A
CONTRIBUTION
TO THE
SCIENCE OF TERATOLOGY.

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IN the following paper it is proposed to bring before the notice of the Society a remarkable instance of congenital malformation of the two upper extremities.

The subject of monstrosities has been ably investigated by Otto St. Hilaire, Vrolik, and many others, but the precise nature of deviations from the normal state has not yet been satisfactorily explained. Descriptive anatomy, as applied to the science of teratology, is still defective; yet it appears to be well calculated to repay investigation. Moreover, accurate dissections, carefully recorded, would be of value for reference, since cases of similar deformity are constantly presenting themselves.

These considerations, together with the importance of the subject as a branch of pathology, and the peculiarities of the example about to be described, make me desirous of bringing before the Society the subject of the present communication.

According to the theory which was first propounded by Meckel, the case about to be described is one of malformation produced by "retardment" or "arrest of development." Otto would have placed it in his Third Order, "*Monstra peromelas artubus defectivis*," and the Second Genus, "*Monstra perochiras artubus anterioribus defectivis*."

I hope that in the course of this inquiry we shall be able to point out, not only that there is a *deficiency* of development, but that there is evidence of *excessive* formation to compensate to a certain extent for the original defect, but differing somewhat from the "quantitative antithesis" of Geoffrey St. Hilaire, which he denominates "*loi de balancement*." This will be fully explained hereafter.

For the following particulars relating to the mother of the child I am much indebted to Mr. McLanglin, who attended at the confinement.

On the 10th January, 1857, Mrs. M—, æt. 35, residing near Clapham, London, was safely delivered of the present child. At the period when the labour came on, Mrs. M— believed herself to be at least *four weeks from the full period of utero-gestation*. The evidence of this was, however, doubtful. She has had ten well-formed children born alive, and two miscarriages. The previous child to this one was a girl, born at the sixth month, who appeared free from deformity, but lived only twenty-four hours. There is no history of accident or illness during pregnancy. On neither maternal nor paternal side could there be discovered any hereditary tendency to congenital malformation. The dietary had been in no respect peculiar. The presentation was cranial, the placenta small, and the cord thin. The mother can assign no cause for the deformity, except her having heard of the birth, in her neighbourhood, of a child

without either arms or legs. This news probably was received before she became pregnant. The child (a male) breathed and cried, but lived about ten minutes only.

On examination, both upper extremities were found to be deformed—the left more so than the right.

The Right Arm. (Pl. I, fig. 1.)—The shoulder and upper arm deviate but little from the regular form. The forearm appears shorter than usual. This is occasioned by the situation of the hand, which is fixed in a prone position, and flexed to such an extent that the radial side of the index finger lies adjacent to the radial side of the forearm. The forearm itself is directed a little outwards, so as to form an angle with the outer side of the upper arm. The hand presents four fingers, without the slightest indication of a thumb.

Upon dissection, the radius is found to be entirely absent. The upper part of the ulna and the lower extremity of the humerus are modified to compensate for the deficiency. The defective parts of the hand are the scaphoid trapezium, and the metacarpal bone and phalanges of the thumb. The pronators, supinators, flexors, and extensors of the radial side of the carpus and of the thumb are absent. The flexors and extensors in the middle of the arm are abnormal, but those on the ulnar side are normal. The radial artery is absent.

The Left Arm is more deformed. (Pl. I, fig. 6.)—The shoulder is flattened, and the limb tapers gently to the wrist, and hangs down by the side of the chest, with the hand directed backwards and upwards, and fixed in such a position that the palm of the hand faces the back of the forearm. The upper arm seems to be nearly absent, and the prominence of the elbow is felt close to the posterior fold of the axilla. The hand presents only two fingers, the ring and the little finger. Upon more close examination the scapula is found to be well formed, except that the glenoid

cavity has grown into a hemispherical eminence, becoming an example of "excessive formation."

The humerus is so mal-formed that little more than the lower extremity exists.

The only portion of the radius which has been developed is a small cartilaginous nodule, which appears to represent the head of that bone.

The ulna is but slightly modified.

The carpus presents the three inner bones only, viz., pisiform, cuneiform, and unciform.

The metacarpus presents the three inner bones.

The phalanges of two inner fingers only are present.

The muscles of the upper arm are all either absent or very abnormal, and those of the forearm are quite as defective as those of the right arm.

Some interesting peculiarities are met with in the vessels and nerves of both arms.

The integument of both upper extremities is well supplied with fat, and does not present the slightest appearance of a scar.

RIGHT ARM.

The Bones, (see Pl. I.)

Scapula.—Not peculiar.

Humerus (Pl. I, fig. 2).—Abnormal at the lower extremity. The capitellum is well marked, but less rounded off than usual; no fossa anterior minor or radial depression exists above it, and the semicircular ridge, which usually is lodged in the space intervening between the radius and ulna, is entirely absent.

Radius.—Absent.

Ulna (Pl. I, fig. 2).—The shaft does not taper gradually from above downwards, but slightly increases in size from about half an inch (two-fifths) below the articular surface

(in front) to the lower extremity, the breadth augmenting from one tenth to one fifth of an inch.

It has a uniform gentle curve, the concavity directed forwards. The inner side is rendered slightly concave by the projection inwards of the upper extremity. The outer side is nearly straight. No oblique line is met with on this surface. The olecranon process is well marked.

The outer surface of the coronoid process does not present the lesser sigmoid cavity, but is uniformly convex and rough.

The greater sigmoid cavity is divided, as usual, into two portions, an internal and an external. The internal is small, and concave transversely, as well as from above downwards, directed upwards and inwards; into this the outer part of the trochlea of the humerus accurately fits. The external is rendered larger than usual by projecting forwards as well as outwards; being also concave in the same way, and directed upwards, outwards, and forwards, it is exactly adapted to the capitellum of the humerus, which normally articulates with the head of the radius.

Lower extremity. The ulna ends by a rounded cartilaginous epiphysis. There is no styloid process, but on the outer side there is a slight projection, which, however, does not descend so low as the cartilaginous extremity.

The transverse section of the shaft of the ulna is triangular. The medullary foramen is large, and runs upwards.

The ulna (Pl. I, fig. 2¹) is set on the humerus very obliquely outwards. This is occasioned by the outer concave portion of the greater sigmoid cavity, which articulates with the capitellum of the humerus, being on a lower level than the inner part of the sigmoid cavity, which is applied to the inner part of the trochlea.

The ulna forms an angle of from thirty to forty degrees with the produced line of the axis of the shaft of the humerus; usually the angle does not exceed ten degrees.

Carpus (Pl. I, fig. 3).—The carpus is unossified. The

scaphoid and trapezium entirely absent. Trapezoid abnormal; it is free above; and on the outer side, where it is convex and smooth, it rests upon the base of the metacarpal bone of the fore finger; the inner side of the trapezoid articulates with the magnum.

Metacarpus and Phalanges (Pl. I, fig. 3).—The thumb is absent; the other fingers are well formed.

The carpus is loosely attached to the lower part of the ulna by ligamentous fibres, in such a way that the hand is at right angles with the anterior surface of the ulna. These fibres are attached to the ulna above the cartilaginous epiphysis, and descend to the carpus, where they unite with bands of ligament uniting the bones of the carpus with one another. No synovial cavity appears to exist.

The distance of the carpus from the ulna was one tenth of an inch, when the ligaments were put on the stretch.

Upper Arm.—Defective muscles, nerves, vessels, &c.

The biceps muscle (Pl. I, fig. 4 N) is thin and flattened. The inner head arises from the coracoid process by a broad ligamentous attachment. The fibres have a direction downwards and outwards, and rest upon the coraco-brachialis muscle with which, to its insertion, they are inseparably united.

About the middle of the arm the biceps is joined by a slender slip of muscle which arises, by a pointed tendinous process, from the ligamentous investment of the humerus, immediately below the insertion of the latissimus dorsi. It passes down between the attachment of the coraco-brachialis, on the inner side, and the pectoralis major and deltoid, on the outer side. Its extreme length is about half an inch, and its breadth, at the point of junction, one eighth of an inch. It does not extend up to the joint, nor even up to the groove of the humerus, which is usually occupied by the long head of the biceps.

The muscle thus formed is thin, and more or less united with the brachialis anticus, and, a little above the elbow-joint, terminates, partly by joining a piece of tendinous

fascia which passes into the forearm, and will be described hereafter, and partly by attachment to the outer condyle.

The brachialis anticus (Pl. I, fig. 4 o) is not well developed. It appears chiefly as a small mass of muscle at the inner side of the biceps, at its lower part. It arises as usual, and is inserted below into the piece of fascia which has been mentioned as the tendon of the biceps, to be traced into the forearm, and also into the coronoid process of the ulna.

There is nothing remarkable about the brachial artery. The nutritious and other branches are not defective.

The brachial plexus. The only nerves requiring special notice are the musculo-cutaneous and the musculo-spiral.

The musculo-cutaneous leaves, as usual, the outer cord of the plexus at the lower border of the pectoralis minor, and soon divides into two, and afterwards into several branches, which pass into the muscles arising from the coracoid process; they descend among the muscular fibres as far as the middle of the upper-arm, and appear to mark the distinction between the coraco-brachialis and the biceps, and the brachialis anticus and the biceps.

The musculo-spiral nerve takes its usual course, but when it arrives in front of the outer condyle it is very small, and, instead of giving off the radial and posterior interosseous nerves, it divides into several very minute branches, which are soon lost in the adjacent muscular structures, particularly the anconeus. It is accompanied by the profunda arteria, which has a similar course and distribution.

The supinator radii longus, extensor carpi radialis, longior and brevior muscles are absent.

The inner condyle of the humerus gives origin to muscular fibres which probably represent, or are the imperfect rudiments of, the pronator radii teres and the flexor carpi radialis. They form a small mass of muscle (p), which crosses the elbow-joint obliquely, outwards and downwards: the upper fibres become lost among the descending fibres of the biceps and brachialis anticus,—the lower fibres are attached to the inner surface of the sheet of fascia, which has been mentioned as the prolongation of the tendon of

the biceps, and passes into the forearm as an intermuscular septum.

The shoulder-joint is rendered defective by the absence of the tendon of the biceps muscle ; in other respects it appears well formed.

Front of the forearm.—The flexor carpi ulnaris, palmaris longus, and flexor sublimis are on the same level, and, with the ulnar artery and nerve, rest upon the profundus.

The flexor carpi ulnaris and palmaris longus muscles are quite normal.

The pronator radii teres and flexor carpi radialis are mentioned above as presenting their usual origin, their further development only being arrested.

The flexor sublimis (Pl. I, fig. 5 s) arises from the inner condyle of the humerus, between the “rudiments of the pronator radii teres and flexor carpi radialis,” and the flexor carpi ulnaris, by a common origin, and from that rudimentary mass as far outwards as the tendinous slip from the biceps, and also from the coronoid process of the ulna. It soon divides into two parts ; the inner part supplies tendons to the inner two fingers in the usual way ; the outer part also supplies two tendons, one of which passes to the fore finger, but the other could not be traced to the second finger, but appeared to be lost in cellular tissue on the outer side of the fore finger. The outer edge of the muscle is free and rounded, and the vessels and nerves for the outer side of the hand emerge from under it. The inner edge, also free, is adjacent to the palmaris longus and flexor carpi ulnaris, with the ulnar nerve and artery between them. It rests upon the profundus.

The flexor digitorum profundus (Pl. I, fig. 5 r) arises from the anterior and inner surface of the ulna for three-quarters of the length of the bone, from the inner part of the olecranon, and from an aponeurosis common to this muscle and the flexor carpi ulnaris. The fibres have a downward and outward direction, and divide beneath the annular ligament into four tendons, whose destinations are the last phalanges

of the fingers. The outer border of the muscle is free, thick, rounded, and fleshy, and touches the vessels and nerves for the outer side of the hand. The cutaneous aspect of the muscle forms an expanded surface, and is in contact with the ulnar nerve and vessel, the flexor sublimis, and the flexor carpi ulnaris.

Length of origin, from inner side of ulna, one inch. Length of ulna, one inch and three quarters.

The flexor sublimis and profundus tendons pass through the same compartment in the annular ligament.

Ulnar nerve (Pl. I, fig. 5, 5).—Quite regular in its course and distribution, both in the hand and arm.

The brachial artery enters the forearm beneath the mass of muscular fibres called the “rudiments of the pronator teres,” &c., and the flexor sublimis; it may be considered to become ulnar when it enters the forearm.

The ulnar artery is the direct continuation of the brachial, and, as usual, gives off the anterior and the posterior ulnar recurrent branches, and then pursues its accustomed course until it reaches the wrist. (See Pl. I, figs. 5, 7.)

Palmar part of the ulnar artery.—After passing beneath a slip of tendon from the annular ligament, the ulnar artery is directed outwards in the palm of the hand, and divides into two digital branches for the supply of the little and ring-fingers.

The profunda branch takes its usual course, and appears to unite with the profunda branch of the radial, after passing beneath the abductor indicis.

Branches of ulnar artery (Pl. I, figs. 4 and 5).—At the outer border of the flexor profundus, and covered by the flexor sublimis, the ulnar artery gives off a branch (the interosseous) nearly equal in size to itself, which divides immediately into two vessels—the anterior and the outer.

1. The anterior (median?) passes downwards, at first concealed by the flexor sublimis, but it soon emerges, and takes the course of the outer border of the flexor sublimis, and is accompanied by the median nerve, which at first rests upon it and then passes to its inner side. The artery divides

near the wrist into two branches—deep and superficial palmar.

The superficial palmar branch passes into the hand on the outer side of the tendons of the flexor sublimis, and at the base of the fore finger divides into two branches, for the supply of the fore and the next finger (outer side), and probably communicates with the palmar part of ulnar artery. These palmar digital branches are superficial to the tendons of the sublimis. The superficial branch gives off also a dorsal branch to the index finger.

The deep branch, or carpal, passes into the hand at the base of the metacarpal bone of the fore finger, and is distributed to the deep structures.

2. The outer vessel appears to represent the anterior interosseous branch of the ulnar artery. It is directed backwards, and is overlapped by the profundus, and rests upon the ulna, between the profundus and the extensor digitorum communis. It is accompanied by a branch of the median nerve (interosseous?). Near the wrist it gives off three branches—the outer one to the extensor communis, the middle to the structures about the wrist-joint, and the inner to the profundus, as well as muscular branches to the profundus.

The median nerve (Pl. I, figs. 4 and 5) passes into the forearm beneath the little mass of muscle arising from the inner condyle called “rudiment of pronator teres,” &c., and the flexor sublimus; thence its course to the wrist is natural.

The nerve dips beneath the annular ligament to enter the palm of the hand, where it is thus distributed—

1st. An undivided nerve is given off to the outer side of the fore finger.

2nd. It divides at the base of the fore and middle fingers for their opposed sides.

3rd. A connecting branch is given to the ulnar nerve, and probably supplies the opposed sides of the middle and ring-fingers.

Branches.—Whilst the median nerve is beneath the flexor sublimis and the muscular mass arising from the inner

condyle, it gives off its first branch, which turns outwards and soon divides into three branches.

The first has a course directly outwards towards the outer condyle, and then, dividing into two minute branches, is distributed to the muscular slip which appears to be a portion of the profundus muscle arising from the outer side of the ulna.

The middle branch has the same course and distribution as the interosseous artery, and at length enters the structures at the base of the metacarpal bone of the fore finger with the deep palmar vessel mentioned above.

The last nerve gives off what appears to be a cutaneous branch for the outer side of the palm of the hand.

The radial nerve is supplied by a branch of the median (Pl. I, fig. 4), for just as the median nerve is emerging from the outer border of the flexor sublimis, it gives off a branch which takes the same course as the median down to the wrist, where it becomes cutaneous on the back of the hand. It then divides into three parts for the supply of the fingers.

One is an undivided nerve for the radial side of the fore finger; the other two divide at the base of the fingers for the opposed sides of the fore and middle, and outer side of ring, and communicate with the dorsal cutaneous branch of ulnar nerve. Length, from origin to back of hand, half an inch.

At this stage of the dissection we are able to trace the slip of fascia from the biceps into the forearm to its termination (Pl. I, fig. 4). This slip or process of fascia, after covering the outer surface of the lower part of the brachialis anticus mass, passes down as an intermuscular septum into the forearm, between the profundus and the extensor communis digitorum. It then attaches itself to the free margin of the portion of the extensor communis digitorum muscle which arises from the ulna, and, passing down on its outer surface as a thin membrane, is fixed to the greater part of the length of the ulna between the extensor carpi ulnaris and the aforesaid portion of the extensor communis digitorum.

Back of the Forearm.—The extensor communis digitorum, extensor carpi ulnaris, and anconeus, are the only muscles of the superficial layer present.

The extensor communis digitorum (Pl. I, fig. 4 v) is a slender muscle arising from the fascia covering the outer condyle, immediately on the outer side of the biceps, by a pointed process, and the fleshy fibres descend to a tendon which spreads out as a fascia over the back of the hand. Processes may be traced up the back of the middle, ring, and little fingers. The muscle crosses the arm obliquely downwards and backwards, nearly touching the flexor sublimis above; they are separated below from each other by a distance of a quarter of an inch. In this interval may be seen part of the flexor profundus, and the nerves and vessels of the limb.

Along the posterior border is the extensor carpi ulnaris.

Beneath it is the remnant of the extensor communis digitorum.

The extensor carpi ulnaris (Pl. I, fig. 4 w) arises from the outer condyle of the humerus, and from the upper half of the posterior border of the ulna; in other respects it is normal, but there is no extensor of the little finger on the outer side, and no annular ligament on back of the wrist.

The anconeus muscle is present, but requires no special description.

The muscle which has been referred to as the remnant of the extensor communis digitorum, arises from the posterior edge of the ulna, below the origin of the extensor carpi ulnaris (?) and from the outer surface of the ulna down to within one eighth of an inch of the wrist-joint. Pointed above, and becoming wider as they descend, the muscular fibres are inserted into the outer and anterior aspects of the carpus; a few fibres pass round the outer side of the carpus, above the base of the metacarpal bone of the fore finger, and are attached to the fascia covering the back of the hand.

The muscle is situated between the flexor profundus and the extensor carpi ulnaris, and is covered by the extensor communis digitorum.

The anterior edge would be free but for the attachment of the slip of tendon from the biceps and brachialis; and as it descends to the ulna it coats the outer surface of the muscle.

THE LEFT ARM. (Pl. I, fig. 6, and Pl. II.)

The Bones.

THE only part of the scapula which is abnormal is that usually called the head of the bone; this presents a hemispherical eminence, slightly flattened at the end, and having a small depression representing the glenoid cavity. The whole is cartilaginous, and enters into the formation of the shoulder-joint. (Pl. II, fig. 6.)

The humerus (Pl. II, figs. 1, 2, 3) is very diminutive in size, being little more than half an inch in length and rather less in breadth. It is composed principally of cartilage, but a small piece of bone, having somewhat the shape of a truncated cone, is situated at the upper and outer part.

The lower extremity, cartilaginous. Is flattened from before backwards, so that its transverse exceeds its antero-posterior diameter. It is not curved forward so as to present to view any of the articular surface.

The condyles.—The outer condyle is absent. The inner condyle is a rough conical eminence, projecting one fifth of an inch from the inner part of the humerus, to which it is united by its base; at the upper part the juncture is made with the bony portion of the humerus, and there a canal is formed for the transmission of the median nerve.

The articular surface is longest in the transverse direction and is divided by a slight groove into two lateral portions, viz., an external, small, globular eminence, or capitellum for articulation with the upper extremity of the

radius, and situated at the outer and lower angle of the humerus, and an internal pulley-like surface for articulation with the ulna.

The groove which usually intervenes between the capitellum and the trochlea is scarcely marked.

The trochlea turns over behind the bone, but is not apparent before when the bones are *in situ*; it is convex from before backwards, concave from side to side. The trochlea has no outer margin, the concavity passing without any ridge into the capitellum. The inner margin of the trochlea is well marked. The fossæ do not exist, and the elbow-joint is incapable of flexion.

The body.—An irregular bony truncated cone, the axis directed upwards and outwards, and free, the base united with the remaining cartilaginous part of the humerus at its upper and outer angle.

It is flattened in front, convex behind and at the side, so as to be somewhat prismatic in form.

The borders.—The outer runs from above the capitellum towards the apex; the inner from the inner condyle also towards the apex; and the posterior produces the prominence of the posterior surface.

The junction of the bony portion with the cartilaginous takes place anteriorly by a curved line commencing at one tenth of an inch above the capitellum, turning upwards to nearly one third of an inch from the free extremity of the inner condyle, and posteriorly at a distance of about one tenth of an inch from the top of the olecranon.

The radius (Pl. II, figs. 1, 2, 3) is very defective; it appears as a small rounded cartilaginous nodule, slightly flattened from before backwards, and articulating with the capitellum of the humerus and the lesser sigmoid cavity of the ulna. The head of the radius seems to be the part represented. Its greatest diameter is less than half an inch. The upper extremity is composed of two parts, one on the inner side which corresponds with the "cartilaginous circumference," semicircular and convex, for articulation

with the lesser sigmoid cavity of the ulna; the other, terminal, circular, and concave, having a direction upwards and inwards, represents the "expanded articular summit" of the bone; it articulates with the capitellum of the humerus. The junction of these articular surfaces corresponds with the line of contact of the humerus and ulna.

The ulna (Pl. II, fig. 3) deviates but little from the regular form. The olecranon is well formed; the triceps is attached to its inner edge rather than to its *summit*; it is ossified. The lesser sigmoid cavity appears to be less concave than usual. The annular ligament is absent.

The lower extremity or head of the ulna is cartilaginous, and presents a rounded, slightly concave, articular surface on its inner side, which articulates with the upper part of the cuneiform bone, without the interposition of a fibro-cartilage.

The outer side of the head is smooth, convex, and prominent.

The shaft is much more nearly cylindrical than usual, and does not present its accustomed curves.

The borders are rounded and indistinct, and not flexuous in their course. The posterior border is the more prominent.

The surfaces are slightly convex, and the medullary foramen is situated on the inner instead of the anterior surface, at the junction of the upper and middle thirds.

The carpus (Pl. II, fig. 4).—Two wedge-shaped pieces of cartilage, together with the pisiform, represent the carpal bones. The upper, which answers to the cuneiform, is the smaller, and is convex superiorly for articulation with the ulna; concave inferiorly, where it is opposed to the carpal element below. The inferior and larger, which is the representative of the unciform, is also convex superiorly, and is flattened below, and upon it rest the bases of the three metacarpal bones.

The Fingers.—To the hand belong only two perfect fingers, the ring- and the little finger.

A third metacarpal bone is found on the outer side of the metacarpal bone of the ring-finger, but is considerably smaller in every respect than any of the others, and has no phalanges resting upon it.

The shoulder-joint (Pl. II, fig. 6) is formed between a fibro-cartilaginous cap covering the convex glenoid extremity of the scapula, and the upper and posterior part of the cartilaginous element of the humerus above the summit of the olecranon, and the posterior surface of the bony portion between the posterior and inner borders.

A capsular ligament surrounds the articulation and holds the parts together, and is strengthened by some ligamentous fibres from the contiguous tendons, especially from the pectoralis major and the triceps.

The capsular ligament at the upper part is fixed around the neck of the above-mentioned cartilaginous cap, and at the lower part the ligament is attached to the humerus at its upper and posterior surface.

The tendons of the pectoralis major, deltoid, and triceps muscles are attached just behind the inner border of the bony portion of the humerus, and thus intervene between it and the capsule of the joint.

A synovial membrane lines the capsular ligament. The following muscles surround the articulation, on the inner side; coraco-brachialis, and pectoralis major; above and on the outer side, deltoid and triceps.

The nerves belonging to the outer side of the arm pass beneath the capsular ligament.

Elbow-joint.—The bones are so firmly bound together *in situ* by fibrous tissues that no movement is permitted.

The pectoralis major (Pl. II, fig. 5 *a*) has its usual origin from the chest and clavicle, and ends in a tendon, which, instead of being inserted into the bicipital groove of the

humerus, is attached to the inner border of the conical bony portion of the humerus from the base nearly to the summit. Its posterior surface, after crossing the coraco-brachialis, lies upon the capsule of the shoulder-joint. To the upper border of the tendon, near its insertion, are attached fibres from the deltoid.

A process of membrane from the tendon of the pectoralis major passes upwards to the coracoid process, and assists in strengthening the joint and in retaining the arm in position. The tendon of this muscle is a strong flat membrane, three tenths of an inch broad at its insertion.

The pectoralis minor (Pl. II, fig. 5 *b*) is attached to the tip of the coracoid process, but is not united with the short head of the biceps, this being absent.

The axillary artery (Pl. II, fig. 5 *c*) commences at the lower border of the first rib, and terminates by the vessel entering the forearm beneath the origin of the flexor carpi ulnaris. The length of the artery is not more than one inch. Above and beneath the small pectoral muscle its connexions with surrounding parts is normal. Beyond that muscle the artery is concealed in part by the lower border of the pectoralis major; but thence to its entrance into the forearm it is covered only by integuments and fascia. Behind it is the lower part of the subscapularis and its tendon. To the outer side is the coraco-brachialis. The artery is surrounded by the nerves of the brachial plexus, and the axillary vein is on the thoracic side.

Just before the vessel enters the forearm it is overlapped by the coraco-brachialis on the outer side, and by the ulnar nerve on the inner side, and it rests upon the inner side of the semi-cartilaginous cap, covering the glenoid extremity of the scapula. All the branches of the axillary artery are represented except the circumflex; those belonging to the limb come off by one trunk just before the artery enters the forearm. This branch soon divides into the scapular, which runs along the lower costa; the profunda and muscular, which wind backwards behind the joint to the triceps and outer side of the arm with the musculo-spinal nerve.

The *latissimus dorsi* (Pl. II, fig. 5 d) arises as usual from the trunk of the body, and crosses the lower angle of the scapula. But the *latissimus dorsi* and the *teres major* tendon, instead of being inserted into the bottom of the bicipital groove of the humerus, are arrested in their course, for, meeting with the long head of the *triceps* as it descends from the inferior costa of the scapula near its neck, they join it and are conducted upwards on its tendon to its origin, and are inserted into the neck of the scapula. A tendinous intersection marks the line of junction. The *deltoid* muscle also sends down fibres to this point.

The *serratus magnus* and *intercostal* muscles are normal.

The *subscapularis* muscle (Pl. II, fig. 5 e) arises, as is usual, from all the concave surface of the ventral aspect of the scapula; but the tendon, instead of being inserted into the small tuberosity of the humerus, unites with the tendons of the other scapular muscles, viz., the *supra-spinatus*, *infra-spinatus*, and *teres minor*, and forms with them a smooth white cap, of cartilaginous hardness, fitting upon the glenoid extremity of the scapula, which, instead of being a cavity, is a smooth globular head covered with cartilage. The concavity of the cap is smooth, and freely moveable upon this rounded end of the scapula, whilst the convexity of the cap projects into and forms the scapular element of the shoulder-joint. The capsular ligament of the joint is attached around the neck of this cap. In other respects the *subscapularis* has its normal connexions.

The *supra-* (Pl. II, fig. 6 f) and the *infra-spinatus* (g) have their regular origin, and their fibres converge to a tendon which unites with the *teres minor* and *subscapularis*, as described above.

The *teres minor* (Pl. II, fig. 6 h) is a narrow fleshy slip, which is inseparably united with the *infra-spinatus*, along whose lower border it lies. Its origin is normal. (For insertion, see above.)

The *teres major* (Pl. II, fig. 6 i) arises from the rough surface on the dorsum of the scapula, near the inferior costa for some distance; the fibres are united with the

latissimus dorsi at the common point of tendinous intersection for these muscles, the triceps and the deltoid.

The deltoid (Pl. II, fig. 6 *k*) has its usual origin and form, and its fibres converge to a very extended insertion—the inner portion into the outer part of the tendon of the pectoralis major, just at its attachment to the inner border of the bony element of the humerus, between it and the capsule of the joint; it is, however, separated from the humerus by the origin of the triceps—the middle portion into the upper end of the humerus, between the capsular ligament and the triceps, and also inseparably united with them—the outer fleshy fibres to the upper edge of the teres major for its whole length, and especially to the common point of union for the teres major, latissimus dorsi, and triceps.

The upper arm.—The coraco-brachialis muscle passes from the coracoid process to the inner condyle of the humerus; at its inner side are the artery and nerve for the arm. The triceps covers all the humerus except the inner condyle.

The coraco-brachialis (Pl. II, fig. 5 *l*) arises from the tip of the coracoid process, and is inserted into the upper part of the inner condyle of the humerus; its length is half an inch. The tendon of the pectoralis major covers it, except at its insertion, which is subcutaneous. It rests upon the subscapularis. Perforating it just below the coracoid process is the musculo-cutaneous nerve; the median nerve rests upon the muscle, as well as a small communicating branch. Along the inner border are the axillary artery and the ulnar nerve.

The triceps (Pl. II, fig. 6 *m*) covers the whole humerus, except the inner part of the inner condyle, and is the only muscle at the back of the upper arm. It arises from the neck of the scapula, and from the inferior costa of that bone. It is here inseparably connected with the tendons of the latissimus dorsi and teres major, as before described; from this origin the fibres pass nearly vertically downwards to

be inserted into the olecranon process of the ulna, which is just below. The rest of the muscle arises from the anterior surface of the inner condyle, also from the inner and outer borders and posterior part of the apex of the bony body of the humerus, but separated from the capsule of the joint by the attachment of the tendons of the pectoralis major and deltoid, and also from the whole of the anterior, outer, and posterior surfaces of the humerus. From this extensive origin some of the fibres are directed to the tendon of insertion which is fixed to the end of the olecranon; the rest are connected with the fascia or muscles of the forearm, particularly with the extensor communis and anconeus. The triceps is quite superficial. It conceals the musculo-spiral, the median nerve, the profunda vessel, and the rudimentary radius.

Brachial plexus (Pl. II, fig. 5.)—There appears to be nothing peculiar about the three large cords composing the brachial plexus, except the absence of the circumflex nerve. It consists, as is usual, of three large cords—one is on the outer side, one on the inner, and one behind the artery.

1. The outer cord gives origin to one anterior thoracic, the musculo-cutaneous, and the outer head of the median.

2. The inner cord produces a second anterior thoracic, the inner head of the median, the ulnar nerve, and two cutaneous nerves.

3. The posterior furnishes the subscapular branches, and ends in the musculo-spiral.

The anterior thoracic, subscapular, upper, lower, and long, and the posterior thoracic (ext. respiratory, Bell), are quite regular.

The median nerve (Pl. II, fig. 5, 4) arises by two roots from the brachial plexus, one from the outer, the other from the inner cord. Commencing on the outer side of the artery, the nerve crosses over the vessel and passes across the coraco-brachialis muscle where it is joined by a fasciculus from the musculo-cutaneous nerve; it immediately changes its direction, and, proceeding downwards to the forearm, it

traverses a narrow foramen in the upper part of the inner condyle of the humerus (within the one tenth of an inch from the bony portion), and then enters the forearm between the origin of the flexor sublimis and the extensor digitorum communis.

The ulnar nerve (5) is derived from the inner cord of the brachial plexus, and lies close to the inner side of the axillary artery, and parallel to the coraco-brachialis, and rests upon the tendon of the subscapularis; it passes from the axilla into the forearm beneath the tendinous arch which stretches between the inner condyle of the humerus and the olecranon, and from which arises the flexor carpi ulnaris. Here it rests upon the line of junction of the olecranon and the humerus;—one twelfth of an inch broad.

The musculo-cutaneous nerve (6) leaves the outer cord of the plexus at the lower border of the pectoralis minor. It perforates directly the coraco-brachialis, and, upon emerging, gives off a fasciculus to join the median; it is then directed obliquely; passing from under the pectoralis major tendon, it becomes cutaneous at the back of the upper arm. Length, from origin to perforation, half an inch. Diameter, one twentieth of an inch.

The musculo-spiral nerve (17) arises from the posterior cord of the brachial plexus, of which it is the largest trunk. At first the nerve is behind and close to the main artery of the limb, but at the lower border of the tendon of the subscapularis it winds to the outer side of the arm, between that tendon and the upper part of the humerus, and behind the shoulder-joint; it enters the arm by passing through the triceps at its attachment to the upper extremity of the humerus, just behind its bony apex. It then, resting on that bone and covered by the triceps, winds from the back of the humerus to its outer and anterior surface, crossing in its course the ligamentous fibres between the humerus and the rudimentary radius. The body of the humerus is set on rather obliquely, so that with the projecting radius a groove is formed, in which the musculo-spiral nerve lies. This nerve enters the forearm between the extensor com-

munis and the extensor minimi digiti, after giving off branches to the triceps.

The superior profunda, a small artery, accompanies the musculo-spiral nerve.

The Forearm (Pl. II, figs. 7, 8, 9).—On the anterior aspect of the forearm are two superficial muscles, viz., the flexor carpi ulnaris and the flexor digitorum sublimis, and between them the ulnar vessel and nerve. The flexor digitorum profundus lies under them, but at the inner side of the flexor carpi ulnaris it is subcutaneous, and its tendons near the wrist may be observed in the interval between the tendons of the more superficial muscles.

The flexor carpi ulnaris (Pl. II, fig. 7 *r*) appears to be perfectly normal as to its origin, insertion, and relations. Its length is two inches ; its breadth, a quarter of an inch.

The flexor digitorum sublimis (Pl. II, figs. 7 and 8 *s*) arises from the anterior and outer surface of the inner condyle of the humerus, from the coronoid process of the ulna, and from the ulna for a short distance below, where it is inseparably united with the profundus, upon which it rests. Rather below the middle of the forearm the muscle ends in a small round tendon, which passes beneath the annular ligament, and divides in the palm of the hand into two tendons, which are continued across the hand, to be inserted into the middle phalanges of the two fingers in the usual way, after being perforated by the deep flexor tendons. The flexor sublimis is quite superficial. Along the inner border is the flexor carpi ulnaris, the ulnar vessel and nerve between them. To the outer side is the extensor communis digitorum. The superficial flexor rests upon the flexor profundus.

Just above the annular ligament the tendons of the sublimis and flexor carpi ulnaris are separated by an interval of one eighth of an inch, which allows the tendons of the profundus to come into view.

The ulnar artery (Pl. II, fig. 7 *7*) is the direct continuation of the axillary ; its course is in a straight line from its

origin to the wrist. The vessel passes with the ulnar nerve into the arm beneath the tendinous arch between the inner condyle of the humerus and the olecranon, which gives origin to the flexor carpi ulnaris, but it soon becomes quite superficial between the flexor carpi ulnaris and the flexor sublimis, and is concealed only by the common integuments and the fascia of the limb, though the former muscle somewhat overlaps it. The ulnar nerve at first lies upon, but soon passes to its inner side. Beneath the vessel is the flexor profundus. On the annular ligament the artery lies close to the tendon of the flexor carpi ulnaris and is crossed by a band of fibres from the tendon of that muscle. The ulnar nerve is still on the inner side.

The palmar part of the ulnar artery (two digital branches), after passing the annular ligament, is continued into the palm of the hand, where it divides into two principal branches, one for the radial side of each finger, *i. e.*, little and ring-finger. There is also a profunda artery.

Branches,—the anterior interosseous and the metacarpal.—The anterior interosseous arises immediately after the ulnar artery has entered the forearm. It is at first directed outwards and downwards under the flexor sublimis to the interval between that muscle and the extensor communis digitorum. It then runs down between these muscles, resting at first on the profundus and afterwards on the ulna, until within a half an inch from the wrist, when, passing under the extensor communis, it pursues its course to the back of the hand between the tendons of the extensor communis and extensor minimi digiti. It is accompanied by two interosseous nerves, terminal branches of the median.

The metacarpal branch, arising from the ulnar artery about a quarter of an inch above the lower end of the ulna, is directed obliquely backwards beneath the flexor carpi ulnaris, and, winding round the inner side of the hand, it divides into three branches—one for the inner side of the little finger, the other two for the opposed sides of the little and ring-fingers. It has the same course and distribution as the dorsal cutaneous branch of the ulnar nerve. It anastomoses freely with the former branch.

The ulnar nerve (Pl. II, fig. 7, 5) enters the forearm between the attachments of the flexor carpi ulnaris to the olecranon and inner condyle of the humerus with the ulnar artery (that is, behind the inner condyle). It has a straight course through the arm under cover of the flexor carpi ulnaris. It at first rests upon the ulnar artery, but about the middle of the forearm it is continued on the inner side of the vessel to the hand.

It supplies muscular branches to the flexor carpi ulnaris and profundus. The only irregularity of this nerve so far is its first relations with the ulnar artery.

The dorsal cutaneous branch for the hand arises about a quarter of an inch above the end of the ulna, and passes, as usual, obliquely backwards beneath the flexor carpi ulnaris; finally, perforating the aponeurosis of the limb, it is found on the back of the hand, where it supplies the fingers in the following way:

One undivided branch passes to the inner side of the little finger, another branch to the space between the little and ring-fingers, and divides for the supply of their opposed sides. No branch of nerve is found for the outer side of the ring-finger. The dorsal cutaneous branch ought to communicate with a branch of the radial nerve that should supply the space between the ring- and middle-fingers; in other respects it is normal.

The palmar part of the ulnar nerve is normal in every respect, except that it gives a distinct branch to the outer side of the ring-finger. This is usually supplied from the median nerve.

The median nerve (Pl. II, fig. 8, 4), after traversing a canal in the humerus, as before mentioned, descends into the forearm under cover of the triceps, and then passes down deeply between the flexor sublimis and extensor communis, and, resting on the flexor profundus, it gives off the anterior interosseous nerve which accompanies the interosseous artery. The nerve itself, becoming very minute, passes under the annular ligament between the tendons of the flexor profundus and extensor communis, and lies on the

ulna. It next enters deeply into the palm of the hand and divides into three small filaments, thus :

The first was traced into the small interosseous muscle between the rudimentary metacarpal bone for the middle finger and ring-finger. The second divides into two branches—to the lumbricales (?) The third sends off two branches to the structures about the base of the ring and little finger, and each gives a thread to the interosseous muscle.

The flexor profundus digitorum (Pl. II, figs. 7, 9 *t*) arises from the anterior and inner surfaces of the ulna for three fourths of the length of the bone, and as far outwards as the origin of the extensor digitorum communis, and from the inner part of the olecranon. The muscle is thick and fleshy, and ends in three tendons, which are not separate above the annular ligament.

The cutaneous surface of the muscle is in contact with the ulnar nerve and vessels, the flexor sublimis, and the flexor carpi ulnaris, and the deep surface rests on the ulna. The outer border touches the extensor digitorum communis and the interosseous vessels and nerve, and the median nerve. The inner is subcutaneous, and is connected by the aponeurosis to the posterior margin of the ulna. So that its only irregularities are that it does not arise from the inner half of the interosseous ligament, and that the outer border does not touch the flexor pollicis longus and the quadratus, these parts being absent. The presence of the median nerve is also abnormal, as well as the relation with the extensor communis.

The tendons.—The two inner tendons have the usual insertion into the last phalanges of the fingers ; but a third, a small slip of tendon on the outer side, after forming an expansion which covers the rounded head of the small rudimentary third metacarpal bone, is inserted into the fascia at the base of the ring-finger. (First phalanx.)

Palm of the hand.—The parts which belong generally to the little and ring-finger only are present, and require no special description.

The back of the left forearm. (Pl. II, figs. 8, 9.) The following muscles are present :

Extensor digitorum communis.

Extensor minimi digiti.

Extensor carpi ulnaris.

Anconeus.

The continuation of the musculo-spiral nerve enters the forearm between the common extensor of the fingers and the extensor of the little finger.

The extensor digitorum communis (Pl. II, fig. 8, *u*) arises from the whole of the outer surface of the ulna and from its posterior border to within half an inch of the end of that bone, between the attachments of the flexor profundus and the extensor minimi digiti. It is connected at the upper part with the triceps. Its fibres end in a tendon, which passes through a distinct compartment in the annular ligament at the outer side of the wrist, and then divides into two, which are directed along the back of the hand to be inserted in the usual way into the two last phalanges of the little and ring-fingers.

On the back of the hand the tendon of the ring-finger is united by an oblique band with the tendon of the little finger.

This muscle is situated between the sublimis and the extensor minimi digiti, and partly conceals the profundus. But there exists a small triangular interval in the upper part of the arm, between the sublimis and the extensor communis, in which may be seen the prolongation of the median nerve and the anterior interosseous artery resting on the profundus.

The extensor minimi digiti (Pl. II, figs. 8, 9 *v*) arises from the lower extremity of the rudimentary radius and from the ulna just below it, from about the upper one third of the posterior border, and from the intermuscular septum situate between itself and the extensor carpi ulnaris. Its direction is downwards and a little forwards, and it passes through a distinct sheath of the annular ligament on the outer side of the ulna, and its tendon, which is split into two

directly afterwards, ends by joining the common expansion on the first phalanx of the little finger.

The continuation of the musculo-spiral nerve in the forearm (Pl. II, figs. 8, 17). It enters the outer side of the forearm between the extensor communis digitorum and the extensor minimi digiti, and, after giving off branches to the extensor carpi ulnaris and extensor minimi digiti, ends in filaments distributed to the extensor communis.

The extensor carpi ulnaris (Pl. II, fig. 9, *w*) arises from the end of the rudimentary radius and from the posterior border of the ulna, middle one third, below the anconeus, between the attachment of the flexor profundus on the inner side and the extensor minimi digiti on the outer side. Its course is downwards, forwards, and inwards, having on its inner side, successively, the anconeus, the flexor profundus, and the tendon of the flexor carpi ulnaris. It passes through a distinct sheath of the annular ligament on the inner side of the ulna, to be inserted into the base of the metacarpal bone of the little finger.

At their origin the extensor carpi ulnaris and the extensor minimi digiti are in contact, but, as these muscles descend, they diverge from each other, one passing forward and inward, the other forward and outward, so that their tendons have a corresponding position on opposite sides of the extremity of the ulna. By this divergence a triangular portion of the ulna, about the lower quarter of its posterior surface, becomes subcutaneous. The rounded extremity of this bone forms the projection at the back of the wrist.

The anconeus (Pl. II, fig. 9 *x*) arises from the end and outer side of the rudimentary radius in common with the extensor carpi ulnaris, and from the adjacent part of the humerus; in other respects it requires no special notice.

The annular ligament, after arching over the tendons, passes round behind the lower extremity of the ulna, and, connected with the fascia of the back of the hand below and with the aponeurosis of the forearm above, forms a sheath which encloses the small cartilaginous representatives of the carpal bones.

NORMAL.	RIGHT ARM.	LEFT ARM.
<p><i>Ulnar Artery.</i></p> <p>The continuation of the brachial in size, but not in direction. Has a curved course. Enters the forearm under cover of superficial muscles arising from the inner condyle. Comes in contact with ulnar nerve at juncture of upper and middle one-third of arm.</p> <p>Branches :</p> <ol style="list-style-type: none"> 1. Anterior ulnar recurrent. 2. Posterior ulnar recurrent. 3. Common interosseous. <ul style="list-style-type: none"> (a.) Anterior interosseous. (γ.) Median artery. (b.) Posterior interosseous. 4. Muscular. 5. Carpal. <ul style="list-style-type: none"> (a.) Anterior. (b.) Posterior. Metacarpal artery. 6. Superficial palmar arch. <ul style="list-style-type: none"> (a.) Profunda. (b.) Four digital. <ol style="list-style-type: none"> 1. Inner side of little finger. 2. Contiguous sides of ring- and little fingers. 3. Contiguous sides of ring- and middle fingers. 4. Contiguous sides of middle and index fingers. <p><i>Radial Artery.</i></p>	<p><i>Ulnar Artery.</i></p> <p>Ditto.</p> <p>Branches :</p> <ol style="list-style-type: none"> 1. Ditto. 2. Ditto. 3. Ditto. (a.) Ditto. (γ.) Median supplies — Carpal. Two digital (palmar) to fore and middle finger. Dorsal to index finger. 4. Ditto. 5. — See (γ.) Median artery. 6. Superficial palmar. <ul style="list-style-type: none"> (a.) Profunda. (b.) Two digital. <ol style="list-style-type: none"> 1. Little finger. 2. Ring- and little fingers. <p>Absent.</p>	<p><i>Ulnar Artery.</i></p> <p>Ditto. Continuation both in size and direction. Has a straight course. Enters the forearm behind the inner condyle under the flexor carpi ulnaris. Accompanied by the ulnar nerve.</p> <p>Branches :</p> <ol style="list-style-type: none"> 1. — 2. — 3. — (a.) Anterior interosseous. 4. Muscular. 5. — Metacarpal artery. Three digital and interossei. <ol style="list-style-type: none"> 1. Inner side of little finger. 2. and 3. Contiguous sides of little and ring-fingers. 6 Superficial palmar. <ul style="list-style-type: none"> (a.) Profunda. (b.) Two digital. <ol style="list-style-type: none"> 1. Inner side of little finger. 2. Contiguous sides of little and ring-fingers. <p>Absent.</p>

NORMAL.	RIGHT ARM.	LEFT ARM.
<i>Ulnar Nerve.</i>	Regular.	Regular.
<p><i>Median Nerve :</i></p> <ol style="list-style-type: none"> 1. Enters the forearm between two heads of pronator radii teres. 2. Is placed between the superficial and deep flexors. 3. At the lower part of arm is covered only by integuments, and lies between the flexor carpi radialis and the superficial flexor of the fingers. 4. Takes the middle line of the arm, and enters the palm beneath the annular ligament. <p>Branches :</p> <p><i>Muscular.</i>—To pronators and flexors, except flexor carpi ulnaris and part of profundus.</p> <p><i>Interosseous.</i>—Course of interosseous artery.</p> <p><i>Cutaneous Palmar.</i></p> <p><i>Palmar part.</i>—Five digital—</p> <ol style="list-style-type: none"> 1 and 2. Thumb. 3. Outer side of index finger and 1st lumbrical. 4. Index and middle fingers and 2d lumbrical. 5. Middle and ring-fingers, and communication with ulnar. 	<p><i>Median Nerve:</i></p> <ol style="list-style-type: none"> 1. Enters the forearm beneath the band of fibres arising from the inner condyle. 2. Is placed between the superficial and deep flexors. 3. At the lower part of arm is covered only by integuments, and lies along the outer border of flexor sublimis. 4. Ditto. <p>Branches :</p> <p><i>Muscular.</i>—To profundus also.</p> <p><i>Interosseous.</i>—Ditto.</p> <p><i>Radial Nerve ?</i> (Back of hand.)</p> <ol style="list-style-type: none"> 1. Radial side of fore finger. 2. Opposed sides of fore and middle fingers. 3. Opposed sides of middle and ring-fingers, and communicating with ulnar. <p>Ditto.</p> <p><i>Palmar part</i>—</p> <ol style="list-style-type: none"> 1. Outer side of fore finger. 2. Opposed sides of fore and middle fingers. 3. Communicates with ulnar, and probably supplies middle and ring-fingers. 	<p><i>Median Nerve :</i></p> <ol style="list-style-type: none"> 1. Enters the forearm through a canal in the humerus. 2. In forearm is placed between the flexor sublimis and extensor communis, and rests upon the flexor profundus. 3. Lies deeply between the tendons of flexor profundus and extensor communis, and rests on the ulna. 4. Enters the palm beneath the annular ligament. <p>Branches :</p> <p>.....</p> <p><i>Interosseous.</i>—Course of interosseous artery.</p> <p>.....</p> <p><i>Palmar part.</i> — Three branches to lumbricales and interossei muscles.</p>

ABSENT BONES.

RIGHT ARM.	LEFT ARM.
Radius.	Radius, except the head.
Scaphoid.	Scaphoid semilunar.
Trapezium.	Trapezium trapezoid magnum.
Metacarpus and phalanges of thumb.	Metacarpal bones of thumb and fore finger.
	Phalanges of thumb, fore and middle fingers.
	Upper part of humerus.

MEASUREMENTS.

	RIGHT ARM. inches.	LEFT ARM. inches.
Length of humerus	$2\frac{7}{10}$ ths	$\frac{1}{2}$
Length of ulna	$\frac{1}{10}$ th of inch more than $1\frac{1}{2}$ inch.	$\frac{1}{10}$ th of inch less than 2 inches.
Breadth of condyle of humerus	$\frac{1}{2}$	$\frac{3}{4}$ ths
Length of hand from wrist to tip of fingers	2	Nearly 2.
Circumference of upper arm	Nearly 3.	...
Circumference of forearm	...	$2\frac{1}{2}$

Conclusions.

1. The deformity appears to be the result of—first, the original malformation of the germ; secondly, the subsequent deformation of the embryo and foetus, by causes operating on its development; and, thirdly, certain *compensations* and vital accommodations having a conservative tendency.

2. The arrest of development reacts on various parts of the body, and particularly on such parts as have either a casual or a natural connexion with the original malformation.

3. A *law of compensation* prevails during the growth of the body in monsters. It consists in a certain tendency to render the parts as nearly normal as possible, and to make up by excessive formation for the defective development of an adjoining part.

This principle may be shown to exist equally in the vegetable kingdom. If the leading shoot of a plant be cut off, its place is supplied by the development of a lateral branch. So also when a portion of the carpel of a fruit is abortive, the defect is remedied by the excessive development of a similar or corresponding part; for instance, in the common walnut,

when one shell is abortive, the gap is closed by the growth of the remaining shell.

In the animal kingdom, when one bone is arrested in development, a neighbouring bone has the power of excessive increase, so as to make up, to a certain extent, for the deficiency. Thus, in the subject before us, the outer part of the great sigmoid cavity of the ulna is rendered larger than usual by projecting forwards and outwards. It is concave, and the concavity is directed upwards and outwards, and it becomes exactly adapted to the capitellum of the humerus, or that portion of the lower articular extremity of the humerus which usually articulates with the head of the radius. In this way the integrity of the elbow-joint is to a certain extent maintained, notwithstanding the entire absence of the radius.

The same law, when applied to the vascular system, leads to increase of size and to the distribution of a usually small branch of artery to compensate for the deficiency of the normal trunk. For instance, the superficial palmar arch, generally supplied by the ulnar artery, is defective in the right arm. The median artery, which is usually a small branch of the interosseous artery, accompanying the median nerve, compensates for the deficiency, and, passing with the median nerve into the palm of the hand, gives off digital branches to the fingers which require them, and ends by completing the superficial palmar arch.

This peculiarity of the median artery is noticed in Dr. Quain's 'Elements of Anatomy,' in which the vessel is regarded as a "reinforcing vessel."

In the left arm, the metacarpal branch, arising as a separate artery and supplying digital branches, affords an illustration of the same law.

An instance occurring in the nervous system may be mentioned. In the right arm, a branch of the interosseous nerve, given off from the median trunk, compensates by its distribution for the absence of the radial nerve, and supplies digital branches, usually supplied by the radial, to the back of the hand.

Possibly the very remarkable state of the left shoulder-joint may be explained by reference to this law of compensation. The upper portion of the humerus which enters into the formation of the articulation is concave; the glenoid extremity of the scapula appears to compensate for this deficiency by becoming convex and prominent, projecting into the capsular ligament so as to meet the concavity of the humerus, and thus to form a ball-and-socket joint. The ball in this case is transferred from the humerus to the scapula.

The law of compensation differs entirely from the "quantitative *antithesis*," which Geoffroy St. Hilaire denominates "loi de balancement." According to this law, the excessive development of one part of the body is often connected quantitatively with checked formation of another. For anencephalia, cyclopia, spina bifida, are often attended by excessive multiplication of fingers and toes; sireno-melia, by superfluous vertebræ and ribs; and frequently there occur in double monsters malformations of the head. Meckel saw, in one single instance, this "*antithesis*" exhibit itself in different children of the same mother. A girl had on each extremity a superfluous digit, whilst one hand of her sister wanted four fingers, being the precise number of digits which her sister had in excess, reckoning the four extremities together. (Article "Teratology," Dr. Todd's 'Cyclopædia,' by Vrolik.)

4. The present inquiry confirms, in some measure, the opinion held by Vrolik, Müller, Bischoff, Stannius and others, that the several parts of the body are formed and developed independently of one another. An example may be taken from the osseous system. The radius may be defective in both arms, although the condition of both arms differs as to the humerus and carpus, while the ulna remains in its normal state in both arms. But it must be admitted that the presence or absence of the radius or ulna seems to exert an influence on the presence or absence of their respective sides of the hand. Probably the absence of the trapezium causes the disappearance of the thumb, as is known to be the case in comparative anatomy. Although the several parts of the

body may appear to be formed originally independently of one another, and no doubt their normal form is from the first impressed upon them, still the principle of mutual compensatory adaptation seems ultimately to prevail.

5. The absence, arrest of development, or defective condition of the radius, which appears to be the rule in congenital malformations of the human forearm, is not the normal state in beasts: the ulna is the bone which in them is atrophied. In the horse or the ox the ulna is retained only in so far as it is required to strengthen the radius, make the joint of the elbow secure, and give advantageous attachment to certain muscles, and forms what in human anatomy would be called a process of that bone. In the bat the ulna is similarly atrophied, and reduced to its olecranon and proximal half, which is ankylosed to the radius. (See Owen's 'Nature of Limbs.')

6. "As the transient forms of the human fœtus are for the most part comparable to the persistent forms of the lower animals, the malformations occasioned by impeded development often acquire a brute appearance." (Vrolik.) For example, in this case the arrest of development of the humerus suggests a resemblance to the fin of a fish, in which we find one segment of the limb abrogated, and its framework attached to the scapular arch by the two bones answering to the radius and ulna. With regard to the convex head of the scapula, we know that some animals have the socket on the humerus and its articulating ball on the scapula, so that instead of a convex head moving on a concave socket, a concave surface, formed on the head of the humerus, moves on a convex articular surface on the scapula. There may be found in animals an example of this kind. "C'est à dire qu'une concavité se meut en tout sens sur une convexité; mais l'homme ne présente point cette disposition." (Bichat, 'Anatomie générale,' p. 170.) But, as a whole, in man the organization is always essentially human.

7. The muscles are directed to fixed points of attachment,

and in the most nearly regular way possible under the altered circumstances. When a bony insertion is unattainable, they unite together by their tendons; there is a vital accommodation to the exigence of the case. The following are illustrations of this fact: In the right arm, where the radius is absent, the biceps tendon passes into the forearm and is inserted into the ulna. The latissimus dorsi is attached to the neck of the scapula, the usual place of insertion being absent, and the scapula being adjacent; the latissimus dorsi is first united with the tendon of the triceps muscle, and is by it directed to the above-mentioned bony attachment. The union of muscles by their tendons, so as to obtain as firm an attachment as possible, is well exemplified by the scapular muscles of the left shoulder. The tendon of the subscapularis, instead of being inserted into the small tuberosity of the humerus (which is absent), unites with the tendons of the other scapular muscles, viz., the supraspinatus, infraspinatus, and teres minor, and forms with them a tendinous cap, which fits upon the glenoid extremity of the scapula.

8. The absence of the usual bony attachment, or the want of a firm point of insertion, exerts a material influence upon the development of a muscle. This dissection furnishes many examples of this fact. There is one so remarkable that it requires to be mentioned. The long head of the biceps in the right arm is undeveloped; the shoulder-joint appears well formed in other respects; but the radius is absent, and the tendon of the biceps below exhibits a very unsatisfactory attachment in the forearm. These causes may perhaps operate upon the nutrition of the muscle.

9. The absence or defective state of an organ reacts unfavorably upon the formation of the nerves and vessels which supply it, even at a distance. This proposition is similar to that of the preceding paragraph, but is applied to the nervous and vascular systems. The absence of the radial artery and nerve in both arms affords an example, the radial side of both arms being defective.

The facts pointed out in the last three propositions, together with the law of compensation (No. 3), indicate an increased divergence from the regular anatomy of the part, but have nevertheless a most beneficial and conservative tendency, rendering the capacity for life as great as possible, notwithstanding the malformation.

10. The hand is maintained in its proper position by the radius. If the radius be defective in length, absent, or in excess, the posture of the hand is abnormal. The following cases are recorded :

First. Congenital deficiency in the length of the radius.

There are certain cases of what have been called "congenital luxations of the wrist-joint," in which the bones of the forearm are placed on the dorsum of the carpus, which, I think, are explicable on this supposition.

Cruveilhier, in his 'Pathological Anatomy' (liv. ix, 1833), has published an example of this deformity, occurring in an adult female, although he was not aware of the true nature of the case. In this case the forearm was preternaturally short, and it formed a right angle with the hand, which besides was inclined to the radial side of the forearm ; extension was impossible ; flexion, to a certain degree, was permitted ; the inferior extremities of the radius and ulna were dislocated backwards, and formed a very considerable prominence beneath the skin posteriorly. *The extremity of the radius was less salient, and descended much less (half an inch) than that of the ulna.* (See the article "Wrist-joint," in Dr. Todd's 'Cyclopædia,' by Robert Adams, Esq.)

Case 2, from the same source.—"The lower extremities of the bones of the right forearm could be seen and felt on the dorsum of the carpus, where they formed a very remarkable projection. The lowest extremity of the ulna could be seen to descend below the level of the lowest extremity of the dislocated radius. The hand inclined to the radial side ; it could be extended on the forearm freely, but flexion was incomplete. The forearms appear scarcely more than half their normal length. The radius was only four

inches and a half in length ; the ulna, six inches in length, was prolonged below the radius nearly half an inch."

Case 3 presents similar appearances.

Secondly. Congenital absence of the radius, the source of malposition of the hand.

Vide 'Monstrorum Sexcentorum Descriptio Anatomica,' A. G. Otto.

No. CCXXXV.—"Manus simul in parte radiali ita inflexæ sunt, ut pars radialis digiti indicis parti radiali antibrachii adiaceat."—"Radium cum parte musculorum vicinorum et cum parte ossium carpi adhuc cartilagineorum in radiali carpi latere deesse apparebat. Ulna normalis est."

No. CCXXXVI.—"Artus superiores eodem fere vicio laborant atque in monstro superiore."—"Et manus, quarum margines radiales ad antibrachia adducti sunt ; pollicibus carent."

No. CCXXXVII.—"Manus vero et contortæ sit, ita ut margo ejus radialis antibrachio incumbat, et pollice careat."—"Radius et cum eo omnes muscoli, qui ei affixi sunt, prorsus desiderantur."

No. CCXXXVIII.—"Manus autem incurvata, quatuor tantum digitis instructa, quum pollice careat, præterea adeo introrsum et deinde sursum directa est, ut radiale manus et digiti indicis ipsum marginem radialem antibrachii attingat."—"In antibrachio utriusque lateris radius plane desideratur pariter atque pars ossium cartilagineorum radialis carpi lateris. Ulna normalis est neque solito crassior."—"Supinatores et pronatores desunt ; etiam pars inflexorum et extensorum radialium desiderari videtur."

No. CCXXXIX.—"Manus autem ita introrsum flexæ inveniuntur, ut margines eorum radiales antibrachia spectent—radius prorsus deesse vidi, quocum etiam omnes muscoli rotatores, abductores et bini extensores pollicis desiderantur."

The dislocation or flexed condition of the hand appears to depend, in those cases in which the radius and thumb are absent, upon the want of the support of the radius, and upon the contractions of the flexors of the fingers not being opposed by the absent extensors of the thumb.

Thirdly. Dislocation of the hand, of which the radius is excessive in length.

Cases of this kind seem to be very rare. Mr. Adams mentions (in his article "Wrist-joint," before referred to) having seen such a case of congenital luxation of the wrist. He says: "The radius has, at its lower extremity, passed half an inch lower down on the back of the carpus than the ulna."

11. The deformity in the right arm does *not* conform to the rule laid down by Rokitansky: "When the radius is wanting, the thumb and fore finger, with so much of the carpus as belongs to them, are wanting too."

12. Although both upper extremities are deformed, the malformation is not precisely the same on each side.

In this paper I have purposely avoided entering upon the general subject of monstrosities, and have endeavoured to keep closely to the facts and inferences suggested by the particular instance before us.

Such observations as naturally presented themselves from consideration of the dissection have been noted, and one object of these has been to point out that a full grown monster is no *lusus naturæ*, but that its form is the result of certain definite laws, the tendency of which is to compel the tissues to rectify as far as possible the original defect in the germ, by means of a principle of vital accommodation and compensation; moreover, if, as Mr. Lawrence (in the 'Transactions,' vol. v, p. 213) proves, the malformation of the germ "owes its origin to something connected with our peculiar mode of existence"—and if, as I have endeavoured to show, the tendency of the laws regulating the formation of the body is to render the parts as nearly normal and the body as capable of life and existence as possible—it can scarcely be said that monstrosities "offer an apparent *exception* to the inferences which have been drawn from the animal kingdom in general concerning some attributes of the creating power." (Ibid.)

Fig 1

Fig 2

Fig 3

Fig 4

Fig 5

Fig 6

Fig 7