

section at the top of the splint is then closed with strong linen, or shoemaker's thread; and in order to give it a more regular curve, and to render it smooth, it may be hammered.

Some of the splints which surgeons prepare, in imitation of this general plan, extend too far upon the shoulder, and are liable to be disturbed in the motions of the neck or of the arm. It is only necessary that the splint should embrace the shoulder sufficiently to prevent its sliding down. The splint will now be completed by inclosing it in a loose flannel sack, stitched on the outside. If the arm is swollen and tender, or the skin very delicate, a thin sheet of cotton wadding should be laid between the cover and splint.

The "short" splint made of leather, or gum-shellac cloth—binders' board will answer equally well—carefully trimmed, and covered with flannel cloth, must have sufficient length to extend from the free margin of the axilla to the internal condyle, taking care that it shall not touch either. The purpose of this splint is not to support the fragments, for it is apparent that it cannot extend so high, even, as the point of fracture; but it is solely to protect the delicate skin beneath the arm from the bandages, which are apt to form cords and cause excoriations. In this point of view it is of great importance, and cannot properly be omitted.

The splints being laid upon the arm, and while extension and counter-extension are maintained by assistants, for the purpose of restoring the fragments to position if possible, the surgeon will apply a roller, inclosing the splints, from the elbow to the axillary margins. This roller must be carefully stitched to the covers of both splints. A second roller is then carried from the top of the long splint to the opposite axilla, and by several successive turns the upper end of the splint and the shoulder are completely covered in. This is also to be made fast to the cover of the long splint, by stitches. Finally, a third roller is made to inclose both the body and the lower portion of the arm; and the forearm is secured at a right angle with the arm by a sling, looped under the forearm. It is important that the sling shall not embrace the elbow, since it will, if thus applied, tend to displace the fragments and drive them past each other.

The bandage or roller hitherto applied by surgeons to the hand and forearm, when dressing a broken humerus, is wholly unnecessary and often a source of annoyance. The roller inclosing the arm and splints will seldom give rise to serious congestion or swelling of the forearm and hand unless it is applied too tightly; and when swelling does occur it will be promptly relieved by a few hours' or days' confinement in the horizontal position. The most serious objection, however, to the roller applied to the hand and forearm, is not that it is unnecessary, but that it is, in most cases, injurious. It is exceedingly liable to become disarranged, especially if the patient is permitted to move the arm at the elbow-joint; and in most cases it will be soon found, by its unequal pressure, to cause those congestions and swellings which it was designed to prevent. Perhaps it will be sufficient for me to say that for many years I have rejected this bandage altogether in all fractures of the humerus, and that no harm has ever come of the practice.

It will be readily seen that the first roller performs the most important

function in this dressing. The long outer splint being firm and unyielding, and being supported above by the projection of the head of the humerus, the first roller draws the upper end of the lower fragment outwards, and thus, as far as possible, accomplishes its readjustment. The upper fragment is always beyond our control. The second roller is not of much use, inasmuch as it soon becomes loose; and in any event it can only hold the top of the splint a little more firmly against the head of the humerus. I occasionally omit it. The third roller insures quietude to the arm, in the best position, namely, beside the body.

When the patient is standing or sitting, the forearm needs to be suspended in the sling; but when reclining, the forearm may, if the patient chooses, be extended. If the entire dressing is well stitched it is not much liable to disarrangement, and may be worn two or three weeks at a time without removal; but from time to time, as the swelling subsides or the muscles atrophy, the bandages may need to be tightened by over-stitching, or by supplementary rollers.

I have been thus minute in my description of this dressing, because its value depends upon the care with which the details are carried out; and because, essentially, the same dressing is used by me in all fractures of the humerus occurring through its upper or middle thirds; moreover, I do not wish to be held responsible, in any case, for bad results when dressings are applied in an imperfect or slovenly manner.

If union takes place without overlapping, of course the arm is not maimed by the fracture; but even when the union occurs with considerable overlapping, the usefulness of the arm is seldom impaired.

In case the functions of the arm are seriously impaired in consequence of the displacement of the fragments, and many months or years have elapsed without any improvement, a result which, to say the least, is very uncommon, the surgeon might consider the propriety of surgical interference after the method of Lindner; who cut down and reduced the fracture, with the result of only a partial reduction, with fibrous union, but it is added, that the functions of the arm were restored. It is my opinion, however, that the discreet surgeon will not find satisfactory reasons for such a procedure.¹

§ 5. Shaft, below the Surgical Neck and above the Base of the Condyles.

Causes.—In a record of 36 cases in which the cause of the fracture is stated, I find this portion of the shaft broken from direct violence 21 times; from indirect blows, the concussion being received upon the elbow, 9 times; twice it was a consequence of tertiary lues, once it occurred during birth, and three times in the same patient it has been broken from muscular action alone, each consecutive fracture occurring at a different point. The records of surgery furnish many examples of fracture of the shaft of the humerus from muscular action, as in throwing a stone or snowball; but the most singular examples are those in which the bone has been broken in a trial of strength between two persons, by grasping the hands palm to palm, with the elbows resting

¹ Lindner, *Centralblatt für Chir.*, 1881, April 16.

upon a table, and twisting, when the humerus has suddenly given way a little above the condyles. This practice is called by the French "*tourner poignet*," the game of turning wrists. I have seen one case of this kind, which was under the care of Dr. Winne, and Malgaigne has collected five other similar cases, two of which were reported by Lonsdale. In *L'Union Médicale* is reported an example in which the fracture occurred on a level with the insertion of the deltoid, a little below the insertion of the pectoralis major and latissimus dorsi. The fracture seemed to be nearly transverse.¹ A case is also mentioned in the *Canada Med. and Surg. Journ.*, 1875, the fracture occurring at about the same point.

The example of fracture during birth, to which I have referred occurred in a healthy female child, whose parents were also healthy. The mother was in labor six or eight hours, but the labor was not severe. She was attended by a midwife, and does not know whether violence was employed or not. Dr. Lockwood, of Buffalo, was called on the third day, and found the arm broken a little below its middle, and moving as freely as it did at the elbow-joint; he applied lateral splints with bandages, etc. I saw the child with Dr. Lockwood on the seventeenth day after its birth. There was then a perfect ferrule of ensheathing callus surrounding the fragments, and which, owing to the softness of the flesh, could be easily detected and defined. The fragments had been firm at least three or four days. Nearly a year after, I again examined the arm, and could not discover any traces of the accident.

Dr. Löwenhardt has also reported a case in which the evidence was conclusive that the fracture was caused solely by the contractions of the uterus, which forced the arm against the pubes; the arm being heard distinctly to snap when it was passing this point and while the hands of the accoucheur were not aiding in the delivery. In this case the humerus was broken in its upper third.²

Dr. N. Fanning, of Catskill, N. Y., has reported to me the following as having occurred in his own practice:

"Mrs. H., of Catskill, was delivered June 8, 1865, after a short and not severe labor, of a full-grown and healthy male child. The mother was well formed, with ample pelvis. The labor was natural, and the presentation the most favorable, the occiput corresponding to the left acetabulum; but immediately after the delivery of the head, a hand and a portion of the forearm of the child were felt above the pubes. The shoulders and body were delivered very quickly after the head, and during a single pain. Just as the right shoulder of the child was passing under the arch of the pubes, I heard a snap, not unlike that caused by the breaking of a pipe-stem, which I soon found, as I suspected, to be caused by the fracture of the right os humeri of the child in its upper third." The bone united with some deformity.

Dr. Fanning is of the opinion that, in this case, the contraction of the uterus, occurring while the arm of the child occupied some unusual

¹ Amer. Med. Times, vol. iv. p. 153.

² Löwenhardt, American Journal of the Medical Sciences, January, 1841, p. 250, from Medicin. Zeit., Mai 6, 1840.

position, was the cause of the fracture. It was certainly not due to any force applied by Dr. Fanning himself.

Seat and Direction of the Fracture.—The seat of the fracture is more often below than above the middle of the bone; thus, I have found the fracture fourteen times near the middle, and the same number of times below the middle third, but only seven times above the middle third. The observations of Norris, who found four fractures of the shaft above the middle, and nine below, correspond with my own;¹ but M. Guéretin, in the same number of fractures, found nine above the middle and four below.²

The line of fracture is generally oblique, but more often transverse than in fractures of the clavicle, femur, or tibia.

Displacement.—The direction of the displacement depends, no doubt, sometimes upon the precise point of the fracture and upon the action of the muscles operating upon the two fragments; thus, if the fracture takes place just above the insertion of the deltoid, the lower fragment is liable to be drawn upwards and outwards, in the direction of its fibres, while the upper fragment is carried toward the origin of the pectoralis major, etc.; but, in a great majority of cases, the influence of these muscles is more than counterbalanced by the direction of the force, and by the direction of the fracture. Practically, therefore, it is seldom of much importance to determine the exact point of fracture, as to whether it is just above or below the insertion of a particular muscle; nor, indeed, is it generally very easy to ascertain this point with much precision.

The amount of displacement varies considerably in different persons and in fractures at different points, but it will average about three-quarters of an inch. When the fracture is produced by muscular action alone, it is generally transverse, and displacement seldom occurs. Such was the fact in every instance where my own patient broke the arm three times consecutively at different points; and union was speedily accomplished, and with no deformity. Dupuytren, however, saw a case which constituted an exception to this general rule. The fragments became completely separated, and were so movable that union could not be effected, and he was compelled, after three months, to resort to resection.

The average shortening after these fractures, exclusive of those which do not shorten at all, seems to be about half an inch; but a considerable number are never displaced, as the fractures are so nearly transverse that they are easily reduced and maintained in place, and consequently the total average of shortening is probably less than half an inch; in a few cases it is much greater. Practically, the shortening is a matter of no importance. In the case of Margaret O'Brian, admitted to my ward, Bellevue Hospital, April 9, 1878, with a fracture of the humerus, near its middle, and treated with my splint, the fragments being united, the broken arm was found to be half an inch longer than the other.

I have met with a number of examples of delayed and of fibrous union of this bone after a fracture (exclusive of gunshot fractures). In the first example of a complete failure the fracture was in the lower third of the shaft, oblique and compound, and no union had taken place at the end of five months. The man was intemperate, but in pretty good

¹ Norris, Am. Journ. of Med. Sci., January, 1842, vol. xix. p. 28.

² Guéretin, Presse Médicale, vol. i. p. 45.

health.¹ In the second case, the fracture had occurred a little below the middle of the bone, and it was simple. Five months after the accident this patient consulted me, when I found the elbow ankylosed, the forearm being fixed at a right angle with the arm.² Neither of these patients had been under my care previously, but I learned that an intelligent Canadian surgeon had treated one of them, and the other had been seen and treated by several surgeons.

In the third case, a lad, five years of age, received a fracture about three or four inches above the elbow-joint, by the passage across the limb of a heavy army wagon. The arm was dressed with splints, and in about five weeks several fragments of necrosed bone were removed by Dr. Pope, of St. Louis, and the splints were again applied. Ten months from the date of the injury, Dr. Brinton, of Philadelphia, operated by perforation, and reapplied splints. When the splints were removed, the limb was straight and apparently firm, but the bond of union gradually gave way, and when he came under my charge in November, 1864, more than two years after the accident, the arm was bent at an angle of 45°, and the union was fibrous only. Under my advice all restraint and dressings were removed, and he was sent into the country to improve his general health, with the understanding that I would operate at some future day. Subsequently, on the 14th of April, 1867, I resected the bone at the seat of fracture, securing the fragments with wire, and supporting the arm with a gutta-percha splint. The result was a perfect bony union, and very useful arm.

The fourth case is briefly as follows: Charles Cunz, æt. about 35, broke his right arm a little below its middle, Oct. 29, 1876. He was placed under the care of an excellent physician, but, for some reason not satisfactorily explained, the fragments united only by fibrous tissue. March 25, 1877, five months after the fracture had occurred, I incised to the bone, and with an ordinary steel gimlet transfixed the overlapping fragments. Splints were then applied. The gimlet was permitted to remain six weeks, during which time it became quite loose, and an abscess formed below the wound. At the end of this time the bond of union was quite firm, but the splints were continued six weeks longer. At this date the union remains perfect, the humerus is straight, and the usefulness of his arm is unimpaired.

In a fifth case, that of F. H. Fennell, of Pittston, Pa., æt. 21, the right arm was broken below its middle, a simple fracture; pasteboard and wooden angular splints were employed, but only a fibrous union took place. When he consulted me, eight months after the accident, the fragments remained ununited, and overlapped one inch. He was not prepared to submit to the treatment I proposed, namely, perforation of the fragments, and I have not heard from him since.

Muhlenberg, in his tables of delayed union and ununited fractures of long bones, including 656 cases, has recorded 219 of the humerus: of 13 treated by manual friction, 4 were cured and 9 failed; of 10 treated by mechanical appliances, 6 were cured, 3 relieved, and 1 failed; of 42 treated by seton, 12 were cured, 24 failed, and 1 died; of 13 treated by immobilization, 5 were cured, 6 failed, and 1 died; of 83 treated by

¹ Report on Deformities, etc., Case 33.

² Ibid., Case 21.

resection, 43 were cured, 31 failed, 6 were relieved, 2 died, and in 1 the result is unknown; of 35 treated by drilling, 21 were cured, 2 were relieved, and 11 failed.

In a few cases the elbow has remained somewhat stiff a long time after the splints were removed; and in one case which was brought to my notice complete freedom of motion was not restored at the end of fifteen years. Generally, however, the motions of the elbow-joint have been very soon restored after the removal of the splints and sling.

I ought to mention that, not unfrequently, fractures of the shaft of the humerus, and especially where they are occasioned by direct blows, are followed by great swelling, and sometimes by abscesses. In one instance, the fracture having taken place within the insertion of the deltoid muscle, the sharp extremity of the lower fragment was made to penetrate the flesh, causing an abscess, and finally tetanus, of which my patient soon died.

Dr. Lee writes to me, under date of Oct. 13, 1876, that a simple fracture of the lower third of the shaft, occurring in a child six years old, terminated in gangrene, and demanded amputation. Two other similar cases have been reported to me. In all of these cases a question arose as to the causes of the gangrene; but the practice of the surgeons was sustained by the courts.

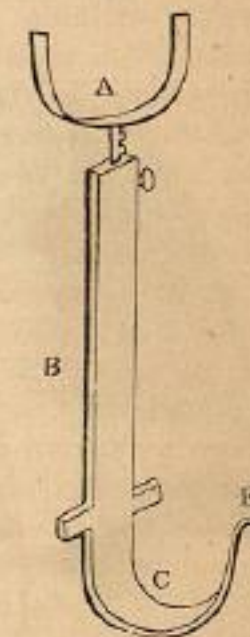
Dec. 1, 1877, Peter Folan, æt. 21, was admitted to Bellevue, with a fracture of the left humerus, near its middle. The fracture was caused by a fall from a wagon on the same day. My splint was applied, and it was continued four weeks, when the fragments were found united, but he was discovered to have paralysis of the extensor muscles of the left hand and fingers. Two or three months later, their condition had much improved. The arm was perfectly straight. The bandage was never tight, and the cause of the paralysis was unexplained.

Muhlenberg, in his tables of united fractures, has recorded 219 of the humerus, in a total of 656 of all of the long bones.

The following remarks of Malgaigne are too pertinent to be omitted in this connection: "When there is great obliquity, with overlapping, or a fracture with splintering, or a multiple fracture, a certain amount of deformity is inevitable, and the formation of callus demands one or two weeks more. With the inflammation comes also the danger of suppuration, and later, a rigidity of the articulations difficult to dissipate. In short, we must not forget that of all fractures, those of the humerus are most liable to fail of consolidation."

On the other hand, we shall find, in the case of this bone, as in all others, some remarkable exceptions, where, although the fracture may be compound, and badly comminuted, yet the limb has been saved and made useful.

FIG. 75.



Lonsdale's extension apparatus.—A. Crutch. B. Shaft. C. Elbow rest. D. Hook for attachment of bandage, opposite which is a crossbar for the same purpose.

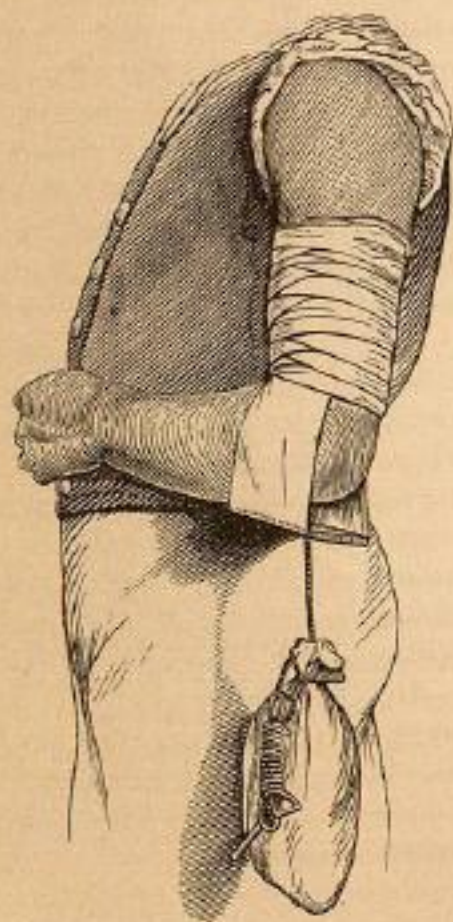
Treatment.—In the treatment of fractures of that portion of the shaft of the humerus now under consideration, we shall do best to adopt essentially the same plan which I have recommended for fractures of the surgical neck. In proportion as the fracture occurs at a lower point of the humerus, however, will it be necessary to extend the long splint downwards, in the direction of the elbow; so that, while in fractures of the surgical neck and upper half of the shaft it may not be necessary to extend the splint quite so low as the external condyle, in the case of fractures in the lower half of the shaft it will be necessary to include the condyles with the splints, and sometimes it may be necessary to employ the gutta-percha angular splint, which will be recommended hereafter in fractures involving the elbow-joint. It is in these latter cases, also, that we shall find, sometimes, the plaster-of-Paris dressing, including the forearm, arm, and shoulder, giving the most satisfactory results: never neglecting, however, when using this or any other form of immovable dressing, to observe the condition of the arm frequently as to the swelling or shrinkage. Whenever the splints are made to touch or include the condyles, very great care must be taken to protect them from pressure.

Other surgeons have sought to make permanent extension in these and certain other fractures of the humerus, by various contrivances. Mr. Lonsdale constructed an instrument which might be lengthened or shortened to suit the case; it was made of steel, and was worked with a screw

operating upon cogs in a sliding bar; resembling, in some respects, the arm portion of Jarvis's adjuster. In the second London edition of a series of plates illustrating the action of the muscles in producing displacement in fractures, by S. W. Hind, is a drawing of an apparatus invented by the author for the same purpose, which is very simple, and in some respects more complete than Lonsdale's, and which may be easily adapted to almost any form of arm-splint. Indeed, nothing more is necessary than to attach to the ordinary long splint a movable crutch.

Dr. Henry A. Martin, of Boston, has invented a splint, also for the purpose of making extension in fractures of the humerus, the counter-extension being made, by adhesive plasters, from the side of the chest. The apparatus is elongated by a ratchet operating upon two steel bars, which are thus made to move upon each other.

In my opinion, and in the opinion of nearly all practical surgeons who have written upon this subject, it is impossible by these or any other similar contrivances to make extension in fractures of



Clark's extension in fractures of the neck of the humerus.

the humerus. The axilla can never be made a proper point of support for permanent counter-extension; and Dr. Martin's method, while it avoids the dangers of axillary pressure, cannot prove efficient. The adhesive plasters must inevitably fail to retain their places when even a moderate amount of traction is continuously made upon them.

The late Dr. E. A. Clark, of the St. Louis City Hospital, proposed to accomplish the extension, in fractures of the head and surgical neck, by suspending a weight from the elbow. He reports one case successfully treated by this method; and Dr. Tyndale, of New York, formerly his House Surgeon, informs me that several of the cases were treated in the same manner, all of them being in the lower third of the humerus. When the patient is in the recumbent posture, the weight must be suspended over a pulley. No doubt this is the only method by which really effective extension can ever be made in fractures of the humerus. There may be, perhaps, examples of fractures of the neck of the humerus in which the fragments overlap persistently, where it will be proper to resort to this novel expedient. When fractures occur above the deltoid, the overlapping is often excessive, and there is not much danger of their being forcibly separated by the extension; but in fractures below this, Dr. Clark's method might possibly expose to the danger of separation and non-union of the fragments, but it will be observed that this was the class of cases successfully treated by Dr. Clark. In the case of fractures of the neck, no splints are advised by Dr. Clark; yet, as a means of holding the lower fragment out, a single outside splint might be useful.

I have seen a case of compound fracture of the humerus treated by Dr. Stephen Smith, at Bellevue, in this manner, while the patient was confined to the bed, with the most satisfactory results; and recently, in a case of fracture of the humerus, a little above the middle, complicated with other severe injuries, which eventually proved fatal, this method of extension was employed successfully by me, to prevent the violent spasmodic contractions of the muscles. In this case the arm and forearm were kept extended, the adhesive plaster extension strips being made fast to the hand and forearm, and the pulley and weight being arranged at the foot of the bed.

In reference to those forms of apparatus which are intended to press upon the axillary margins, it ought to be stated here, since we have omitted to speak of it in connection with fractures of the surgical neck, that in all fractures of the upper half or third of the humerus, including fractures of the surgical neck, they are not only useless, but they actually tend to defeat their own purpose. They are intended to replace the fragments; but by their pressure upon the pectoralis major and latissimus dorsi, which compose the free margins of the axillary space, they must inevitably cause the separation of the fragments.

Malgaigne, when speaking of the apparatus of Lonsdale, remarks: "But the surgeon should never lose sight of the fact that permanent extension is a resource always dangerous, often useless, and which demands in its application much caution and watchfulness."

The following example will illustrate the practical difficulty of employing permanent extension in fractures of the humerus:

A laborer, aged thirty, was admitted into the Buffalo Hospital of the

Sisters of Charity, on the second day of October, 1853, with a simple oblique fracture of the humerus, which had occurred three days before. The fracture was situated within the insertion of the deltoid, and, having been produced by the rolling of a log upon the arm, the whole limb was much swollen. The night following his admission, in a fit of delirium tremens, he removed all of the dressings. When I visited the wards in the morning, I found the fragments displaced and the muscles contracting violently. The ordinary dressings were applied, and continued until the fifth day, when, as the delirium had not ceased, and the muscles continued to contract with great violence, it was determined to attempt permanent extension. For this purpose we lifted the elbow upwards and outwards, to relax the deltoid, and then, having made extension with the forearm placed at a right angle with the arm, we fitted carefully a large gutta-percha splint to the forearm, arm, axilla, and side, in such a manner that when the splint was secured to these several parts, the arm could not fall to the side of the body completely, and in proportion as it did fall downwards, it would make extension upon the arm. This splint was well padded, and secured in place by rollers.

On the sixth day the delirium had ceased, and never returned. The dressings were well in place, and seemed to accomplish the indication we had in view; but, on the seventh day, although he had kept very quiet, everything was disarranged, and the whole had to be readjusted. On the eighth and ninth the same thing occurred. During this time we had varied the dressings, position, etc., each day, to meet, if possible, the difficulties; but it was at length deemed unwise to pursue the attempt any farther, and we returned to the use of the ordinary splints, laying the arm against the side of the body. The union was finally completed without either overlapping or angular displacement. I have no doubt now that we would have done much better if we had resorted to extension, as practised by Dr. Clark.

Something may always be accomplished when the patient is walking about, by allowing the elbow to escape from the sling, so that its weight shall make constant traction upon the lower fragment; and the plan which I suggested some years since, of treating certain cases of delayed union of the humerus, namely, extending the arm at full length by the side of the body, so that the lower fragment shall receive the whole weight of the forearm and hand, might occasionally prove valuable in recent fractures where the tendency to override was very great.

The precise plan, and my reason for its adoption in certain cases of delayed union, were set forth in the following paper, read before the Buffalo City Medical Association, and published in the *Buffalo Medical Journal* for August, 1854.

"I have observed that non-union results more frequently after fractures of the shaft of the humerus, than after fractures of the shaft of any other bone.

"Comparing the humerus with the femur, between which, above all others, the circumstances of form, situation, etc., are most nearly parallel, and in both of which non-union is said to be relatively frequent, I find that of forty-nine fractures of the humerus, four occurred through the surgical neck, twelve through the condyles, and twenty-nine through

the shaft. In one of the twenty-nine the patient survived the accident only a few days. In four of the remaining twenty-eight union had not occurred after the lapse of six months, and in many more it was delayed beyond the usual time. Two of the four were simple fractures, and occurred near the middle of the humerus; the third was compound, and occurred near the middle also; the fourth was compound, and occurred near the condyles.

"This analysis supplies us, therefore, with four cases of non-union, from a table of twenty-eight cases of fractures through the shaft.

"Of eighty-seven fractures of the femur, twenty occurred through the neck, one through the trochanter major, and one through the condyles. The remaining sixty-five occurred through the shaft, and generally near the middle, and not in one case was the union delayed beyond six months.

"To make the comparison more complete, I must add that of the twenty-eight fractures of the shaft of the humerus, six were compound; and of the sixty-five fractures of the shaft of the femur, six were either compound, comminuted, or both compound and comminuted. The six compound fractures of the shaft of the humerus furnished two cases of non-union. The six cases of either compound or comminuted or compound and comminuted fractures of the femur, furnished no case of non-union.

"I beg to suggest to the Society what seems to me to be the true explanation of these facts.

"It is the universal practice, so far as I know, in dressing fractures of the humerus, to place the forearm at a right angle with the arm. Within a few days, and generally, I think, within a few hours, after the arm and forearm are placed in this position, a rigidity of the muscles and other structures has ensued, and to such a degree that if the splints and sling are completely removed, the elbow will remain flexed and firm; nor will it be easy to straighten it. A temporary false ankylosis has occurred, and instead of motion at the elbow-joint, when the forearm is attempted to be straightened upon the arm, there is only motion at the seat of fracture. It will thus happen that every upward and downward movement of the forearm will inflict motion upon the fracture; and inasmuch as the elbow has become the pivot, the motion at the upper end of the lower fragment will be the greater in proportion to the distance of the fracture from the elbow-joint.

"No doubt it is intended that the dressings shall prevent all motion of the forearm upon the arm; but I fear that they cannot always be made to do this. I believe it is never done when the dressing is made without angular splints, nor is it by any means certain that it will be accomplished when such splints are used. The weight of the forearm is such, when placed at a right angle with the arm, and encumbered with splints and bandages, that even when supported by a sling, it settles heavily forwards, and compels the arm-dressings to loosen themselves from the arm in front of the point of fracture, and to indent themselves in the skin and flesh behind. By these means the upper end of the lower fragment is tilted forwards. If the forearm should continue to drag upon the

sling, nothing but a permanent forward displacement would probably result. The bones might unite, yet with a deformity.

"But the weight of the forearm under these circumstances is not uniform, nor do I see how it can be made so. It is to the sling that we must trust mainly to accomplish this important indication. But you have all noticed that the tension or relaxation of the sling depends upon the attitude of the body, whether standing or sitting; upon the erection or inclination of the head; upon the motions of the shoulders; and in no inconsiderable degree upon the actions of respiration. Nor does the patient himself cease to add to these conditions by lifting the forearm with his opposite hand whenever provoked to it by a sense of fatigue.

"This difficulty of maintaining quiet apposition of the fragments while the arm is in this position, at whatever point it may be broken, becomes more and more serious as we depart from the elbow-joint, and would be at its maximum at the upper end of the humerus, were it not that here a mass of muscles, investing and adhering to the bone, in some measure obviates the difficulty. Its true maximum is, therefore, near the middle, where there is less muscular investment, and where, on the one hand, the fracture is sufficiently remote from the pivot or fulcrum to have the motion of the upper end of the lower fragment multiplied through a long arm, while, on the other hand, it is sufficiently near the armpit and shoulder to prevent the upper portion of the splint and arm-dressings from obtaining a secure grasp upon the lower end of the upper fragment.

"It must not be overlooked that the motion of which we speak belongs exclusively to the lower fragment, and that it is always in the same plane forwards and backwards, but especially that it is not a motion upon the fracture as upon a pivot, but a motion of one fragment to and from its fellow. This circumstance I regard as important to a right appreciation of the difficulty. Motion alone, I am fully convinced, does not so often prevent union as surgeons have generally believed. It is exceedingly rare to see a case of non-union of the clavicle. Of forty-seven cases of fracture of the clavicle which have come under my observation, and in by far the greater proportion of which considerable overlapping and consequent deformity ensued, only one has resulted in non-union, and in this instance no treatment whatever was practised, but from the time of the accident the patient continued to labor in the fields, and hold the plough as if nothing had occurred. I have, therefore, seen no case of non-union of the clavicle where a surgeon has treated the accident. Indeed, what is most pertinent and remarkable, its union is more speedy, usually, than that of any other bone in the body of the same size. Yet to prevent motion of the fragments in a case of fractured clavicle with complete separation and displacement, except where the fragment is near one of the extremities of the bone, I have always found wholly impracticable. Whatever bandage or apparatus has been applied, I have still seen always that the fragments would move freely upon each other at each act of inspiration and expiration, and at almost every motion of the head, body, or upper extremities. It is probable, gentlemen, that you have made the same observation.

"From this and many similar facts I have been led to suspect, for a

long time, that motion has had less to do with non-union than was generally believed.

"I find, however, no difficulty in reconciling this suspicion with my doctrine in reference to the case in question; and it is precisely because, as I have already explained, the motion, in case of a fractured humerus, dressed in the usual manner, is peculiar.

"In a fracture of the clavicle through its middle third (its usual situation), the motion is upon the point of the fracture as upon a pivot; although, therefore, the motion is almost incessant, it does not essentially, if at all, disturb the adhesive process. The same is true in nearly all other fractures. The fragments move only upon themselves, and not to and from each other. I know of no complete exception but in the case now under consideration.

"Aside from any speculation, the facts are easily verified by a personal examination of the patients during the first or second week of treatment, or at any time before union has occurred, both in fractures of the humerus and clavicle. The latter is always sufficiently exposed to permit you to see what occurs; and as soon as the swelling has a little subsided in the former case, you will have no difficulty in feeling the motion outside of the dressings, or, perhaps, in introducing the finger under the dressings sufficiently far to reach the point of fracture. I believe you will not fail to recognize the difference in the motion between the two cases. Such, gentlemen, is the explanation which I wish to offer for the relative frequency of this very serious accident—non-union of the humerus.

"I know of no other circumstance or condition in which this bone is peculiar, and which, therefore, might be invoked as an explanation. Overlapping of the bones, the cause assigned by some writers, is not sufficient, since it is not peculiar. The same occurs much oftener, and to a much greater extent, in fractures of the femur, and equally as often in fractures of the clavicle, yet in neither case are these results so frequent. Nor can it be due to the action of the deltoid muscle, or of any other particular muscles about the arm, whether the fracture be below or above their insertions, since similar muscles, with similar attachments, on the femur and on the clavicle, tending always powerfully to the separation of the fragments, occasion deformity, but they seldom prevent union.

"If I am correct in my views, we shall be able sometimes to consummate union of a fractured humerus where it is delayed, by straightening the forearm upon the arm, and confining them to this position. A straight splint, extending from the top of the shoulder to the hand, constructed from some firm material, and made fast with rollers, will secure the requisite immobility to the fracture. The weight of the forearm and hand will only tend to keep the fragments in place, and if the splint and bandages are sufficiently tight, the motion occasioned by swinging the hand and forearm will be conveyed almost entirely to the shoulder-joint. Very little motion, indeed, can in this posture be communicated to the fragments, and what little is thus communicated is a motion, as experience has elsewhere shown, not disturbing or pernicious, but a motion only upon the ends of the fragments, as upon a pivot.

"I do not fail to notice that this position has serious objections, and that it is liable to inconveniences which must always, probably, prevent its being adopted as the usual plan of treatment for fractured arms. It is more inconvenient to get up and lie down, or even to sit down, in this position of the arm, and the hand is liable to swell. But I shall not be surprised to learn that experience will prove these objections to have less weight than we are now disposed to give them. Remember, the practice is yet untried—if I except the case which I am about to relate, and in which case, I am free to say, these objections scarcely existed. The swelling of the hand was trivial, and only continued through the first fortnight, and the patient never spoke of the inconvenience of getting up or sitting down, or even of lying down.

"The following is the case to which I have just referred: 'Michael Mahar, laborer, æt. 35, broke his left humerus just below its middle, Dec. 14, 1853. The arm was dressed by a surgeon in Canada West, and who is well known to me as exceedingly "clever." After a few days from the time of the accident, "the starch bandage was put on as tight as it could be borne, and brought down on the forearm, so as to confine the motions of the elbow-joint." Six weeks after the injury, January 29, 1854, Mahar applied to me at the hospital. No union had occurred. The motion between the fragments was very free, so that they passed each other with an audible click. There was little or no swelling or soreness. In short, everything indicated that union was not likely to occur without operative interference. The elbow was completely ankylosed. I explained to my students what seemed to me to be the cause of the delayed union, and declared to them that I did not intend to attempt to establish adhesive action until I had straightened the arm. They had just witnessed the failure of a precisely similar case, in which I had made the attempt to bring about union without previously straightening the arm.

"On the 6th of February, 1854, we had succeeded in making the arm nearly straight. I now punctured the upper end of the lower fragment with a small steel instrument, and, as well as I was able, thrust it between the fragments. Assisted by Dr. Boardman, I then applied a gutta-percha splint from the top of the shoulder to the fingers, moulding it carefully to the whole of the back and sides of the limb, and securing it firmly with a paste roller. March 4th (not quite four weeks after the application of the splint) we opened the dressings for the second time, and carefully renewed them. A slight motion was yet perceptible between the fragments. March 18th, we opened the dressings for the third time, and found the union complete. This was within less than forty days. The patient was now dismissed. On the 29th of April following, the bone was refractured. Mahar had been assisting to load the "tender" to a locomotive. As the train was just getting in motion, he was hanging to the tender by his sound arm, while another laborer seized upon his broken arm to keep himself upon the car, and with a violent and sudden pull wrenched him from the tender and reproduced the fracture. The next morning I applied the dressings as before, and did not remove them during three weeks; at the end of which time the

union was again complete. The splint was, however, reapplied, and has been continued to this time—a period of about six weeks."¹

Since the date of the above paper I have several times had opportunities to test the value of this mode of treatment in cases of delayed union of the humerus, and in each case with the same favorable result. Donald Maclean, of Ann Arbor, Michigan, and several other surgeons, have adopted the same procedure in similar cases successfully.²

Measurement.—It may be well to indicate in this place by what method we shall best insure an accurate measurement of the arm, or forearm.

In either case, the point from which the measurement can be most satisfactorily made, above, is the posterior and inferior edge of the acromion process, at the most salient point of this margin, about opposite the scapulo-clavicular articulation. If the arm can be straightened, the extremity of either of the fingers can be used as the lower fixed point. If the arm cannot be straightened, we may use as the lower point either condyle, or the point of the elbow. In order to get the point of the elbow accurately, the hands should be clasped in front of the body; and as the elbows are pressed back, a rule may be laid beneath, and the measurements made from the upper surface of the rule.

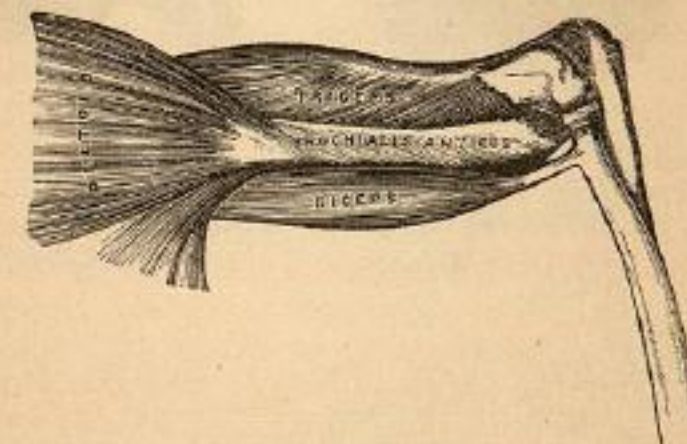
§ 6. Base of the Condyles.

Syn.—Supracondyloid Fractures of the Humerus.—Malgaigne.

Causes.—Of 18 fractures at this point, 12 occurred in children under ten years of age, the youngest being two years old.

In 11 cases the fracture had been produced by a fall, and it is presumed that the blow was received upon the elbow; in the remaining six cases the cause is not stated. I believe, therefore, that this fracture is

FIG. 77.



Fracture at the base of the condyles. (From Gray.)

generally the result of an indirect blow, inflicted upon the extremity of the elbow; in a few examples it has been produced by a blow received directly upon the point of fracture, as by the kick of a horse, etc., but I

¹ Buffalo Med. Journ., vol. x, pp. 14-147.

² Maclean, Phys. & Surg., May, 1880; also July, 1882.