anastomotica magna descend, uniting with the anterior and posterior ulnar recurrents. The anastomotica magna also sends an arch across above the olecranon, uniting with all the other vessels on the posterior surface of the elbow.

The median nerve, having crossed the brachial artery above at a very acute angle, lies in this region at its inner side, usually separated from it by a slight interval. It then passes deeply between the two heads of the pronator radii teres, the coronoid head separating it from the division of the brachial and the ulnar artery, and finally leaves the region of the elbow and gains the middle of the forearm by passing under the arch of the flexor sublimis digitorum. The motor branches of the median nerve are all given off at or near the elbow. Sometimes all the branches for the forearm are derived from a common trunk which then might be known as the deep median nerve (*N. profundus medianus*, Schwalbe). The usual arrangement, however, is for three nerves to separate in succession: (1st) one that supplies the humeral head of the pronator radii teres, given off a little before the nerve passes under the bicipital fascia; (2d) a trunk for the superficial muscles of the forearm, given off between the two heads of the pronator radii teres and including a branch for the coronoid head of that muscle; (3d) a trunk for the deep muscles of the forearm, usually given off between the pronator radii teres and the flexor sublimis digitorum.

The musculo-spiral nerve, after winding around the humerus from behind, reaches the region in front of the elbow a short distance above the condyles, by perforating the external intermuscular septum. It then lies at the bottom of the external bicipital groove, against the fibres of the brachialis anticus which separate it from the joint capsule, and between the supinator longus and the biceps. It divides, usually at the level of the articulation or slightly above it, but sometimes as far down as the head of the radius, into the posterior interosseous and radial nerves. The radial recurrent artery often lies in the angle of bifurcation. The posterior interosseous branch, exclusively motor, leaves this region by perforating the supinator brevis muscle and thus reaching the back of the forearm. The radial proceeds downward under cover of the supinator longus, lying to the outer side of the radial artery.

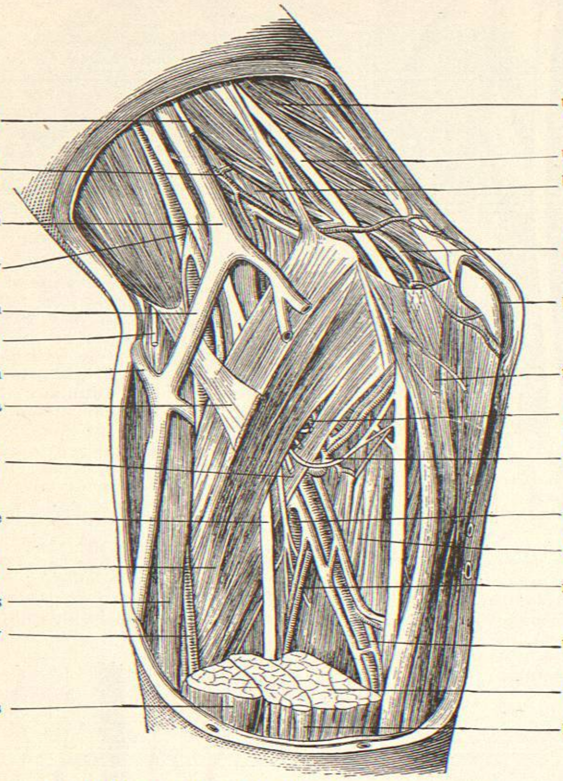

FIG. 1821.—Dissection of the Elbow from the Inner Side.

Behind the elbow the muscular mass is composed of the triceps and the anconeus, its continuation upon the lower arm. The portion of the triceps that comes properly within this region is its insertion, which consists, first, of a thick, firm, aponeurotic expansion which receives fibres from all the heads and is inserted upon the superior surface and lateral edges of the olecranon; second, of fibres from the external and internal heads that are implanted without any intermediary tendon directly upon the olecranon.

Below and externally the triceps blends intimately with the anconeus, there often being no appreciable interstice between them. This continuity and its supply by the same branch of the musculo-spiral nerve that innervates the internal head of the triceps, have led some to the conclusion that the anconeus should be considered as a fourth head of the triceps. It radiates fan-like from a short and strong tendon attached to the posterior and inferior portion of the external condyle, its fleshy fibres being inserted by direct implantation into the side of the olecranon and over the entire extent of the excavated posterior surface of the ulna that lies above the oblique line.

At the sides of the elbow the muscular masses are arranged in two groups, quite distinct in their origin, function, and innervation. The inner group arises from the internal condyle or near it, contains pronators and flexors, and is innervated by the median and ulnar nerves; the outer group arises from the external condyle and the condylar ridge above it, contains supinators and extensors, and is innervated by branches from the musculo-spiral nerve.

Some explanation of the peculiarities of these lateral muscles is afforded by the history of the development of the arm. In the fœtus each limb arises as a budlike outgrowth from the trunk, and is covered by a prolongation of the ventro-lateral common muscular sheet. As it increases in length this prolongation becomes segmented near the elbow into a pronato-flexor mass and a supinato-extensor mass. In lower animals, like reptiles, that have







no independent movements of the different parts of the hand, these masses remain in their primitive condition, but in those that have a variety of movements for the hand, the masses become split into layers and finally into distinct muscles. Irregularities in this process cause numerous varieties. In adult man traces of the primitive condition persist at the place of origin of the muscles, many of which continue to spring from an undifferentiated mass, or, as it is styled, from a common tendon.

The muscles of the pronato-flexor mass found in the region we are considering are the pronator radii teres, the flexor carpi radialis, the palmaris longus, the flexor carpi ulnaris, and the flexor sublimis digitorum. The first four of these form a superficial layer, while the flexor sublimis constitutes a layer by itself (see Fig. 1821).

The pronator teres lies farthest to the radial side and therefore forms the inner boundary of the cubital fossa. Besides its origin from the internal condyle it has a slip attached to the coronoid process of the ulna. Between these two slips of origin passes the median nerve as already mentioned.

The flexor carpi radialis and the palmaris longus have no special anatomical importance in this region, merely arising from the internal condyle by the common tendon and presenting spindle-shaped masses lying approximately parallel to the pronator. The flexor carpi ulnaris arises by two heads, one from the internal condyle by the common tendon, one from the olecranon and the upper two-thirds of the crest of the ulna. These heads are united by a fibrous arcade under which pass the ulnar nerve and the posterior ulnar recurrent artery. The nerve descends behind the internal muscular septum, accompanied by the inferior profunda artery which lies in front of it, enters the slight groove behind the internal condyle, sometimes held in place by a slight elevation of bone arising from the condyle. It is here in close relation with the internal lateral ligament of the elbow-joint, which throws over it a fibrous investment which, according to Sutton, is the remains of an atrophied muscle, the epitrochleo-anconeus, rarely found in man but common in apes. These fibres help to fix the nerve and prevent it from slipping from its groove, a common accident in dislocations. During flexion the groove widens somewhat owing to the slight lateral displacement of the humerus. A small bursa often lies between the nerve and the bone, necessitated by the movements of the nerve during flexion and extension. In this situation the nerve is almost subcutaneous, crossed by branches from the internal cutaneous nerve, and as it lies against an unyielding surface it is particularly subject to injury when the inner edge of the elbow is struck. This has led to the designation of its locality as the "funny bone." It is mainly on account of the presence of the nerve on this side that the joint is opened from without in operations for resection.

The flexor sublimis digitorum has also a double origin, one by a thick and strong slip from the internal condyle and coronoid process by the common tendon, closely blended with the internal lateral ligament of the joint, another by a broad and thin lamina from the oblique line and anterior border of the radius. The two heads united bound an oval foramen through which pass the median nerve and the ulnar artery.

The muscles of the supinato-extensor mass found in this region are divided into two groups: an external one, comprising the supinator longus and brevis and the two radial extensors of the wrist; and a posterior one, comprising the common extensor of the fingers, the extensor of the little finger, and the ulnar extensor of the wrist. The ulnar crest separates these groups from the pronato-flexor muscles.

The supinator longus is the most superficial of its group, arising from the upper two-thirds of the external supracondyloid ridge of the humerus and from the external intermuscular septum, and extending down along the outer side of the forearm to which it imparts its characteristic shape. The muscle is drawn forward by the deep fascia of the forearm and forms the external boundary of the cubital fossa. Above the elbow it lies upon the musculo-spiral nerve and the radial recurrent artery, below upon the radial vessels and nerve. Its functions as a supinator are brought into play only when the arm has been previously strongly pronated. Its usual office is that of a flexor of the forearm.

Closely connected with the supinator longus at its origin is the long radial extensor of the wrist, for its fibres immediately succeed those of the supinator upon the external condyloid ridge, here somewhat enlarged, extending down for about an inch, or to the base of the condyle. It is partly covered by the supinator longus and is in contact with the upper part of the capsule of the joint.

Lying directly under the foregoing and arising from the anterior surface of the external condyle is the short radial extensor of the wrist. The two muscles are not infrequently interblended in various ways.

The supinator brevis lies deeply under both of these, a bursa usually intervening, and close against the joint capsule. Arising from the lower part of the external condyle and the common tendon, also from the interosseous border of the ulna and the excavation below the lesser sigmoid cavity, its fibres run spirally from above downward and outward and are inserted around the upper third of the radius, embracing the neck and reaching the tuberosity and the oblique line. It adheres closely to the external lateral and orbicular ligaments of the elbow-joint. The muscle is divided into two planes of fibres between which the posterior interosseous nerve passes. It shares with the biceps the function of supinating the hand and arm by rotating the radius.

The muscles of the posterior region of the upper forearm radiate from the external condyle just below the anconeus. The common extensor of the fingers is the most external of these, appearing in this region as an undivided pyramidal mass arising from the lower and anterior portion of the condyle and the common tendon. It is in contact with the external lateral ligament and the supinator brevis and wedged between the short radial extensor and the ulnar extensor.

Interposed between the common and ulnar extensors and seemingly differentiated from the former is the extensor of the little finger. It arises mainly from the fascia of the forearm and the septa that lie between it and the two contiguous muscles. In about four per cent. of cases its muscular belly is indistinguishable from that of the common extensor.

The ulnar extensor of the wrist runs diagonally across the back of the arm from the external condyle to the ulnar side. It arises from the lower and posterior portion of the condyle and the common tendon, from a strong intermuscular septum that springs from the upper three-fourths of the crest of the ulna and from the fascia of the forearm. A bursa is often found beneath its condylar tendon, often extending also beneath the origin of the common extensor.

*Elbow-joint.*—In this important joint there are united in a single capsule three articulations: one between the humerus and the ulna; one between the humerus and the radius, and one between the ulna and the radius. This diversity of union permits a great variety of motions for the forearm and hand and determines largely the distinction that exists between the upper and the lower extremity. Thus there is produced by this means an angular motion of great steadiness by which the forearm is flexed and extended, and also a motion by which the radius and ulna are altered in their relations, being made to turn over each other across their long axes, and thus rotate the attached hand. Movement of this kind toward the median line, turning the palm downward, is termed pronation; in the opposite direction, turning the palm upward, supination.

The humero-ulnar articulation gives the whole system solidity, its strength being due to the configuration of the articulating surfaces, and the peculiar arrangement of the ligaments.

The humerus presents at its lower end a surface curved like an Ionic volute, and grooved like a pulley, which gives it its name of trochlea (see Fig. 1822). The surface is obliquely directed, and the groove is not quite symmetrical, but has a slight lateral twist. On this surface the ulna glides, embracing it by the gap between the olecranon and the coronoid processes known as the greater sigmoid cavity (see Fig. 1823), not quite a semicircumference, the olecranon passing up behind into the fossa of that name in the humerus when the arm is extended, and the coronoid process similarly fitting into its appropriate fossa in front during flexion (see Fig. 1824). The coronoid and olecranon portions of the ulnar surface are separated by a transverse line devoid of cartilage (see Fig. 1823), corresponding to the place where the epiphysis unites with the shaft. The whole olecranon process is a secondary growth, as in fœtal life the joint begins its development as a simple slit between two ends of bone which are apposed very much as the ends of the finger bones are in the adult. At birth the process is not completely developed, and the olecranon and coronoid fossæ of the humerus are not so deep as they are in the adult. It is interesting to note that in renewal after resection the fœtal conditions reappear, the ulna not usually acquiring an olecranon, but resembling more the upper end of the tibia. The transverse line above mentioned is crossed at nearly right angles by a guide ridge which fits into the deepest part of the trochlear groove. The direction of this is not quite the same in the two portions, and a piece cut from the olecranon or coronoid process will not exactly fit all parts of the trochlea. There is usually, therefore, a slight deviation or lateral wabbling of the joint in flexion and extension, which is not, however, sufficient to be noticeable without instrumental measurements. The results of tracings made by points carrying ink are shown in Figs. 1825 and 1826, the two lines there drawn on the trochlea being tracings of points attached to the coronoid and olecranon processes, respectively. The curves bend and return into each other, so that, though there is a slight lateral working, it is readjusted before the end of the course. This may be easily demonstrated by observing, during flexion and extension, a spot of ink placed on the most prominent point of the olecranon. By carefully sighting this with a

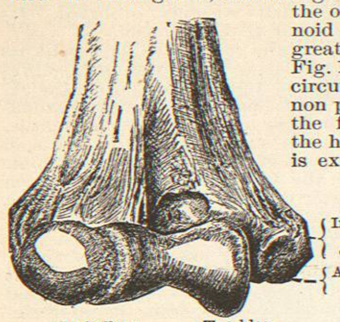


FIG. 1822.—The Lower End of the Humerus, showing the Articular Surface.

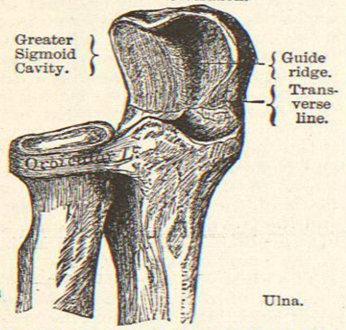


FIG. 1823.—The Upper End of the Radius and the Ulna, showing the Articular Surfaces.

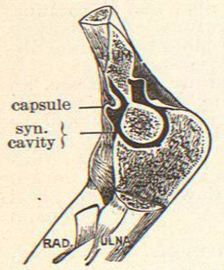


FIG. 1824.—A Sagittal Section through the Elbow-joint, showing the Adaptation of the Articular Surfaces, and Folds of the Capsular Ligament.

vertical thread, it will be seen to move laterally. It may also be demonstrated by making a vertical section through the extended joint, and then flexing, when the cut surfaces of the bones will be seen to ride past each other. It appears, then, that there is a slight interval between the articular surfaces at the sides, only the guide ridge remaining constantly in contact. The joint cannot, therefore, be said to be a perfect hinge, although it may be so regarded for all practical purposes.

External to the trochlear surface of the humerus, and separated from it by a shallow groove, is a rounded portion about as large as an ordinary marble, called the capitellum or radial head (see Fig. 1822). It does not extend far back, but looks directly forward, and the button-like head of the radius which articulates with it can be felt behind, moving from side to side when the extended arm is supinated. This is an important assistance in diagnosticating dislocations and other injuries here. The head of the radius is in contact with the capitellum only when the forearm is flexed at right

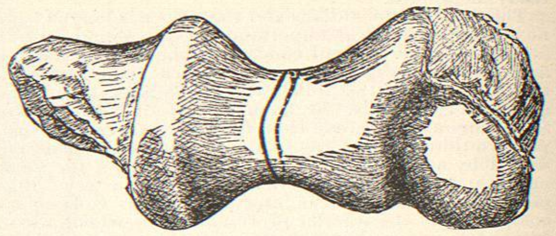

FIG. 1825.—The Trochlear Surface of the Humerus, showing Tracings of the Paths of the Olecranon and Coronoid Processes of the Ulna during Flexion and Extension. (After Braune and Kyrklund.)

angles; during complete extension its anterior edge touches but its posterior half is entirely free. The shallowness of the depression by which the radius fits would make the joint very insecure, were it not that that bone is bound sidewise to the ulna by a strong band called the orbicular ligament (see Fig. 1823), articulating in a shallow depression called the lesser sigmoid cavity. The broadest part of the radial rim fits this, in the position of the arm which is most usual, viz., that of semi-pronation. The rim passes a little beyond the sigmoid cavity and just touches the bevelled edge which separates the capitellum from the trochlear portion of the humerus, rolling upon it in pronation and supination. The combination of flexion with pronation, and of extension with supination, are therefore in accordance with the nature of the articular surfaces. The line of the articulation is oblique, and in amputating it is useful to remember that it lies about three-eighths of an inch below the external

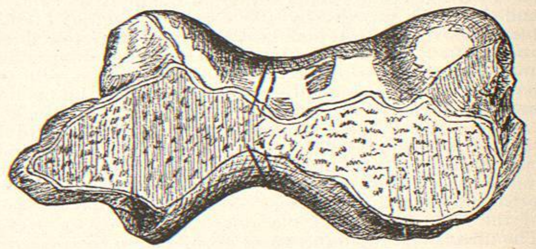

FIG. 1826.—The Same Detached from the Shaft, so as to show how the Paths meet if continued.

condyle, and one-fourth inch lower on the inner side. The head of the radius, which can be felt as mentioned above, is the best guide to it.

From the configuration of the surfaces here described, it will be noticed that lateral luxations must be rare, the dislocation outward being easier than inward; that antero-posterior luxations are easier and can be effected in any position of the joint, the posterior one being necessarily the most common. When a single bone is dislocated it must be the radius.

A fibrous capsular ligament lined with synovial membrane invests the joint. Above and below it is attached





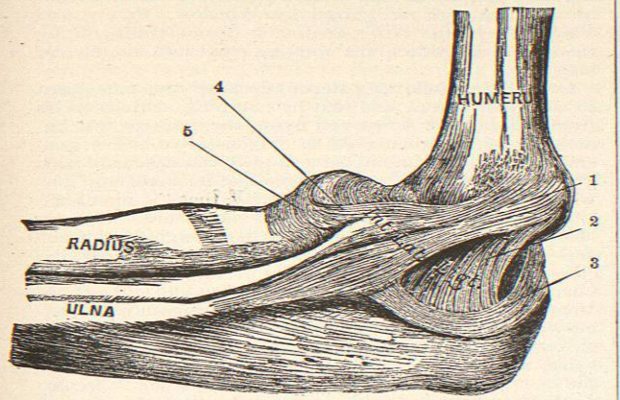


FIG. 1827.—View of the Ligaments of the Elbow-joint from the Inner Side. 1, Band extending from the condyle to the tuberosity of the coronoid process; 2, radiating bundles from the condyle to the border of the greater sigmoid cavity; 3, arciform fibres which pass forward from behind and protect the ulnar nerve; 4, oblique band which passes to the head of the radius, blending with 5, the orbicular ligament of the radius.

beyond the articular surfaces of the corresponding bones, the head of the radius being, as it were, stuck through a slit in it. Being quite loose, to admit of extensive movements (see Fig. 1824), it would be nipped in front and behind during flexion and extension, were it not held out of the way by the flexor and extensor muscles which blend intimately with it. It is further protected by a pad of fat in each fossa, and over this the muscles pull. The capsule is thinner behind than in front, and an effusion into the joint cavity first shows there, on either side of the olecranon and the tendon of the triceps.

In certain situations the capsule is strengthened by accessory bands, which have received special names. The strongest of these are the lateral ligaments, which radiate from points on the humerus which are approximately in a line with the axis of rotation, and some of their fibres are therefore tense in every position of the joint. They are important sustainers of the articulation—indeed, if they are intact the anterior and posterior portions of the capsule may be removed without affecting the security of the joint. They also prevent the coronoid and olecranon processes from quite reaching the bottom of their respective fossæ in the humerus, which might cause chipping of the bone.

The internal lateral ligament (Fig. 1827) presents several small bundles, which radiate to the coronoid process and the internal border of the olecranon. In front it is intimately blended with the origin of the flexor sublimis digitorum; behind it forms, together with some arching fibres and the tendon of origin of the flexor carpi ulnaris, a smooth groove for the ulnar nerve, which lies so closely on the ligament that it cannot be divided here without risk of opening the joint. In forced extension, caused by violence, the internal lateral ligament is always ruptured or injured, and the bones are fractured in some manner. The anterior band of the ligament appears to check pronation, as it is ruptured when this movement is violently performed. In forced flexion the posterior band is frequently torn. In fracture of the olecranon this ligament often prevents separation of the fragments.

The external lateral ligament (Fig. 1828) blends in front with the supinator brevis, the tendon of origin of that muscle being, in fact, a part of it. Below, it unites with the orbicular ligament, sends a strong band to a tubercle below the lower sigmoid cavity of the ulna, and adheres to the internal edge of the olecranon. In forced movements (except adduction) this ligament does not usually give way until others are ruptured. The middle band is especially strong, and may tear a piece off the bone before parting. If the orbicular ligament is broken, the supinator brevis and the biceps pull the radius out of its socket. As this bone is more loosely attached than the ulna, the accident is not infrequent, being usually caused by falls on the pronated hand, or, in young children, by a strong jerk on the arm.

The orbicular ligament is considerably more elastic in children. A band, sometimes described as the quadrate ligament, usually passes from the lower border of the sigmoid cavity to unite with the orbicular ligament (Fig. 1828). Ordinarily relaxed, it limits pronation and supination.

The synovial membrane is large, and contains numerous deposits of fat, which are especially abundant in front and behind.

Flexion and extension may, as stated above, be considered for practical purposes as occurring in a single plane. The plane of flexion and extension is not parallel with the median plane of the body, but is directed obliquely, so as to carry the hand toward the mouth. This results from the fact that the axis of rotation of the joint is not at right angles to the long axis of the humerus, but makes with it an angle of some twenty degrees (see Figs. 1828 and 1830). This obliquity does not occur in the fœtal joint, and is marked in the lower races of men or in the anthropoid apes. In them ease of bringing the arm across the body is effected by an obliquity of the trochlear axis to the frontal plane. This can be measured by noting the inclination of the trochlear axis to a line drawn through the axis of motion in the head of the humerus. Careful measurements made by Welcker, Lucæ, Gegenbaur, and Schmid show that this angle averages about sixteen degrees in Europeans and thirty-two degrees in negroes and Malays (see Fig. 1829).

In the fœtus the angle is about forty-three degrees, and in a child of one year about thirty-eight degrees. It would appear from this that the humerus has undergone a twisting about its long axis to bring the palmar surface of the hand forward, and thus make it more useful as a prehensile and tool-using organ, and that this is more complete in the higher races. When this torsion becomes nearly complete it would make it difficult to carry the

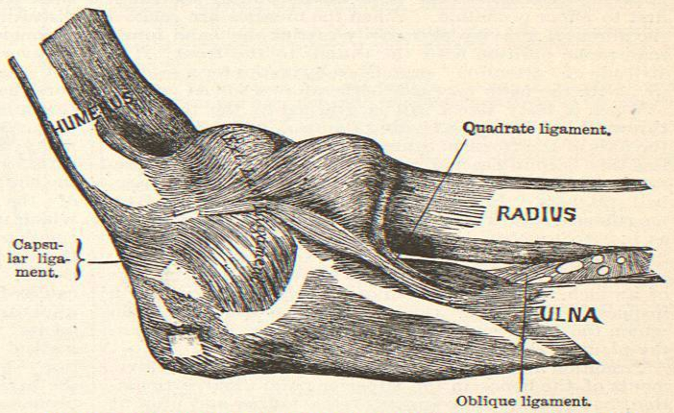


FIG. 1828.—View of the Ligaments of the Elbow-joint from the Outer Side.

hand across the body, were it not compensated for by the inclination of the trochlear axis which proceds *pari passu* with it.

As a result of this inclination the arm and forearm make, in extreme extension, an outwardly directed angle of about one hundred and sixty-five degrees. This is

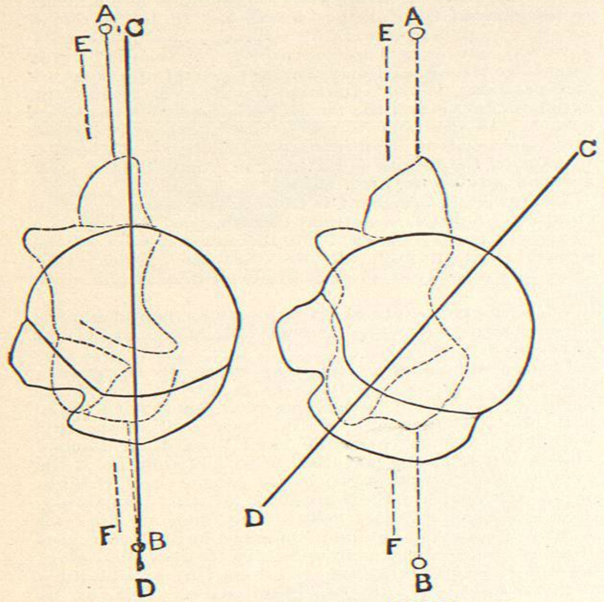


FIG. 1829.—Inclination of Axis of Elbow-joint to the Frontal Plane of the Body. *A, B*, Line drawn through the condyles of the humerus; *C, D*, line drawn through the long axis of the articular surface of the head of the humerus; *E, F*, axis of elbow-joint. (After Welcker and Lucæ.)

most marked in supination, and almost entirely disappears on pronating the hand. It is therefore best, when applying extension to the humerus by pulling the hand, first to effect pronation. When the muscles are relaxed the force of gravity necessarily carries the hand into a semi-prone position with the thumb to the front. The attitude of "attention" prescribed by tactics for a soldier, *i.e.*, with the palm forward, is therefore a forced one.

When a body like a ball is grasped by the hand and thrown by suddenly extending the arm, the inclination of the axis of the forearm causes it to be sent obliquely unless this is counteracted by strongly pronating the forearm. This pronation is the so-called "twist" of baseball pitchers. In performing it the limb is slightly lengthened. This may be demonstrated by standing so as just to touch a horizontal table with the end of the index finger in pronation and then supinating the hand, when the finger will be found to rise about three-eighths of an inch. The mechanism of this will be apparent on inspecting Fig. 1830, which shows that the plane *f*, in which the lower end of the radius moves, is oblique to the plane of the table.

Pronation and supination involve not only the movements of the bones in the superior radio-ulnar articulation, but also the movements of the radius and ulna at the wrist. Anatomists have been divided in opinion as to exactly what part is taken by each bone in this motion. By far the greater number have held, with Galen, Vesalius, and Albinus, that the ulna can take no part in the movement, being incapable of lateral motion at the elbow. The prevailing view is illustrated in Fig. 1831, which represents the usual method of articulating the bones for class demonstration. A fixed axis passes through the head of the radius above and the head of the ulna below, so that the radius flaps back and forth around this in a way that may be rudely expressed by two boards obliquely hinged together (Fig. 1832).

It is rather strange that the absurdity of this view has not been more generally seen, especially as a movement of the ulna was recognized by Winslow, Monro, and Vicq d'Azyr, the latter anatomist demonstrating it by the impression which the rotating hand left in a bed of clay.

Cruveilhier (following Bertin) declared this movement to be only apparent, and that by stripping off the muscles from the shoulder down and fixing the humerus, the immobility of the ulna could be demonstrated. The general treatises on anatomy have copied this statement with great docility, only a few investigators insisting, notwithstanding the weight of authority, that the ulna actually does move. Among these is Duchenne, who, by observing the movements of the end of a style fixed transversely upon the ulnar prominence of his own wrist, declared that the lower extremities of the radius and the ulna describe semicircles equal in extent and opposite in direction. Lecomte showed that by fitting an inextensible ring around the wrist above the styloid processes the movements of pronation and supination could still take place, which would not be the case were the radius alone active. He believed the ulna to be capable of circumduction, and pointed to the multiple facets in the sigmoid cavity as being proof that there is a riding from side to side. He compared the bones of the forearm to two revolving axles (arbres) parallel, supporting and pivoting upon each other with their extremities united by very movable articulations. The ulna has a pronator, the anconeus, and a supinator, the pronator quadratus. This latter muscle shows, by its attachment wrapping around the shaft of the ulna, that it is intended to roll that bone toward the radius.

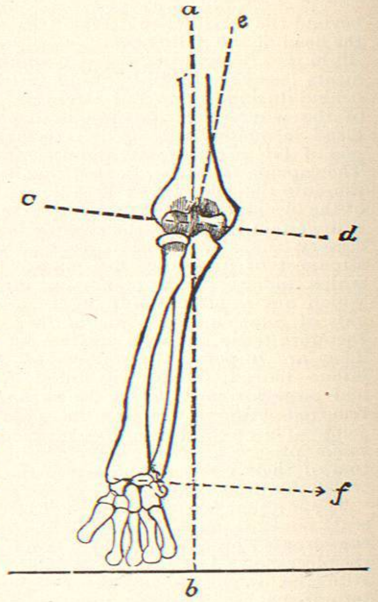


FIG. 1830.—The Bones of the Right Arm in Extension and Supination. *a, b*, Axis of humerus; *c, d*, axis of motion of elbow-joint; *f*, the plane in which the styloid process of the radius moves in pronation and supination.

Later observers have pointed out that, as Lecomte discarded all experiments on the cadaver, he could not have been sure that he fixed the humerus, and that consequently many of his results arise from the slight rotation of the humerus which usually accompanies pronation and supination. The ring causes forced and unnatural movements. A mathematical calculation shows that the action of the pronator quadratus must vary according to the situation of the axis around which the bones turn, and may be in one direction or the other, as that axis varies.

In 1883 Heiberg published the results of some investigations made by him on the cadaver, which seemed completely to confirm Lecomte's views. Disarticulating at





the wrist, he inserted into the radius and the ulna stiff rods, at the end of which were brushes charged with ink. It was necessary to use brushes, as the motions described were not in a single plane. On effecting movements of pronation and supination, these brushes described on paper curves which are approximately shown in Fig. 1833.

That for the radius is rather flat and appears to be a portion of a cycloid, while that for the ulna is smaller and is nearly an arc of a circle. In order to ascertain if similar results could be obtained in the living subject, he strapped a metal rod firmly to the arm along the edge of the ulna, carrying it out beyond the olecranon process so far that the distance between the lower edge of the greater sigmoid cavity and the end of the rod should be approximately equal to the distance between the same point and the styloid process of the ulna.

This upper end he found to describe curves which were similar to those described by the lower end in the cadaver, and he therefore concluded that the ulna describes movements of circumduction during pronation and supination, the lower portion generating a conical surface and the upper portion another, the vertices of the cones meeting at the lower edge of the greater sigmoid cavity. He presented his views to the International Medical Congress in 1884, and a lively discussion ensued. It was pointed out that his apparatus must necessarily produce very inexact results. Since that Cathcart has stated that in patients who have ankylosis of the humerus at the shoulder-joint he finds pronation and supination to be difficult, and Flesch found that in an apparatus rigged to imitate the elbow-joint the movements of the ulna appeared to be mainly those of flexion and extension. In the living subject the anconeus strongly contracts during pronation, and the brachialis anticus and flexor carpi ulnaris during supination.

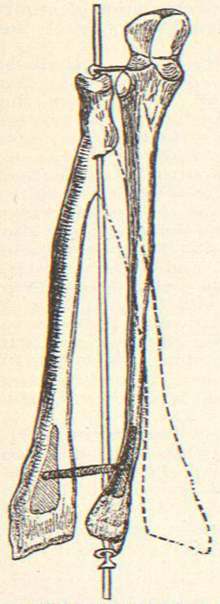

FIG. 1831.—Usual Method of Illustrating the Movements of Pronation and Supination. The radius and ulna joined together by means of a rod passing through the head of the radius and the head of the ulna.

My own experiments completely confirm this. The most important paper that has recently appeared has been one by Braune and Fischer, who made, during 1885, a series of most careful experiments on the cadaver, in order to establish the character of Heiberg's curves of movement. The cadaver used was that of a suicide, and quite recent. The motions were induced by weights and pulleys acting as nearly as possible in the line in which the muscles pull during life, and pains were taken not to force them by making the weights too heavy. Styles were inserted firmly into the ulna and radius, and the path described by their ends was carefully observed and traced upon glass in at least two planes, or marked by reflecting mirrors on a wall. From the tracings, a system of co-ordinates was obtained by which the path of each style was calculated. It was found that the paths described by the ulna belonged to no regular curve, but were a series of motions of flexion and extension, with a slight degree of lateral motion.

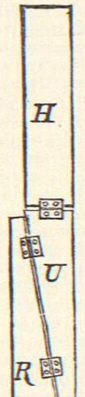


FIG. 1832.—The Same Mechanism Illustrated by Pieces of Board Hinged Together. (After Welcker.)

These results agree with experiments which I have myself made on this subject, but it should be added that

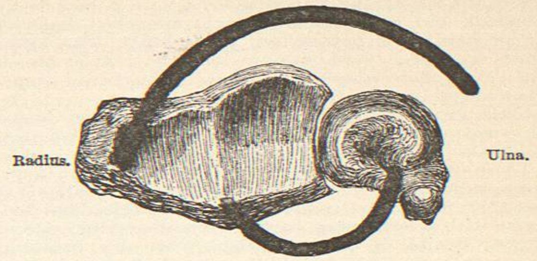


FIG. 1833.—The Lower Ends of the Radius and Ulna; showing the Movements of Pronation and Supination. (According to Heiberg.)

the amount of ulnar movement undoubtedly varies considerably according to circumstances, and that the axis of motion, instead of being fixed, as usually stated, changes according to the act performed.

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BIBLIOGRAPHY.

Henke and Reyher: Ueber die Entwickelung der Gelenke. Sitzungsb. der Wiener Acad. der Wissensch., naturmath. Classe, vol. lxx.
Braune, W., and Kyrklund, K.: Ein Beitrag zur Mechanik des Ellenbogengelenks. Archiv f. Anat. und Entwickgsch., Leipzig, 1879, p. 321.
Meissner, G.: Henle and Pfeuffer's Zeitsch., III. Reihe, vol. i., 1857, p. 514.
Langer, C.: Lehrbuch der system. und topographischen Anatomie, 3d ed., Wien, 1885, p. 77.
Henle, J.: Bänderlehre, 2d ed., p. 77.
Henke, J. W.: Handbuch der Anatomie und Mechanik der Gelenke, 1863, p. 146.
Humphry, G. M.: The Human Skeleton, including the Joints, London, 1858.
Sutton, J. B.: On the Nature of Ligaments. Jour. Anat. and Phys., London, xviii., 225; xix., 27, 245.
Zuckerkandl, E.: Ueber das Gleiten des Ulnarnerven auf die volare Seite des Epicondylus internus während der Flexion im Ellbogengelenke. Stricker's mediz. Jahrbücher, 1880, pp. 135–140.
Honigschmied, J.: Leichen-Experimente über die Zerreissungen der Bänder im Ellbogengelenk. Deutsche Zeitsch. f. Chir., Leipzig, 1879, xii., 317–332.
Pingaud, E.: Dict. Encycl. des Sciences Médicales, article Coude, vol. xxi., 1re sér., Paris, 1878.
Denucé: Nouveau Dictionnaire de Méd. et Chir. Pratiques, article Coude, Paris, 1877.
Lucæ, G.: Die Stellung des Humeruskopfes zum Ellbogengelenk beim Europaer und Neger. Arch. f. Anthrop., Braunschwg., 1866, i., 273–276.
Gegenbaur, C.: Jen. Zeitsch., iv., 50.
Schmid, F.: Ueber die gegenseitige Stellung der Gelenk- und Knochenaxen der Vorderarm und hinteren Extremität bei Wirbelthieren. Arch. f. Anthrop., vi., 181.
Martins, Charles: Mém. de l'Acad. des Sciences de Montpellier, iii., 482.
Albrecht, P.: Beitrag zur Torsionstheorie. Schriften der Univ. zu Kiel, 1875.
Langer, C.: Anatomie der äusseren Formen des menschl. Körpers, Wien, 1884.
Welcker, H.: Arch. f. Anat. und Phys., 1875, pp. 1–46.
Vicq d'Azyr: Œuvres, Paris, 1805, vol. v., 347.
Cruveilhier, J.: Anatomie Descriptive, Paris, 1871, vol. i., 368.
Duchenne, G. B.: Physiologie des Mouvements, Paris, 1867, p. 130.
Lecomte, O.: Du Mouvement de la Rotation de la Main. Arch. Gén. de Médecine, Paris, 1874, xxiv., 129–149.—*Ibid.*: Le Coude et la Rotation de la Main., do., 1877, xxix., 533 and 663.
Koster, W.: Bijdrage tot der Kenniss van het Mechanisme der Bewegingen in het Elleboogsgewicht. Nederl. Tijdsch. voor Geneesk., 1880, p. 213.
Braune, W., and Flügel, A.: Ueber Pronation und Supination des mensch. Vorderarms und der Hand. Arch. f. Anat. und Entwickgsch., 1882, pp. 169–196.
Einthoven, W.: Quelques Remarques sur le Mécanisme de l'Articulation du Coude. Arch. Neerland. d. sc. exactes, etc., Haarlem, 1882, xvii., 289–298.
Heiberg, J.: Ueber die Drehung des Vorderarms. Christiania Videnskabs Forhandlinger, 1883, No. 8.—*Ibid.*: Zur Geschichte der Lehre von der Drehung der Hand, do., No. 11.
Cathcart, C. W.: On the Movements of the Ulna in Pronation and Supination. Jour. Anat. and Phys., London, xix., 1884–85, p. 355.
Flesch, Max: Zur Pronation und Supination der Hand. Arch. f. Anat. und Entwickgsch., 1885, p. 216.
Braune, W., and Fischer, O.: Die bei der Untersuchung von Gelenk-