epiphysis, and the examples of separation of the lower epiphysis have seldom been clearly made out. I have already mentioned one as having been reported by Robert Smith. He speaks also of other cases occurring in conjunction with a separation of the lower end of the ulna, and which, he thinks, are liable to be mistaken for dislocations.[1]

Malgaigne says that we have reasons to suspect this accident when the fracture occurs in persons under twenty years of age. Cloquet ascertained its existence by a dissection in a child of twelve years; Roux also in a child whose age is not given, and Voillemier produced it easily in the dead bodies of children, and once in the body of a robust man of twenty-four.[2] Schmit[3] and Girdner[4] have also noticed the frequency of the epiphyseal separation when, in the case of infants, the fracture is caused by avulson upon the cadaver. The experiments of Dr. Girdner, made at my request, also showed, that in early life avulsion sometimes caused a fracture just above the epiphysis, sometimes a bending of the bone, without fracture, and sometimes only a rupture of the ligaments. I think I have broken the radius at the epiphyseal junction in some of my experiments of forced flexion in adult females.

The treatment of this accident will not demand any special consideration, since it will not differ essentially from the treatment required in a fracture occurring at the same point.

Delayed or Non-union of Fractures of the Radius.—Muhlenberg in his tables has recorded 23 cases, of which 17 are reported as having been cured, and in 6 the attempts to cure have failed. Resection and drilling furnish the largest percentage of cures. I have never met with an example of non-union in a fracture of the lower end of the radius.

CHAPTER XXIII.

FRACTURES OF THE ULNA.

§ 1. Fractures of the Olecranon Process.

Causes.—My records furnish me with accounts of only 19 of these fractures, and, so far as I have been able to ascertain, all were occasioned by falls upon the elbow, or by blows inflicted directly upon the part. Malgaigne has, however, been able to collect accounts of six examples of fracture of the olecranon, produced, as is affirmed, by the violent action of the triceps; as in pushing with the arm slightly flexed, in throwing a ball, in plunging into the water with the arms extended, etc.; but only four of these reported examples does he think are sufficiently authenticated to entitle them to be received as facts; nor do I think it possible to affirm positively that in any instance, where the whole

[1] Robert Smith, op. cit., p. 164.
[2] Malgaigne, op. cit.
[3] Schmit, Thèse de Paris, 1878, No. 114.
[4] Girdner, Jno. H., Med. Rec., Feb. 26, 1881.

process is broken off, the triceps alone has occasioned the separation. For example, Capiomont reports the case of a cavalier, who, being intoxicated, was thrown head-foremost from his horse, and, striking probably upon his head, was found to have broken the olecranon process. We do not, in this example, see evidence alone of a forcible contraction of the triceps, but also of violent pressure against the hand and in the direction of the axis of the forearm toward the elbow-joint, by which the olecranon process might have been so thrown forwards against the fossa of the humerus as to cause its separation. The same explanation might apply to several of the other examples.

Point and Direction of Fracture; Displacement, etc.—The process may be broken at its summit, at its base, or intermediate between these two extremes, the last of which is the most common.

It is probable that when the action of the triceps alone has produced the fracture, it will be found that only that portion which receives the insertion of the triceps has been broken off. Malgaigne, who has been able to find upon record only two cases of a fracture of the extreme end of the process, declares that they were both occasioned by muscular action.

Fractures of the middle are generally transverse, or only slightly oblique, occurring in the line of the junction of the epiphysis with the diaphysis.

Fractures through the base are generally quite oblique, the line of fracture extending from before downwards and backwards, so that not only the whole of the process, but a portion of the back of the shaft is carried away; and this accident can scarcely happen, except by a blow received upon the front and lower end of the humerus, while the arm is extended; or by a blow upon the back of the forearm, whether the arm be in a position of flexion or extension, received at a point a little below where the shaft of the ulna joins the olecranon.

The only displacement to which the upper fragment seems to be liable, is in the direction of the triceps; and the degree of this displacement does not depend so much upon the point at which the fracture has taken place as upon the violence which has occasioned it, the extent of the disruption of the ligaments, aponeurosis of the triceps and of the capsule, and upon whether, since the accident, the arm has been flexed or kept extended.

FIG. 112.

Fracture at the base.

In five instances I have found distinct crepitus immediately after the fracture has occurred, produced by only moving the fragment laterally, showing plainly that little or no displacement had taken place. The following example will show also that this displacement does not always happen even after the lapse of several days, and where no surgical treatment has been adopted.

Samuel Duckett, æt. 14, fell upon the point of the elbow, and two

days after was admitted to the Buffalo Hospital of the Sisters of Charity. The elbow was then much swollen, but no crepitus could be detected, and he could nearly straighten his arm by the action of the triceps. On the sixth day, the swelling having sufficiently subsided, a distinct crepitus was discovered when the olecranon process was seized between the fingers and moved laterally. We extended the arm immediately, and applied a long gutta-percha splint to the whole front of the arm and forearm, securing it in place with a roller. On the eleventh day, five days after the first dressing, the splint was taken off and its angle at the elbow-joint slightly changed; and this was repeated every day until the twenty-second from the time of the accident. The splint was then finally removed, when the fragment was found to be united without any perceptible displacement, and the motions of the joint were unimpaired.

It must not be inferred, however, that it is always prudent to leave this fracture thus unsupported, since it has occasionally happened that the displacement, which did not exist at first, has taken place to the extent of half an inch or more, after the lapse of several days. Mr. Earle mentions a case in which the separation did not take place until the sixth day, when it was occasioned by the patient's attempting to tie his neckcloth.

Symptoms.—The usual signs of a fracture of the olecranon process are, when the fragments are not separated, crepitus, discovered especially by seizing the process and moving it laterally; or, when displacement has actually taken place, the crepitus may be discovered sometimes by extending the forearm, and pressing the upper fragment downwards until it is made to touch the lower fragment; the existence of a palpable depression between the fragments, partial flexion of the forearm, and inability on the part of the patient to straighten it completely, or even to flex the arm in some cases. If the fragments do not separate, gentle flexion and extension of the arm, while the finger rests upon the process, may enable us to detect the fracture.

It will sometimes happen that, owing to the rapid occurrence of tumefaction, the evidence of a fracture will be quite equivocal: and, in all cases where a severe injury has been inflicted upon the point of the elbow, it will be well to suspend judgment until, by repeated examinations, made on successive days, the question is determined. Meanwhile, the arm ought to be kept constantly in an extended position, as if a fracture was known to exist.

Prognosis.—In a large majority of cases this process becomes reunited to the shaft by ligament, which may vary in length from a line to an inch or more, and which is more or less perfect in different cases. Sometimes it is composed of two separate bands, with an intermediate space, or the ligament may have several holes in it; at other times it is composed in part of bone and in part of fibrous tissue; but most frequently it is a single, firm, fibrous cord, whose breadth and thickness are less than that of the process to which it is attached.

If the fragments are maintained in perfect apposition, a bony union may occur, yet it is not invariably found to have taken place, even under these circumstances. Malgaigne thinks, also, he has seen one case in which there was neither bone nor fibrous tissue deposited between the

fragments. This was an ancient fracture at the base of the olecranon; the superior fragment remained immovable during the flexion and extension of the arm, yet it could be moved easily from side to side.

In my own cases I have five times found the fragments united without any appreciable separation, and have presumed that the union was bony. One of these examples I have already mentioned; the second was in the person of a lady, aged about forty years, who, having fallen down a flight of steps on the 8th of September, 1857, sent for me immediately. I found a large bloody tumor covering the elbow-joint, but there was no difficulty in detecting a fracture of the olecranon process. It was easily moved from side to side, and this motion was accompanied with a distinct crepitus. During the first week the arm was only laid upon a pillow, but as it was found to become gradually more flexed, and the swelling having in a great measure subsided, the arm was nearly, but not quite, straightened, and a long gutta-percha splint applied to the palmar surface of the forearm and arm. The fragments united in about twenty or twenty-five days, and without separation, so far as could be discovered in a very careful examination.

The third example to which I have referred, occurred in a boy fourteen years old, and was treated by Dr. Benjamin Smith, of Berkshire, Massachusetts. Sixty-nine years after, he being then eighty-three years old, I found the olecranon process united apparently by bone, but to that day he had been unable to straighten the arm completely, or to supine it freely.

In one instance I found the fragment, after the lapse of one year, united by a ligament, which seemed to be about one-quarter of an inch in length, and the arm appeared to be in all respects as perfect as the other. He could flex and extend it freely.

In the two following examples, also, the bond of union was ligamentous:

John Carbony, æt. 18, having broken the olecranon, it was treated with a straight splint. Nine years after, I found the process united by a ligament half an inch in length, and he could nearly, but not entirely, straighten the arm. In all other respects the functions and motions of the arm were perfect.

A lad, æt. 15, was brought to me by Dr. Lauderdale, a very excellent surgeon in the town of Geneseo, Livingston Co., N. Y., whose olecranon process had been broken by a fall six months before, and at the same time the head of the radius had been dislocated forwards. I found the radius in place, and the olecranon process united by a ligament about half an inch in length. He was not able to straighten the arm completely, the forearm remaining at an angle of 45° with the arm.

FIG. 113.

Union by ligament.

Treatment.—It will surprise the student who is yet unacquainted with the literature of our science, to learn that in relation to the treatment of a fracture of the olecranon process, a wide difference of opinion

has been entertained as to what ought to be the position of the arm and the forearm, in order to the accomplishment of the most favorable results; and that, while some insist upon the straight position as essential to success, others prefer a slightly flexed position, and still others have advocated the right-angled position. Thus Hippocrates, and nearly all of the earlier surgeons, down to a period so late as the latter part of the last century, directed that the arm should be placed in a position of semiflexion; Boyer, Desault, and, after them, most of the French surgeons of our own day, prefer a position in which the forearm is very slightly bent upon the arm; while Sir Astley Cooper, and a large majority of the English and American surgeons, employ complete or extreme extension.

The arguments presented by the advocates and antagonists of these various plans deserve a moment's consideration.

In favor of the position of semiflexion, requiring no splints, and, in the opinion of some writers, not even a bandage, but only a sling to support the forearm, it is claimed that it leaves the patient at liberty at once to walk about and to move the elbow-joint freely, so soon at least as the subsidence of the swelling and pain will permit, and that in this way the danger of anchylosis is greatly diminished; that, moreover, if anchylosis should unfortunately occur, the limb is in a much better position for the proper performance of its most ordinary functions than if it were extended. Some have also added to this argument a statement that a fibrous union, under any circumstances, is inevitable, and that it is a matter of little consequence whether the ligament thus formed is long or short, since in either condition it will be equally serviceable.

In reply to these statements, it may be said briefly that they are nearly all based upon false premises, or that they have been proved in themselves to be essentially erroneous.

Anchylosis is always a serious event, which by all possible means the surgeon will seek to prevent, but position has nothing to do with determining this result; when it does occur, it may usually be ascribed either to the severity and complications of the original injury, to the violence of the consequent inflammation, or to having neglected, at a proper period and with sufficient perseverance, to move the joint.

That a fibrous union is inevitable under any circumstances, has been proved to be an error; and while a short ligamentous union, such as is usually obtained when the arm is kept straight, may serve its purposes quite as well as a bony union, yet a long fibrous union, such as must very often be obtained when the arm is kept at a right angle, would seriously impair the usefulness of the limb.

The only argument which remains, and which really possesses any weight, is, that, if permanent anchylosis does actually occur, the arm, when semiflexed, is in a better position for the performance of its ordinary functions; and this, considered as an argument in favor of the universal or even general adoption of the flexed position, is successfully met by a statement of the infrequency of permanent anchylosis after a simple fracture, when the case has been properly treated, whether by the flexed or straight position; while, if the limb is flexed, a maiming, as a result of the great length of the intermediate ligament, is quite as likely to occur.

Yet if, in any case, from the great severity and complications of the injury, especially in certain examples of compound and comminuted fracture, it were to be reasonably anticipated that permanent bony anchylosis must result, or even where the probabilities were strongly that way, the surgeon might be justified in selecting for the limb, at once, the position of semiflexion; or he might leave the arm without a splint, and at liberty to draw up spontaneously and gradually to this position, as it is always very prone to do.

In favor of moderate, but not complete extension, it is claimed that it is less fatiguing than the latter position, while it accomplishes a more exact apposition of the fragments, if they happen to be brought actually into contact.

I am unable, however, to understand how the apposition can be rendered less exact by complete extension, unless by this is meant a degree of extension beyond that which is natural, and which, I am well aware, is permitted to the elbow-joint when this posterior brace is broken off. It would certainly derange the fragments to place the arm in this extreme condition of extension—that is, in a condition of extension approaching dorsal flexion, which is beyond what is natural. Indeed, perhaps we may admit that, in order to perfect apposition, the extension ought to be less by one or two degrees than what is natural, sufficient to compensate for the trifling amount of effusion which may be presumed to have occurred in the olecranon fossa, and which would prevent the process from sinking again fairly into its fossa.

As to its being less fatiguing, it is well known to those accustomed to treat fractures of the thigh by permanent extension that the muscles rapidly acquire a tolerance, which soon dissipates all feeling of fatigue, and that, after a few hours, or days at most, the patients express themselves as being more comfortable in this position than in the flexed.

Finally, the advocates of complete, natural extension claim that in this position alone is the triceps most perfectly relaxed, and consequently the most important indication, namely, the descent of the olecranon, most fully accomplished. In this opinion we also concur; and regarding all other considerations, in the early days of the treatment, as secondary to this one, we unhesitatingly declare our preference for what has been called the "position of complete extension," as opposed to flexion, semiflexion, or extreme extension.

It only remains for us to determine by what means the limb can be best maintained in the extended position, and the olecranon process most easily and effectually secured in place.

For this purpose a variety of ingenious plans have been devised, such as the compress and "figure-of-8" bandage of Duverney, without splints; or a similar bandage employed by Desault, with the addition of a long splint in front; the circular and transverse bandages of Sir Astley Cooper, with lateral tapes to draw them together, to which also a splint was added; and many other modes not varying essentially from those already described, but nearly all of which are liable to one serious objection, namely, that if they are applied with sufficient firmness to hold

upon the fragment, and Boyer says they "ought to be drawn very tight," they ligate the limb so completely as to interrupt its circulation, and expose the limb greatly to the hazards of swelling, ulceration, and even gangrene. How else is it possible to make the bandage effective upon a small fragment of bone, scarcely larger than the tendon which envelops its upper end, and with no salient points against which the

FIG. 114.

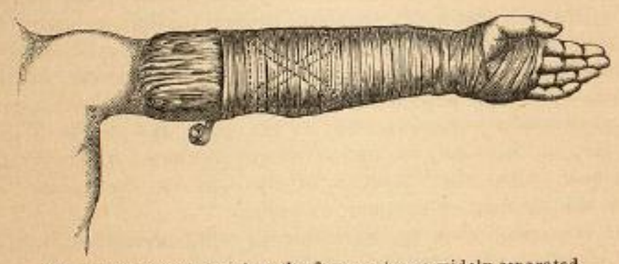
Sir Astley Cooper's method.

compress or the roller can make advantageous pressure? If, then, these accidents—swelling, ulceration, and gangrene—are not of frequent occurrence, it is only because the bandage has not been generally applied "very tight," and while it has done no harm, it has as plainly done no good.

The dangers to which I allude may be easily avoided, without relaxing the security afforded by the compress and bandage, by a method which is very simple, and the value of which I have already sufficiently determined by my own practice.

The surgeon will prepare, extemporaneously always, for no single pattern will fit two arms, a splint, from a piece of thin, light board. This must be long enough to reach from near the wrist-joint to within

FIG. 115.



The author's method when the fragments are widely separated.

three or four inches of the shoulder, and of a width nearly or quite equal to the widest part of the limb. Its width must be uniform throughout, except that, at a point corresponding to a point three inches, or thereabouts, below the top of the olecranon process, there shall be a notch on each side, or a slight narrowing of the splint. One surface of the splint is now to be thickly padded with hair or cotton-batting, so as to fit all of the inequalities of the arm, forearm, and elbow, and the whole covered neatly with a piece of cotton cloth, stitched together upon the

back of the splint. Thus prepared, it is to be laid upon the palmar surface of the limb, and a roller is to be applied, commencing at the hand and covering the splint, by successive circular turns, until the notch is reached, from which point the roller is to pass upwards and backwards behind the olecranon process and down again to the same point on the opposite side of the splint; after making a second oblique turn above the olecranon, to render it more secure, the roller may begin gradually to descend, each turn being less oblique, and passing through the same notch, until the whole of the back of the elbow-joint is covered. This completes the adjustment of the fragments, and it only remains to carry the roller again upwards, by circular turns, until the whole arm is covered as high as the top of the splint.

The advantage of this mode of dressing must be apparent. It leaves, on each side of the splint, a space upon which neither the splint nor bandage can make pressure, and the circulation of the limb is, therefore, unembarrassed, while it is equally effective in retaining the olecranon in place, and much less liable to become disarranged.

Before the bandage is applied about the elbow-joint, the olecranon must be drawn down, as well as it can be, by pressure with the fingers, and a compress of folded linen, wetted to prevent its sliding, must be placed partly above and partly upon the process; at the same time, also, care must be taken that the skin is not folded in between the fragments.

When the fragments are not much, or at all separated, and consequently no such force is required to draw down the upper fragment, and when, from the nature of the injury, there is little cause to anticipate much swelling, a splint may be employed, constructed like that recommended by Sir Astley Cooper, made of light wood, curved to fit the limb, or of gutta percha, gum-shellac cloth, or sole-leather. This should be covered with a flannel or cotton sack, and then secured in place by a roller. The sack will enable the surgeon to stitch the roller to the splint, and he can thus employ effectively the oblique and figure-of-8 turns about the elbow-joint. Indeed, the latter method will prove adequate in most cases, while it is less cumbrous than that which I have first described as being required when the separation is very great, and the injuries unusually severe.

The dressing ought, no doubt, to be applied immediately, since, if we wait, as Boyer seems to advise, until the swelling has subsided, it will be found much more difficult to straighten the arm completely than it would have been at first, and the olecranon process will be more drawn up and fixed in its abnormal position. Something will be gained by these means, adopted early, even if the bandage cannot be applied tightly; and moderate bandaging will not in any way interfere with the proper and successful treatment of the inflammation. We must always keep in mind, however, the fact that the fracture being usually the result of a direct blow, considerable inflammation and swelling around the joint are about to follow rapidly; and on each successive day, or oftener if necessary, the bandages must be examined carefully, and promptly loosened whenever it seems to be necessary. For this purpose it is better not to unroll the bandages, but to cut them with a pair of

scissors, along the face of the splint, cutting only a small portion at a time, and as they draw back, stitch them together again lightly; and thus proceed until the whole has been rendered sufficiently loose.

As soon as the inflammation has subsided, and as early sometimes as the fifth or seventh day, the dressing ought to be removed completely; and while the fingers of the surgeon sustain the process, the elbow ought to be gently and slightly flexed and extended two or three times. From this time forwards, until the union is consummated, this practice should be continued daily, only increasing the flexion each time, as the inflammation and pain may permit. If it is thought best, at length, to change the angle of the arm, and to flex it more and more, it may be done easily by substituting a very thick sheet of gutta percha for either of the other forms of dressing.

Dieffenbach has several times, in old fractures of both the olecranon and patella, where the fragments were dragged far apart, divided the tendons, so as to be able to bring the two portions together, and, by friction of them one upon the other, has endeavored to excite such action as might end in the formation of a shorter and firmer bond of union. In some instances, it is said, considerable benefit was obtained, after all other means had failed; in others, the result was negative. One example of an old ununited fracture of the olecranon is mentioned, in which he divided the tendon of the triceps, secured the upper fragment in place, and every fourteen days rubbed it well against the lower one; in three months "the union was firm."[1]

Mr. Lister, in the case of a patient whose olecranon had been broken many months before, and not satisfactorily united, exposed, with antiseptic precautions, the fragments and brought them together with strong silver wire, thus securing a bony union without any accident. He has repeated this operation in an analogous case, with like success.[2]

Rose,[3] MacCormac,[4] and Lesser[5] have each reported one example of success in the same class of cases.

Neither the methods of Dieffenbach nor of Lister are without their hazards, and no doubt ought to be reserved for extreme cases.

Plaster-of-Paris, or any other form of immovable dressing, which excludes the surface of the limb from observation, and which is made sufficiently tight to hold permanently upon the upper fragment, exposes the patients to the dangers of swelling and gangrene. If not sufficiently tight to expose to these dangers, they serve no other purpose than to keep the limb straight.

In 1850, Rigaud, of Strasbourg,[6] introduced two screws into the upper and lower fragments, respectively, and drew them together with a string. The screws remained in position two months, and the result was a "perfect cure." One might wish to know more precisely, in what sense it was "perfect."

[1] Dieffenbach, American Journal of the Medical Sciences, vol. xxix. p. 478; from Casper's Wochenschrift, Oct. 2, 1841.
[2] Lister, The Lancet, June 4, 1881, p. 914.
[3] Rose, The Lancet, 1880, vol. I. p. 835.
[4] MacCormac, The Lancet, June 4, 1881, p. 913.
[5] Lesser, Quentin, Bruch. des Olek., Inaug. Diss., Bonn, 1881.
[6] Rigaud, Rev. Med. Chir., 1850.

In 1864, Busch applied a plaster-of-Paris splint, furnished with a fenestra at the posterior part of the elbow; after which he made fast a metallic clamp, one point of which penetrated the upper fragment, and the two lower points were made to penetrate the plaster of Paris; by means of a screw the fragments were approximated.[1] Madelung[2] has three times adopted the same method; in one of which the method had to be abandoned on account of the "indocility" of the patient. Pingaud[3] reports, also, an example of success by this method.

Lauenstein proposes to aspirate the joint where there is much interarticular effusion, in order to secure better apposition of the fragments. The fact that he has seen no serious results from this practice, will hardly justify the prudent surgeon in performing an operation of so much hazard and of so little probable utility.

Separation of the Olecranon while in its Epiphyseal State.—Recently a gentleman called upon me with his son, aged seven years, who had an unreduced dislocation of the radius and ulna backwards of nine weeks' standing. While reducing this dislocation, it being necessary to flex the arm forcibly, the epiphysis constituting the olecranon process gave way, and became separated from one-half to three-quarters of an inch. This is the only example of separation of this epiphysis which has come to my knowledge. I have, however, twice since broken the olecranon in attempts to reduce old dislocations of the radius and ulna backwards, and I have not regretted the occurrence, since it enabled me to reduce the dislocations without cutting the triceps.

§ 2. Coronoid Process of the Ulna.

Dissections have established the existence of this fracture in the living subject. The fact, however, that the number of authentic observations is very small, seems to imply that the accident is infrequent, and especially as a simple fracture, unassociated with other fractures.

Malgaigne thought that it was more frequent than the small number of reported examples would lead us to suppose; and especially because he had noticed how often the summit of the process is broken off when dislocation of the radius and ulna backwards is produced on the cadaver. In three or four cases also of dislocations of these bones backwards and inwards, which had come under his notice he was unable to feel this process, and he, therefore, thought it probable that it was broken off. Other surgeons have thought also that it was not an infrequent accident in connection with a dislocation. Fergusson has, indeed, made the extraordinary statement that in dislocations of the radius and ulna backwards "the coronoid process will probably be broken."

Clinical Examples not Verified by Dissection.—In the two following cases, the existence of a fracture of the coronoid process was at first suspected by me, but I have now very little doubt that my diagnosis was incorrect. I shall relate them, however, as examples of those accidents which are likely to be mistaken for fracture of this process.

[1] Busch, Poinsot, op. cit., p. 397.
[2] Madelung, Quentin, op. cit.
[3] Pingaud, Dict. Encyc., Art. Coude, p. 639 (1878).

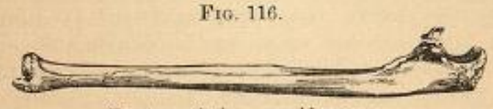
A laboring man, aged about twenty-five years, had been seen and treated by another surgeon, for what was supposed to be a simple dislocation of the radius and ulna backwards. The surgeon thought he had reduced the dislocation very soon after the accident. On the following day he found the dislocation reproduced, and he requested me to see the patient with him. The arm was then much swollen, but the character of the dislocation was apparent. By moderate extension, applied while the arm was slightly flexed, and continued for a few seconds, reduction was again effected, the bones returning to their places with a distinct sensation; but on releasing the arm the dislocation was immediately reproduced. These attempts to reduce and retain in place the dislocated bones were repeated several times during this day and on subsequent days, but to no purpose, and the patient was dismissed after about two weeks with the bones unreduced.

The impossibility of retaining the bones in place, and the existence of an occasional crepitus during the manipulation, inclined me to believe at the time that the dislocation was accompanied with a fracture of the coronoid process.

Another similar case has since presented itself in a child nine years old, and in which the subsequent examinations not only demonstrated the non-existence of a fracture, but also rendered doubtful the justness of the conclusions which I had drawn in the case just related.

This lad fell, November 4, 1855, and his parents immediately brought him to me; but as he lived many miles from town, I did not see him until eighteen hours after the injury was received. I found the arm much swollen, slightly flexed, and pronated. Flexion and extension of the arm were very painful, the pain being referred chiefly to the front of the joint, near the situation of the coronoid process; and at this point also there was a discoloration of the size of a twenty-five cent piece. Flexing the forearm moderately upon the arm and making extension, the bones came readily into place, but without sensation of any kind, either a snap or a crepitus. That the bones had now resumed their position, however, I made certain by a very careful examination with the hand

FIG. 116.



Fracture of the coronoid process.

and by measurement, yet they would not remain in place one moment when the extension was discontinued. The reduction was made several times, and constantly with the same result. We then applied a right-angled splint to the arm, having first reduced the bones, and thus were able to retain them in position. I believed that the coronoid process was broken, and so informed the surgeon, to whose care the boy returned.

Five months after, he was brought again to me, and I then found that the radius and ulna had been kept in place; the motions of the joint were perfect, and if the coronoid process had ever been broken it was now again in its natural position, and with every structure about it in a condition as complete as it was before the accident.

Malgaigne mentions three reported examples, namely, one published by Combes Brassard, an Italian surgeon, in 1811, which Brassard saw only after a lapse of three months; one seen by Pennock, and published in the *Lancet* in 1828, the patient then being sixty years old, and the accident having occurred when he was a young man; the third was seen by Sir Astley Cooper, several months after the accident, and is reported by himself in his excellent treatise on Fractures and Dislocations. Says Sir Astley: "It was thought, at the consultation which was held about him in London, that the coronoid process was detached from the ulna." This was the only living example seen by Sir Astley in his long and immensely varied surgical practice; and even here we cannot fail to notice the apparent reserve with which he expresses his opinion—"It was thought at the consultation."

Dorsey says that Dr. Physick once saw a fracture of the coronoid process. The symptoms resembled a luxation of the forearm backwards, "except that when the reduction was effected, the dislocation was repeated, and by careful examination, crepitation was discovered. The forearm was kept flexed at a right angle with the humerus. The tendency of the brachialis internus to draw up the superior fragment was counteracted in some measure by the presssure of the roller above the elbow. A perfect cure was readily obtained."[1] In 1830, Dr. William M. Fahnestock reported a case occurring in a boy, who, having fallen from a haymow, received the whole weight of his body "on the back part of the palm of the left hand," while the arm was extended forwards. It seemed to be a dislocation of the forearm backwards, but when reduced it was again immediately displaced, with an evident crepitus. The arm was secured in the angular splint of Dr. Physick and "recovered very speedily."[2] Dr. Couper, of the Glasgow Infirmary, also has reported a dislocation of the forearm backwards and outwards, occurring in a young man aged seventeen, and which he thinks was accompanied with this fracture. The dislocation was easily reduced, but returned again immediately on ceasing the extension. The fragment was not felt, nor does he speak of crepitus; the existence of the fracture being inferred from the fact that the bones would not remain in place without help. The forearm was placed across the chest, with the fingers pointing toward the opposite shoulder, and secured in this position with splints and a bandage. At the end of four weeks union had taken place, with only slight deformity, although with some stiffness of the joint.

In relation to this example, the editor remarks that the symptoms were not to his mind conclusive in determining the existence of a fracture of the coronoid process, and he inclines to the belief that it was rather an oblique fracture of the lower extremity of the humerus. "In cases like these," he adds, "where very rare accidents are suspected, we think that unless the diagnosis is clear, the leaning should always be the other way: we mean that, *cæteris paribus*, the symptoms should rather be referred to the common than the extraordinary injury. The contrary practice introduces a dangerous laxity in diagnosis."[3]

[1] Dorsey, Elements of Surgery, vol. i. p. 152. Philadelphia, 1813.
[2] Fahnestock, Amer. Journ. Med. Sci., vol. vi. p. 267.
[3] Couper, Med.-Chir. Rev., new ser., vol. xi. p. 509.

Dr. Duer, of Philadelphia, has reported a case which occurred in a boy six years old, and in which he felt and moved the fragment with his fingers. It was complicated with a dislocation, which remained unreduced. This case was last seen about seven weeks after the accident.[1] The Doctor adds: "If at a later period we could be permitted to examine the patient, it is probable that the diagnosis might be rendered certain."

In the *American Medical Monthly* for October, 1855, also, I find the report of a trial for malpractice, in which a lad nine years old received some injury about the elbow-joint which resulted in a maiming. The defendant claimed that there had been a dislocation of the forearm backwards, accompanied either with a fracture of the trochlea of the humerus, or of the coronoid process of the ulna.

Says Mr. Liston: "The coronoid process is occasionally pulled or pushed off from the shaft, more especially in young subjects. I saw a case of it lately, in which the injury arose in consequence of the patient, a boy of eight years, having hung for a long time from the top of a wall by one hand, afraid to drop down;"[2] after whom Miller, Erichsen, Skey, Lonsdale, and most of the Scotch and English surgeons have repeated the assertion that this process may be broken in this manner by the action of the brachialis anticus alone, yet no one of them has to this day seen another example.

Fig. 117.

Ulna, with epiphysis. (From Gray.)

The explanation of the accident in the case of the boy, given by Liston, implies two anatomical errors: first, that the coronoid process is an epiphysis during childhood; and second, that the brachialis anticus is inserted upon its summit. The coronoid process is never an epiphysis, but is formed from a common point of ossification with the shaft; the olecranon process and the lower extremity of the ulna having also separate points of ossification; the olecranon becoming united to the shaft at the sixteenth year, and the lower epiphysis at the twentieth. Moreover, the brachialis anticus has its insertion at the base of the process and partly upon the body of the ulna, but in no part upon its summit; indeed, the process seems rather to be intended as a pulley over which the brachialis anticus may play; resembling also somewhat, in its function, the patella; serving to protect the joint and perhaps the muscle itself from becoming compressed in the motions of the joint. Certainly it could never have been broken by the action of this muscle, and the case mentioned by Mr. Liston must find some other explanation. It may have been a rupture of the brachialis anticus itself, or of the biceps, or possibly a forward luxation of the head of the radius. Either of these suppositions is more rational than the statement made by Mr. Liston, because either one of them is possible, while his supposition is impossible.

[1] Duer, Amer. Journ. Med. Sci., Oct. 1863, p. 390.
[2] Liston, Practical Surgery, p. 55.

Ulrichs,[1] Battams,[2] Laugier,[3] Lorinzer,[4] Zeis,[5] Lotzbeck,[6] Comoy,[7] Gripat,[8] have also reported clinical examples not verified by dissection.[9]

The first two of the above enumerated (Brassard's and Pennock's) were not satisfactory to Malgaigne; the third is spoken of cautiously by Sir Astley Cooper, as if it needed, in addition to his own great name, the indorsement of the "London council." Dorsey reports his case upon hearsay, and the result is quite too satisfactory to give it much claim to credibility. Fahnestock's case is, to my mind, far from being fully proven. Couper's case is doubted by Dr. Johnson; and the New Hampshire case was not made out satisfactorily to either the jury or the medical men. Liston's case was simply impossible. Duer's case could have been better verified at a later period.

Poinsot, speaking of some of the more recently reported clinical cases, says: "The first case of Ulrichs's is more than doubtful; the author himself admits that the diagnosis was made *by exclusion*. As to the case of Battams, the diagnosis is based solely upon the ease with which the dislocation was produced and reproduced; it is, therefore, truly a claim on principles, the point at issue being to know precisely if that tendency to be reproduced was really to be attributed to the fracture of the apophysis. The same remark applies to the cases of Lorinzer and of M. Richet. I have already said why I thought that Laugier's case and my own should be rejected. Zeis, in his case, does not define in any way the character of the injury. There only remain, therefore, the cases of Lotzbeck, where the diagnosis seems to be clothed with all the guarantees; but is it not to be somewhat wondered at that the same surgeon should have met with three cases so absolutely analogous, and terminating with such equally happy results? At all events, these cases can only be considered as exceptions."

In the case described by Laugier, a boy æt. 12, had fallen upon the right hand, the forearm being slightly flexed. He was admitted to the hospital, July 6, 1840, with a dislocation of the radius and ulna backwards. The dislocation was easily reduced, and the motions of the joint were completely restored. The swelling having subsided after 10 or 12 days, a small, very hard, circumscribed and slightly movable tumor was observed a little below the bend of the elbow, which interfered with flexion.

Having described the case, of which I have only given a summary, Poinsot relates what he regarded as a similar case sent to him by his colleague, M. Gautier. A man, twenty days before, had fallen upon his hand. Gautier found a dislocation, which he reduced easily, and the

[1] Ulrichs, Deuts. Zeits. für Chir., t. 10, Nov. 1878.
[2] Battams, The Lancet, 1878, vol. 2, p. 607.
[3] Laugier, Bullet. Chir., 1840.
[4] Lorinzer, Zeits. der K. K. Ges. der Ac. für Wein, vii. Jarh., Heft 7.
[5] Zeis, Schmidt's Jahr. für 1866, p. 134.
[6] Lotzbeck, Die Frak. Pr. Cor., Munchen, 1865.
[7] Comoy, Frac. de l'Apoph. Cor. etc., Thèse Paris, 1881.
[8] Gripat, Bull. Soc. Anat., 1872.
[9] When speaking of fractures of the head of the radius I have said, that Dr. Hodges had three times found the coronoid process broken in that connection. I ought to have said he had found *in the reported dissections*. To these I shall hereafter refer.

motions of the joint were completely restored. When seen by Poinsot there existed a hard, circumscribed tumor, which seemed united to the tendon of the brachialis anticus. The limb could not be flexed well. Upon careful examination, Poinsot, who at first thought it might be a fracture of the coronoid process, decided that it was "an induration, such as results from certain contusions; and that opinion seems now to be confirmed by the researches of M. Charvot, on the transformation of sanguinolent deposits at the bend of the elbow. I believe that Laugier's case should receive the same explanation."

Poinsot refers also to the two supposed cases reported by Lorinzer and Comoy, respectively, both accompanied with a dislocation backwards. In the first case there was marked bony crepitus in the region of the coronoid process, but Lorinzer was compelled to recognize the fact that no swelling existed in the supposed seat of fracture. In the second case, a fine and dry crepitus could be felt at the bend of the arm. Professor Richet, in whose wards the patient was, recognized a fracture, but could not fix its exact location.

The three cases met with by Lotzbeck presented, says Poinsot, "a most complete similarity with each other. In the three instances, there was felt at the bend of the elbow a small tumor, hard and circumscribed, movable laterally, and giving rise to crepitation when moved. The displacement (twice both bones, and once the ulna only were dislocated) was easily reduced, but would be reproduced immediately. In the three cases the cure was accomplished and the movements of flexion were regained pretty promptly and with almost their normal freedom."

Of the clinical case reported by Ulrichs, the same writer remarks: "A young boy fell upon his left side while helping to carry a beam whose weight was resting on his left forearm, which was bent at a right angle. He experienced a violent pain and could neither flex nor extend the forearm. The surgeon who was called felt a pretty obscure crepitus in the region of the bend of the elbow; but there being no displacement of the bony prominences, the diagnosis of fracture of the coronoid process was made by exclusion."

"M. J. Scott Battams, of Royal Free Hospital," says Poinsot, "thought he had to deal with a fracture of the coronoid process in the case of a man who, slipping on a sidewalk, had his elbow caught between his hip and the pavement. At first it was difficult to determine the nature of the lesion; the patient could, with pain it is true, extend and flex the forearm a little beyond a right angle. Supination and pronation were performed slowly, but well; the bony prominences of the elbow had kept their normal relations, and the head of the radius was in its ordinary position. Up to that time the patient had supported the wounded arm with the other hand; suddenly he allowed it to drop, and at once the ulna was dislocated backwards, the radius remaining in place. This dislocation was reduced easily, but to be reproduced with the same facility. The limb was placed on an elbow-splint, which was allowed to remain for three weeks. At that time, there existed a small indurated growth on a level with the coronoid process, *at the point where in the beginning there was a bloody effusion*. The movements, at first impeded, were soon completely regained."

Certainly it is not upon such testimony as this that we can rely to sustain Mr. Fergusson's opinion that this fracture is likely to occur in all dislocations of the forearm backwards, or of Malgaigne's conjecture that it is of more frequent occurrence than the published cases would seem to show. Nor will it be regarded as conclusive, that the beak of the process is often found broken after luxations made upon the subject; since between luxations thus produced and luxations occurring in the living subject there exists this important difference, that, in the case of the latter, muscular action is the principal agent in the production of the dislocation, while in the former it is the external force alone which drives the bone from its socket.

The fact, therefore, that so few cases have ever been reported, and that most of these are far from having been clearly made out, remains presumptive evidence that the actual cases are exceedingly rare; but if to this we add such evidence as is furnished by actual dissections, and by examinations of the pathological cabinets of the world, we think the testimony is almost conclusive.

Examples supposed to be established by dissection.—In 1834, M. Bérard[1] examined the arm of a man who had been killed by a fall from a second story. The forearm was dislocated backwards. In attempts at reduction and redislocation, there was observed, under moderate pressure, a slight crepitation. There was found a fracture of the coronoid process, of the anterior third of the head, including a portion of the neck. Sir Astley Cooper[2] says that a person was brought to the dissecting-room at St. Thomas's Hospital, who had been the subject of this accident. "The coronoid process, which had been broken off within the joint, had united by a ligament only, so as to move readily upon the ulna, and thus alter the sigmoid cavity of the ulna so much as to allow in extension that bone to glide backwards upon the condyles of the humerus." Mr. Bransby Cooper adds, in a note, that the external condyle of the humerus was also broken and united by a ligament.

Samuel Cooper describes, rather obscurely, a specimen contained in the University College Museum, "in which the ulna is broken at the elbow, the posterior fragment being displaced backwards by the action of the triceps; the coronoid process is broken off; the upper head of the radius is also dislocated from the lesser sigmoid cavity of the ulna, and drawn upwards by the action of the biceps. In this complicated accident the ulna is broken in two places."

Velpeau has also established by two autopsies the existence of a fracture of the coronoid apophysis.

Dr. Charles Gibson, of Richmond, Va., has stated to me, by letter, that he has in his possession a specimen of this fracture, evidently belonging to an adult. The process was broken transversely near its extremity, and has united again quite closely and without any displacement, and without ensheathing callus.

Lotzbeck[3] has seen, as he thinks, an ancient fracture of this process, in the cadaver, the line of fracture passing beneath the lesser sigmoid cavity and into the greater sigmoid cavity. The condyle was broken

[1] Bérard, Dic. de Med. Art. Coude.
[2] Sir A. Cooper, Dislocations and Fractures, p. 411.
[3] Lotzbeck, loc. cit.

also, and was reunited by fibrous tissue and cartilage. The coronoid was united by bone, and loaded with osteophytes.

Ulrichs[1] found, in a cadaver, a fissure of the summit of the coronoid process, caused by tortion or twisting of the forearm, without any other lesion of the bone. In a cadaver seen by Gripat, the coronoid process was fractured at its base, and the radius and ulna were dislocated backwards and upwards.

Allandale[2] also, having performed resection for an ancient dislocation, found this process fractured, and a bony callus had united the ulna to the humerus.

Gurlt[3] has described a specimen, contained in the museum at Braunschweig, illustrating a fracture of the extremity of the coronoid process. A small fragment was also broken from the ulnar side of the olecranon. Both fragments have united by bone.

Says Mr. Flower, Conservator of the Museum of the Royal College of Surgeons, "the cases that have been reported in which it has been observed in the living subject are exceedingly unsatisfactory." . . . "I have been able to meet with but three or four specimens, and recorded post-mortem examinations of this injury" (alluding, I presume, to clinical cases). "One of the former is in the museum of Guy's Hospital. Another case is that of a man killed by a fall from the roof of St. George's Hospital; in whom the coronoid processes were found to be fractured, and the two bones of the forearm dislocated backwards on both sides."[4] The first of the specimens (Guy's Hospital) has been described by Mr. Bryant,[5] as having occurred in a woman seventy years old, and as having been caused by a fall upon the elbow. In addition to a fracture of the coronoid near its extremity, there was a comminuted fracture of the anterior third of the head of the radius. Indeed, it will be observed that in several of the cases verified by dissection, the fracture of the coronoid process was accompanied with other fractures in the vicinity of the joint; a circumstance which would not usually permit them to be studied or classified as simple fractures. Perhaps, however, we ought to consider, from the frequency of its concurrence, a longitudinal fracture of the head of the radius as a natural complication of the fracture now under consideration, when it is caused by a dislocation of the radius and ulna backwards.

In reference to the specimen belonging to my distinguished friend, Dr. Gibson, of Richmond, Va., notwithstanding the respect which I entertain for his opinion, I cannot avoid a suspicion that the bone was never broken at all, since I find it more easy to believe that he is deceived by certain appearances, than that it should have united by bone again, and so perfectly as not to leave any line of separation or degree of displacement. Certainly the fracture was too high to have been produced by the action of the muscle, if such a thing were ever possible; and if broken by a dislocation, which must have forced it violently from its

[1] Ulrichs, loc. cit. [2] Allandale, Med. Times and Gaz., May 25, 1875.
[3] Gurlt, Von den Knocken., 1862, vol. i. p. 41.
[4] Flower, Holmes's Surgery, 2d New York ed., vol. ii. p. 790.
[5] Bryant, System of Surgery, 1st London ed., pp. 939, 941.

position, as the ulna was driven upwards, it seems improbable that, if broken at this point, it could ever be made to unite again so perfectly.

Poinsot, speaking of Lotzbeck's case, and after recapitulating in detail the anatomical conditions presented, concludes, that it "was much more probably a case of dry arthritis, following the fracture of the condyle, than a simultaneous fracture of the coronoid process and the ulna."

Causes.—Judging from the clinical cases alone, it would seem that the most frequent cause of this accident is a fall upon the outstretched hand, and generally upon the palm of the hand; the force of the blow being received upon the lower end of the radius, and, through its numerous muscles and ligamentous attachments, being indirectly conveyed to the ulna, producing a violent concussion of the coronoid process against the trochlea of the humerus, and resulting finally in a fracture of this process and a dislocation of both bones of the forearm backwards. The examples verified by dissection, however, seem to have been produced by a variety of causes. The gentleman seen by Sir Astley had fallen upon his extended hand while in the act of running. Brassard's patient had fallen also upon his hand with his arm extended in front. The same was the fact in the cases seen by Lorinzer, Richet, and Lotzbeck; the latter of whom has recorded two cases due to this cause. Pennock's patient, a man of sixty years, had fallen upon the palm of his hand, and Fahnestock's fell upon the "back of the palm." In one of Lotzbeck's cases the fracture was supposed to be caused by extreme flexion of the forearm; and in another case of supposed fracture, seen by Lotzbeck, it seemed to be the result of direct violence. While in a case seen by Ulrichs, a longitudinal fissure was caused by violent tortion or twisting of the forearm. In the case mentioned by Bryant, the patient fell upon the elbow.

Symptoms.—Partial or complete displacement of the ulna, or of the radius and ulna backwards, accompanied with the usual signs of these luxations. In two of the examples mentioned by Malgaigne there was a luxation of the forearm backwards; such was also the fact in the case seen by Fahnestock; in Couper's case it was dislocated backwards and outwards, and in Sir Astley's case I infer that there was only a subluxation of the ulna backwards. In a case seen by Gripat, verified by an autopsy, there was a dislocation of the ulna. In the cases of Lorinzer and Richet, both bones were dislocated backwards, and in two of those seen by Lotzbeck. A feeble crepitus has sometimes been recognized; and it is fair to presume that in some examples the fragment, carried forwards by being driven against the trochlea, may be felt displaced and movable in the bend of the elbow. We must be careful, however, not to mistake a hard nodule following traumatisms in this region, and the frequent occurrence of which has been signalized by Charvot, for the coronoid process. If only the summit is broken off, the brachialis anticus could have no influence upon it; but if it were broken fairly through the base, it might be displaced slightly in the direction of the action of this muscle.

The symptoms, however, which have been regarded as most diagnostic, are the disposition to reluxation manifested in most of these examples when the extension has been discontinued. But it must not be forgotten that other conditions than a fracture of the coronoid process may cause

a reluxation, such as a fracture of the internal condyle, of the trochlea, or a splitting of the condyles, or some other derangement of the articular surfaces, or of the ligaments or muscles concerned in the articulation. Possibly, where the force applied has been great, as in falls from a great height, the brachialis anticus may have been detached.

Prognosis.—In the case of Cooper's patient, seen several months after the accident, the ulna projected backwards while the arm was extended, but it was without much difficulty drawn forwards and bent, and then the deformity disappeared. He thought that during extension the ulna slipped back behind the inner condyle of the humerus. Brassard's patient, seen after three months, retained the power of pronation and supination, with also extension, but flexion was impossible, the forearm being arrested in this direction by the small, slightly movable fragment of bone in front of the elbow-joint, and which was supposed to be the process itself. Pennock's old man, who had met with the accident in boyhood, had still the radius luxated forwards and outwards, and the olecranon more salient backwards than in the sound arm. Extension and flexion were nearly but not quite complete. Fahnestock informs us that his patient "recovered completely," but whether without deformity or maiming we are not told. Couper says the bone was united in four weeks, and that only a slight deformity and a little stiffness remained. Physick's patient made a perfect recovery.

"The same result," says Poinsot, "followed in Dr. Scott Battams's patient, in whom the difficulty in flexion and extension which existed at first, disappeared in a few weeks. In the case of Allandale, the dislocation had remained unreduced, but no mention is made of the kind of dressing employed at the beginning. In Lorinzer's case, the movements of the elbow remained limited, the patient could only flex the forearm to a right angle. On the contrary, Richet's patient showed no remaining trace of the accident when she left Hôtel-Dieu at the end of fifty-two days. It has already been seen that in Lotzbeck's cases, the result was no less favorable."

Let us return to the examples verified by dissection and to the cabinet specimens. Rejecting the doubtful specimens belonging to Dr. Gibson, and that of Lotzbeck, also those of "Hodges,[1] of Gripat, and of Ulrichs, where there was no opportunity to get a history of the fracture, as well as that of Allandale, where it is difficult to determine what part of the tumor surrounding the humerus and ulna is due to the consolidation of the fracture." (Poinsot.)

In the specimen described by Gurlt, without a history, the fragment is united, in position, with exuberant callus on the anterior surface.

And in the specimen referred to by Bryant, the coronoid process and a portion of the head of the radius having been broken, bony union has taken place without displacement of either.

Samuel Cooper says that in the case of the University College specimen the radius remains dislocated forwards and upwards, and the olecranon is displaced backwards, but he does not say whether the coronoid process

[1] The case of Hodges probably here referred to, and reported first in 1866, vol. 75, p. 383, of the Boston Medical and Surgical Journal, and subsequently in vol. 96, p. 65, of the same journal, was not properly speaking a fracture of the coronoid process, but a longitudinal fracture of the upper end of the ulna.

has united, nor describe its position; but Sir Astley informs us that in the example seen and dissected by him the process was united by ligament, which was sufficiently long and flexible to allow the fragment to move upwards and downwards in the motions of flexion and extension.

In the absence of other testimony, we may be allowed to express an opinion that when the fracture has taken place across the summit or above the insertion of the brachialis anticus, nothing but a ligamentous union can be regarded as possible, since the fragment can only derive nourishment from a few untorn fibres of the capsule and perhaps of the internal lateral ligaments; and although it may not be displaced, it cannot have the advantage of impaction, upon which alone, I suspect, a fracture of the neck of the femur within the capsule must rely for a bony union, if it ever does so unite. If, however, the fracture has taken place at the base, and fortunately it has not become much displaced by the force of the concussion against the humerus, it does not seem to me improbable that under favorable circumstances a bony union might occur. It will be remembered that a good portion of the attachment of the brachialis anticus is still below the fracture, and the remaining fibres are not therefore very likely to displace the fragment, especially when the arm is sufficiently flexed, so as properly to relax this muscle.

It will be of small importance, however, whether the union is bony or ligamentous, provided only there is not great displacement.

Treatment.—Whatever view we take of the mechanism or pathology of this accident, the rational mode of treatment would seem to be to flex the arm at a right angle, and retain it a sufficient length of time in that position; not forgetting, however, the danger of anchylosis from long-continued confinement in one position.

An angular splint may be useful in preventing motion at first, but I think it ought not to be continued beyond seven or ten days at the most. After this, a simple sling is all that is necessary, since from this period some motion must be given to the joint if we would take the proper precautions to prevent stiffness. Sir Astley Cooper thought the limb ought to be kept immovable three weeks, and Velpeau preferred four; but I cannot agree with them, believing that the question of the future mobility of the elbow-joint is vastly more important than the question of a bony or ligamentous union between the fragments. Couper says that he adopted in the treatment of the case reported by him, extreme flexion; but both Physick and Fahnestock placed the arm at right angles, and Sir Astley Cooper has recommended the same position. The latter position has always the advantage in case permanent anchylosis occurs, and the former cannot add much to the chance of complete replacement of the fragment.

Bandages are only serviceable to retain the splint in place, and they may be thrown aside as soon as the splint is removed.

§ 3. Shaft of the Ulna.

Causes.—The shaft of the ulna, when it alone is the seat of fracture, is generally broken by a direct blow. I have never seen an exception to this rule; but Voison related in the *Gazette Médicale* for 1833 a

single exception, in which it was said to have been broken by a fall upon the palm of the hand. Malgaigne thinks it is most often broken when one seeks to ward off a blow with the arm; but it has happened most often to me to see it broken by a fall upon the side of the arm.

Point of Fracture, Direction of Displacement, etc.—In an analysis of thirty-six cases, I find the shaft has been broken eleven times in its upper third, fourteen times in its middle third, and ten times in its lower third. All portions seem, therefore, to be about equally liable to fracture. I think, also, the fractures have generally been oblique.

Contrary to what has been observed by other writers, I have noticed that no law prevailed as to the direction in which the fragments have become displaced; the broken ends being found directed forwards, backwards, inwards, or outwards, according to the direction of the blow which has occasioned the fracture; and this is in accordance with the general rule in other fractures occasioned by direct blows. No doubt, however, other things being equal, the tendency of the lower fragment would be toward the interosseous space, in consequence of the action of the pronator quadratus in this direction; while the upper fragment, owing to its broad and firm articulation at the elbow-joint, can only be displaced forwards or backwards, at least to any great extent.

Complications.—In no case of the shaft of a long bone have I found serious complications more frequent than in fractures of the shaft of the ulna. Four have been compound; twelve complicated with a forward, or forward and outward dislocation of the head of the radius; one with a partial dislocation of the lower end of the radius backwards; and one with a dislocation of both radius and ulna backwards at the elbow-joint. It will be seen, therefore, that eighteen, or nearly one-half of the whole number, have been seriously complicated.

Fig. 118.

Fracture of the shaft of the ulna.

Symptoms.—Occasionally this fracture is found to exist without sensible displacement. In such cases the diagnosis is sometimes difficult, and can only be determined by the crepitus and mobility. If, however, the ulna is firmly seized above and below the point which has suffered contusion, and pressed in opposite directions, these signs will generally be sufficiently manifest, and will render the diagnosis certain.

But in cases where there is considerable displacement, the inner margin of the bone is so superficial as to enable us to detect its deviations with the eye alone, or, when swelling has already occurred, by the fingers carried firmly and slowly along this margin.

If the head of the radius is dislocated also, the displacement of the broken ends of the ulna must always be considerable, and the consequent deformity palpable. I have known one instance, however, in which a surgeon living in the neighboring province of Upper Canada recognized and reduced a dislocation of the radius and ulna backwards, but did not detect a fracture of the ulna two inches above its lower end. Six months after, in the month of March, 1856, the patient called upon me with

a marked deformity near the wrist, occasioned by the backward projection of the broken ulna, and with a complete loss of the power of supination. It will not surprise us that this fracture was overlooked when we learn that the man had fallen fifty-five feet.

Prognosis.—In simple fractures the prognosis is generally favorable, since no overlapping can occur, and the lateral displacements are not usually sufficient to produce a marked deformity, or to interfere materially with the functions of the arm; yet it is not unfrequent to find the fragments inclining slightly forwards or backwards, inwards or outwards. If the fragments fall toward the radius, I have noticed in three or four instances a slight projection of the lower end or styloid process of the ulna to the ulnar side; but not interfering in any degree with the motions of the wrist-joint.

I have seen a dislocation of the head of the radius left unreduced nine times after a fracture of the ulna, and in each example the forearm was shortened. A boy, æt. 17, was struck by a locomotive, and severely injured in various parts of his body, June 5, 1855. I saw him, with two very intelligent country practitioners, a few hours after the accident. The whole left arm was then greatly swollen. Crepitus was distinct, and we easily recognized the fracture of the ulna about three inches below its upper end, with which an open wound was in direct communication. We suspected, also, a dislocation of the head of the radius forwards, but as we could not make ourselves certain, and finding that the arm was in such a condition as to preclude any further manipulation without greatly diminishing the chance of saving the limb, we made no attempt at reduction, but laid the arm upon a pillow and directed cool water lotions.

At no subsequent period, in the opinion of the medical gentleman who was left in charge, did a favorable opportunity occur to reduce the radius; and at the end of two months I found the ulna united, with the fragments bent forwards and outwards toward the radius, while the head of the radius lay in front of the humerus. The forearm was shortened three-quarters of an inch. He could flex his arm freely to a right angle and a little beyond; and he could straighten it perfectly. Hand slightly pronated, with partial loss of supination. Whole arm nearly as strong and as useful as before the accident.

The second case occurred in the person of a man æt. 26, residing about twenty miles from town, and was occasioned by the kick of a horse. This was also a compound fracture. It does not appear that his surgeon discovered the dislocation of the radius, but supposed that it was a fracture of both bones. On the ninth day the patient became dissatisfied and dismissed his surgeon, but employed no other.

Oct. 1, 1849, eleven weeks after the accident, he called upon me. I found the ulna united, with a manifest displacement, but I could not discover that there had been any fracture of the radius. The head of the radius was in front of the external condyle, and a depression existed where it formerly articulated. When the arm was flexed, the head did not strike the humerus so as to arrest the flexion, but it glided upwards and outwards along the inclined base of the external condyle. He had

already begun to use his arm considerably in labor. The forearm was shortened one inch.

Three times I have noticed after the lapse of several years that the forearm could not be perfectly supinated; but pronation was never permanently impaired. I think, also, that the motions of flexion and extension have always, except where the radius has remained dislocated, been completely restored soon after the splints were removed; and even in these latter cases it is only extreme flexion which has been hindered.

I have occasionally met with examples in which this bone has failed to unite, and Muhlenberg, in his tables, records sixteen cases.

Treatment.—In simple fracture we must look carefully to the lateral deviation of the fragments; and if they are found to be salient forwards or backwards, pressure made directly upon or near their extremities restores them to place, but it often requires considerable force to accomplish this. A gentleman fell and broke the right ulna near its middle. He came immediately to me, and I found the fragments displaced backwards. Pressing strongly with my fingers they sprung forwards with a distinct crepitus, and I thought they were now in exact line. A broad and well-padded splint was applied to the forearm, and I took especial pains with compresses nicely adjusted, from day to day, to keep everything in place. The arm was placed in a sling. Eight months after the accident this gentleman died of cholera, and I was permitted to dissect the arm. I found the fragments well united, but with a very palpable projection of the fragments backwards, in the direction in which they were at first.

If the displacement is in the direction of the radius, it is more difficult to overcome, but its necessity is much more urgent, since, if the fragments fall completely against the radius, a bony union may take place, occasioning a complete loss of the power of pronation and of supination.

While moderate extension is being made, and the hand is well supinated, the fingers of the surgeon should be pressed firmly, and in spite sometimes of the complaints of the patient, between the radius and ulna, and the fragments of the broken ulna fairly pushed out from the radius.

The forearm may now be laid in the usual position against the front of the chest, midway between supination and pronation, and the same splints applied and in the manner which we shall hereafter describe for fractures of the shaft of both bones.

We ought, however, especially to bear in mind the danger of pushing the fragments toward the radius, by allowing the sling or the bandage to rest against the middle of the ulnar side of the bone. To prevent this the sling ought to support the arm by passing only under the hand and wrist, or the forearm may be laid in a firm gutter, which will touch the forearm only at the elbow and wrist, or it may be laid upon its back, as suggested and practised by Scott, and also by Fleury, the latter of whom, according to Malgaigne, had a case which had been treated in the position of semi-pronation, and which remained not only displaced, but refused to unite; but when the arm was supinated, the fragments came at once into contact, and bony union speedily took

place. This position may be adopted whenever it is found to be practicable; but the position of semi-pronation is generally much more comfortable to the patient, at least when the forearm is laid across the chest, and I have found very few patients who would submit to a position of complete supination.

In fractures accompanied with dislocations of the head of the radius forwards or backwards, nothing should prevent the immediate reduction of the dislocation but a demonstration of its impossibility, or a condition of the limb which would render manipulation hazardous. It can be reduced, generally, by pushing forcibly upon the head of the bone in the direction of the socket, while the arm is moderately flexed so as to relax the biceps, and while extension is being made at the forearm by an assistant. In making the counter-extension, care should be taken to seize the lower end of the humerus by the condyles, rather than by its anterior aspect, by which precaution we shall avoid pressing upon and rendering tense the tendon of the biceps.

July 29, 1845, a lad, æt. 9, fell from his bed, breaking the ulna and dislocating the head of the radius. Dr. Austin Flint was called on the following morning, and at his request I was invited to see the patient with him. We found the ulna broken obliquely near its middle, and the head of the radius dislocated forwards. While Dr. Flint seized the elbow in front of the condyles, I made extension from the hand, the forearm being slightly flexed upon the arm, and at the same moment I pushed forcibly the head of the radius back to its socket. The reduction was accomplished easily and completely.

We then dressed the arm with an angular splint, constructed with a joint opposite the elbow. This was laid upon the palmar surface, and the whole was nicely padded, especially in front of the head of the radius. In two weeks pasteboard was substituted for the angular splint. At the end of six weeks I was permitted to examine the arm, and found the head of the radius perfectly in place, but the points of fracture slightly salient. All of the motions of the arm were fully restored.

June 2, 1845, C. C., æt. 9, fell upon his arm, breaking the ulna obliquely near its middle, and dislocating the head of the radius forwards. Dr. J. P. White being called, requested me to visit the patient with him. We found one of the broken fragments protruding through the skin, on the inside of the arm.

With great ease, and by simply pressing with considerable force upon the head of the radius, it was made to slide into its socket. The case was left in charge of Dr. White.

Five weeks after, I found all of the motions of the forearm completely restored, except that he could not extend it perfectly. The head of the radius was also a little more prominent in front than in the opposite arm.

Four or five years later, the projection of the head of the radius had disappeared, and the functions of the arm were perfect.

In Dr. Muhlenberg's tables of delayed and non-union, resection was practised three times, but with no recorded cures. This is a result which might reasonably be expected; while drilling was practised six times, with five successes.

§ 4. Fracture of the Styloid Process of the Ulna.

The occasional complication of a Colles's fracture with a fracture of the styloid process of the ulna has already been noticed. Much more rarely this process is broken alone, as a result of direct violence.

I am unable to speak of the symptoms or treatment of this accident farther than to say, that it must be easily recognized by its mobility, and probably by the presence of crepitus; and that its treatment demands immobilization, while the wrist is maintained in a straight position, or in a position slightly inclined towards the ulna. At least a fibrous union ought thus to be easily obtained.

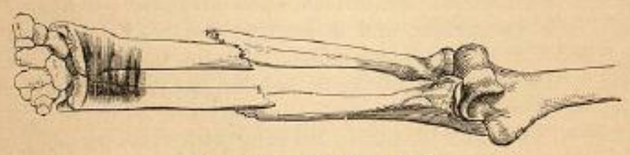
CHAPTER XXIV.

FRACTURES OF THE RADIUS AND ULNA.

Causes.—In a majority of the examples of this fracture seen by me, which have been of such a character as to warrant an attempt to save the limb, the accident has been occasioned by a fall upon the palm of the hand while the arm was extended in front of the body. Yet this cause is not so constant as in fractures of the radius alone, since a considerable number have been occasioned by direct blows; and if we were to add to this estimate all of those bad compound fractures which have demanded immediate amputation, the proportion of fractures occasioned by direct and indirect blows might be found to be pretty nearly balanced.

Point of Fracture, Character, Direction of Displacement, etc.—In a record of seventy-two fractures of both bones, not including gunshot

FIG. 119.



Fracture in the middle third.

fractures, or those demanding immediate amputation, I have found six broken in the upper third, thirty-one in the middle third, and thirty-five in the lower third.

In one case the radius was broken three-quarters of an inch above its lower end, and the ulna about one inch below the coronoid process. Four of the fractures belonging to the lower third were probably epiphyseal separations.

Fifty-eight were simple, eight compound, one was comminuted, three both compound and comminuted, one complicated with a fracture of the humerus, and one with a partial luxation of the lower end of the radius.

With three exceptions, all of these more serious accidents were arranged among fractures of the lower third, and generally the bones had been broken near the wrist.

Partial, or "green-stick," fractures have been frequently observed in children, but having treated of these accidents fully in the general chapter on Incomplete Fractures, I shall not think it necessary to make any further allusion to them in this place.

Prognosis.—Generally these bones unite in from twenty to thirty days; but I have seen the union occasionally delayed considerably beyond this time, and this delay has occurred especially in the case of the radius. Thus, in three cases of compound and comminuted fracture, the ulna united within four or five weeks, while the radius did not unite until the ninth or tenth week. Twice in simple fractures the ulna has united in the usual time, but the radius not until the sixteenth week. Once the ulna has united promptly and the radius remained ununited at the end of two years, at which time I practised resection of the broken ends of the radius, and union was speedily established.

On the other hand, I have once seen the union delayed four months in the case of the ulna, when the radius had united in the usual time; and in one example of compound fracture both bones refused to unite until after the fifth month. Muhlenberg has recorded thirty-seven cases of delayed and non-union of both bones, out of a total of six hundred and fifty-six similar examples in all the long bones.

FIG. 120.

Fracture in the lower third.

FIG. 121.

Union with slight lateral displacement.

A majority of the whole number seen by me have united without any appreciable deformity, and fifteen are known to have left some marked defect, while two have resulted finally in the loss of the arm. Of the remainder I cannot speak positively.

I have seen the fragments deviate slightly in almost every direction, but most often it has been noticed that the deviation was to the radial or ulnar sides. Thus, in three examples, two of which had been compound fractures, the bones have united in such a position as that from the point of fracture downwards the forearm has been deflected to the ulnar side, and a marked projection has been left at the seat of fracture on the radial side; while in two examples, both of which were simple fractures, exactly the opposite condition has obtained, the lower part of the forearm being deflected to the radial side.

In most cases the hand has been left with some tendency to pronation; in many instances this tendency was very slight and scarcely appreciable,