movable joint is used, slight changes may be made while the splint is on the arm; but if the angle is much changed without removing the rollers, they become unequally tightened over the arm, and may do mischief.

When anchylosis has actually taken place, we may more or less overcome the contraction of the muscles and of the ligaments by gentle, passive motion, or by directing the patient to swing a dumb-bell or some other heavy weight, as first recommended by Hildanus; but we must bear in mind the danger of causing a refracture by too early or immoderate force.

§ 7. Fracture at the Base of the Condyles, complicated with Fracture between the Condyles, extending into the joint.

This fracture, which is but a variety or complication of the preceding, is even more difficult of diagnosis; and its signs, results, and proper treatment differ sufficiently to demand a separate consideration.

Fig. 85.

Fracture at the base of, and between, the condyles.

I have recognized the accident six times. Confined to no period of life, it seems to be the result of a severe blow inflicted directly upon the lower and back part of the humerus, or upon the olecranon process. Dr. Parker, of New York, was inclined to regard an obscure accident about the elbow-joint, which he saw in a lad sixteen years old, as a longitudinal fracture of the humerus, with separation of one condyle, but which had been occasioned by a fall upon the hand.[1] For myself, I should regard this latter circumstance as presumptive evidence that it was not a fracture of this character, yet I do not mean to deny the possibility of its occurrence in this way.

Its characteristic symptoms are, increased breadth of the lower end of the humerus, occasioned by a separation of the condyles; displacement upwards and backwards of the radius and ulna; shortening of the humerus; crepitus and mobility at the base of the condyles, with crepitus also between the condyles, developed by pressing them together; or in case the radius and ulna are drawn up and back, the crepitus may be detected, after restoring these bones to place, by pressing upon the opposite condyles.

Its consequences are, generally, great inflammation about the joint, permanent deformity, and bony anchylosis. An opposite result must be regarded as fortunate, and as an exception to the rule.

Of the treatment, we can only say that it must be chiefly directed to the prevention and reduction of inflammation; at least during the first few days. Nor is this inconsistent with an early reduction of the fragments, and moderate efforts, by splints and bandages, such as I have directed in case of a simple fracture at the base of the condyles, to keep the fragments in place. No surgeon would be justified in refusing altogether to make suitable attempts to accomplish these important indications; but he must always regard them as secondary when compared with the importance of controlling the inflammation.

[1] Parker, New York Journal of Medicine, Nov. 1856, p. 391, 3d series, vol. i.

When splints are employed, the same rules will be applicable, both as to their form and mode of application, as in cases of simple fracture above the condyles. Plaster of Paris, or some of the immovable forms of dressing, furnished with ample fenestræ, will sometimes be preferred.

The following examples will more completely illustrate the character, history, and proper treatment of these cases than any remarks or rules which I can at present make.

A woman, æt. 44, fell upon the sidewalk in January, 1850, striking upon her right elbow. I saw her a few minutes after the accident, but the parts about the joint were already considerably swollen, and it was not without difficulty that the diagnosis was made out. The forearm was slightly flexed upon the arm, and pronated. On seizing the elbow firmly, a distinct motion was perceived above the condyles, and a crepitus. I could also feel, indistinctly, the point of the upper fragment. While moderate extension was made upon the arm, the condyles were pressed together, when it was apparent that they had been separated. On removing the extension, they again separated, and the olecranon drew up. She was in a condition of extreme exhaustion, and the bones were easily placed in position.

An angular splint was secured to the limb, and every care used to support the fragments completely, but gently.

From this date until the conclusion of the treatment the dressings were removed often, and the elbow moved as much as it was possible to move it.

Seven months after the accident, the elbow was almost completely anchylosed at a right angle. The fingers and wrist, also, were quite rigid. Six years later, the anchylosis had nearly disappeared; she could now flex and extend the arm almost as much as the other; the wrist-joint was free, and the fingers could be flexed, but not sufficiently to touch the palm of the hand. The line of fracture through the base could be traced easily, but the humerus was not shortened. There was, moreover, much tenderness over the point of fracture through the base, and at other points. Occasionally, a slight grating was noticed in the radio-humeral articulation. She experienced frequent pains in the arm, and especially along the back and radial border of the ring finger. During the first year or two after the accident, the arm wasted very much, but although the hand remained weak, the muscles were now well developed.

A gentleman was struck with the tongue of a carriage with which a couple of horses were running. The blow was received directly upon the back of the left elbow. Dr. Sprague and myself removed some small fragments of bone, and while opening the wound for this purpose, we could see distinctly the line of fracture extending into the joint as well as across the bone. The condyles were not separated.

The subsequent treatment consisted only in the use of such means as would best support the limb, and most successfully combat inflammation. The arm and forearm were laid upon a broad and well-cushioned angular

splint, covered with oil cloth, to which they were fastened by a few light turns of a roller.

Twelve years after, I found the humerus shortened one inch and a half. During the first year, he says, there was no motion in the elbow-joint, but he can now flex and extend the forearm through about 45°; when flexed to a right angle, it seems to strike a solid body like bone. Rotation of the forearm is completely lost, the hand being in a position midway between supination and pronation. He suffers no pain, and his arm is quite strong and useful. No means have been employed to restore the functions of the limb but passive motion at first, and subsequently constant, active use of the hand and arm.

The late Dr. Thomas Spencer, of Geneva, used to relate a case in which a surgeon was called to what he supposed to be a fracture of the lower end of the humerus, and which he treated accordingly, with splints, etc. On the second or third day, another surgeon was called, who removed the splints and bandages, and pronounced it a dislocation of the radius and ulna backwards; but he was unable to reduce it.

After some time, the first surgeon was prosecuted for having treated as a fracture what proved to be a dislocation. Dr. Spencer, who had examined the arm carefully, gave his testimony last, and at a time when, from the evidence, it seemed almost certain that the surgeon must be mulcted in heavy damages; but he declared his belief that both surgeons were right, since, on measuring the breadth of the humerus through its two condyles, he found that the humerus of the injured arm was three-quarters of an inch wider than the opposite. His conclusion, therefore, was that the condyles had been split asunder and were now separated; that the first surgeon properly reduced this fracture, but that when, on the second or third day, the second surgeon removed the splints and the dressings, a contraction of the muscles had taken place and the dislocation occurred, the bones of the forearm being drawn up between the fragments. Dr. Spencer believed this was an example of the variety of fractures now under consideration, but it is not quite certain that there was anything more than an oblique fracture extending into the joint, followed by a dislocation. In either case, the first surgeon was entitled to an acquittal, and so the jury promptly declared by their verdict.

Although the flexed position must usually be regarded as the best in these fractures, for the reason that it most completely relaxes the biceps, brachialis anticus, and the flexors of the forearm, and because if anchylosis ensues the flexed position gives the most useful arm, yet I think it might be proper to try what better may be accomplished by permanent extension, with the forearm straightened upon the arm, according to the method Dr. Clark, described in the preceding pages.

In a case of compound comminuted fracture of the character now under consideration, Dr. Stone, of the Bellevue Hospital, New York, removed the condyles and sawed off the sharp end of the humerus. The woman was twenty-six years old and intemperate. The operation was made as a substitute for amputation. No serious complications followed. On the ninety-sixth day the wounds were completely healed, and she could bend the forearm to a right angle with the arm, the action of the muscles having drawn up the radius and ulna against the lower end of the shaft

of the humerus, so that the motions were natural and free.[1] The practice, as the result sufficiently shows, was eminently judicious; and its practicability ought always to be well considered before resorting to the serious mutilation of amputation. The great principle upon which the success of resection is here based is the shortening of the bone, whereby the reduction may be accomplished without painful tension to the muscles; a principle which will demand of us hereafter a more careful consideration and a wider application.

Fractures and Diastases of the Condyles and Epicondyles.

Chaussier described that portion of the lower end of the humerus which articulates with the ulna as the trochlea, and that portion which articulates with the radius as the condyle; naming the two lateral projections, respectively, epitrochlea and epicondyle. Some of the French writers have adopted this nomenclature, but I prefer, as being more familiar to my own countrymen, the terms external and internal condyles, to which it will be convenient to add the terms external epicondyle and internal epicondyle, as indicating the abrupt lateral projections on either side of the condyles, of which the largest portions are epiphyseal. These crests or projections are formed in part by a prolongation of the outer and inner elevated margins of the humerus, and in part from separate centres of ossification, which in early life mainly overlie the two sides of the lower epiphysis. In advancing years these lateral epiphyses prolong themselves upwards to reach and partially overlie the humeral portions: the outer epiphysis becomes united by bony tissue to the shaft or humeral apophysis, about the sixteenth or seventeenth year; while the inner epiphysis, much larger than the outer, is not united usually to its corresponding apophysis until the eighteenth year. Gurlt places the period of union of both of these epiphyses a year or two later.

I shall hereafter speak of the epicondyles as all of those portions of the lower end of the humerus which project abruptly from the condyles, and are composed in large part of the lateral epiphyses, but not entirely. Practically, this definition leaves no portion of the lower extremity of the humerus outside of the capsule except the epicondyles. I say "practically," because it leaves no portion outside except the epicondyles which could possibly be broken off by an external or traumatic injury. We shall therefore have to speak only of fractures of the epicondyles, and of fractures of the condyles involving the joint; the condyles proper, as distinguished from the epicondyles, constituting on the one hand the outer end of the lower extremity of the humerus, including so much of the articular surface as belongs to the eminentia capitata; and, on the other hand, so much of the inner portion of the articular surface as includes the trochlea.

As the reader will see hereafter, the epicondylar separations consist of two varieties, one of which is an epiphyseal separation, and the other a true fracture: one of which includes only a portion of the epicondyle, and the other includes the whole. The remaining fractures will all be intracapsular.

[1] Stone, New York Journ. of Med., May, 1851, p. 302, vol. vi. 2d series.

§ 8. Fracture of the Internal Epicondyle; and Fracture or Diastasis of the Internal Epicondylar Epiphysis.

I will here add, to what I have already said in the preceding pages of the anatomy and development of the humerus, the very careful description of the development of the lower end of the humerus given by Dr. Zuckerkandl, Demonstrator of Anatomy in the University of Vienna.[1]

"The inferior extremity of the humerus proceeds from a synostosis of five separately developed portions of bone. These are: 1st, the humeral diaphysis, which includes the supratrochlear fossa, a minute portion of the eminentia capitata, and on the dorsal surface the ribbon-like zone of the trochlea; 2d, the trochlea; 3d, the eminentia capitata; 4th and 5th, the epicondyles. On the fully formed humerus that part is called the internal epicondyle which projects lever-like above the trochlea, and serves as the point of origin of the flexor group. Though this bony prominence presents itself as a united whole at this stage, still an examination of the humerus, in the earlier periods of its development, teaches us that the internal epicondyle of the adult consists of two pieces, the superior of which belongs to the humeral diaphysis, to the median surface of which the osseous nucleus of the epicondyle applies itself, enlarges, and finally unites with the upper portion to form the lever of the flexor group of muscles. Accordingly what, in ordinary acceptation, is called a fracture of the epicondyle is something more, since it includes also a part of the humerus. It is difficult to believe, that only that part of the internal epicondyle, which corresponds to the epiphyseal centre of ossification, should be broken off in the adult, so that distinct cases of epicondylar fracture can occur only in youthful persons.

"What we call external epicondyle, on the completely developed humerus, and a small portion of which (called 'la petite saillie,' in the above quotation from Malgaigne) can be felt and seen through the skin of the arm in lean subjects, belongs, as taught by embryological observation, not properly to the external epicondyle, but represents the most inferior prominence of the crista externa humeri, with which the more posteriorly extending epiphyseal nucleus of the external epicondyle finally unites. The epicondyles of adults, therefore, belong partly to the humerus and partly to the actual epiphyseal epicondyles, as a glance at the humeri of young persons teaches us. From the real internal epicondyle, which we term epiphyseal, arise the radialis internus, ulnaris internus, palmaris longus, and a small portion of the pronator teres, while from that part of the epicondyle which belongs to the humeral diaphysis, arises the greater portion of the pronator above named. On the external epiphyseal epicondyle are found the common extensor of the fingers, the ulnaris externus, and the anconeus quartus."

These views of the anatomy and development of the condyles and epicondyles, and which are no doubt correct, compel me to reconsider

[1] Zuckerkandl, on the Epicondylar Fracture of the Humerus. Hosp. Gazette, Sept. 27, 1879. Separat-Abdruck aus der "Allgem. Wiener Mediz. Zeitung," 1878, Nr. 9.

the statements I have made in the earlier editions of this work, and to correct certain errors into which the author, in common with all other writers, has fallen in the classification of certain reported examples of fractures of the epicondyles. Hitherto, while in speaking of fractures of the internal epicondyle, I have distinctly stated that my remarks were limited to separations of the epicondylar epiphyses, I have not hesitated to include as proper examples those cases in which I believed the entire epicondylar projection to be included. Other writers have, without exception so far as I know, done the same. The observations of Zuckerkandl, however, show that, as I have before stated, these extreme projections are composed only in part of the true epicondylar epiphyses. We must then hereafter speak of those separations which are epicondylar, and only epiphyseal, as composing one class of accidents, and which must be in a great measure peculiar to children; and of those which are epicondylar, but include also that portion of the epicondyle which is not epiphyseal, as another class, belonging chiefly to adults, but possible in children.

According to Zuckerkandl, it has been observed by Rambaud and Renault that there is sometimes a persistence of the epiphysis, the separation continuing to adult life; from which we must infer that an epicondylar epiphyseal diastasis might take place in the adult, but it must nevertheless be very infrequent. We can have, usually, no means of determining this point except in the autopsy, and we must therefore be left in doubt sometimes whether a particular clinical case is to be regarded as an epiphyseal separation or a true fracture: our only means of differential diagnosis being the probabilities afforded by the age of the patient, the cause, and the size and form of the fragment.

In treating of this subject then we can only relieve ourselves of the embarrassment by treating of epicondylar fractures and diastases as a class, existing in two subordinate forms—namely, one in which only the epiphysis is torn off before bony union to the crista humeri has taken place—a true diastasis; and the second, in which, bony union having been completed, the whole of the extreme projection or epicondyle is separated from the shaft—a true fracture.

We shall consider first—

Diastasis of the Epiphyseal Portion of the Internal Epicondyle.

This is probably the accident which Granger first described, and which he ascribed solely to muscular action. He does not speak of it, however, as a diastasis of the epicondyle, but as "a particular fracture of the internal condyle."

"A distinguishing circumstance attending this fracture," says Mr. Granger, "is that of its being occasioned by sudden and violent muscular exertion; and it will be recollected that from the inner condyle those powerful muscles which constitute the bulk of the fleshy substance of the ulnar aspect of the forearm have their principal origin. The way in which the muscles of the inner condyle are involuntarily thrown into such sudden and excessive action I take to be this: the endeavor to pre-

vent a fall by stretching out the arm, and thus receiving the percussion from the weight of the body on the hand"[1]

It is a fact of significance in this connection, that most of these fractures hitherto reported as epicondylar have occurred in children, before the union of the epiphysis is completed, when muscular contraction might more often prove adequate to its separation, and when the epicondyle is less prominent, and, therefore, less exposed to direct blows than in adult life. M. A. César has collected fourteen cases, of which number only four were adults, two were from eight to ten years old, five from eleven to twelve, and three from fifteen to sixteen.[2] While of five fractures which I have regarded as fractures of the epicondyle, all except one occurred between the ages of two and fifteen years. But then it is equally true that a large majority of all the fractures of the internal condyle, including those which enter the articulation, as well as those which do not, belong to childhood and youth. I have seen but two exceptions in fifteen cases. Since, then, direct blows generally produce those fractures which penetrate the joint, no good reason can be shown why they should not sometimes produce fractures of the epicondyle. One of the exceptions to which I have referred as not having occurred in early life, is sufficiently rare to entitle it to especial notice.

On the 16th of May, 1856, a laborer, thirty-four years of age, fell from an awning upon the sidewalk, dislocating the radius and ulna backwards; the dislocation was immediately reduced by a woman who came to his assistance, but when he called on me soon after, I found a small fragment of the inner condyle, probably the epicondyle alone, broken off and quite movable under the finger. It was slightly displaced in the direction of the hand.

I could not learn positively whether in falling he struck the elbow or the hand, but there was presumptive evidence that he struck the hand; if so, then probably the fracture was the result of muscular action, which is the more extraordinary as having taken place in a man of his age, but in which case it must be assumed that the epiphyseal union was delayed.

It is pretty certain, however, that the theory of causation adopted by Granger is too exclusive. A lad was brought to me in October, 1848, aged eleven, who had just fallen upon his elbow, the blow having been received, as he affirmed, and as the ecchymosis showed pretty conclusively, directly upon the inner condyle. The fragment was quite loose, and crepitus was distinct. He could flex and extend the arm, and rotate the forearm, without pain or inconvenience. I am quite sure the fracture did not extend into the joint; the result seemed also to confirm this opinion, for in three months from the time of the accident the motions of the elbow-joint were almost completely restored. Out of fourteen cases collected by César, at least eight, says Poinsot, were produced by a direct cause.

Indeed, Mr. Granger has failed to establish, by any particular proofs, that in more than one or two of his cases the fracture was the result of

[1] "On a Particular Fracture of the Inner Condyle of the Humerus," by Benjamin Granger, Surgeon, Burton-upon-Trent. Edinburgh Med. and Surg. Journ., vol. xiv. p. 196, April, 1818.

[2] César, Essai sur la frac. de l'épitrochlée, th. de Paris, 1876.

muscular action; but, on the contrary, I am disposed to infer, from the violent inflammation which generally ensued in his cases, from the frequency of ecchymosis, and especially from the injury done to the ulnar nerve in at least three instances, that most of them were produced by direct blows inflicted from below in the fall upon the ground. Fractures produced by muscular action are seldom accompanied with much inflammation or effusion of blood, and it is much more probable that the ulnar nerve should have been maimed by the direct blow which caused the fracture, than by the displacement of the epiphysis, which is, as I shall presently show, almost always carried downwards, and oftener slightly forwards than backwards. It is only when the fragment is forced directly backwards that the ulnar nerve could be made to suffer; a direction which, it does not seem to me, it could ever take from muscular action alone.

Of all the cases above alluded to, including Granger's cases, it may be justly said that they were not verified by an autopsy, and that they do not, therefore, prove absolutely the existence of such a diastasis.

In a case reported by Denucé, there was an exostosis resulting from a fracture, which caused paralysis of the ulnar nerve; but there is no evidence that the injury to the nerve was the result of displacement of the fragment. It was cured, however, by excision of the exostosis.[1]

Poinsot suggests that when a fracture of the internal epicondyle is caused by a fall upon the hand, the result may sometimes be due rather to the action of the internal lateral ligament than to muscular action; and he says that Granger, Fergusson, Dale, and Richet have observed cases of this kind. He, however, refers to one case mentioned by Hirtz, in which the accident was declared to be plainly the result of muscular action, it being occasioned in a little boy by the act of raising himself by his arms while suspended from a trapeze.

Malgaigne speaks of this accident as a "fracture of the epitrochlea;" evidently including in this term all of the epicondylar projection. He states, however, that "there is good ground for supposing that, in some cases at least, it is a disjunction of the epiphysis." Gurlt distinctly states, also, that clinical experience shows that both the inner and outer epiphyses are sometimes broken, however difficult it may be to demonstrate the fact anatomically. The case of which he furnishes an illustration in his book (p. 797, Fig. 109), and as being in the pathological collection at Würzburg, may indeed have been a fracture of the entire internal epicondyle, including both the epiphysis and the apophysis, but there is no evidence or pretence that it was the epiphysis alone.[2]

The specimen described by Zuckerkandl, found in the dissecting-room, and without a clinical history (Fig. 86), and which he has kindly sent to me, is probably the only example of which we can speak with any degree of positiveness as having been sustained by an autopsy. The following is his account of the specimen:

"The separation of the internal epicondyle I found on the left arm of a strong-boned man. After the removal of the flexors, the epicondyle

[1] Poinsot, op. cit., pp. 314–317.

[2] Handbuch der lehre von den Knochenbrüchen. Von Dr. E. Gurlt, Prof. der Chirurgie an der Königlichen Universitat zu Berlin. Hamm, 1862, pp. 796, 797.

appeared projecting forwards tumor-like, but immovable, so that at first sight I thought of a fracture healed by callus. As I removed the dense connective tissue, which surrounded the epicondyle, there appeared a furrow, which encircled the irregular bony prominence, and formed a sharp line of demarcation between it and the humeral epicondyle. The tumor-like bony prominence, therefore, represented the epiphyseal epicondyle. On farther examination it was seen that the epiphyseal was connected with the humeral epicondyle only by dense tissue, was irregularly formed on its uneven upper surface, slightly concave on its superior attached side, and of about the size of an os lunatum.

"In the figure is plainly seen the intact humeral epicondyle, the epiphyseal epicondyle, and between them the above-described furrow, which was filled with fibrous tissue. The separated epicondyle does not correspond in form to that of a youthful person, nor to the inferior part of the flexor condyle in the adult. Its long axis in the latter is parallel with that of the humerus—in our preparation, however, it is sagittal, twisted, as it were, on its axis. The inferior portion of the epicondyle is in the adult about one-half cm. distant from the edge of the trochlea, but it is more than one cm. removed in this preparation; so that the lateral surface of the trochlea is very deep."

The bone is from an adult, as stated by Dr. Zuckerkandl, but he has omitted to mention that the coronoid fossa is small, and the olecranon fossa is nearly obliterated, indicating that for a long time before death the motions of the joint were limited. The presumption is, therefore, that this was an old fracture; a fact which increases greatly the difficulty of determining precisely the original character of the accident.

There is a broad vertical and remarkable facet mentioned by Dr. Zuckerkandl on the inner side of the trochlea; the outer condyle is probably not normal in its shape, and altogether there are indications that the bone has at some time suffered a very severe and perhaps complicated injury. Perhaps there was more than one line of fracture; possibly a transverse fracture through the shaft at the base of the condyles, or through the line of the epiphyseal junction. If such were the fact, the specimen does not illustrate a simple fracture of the epicondyle; but these are points which the ancient character of the fracture does not permit us to determine positively.

FIG. 86.

Separation of the epiphyseal portion of the internal epicondyle. (Zuckerkandl's specimen.)

We think, however, this may properly be called a separation of the epiphyseal portion of the internal epicondyle, but whether it was a simple fracture or separation, uncomplicated with any other lesion of the bone, cannot now be determined.

Direction of Displacement, Symptoms, etc.—I have seen what I suppose to be this epiphysis displaced in the direction of the hand, or downwards, very manifestly, twice, and in two other examples a careful measurement showed a slight displacement in the same direction. The greatest displacement occurred in a boy fifteen years old, who was brought to me from St. Catharine, Canada West. He had fallen upon his arm in wrestling, and his surgeon found a dislocation of the bones of the elbow-joint, which he immediately reduced. The diastasis of the epicondyle was not at that time detected, the arm being greatly swollen. No splints were applied. It was three months after the accident when I saw him, at which time I found the internal epicondyle removed downwards toward the hand one inch and a quarter; and at this point it had become immovably fixed. Partial anchylosis existed at the elbow-joint, but pronation and supination were perfect.

In one instance I believed the fragment to be carried about three lines upwards and two backwards toward the olecranon; in each of the other examples the fragment did not seem to be displaced.

Granger found, also, in the five examples which came under his notice, the epicondyle carried toward the hand, with more or less variation in its lateral position, so that while in some instances it touched the olecranon, in others it was removed an inch or more in the opposite direction.

It is probable that, except where controlled by the force and direction of the blow, or by some complications in the accident, the fragment, if displaced at all, always moves downwards toward the hand, or downwards and a little forwards, in the direction of the action of the principal muscles which arise from this epiphysis; and when the fracture or separation is the result of muscular action alone, this form of displacement seems to me to be inevitable. In addition to the small size, mobility, crepitus, and generally slight displacement of the fragment, which, in connection with the age of the patient, are the principal signs of this fracture, it may be noticed that there is usually some embarrassment in the motions of the elbow-joint, which may be due in part to the swelling, and in part to the detachment of the point of bone from and around which most of the pronators and flexors of the forearm have their rise. In one instance, already quoted, that of the lad aged eleven years, who is supposed to have had a detachment of the epiphysis from a direct blow, the motions of pronation, with flexion, were not at all impaired, neither immediately, nor at any subsequent period, but the fragment was never sensibly, or only very slightly, displaced.

Granger has recorded another class of symptoms, to which I have already alluded, his explanation of which, however, I am not prepared to admit. One of these cases he describes as follows: A boy, eight years old, fell with violence, and broke off completely the whole of the inner epicondyle of the right humerus. The lad said he had fallen on his hand. The fragment was displaced toward the hand. Severe inflammation followed, but he recovered the free and entire use of the elbow-joint in less than three months after the accident. No splints or bandages were ever employed.

From the moment of the accident, the little finger, the inner side of

the ring finger, and the skin on the ulnar side of the hand, lost all sensation. The abductor minimi digiti and two contiguous muscles of the little finger were also paralyzed. This condition lasted eight or ten years, after which sensation and motion were gradually restored to these parts. As a consequence of this paralyzed condition of the ulnar nerve, also, successive crops of vesications, about the size of a split horse-bean, commenced to form on the little finger and ulnar edge of the hand some weeks after the accident, leaving troublesome excoriations. This eruption did not entirely cease for two or three months.

In two other cases, Mr. Granger remarks that he found "the same paralysis of the small muscles of the little finger, the same loss of feeling in the integuments, and the same succession of crops of vesicles on the affected parts of the hand, as occurred in the preceding case."

Without intending to intimate a doubt of the accuracy of Mr. Granger's statement, that such phenomena have followed in three cases out of the five which he has seen, I must express my belief that it was only a remarkable occurrence of circumstances, since the same phenomena have never been seen by myself, nor do I know that they have been observed by any other surgeon. That they indicated some injury to the ulnar nerve is no doubt correct, but it is not so plain that it was caused by the displacement of the fragment.

Results.—As in all other accidents about the elbow-joint, a temporary rigidity is likely to ensue. The mere confinement of the arm in a flexed position is sufficient to determine this result without the interposition of a fracture; but when inflammation occurs, more or less contraction of the tendons, muscles, etc., about the joint must ensue. To this circumstance, therefore, added to the confinement, rather than to the fracture, will be due the anchylosis. If the fragment is not displaced, the fracture cannot certainly be responsible for the loss of motion, since it does not in any way involve the joint; and if displacement exists, its ultimate effect in diminishing the power of the muscles which arise from the epiphysis must be only trivial and scarcely appreciable. We might, therefore, reasonably conclude that where the accident has been properly treated, permanent anchylosis would be the exception, and not the rule. This view of the matter seems also to be sustained by the recorded results. In Granger's cases, the full range of flexion and extension of the forearm has been finally restored, or with so trifling an exception as not to be observable without close attention, in every instance; except in the one already mentioned, which was originally complicated with dislocation; and even in this case the ultimate maiming was inconsiderable. Malgaigne, who says "it ought to be understood that in this accident articular rigidity is almost inevitable," seems nevertheless to admit the justness of Granger's observation as to the final result, if the proper means are employed to prevent it. I have myself found only once any considerable anchylosis of the joint after the lapse of a few years.

Treatment.—This accident does not constitute an exception to the rule which experience has established, that small epiphyseal projections, when once displaced, can seldom be restored completely to, or maintained in position. Granger remarks: "I have purposely avoided saying one word about replacing the detached condyle" (epicondyle), "and for these reasons: during the state of tumefaction of the limb, no means could be adopted for confining the retracted condyle in its place, beyond that of the relaxation of the muscles; and both before the tumefaction has commenced, and after it has subsided, all endeavors to replace the condyle, or even to change the position of it, have failed." He even proceeds so far as to declare that, while attention ought to be given to the reduction of the inflammation by appropriate means, we ought, nevertheless, to instruct the patient to flex and extend the arm daily from the moment the accident occurs until the cure is completed, and without any regard to the consolidation of the fragment; "the exercise of the joint in this manner must constitute the principal occupation of the patient for several weeks; and should it be remitted during the formation and consolidation of the callus, much of the benefit which may have been derived from this practice will be lost, and will with difficulty be regained."

With only slight qualifications I would adopt the advice of Mr. Granger. The limb ought, at first, to be placed in a position of semiflexion, so that if anchylosis should unfortunately ensue, it would be in the condition which would render it most serviceable, and also because in this position the muscles which tend to displace the fragment would be most completely relaxed. While thus placed, an attempt ought to be made, by seizing the epiphysis, to restore it to position; and if the effort succeeds, as it certainly is not very likely to do, a compress and roller ought to be so applied as to maintain it in position; provided, always, that it shall not be found necessary to apply the roller so tight as to endanger the limb, or increase the inflammation. An angular splint would be an almost indispensable part of the apparel, at least with children, where this indication is in view. In no case, however, ought more than fourteen days to elapse before all bandaging and splinting should be abandoned, and careful but frequent flexion and extension be substituted.

In three cases seen by me, a displacement of the fragment, either forwards or backwards, has occurred whenever the arm was flexed, and it has been necessary, therefore, to treat the case with the arm in a straight position. These are plainly only exceptions to the rule.

§ 9. Fracture or Diastasis of the External Epicondyle. (Epicondyle, Chaussier.)

The anatomy of the external epicondyle has already been described when speaking of the epicondyles generally. Like the internal epicondyle, it is composed in part of an epiphysis, and in part an apophysis projected from the shaft of the humerus, which portions become united to each other by bony tissue, usually about the sixteenth or seventeenth year of life; occasionally the consolidation is delayed much longer. It is very small, and serves for the attachment of some of the common extensors of the forearm and hand, and the external lateral ligament.

Whether this small epicondyle—speaking now of it as a whole, composed in part of the epiphysis and in part of the process from the shaft of the humerus—whether this can be broken off or separated as a traumatic accident, and as a simple, uncomplicated fracture, needs no longer

to be discussed. It is plainly impossible, unless the line of fracture includes a portion of the joint, and in that case it is to be designated as a fracture of the condyle, and not of the epicondyle. At least I may say that no satisfactory clinical example, or anatomical specimen, has ever been presented.

Fig. 87.

Supposed fracture of the entire external epicondyle.

It is not difficult to admit, however, the possibility of a detachment of the epiphyseal portion prior to its consolidation with the shaft of the humerus; and, indeed, the occurrence of such an accident would seem quite probable, yet we lack any absolutely conclusive evidence that it has ever taken place. The specimen sent to me by that distinguished anatomist Dr. Zuckerkandl, of Vienna, and to whose communications upon this subject I have already referred, when speaking of fracture of the epicondyles in general, and of the internal epicondyle in particular, will not bear the test of a critical examination. It was found in the dissecting-room, and is unaccompanied with any clinical history; but it is evidently from a person near the twentieth year of life. There is, indeed, an apparent absence of a portion of the external epicondyle, and there are two ossicula, situated in the external lateral ligament, with smooth, slightly bosselated surfaces. Dr. Z. explains the presence of two by supposing it was an exceptional process of development; but it is more difficult to explain how the epiphysis should have found its way into the lower or distal portion of the external lateral ligament, where he correctly states that it is situated. The supposed original seat is covered in by perfectly formed lamellated tissue, and underneath the situation in which the ossicula are found is a deep fossa fitted exactly to receive them.

§ 10. Fractures of the Internal Condyle. (Trochlea, Chaussier, and Malgaigne. Internal, Oblique Trochlear Fracture, Denucé.)

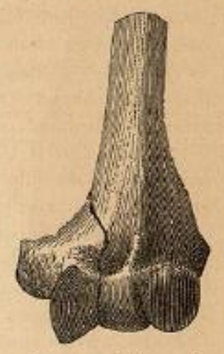
According to the nomenclature which I have adopted, those fractures alone which involve the joint can be so designated. They are those fractures which, commencing outside of the joint above the base of the epicondyle, extend downwards and outwards through the articular surface of the bone; the condylar fragment carrying with itself more or less of the trochlea, in most cases passing through the olecranon fossa, the anterior fossa, and the groove of the trochlea.

Malgaigne regards the occurrence of this fracture as very rare, and declares that he has never seen a case. He admits, however, that it happens occasionally, and cites a specimen shown to the Société Anatomique by M. Guéneau de Mussy, in 1837, which had united with the fragments in place.

On the other hand, Sir Astley Cooper, B. Cooper, South, Gurlt, and others, speak of it as a frequent fracture, especially in children. For myself, I have a record of twenty examples of this fracture seen by myself, while the number of fractures of the external condyle recorded by me, is twenty-nine; this difference in frequency being slight, but a little in favor of the external condyle.

Causes.—It has already been stated that fractures of the internal condyle, as well as fractures of the epicondyle, belong almost exclusively to infancy and childhood, only two instances having come under my notice after the eighteenth year of life.

Fig. 88.



Fracture of internal condyle.

I have seen no instance which could be traced to any other cause than a direct blow, such as a fall upon the elbow, the force of the concussion being received directly upon the elbow. M. Pingaud[1] thinks that even in this case the force applied acts indirectly, since it is applied usually to the posterior and internal surface of the olecranon process; and that the condyle yields to the pressure of the crest of the sigmoid cavity of the ulna, supplemented by the tension of the muscles and ligaments attached to the inner condyle.

Line of Fracture, Displacement, Symptoms.—The direction of the line of fracture is tolerably uniform; commencing at or near the centre of the trochlea, it extends obliquely inwards through the coronoid and olecranon fossæ, and terminates about one-quarter or half an inch above the internal epicondyle.

Displacement of the lower fragment can take place only in a direction upwards, backwards, forwards, and inwards (to the ulnar side). The fragment cannot be carried downwards, in the direction of the hand, nor outwards, in the direction of the radius, unless the radius also is broken or dislocated.

The most common form of displacement is upwards and backwards, and perhaps at the same time a little inwards; the ulna remaining attached to the lower fragment, and following its movements. I have seen one instance in which the fragment was carried directly downwards toward the hand, but this action was originally complicated with a dislocation of the radius backwards. The dislocation was immediately reduced. Five years after, when the young man was twenty-three years old, I found the condyle displaced downwards and forwards about half an inch, so that when the forearm was extended it became strikingly deflected to the radial side.

The symptoms which characterize this fracture are crepitus, almost always easily detected; mobility of the fragment, discovered especially by seizing upon the epicondyle, or by flexing and extending the arm; displacement of the smaller fragment and a projection of the olecranon process, this latter being very marked when the forearm is extended upon the arm, but almost completely disappearing when the elbow is bent; projection of the lower end of the humerus in front when the arm is extended; the humerus shortened when measured along its ulnar side,

[1] Pingaud, Art. Coude. Dic. Encyc. des Science Med., prem. sér. t. 21, p. 613.

from the internal epicondyle; the breadth of the humerus through its condyles generally increased slightly, sometimes half an inch or more; if the lesser fragment is carried upwards, it will also be found that when the limb is extended, the forearm will be deflected to the ulnar side.

Sir Astley Cooper remarks that it is frequently mistaken for a dislocation; and Thomas M. Markoe, of New York, has shown that it is, in fact, frequently complicated with a dislocation of the head of the radius backwards; indeed, he expresses a belief that this dislocation of the radius seldom or never occurs without a fracture of the internal condyle.[1]

Results.—It is probable that in a majority of cases no permanent displacement exists; although the irregularity of the bony deposits around the base of the condyle, which generally may be easily felt, would lead to a contrary opinion. The fact that the lower fragment usually follows the motions of the olecranon, renders its replacement and retention comparatively easy, unless some complication exists. It is not from displacement, therefore, so much as from permanent muscular, and especially bony anchylosis, that serious maiming so often results. Under any treatment bony anchylosis will sometimes ensue, and under improper treatment it is almost inevitable.

Poinsot says, that of five cases reported by Senftleben, only one recovered without anchylosis. In one case where anchylosis resulted, the operation of resection of the elbow terminated fatally.

Treatment.—The arm must be immediately flexed to nearly or quite a right angle, when, without much manipulation, the fragments will be made to resume their place. A gutta-percha, or felt, right-angled splint, such as I have already directed for fractures occurring just above the condyles, well and carefully cushioned, may now be applied, and secured by rollers. Suitable pads must also aid the splint and roller, in keeping the fragments in place. Markoe prefers keeping the forearm in a position about ten degrees short of a right angle, believing that in this position the ulna itself will act as a splint, and, by its support on the uninjured portion of the trochlea, hold in its place the broken condyle. Very properly, also, he prefers to lay the angular splint, made of tin, and fitted to the arm and forearm, upon the back of the limb, instead of upon the front or sides. If it is upon the inside, it covers the broken condyle, and we are unable to know so well its position; if upon either side, it is apt to press injuriously upon the epicondyles; and if it is in front, the fragments cannot be so well adjusted or supported. Upon this point, however, surgeons are not very well agreed, and no doubt more will depend upon the care with which the splint is applied than upon the surface against which it is laid.

Considerable swelling is almost certain to follow, and no surgeon ought to hazard the chances of vesications, ulcerations, etc., by neglecting to open or completely remove the dressings every day. Within seven days, and perhaps earlier, passive motion must be commenced, and perseveringly employed from day to day until the cure is accomplished; indeed, in many cases it is better not to resume the use of splints after

[1] Markoe, New York Journal of Medicine, May, 1855, p. 382, second series, vol. xiv. Also paper read before N. Y. Surg. Soc., May, 1880.

this period; for, although at this time no bony union has taken place, yet the effusions have somewhat steadied the fragments, and the danger of displacement is lessened, while the prevention of anchylosis demands very early and continued motion.

When the fracture is compound, or otherwise complicated, these simple rules will seldom be found applicable; indeed, fractures attended with no such complications will occasionally be found difficult to reduce, or to maintain in position after reduction.

§ 11. Fractures of the External Condyle.

It is necessary again to call attention to the fact that the author recognizes no fractures as fractures of the condyles, either external or internal, which do not enter the joint. All not included in this definition and occurring in these regions, are epicondylar fractures or diastases.

Causes.—All the fractures (29) of the external condyle, of which I have a record, occurred in children under fifteen years of age, except two; one, in which a woman, eighty-eight years of age, fell upon her elbow when intoxicated, breaking off the outer condyle. Two months after the accident I found the fragment displaced half an inch upwards, and firmly united. The other was a man æt. 49.

In a large majority of these cases the patients themselves have affirmed, and the surface of the skin has furnished conclusive evidence, that the fracture was produced by a direct blow, generally by a fall upon the elbow.

Line of Fracture, Displacement, and Symptoms.—The direction of the fracture is generally such that, commencing at or just within the capitellum, or articulating surface upon which the radius is received, it terminates above and to the outer side of the external condyle; or, commencing at the middle of the trochlea, it passes through the olecranon fossa and terminates above the condyle, externally.

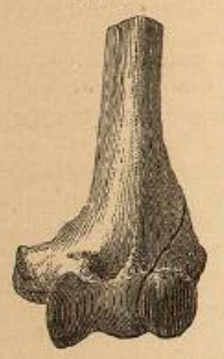
It is quite probable that in the latter case, the force which occasioned the fracture has been applied directly to the olecranon, and only indirectly to the condyle, as suggested by Pingaud; but this theory of mechanism could not apply to the first class of cases, or those in which the line of fracture is through or just within the capitellum, and which, I think, is the most common. It is in these cases especially, the line of separation being more superficial, that the fragment is liable to become displaced backwards, forwards, or outwards; generally, I have found it displaced a little outwards, sufficiently to increase manifestly the breadth of the condyles, or it has been carried backwards; once slightly forwards; it is also, in some cases, carried upwards in a small degree, although the action of the supinators and extensors would seem to render a downward displacement more common. These displacements are usually not considerable, and in a few cases there is none at all. Whatever may be the direction or degree in which the fragment is moved, however, the head of the radius is found almost always to accompany it; but in the case which I am about to relate, the head of the radius became completely separated from the condyle.

Frederick Keaffer, æt. 11, fell from a load of hay, and he is confident

that he struck the ground with the back of his elbow. Six hours after the accident he was brought to me by the physician who was first called to him. The arm was much swollen, and the external condyle could not be distinctly felt; but when pressure was made directly upon it, crepitus and motion became manifest. The head of the radius was at the same time dislocated backwards, and separated entirely from the condyle, its smooth, button-like head being very prominent. It is difficult to conceive how a blow from behind should leave the head of the radius dislocated backwards, or how the radius could have separated from the broken condyle; but as the examination was repeated several times, and while the patient was under the influence of ether, I have no doubt of the fact. Several other surgeons who were present concurred with me in opinion fully.

While prosecuting the examination, I reduced the dislocation of the radius, but it would not remain in place a moment when pressure or support was removed. The lad recovered with a very useful arm, the motions of flexion and extension, with pronation and supination, after the lapse of a year, being nearly as complete as before the accident, the radius remaining unreduced.

FIG. 89.



Fracture of the external condyle through the capitellum.

Sometimes it will be noticed that while the portion of the condyle which is attached to the radius falls backwards, its upper and broken extremity pitches forwards; and this attitude it is especially prone to assume when the forearm is extended.

It is even possible, when the fracture traverses the trochlea, for the ulna also to become displaced backwards along with the radius and the lesser fragment.

Crepitus, which is usually very distinct, is most easily obtained by rotating the radius, or by seizing upon the condyle with the thumb and fingers, and moving it backwards and forwards.

Results. — Ordinarily, this fragment unites promptly, and by the interposition of a bony callus; but in five cases, I have noticed that either no union has occurred, or the union has been accomplished only through the medium of fibrous structures, and the fragment continued afterward to move with the radius.

As a consequence, probably, of the displacement of the lesser fragment upwards, the forearm, when straightened, is occasionally found deflected to the radial side. The surgeon must not, however, confound the deflection which is natural, and which is greater in children than in adults, with the unnatural radial inclination which is occasioned sometimes by this accident. I have met with this phenomenon three times in children under three years of age, in one of which I could not discover that the condyle was carried toward the shoulder, but only outwards; in each of the other cases the fragment had united by ligament. The following is one of the examples referred to:

A girl, æt. 3, fell and broke the external condyle of the left humerus, the fracture extending freely into the joint; crepitus distinct; forearm

slightly flexed; prone. Lesser fragment displaced outwards and a little backwards, carrying with it the radius. On the second day I was dismissed on account of the unfavorable prognosis which I gave, or rather because I refused to guarantee a perfect limb, and an empiric was employed.

July 2, 1857, several months after the accident, the father brought her to me for examination. There was no anchylosis, but the lesser fragment had never united, unless by ligament, moving freely with the head of the radius. When the forearm was straightened upon the arm, it fell strongly to the radial side, but resumed its natural relation again when the elbow was flexed.

Two other examples are reported at length, in the second part of my Report on Deformities after Fractures, as Cases 57 and 59 of fractures of the humerus.

In one other example, however, mentioned also in my report as Case 56, the deflection was to the opposite side. I examined the lad one year after the accident, he being then five years old, and I found the external condyle very prominent and firmly united, but not apparently displaced in any direction except outwards. The radius and ulna had evidently suffered a diastasis at their upper ends, but all of the motions of the joint were free and perfect.

Dorsey[1] speaks of this lateral inclination as being always to the ulnar side, but does not indicate to what particular fracture of the elbow it belongs. He has also described a splint, contrived by Dr. Physick, intended to remedy the deformity in question.

Chelius also speaks of the same deformity as occurring after fractures of the internal, but does not mention it in connection with fractures of the external condyle, that is, an inclination of the forearm to the ulnar side.

In more than half of the cases of fracture of this condyle some degree of anchylosis has resulted, lasting at least several months. I have seen it remaining after a lapse of from one to twenty years, but generally it gradually diminishes, and, in a majority of cases, completely disappears after a few years.

Treatment.—I do not know that I need add much to what has already been said in relation to the treatment of fractures of the opposite condyle, and at the base of the condyles, since the measures applicable to the one are, in general, applicable to the other.

Generally, the forearm ought to be flexed upon the arm, especially with a view to overcome the usual tendency in the upper end of the lower fragment to pitch forwards, and which form of displacement is greatly increased by straightening the arm. A remarkable exception to this rule, and one of two which I have seen, must be mentioned.

James Cronyn, aged 6, was brought to me in March, 1857, having, a few minutes before, fallen from a height of four or five feet to the ground. His father said the elbow had been broken at the same point two years before, and from that time had remained stiff and crooked. I found the external condyle broken off, and, with the head of the radius, carried

[1] Elements of Surgery, by Philip Syng Dorsey Phila. ed. 1813, vol. i. p. 146.

backwards. This was the position which it occupied constantly, although it was easily restored and maintained in position when the arm was straight, but not by any possible means when the elbow was flexed. I dressed the arm, therefore, in an extended position, with a long felt splint, and the fragments remained well in place until a cure was accomplished.

It is especially deserving of notice that, in the five cases in which I have observed bony union to fail, and the fragments to continue movable, the motions of the elbow-joint have, in a very short time, been completely restored. If it does not prove that Granger was correct in his views as applied to fractures of the internal epicondyle, namely, that it was of little or no consequence whether the fragment united or not, and that the elbow-joint ought to be submitted to free motion from the beginning to the end of the treatment—if it does not absolutely prove, I say, the correctness of his views, it at least must abate our apprehensions of the supposed evil results of non-union in the case of the fracture now under consideration.

I shall take the liberty of quoting, also, with a qualified approval, the opinion of Dr. John C. Warren, of Boston, as stated by Dr. Norris in his Report on Surgery, made to the American Medical Association in 1848:

"In the treatment of fractures of the condyles of the os humeri, a course is usually recommended which he believes to be hurtful, inasmuch as it favors the worst consequences of the injury, namely, loss of motion in the joint. By this mode of treatment, the fractured piece becomes sufficiently fixed to create partial anchylosis; and there is so much pain afterwards in the proposed passive movements as to cause the omission of these measures until permanent stiffness takes place. The proper course in the management of these accidents, he conceives to be —1st. To apply no splints, but in the earlier days to make use of the proper means to prevent inflammation. 2d. To accustom the patient to early and daily movements of flexion and extension. 3d. When the action of the joint becomes limited, to overcome the resistance by force, and repeat it daily until the tendency of the joint to stiffen ceases.

"The accomplishment of this process, he adds, is so very painful that few patients have courage to submit to it, and few surgeons firmness to prosecute it. The consequence has been that in a great number of cases the use of the articulation to a greater or less extent has been lost. The introduction of etherization, by preventing the pain, gives us, in the opinion of Dr. Warren, the means of overcoming the resistance. By its aid he has restored the motion of a considerable number of anchylosed elbows, and has successfully applied the same measures to other joints, particularly to the shoulder and knee. This has now become his settled practice, with the results of which he is entirely satisfied. The inflammation consequent upon the forced movements of an anchylosed joint is not to be lost sight of. By a reasonable abstraction of blood, and other anti-inflammatory treatment, he has never found it alarming."[1]

My respect for the distinguished surgeon whose opinion is here given does not permit me to question the correctness of his practice; but I

[1] Transactions of the American Medical Association, vol. i. p. 174.

cannot avoid a belief that his language does not convey a precise idea of his views. If he intends to say that he would move the joint freely when it is suffering from acute inflammation, and when motion occasions great pain, I must protest against the practice as likely to do vastly more harm than good in any case; but if he would move the joint from the first, when the inflammation and swelling are trivial, and when it occasions only a moderate amount of pain, then his views are just, and his practice worthy of imitation.

§ 12. Fractures of the Articular Processes of the Lower End of the Humerus; wholly within the Capsule.

Three examples illustrating this variety of fracture have been referred to by Stimson.[1] The first was seen by Laugier,[2] in the person of a girl seventeen years old, who had fallen upon her hand. It was not followed by swelling or by effusion within the joint. Laugier considered it a fracture of the trochlea alone. The treatment consisted in rest, the forearm being slightly flexed and pronated. In a few weeks recovery took place, with complete restoration of the functions of the arm.

The second case is from Gurlt,[3] a museum specimen, without history. It is an adult bone. The trochlea and capitellum are broken off and displaced forwards and upwards, and have re-united with the bone above the coronoid fossa; the articular surfaces being still covered with cartilage.

The third[4] is that of a woman, æt. 67, who having received an injury upon her elbow, the surgeon diagnosticated a fracture of the neck of the radius; but the patient having died four years later, the capitellum was found broken off and displaced; having reunited with its upper border resting in the radial depression (fovea minor). The head of the radius was not broken.

The same difficulties present themselves here as in the supposed examples of intracapsular fractures of the head of the humerus. In the clinical example related by Laugier, the exact line could not have been absolutely determined. And this difficulty is illustrated by the third case, in which the clinical diagnosis was greatly at fault. The third case, also, where an autopsy was made after four years, can only be regarded as furnishing conclusive evidence that the capitellum was broken; inasmuch as the changes in its form and size, caused by absorption, as we have seen happens in intracapsular fractures of both the heads of the humerus and femur, must render it difficult to say that the line of fracture was not outside of the capsule. The second case was a museum specimen, unaccompanied with a history, and for the same reason there can be no conclusive evidence that it was intra-articular. Whenever we find a recent accident, in which the autopsy shall show that the line of fracture was wholly within the capsule, the testimony will be conclusive. At present this kind of testimony is wanting.

[1] Stimson, Treatise on Fractures, p. 413.
[2] Laugier, Arch. Gén. de Med., 1853, v. i. p. 45.
[3] Gurlt, Knochenbrüchen, vol. 2, p. 801.
[4] Gurlt, op. cit., vol. 2, p. 831.