-union.‡

* Norris, *loc. cit.* † *Op. citat.*, p. 143.

‡ Frederick E. Hyde, New York *Medical Record*, 1875, vol. x., p. 513.

Malgaigne tells us that Lonsdale saw only five or six instances of non-union among nearly 4000 cases of fracture treated at the Middlesex Hospital.* These statistics, though I always distrust statistics, give an idea of the comparative infrequency of deficiency of union after fractures. The persistency with which union occurs is well shown in the boy reported above, who sustained four fractures of the forearm, and yet, when seen eight or nine weeks after the last fracture, had firm union. He would have been subjected to refracture by Dr. Levis, for relief of the deformity and pain resulting from last fracture, had he not become dissatisfied and left the hospital. I have looked carefully over a large number of journals and systematic works on surgery without finding any case reported where a false joint followed refracture, except that of Whitridge already mentioned.

Norris states † that Sir William Fergusson once amputated a limb for ununited fracture of the femur occurring after the bone had been rebroken on account of malposition. This is probably a mistake, for I have referred to the original report of the case as cited by Norris, and find that the amputation was done for an ununited fracture, but the cause of the non-union is not given as resulting from refracture.‡ It must be recollected in this connection, I admit, that we are unfortunately apt to neglect reporting bad results following important operations, hence other instances of non-union may have occurred. As having some bearing on this part of the subject I may refer to a case where both the femur and the humerus were refractured at the same time, and union took place in six and a half weeks without difficulty. Again, it will be proper to refer to a man who had originally fractured both humeri as well as the leg, and yet, though the leg was rebroken after the lapse of six weeks, union occurred in

* "On Fractures," translated by Packard, p. 120.

† "Contributions to Practical Surgery," p. 131.

‡ *Lancet*, vol. ii., 1850, p. 653.

six and a half weeks without any trouble. A similar instance may be mentioned by me in which a boy had the radius and ulna of one arm broken in two places at the time of the fracture of the femur. Union occurred at all the fractures, and after refracture of the femur it united readily a second time in eight weeks. These facts are mentioned to show that there seems to be no narrow limit to the capability of the healthy system furnishing callus for the consolidation of multiple or repeated fractures.

Death may undoubtedly follow this, as indeed it may the most trivial operations, and Haly Abbas, Morgagni, and Laugier have each recorded such a result. The repeated allusions to these same cases, however, in the text-books, show how infrequent the occurrence is.

The after-treatment of cases of refracture is sufficiently plain. In some instances it may be well to keep up great extension with the pulleys for an hour or so after refracture has been accomplished, in order to fully stretch the parts, and exert a certain paralyzing influence upon the muscles which tend to displace the fragments. The most successful treatment will probably be some form of extension combined with well-directed pressure of splints and pads over the situation of the angular displacement. The extension method is of course applicable in refracture for deformity of the upper as well as the lower extremity, though not so frequently required. The extending weight should be sufficient to do the work, and if adhesive plaster strips will not bear the strain, it may be re-enforced by the application of some apparatus made of straps and buckles. If the fracture is low down near the ankle, it may be necessary to use a footboard, strapped to the sole of the foot, in order to get attachment for the extending weight. The necessity of employing splints of wood, pasteboard, or felt at the seat of fracture is obvious, since the extension merely obviates overriding, without keeping the fragments at rest or preventing angular or rotatory deviation.

In occasional instances tenotomy may be required to assist in preventing displacement, and this is not to be deprecated, for it does not add much to the severity of the operation, since the tendon cut is generally at a distance from the fracture, and hence the puncture does not make the fracture compound.

The most important consideration is yet to be discussed; namely, the results of refracture as to the relief of deformity, and in regard to the usefulness of the limb afterwards. In this paper I have endeavored to collect all the cases that have occurred in the Pennsylvania Hospital from January, 1873, to December, 1877, excluding, of course, those which were treated by excision or drilling, because they were subject to different conditions, from the fact that more or less air had access to the seat of fracture. It was my intention to collect a much larger number of cases from the periodical literature of the last twenty-five years. After looking over many pages of journals and text-books I obtained some thirty additional cases occurring in America; I found, however, that no reliable deductions could be drawn from these, because of the well-known fact that practitioners are loath to report unsuccessful operations, and because, on the other hand, many cases were only partially reported, and dozens, doubtless, were never recorded at all, owing to the supposed unimportance of one or two operations of this kind.

My investigation of the records shows that during the time mentioned eight patients were treated in the hospital by refracture; the number of operations, however, was nine, because one patient had both an upper and a lower extremity operated on at the same time for deformity, resulting from mal-union. In all cases tabulated except one there was very marked amelioration of deformity, and, as far as relief from lameness, etc., is concerned, we may consider the patients cured. This is very noticeable in the refractures of the femur, because we have the amount of shortening before

and after treatment recorded. In the four cases it was reduced to one-half inch, one-half inch, none at all, and one-quarter inch respectively; while before treatment there was three and one-half, one and one-quarter, one and one-half, two and three-quarters inches. Another feature is the non-occurrence of marked inflammation after the violent manipulations necessary to effect rupture. In the hospital notes I find no mention of any such occurrence in any case of the whole number, and reference to the fact would hardly have been omitted in the running notes of the patients if it had occurred to any extent. The time of treatment after refracture will be found to be about the same as usually required for the uniting of ordinary fractures in similar situations. I have calculated the time by counting the number of weeks between the day of operation and the day on which the splints were discarded and the union found to be firm, though in cases of fractures of the lower extremity the patient was required to sustain a portion of his weight on crutches or canes for some time longer as a precautionary measure. This, of course, would vary much with different surgeons and attendants, and has therefore been left out of the calculation.

The lessons taught by an examination of these cases may be formulated as follows:

Refracture is the best method of correcting deformity after mal-treated fractures, because it gives relief without suppuration, which is more liable to follow osteotomy or excision; and these operations are still available if it is difficult to refracture the bone.

It may be undertaken whenever there is a possibility of overcoming the causes that gave rise to the deformity after the original fracture.

The time is only limited by the ability of the surgeon to rupture the bond of union.

Refracture is accomplished by bending, either alone or combined with powerful extension.

If the bone be healthy, there is no danger of fracturing in any situation but that of the original lesion.

The occurrence of erysipelas, abscess, necrosis or pyæmia is too rare to be considered an objection to the operation.

Non-union almost never occurs.

The results as to correction of deformity and as to usefulness are uniformly satisfactory.

IX.

FRACTURES OF THE CRANIUM.

The conversion of a closed (simple) fracture of the cranium into an open (compound) fracture by incision of the scalp is, with the improved methods of treating wounds, attended with very little increased risk to life.

Uncertainty as to the character of a cranial lesion is more dangerous to health and life than the conversion of a closed into an open fracture of the skull. If I but learn the character of the skull injury, I am acquainted with surgical expedients that render restoration to health more probable than the complication due to the incision renders it improbable.

Antiseptic methods have done away with much of the danger of open wounds, as is shown by the frequent advocacy of resection for ununited and for malunited fractures, and of osteotomy and similar operations for conditions not urgently demanding surgical interference. No surgeon would hesitate to convert a closed recent fracture of the thigh or leg into an open one if it were otherwise impossible to replace fragments or avert danger to life. Hence I strongly advocate exploratory incision of the scalp in obscure injuries of the skull.

Some years ago a man, who, it was said, had fallen from a heavy wagon, and had been run over, was admitted into my ward of St. Mary's Hospital. Behind the left ear was a large hæmatoma, where it was asserted the wagon-wheel had struck him. My resident surgeon made a two-inch incision, and removed the clots; but, finding no fracture, closed the wound with sutures, and applied corrosive sublimate dressing. The knowledge that no fracture existed was very satisfactory, I can assure you. Three days later, the incision had healed

up without suppuration except in a space of three-eighths of an inch, and the sutures were removed. Such rapid union without complication will not always occur, but it shows the possibility of little risk in the majority of cases.

The removal of portions of the cranium by the trephine or other cutting instruments is, if properly done, attended with but little more risk to life than amputation of a finger through the metacarpal bone.

Much of the mortality attributed to trephining belongs to the serious brain-lesions that have accompanied the fractures for which trephining has been done, and to the absence of proper surgical antisepsis. Many patients have been trephined and have undoubtedly died; but the opponents of trephining must show that cause of death lay in the operation itself. In deaths occurring from lesions for which trephining is the admitted treatment, they must likewise show that the operation was done early enough to remove the causative factor of death before they can assert that the operation was unavailing. Gross, Michel, and many others have frequently quoted historical facts and cases which show the slight risk incurred by uncomplicated trephining. Briggs says: "My opinion, based on a large personal experience, is, that trephining the skull is one of the safest of the capital operations of surgery." *

The opposite view, however, was held by Dr. H. F. Campbell, at a recent meeting of this Association, at which he said: "I have ever regarded trephining as one of the most serious of all capital operations." †

Nancrede,‡ from a careful investigation, gives a mortality of 10.69 per cent. as being a probably fair estimate of the risk of the operation *per se*, and a death-rate of 15.29 per cent. as an expression of the probable risk in trephining a sim-

* "Annals of Anatomy and Surgery," vol. vii., 1883, p. 65.

† "Transactions of the American Surgical Association," vol. i., p. 94.

‡ "International Encyclopædia of Surgery," vol. v., pp. 94, 95.

ple depressed fracture. This author further says that his own experience has taught him that trephining is not a dangerous operation, and that more patients die from complications, that might have been prevented by timely operation, than from the removal of a disk of healthy bone.

Dr. R. W. Amidon of New York has collected 115 cases of trephining and kindred operations occurring since 1879. These operations were done for various causes, and were unselected by Dr. Amidon; nor did he confine himself to cases treated antiseptically.* Of these 115 unselected cases, 29 died; but of these 25 presented, at the time of operation, symptoms endangering life, leaving therefore but four cases in which the fatal issue could be attributed to the operation. This gives a mortality of a little over three per cent. to the operation. He announces his reasons for considering the 25 deaths as not attributable to operation in the following words: "In six cases, symptoms of abscess of the brain declared themselves before the operation was performed. In five a meningitis existed at the time of operation. In four cases shock caused death; two died of hemorrhage from a branch of the middle meningeal artery (not wounded in the operation); one died of hemorrhage from the middle cerebral artery, severed by a stab wound of the head; one died of hemorrhage from a lacerated longitudinal sinus; one of galloping consumption, which was hereditary; one of pneumonia; one of extensive laceration of the brain; one of opium poisoning; and three I accept, on authority of the physician reporting them, as not dying from the effects of the operation." †

Yeo ‡ trephined twenty-six monkeys under antiseptic precautions, and had only one death attributable to intracranial inflammation, though six other deaths from exposure to cold

* *Annals of Surgery*, St. Louis, March, 1885, p. 205; see also, his previous paper, *Medical News*, June 21, 1884.

† This list accounts for the death of 26 instead of 25 patients, and apparently contains an error.—J. B. R.

‡ *British Medical Journal*, May 14, 1881, p. 763.

weather, chloroform poisoning, or hemorrhage occurred among his cases. In some of the animals portions of the brain were excised. Of other monkeys trephined without antiseptic precautions all died.

Much stress has been laid by some writers on the danger of wounding the membranes and brain with the trephine. With a conical trephine or the burr of the surgical engine, as recommended by Dorr and by myself,* there is no danger of this. Even if such an accident should occur to the membranes, it is, in my opinion, of very minor importance unless the damage is much greater than could occur except by gross carelessness. Dr. Gunn disapproves of the use of the mallet and chisel, because he believes that the repeated shocks to the brain may prove injurious to the nerve-tissue.† For removing large or irregular areas of bone, the flat burr of the surgical engine is certainly much more accurate and desirable. Osteoplastic resection with chisel, electric engine, or wire saw gives easy access to the brain.

I have compared trephining with amputation through the metacarpal bone, because in both operations there is exposure of cancellated bone structure. I do not know that the mortality of such finger amputations has been accurately computed, but is certainly regarded by all as slight. It is seldom that patients are confined to the house after such amputations. Trephining in itself is, I am convinced, little if any more hazardous. I believe that one of us trephined to-day might, if it were necessary, go home without incurring any great risk to life; though I would not advise such a procedure. Amputation of the finger may be followed by erysipelas, septicæmia, or death; so may trephining, but it is not to be expected. The mortality of amputations of the thumb and fingers is, according to Ashhurst,‡ 3.3 per cent. This un-

*Buffalo *Medical and Surgical Journal*, xix., 1879–80, p. 475; Philadelphia *Medical Times*, 1881–82, xii., 206.

† "Transactions of the American Surgical Association," vol. i., p. 88.

‡ "International Encyclopædia of Surgery," vol. i., p. 637.

doubtedly is less than the mortality of amputations through the metacarpus, because amputations of distal phalanges, which are almost without risk, are of course included. The same writer gives partial amputations of the hand a mortality of 6.6 per cent. If, therefore, we estimate amputation of a single finger through the metacarpal bone as having a mortality of 4 or 5 per cent., it will probably be nearly correct. According to the figures of Amidon, given above, trephining is actually much less dangerous to life than this.

In the majority of cranial fractures, the inner table is more extensively shattered and splintered than the outer table.

Many experimental fractures made in the dissecting-room, and observation of cases in the practice of myself and of others,

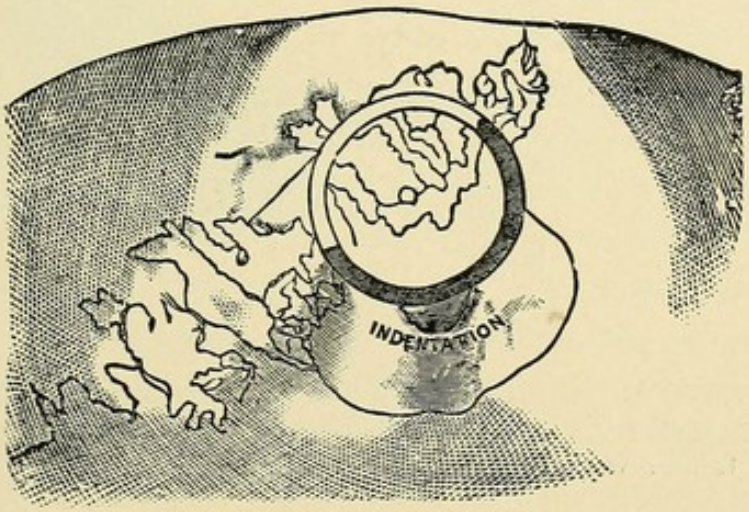

FIG. 7.

Accentuated fracture showing a slight indentation in external table.

teach me that extensive shattering of the inner table, with only a moderate amount of fracturing of the external table, is of frequent occurrence in other as well as in punctured fractures. I admit that the condition in the cadaver, preserved by zinc chloride, with its shrunken brain, is different from that in the living; but there is much evidence of the same splintering to be found in the study of accidental and homocidal cranial fractures. This is in accordance with the well-

known mechanical law, that compressing force applied to the outside of a surface, as are undoubtedly most fracturing forces applied to the skull, tends to produce more extensive breaking of the inner surface. This is especially so in all localized blows. Punctured fractures have long been treated by early trephining, to avert encephalitis. For the same reason I recommend resort to trephining even in more diffused and less accentuated fractures. It is to prevent inflammatory se-

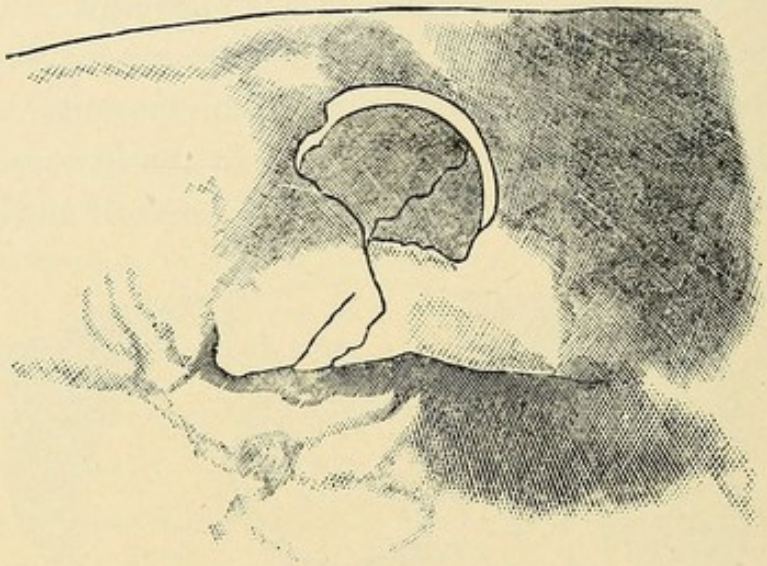

FIG. 8.

Accentuated fracture showing marked depression of internal table revealed by trephining. Same case as Fig. 7.

quences due to splinters forced into the membranes and brain and to avert a consecutive occurrence of epilepsy and insanity, that the operation should be performed; not because of the fear that symptoms of compression of the brain may arise, nor because necrosis of detached portions of bone may occur.

Sometimes there is no fissure in the outer table, though the inner table is extensively broken and depressed. Twenty such cases are reported as having occurred during the late Civil War.* All of these patients died from intracranial inflam-

* "Medical and Surgical History Rebellion," Pt. I., Surgical Volume, p. 150.

mation except one, in which the splintered portion of the inner table was removed as a sequestrum.* I show you a piece of skull removed from a patient who recently died under my care. He was struck with a pitcher, which caused a small scalp wound through which my finger-tip felt rough bone. I enlarged the incision, came upon a very rough surface, due to unusual irregularity of the lambdoidal suture, with small Wormian bones, and found only a small dent or fissure looking much like the entrance of a vein. I determined to do exploratory trephining because of the nature of the vulnerating force. Dr. George Dock, under my direction, cut out a disk of bone close to the external dent, at the position which was thought would give best access to any splinters. Nothing was found but a small fissure crossing the inner surface of the disk. A probe slipped between the inner table and the dura disclosed no irregularity; therefore no further operative steps were taken. A portion of the inner table left in the bottom of the trephine-hole was undisturbed because it was smooth. The patient died in about forty-two hours of delirium tremens. Dr. H. F. Formad, the pathologist, found no inflammation of brain or meninges, but intense œdema of the brain and membranes, and at the inquest swore that death occurred from alcoholic delirium. The section of bone presented to you shows a marked depression of the table due to a T-shaped fracture under the seat of the external dent, beneath which was a small clot upon the dura mater. The top line of the T, which in the figure is vertical, is one and one-quarter inch long. The cleansed bone shows a semi-elliptical fissure of the external table encircling the slight dent.

If this patient had lived, he would have been very liable, I think, to epilepsy or insanity. Only a few weeks ago I saw, in consultation with Dr. Charles K. Mills, a man of twenty-two years who was suffering with marked mental impairment occur-

* Prescott, Hewett, and Lidell have furnished other statistics of such cases. Holmes' "System of Surgery," American edition, 1881, vol. i., p. 636.

ring as he and his brother said, subsequent to a fracture of the skull received about four years previously. Reference to the notes of the Pennsylvania Hospital, in which he had been treated, showed that he had been admitted for a compound depressed fracture of the skull, which was so slightly marked that operation was not deemed necessary. It is probable that his mental impairment was due to a depression similar to that seen in this specimen. It was my intention to trephine in this case of mental failure if further investigation of his condition by Dr. Mills conclusively traced the aberration to the injury. Unfortunately, the patient passed out of our control by returning to his country home before I had a second opportunity of examination.

I feel sure that the element of danger in skull fractures is this splintering of the inner table; and I differ most decidedly from those who esteem it of comparatively little importance. Its danger in those abruptly depressed fractures, called punctured fractures, has been quite generally recognized; but its great frequency and risk in other forms of fracture are still not sufficiently emphasized by all authorities. Ashhurst, in the edition of his "Surgery" published in 1882,* said, in speaking of simple depressed fractures, "I have never seen a case of this kind in which I thought the use of the trephine justifiable, nor an autopsy which showed that the operation could possibly have saved life." In compound depressed *impacted* fractures he would not advise operation, "even if symptoms of compression were present." He goes on to say that the trephine "is not to be used with the idea of relieving compression, nor with the idea that there is any special virtue in the operation to prevent encephalitis." In punctured fracture the same distinguished surgeon thinks the trephine may be necessary to slightly enlarge the opening in the skull to remove the spicules which are apt to be broken from the more ex-

* Pp. 325, 326.

tensively involved internal plate; but says, "It is better to leave imbedded in the brain, a foreign body, or even a fragment of bone, than to add to existing irritation by reckless attempts at its removal."

Perhaps Dr. Ashhurst has changed his views within the last few years. If he has not, I must disagree with him on this subject, except in the opinion that reckless surgery is always unjustifiable. His definition of what constitutes reckless surgery may differ from mine.

Many writers, while admitting the probability of greater damage to the inner table, do not give its disastrous consequence sufficient stress. Briggs,* however, truly says that the great danger in depressed fracture is not compression, but inflammation set up by displaced fragments of bone. Dr. Sands says † that advocacy of early trephining, on the ground that loose pieces of bone in simple comminuted fracture will probably become necrosed and set up fatal intracranial inflammation, is improper. I believe that few advocates of early trephining give necrosis as a reason for their belief. Necrosis is not, but encephalitis is, very liable to occur.

Dr. Sands also believes that the apprehensions felt by those who advocate preventive trephining in closed depressed fracture without head symptoms, with the object of removing sharp fragments of the inner table, are scarcely justified by observation. These extensive osseous lesions are, in his opinion, often recovered from without surgical interference. He states ‡ that immediate resort to the trephine is imperatively required, however, in fractures of limited extent, and in those in which there is reason to think, from their situation or the occurrence of monoplegia, monospasm, or hemiplegia, that a splinter has penetrated the motor area of the cortex. Trephining is also demanded, in Dr. Sand's opinion, when com-

* "Annals of Anatomy and Surgery," vol. vii., p. 69.

† *Ibid.*, vol. viii., 1883, pp. 101–103.

‡ "Annals of Anatomy and Surgery," vol. viii., 1883, p. 106.

pression of the brain is due to blood between the dura and cranium.

Perforation of the cranium is to be adopted as an exploratory measure almost as often as it is demanded for therapeutic reasons.

I have shown that the occurrence of fatal encephalitis is frequently due to spiculation of the inner table, and that spiculation or extensive shattering of the inner table is common in limited fractures of the external table. Hence it follows that exploratory perforation of the cranium is justifiable in all cases where the nature of the impinging force, or the appearance of the external table, renders spiculation of the inner table probable, provided that less danger to life and health is inherent in perforation than in the probable spiculation. I have already asserted my belief in, and given reasons for, a low mortality risk of perforation. I am of the opinion that fractures of the cranial vault, produced by such general application of force as occurs when a man falls from a great height upon his head are less frequent than fractures by direct and comparatively localized blows, such as occur from ordinary missiles, bullets, and falls from low elevations. These latter are those which tend to produce internal spiculation. Hence I am driven to the conclusion that exploratory perforation to determine the absence or presence of internal spiculation is often demanded by the uncertainty of the invisible condition. Without a knowledge of the true state of affairs treatment is empirical; and the risk to subsequent mental health or to life is too great to permit reliance on empirical treatment, when a knowledge of the true condition is obtainable with the slight danger that pertains to antiseptic trephining.

Whenever the fracture, whether originally an open one or so made by an incision, presents the possibility of the inner table being detached and splintered more extensively than the outer, I should be inclined to advise perforation. In other

words, I would cut the scalp to see the condition of the outer table, and I would cut the bone to see the condition of the inner table, in every case where the risk of obscure knowledge is greater than the risk of divided scalp and perforated bone.

The tendency to procrastination in such matters has destroyed many lives. Nancrede * recommends early preventive trephining strongly, because, after encephalitis has once begun, trephining does not remove the inflammation, but merely one source of irritation without influencing the existence of the inflammatory process which has been aroused. His statistics show the mortality of the operation, after symptoms of brain disease have arisen, to be much more than twice as great as in preventive operations—the figures are 52.8 per cent. and 22 per cent. He further says, that, although the operation should be done early, it is never too late in neglected cases to make the attempt; for an abscess may be found and evacuated with the result of saving life. Stimson † says that the percentage of recovery in early operative interference is actually high compared with tardy operations; and cites instructive cases to prove that his opinion is correct. Wound of the longitudinal sinus and removal of about three square inches of bone were no bar to recovery in a case which he treated by immediate trephining, though no brain symptoms except stunning were present.

In discussing the treatment of cranial fractures I shall ask myself four questions:

1. What conditions demand incision of the scalp?
2. What conditions render incision of the scalp unjustifiable?
3. What conditions demand perforation of the skull?
4. What conditions render perforation of the skull unjustifiable?

These queries are best answered by the tabulated statement

* "International Encyclopædia of Surgery," vol. v., p. 95.

† "Treatise on Fractures," p. 248.

which follows. I admit that the line of treatment advocated is more heroic than that generally taught, but it has been accepted only after careful consideration of the reasoning of those who hold the opinion contrary to my own. Every case must be individually studied, and the patient's chances of death, of life with subsequent epilepsy or insanity, or of return to perfect health, carefully weighed; but for a working rule to guide the student and practitioner I think experience will show that the indications given in the table are correct. Trephining, properly performed, is in itself so free from danger that in a doubtful case the patient had better be trephined than allowed to run the risk of death, epilepsy, or insanity. Legouest was very nearly right when he said: "Whenever there is a doubt whether trephining should be done, this doubt is probably an indication that operation should be performed." *

Syllabus of the Treatment of Fractures of the Cranium.

Closed Fissured Fractures.

1. No evident depression, no brain symptoms. No operation.
2. No evident depression, with brain symptoms. Incise scalp and trephine.
3. With evident depression, no brain symptoms. Incise scalp and probably trephine.
4. With evident depression, with brain symptoms. Incise scalp and trephine.

Closed Comminuted Fractures.

5. No evident depression, no brain symptoms. Incise scalp and probably trephine.
6. No evident depression, with brain symptoms. Incise scalp and trephine.

* Lucas-Championnière, "Trépanation guidée per les localisation cérébrales," p. 23.

7. With evident depression, no brain symptoms. Incise scalp and trephine.

8. With evident depression, with brain symptoms. Incise scalp and trephine.

Open Fissured Fractures.

9. No evident depression, no brain symptoms. No operation, but treat wound.

10. No evident depression, with brain symptoms. Trephine.

11. With evident depression, no brain symptoms. Trephine.

12. With evident depression, with brain symptoms. Trephine.

Open Comminuted Fractures.

13. No evident depression, with brain symptoms. Trephine.

14. No evident depression, with brain symptoms. Trephine.

15. With evident depression, no brain symptoms. Trephine.

16. With evident depression, with brain symptoms. Trephine.

Punctured and Gunshot Fractures.

17. In all cases and under all circumstances. Trephine.

The operation, when decided upon, should be performed at once, or certainly not delayed more than a few hours.

All cases, whether trephined or not, should be treated as cases of incipient inflammation of the brain.

X.

SUBCUTANEOUS NAILING, EXPLORATORY INCISION AND THE EXTENDED ELBOW IN CONDYLOID FRACTURES OF THE HUMERUS.

It is my desire to present in a succinct manner such personal opinions as will lead to a similar expression of views from other surgeons. That which I shall contribute to the debate will advocate no very striking novelty in procedure and will record no conspicuous discovery in surgical pathology. It will simply show the conclusions in regard to certain problems in practical surgery at which I have arrived from thoughtful consideration of personal experience, combined with a limited amount of experimental work and more or less familiarity with surgical literature.

These conclusions I shall for the sake of brevity and clearness formulate as definite propositions:

1. *Anchylosis of the elbow-joint after condyloid fractures is usually due to imperfect reduction of fragments or incomplete restitution of structural relations.*

The interference with mobility largely results from distinct alterations in shape of the articulating surfaces, due to the incorrect coaptation, though overgrowth of bone from stripped-up periosteum, and ossific depositions in the sero-ligamentous capsule aid in its production. Experience seems to show that mobility of the joint is as a rule promptly regained when the play of the olecranon and coronoid processes around the trochlear surface is not obstructed by bony displacement or new deposits. In persons of an arthritic diathesis intra-articular and par-articular adhesions may undoubtedly restrict motion, but these are not the usual cause of

anchylosis, after fractures of the humeral condyles. To hemorrahagic effusions into the joint have been attributed adhesions of newly formed connective tissue and thickenings of the synovial membrane; but these causes of anchylosis are relatively unimportant.

Powers of Denver has reported * an interesting instance of anchylosis in extension, after fracture at the elbow, in which exploration disclosed a broken-off coronoid process situated *behind* the joint. This was removed, part of the broken condyle chiseled away and the patient finally given almost perfect mobility of the elbow. This case is valuable in showing that displaced bone causes anchylosis; and that incision at the time of the receipt of the lesion would probably have permitted restoration of bony contour and prompt recovery of functional activity.

2. *Conservation of the normal angle between the axes of the humerus and ulna is desirable.*

Much attention has been given in recent years to the possibility of fractures of the lower end of the humerus causing cubitus varus or "gunstock deformity" of the arm, thereby interfering with the so-called "carrying function" of the upper limb. This deformity has been supposed to result from ascent of a detached internal condyle; descent or rotation forwards and inwards of a detached external condyle; and rotation forwards and towards the middle line of the body of the condyloid mass, after transverse or comminuted fracture.

H. L. Smith of Boston, Mass., believes † that this deformity is not apt to occur from fracture of a single condyle, but after a break traversing the entire width of the humerus; and he considers that the deformity has been given unnecessary importance in the determination of the best posture in which to treat fractures at the lower end of the arm bone. Stimson of New York, on the other hand, has asserted ‡

* *Medical Record*, 1896, vol. i., p. 615.

† Boston *Medical and Surgical Journal*, October 18, 1894, p. 389.

‡ "Transactions American Surgical Association," ix., 1891, p. 270.

that displacement of a condyle, not exceeding one-quarter inch or one-eighth inch in amount, may effect a change in the humero-ulnar angle. The analogous displacements produced intentionally, by Ogston's condyloid and Macewen's supracondyloid osteotomy, for the relief of knock-knee, suffice to explain the mechanical factors in the production of gunstock deformity of the arm and convince me that fracture of one or of both condyles may produce the unsightly deformity. This I have proved by experimental fracture detaching the internal condyle and other fractures causing more complicated bony lesions of the lower end of the humerus. I am not so certain of the deformity being readily produced by descent of the external condyle, when it alone is separated from the shaft of the bone.

It must be recognized that the humero-ulnar angle differs greatly in individuals. I have found it less conspicuous in children and women than in men; and believe it to be most marked in those of well-developed muscular power. Smith has found it to vary between —5° and +30°, and states that even in the same person the two uninjured arms may differ as much as 10° to 15°. He also found that the width of the condyloid portion of normal arms differed on the two sides of the same person. The average variation in 50 cases measured was 3.1 mm. He investigated 75 cases of united fracture of the elbow, treated according to traditional methods, to find that the average difference on the two sides was 5.5 mm. The increased width was, if I correctly understand him, on the side injured. He makes the important statement that in 20 cases treated by *acute* flexion, the average difference in width after union was 4 mm. and that in these same cases the carrying angle was unchanged in 40 per cent. In the 75 cases treated by various persons in the ordinary ways the carrying angle was unaltered in 10 per cent.

It is probably true that the conversion of the humero-ulnar angle into a straight line or its change to an angle in the op-

posite direction has little effect on the wage-earning capacity of the patient; but it certainly produces an unsightly deformity and impairs the symmetry and integrity of the human mechanism. It does not of itself interfere with mobility of

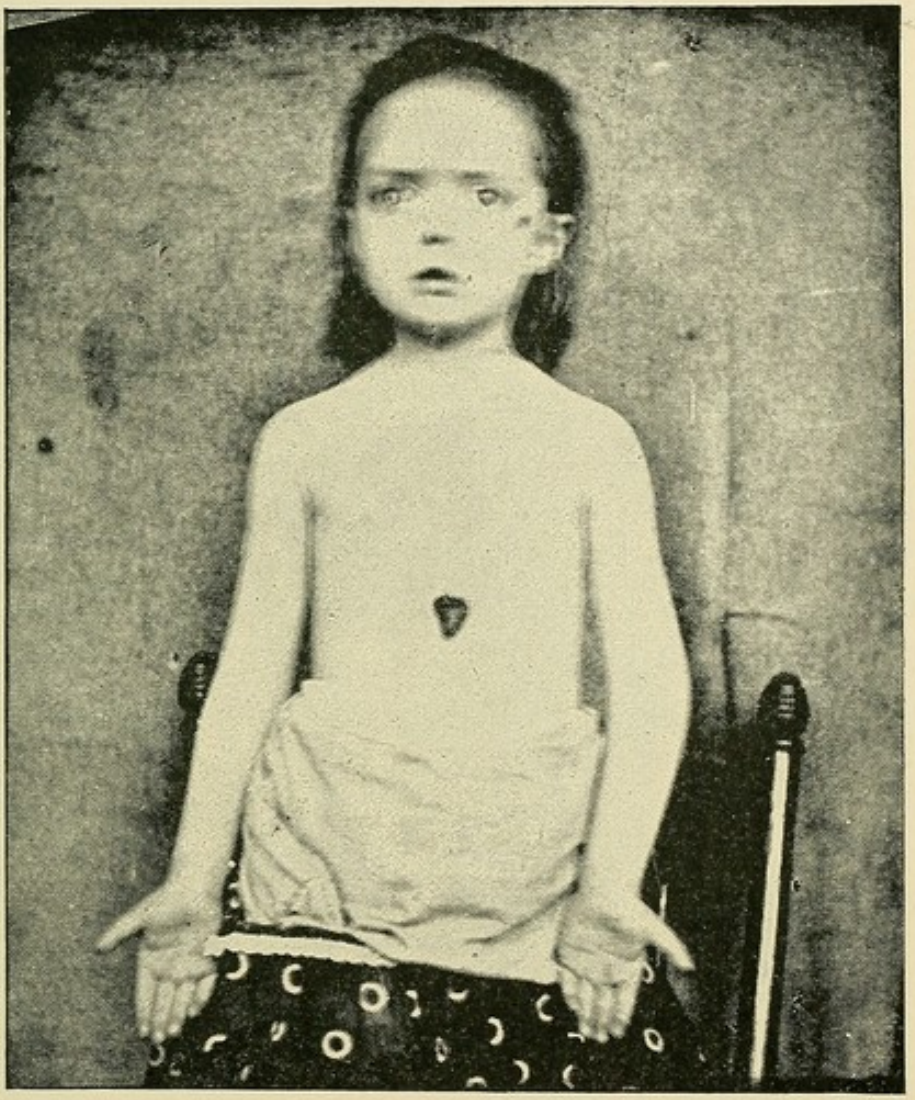

FIG. 9.

Gunstock Deformity of Left Elbow after Fracture of Lower End of Humerus.

the joint. I recently saw a young lady who about fifteen years ago, when a child, broke the condyloid portion of the left humerus. I took part in the treatment of the injury, which was by means of a rectangular trough-shaped posterior splint. She has marked gunstock deformity, as a result of the defec-

tive treatment, but has perfect mobility of the joint. The hand is of course brought nearer the thigh when the limb hangs vertically, but this defect brings no special inconvenience. It might perhaps be a disadvantage to a woman in the lower walks of life, who was compelled to carry burdens in the dependent hand. I refer to this patient, because it was my dismay at the deformity remaining after the treatment adopted that first forcibly directed my attention to the disadvantage incident to right-angle flexion in the management of these bony lesions; and because she by chance came into my office after many years' absence, while I was preparing this paper.

It is an acknowledged duty of the surgeon to restore after injuries the anatomical symmetry as well as the functional usefulness. Hence no extended argument is necessary to prove that it is best to adopt that line of treatment which will attain both ends. Retention of the normal humero-ulnar angle of a broken elbow is therefore not only desirable for cosmetic reasons, but is demanded by anatomical and surgical considerations.

3. *Fixation is satisfactorily obtained by nailing the fragments together with long nails driven through the skin.*

The occasional deformity and limitation of motion, resulting from fractures of the condyloid portion of the humerus, are doubtless due not only to incomplete reduction of the broken bone; but to an imperfect fixation, which has allowed the properly adjusted fragments to slip again into abnormal relations. Stimson is probably not alone in his belief * that "in intercondyloid fracture with marked separation, there is no practicable means surely to maintain reduction." He says further that the impossibility of direct control of the fragments, the contraction of muscles, and the pressure of fascia combine to make the result largely a matter of chance. This opinion was confirmed, he states, by seeing and feeling in open

* "Transactions American Surgical Association," ix., 1891, p. 272.

fractures the difficulty caused by the shiftings of the fragments.

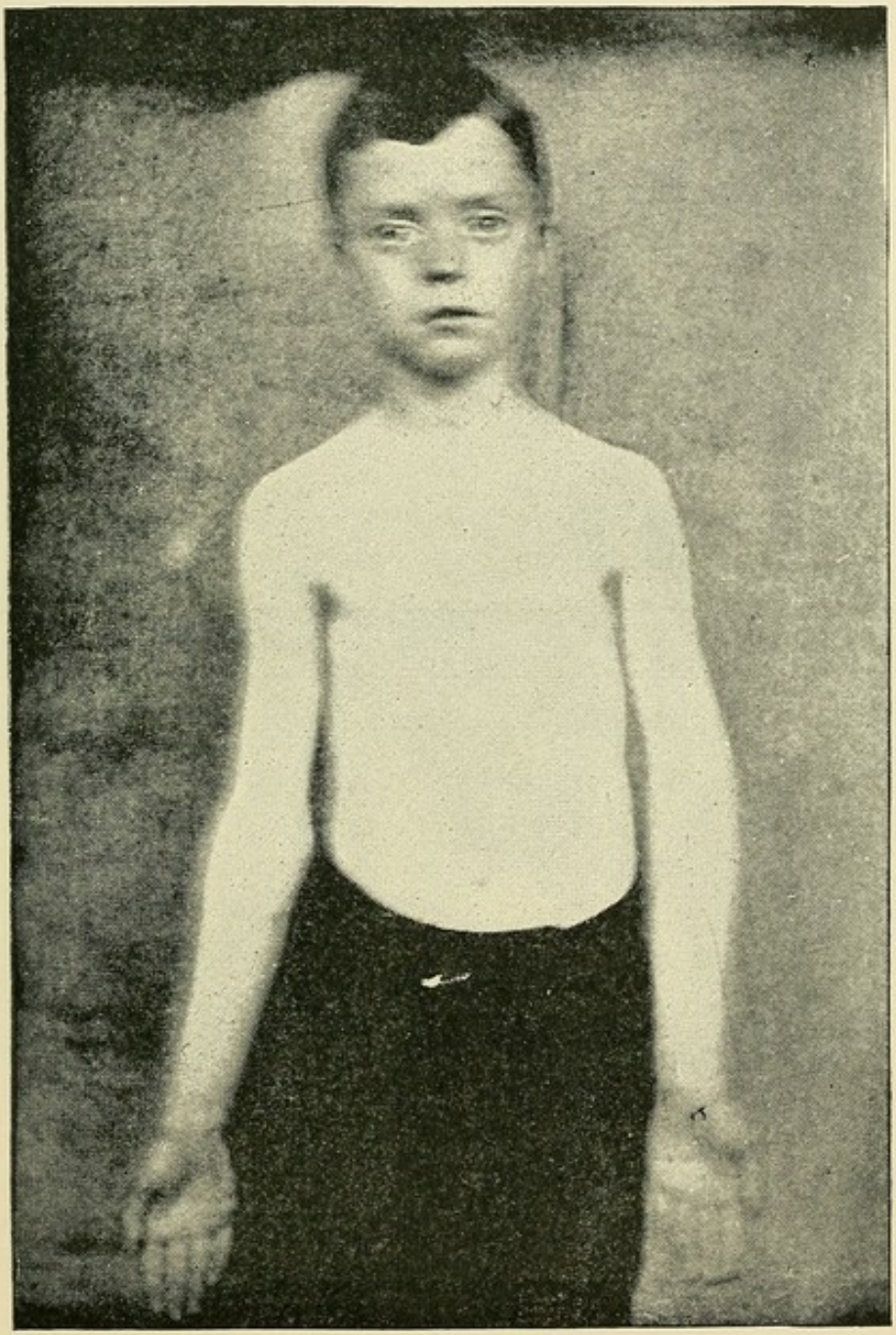

FIG. 10.

Gunstock Deformity of Left Elbow after Fracture of Lower End of Humerus.

I have been making some experimental observations during recent months on the use of nails for direct fixation of frac-

tures; having been led to the investigation by my success at the Philadelphia Polyclinic Hospital in nailing together the fragments of a metacarpal bone. I have found that fractures of the condyles of the humerus, made in the cadaver, can be satisfactorily fixed after reduction by driving wire nails

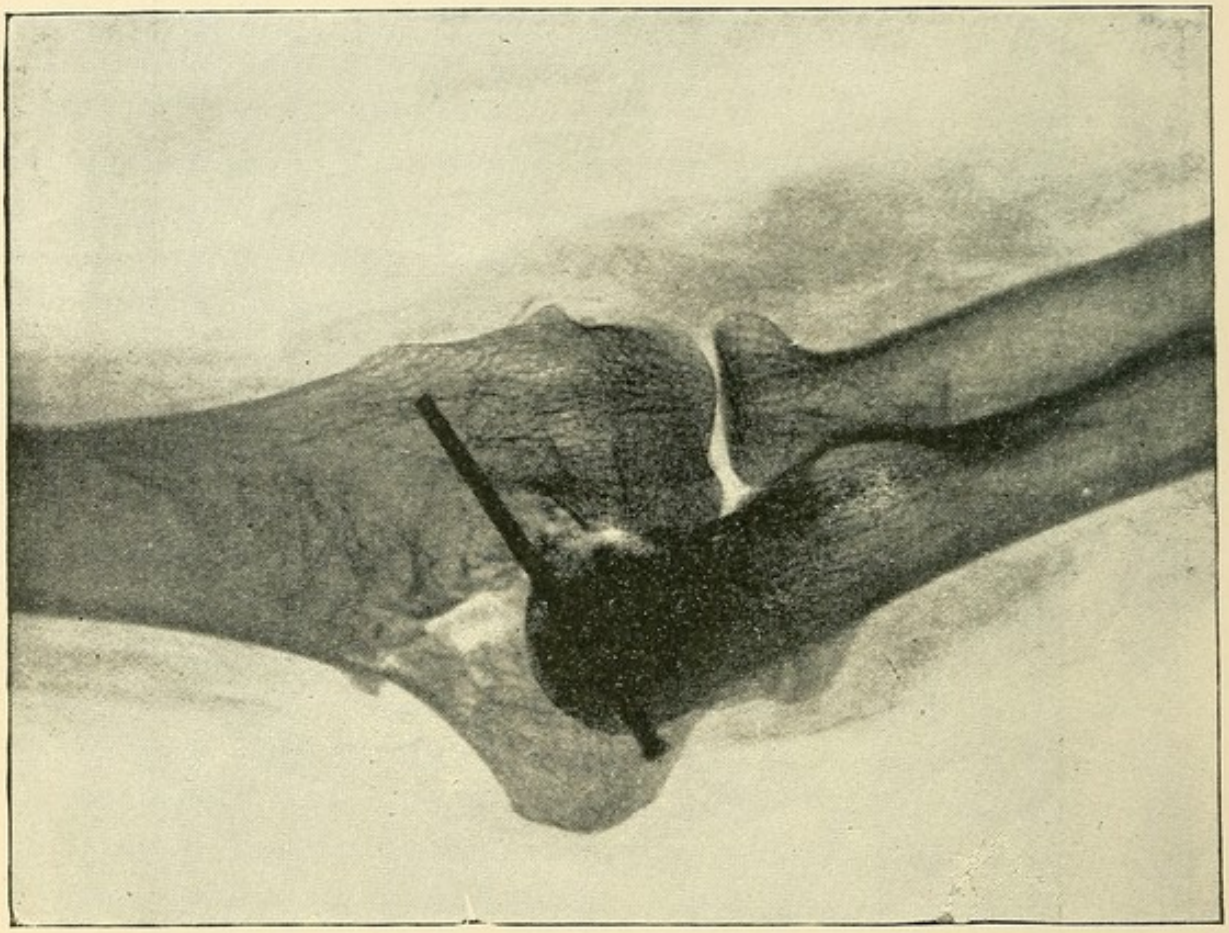

FIG. 11.

Experimental fracture of internal condyle (made with osteotome). Fragments kept in position with wire nail driven through skin. Skiagraph taken with dorsum on photographic plate.

through the skin into the bone and across the lines of separation.

The accompanying skiagraphs show the method better than a verbal description.

I became convinced by this experimental work of the efficiency of fixation by means of slender nails, and of the wis-

dom of adopting the procedure in the comparatively few severe fractures of the humeral condyles needing direct fixation. I have had, however, no personal clinical experience of such operative treatment in elbow injuries; and my opinion

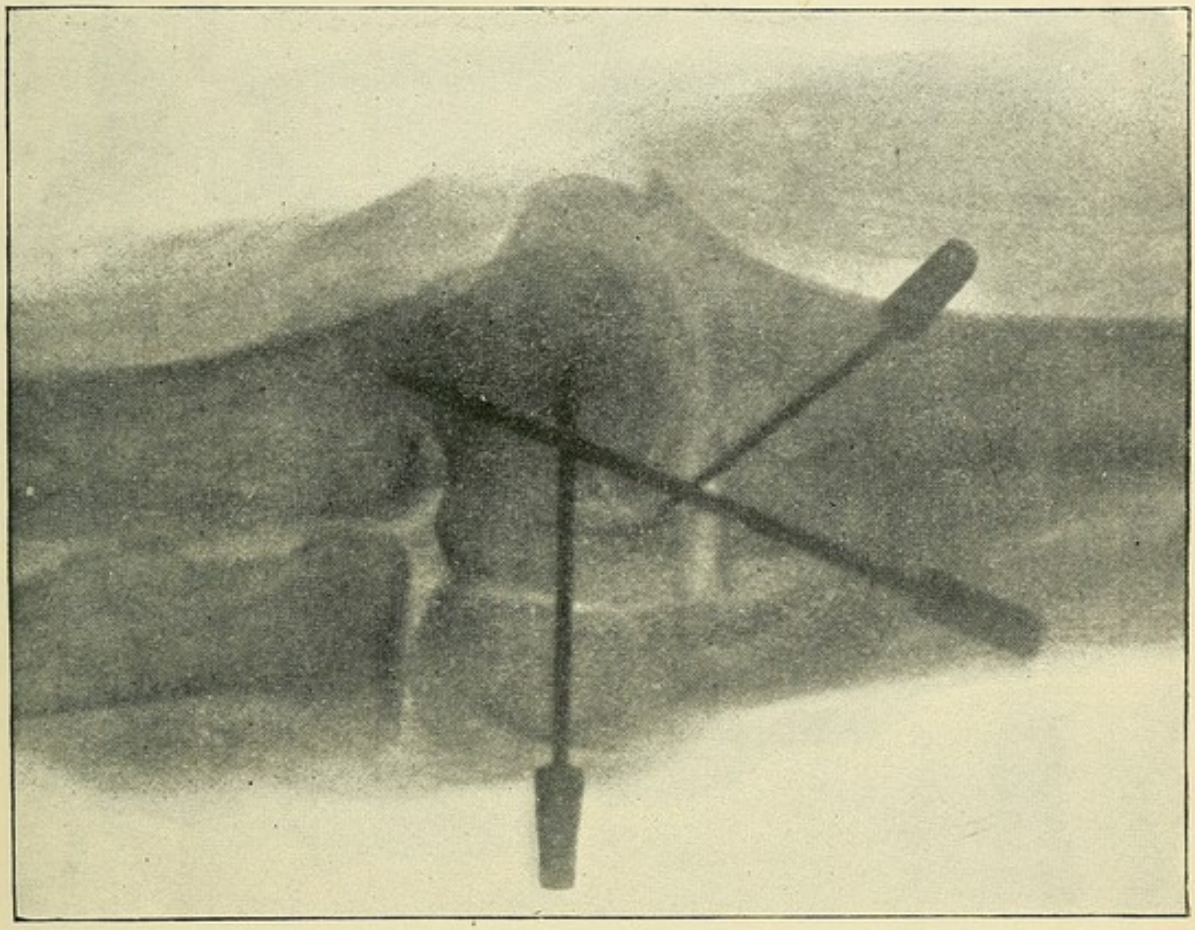

FIG. 12.

Experimental V-shaped fracture of condyles (made with osteotome). Fragments fixed with wire nail driven through skin. Skiagraph taken with anterior surface on photographic plate.

was based on inductive reasoning alone and the use of similar means in resection and osteotomy.

A few days since I came upon Stimson's statement that in an open fracture of the condyles he had "felt constrained to pass a long steel pin transversely through both condyles and the long projecting end of the upper fragment, for in no other

way could they be kept in apposition." * I had undoubtedly seen this report before, but had forgotten it. Stimson does

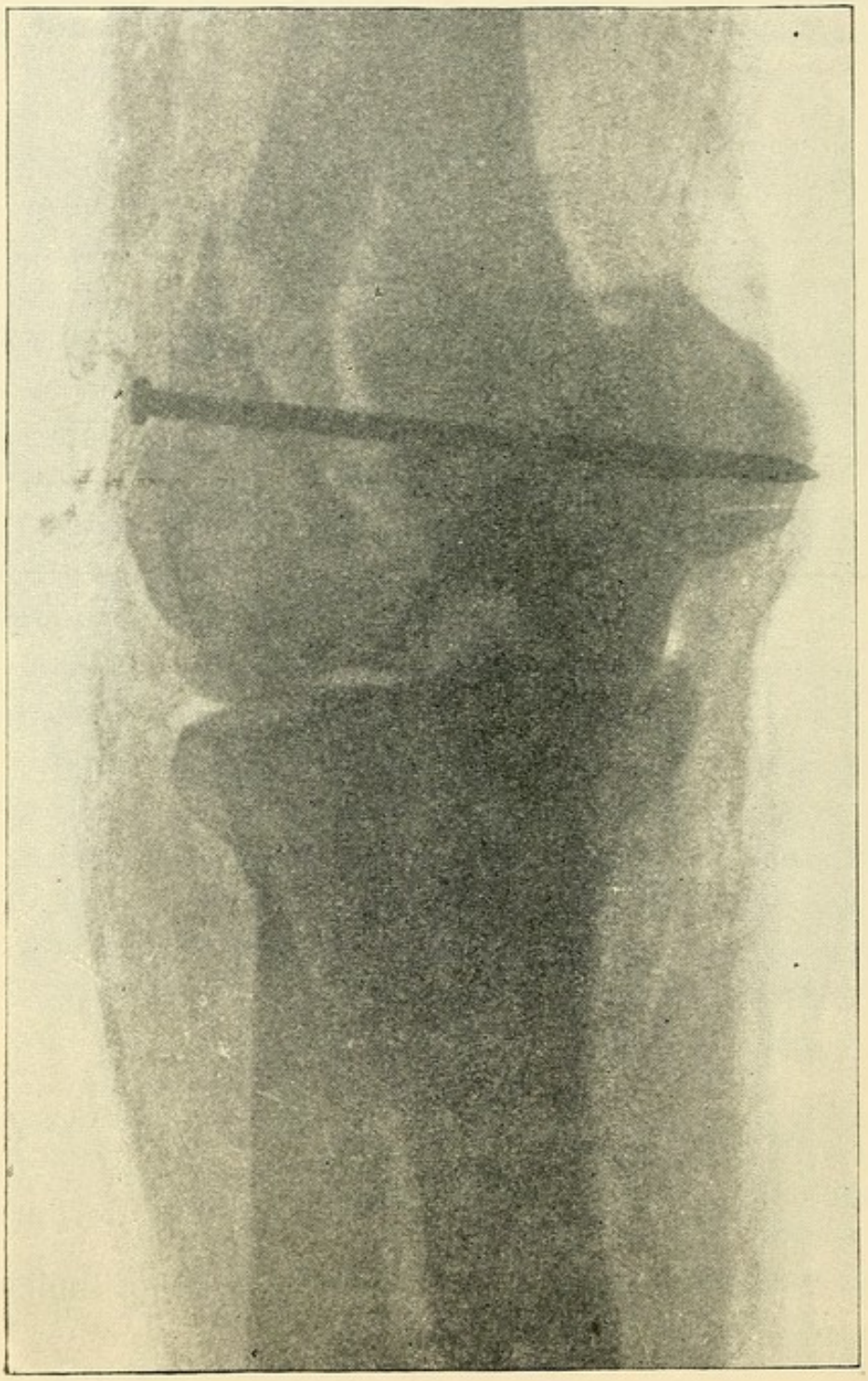

Fig. 13.

Experimental T-shaped fracture of condyles (made with osteotome). Fragments fixed with three "Fracture Nails" driven through skin. Skiagraph taken with anterior surface on photographic plate.

not give the result, but I can see no reason to doubt that the coaptation continued satisfactory. If the operative field was

* "Transactions American Surgical Association," ix., 1891, p. 272.

free, and kept free, of septic complications, the result ought to have been good.

I have had made special "fracture nails" of tempered steel, with a drill-shaped point and a long, square head.

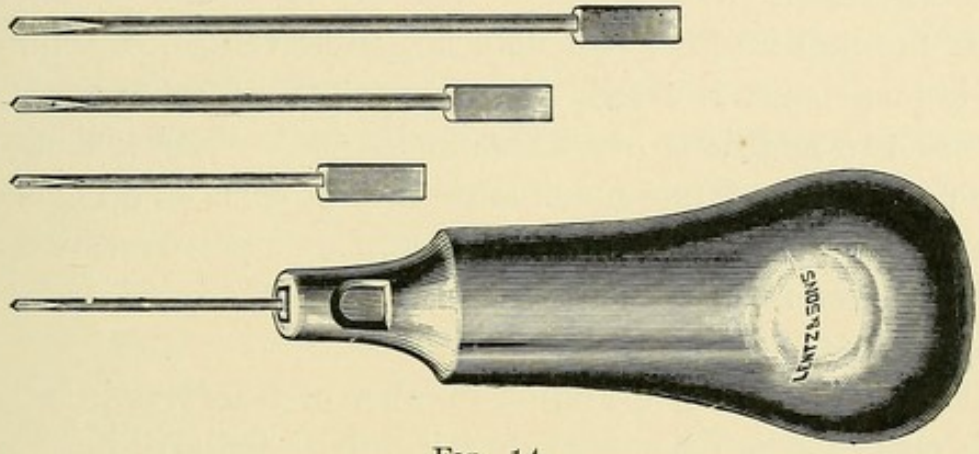

FIG. 14.

Fracture Nails and Drill.

These are readily pushed through the skin, muscles and compact exterior of the bone by means of a handle which fits the head. The handle is then detached and the nails are driven into the deeper portions of bone with a hammer. After two, three, or four weeks the nails should be pulled out by the claw-

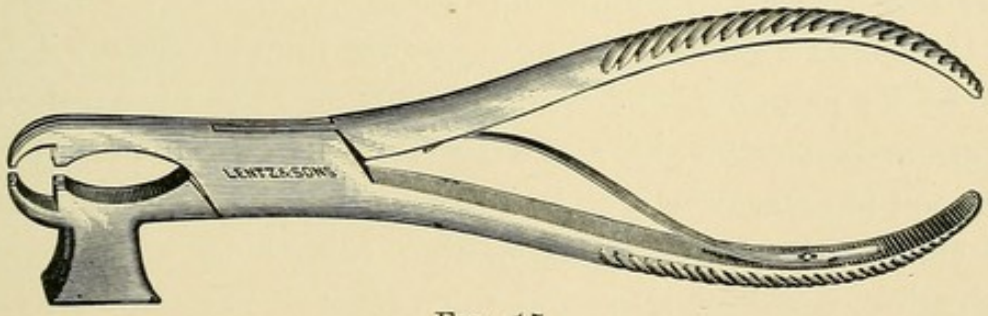

FIG. 15.

Hammer Forceps.

like forceps. For convenience I have had a hammer-head made upon one side of the forceps.

During the driving of the nail or nails the fragments already adjusted are held by the fingers of the operator or assistant; and after fixation is accomplished an aseptic dressing

and a light splint of wood, metal, paper, or gypsum are applied.

Ordinary wire nails and a hammer may be used with satisfaction, but the want of temper and point makes them rather less convenient.

If the nail first inserted does not effectively fix the pieces of broken bone, it should be withdrawn and re-inserted, or one or two additional nails should be used. The placing of the nails will be found much more easy in open than in closed fractures; and will require more skill and patience in comminuted fractures than in those in which there are but two fragments.

There will be but a limited number of fractures in which this operation is demanded, but it will, I believe, be found valuable in a certain proportion of cases. No one should attempt the operation unless he is a believer in asepsis and a conscientious exponent of modern aseptic surgical methods. Careless or incomplete asepsis is not permissible. It is as reprehensible as in abdominal or cerebral surgery.

4. *Previous skiagraphs may be needed to aid in determining the point at which the nails should be introduced and the direction in which they are to be driven.*

If the exact direction of the fracture lines cannot be determined by palpation and manipulation, the use of the fluoroscope or better the study of skiagraphs will often permit the surgeon to determine how best to nail the fragments together. If sufficiently definite information cannot be obtained by palpation, manipulation, and the use of Roentgen rays, exploratory incision is the safest course in severe injuries of obscure character.

5. *Obscure or severe fractures may demand exploratory incision for replacement of fragments and prevention of anchylosis. Such incisions are not employed as often as they should be.*

Aseptic incision of joints, being in competent hands prac-

tically free from risk to life, is demanded in a certain number of elbow fractures, because the anatomical integrity of the joint and its functional usefulness are jeopardized by the surgeon's ignorance of the lesion and his consequent inability to repair the structural damage. After incision, the fragments can be accurately adjusted, the torn periosteum replaced; muscles, fascias and nerves disentangled from undesirable positions between the bone fragments, and sutured if lacerated; and fixation of the fragments consummated. It is probable also that cure will be hastened and pain lessened by the removal of bloodclots and the leakage of synovial fluid and inflammatory exudate, permitted by the incision; and that fat embolism and non-union will be less likely to occur.

The well-informed modern surgeon, who must know the safety of aseptic operations, should not hesitate to adopt exploratory incision in appropriate cases. The patient with a bad fracture of the elbow has an intrinsic right to the benefit derivable from incision in competent aseptic hands.

6. *The best route for this exploratory investigation is through the groove between the biceps and long supinator.*

My investigations at the Laboratory of the Philadelphia Polyclinic have led me to adopt, for exploration of the condition of the lower end of the humerus, a curved incision on the outer portion of the anterior aspect of the elbow joint, which turns up a flap exposing the biceps and long supinator. The cut begins at a point about 8 cm. above the tip of the external condyle and ends about 6 cm. below the tip of the condyle. It is about 15 cm. long and convex towards the middle line of the arm with the center of the curve corresponding with the point midway between the condyles. When this cellulo-cutaneous flap has been raised, the inter-muscular groove between the biceps and long supinator is seen. Blunt dissection down this pathway discloses the front of the humerus and the anterior ligamentous covering of the joint. The muscular-spiral nerve will perhaps be seen, but is easily

preserved from injury. The entire width of the bone and joint is rendered accessible to touch and inspection.

7. *The extended position of the elbow is less likely than right-angled flexion of the joint to be followed by impairment of the normal humero-ulnar angle, which gives the "carrying function" to the upper extremity; and it is therefore the preferable posture in condyloid fractures of ordinary severity.*

It has been my practice to treat these fractures with the elbow extended and to carefully compare the injured with the sound limb, in order to preserve by my splints the humero-ulnar angle. I reduce the fragments, compare the two arms, and apply a splint of wood or of gauze and gypsum to keep the joint not quite fully extended. Full extension is more apt to be irksome to the patient; and it is a wise precaution to run no risk of displacing the fragments by hyperextension of the injured joint. A thin narrow board is usually laid on the front of the normal arm and the direction of the axes of the humerus and ulna marked on it. A penknife is then employed to whittle the board into proper shape, and, by reversing it, a proper splint is made for the broken bone. The splint is padded, a little cotton laid in the flexure of the elbow, and bandages used to hold the splint in position. A gypsum splint molded to the arm is more elegant, but is not always so conveniently obtained.

The extended elbow in these fractures has been advocated for various reasons. It has been said that it enables the surgeon to appreciate more readily any change in the deviation of axes than the right-angled position, which crowds up the soft tissues in front of the joint and obscures the position of the fragments. The angular deformity, to be avoided, has been attributed to the displacing influence of the triceps, which is relaxed by employing the extended posture. If the extended elbow is combined with supination of the radius the biceps is also considerably relaxed. The position advocated seems therefore to relax the important displacing muscles, with the

exception of the anterior brachial. Some writers allege that the displacement of the condyles and the destruction of the "carrying function" by right-angle splints are due to the fact that the radius lies at a higher level than the ulna, and that the splint and bandaging tend to bring them on the same level, thereby raising the internal condyle or depressing the external. I am inclined to believe from experimental evidence on the cadaver, that this is to a certain extent true, though too much importance may heretofore have been accorded to it by us who advocate the extended elbow.

Strong clinical evidence of the worth of the extended posture is the assertion * of Thompson of Washington, who was able in two open fractures to keep the fragments in position when the arm was extended, but found that they were displaced if he attempted to keep them in position with the elbow at right angle. Taylor of San Francisco reports † a similar experience with a closed fracture.

It is unnecessary to intimate to this audience that Liston treated elbow fractures in the straight position, if I am correct in my belief.

Thomas of Liverpool, Jones of Liverpool, as well as Dulles ‡ of Philadelphia; H. L. Smith § of Boston, and Bruce ‖ of Dingwall, Scotland, recommend *acute* flexion in the management of these injuries; but I have never tried it, though some of my colleagues at the Philadelphia Polyclinic have had, I understand, satisfaction in its employ.

* "Transactions American Surgical Association," x., 1892, p. 58.

† "Transactions American Surgical Association," x., 1892, p. 65.

‡ Boston *Medical and Surgical Journal*, August 30, 1894.

§ Boston *Medical and Surgical Journal*, October 25, 1894, and July 4, 1895.

‖ *British Medical Journal*, 1896, ii., p. 1201.

XI.

TREATMENT OF FRACTURES OF THE LOWER END OF THE HUMERUS AND OF THE BASE OF THE RADIUS.

The frequency of fractures at the lower end of the humerus and at the base of the radius and the necessity of maintaining functional integrity of the joints of the upper extremity, make the consideration of such injuries of primary importance. The desirability of an accepted and usually practiced method of treatment for these fractures will be unquestioned; while the value of establishing such rules of practice is fully recognized by all interested in surgical jurisprudence.

The great diversity of opinion exhibited by the members of this Association last year, when the subject of elbow injuries was introduced by Dr. L. A. Stimson, was a revelation to me. I had, up to that time, believed that my own views, derived from the study of surgical literature and clinical cases, were not very different from those of other surgeons. Hence, I was somewhat unprepared for the remarks of many of the speakers on that occasion.

A pretty thorough examination of the text-books in the hands of the practitioners and students of this country and an investigation of some of the writings of foreign surgeons have led me to believe that much bad surgery is taught and practiced. This state of affairs must be due to ignorance of recent advances in surgical pathology or to an indisposition to accept statements and methods of treatment which appear to me to appeal very strongly to surgical experience and intelligence. As an illustration I quote from a recent work of M. Armand Despres, published in 1890. The author, in speaking of fractures at the lower end of the radius, says: * "I am

* "Treatise on Fractures," translated by Dr. E. P. Hurd, p. 4.

of Nelaton's opinion that the reduction is not necessary: the apparatus when well applied reduces the fracture by degrees and without pain." He, moreover, does not apply the splints until from twenty-four to thirty-six hours after the injury, but uses up to that time warm fomentations or cataplasms. Such a method of treatment seems to me so totally opposed to surgical principles and the advice of such a dangerous character to give students that any discussion which will neutralize the effect of this author's words cannot be without value.

Again, I find in Dr. Henry R. Wharton's valuable treatise on "Minor Surgery and Bandaging," published in 1891,* the direction given that, before applying any splint in fractures of the lower end of the humerus, "it is well in many cases to apply over the region of the fracture several folds of lint saturated with lead water and laudanum, and to cover this dressing with wax paper or rubber tissue, to diminish as far as possible the swelling which is very marked after these injuries." My own belief is very strong that such dressing is not only useless but harmful; because the application of these poultices over the injured limb often gives rise to the occurrence of cutaneous vesication in the inflamed region. Evaporation of the lotion is prevented by the rubber tissue or wax paper and the encouragement of serous exudate beneath the cuticule is not infrequently followed by large blebs. Such applications are never required in fractures, since the swelling and œdema, due to the aseptic traumatic inflammation, rapidly subside if the fragments are properly adjusted and kept at rest. I have a continual struggle with young hospital residents to prevent their following this pernicious advice, which appears to be taught by more than one lecturer. In cases where the swelling and œdema will not subside by coaptation of the fragments and rest, more active surgical interference than applications of lead water and laudanum is required.

The unfortunate tendency to use complicated fracture dress-

* P. 325.

ings, which obtained in the early history of surgery, still remains to be overthrown by the continued advocacy of mechanical simplicity. Most of these appliances appear to have been invented by those more interested in the construction of machinery than in a simple solution of the mechanical problems presented by osseous injuries. The application of these complicated dressings is nearly always expensive and uncomfortable to the patient, confusing to the average practitioner, and unintelligible to the student. Their use, moreover, tends to direct the attention of the surgeon to the kind of apparatus rather than to the conditions presented by the special injury under his care. No better illustration of this tendency to devise unnecessary appliances for fractures is needed than this drawing of an apparatus of Professor Bardenheuer for fractures of the lower end of the radius. You see the patient confined to bed, on the framework of which are fastened six pulleys, through which five cords with weights make traction on as many different parts of the arm and hand. You will be surprised perhaps when I tell you that this device of the Inquisition is described in his book published in Stuttgart in 1891.* The other splints and dressings represented and advocated by this writer in like manner strike the practical surgeon with amazement. If it were not for the indisputable evidence of the title page, the book might be regarded as the work of a mediæval author. Think of a man with fracture of the lower end of the radius, which usually needs no splint and often need not keep him from his business for one hour, being confined to bed with five weights pulling on his unhappy arm!

These considerations make me believe that a discussion by this representative body of the treatment of some of the common fractures of the upper limb will not be valueless. Simplicity in dressings, comfort to the patient and very early restoration of function are the demands made by the public when fractures require treatment. I believe these demands

* "Leitfaden der Behandlung von Fracturen und Luxationen," p. 96.

can and will be met in nearly all fractures, if surgeons will but use their intelligence, instead of blindly following the advocates of special splints; and if systematic authors will resist the temptation of describing and cataloguing every device that has been employed for these lesions.

Believing that the methods which I have been led to adopt are founded upon good anatomical and pathological reasoning, I cannot but think that a trial of the simple dressings proposed in this paper will lead to a recognition of their value. I venture to hope that their adoption by surgeons generally will change the opinion, apparently existing in many minds, that good results after fractures at the elbow and wrist are rather the exception. I adhere strongly to the statement which I made at last year's meeting—that I approach ordinary fractures at the lower end of the humerus and of the base of the radius with a feeling that I shall almost certainly obtain results satisfactory to myself as well as to the patient.

It is proper to explain what is meant here by the term "uncomplicated" fractures, since a proper understanding of the word as used in this communication is essential to the subsequent discussion. I mean fractures in which there is no dislocation of the joint, no rupture of large vessels, no laceration of the nerve trunks and no unusual contusion or laceration of surrounding tissues. In many of the cases which I am considering there is involvement of the adjacent joint by lines of fracture, splitting the lower fragment. I consider these cases uncomplicated, if the fractures are closed ones and if the comminution of the lower fragments is not extraordinarily great. I am aware that this involvement of the joint by fissures is technically a complication; but it is so common in the fractures which I desire to bring before you, and so unimportant so long as the injury is free from septic contamination, that I have used the word uncomplicated in connection with it.

In order to facilitate discussion I shall at once state my

opinions and the methods of practice which I have come to adopt in these injuries. They are as follows:

HUMERUS.

1. In the treatment of fractures of the lower end of the humerus the divergent angle between the axes of the arm and forearm must be preserved; and hence dressings which interfere with the normal difference in level of the radius and ulna are not permissible.

2. Fractures of the lower end of the humerus of ordinary severity are, as a rule, more successfully treated in the extended than in the flexed position; because the carrying function is less liable to be impaired.

3. Passive motion at an early date is unnecessary, and may be deferred until union has occurred and the dressings have been finally removed.

4. Good results as to anatomical conformation and as to motion are generally to be expected and can usually be obtained.

5. Recent fractures in which satisfactory coaptation is not obtained under anæsthesia may with propriety be subjected to exploratory aseptic incisions. Old fractures in which deformity and impairment of function are marked may, within certain limitations, be subjected to refracture or osteotomy for the relief of these conditions.

RADIUS.

1. Fractures of the lower end of the radius vary comparatively little in their general characteristics, because but one form is usual.

2. Muscular action has little or nothing to do with producing or maintaining the deformity.

3. Immediate reduction of the fragments is the essential of treatment.

4. Many of the splints devised for the treatment of this fracture have been constructed in ignorance of the pathology of the condition.

5. The ordinary fracture of the lower end of the radius usually requires no splint, and should be dressed with a wristlet of adhesive plaster or bandage.

6. When a splint is required a narrow short dorsal splint fixing the wrist is all that is necessary.

7. The method of dressing here advocated is the best, because it, by avoiding cumbersome appliances, annoys the patient as little as possible, and it permits free voluntary movements of all of the finger joints.

8. Passive motion is unnecessary until union has occurred and the dressings have been finally removed.

9. Good use of the wrist and fingers is early obtainable and the antomical conformation is restored as well as, and perhaps better than, by other more complicated dressings.

10. Fractures which have been improperly treated by omission of immediate reduction, may, with considerable success, be subjected to refracture even after the lapse of several months. At later periods readjustment may be possible only by osteotomy, which is a legitimate means of treatment.

FRACTURES OF THE HUMERUS.

Surgeons now generally recognize the necessity of maintaining the so-called carrying function of the upper extremity, and methods of treatment which tend to alter the relations of the axes of the arm and forearm should be discarded. The reasons assigned by Allis * for the frequent occurrence of "gunstock" deformity after fracture of the lower end of the humerus are, I think, correct. The commonly employed splints, and the displacing influence of the ordinary sling, tend to bring the ulna and radius on the same level, and thereby

* "Annals of Anatomical and Surgical Society," Brooklyn, August, 1880.

destroy the divergent angle of the bones at the elbow or create an angle in the opposite direction. It is asserted that the ascent of the internal condyle one-quarter of an inch will de-

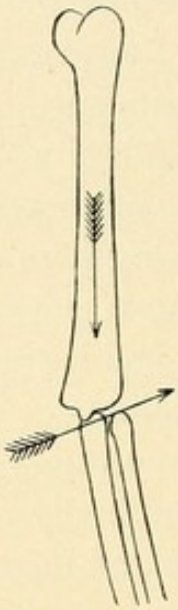

FIG. 16.

Normal angle of bones of forearm. (Allis.)

stroy the normal angular deflection at the elbow.* The direction of line of fracture and the point at which it enters the joint have, it must be remembered, a great influence on the

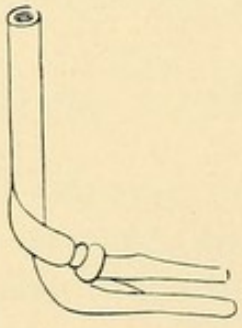

FIG. 17.

Differing planes of the radius and ulna. (Allis.)

possible occurrence of change in the axes of the arm and forearm. The principle is the same as that utilized in condyloid and supracondyloid osteotomy in knock-knee.

* Stimson, "Fractures and Dislocations," p. 403.

Packard makes the important assertion * that the place of the articular surface of the humerus corresponds with the oblique furrow of the skin on the anterior part of the joint. We know, moreover, that when the elbow is flexed at a right angle the axes of the arm and forearm coincide. For this reason, it is much more difficult to be sure that the fragments are in the proper position to insure integrity of the angular deflection, when the arm is about to be dressed in the flexed

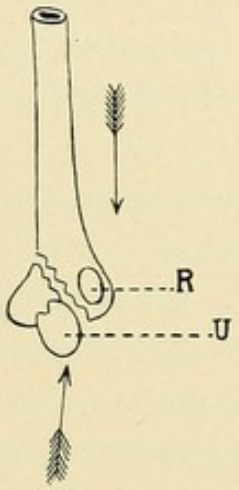

FIG. 18.

Relation of articulating portions of radius and ulna to humerus, in fracture of internal condyle; showing ease with which ulna and broken condyle can be forced up by splints and bandage, or sling, thus destroying carrying function of the arm. (Allis).

position, than when the surgeon compares the two arms and replaces the fragments while the injured limb is extended.

In my experience the angle of deviation is greater in muscular persons than in those of opposite development. In women and children it sometimes scarcely exists. It is well to remember that Pilcher says † that there is a variation in the degree of this angular deviation in normal arms of the same individual. He found as much as five and one-half degrees difference in the two arms of one of the children whom he

* "International Encyclopædia Surgery," vol. iv., p. 144.

† "Annals of Anatomical and Surgical Society," Brooklyn, September, 1880, p. 367.

measured. In his opinion muscular action, particularly the action of the triceps, has much to do with the creation of the angular distortion which often occurs when elbow fractures are treated in the flexed position.

I see no objection to the surgeon cutting down upon the displaced fragments when it is impossible to properly coapt the irregular surfaces. An aseptic exploration of a closed fracture is better surgery than the conservatism which gives a rigid and distorted elbow.

A surgeon who fully realizes the probability of impairment of the carrying function in these fractures can without doubt treat them equally well in either the flexed or the extended position. Accurate adjustment of the fragments and provision for a careful maintenance of the coaptation will usually produce good results. In the flexed position plastic dressings, made with gypsum and similar agents, are far preferable to angular splints of wood, metal or other rigid material. The former are made to accurately conform to the limb immediately after the surgeon has reduced the fracture; hence there is not much opportunity for subsequent displacement to produce a change in the normal outline. If rigid splints are applied, however, the movable fragments are liable to be forced into undesirable relations by the bandage and sling. This occurrence is possible for many days after the fractured portions of the humerus have been skillfully adjusted by the surgeon.

Practitioners who see comparatively few cases are, however, less liable than surgeons to appreciate the probability of a " gunstock " deformity. In the flexed position of the elbow, moreover, the deviation of the axes of the arm and forearm does not exist; hence in this position a slight displacement of the plane of the articular surface of the humerus is easily overlooked. For these reasons the extended position is the better for general adoption, since the angularity of the unbroken arm is then noticeable, and any interference with the normal deviation is very apparent.

If the sentiment of the profession was in favor of usually treating these fractures in the extended position there would be very many less deformed arms. A specialist will vary his methods to suit each case; but for general use is needed a rule that will lead the practitioner of average experience and intelligence to get good results in the greatest possible number of cases. The extended position will, I believe, secure this result. By "extended position" I mean that position in which the elbow is extended almost, but not quite, fully. The forearm and hand are to be supine. Complete extension would be exceedingly uncomfortable to the patient, and is not what is meant.

Dr. Lane gave in his paper in the "Transactions" of last year a very interesting account of the views of various surgical authorities on this question.

I have for a number of years used a narrow, light wooden splint, long enough to extend from the upper part of the arm to the wrist, having a divergent angle at the elbow. I usually make this splint out of a thin board at the time of dressing the fracture, using the sound arm as a guide. A little padding of cotton or oakum is laid in the bend of the elbow, to fill the hollow present there, because the joint is not fully extended. This padding is not intended to make pressure on the fragments. In cases where there is too much swelling to permit extension of the arm I apply an anterior obtuse angle splint or a posterior obtuse angle trough for a few days; but I soon change it for the anterior deviating splint above described. This method of treating fractures above the elbow has been fully discussed by me elsewhere.*

In supracondyloid fractures, however, I have employed the flexed position, maintaining it by an anterior right-angle splint or a posterior right-angle trough. The reading and investigation necessitated by the preparation of this paper have, however, caused me to incline towards the adoption of

* "Modern Surgery," Lea Bros. & Co., Philadelphia, 1890. P. 399.

the extended position for supracondyloid as well as condyloid fractures. The relaxation of the triceps so induced seems to me to be desirable, especially as the supination of the forearm and hand relaxes the biceps, one of the main opponents of the triceps. This position, therefore, relaxes two of the strong factors tending to produce the backward displacement, which is so much feared by many in supracondyloid fractures or epiphyseal descriptions.

Allis,* Pilcher,† Verneuil,‡ Gibney, Powers,§ and others are correct when they deprecate zeal in the use of passive motion in fractures about the elbow and other joints. Stimson puts it very ably when he says,‖ "that the anchylophobia of the surgeon is more dangerous to the patient than the traumatism." Orthopedic surgeons give the same evidence in the study of the collateral topic of rest in joint diseases. Phelps ¶ has seen normal joints immobilized for ten, twelve and eighteen months without anchylosis occurring in either the normal or the inflamed articulations. Experimental study on dogs has shown the same fact.

In 1885 I stated in an article on "False Doctrine in the Treatment of Fractures" ** that passive motion need not be commenced until union of a fracture is pretty well accomplished. My belief is that it may be best for some practitioners to delay it until union has occurred and the retaining dressings have been finally removed. If begun earlier it may be harmful by giving pain, causing arthritis, or displacing the fragments. Massage and very slight movements of the joint, in judicious hands, will hasten restoration of muscular movements and do great good, if begun at the time of

* "Annals of Anatomical and Surgical Society," Brooklyn, August, 1880, p. 306.

† *Idem*, September, 1880, p. 369.

‡ Quoted by Pilcher.

§ *Medical Record*, New York, December 22, 1888.

‖ "Transactions American Surgical Association," 1891, p. 269.

¶ "Proceedings Philadelphia County Medical Society," 1891, p. 439.

** *Journal American Medical Association*, May 30, 1885, p. 589.

fracture and continued daily. This is not what is usually meant by "passive motion" after fractures, and requires skill for its proper use. If the doctor does not feel sure of his ability in this direction, it is better not to move the joint until the union is nearly or quite firm.

It is interesting to note that Dr. L. C. Lane * believes that the flexed position of the elbow during treatment of fractures of the region under consideration is more favorable to anchylosis than the extended; because there is more room for neoplastic deposits in the anterior muscular and fibrous structures, which are plicated during flexion.

Deformity and impaired mobility may at times be improved by refracture or osteotomy done with careful asepsis. Cases for such radical measures must be judiciously chosen.

Correspondence with the Fellows of the American Surgical Association, the Members of the New York Surgical Society, and the Fellows of the Philadelphia Academy of Surgery, shows me that I am correct in the opinion that such uncomplicated fractures of the lower end of the humerus as I am discussing usually recover, if judiciously treated, with little or no deformity and with good motion. My experience, then, is simply corroborative of that of other surgeons.

Letters sent to these surgeons elicited eighty-eight replies:

I.

a. The number who preferred the flexed position in treatment were,	65
b. The number who preferred the extended position in treatment were,	15
c. The number who employed both positions in treatment were,	7
d. The number who gave no definite answer to the query was,	1
Total,	88

* "Transactions American Surgical Association," 1891, p. 413.

II.

a. The number who preferred the flexed position because it was thought to insure better coaptation were, . 37
b. The number who preferred the flexed position because there was a fear of anchylosis were, . . . 18
c. The number who preferred the flexed position because it was more convenient and comfortable for the patient were, ... 6
d. The number who gave no definite reason or answer, . 4

Total, ... 65

III.

a. The number who began passive motion within four weeks were, ... 64
b. The number who began passive motion after four weeks were, ... 7
c. The number who did not use passive motion at all were, ... 15
d. The number who gave no definite answer to the query were, ... 2

Total, ... 88

IV.

a. The number who usually expect to obtain good use of the joint were, ... 80
b. The number who are doubtful about obtaining use of the joint were, ... 8

Total, ... 88

In studying these tables it must be remembered that the manner in which some of the correspondents replied made it a little difficult for me to determine under which heading they

should be classed. I have endeavored to classify the replies correctly by studying the apparent feeling of the writer as well as his phraseology. In some cases several reasons were given for the choice of the flexed position; in these I tabulated the one to which most importance seemed to be attached.

FRACTURES OF THE RADIUS.

It is unfortunate that the name of Colles is still associated with fractures of the base of the radius. Such personal nomenclature is always objectionable; and is especially so here, since Colles placed the seat of lesion at a higher point than that at which fractures of the base of the radius usually occur.

Fractures of the lower end of the radius vary very little in their essential clinical details. The degree of displacement, comminution, or impaction is not always the same; but through all the variations, due to the character and continuance of the vulnerating force, the surgeon sees the same essential lesion, situated at nearly the same point of the bone. The treatment, too, needs little variation, and consists in immediate forcible reduction.

The usual line of fracture is situated at from one-third to three-quarters of an inch above the articular surface of the bone, and is generally more or less transverse in direction, though some tendency to lateral or antero-posterior obliquity is not infrequent. Displacement of the lower fragment backward upon the lower end of the upper fragment is the ordinary deformity, and is due to the fracturing force, not to muscular contraction. Some impaction is not unusual from driving of the dorsal wall of the upper into the cancellated structure of the lower fragment, and actual loss of substance from crushing of the bony tissue is not infrequent. When impaction does not exist, entanglement of the fragments by interlocking of the irregular surfaces is very common. At times there is no displacement; at others it occurs only at the radial, and

not at the ulnar side of the lower fragment, which then is tilted obliquely backward. The styloid process of the radius is carried upward and backward by this displacement, and therefore the radial styloid process is often as high as, or even higher (that is, further from the hand) than, the ulnar styloid process. This angular displacement tends to throw the articular surface with the attached carpus upward, backward, and to the radial side, and produces the peculiar deformity so recognizable. Sometimes the integument over the ulnar head is torn asunder by this radial displacement of the hand, and the ulna may even protrude through the laceration. Such a wound by no means implies an open or compound fracture of the radius, for frequently the wound has no communication with the fractured surfaces.

The fracture just described, with or without comminution of the inferior fragment, is the one usually seen. Associated fracture of the lower end of the ulna, of the ulnar styloid process, or synchronous rupture of the radio-ulnar ligaments; and epiphyseal fracture may, however, occur. Fracture of the lower end of the radius with forward displacement is rather rare.

Fractures identical in pathology and deformity with those found clinically can readily be produced in the surgical laboratory by sudden hyperextension of the hand caused by blows. As there is no opportunity for living muscles to assist in the production or maintenance of deformity here it is reasonable to suppose that muscular action has little influence upon the fracture in patients. The tonic contraction of the muscles of the forearm may be an agent in holding the fragments in their abnormal position, when there is simple entanglement of the rough surfaces without true impaction, and the tendons may similarly cause the normal relations to be maintained after reduction by the surgeon. Further than this, muscular influences are unimportant, if my experience has taught me correctly. The conditions in a transverse fracture

of the base of the radius are very different from those in an oblique fracture of the shaft of this or other long bone surrounded by muscular bellies. The statement * that there is a great tendency to displacement by muscular action after reduction has been accomplished is unconfirmed by clinical observation, unless there be unusual comminution of the lower fragment. When the radius is broken at two and a half inches above the joint, or in the middle third of the shaft, the

FIG. 19.

Deformity in the usual fracture of lower end of radius. Taken from cast made before reduction and treatment.

conditions are probably different; but I am not considering such fractures at this time.

It seems impossible that any surgeon would think of advocating the omission of an immediate or complete reduction of the lower fragment in this fracture in which non-union is practically unknown. Yet, as I have stated in the earlier paragraphs of this communication, M. Després does so. Equally astonishing to me is the advice of Dr. Wyeth † that "in aged patients, who have considerable impaction, it is not advisable to break up the impaction." Mr. Southam ‡ speaks of cases in which the deformity cannot be made to disappear, and another writer § says that the impaction should be undone if possible, implying that impossibility of reduction is not very unusual. About ten years ago I treated a woman of perhaps

* Holmes' "System of Surgery," Am. ed. by Packard, 1881, vol. i., p. 864.

† "Text-Book on Surgery," 1888, p. 296.

‡ Treves' "Manual of Surgery," vol. ii., p. 54.

§ Druitt's "Modern Surgery," edited by Stanley Boyd. Twelth Am. ed., p. 256.

seventy years of age who had fallen from a roof to the ground, breaking both radii with great displacement. My duty would not have been done, in my opinion, if I had not used the same force in overcoming the interlocking of the fragments in this old woman as I would have employed in a young person. She rapidly recovered, with perfect use of wrists and fingers, though distortion at the wrist was marked, because of the probable comminution of the lower fragment and the fact that

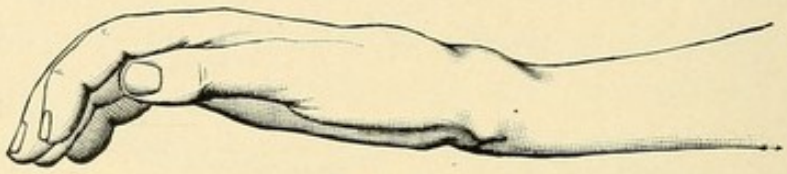

FIG. 20.

Deformity produced by an experimental fracture of the lower end of the radius in a cadaver preserved by zinc chloride. A heavy blow was struck on palm, while hand was fully extended, and forearm vertically placed with elbow on table.

the woman was imbecile and consequently pulled off the splints and dressing.

That reduction is at times impossible may perhaps be true, but I have never seen an instance which the power of my two hands, aided by leverage across my knees, could not reduce under anæsthesia. Reduction is to be accomplished by force, not by *gentle* pressure and manipulation, as some would have us believe. I usually accomplish it by extension and counter-extension applied to hand and forearm, aided by sudden flexion of the wrist with simultaneous pressure on the dorsum of the lower fragment. This maneuver is repeated, if necessary, until I feel no ledge of bone at the seat of fracture, when I carry my forefinger or thumb along the dorsal surface of the lower third of the radius. The reduction is so quickly done that anæsthesia is generally omitted. In recent cases this manipulation is generally sufficient, but in unreduced cases of several weeks' duration, and sometimes in recent cases, I have been obliged to bend the limb over my knee so as to break up

the connection between the misplaced fragments. Very firm impaction, entanglement of the fragments in the tendons, or dorsal periosteal bands may require the surgeon to bend the hand and attached lower fragment strongly backward, in order to release the interlocking, before making traction, flexion and pressure. This manipulation is, however, seldom necessary.

It has been asserted that the long supinator or square pronator opposes reduction of the deformity; this is undoubtedly a fallacy in so far as real obstacle is offered by these muscles. Mr. Howard Marsh * makes this extraordinary statement: "Should reduction not be accomplished on the first trial, the attempt should be repeated a week later, when the fragments may have become somewhat loosened on each other, and when, swelling having subsided, manipulation can be more accurately directed."

Dr. John Ashhurst in a publication issued several years ago † makes statements equally misleading and, in my opinion, exceedingly dangerous. The deservedly high reputation of Professor Ashhurst will cause many practitioners to follow his words implicitly. The result will, I fear, be the production of many unnecessarily stiff wrists and fingers after fracture of the base of the radius. He says, "The important part of the treatment is, of course, to keep the fragments in their proper position. If you bear in mind the mode in which the fracture occurs, you can at once see how the compresses which we use should be applied to counteract the deformity." Two compresses, a dorsal and a palmar, and a Bond's splint, are used by Dr. Ashhurst, who continues, "When the compresses are brought together, the bones are necessarily pushed into position. Even if you cannot accomplish this at once, you will find that, by careful dressing, in a few days the deformity will disappear."

* Heath's "Dictionary of Practical Surgery," vol. ii., p. 293.

† "International Clinics," vol. i., p. 201, Philadelphia, 1892.

It is possible that this method of dealing with a fracture of the lower end of the radius might be admissible and do well at the hands of this eminent surgeon in the case he was discussing, in which the lower fragment may have been greatly comminuted. I feel very sure, however, that the omission to call attention to the necessity of immediate and complete reduction, as the first step in all these fractures, is a grave error, and that the apparent or intentional direction to rely upon the compresses to overcome the deformity is most unwise.

Further on in his clinical lecture, which was delivered at the University Hospital, Dr. Ashhurst states, "I have seen sloughing occur from the pressure of the compresses when this precaution has not been adopted." The precaution to which he has reference is the use of "lead water and laudanum or some other soothing fomentation," in the early stages of the treatment, or when there has been much bruising. Is it not possible that the sloughing was the result of injurious pressure by the compresses rather than the omission of local fomentation? The use of the latter, as I have previously said, in speaking of fractures of the elbow, is always undesirable and useless.

In a paper * read before the Philadelphia Academy of Surgery nine or ten years ago I mentioned that I had repeatedly been obliged to refracture and reduce fractures of the lower end of the radius after treatment in splints by other physicians. In a series of forty-eight cases reported at that time six cases came to me with the lower fragment still unreduced, though a splint had been applied in each instance. This personal experience can be duplicated, doubtless, by nearly every surgeon who sees many fractures in hospital or consultation practice; and is due to the fact that teachers and text-books do not sufficiently emphasize the necessity for reduction. The profession should be shown that the treatment of fractures of the lower end of the radius is reduction, and *not* a splint, either with or without compresses.

* *Medical News*, December 13, 1890, p. 615.

The ignorance of the true pathology of this fracture was formerly so great that many ridiculous splints have been devised for its treatment. Many were constructed on the theory that the extensor muscles of the thumb were a cause of the deformity; and not a few were employed that failed to recognize the curvature of the palmar surface of the lower portion of the radius. These errors are intelligible and were excusable; but I fail to appreciate the acumen of the authors who still figure these useless antiquities in their text-books or of the surgeons who advocate and use them.

After reduction, the ordinary fracture of the inferior extremity of the radius rarely requires such rigid support as the

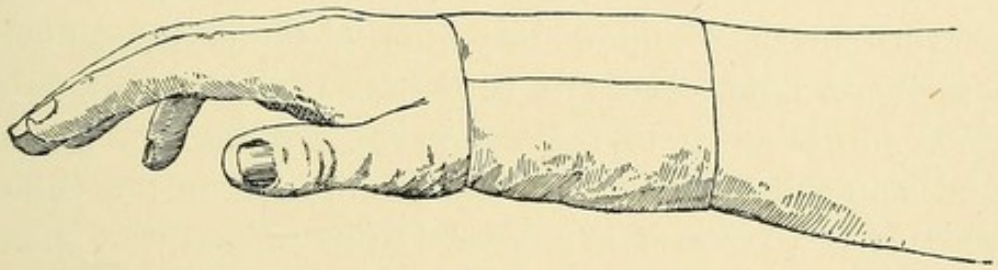

FIG. 21.

Fracture of the lower end of the radius dressed with a wristlet of adhesive plaster.

splint, because the transverse character of the fracture gives a broad, rough surface of contact, and the extensor tendons running over the dorsal surface of the bone act as tense straps to hold down the lower fragment.

If there is much comminution or if the patient is a careless man or a romping boy, it may be wise to use a short and narrow dorsal splint upon the back of the wrist. It may be made of a piece of cigar box, a strip of metal, or consist of two or three whalebones, such as are used in ladies' dress waists. It should only extend from the middle of the metacarpal bones to the junction of the middle and lower thirds of the forearm, being, therefore, about six inches long. Its width need not be over one inch. It can be held in place by adhesive plaster

or a bandage encircling the limb. This dressing should not be employed longer than ten days or two weeks at the most, during all of which time the patient should use his fingers as freely as pain and swelling will permit.

In the great majority of cases this dressing is unnecessary, and a simple roller bandage, or a wristlet made of two or three superimposed strips of rubber adhesive plaster, is all that is required. It makes no difference whether the hand is maintained in the prone or supine position during treatment. The patient holds it first in one and then in the other, varying the position at pleasure. This simple method of treating the fracture gives the patient the necessary freedom in moving his fingers, from the instant the fracture is set, does not prevent his wearing a sleeve, allows inspection of the parts, and is inconspicuous, light, clean and efficient. If the surgeon is unwilling to use either of these forms of dressing, the molded metal splint devised by Levis for application to the palmar aspect of the forearm and hand is the best of the special splints. The arched or curved nature of the palmar surface of the lower third of the radius prohibits a straight splint being applied there; but on the dorsal surface a straight splint may be used.

Passive motion need not be employed in fractures of the lower end of the radius, for the reasons that I have given in speaking of humeral fractures. It is not needed for the wrist joint; and the finger joints are being moved constantly by the patient during the entire treatment, except when pain or swelling makes this impracticable.

When, in ten days or two weeks, sufficient union has occurred for the dressings to be removed, soaking in warm water, friction with liniments, and passive motion are useful to hasten the restoration of function. This is usually very little impaired except in rheumatic subjects, and in cases where great associated injury to the soft parts has occurred.

The dressings employed may usually be discarded in ten

days or two weeks in ordinary cases, and in three or four weeks in comminuted fractures. Long retention of the appliances is unnecessary, and even deleterious when splints are employed, because of the greater tendency to stiffness induced.

In properly treated cases of ordinary severity, perfect use of wrists and fingers is obtained within a few weeks after injury. Patients can often write a little and use the hand for dressing themselves within ten days or two weeks. This facility varies with the amount of comminution and inflammation. Persons of rheumatic or gouty tendencies are probably more liable to stiffness of the fingers and wrist than others. Fractures in other regions present the same complications in such individuals. Much of the rigidity of the wrist and fingers attributed to rheumatic and gouty causes, or to the senility of the patient, I believe to be due to imperfect reduction of the fragments and to unscientific and unwise treatment. I have not recognized the stiffness and rigidity after this fracture in the aged, which some authors mention with emphasis. I expect the same early and perfect freedom of motion in them as in the young, except in so far as the aged are more liable to rheumatism and gout.

It is the opinion of Bryant * that "after this form of fracture the wrist-joint rarely recovers its normal movement." My belief is that after this fracture the wrist-joint usually, if not always, perfectly recovers normal movement, provided that reduction has been complete at the outset of the treatment and the case well managed. Moderate deformity, due to shortening of the radius, alteration in the plane of its articular surface and abnormal prominence of the head of the ulna, is not unusual, but is unimportant if motion is perfect, as it generally is.

Mears † advocates early passive motion, and recommends that after the removal of the splints, at the end of five or six

* "Practice of Surgery," fourth American edition, 1885, p. 880.

† "Practical Surgery," 1885, p. 206.

weeks, the manipulation should be continued to restore function and "remove the rigidity of the articulation which inevitably follows fracture at this point, and enable the patient to regain, to a great degree, if not completely, the function of flexion, extension, supination, and pronation." This seems to indicate his belief that final restoration of motion is possible after a long interval. My experience teaches me that it is usual almost as early as the date at which Dr. Mears discards the splint.

The statement of Stimson * in discussing this topic is, "This rigidity of the fingers is due in part to their prolonged immobilization and in part to inflammation within the sheaths of their tendons in the forearm." This is probably correct and indicates the harmfulness of many methods of treatment in which the fingers are confined for from four to six weeks. Under prognosis, Hamilton † gives the essence of the matter in these words, "In cases treated by myself, where I have exercised great care in reducing the fragments thoroughly, and where the bandages and splints have not been applied too tightly, or kept on too long, deformity to any considerable extent is the exception, and the stiffness is soon dissipated."

If great comminution or crushing has been incidental to the fracture, perfect restoration of the anatomical contour of the wrist may be impossible. Recurrence of deformity may take place after reduction has been well accomplished, if there be unusual comminution of bone and laceration of ligaments. Such cases show preternatural mobility and marked crepitus as symptoms. These cases, and even those of less severity, quite often present, after union and recovery of normal motion, an undue prominence of the ulnar head and a deflection of the hand to the radial side. This deformity is due to

* "Fractures and Dislocations," p. 460.

† "Fractures and Dislocations," edition of 1891, edited by Dr. Stephen Smith, p. 284.

shortening of the radius, the result of imperfect coaptation of fragments, absorption of small particles of the bone separated by crushing, change in the plane of the articular surface of the radius or interference in young patients with the normal growth at the epiphyseal cartilage. This alteration in the anatomical conditions of the lower end of the radius may make it possible for the patient to voluntarily incline or abduct the hand to the radial side very much more than normal.

In March, 1882, I presented to the Philadelphia County Medical Society * several cases of fracture of the lower end of the radius. One was a man of sixty years who, after mounting a high bicycle, had fallen with the machine down a high bank. He fractured the left radius and two ribs. The cure was so perfect that many members of the Society could not tell which had been the broken arm. He was by no means young, but never had any stiffness, such as is attributed by some writers to age. He has, however, to this day much unnatural latitude of motion when he deflects the hand to the radial side as the plaster casts of his forearms and hands show.

When the fragments have not been reduced and vicious union therefore results, the surgeon should, as in malunion of fractures in other regions, resort to refracture. This can be done by bending the limb across the operator's knee, while the patient is under anæsthesia; aided, perhaps, by a hyperextension of the hand and wrist. I have successfully done this as late as eight weeks after injury and have seen it done five and a half months subsequent to the original traumatism. The correction of deformity will not be as perfect as in cases treated properly from the beginning; nor should such good results, as to complete and early mobility of fingers and wrist, be expected. Dr. Richard H. Harte † has reported cases in which he did osteotomy to overcome the vicious union. I am inclined to believe that refracture would have been possible

* "Proceedings 1881–82," p. 159.

† *University Medical Magazine*, 1887.

in his cases, as they were seen early. Osteotomy is undoubtedly the proper treatment when refracture requires force liable to do serious damage to the soft parts. An aseptic or antiseptic osteotomy gives no real risks and allows the surgeon to see the bone and choose the exact line of his osseous incision.

Questions similar to those mentioned in the discussion of fractures of the humerus were sent to the Fellows of the American Surgical Association, the Members of the New York Surgical Society, and the Fellows of the Philadelphia Academy of Surgery.

This correspondence elicited replies from eighty-eight.

I.

a. The number who frequently treat fractures of the lower end of the radius without any form of splint were,	9
b. The number who always use some form of splint were,	78
c. The number who made no definite answer to this particular query was,	1
Total,	88

II.

a. The number who use passive motion within four weeks were,	68
b. The number who use passive motion after four weeks were,	3
c. The number who do not use passive motion at all were,	15
d. The number who made no answer to this query were,	2
Total,	88

III.

a. The number who usually expect to obtain good use of the wrist and fingers were,	69
b. The number who usually expect to obtain good use of the wrist and fingers except in aged, rheumatic or gouty patients, were,	13
c. The number doubtful about obtaining good results were,	4
d. The number who made no definite answer to this query were,	2
Total,	88

The same conditions attach to the compilation of this table as are mentioned after the similar table relative to fracture of the humerus.

XII.

THE IGNORANCE OF SURGEONS REGARDING FRACTURE OF THE LOWER END OF THE RADIUS.

A New York journal published a few months ago an article on fracture of the base of the radius, in which the author, a Professor of Surgery, stated that skiagraphic investigation showed that these fractures of the radius were frequently associated with transverse fracture of the head of the ulna. The statement would perhaps have gained professional acceptance had the author not reproduced the skiagraphs on which his opinion was based, and given the ages of his patients. These details made it evident that the supposed fracture was the skiagraphic picture of the normal unossified epiphyseal cartilage between the shaft and lower end of the ulna.

Some weeks ago I incidentally saw a fracture of the lower end of the radius under the care of a well known surgical teacher and writer. It was being treated with anodyne lotions and a Bond's splint. I stated that in my opinion the fracture was the usual injury with backward displacement of the lower fragment, that it had not been reduced and that it ought to be immediately subjected to sufficiently great force to drive the upper fragment down into position, even if anæsthesia was necessitated for the accomplishment of this essential step. To my profound astonishment the surgeon in charge said that he believed the fragments were partially impacted (to which I fully agreed); that the position was pretty good; and that he preferred to leave such cases alone, since manipulation such as I proposed would probably increase the mobility at the point of fracture; and that a compress over the elevation due to the displacement might per-

haps be judicious. My surprise at these statements can scarcely be expressed. That fractures at the base of the radius must be reduced, if deformity, protracted convalescence, prolonged rigidity of joints, and pain are to be avoided, was, I thought, accepted by every surgeon of the present day. That a compress, applied over the deformity due to impacted and unreduced fragments, was a futile substitute for the muscular force to be exerted on first seeing the injury was, I supposed, recognized by all surgical teachers.

My arguments, supplemented by a diagram giving my idea of the bony conditions present, failed to convince my colleague of the danger of inaction; and, as I had no professional connection with the case, I retired from the room before the splint was reapplied to the unreduced fracture.

These two instances are sufficient evidence that much, that has been learned regarding anatomy, pathology and surgical therapeutics during the last ten or fifteen years, needs constant reiteration in journals, societies and class rooms.

It has been my experience to be obliged to set many fractures of the lower end of the radius, which had previously been put up in splints without reduction of the displacement. This oversight I have found very prevalent among general practitioners, and resident physicians in hospitals. I have attributed the neglect to reduce the fragments by the former class to the teaching of twenty years ago, when the pathology of the lesion was misunderstood; by the latter to insufficient attention to the instructions of their surgical teachers.

Among resident physicians and general practitioners, I never *expect* to see the fracture completely reduced. Some of them, however, do appreciate the supreme importance of immediate and complete reduction and accomplish it; and in other instances the fracture has been attended with little or no displacement and the neglect to reduce the fragments is not demonstrable.

I now have come to feel that perhaps the oversight in re-

cent graduates is due to the fact that their teachers do not insist upon reduction being important; and that undergraduate students do not see this fracture properly treated in the clinical amphitheater and classroom.

These reflections have induced me to present for discussion by the Academy of Surgery the present topic; for I know that much physical suffering will be avoided and the surgical art advanced by having the young graduates, whom the Fellows of this body teach, impressed with the idea that failure to reduce, as soon as possible, a fracture of the base of the radius is an injustice to the patient and an opprobrium of surgery.

In conclusion, I state my position in regard to this fracture in six propositions; and would be glad to have every Fellow do likewise for record in the discussion.

1. Fracture of the lower end of the radius is one of the most satisfactory of all fractures to treat.

2. The patient, as a rule, has little discomfort after the first twenty-four hours, except from the disability and the annoyance of the sling and dressing.

3. Stiffness of the fingers and wrist-joint is seldom present to any marked extent after a week.

4. Deformity is usually so slight as to be unnoticeable to the average observer, except in cases where there has been marked comminution of the lower fragment.

5. These assertions are only justified when the surgeon insists upon forcing the lower fragment into its proper anatomical relation with the upper fragment. This is to be done by the exercise of such a great amount of force as will break up all impaction or entanglement and bring the broken surfaces into accurate coaptation. This sometimes, but not usually, requires general anæsthesia; and may demand that the surgeon bend the broken bone across his knee in order to disentangle the interlocked fragments.

XIII.

DEDUCTIONS FROM FORTY-THREE CASES OF FRACTURE OF THE LOWER END OF THE RADIUS, TREATED WITHIN THREE MONTHS.

Fracture of the lower end of the radius is, in all probability, treated improperly more frequently than fracture of any other part of the skeleton; yet, if treated in a rational manner, it results in a more rapid and better functional cure than any other similar injury.

A large number of otherwise intelligent practitioners, surgeons not excluded, do not understand the mechanism of the fracture, nor the exact cause of the peculiar deformity; hence it is not uncommon to see such fractures woefully mismanaged and the patient subjected to months of unnecessary disability.

The usual cause of the injury is forced extension of the radio-carpal articulation, which produces a transverse fracture of the lower end or base of the radius, about three-eighths or half an inch above the articular surface. The line of break is not always exactly transverse, but for practical purposes, it may be considered transverse.

The characteristic deformity is due to the fracturing force driving the lower or basal fragment upward and backward upon the shaft or the shaft downward and under the basal fragment, so that the basal fragment becomes caught or even impacted upon the dorsal edge of the shaft fragment. Muscular action has little or nothing to do with the production or continuance of the deformity.

In some cases no deformity exists, because the fracturing force was not sufficient to cause displacement; then the diagnosis may rest entirely upon a localized point of great and per-

sistent tenderness, about half an inch above the joint, and the occurrence of a ridge of callus as a later symptom.

In sprains of the wrist the point of tenderness and the swelling due to consequent synovitis, will be half an inch lower than in these fractures without displacement. If the lower fragment is comminuted, as occurs in severe fractures, the characteristic pain and swelling of synovitis will probably be present in addition to the symptoms of fracture. When the fracture shows no deformity, there usually exists no comminution and hence no synovitis, and diagnosis is to be made only by the localized and persistent pain and the subsequent ridge of callus.

The reduction of the fracture is the most important element in the treatment of the injury, and is often ineffectually accomplished, because of the ignorance or carelessness of the attendant. In many cases reduction is not even attempted before the dressings are applied. When reduction has once been thoroughly accomplished, the displacement is not apt to recur, unless the lower fragment be comminuted.

Traction, sudden flexion of the wrist, and direct pressure upon the dorsal aspect of the lower fragment are the proper means of effecting reduction.

Many cases need no splint if the patient is sufficiently intelligent to avoid subjecting the injured bone to sudden strains.

Comminuted fractures, of course, need more support, such as is afforded by splints, than do non-comminuted ones; while fractures without original displacement probably never need the support of a splint.

It is probable that no transverse fracture of the base of the radius ever requires a splint longer than from ten to fourteen days.

Perfect function of the fingers is the rule a very few weeks after the accident, provided that reduction has been promptly and fully effected immediately after the injury, and the treat-

ment such as not to restrain the motion of the fingers during the wearing of the splint.

Slight stiffness of the wrist may be expected to exist for some six weeks after the receipt of injury; and some thickening about the seat of fracture will persist for two or three months.

Permanent shortening of the radius, producing a slight inclination of the hand to the radial side, is to be expected in all cases, but often is detected by very close scrutiny.

The statement of many authorities, that long-persistent disability from stiffness of wrist and fingers may be expected, is I am sure, in the majority of cases, absolutely incorrect, and is due to observation of cases improperly treated.

I have made no reference to methods of treatment, because such teaching is apt to lead to unintelligent practice, whereby a described form of dressing or a delineated splint is applied without the attendant having properly appreciated the character of the injury or having effected reduction. A fracture of the lower end of the radius, once properly reduced, will do better without any professional attention whatsoever, than will one only partially reduced, dressed with the most perfect splint.

In my own practice I use Levis's metal radius splint, applied to the palmar surface, for cases where there is need of a good deal of support. In other cases I use a short steel or wooden splint about six inches in length and a half-inch wide, applied to the dorsum of the wrist by adhesive plaster or a bandage. A piece of corset steel is convenient for the purpose. Cases with no displacement need nothing more than a band of adhesive plaster around the wrist. This is a sufficient splint for many other cases after reduction.

XIV.

NEEDLESSNESS OF SPLINTS IN FRACTURE OF THE LOWER END OF THE RADIUS.

The treatment of fracture of the lower end of the radius is exceedingly satisfactory, because the character of the injury seldom varies and because the results obtained are usually good both in rapidity of cure and in perfect restoration of the function.

This statement is, perhaps, unexpected, since it is not unusual to find the opinion expressed in text-books that this fracture is troublesome to treat and very liable to be followed by deformity of the wrist and stiffness of the fingers. I am convinced that such unfortunate results usually come from mismanagement of the fracture, and are due to a want of appreciation of the nature of the lesion and of the necessity for forcible reduction immediately after its receipt. These errors of judgment and treatment are perpetuated by the current belief that the essential treatment of a fracture is the application of a splint.

I purpose showing that in a great proportion of cases fracture of the lower end of the radius needs no splint; and hence that splints for this injury are usually needless. If the tendency to use a splint impels the practitioner to neglect the all important reduction of the fracture, my position, it seems to me, is strengthened.

The innumerable forms of splint devised for fracture of the lower end of the radius show how much this very common injury has interested the profession. Some of these splints have done great harm because they have misled the practitioner as to the nature of the lesion. A few of them are very good, in

that they have been devised in accordance with the anatomy and pathology of the osseous lesion. As, however, in the vast majority of cases, none of them is really needed they are practically useless. The fact that positive harm is liable to be done by their use is a point in advocacy of the abandonment of all such appliances.

The usual cause of the injury is forced extension of the radio-carpal joint, which produces a transverse disruption through the lower end of the radius from three-eighths to one-half an inch above the articular surface. The characteristic deformity is caused by the fracturing force driving the lower fragment upward and backward upon the shaft, or thrusting the shaft downward and under that fragment, so that it is caught or impacted upon the dorsal edge of the shaft fragment. Occasionally there is a tendency to lateral or antero-posterior obliquity of the line of fracture, but this is quite unimportant. The displacement sometimes occurs much more markedly at the radial than at the ulnar side of the lower fragment, which is then tilted obliquely backward, carrying the styloid process of the radius upward and backward, so that it is on a level with, or even higher than, the styloid process of the ulna. This angular displacement tends to throw the articular surface with the attached carpus upward and backward to the radial side, causing thereby undue prominence of the lower end of the ulna.

Muscular action has nothing to do with the production or the continuance of the deformity. In cases in which the fracturing force has not been sufficient to cause displacement, no deformity exists, and in such instances the diagnosis rests upon a localized point of great tenderness about half an inch above the wrist-joint.

Sometimes comminution of the lower fragment takes place so that lines of fracture enter the radio-carpal joint. The ligaments and cartilages are sometimes extensively injured, and sometimes there occurs actual loss of substance by crush-

ing and pulverizing of the bone tissue. These complications, except that of comminution, are quite rare.

Reduction of the fracture, the most important element in the treatment of the injury, is often ineffectually accomplished, or, indeed, not attempted. This is owing to ignorance rather than carelessness on the part of the attendant. When reduction is once thoroughly accomplished, displacement is not apt to recur, because the broad rough surfaces of bone are held together by their serrations, and because there are no muscular masses tending to displace the fragments.

The condition, it will be observed, is quite different from oblique fracture of the shaft of the bone, in which it is often difficult to maintain accurate apposition because of the muscular displacing forces. Hence if reduction, which is the essential in treatment, is properly performed, no splint is needed. On the other hand, if reduction is neglected, no splint will act as a substitute for it. If reduction has been properly accomplished, an improper splint may displace the lower fragment and cause recurrence of the deformity. Hence, abandonment of splints is often a proper course to pursue.

Comminuted fractures, of course, need more support than non-comminuted ones; but even here, the simple support of a bandage applied in a circular manner or of strips of adhesive plaster wound around the wrist like a collar will usually be found sufficient.

In uncomplicated fractures treatment is required for about three weeks.

Perfect function of the wrist and fingers may be expected in nearly all cases; provided that reduction has been properly effected immediately after the injury, and provided that the fingers have not been restricted in motion at any time during the treatment. Slight stiffness of the wrist may be expected for a few weeks in complicated cases; and in such injuries some thickening about the seat of the fracture will persist

for two or three months. Slight shortening of the radius, due to loss of tissue by crushing and absorption, occurs in most cases, but the resulting inclination of the hand to the radial side in well-treated cases of average severity can usually be detected only by very close scrutiny.

The statement of some authors that long-continued disability of the wrist and fingers is to be expected is, I believe, untrue in the average case of fracture of the lower end of the radius; and is due to observation of cases improperly treated.

The danger of many of the splints advocated for this fracture is due to the non-recognition by their respective inventors of the curved or arched shape of the palmar surface of the lower third of the radius. The dorsum of the bone when covered with the tendons is straight, but the palmar surface is curved. It is readily understood, therefore, that the application of any straight splint (such as that called Bond's splint) to the palmar surface of the broken radius has a tendency to displace the lower fragment upward again, as soon as the bandage which retains the splint in position is applied. A straight splint may, however, be applied with propriety to the back of the wrist. I have used with satisfaction two or three pieces of whalebone held in position by a strip of adhesive plaster. Any rigid article, such as a piece of steel or wood, half an inch wide and five or six inches long, will answer the purpose. The truth is, however, that in a person of ordinary intelligence, who will avoid subjecting the bone to severe strains, there is no need of any rigid splint or support. Exceptions to this rule may perhaps be found in the case of refractory children and of ignorant or stubborn adults. The fact that these persons are liable to use the hand at an early period, and in such a way as to cause a *slight* risk of displacement of the fragments, is evidence of the simplicity and painlessness of the injury and of the satisfactory manner in which union takes place, if reduction has been properly effected.

That the treatment of the fracture is misunderstood by

many practitioners is evident to me from the fact that I have repeatedly been obliged to refracture and reduce partially united fractures of this kind after several weeks' treatment in splints. In a number of instances an exceedingly good splint had been applied though the fracture had not been reduced. A quite recent experience of this kind in which I refractured the bone eight weeks after the injury has forcibly brought the subject to my mind.

Osteotomy, for the purpose of correcting such deformities, is seldom if ever required. I have known a deformed fracture of the radius to be broken for re-adjustment five and a half months after the injury. To do this requires considerable power, but it can generally be accomplished by forcibly bending the bone across the operator's knee.

A few years ago, while holding a position as out-patient surgeon in one of the hospitals of this city, I had occasion to treat, within less than three months, forty-two cases of fracture of the lower end of the radius. Some of these were treated with the molded metal splint recommended by Dr. Levis; others were dressed with a straight dorsal splint of wood; while in some the wrist was immobilized by means of a single strip of steel, or two or three strips of whalebone applied to the dorsum of the joint by means of adhesive plaster encircling the limb. A few were treated during a part of the time by applying to the palmar surface a curved steel strip, such as the " busk-bones " of corsets.

It will be observed that six cases came to me with the lower fragment still unreduced, although in each instance a splint had been applied. In five of these cases Levis' molded splint, the best splint manufactured for this fracture, had been applied. This fact proves my assertion that it is the custom of many to apply a splint, and often a very proper one, without reducing the fracture. It is this belief in the therapeutic value of the splint which causes many physicians to have bad results in the treatment of this fracture. If the

profession were made to understand that no splint can be constructed which will take the place of reduction, better results would be more frequent.

It is interesting to note that all, or nearly all, of the cases tabulated had been originally dressed by the resident physicians belonging to the wards of the hospital. It is also worthy of notice that these residents belonged to a hospital with which at the time were connected two surgeons who have written and done most effective work in teaching the pathology and proper treatment of this particular injury.

The table is instructive, I think, as showing that perfect motion without special deformity was obtained in almost every case. It must be remembered, in addition, that these records were made a few weeks after the receipt of the injury, and that the results, so good at that time, probably became more perfect after the lapse of a longer period.

At the present time I should be inclined in nearly all cases to treat the fracture without using any splint at all; or, at most, I should employ only a thin strip of steel or zinc, or a couple of pieces of whalebone, six inches long, applied to the dorsum of the wrist, and held in place by strips of adhesive plaster.

When the tabulated cases were treated the time during which restrictive dressings were continued was probably less than would be advocated by most surgeons. I have seen no reason to alter my practice in this regard, except perhaps to shorten the time still more. I am now convinced that a roller bandage or a strip of adhesive plaster applied to the wrist in a circular manner is all that is necessary, except in unusually complicated fractures. All ordinary forms of splints should, as a rule, be discarded as useless, needless, or dangerous.

The proper treatment of fracture of the lower end of the radius is reduction. Little else is required in the ordinary cases.

XV.

THE NECESSITY OF FORCE IN THE TREATMENT OF COLLES' FRACTURE OF THE RADIUS.

This paper is presented to call attention to the fact that it usually requires a great deal of force to fully reduce the ordinary fracture of the lower end of the radius. Much has been written on the pathology and treatment of this injury, but sufficient stress has not been laid on the need of force—great force—to fully replace the lower fragment. This fragment is driven backward by the impact of the hand against the ground when the patient falls and sustains the injury. The displacement is nearly always accompanied by entanglement of the two fragments with each other, or by impaction of the dorsal edge of the upper fragment and the cancellated tissue of the lower fragment. Very generally the physician or surgeon who sees the case (and I include the word surgeon advisedly) fails to apply sufficient power, while setting the fracture, to disentangle the pieces of bone, and the backward displacement is not overcome. As a result the so-called silver-fork deformity is only partially corrected or not corrected at all, and the patient has a prolonged convalescence with neuralgic pain, œdema, and stiffening of the fingers. If, on the other hand, the amount of power applied is great enough, the lower fragment will be detached from the upper and driven forward into its place, so as to restore the concavity of the palmar surface of the lower end of the radius and make the dorsal surface practically level. Then there will be little pain or discomfort, and no marked or prolonged œdema or stiffness of the fingers.

It would, perhaps, be well if fractures of the lower end of

the radius were treated by laying the patient's arm flat on the table and, after covering the dorsal surface with a folded towel, striking a good blow on the back of the wrist with a heavy wooden mallet. This would compel the practitioner to employ force enough to drive the lower piece of bone into position, which the average man seems afraid to do with his hands.

These statements are made—in fact this paper has been prepared—because last month I had under my care at the same time two cases in which I was obliged to refracture a united but unreduced Colles' fracture of the radius. One was a woman who had broken the bone six weeks before, and had gone for treatment to the dispensary of one of the largest Philadelphia hospitals; the other was a woman who had been treated for nearly four weeks in the wards of one of the college hospitals of this city. In neither case had the fracture been reduced, and the deformity of the wrist and stiffness of the fingers were such as would be expected under such circumstances. By bending the bone across my knee I ruptured the bone of union, put the fragments in better position, and have had quite satisfactory convalescence.

I do not want to be understood as saying that I advocate a blow from a wooden mallet as the best method of reducing these fractures; but I use the illustration to show that it requires unusual force to accomplish the necessary replacement of the fragments. The physician has the needed strength in his own hands, but ordinarily he does not use it. Sudden flexion of the wrist, with great pressure upon the back of the lower fragment, will nearly always crush the piece of bone into place. This gives great pain, but anæsthesia may be employed if preferred. The setting is done so suddenly that usually no ether is necessary. When the prominence on the back of the arm, caused by the backward displacement of the lower fragment, does not disappear, the effort at reduction must be repeated. On rare occasions it may be well to bend

the hand and lower fragment strongly backward, to disentangle the fragments, before making flexion and pressure to push the basal fragment forward.

As soon as all practitioners adopt these forcible manipulations to set the fracture and abandon the dangerous Bond's splint, little will be heard of unsatisfactory results and long periods of disability in Colles' fracture. The reduction, which is the essential of treatment, is the step usually neglected. A straight splint on the back of the wrist, a molded splint fitting the palmar surface, or a wristlet of adhesive plaster applied around the lower end of the radius is the proper treatment after reduction. The reduction must be accomplished by *force*, except in the few cases where there is no displacement.

XVI.

FRACTURE OF THE LOWER END OF THE RADIUS WITH FORWARD DISPLACEMENT.

My object this evening is not so much to discuss the pathology and treatment of this injury as to show some casts and photographs of the lesion, which I purpose placing in the Mütter Museum, and to exhibit to the Fellows three interesting specimens already belonging to that valuable collection.

A recent study * of this fracture has convinced me that its occurrence is not very rare, and that its recognition is not gen-

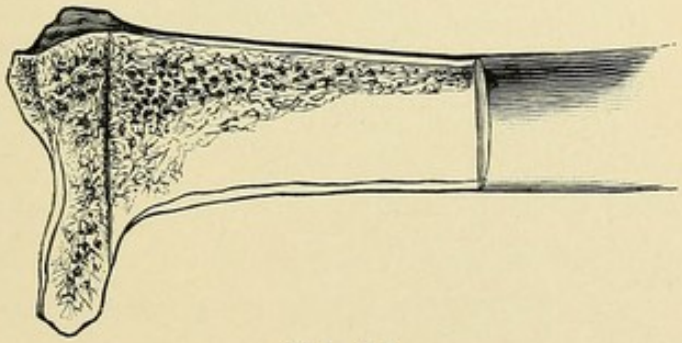

Fig. 22.

Probable Epiphyseal Fracture. (Mütter Museum.)

eral. Within a few years I have seen four cases, all of which had previously been under professional care. Yet in none of them had the deformity been reduced; and in the history of three, if not of all four, it was evident that the true character of the injury had not been suspected.

Well known is the widespread ignorance in the profession of the necessity for *very forcible primary reduction* of the inferior fragment in the usual fracture of the lower end of the radius with backward displacement. It seems as if there

* "Transactions American Surgical Association," 1896.

exists an even greater degree of ignorance or forgetfulness of the possibility of the displacement occasionally being forward instead of backward. If the possibility of such displacement is generally recollected, it must be that the necessity for forcible primary reduction is not appreciated, for in the cases seen by me and in the collection of photographs here exhibited the deformity had not been reduced.

This lesion, sometimes termed "Smith's fracture of the radius," at other times called "Reversed Colles's fracture"

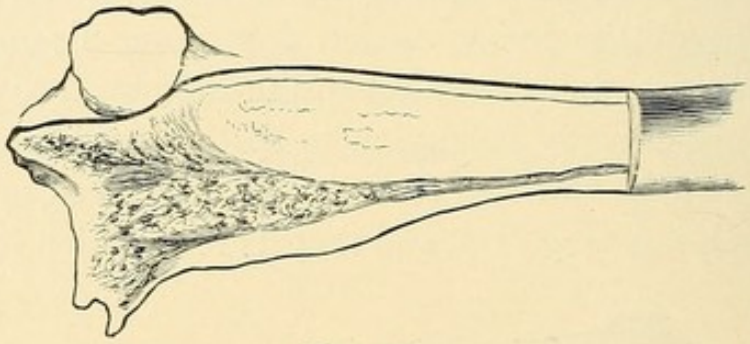

FIG. 23.

Fracture with Probable Stripping up of Periosteum. (Mütter Museum.)

may be produced, if my experimental and clinical studies are correctly interpreted, in three ways:

1. Tearing off of the lower end by a cross-breaking strain exerted through the posterior ligaments during extreme flexion, when the force is applied to the back of the hand in front of the anterior surface of the radius. 2. Crushing of the anterior portion of the bone between the wrist-bones and the shaft, or mutual penetration of the diaphyseal and epiphyseal portions. 3. Rupture of the bony tissue of the weakest point by decomposition of the force to which the limb is subjected. It is possible that there may be at times a combination of more than one method.

In a recent case, treated by my colleague, Dr. M. J. Stern, at the Polyclinic Hospital, the character of which was proved by an immediate skiagraph taken by Dr. Stern, the boy seemed to have received the blow on the palmar surface

FIG. 24.

Skiagraph of Dr. Stern's Case before Reduction.

of the ulnar side of the hand. He was getting upon a horse and fell over on the opposite side of the animal. When examined shortly afterwards the damage done to the skin of the hand by impact on the ground was shown on the palm of the hypothenar eminence and on the ulnar border of the hand. The displacement forwards of the lower fragment and the over-riding of the upper fragment upon its dorsum are beautifully shown in the skiagraph, which Dr. Stern has brought here to-night. Forcible reduction was at once per-

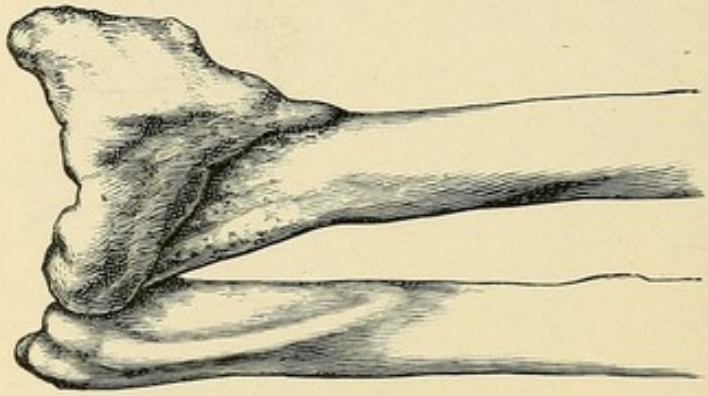

FIG. 25.

Oblique Fracture. (Museum, Trinity College, Dublin.)

formed and the boy now has an excellent arm with little or no deformity.

It can be understood, I think, how such a blow might tend to displace the radial base forward rather than backward. A fall directly upon the whole palm usually tends to forcibly extend the wrist-joint and is one of the methods of producing the classic fracture with backward displacement. This blow coming on the ulnar portion of the hand might readily, it seems to me, drive the lower fragment forward without extending the wrist-joint.

The deformity in this fracture is quite different from that in the ordinary injury with backward displacement. The degree naturally varies with the amount of displacement and the obliquity or transverse character of the line of fracture. It may be almost absent or be very great. Sometimes the dis-

placement is almost entirely forward, at other times it is comparatively slight forward, but very marked in a radial direction. The photographs here shown illustrate these variations very well. The Edinburgh and New York specimens

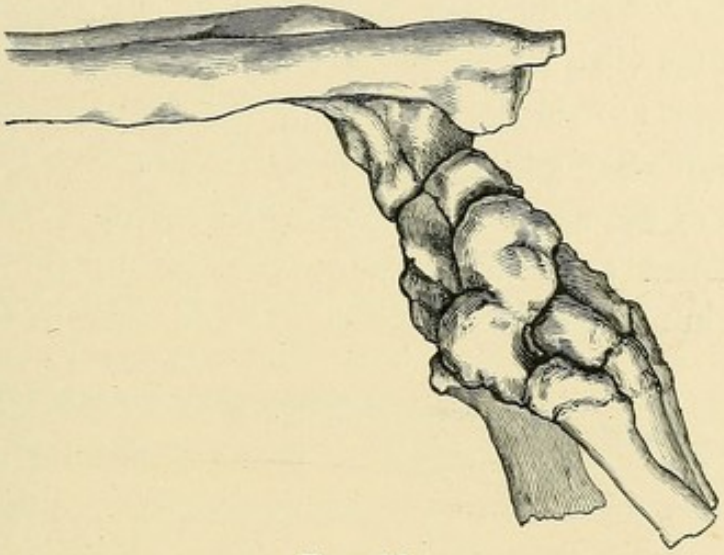

FIG. 26.

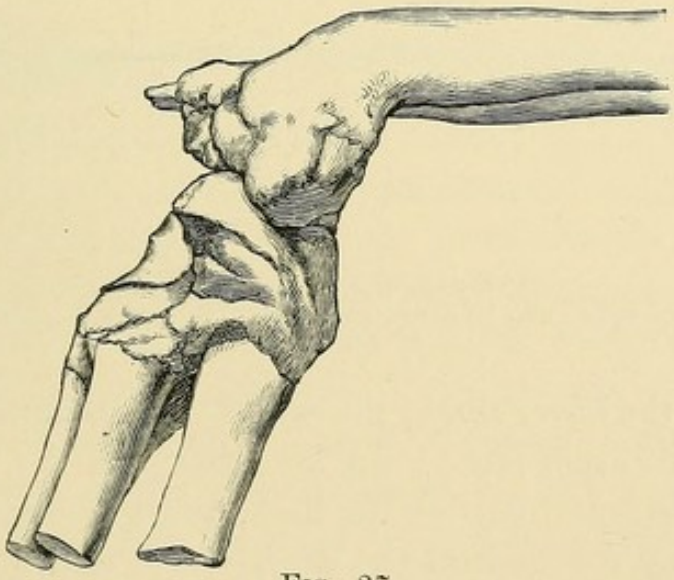

FIG. 27.

Two Views of Fracture with great forward displacement. (Museum Royal College of Surgeons, Edinburgh.)

have marked forward displacement; the specimens from the Royal College of Surgeons in Ireland marked lateral displacement towards the radial aspect of the forearm. The deformity of the forearm and wrist is characteristic in instances where

the carpal fragment is much displaced forward. An elevation is seen across the back of the forearm, running obliquely upward from the ulnar to the radial side. The ulnar portion of this elevation is the more prominent, and is made by the head of the ulna, which was left behind when the carpal fragment of the radius with the attached hand was carried forward by the injury. On the radial side of the limb the elevation is further from the hand and is less prominent. It is due to the lower end of the upper fragment of the radius.

This dorsal prominence is quite different in appearance from the hump on the radial side of the dorsum seen in the

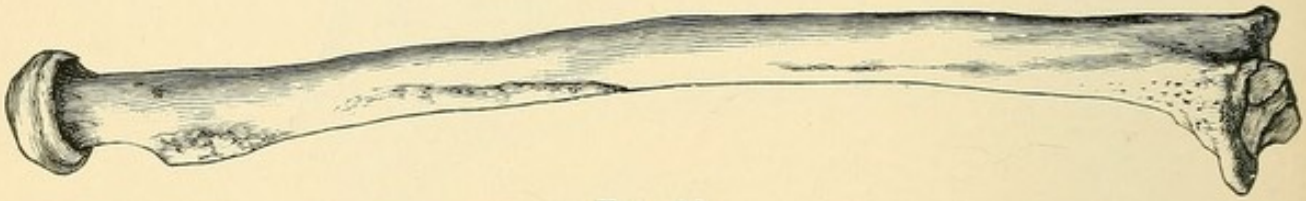

FIG. 28.

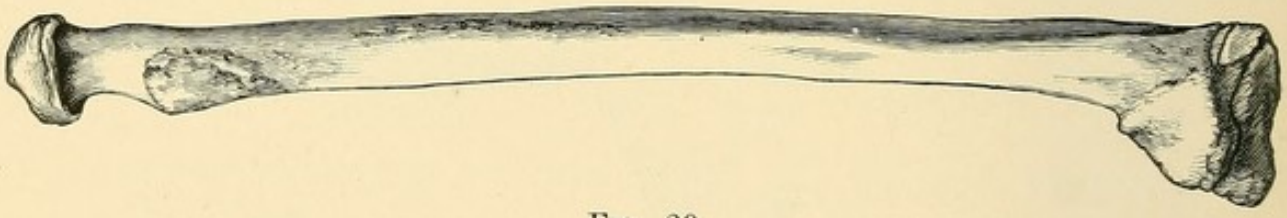

FIG. 29.

Two views of specimen in Museum of St. Thomas's Hospital, London.

fracture of the lower end of the radius with backward displacement of the carpal piece. In the latter case the elevation is great on the radial half of the limb, and the surgeon's finger carried along the back of the shaft of the radius can readily feel the ledge of bone corresponding to the dorsal surface of the lower fragment. The ulna makes little or no prominence on the back of the forearm in the classic fracture, though in both forms it is apt to be prominent on the ulnar edge of the limb, because the outward displacement, common in both instances, carries the hand away from the head of the ulna.

In the fracture under consideration the surface slants down-

ward from the dorsal elevation toward the back of the hand, whose plane is at a lower level than that of the forearm, but more or less parallel to it.

This slant in the surface below the dorsal elevation causes somewhat the appearance of a furrow across the forearm, which is deeper just below the head of the ulna. Pressure with the fingers will make this hollow more evident, and show that the lower end or base of the radius occupies a position more anterior than normal. This sulcus is, as the elevation, a little further from the hand on the radial side.

The lower fragment will usually be felt as a hard mass under the flexor tendons, evidently not pertaining to the ulna.

Lateral deviation towards the radial side of the forearm is probably usual. This specimen, from the Mütter Museum, is an extreme example of this lateral deformity due to a crushing or absorption at an oblique line of fracture.

This tendency to lateral displacement causes the radial styloid to ascend towards the elbow in this fracture as in that with backward displacement of the lower fragment.

The treatment is simple if the fracture be only recognized, —immediate and *forcible* reduction to restore the contour of the lower portion of the radius, followed by the application of a molded splint of metal or gypsum to the palmar surface or a straight splint to the dorsum. There is little or no danger of muscular displacement. The displacement is due, as in the classic fracture, to the vulnerating violence, not to muscular action. It is possible that the concave shape of the palmar surface of the lower end of the radius and the great strength of the flexor muscles may sometimes lead to displacement from muscular action. This is practically never present in the common fracture with posterior displacement of the lower fragment. The so-called Bond's splint often injudiciously employed in the classic fracture is equally undesirable here.

XVII.

A CASE OF FRACTURE OF THE LOWER END OF THE RADIUS WITH ANTERIOR DISPLACEMENT OF THE CARPAL FRAGMENT.

This injury is more frequent than is generally supposed. A recent investigation which I made has convinced me of the importance of the lesion. It is possible that a skiagraph of such a fracture may interest other surgeons.

A boy of about twelve years fell from a bicycle, injuring his wrist. He gave the injury no special attention, but at the end of about four weeks applied to Dr. R. Kindig for treatment. By Dr. Kindig he was referred to me because of the unusual deformity. It was evident from the appearance that there had been a fracture of the radius about an inch and a half above the wrist-joint and that the lower fragment was displaced anteriorly. Union was quite firm as would be expected at the end of four weeks. The skiagraph taken before treatment shows the line of fracture, the forward displacement of the carpal fragment, and the callus deposited for the repair of the lesion.

I refractured the bone and put the fragments in proper position. There was a good deal of tendency to reproduction of the displacement, and I was obliged to resort to anterior and posterior straight splints to keep the fragments in proper position. I believe the tendency to repeated displacement was largely due to the fact that the fracture was farther from the wrist than is usual in fracture of the lower end of the radius. As a consequence, muscular action had more influence in producing displacement than is common when the fracture is nearer the joint. At the lower point the broken surfaces are

more extensive because of the greater thickness of the bone, and therefore retain their position better when once adjusted. My ordinary treatment of fractures of the base of the radius

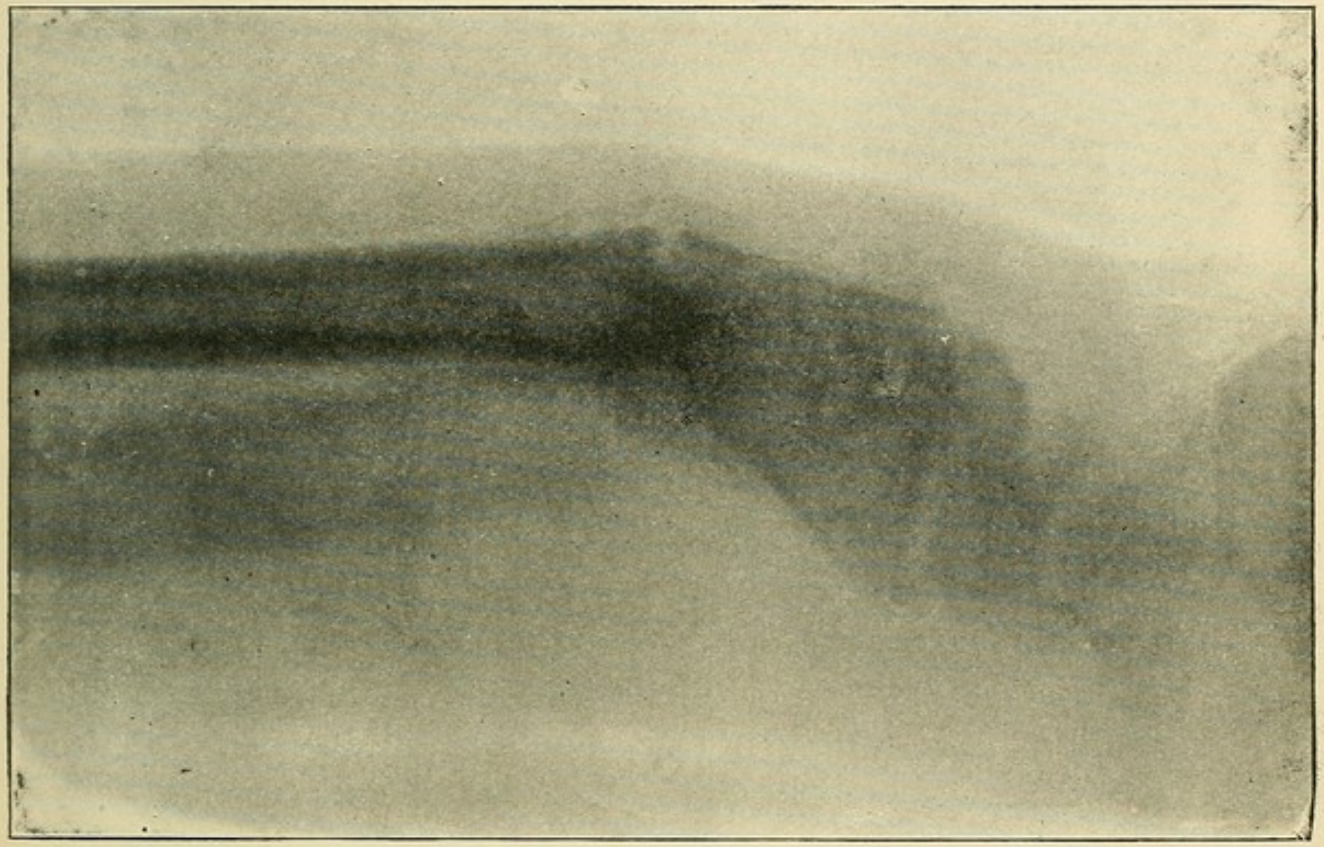

FIG. 30.

Author's Case of Recent Fracture of the Lower End of the Radius with Forward Displacement.

by the metal splint of Levis or by a band of adhesive plaster around the wrist, was not sufficient to keep the fragments properly coapted. The skiagraph was taken with the radial side of the arm against the photographic plate.

XVIII.

FRACTURE OF THE LOWER END OF THE RADIUS WITH DISPLACEMENT OF THE LOWER FRAGMENT FORWARDS.*

This boy of fourteen years presents himself for treatment for pain in the left wrist, which followed shoveling snow. Inspection of the hand and wrist shows an unusual deformity, which consists in deviation of the hand to the radial side and the presence of an elevation on the palmar aspect above the base of the thumb. The boy says that last August a year, which is now eighteen months ago, he fell from a cherry tree and broke his left wrist. He was brought to town and taken to a hospital in the evening of the same day; there he was treated by manipulation of some sort and the application of a wooden splint to the palmar surface of the forearm. He wore the splint for about five weeks. He now has perfect use of the fingers and of the wrist-joint; but has a deformity, which makes it evident that there was a fracture of the radius with displacement of the lower fragment anteriorly, instead of backward as in the usual fracture at this point, and that the present deformity is the result of union with the fragments unreduced.

Careful examination shows that the hand is displaced to the radial side, and thereby causes the head of the ulna to be prominent at the ulnar side of the wrist, though it does not project backward to any special degree. On the palmar surface at the lower end of the radius a mass of bone can be distinctly felt lying beneath the flexor tendons. The edge of this bony mass, which is the carpal fragment, is situated about an inch above the base of the thenar eminence. The bulge

* From the "International Clinics," 1897.

produced by the lower fragment is more clearly shown when the patient makes a fist, because then the flexors of the fingers are contracted and the muscular bellies at the wrist are drawn up the forearm and leave only tendons lying over the bony mass. This makes the outline of the bone more prominent. The lower end of the ulna is not involved in this mass of bone. The radius when grasped by the fingers antero-posteriorly at its lower end is much thicker than that in the normal arm, and the lateral width of the forearm just above the joint is increased. The radial styloid process is about three-eighths of an inch nearer the elbow on the injured side than in the right arm. Deep pressure gives an impression to the fingers

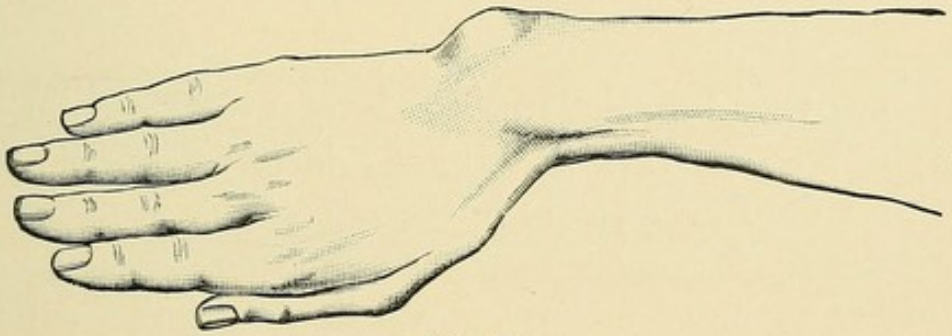

FIG. 31.

Fracture of lower end of radius with forward and lateral displacement of lower fragment; the lateral displacement very marked. (Cast from specimen in Dublin, Ireland.)

that the fracture was oblique, the line running from the ulnar side of the radius upward and outward toward the radial side of the bone. When the palm of the hand is laid flat on a table, the front of the forearm lies closer to the table than in the normal arm. This is due, I think, to the fact that at the time of fracture the carpal fragment was rotated, so as to make the hand abnormally pronated. There is no special increase or diminution in either flexion or extension of the wrist-joint. The boy tells us that this deformity has existed without inconvenience since the time of the accident. I find, however, that he has a little pain in the wrist after using the hand for hard work, and it was this which brought him to the hospital for

treatment. Here is a photograph of a similar fracture in an adult.

This injury is an unusual one and very apt to be overlooked, because the attention of surgeons has not been called to the condition as particularly as it ought to be.

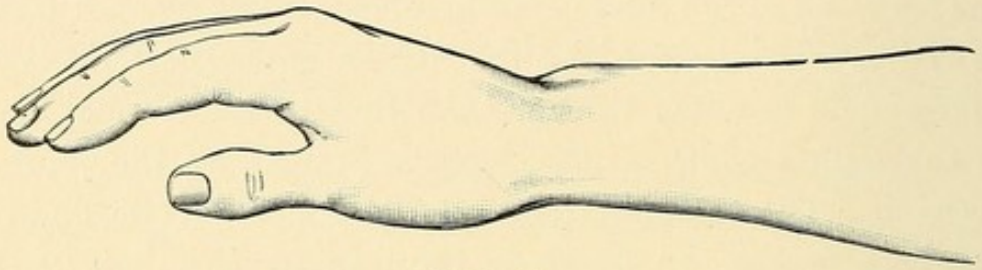

FIG. 32.

Fracture of lower end of radius with moderate forward displacement (radial side).

I showed here a couple of years ago a woman who had sustained this same fracture. It had evidently not been recognized, for the fragments, as in the case of this boy, had not been perfectly reduced. Here is a plaster cast (Figs. 32 and 33) of her hand and forearm, which shows a similar deformity to that exhibited by the boy, except that the hand is not

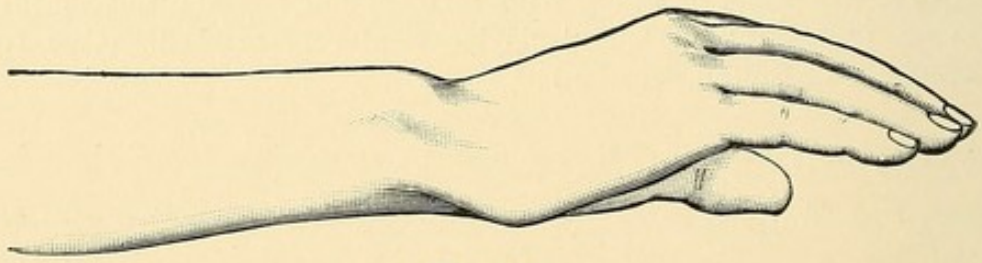

FIG. 33.

Fracture of the lower end of the radius with moderate forward displacement (ulnar side).

deviated much to the radial side. This condition is due to the fact that the fracture was not as oblique as in the patient now before us, and that the displacement forward was very marked. This skiagraph shows the bony changes (Fig. 35).

Very little study has been given to this fracture, and many men of large experience have apparently not seen it. Many

of the text-books refer to the possibility of the injury, but give no cases and refer to no specimens. At the meeting of the American Surgical Association a year ago I called attention to this subject, and in my paper recorded several cases of my own, together with a number collected from surgical literature. At that time I also made quite a search in museums for specimens of this fracture, and was surprised to find how many there were, though nearly all of them had no clinical histories attached to them. They were specimens of the fracture, united with deformity, which had been found in dissecting-rooms (Fig. 27). The illustrations now shown you give an idea of the characteristic appearance of some of these speci-

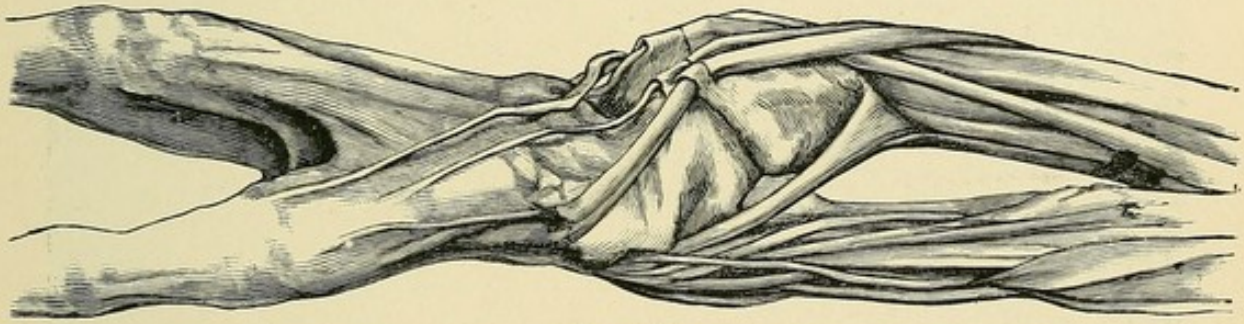

FIG. 34.

Dissected specimen in cabinet of New York hospital showing deformity in radius after fracture with forward displacement.

mens (Fig. 34). R. W. Smith, in his book on "Fractures and Dislocations," published about fifty years ago, calls attention to this injury and gives an illustration of a plaster cast made from such a case.

On account of Smith having called attention to the fracture, it is sometimes denominated "Smith's fracture of the radius." The usual fracture with backward displacement of the lower fragment was especially studied many years ago by Colles, and is often to this day called "Colles's fracture." The injury which you see in this boy is accordingly sometimes called a reversed Colles's fracture. It is interesting to remember that the authors whose names have been attached to these injuries were both Irish surgeons living in Dublin.

There ought to be very little difficulty, I think, in recognizing the injury under consideration if the surgeon only remembers that it is a fracture of possible occurrence. The great frequency of the fracture with backward displacement of the lower fragment gives rise to careless diagnosis when injuries of the radius near the wrist-joint occur. The deformity is quite different, and careful inspection ought to make the nature of the accident apparent (Fig. 25). The

FIG. 35.

Skiagraph showing bend at lower end of radius due to unreduced fracture with forward displacement. The prominence of the head of the ulna at the back of the wrist is well shown.

ordinary fracture of the radial base occurs from blows in which the force of the blow is received on the palm of the hand. It is probably that the opposite displacement is due to the application of force upon the back of the hand tending to strongly flex the wrist. One of the cases of the injury which I have seen occurred in a man who fell while playing football with his hand and wrist doubled under him in a

position of flexion. In the other cases it was not perfectly clear in what manner the force had been applied.

The late Mr. Callender of London reported a case some years ago in which fracture took place from galvanic stimulation of the muscles. In this instance the bone was apparently broken by forced flexion, due to the violent contraction of the flexor muscles when the patient took hold of the handles of the galvanic machine and received the shock.

Some experimental observations which I have made in the anatomical laboratory and a study of the reported cases lead me to believe that the fracture is caused in three ways. Sometimes the lower end of the bone is torn off by a strain exerted through the posterior ligaments during extreme flexion, when the force is applied to the back of the hand. In other cases there may be a crushing of the anterior part of the base of the radius between the wrist-bones and the shaft, so that the lower fragment is forced forward; or the shaft of the bone and the base may be driven into each other by the force of the injury, causing a sort of mutual impaction. In a third series of cases the bony tissue of the radial base may give away at its weakest point by decomposition of the forces to which the bone is subjected.

The symptoms of the lesion will depend somewhat upon the line of fracture, which may be oblique or transverse. There may be a great deal of anterior displacement, as in the woman whose plaster cast is shown you, with very little displacement to the radial side; or there may be, as in the present case, a great deal of displacement to the radial side, due to crushing of the tissue of the base of the radius, with very little anterior displacement. When the lateral displacement is great, the head of the ulna becomes markedly prominent at the ulnar border of the wrist; whereas if the displacement of the lower fragment forward is great, the head of the ulna makes a marked projection on the dorsum of the wrist.

The appearance of the back and front of the wrist is very

different from that which occurs in the ordinary fracture in this region, as will be seen by comparing the casts which I show you: one is a case of an ordinary or classic fracture of the lower end of the radius, the other is the cast of the woman whom I presented at this clinic a couple of years ago. The same thing is evident if you look at this boy's wrist with care, though it is not marked as in the cast of the woman's hand, because, as I have said, the forward displacement is not so great.

Here is an illustration of an experimental fracture in the cadaver which I made for the class here some years ago and

Diagram of Deformity in Fracture with Forward Displacement

Diagram of Deformity in Fracture with Backward Displacement

FIG. 36.

used for illustrating the deformity in the classic fracture with backward displacement. You will see in the fracture with the carpal fragment thrust forward an elevation running across the back of the forearm obliquely upward from the ulnar to the radial side. This elevation is more marked at the ulnar side of the arm, and is due to the lower end or head of the ulna, which is left behind, as it were, when the lower fragment of the radius with the hand attached to it is carried forward by the injury. This eminence on the back is quite different from the elevation on the radial side of the dorsum found in fracture of the lower end of the radius with backward displacement. In that lesion the elevation is greater on the radial half of the forearm, and you can feel with your

finger placed upon the back of the shaft of the radius the elevation corresponding to the dorsal surface of the lower fragment; and the ulna has nothing to do with the prominence on the back of the forearm.

In the fracture under consideration, the posterior surface of the forearm and wrist shows three planes, as it were,—the plane of the back of the forearm, followed by a second plane descending downward towards the back of the hand; and then the plane of the back of the hand, which is at a lower level than that of the forearm, but more or less parallel to it. This causes a sort of furrow below the dorsal elevation; but the dorsal elevation is not raised above the general level of the back of the forearm. It is caused by the lower fragment being thrust forward and leaving an abrupt termination to the plane of the back of the forearm. Pressure will make the hollow more evident, and show that the base of the radius is farther front than normal. In the classic fracture, however, the plane of the back of the forearm is altered by a mound or hump near the wrist-joint, and from the top of this elevation there descends a plane corresponding with the back of the hand. The rude diagram which I make on the blackboard shows you the difference between the two injuries (Fig. 36).

On the palmar surface of this boy's wrist you see a prominence which is quite different from that produced by the lower end of the upper fragment in the classic fracture. The former is nearer the wrist than the latter, and has its edge directed upward instead of downward towards the hand, as in the case when the prominence is due to the lower end of the upper fragment as it is in the usual fracture. In this boy the position of the lower fragment is, as I have previously told you, well shown when the boy contracts the flexor muscles in bending his fingers, because the muscular bellies are then drawn upward and the tendons made more tense over the fragment.

The normal curve of the anterior surface of the radius at

its lower end disappears when the fragment attached to the carpus is thrown forward. There may, however, be made by this displacement a more marked cavity than usual in the normal bone, but it is farther away from the hand. The change in the length of the radius due to the shortening of the bone, caused by the impaction or crushing of the spongy tissue of the base or the displacement, makes the styloid process of the radius to be nearer the elbow than normal. This, of course, occurs also in fractures of the lower end of the

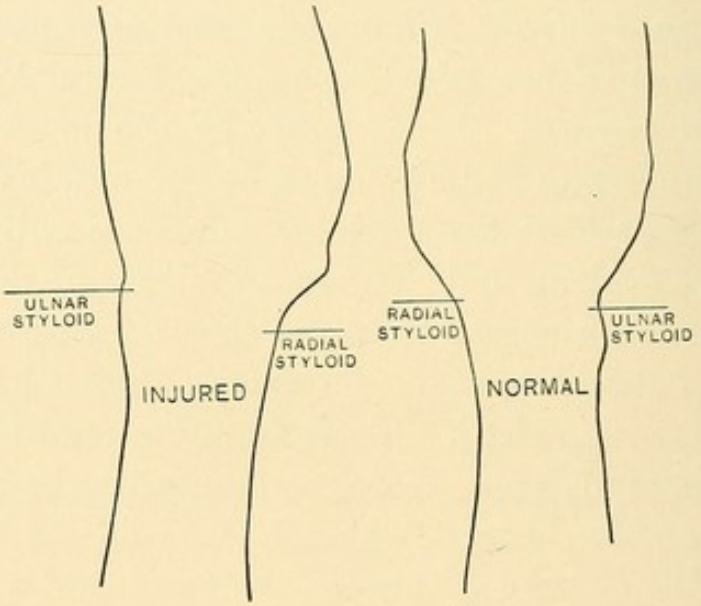

FIG. 37.

Outlines of both hands and wrists, showing on the left the elevation of the radial styloid and increased width of the wrist due to fracture. Taken with the palm laid on the paper and outlines traced with a pencil.

radius with backward displacement. Normally, as you know, the styloid process of the radius is farther from the elbow than that of the ulna. You will notice in this boy's hand that there is an elevation—that is, a displacement toward the elbow—of the ulnar styloid of about three-eighths of an inch. You can estimate this quite well by placing both hands of the patient upon a piece of paper laid upon the table, with the palmar surface next the paper (Fig. 37). If you make an outline of the hand and wrist with a pen-

cil and then drop a perpendicular line from the styloid processes by means of a rule laid against them, you can mark their position on the rude outline which you have drawn. I show you this in the diagrams on this paper. An increase in abduction is also permitted after fractures of the radial base, due to the change in the plane of the articular surface caused by the displacement. This occurs in fractures with forward displacement as well as in those with backward displacement.

The differential diagnosis between fractures of this sort and dislocation of the wrist is to be made by a study of the deformity and the manner in which dislocations are reducible with a distinct snap. This fracture, as well as the one with displacement backward, looks somewhat like a dislocation, and requires considerable force to push the fragments into proper position. There is, however, a grating sound when the lower fragment is forced into place different from the snap elicited when the dislocation is reduced.

The preternatural mobility and crepitus which are found in most fractures may be absent in this injury, because the fragments are impacted. When the fragments have been put in proper position by the application of considerable force they usually remain in place, because the broad surfaces of contact prevent recurrence of the deformity. This is due to the fact that the fracture takes place through the broadened portion of the bone which constitutes the base.

The treatment of a recent fracture of this sort is immediate and complete reduction of the fragments so as to restore the normal outline of the bone. To do this the surgeon should grasp the metacarpus of the patient with one hand and the lower part of the forearm with the other hand, and make strong pressure with his thumb on the carpal fragment so as to force it into proper position in relation to the shaft. It is well to have the patient's hand with the palm upward, so that the surgeon's thumb can be readily placed upon the lower fragment just above the ball of the patient's thumb.

Traction and counter-traction with sudden extension of the hand backward at the wrist with pressure on the lower fragment will usually reduce the fracture. A light splint of wood an inch wide and six inches long applied along the back

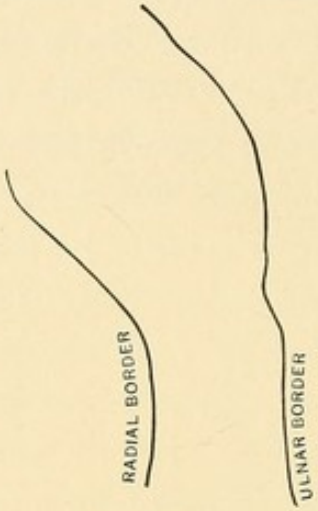

FIG. 38.

Outline of normal hand and wrist in full abduction. Taken with palm on paper.

of the wrist so as to prevent motion at the wrist-joint makes a very satisfactory retentive dressing. If the surgeon prefer he may apply a molded metal splint, or a splint made of plaster of Paris, to the palmar aspect of the forearm and hand. This splint must, of course, correspond with the normal curvature of the lower portion of the radius on its palmar surface. If there is not much tendency to displacement and the patient can be relied upon to put no strain upon the hand and wrist, a rigid splint may be dispensed with, and the motions of the joint be restricted by a simple wristlet or band of adhesive plaster applied around the wrist-joint, in the manner which I have so often shown you in the treatment of the ordinary fracture of the lower end of the radius.

In the present case no treatment is indicated, for the boy has perfect motion and is not particularly annoyed by the deformity due to non-reduction of the fracture at the time of the accident. Osteotomy could be done, but the result would

probably give him no better use of the hand; and the slight improvement in position would scarcely be valuable enough to justify the operation. The slight pain he feels when he uses the hand in heavy work is probably due to the disad-

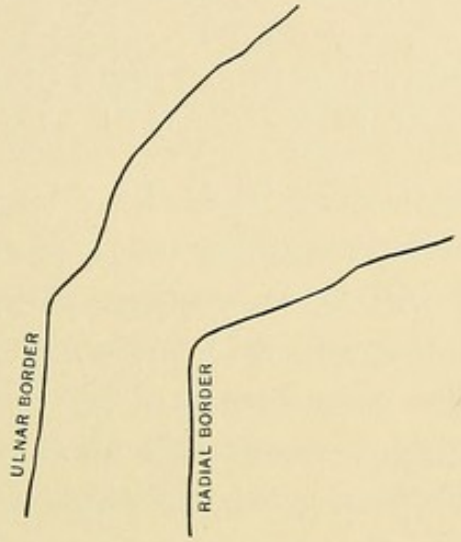

FIG. 39.

Outline of injured hand and wrist in full abduction. Taken with palm on paper. The great increase in abduction due to change in lower end of radius is evident when this diagram is compared with its companion.

vantageous manner in which the muscles act on account of the abnormality in the shape of the bone.

XIX.

THE TREATMENT OF FRACTURES OF THE LOWER PART OF THE TIBIA AND FIBULA.*

WITHIN the last few days there have been admitted to the hospital a considerable number of fractures of the lower extremity, and it will be interesting, perhaps, to show you some of them, as they illustrate several classes of fractures in this region. The cases presented are good illustrations of the forms of fracture of one or other bone of the leg. In two of them the lower portion of the fibula is broken with no injury to the tibia. One is an open or compound fracture of both bones due to the passage of a heavy cart across the front of the leg. The others are closed or so-called simple fractures in the ankle region, interesting because there is a marked tendency to displacement. The fifth patient is a woman whom you saw a few days ago operated upon because of the great displacement of the fragments due to contraction of the muscles of the calf. In her case the fracture involved the lower end of the fibula and the outer portion of the lower end of the tibia without involving the internal malleolus.

These cases are brought before you to illustrate the various methods which are adopted to treat successfully these common injuries. The fibular fractures unaccompanied by fractures of the tibia require very little special treatment, since the tendency to deformity is not great. I generally keep them in an ordinary fracture box or tied up in a pillow without a fracture box for two or three days and then apply an ambulant splint of plaster of Paris and discharge the patient on crutches. They are permitted to dispense with the

* From the "International Clinics," 1897.

crutches and walk on the splint with the support of a cane in a very few days. One of these cases, you see, has the ambulant splint already applied, and is now a dispensary patient. In applying the ambulant splint of plaster of Paris it is important to make it strong enough to bear the weight of the patient in walking. Hence you must have the upper part of the splint applied to the head of the tibia and the condyles of the femur in such a way that the patient's weight comes upon the plaster of Paris at its upper portion and is supported by the stiff splint which extends below the sole of the foot. In this manner the foot and leg hang as it were inside the splint, which acts a good deal as does an artificial leg within which the stump is placed. In order to prevent the weight coming upon the fragments when the patient walks, an ambulant splint should be applied with a considerable amount of cotton put under the sole of the foot. This makes the splint a little longer than the patient's limb and allows the injured bones to be saved from contact with the sole of the splint during walking.

Fractures of both tibia and fibula near the ankle are frequent and often serious injuries. Both bones may be broken without any complication or there may be a good deal of comminution, with fracture of one or both malleoli. The lower end of the tibia is seldom broken without the fibula being similarly injured, though the fracture of the smaller bone will probably be at a higher level. The woman before you had such a fracture, due to a fall which probably caused great eversion of the foot. The fibula was broken an inch or so above the malleolus, and the outer portion of the tibia split off by a line of fracture running from the interior of the ankle-joint upward and outward and obliquely backward. There was no fracture of the malleolus. The obliquity of the line of fracture and the impact of the blow which caused the injury drove the foot outward, causing great eversion and nearly thrust the tibial malleolus through the skin on the

inner side of the ankle. We have attempted to keep the fragments in place by putting the limb in a fracture-box and trying proper padding. It is impossible, however, to reduce the fracture, because of the obliquity of the fracture permitting the calf-muscles to cause overriding and backward displacement, as well as lateral deformity. The deformity can be best corrected, in my opinion, by subcutaneous section of the tendo Achillis, as in the case operated upon a few days ago. This will relieve the muscular tension that displaces the lower fragment. The woman some time ago received a similar fracture of the other leg, and I show you how greatly it is now deformed because the fragments were never properly reduced. You see how markedly the heel projects backward, and how the internal malleolus projects at the inner side of the leg because of the manner in which the foot was allowed to remain in the abnormal position caused by the fracture. This deformity makes her lame. It is curious that the woman should now have received a similar fracture of the other leg. I shall, therefore, have the tendon cut by the resident surgeon; and, now that he has done it, you see how easy it is to put the foot in the proper position and reduce the deformity at the seat of fracture.

The other woman had this operation done upon her a few days ago, and has, as you see, a perfectly symmetrical pair of feet and ankles.

The tenotomy wound is closed with a little gauze held in place by collodion, and a plaster of Paris dressing is now applied from the toes to a short distance above the knee. This puts the parts at rest, and there is no tendency for displacement to occur. The tendo Achillis will soon unite and her muscular power will be as great as ever. This method of treating this fracture is a very valuable one, which is often forgotten or overlooked. Its value I have frequently proved to my own satisfaction.

It is interesting that two patients with a similar injury

should be admitted within a few days of each other, and it is especially interesting that the patient just operated upon should show the result of a similar lesion of the other leg improperly treated.

This man has a fracture of both tibia and fibula, a short distance above the ankle, in which there is a great tendency for the lower fragment to project forward. He was treated for a few days in a fracture box which was suspended from a gallows erected over the bed. The fracture box is a convenient method of dressing fractures of the tibia and fibula, since the degree of pressure and the position of the padding can be changed in accordance with the tendency to displacement and the amount of swelling. It is always better to suspend a fracture box, because then the patient can move about in bed without displacing the fracture. The height at which the box is suspended is easily altered by having a slide of some sort upon the suspending rope. It often rests the patient very much to have the fracture box lowered or raised, since this enables him to bend his knee at a different angle, and therefore gives relief from the cramped position necessitated if the fracture box is lying upon the bed. You have seen in the wards how easy it is for a patient, with a fractured leg thus suspended in a fracture box, to move his hips about from one portion of the bed to the other, and with what ease the nurses can use the bedpan or change the sheets. After this fracture was treated by a fracture box for a few days the regular plaster of Paris splint was applied and cut down the front as soon as it was hardened. We accomplish this by laying a long strip or tape of lead upon the front of the leg before the plaster of Paris bandage is applied. As soon as the plaster is hard a sharp knife is used to divide the plaster over the lead strip, which prevents the point of the knife cutting the patient. The lead is so soft that the point of the knife is not damaged. The splint was opened, as stated, and has been repeatedly removed and reapplied so that the pro-

jection forward of the lower fragment could be watched and corrected.

By elevating the heel, by putting cotton into the splint at the place where the heel is to rest, the resident surgeon has been able to overcome the tendency to displacement. A permanent plaster of Paris splint will now be applied and will not be cut, since the bones have shown a tendency to remain in proper position. Before applying a plaster of Paris bandage it is well to cover the limb with a bandage of flannel or lint, which prevents the skin being made uncomfortable by the plaster of Paris becoming entangled in the hairs or from undue pressure. A very nice method of accomplishing this is to use a long stocking, such as is worn by women, which can be drawn over the leg, and fits more neatly and smoothly than any other bandage. A plaster of Paris splint is then made of the stocking.

I seldom use fracture boxes for more than a few days, since the plaster of Paris splints, or, indeed, any plastic splints, are much lighter, and are more convenient when the swelling has diminished and the tendency to displacement has been relieved.

An ambulant splint is hardly proper for this patient, because there has been such a marked tendency to overriding. In a few days, however, he can get out of bed and go on crutches, if he is careful not to put the foot to the ground. In other words, he can be allowed to walk about with crutches, but not with a cane. I fear that the ambulant splint would be likely to promote displacement. The advantages of having patients with fracture of the leg out of bed early are the improved circulation of the parts, which is gained by a normal position of the limb, and the shortening of the period of confinement to the bed, which interferes with the occupation of the patient and his comfort.

The last case is one of open fracture of the tibia and fibula, due to the passage of a wagon-wheel over the limb. Such

fractures are infected, and are much more serious than closed fractures. The word "compound," which is applied to open fractures, is an unsatisfactory term, since it does not explain its own meaning. The term "simple," applied to fractures not exposed to the air by a wound, is equally unscientific and objectionable. To call one an "open" and the other a "closed" fracture at once signifies the condition present. It is difficult to get rid of the terms "simple" and "compound," however, which have been so long used by English-speaking surgeons. Surgeons of other nations do not use these terms.

In order to make this open fracture aseptic I shall etherize the patient, lay open the wound freely, turn out the clots, sterilize the parts with corrosive sublimate solution, wire the fragments together after having drilled a hole through the upper and lower piece of bone. A couple of drainage tubes will be inserted and the wound dressed with sterilized gauze. Over the whole is applied a plaster of Paris splint. This will not be removed unless pain or rise of temperature indicates that the wound at the seat of fracture is not running an aseptic course. In many fractures treated in this way the plaster of Paris splint need not be removed for several weeks. Where there is a great deal of comminution as well as an opening leading to the fracture, as in this case, it is not unlikely that the attempt at sterilization will fail, and that it may be necessary to open the splint, to give exit to pus and to allow thorough and frequent irrigation of the wound. The patient was told before etherization that it was quite possible that the leg would have to be amputated because of the severe crushing injury. It seems, however, that it may be saved, since both the anterior and posterior tibial arteries can be felt beating at the ankle.

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