LECTURES ON HUMAN MYOLOGY.

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of England.*

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LECTURE I.—*June 17th, 1872.—(Concluded.)*

THE ventral system of muscles—that is, the system of muscles in front of the lateral line—presents much greater deviation from the primitive simple pattern, and much greater difference in its different parts, than does the dorsal system, owing to the fact that all the viscera, as well as the limb-girdles, are situated in this region; and the muscles are accordingly expanded and modified in various ways to accommodate and subserve these organs and the limbs. Still, the transverse septal remains of the primitive skeleton are presented by the inscriptions in the rectus abdominis, and occasionally in the sterno-hyoid, and by the tendinous interruption of the omo-hyoid; and ossifications of parts of the septa constitute the ribs, the limb-girdles, and the hyoid bone.

I have divided the ventral muscles, like the dorsal muscles, into three layers or strata, as indicated in the drawings and in the scheme.

SCHEME OF VENTRAL MUSCLES.

Superficial Stratum.

	External oblique	Pectoralis	Sterno-cleido mastoid	Digastric ant. Genio-hyoid.
Gracilis				
Sartorius*				
Tensor vaginae femoris	External oblique	—	—	—
Glutæus maximus	Latissimus dorsi	Deltoid	Trapezius	—

Middle Stratum.

				Sterno-hyoid. Stylo-hyoid. Sterno-thyroid. Digastric post. Omo-hyoid. Lingual. Thyro-hyoid. Pharyngeal.
Compressor urethrae	Internal oblique	—	—	
ischio-cavernosus	Rectus and pyramidalis	—	—	
Transversus perinaei	—	Intercostales ext.	Subclavius	
Sphincter ani internus	Internal oblique	—	Serratus	
Muscles from pelvis to femur.	Quadratus lumborum	Intercostales ext.	—	Levator scapulae Scalenii.

Deep Stratum.

Levator ani	Transversalis and Diaphragm	Intercostales interni	—	—
	Psoas and crura of diaphragm	Triangularis sterni	—	—
		Intercostales interni	—	Longus colli. Rectus capitis ant. major.

Of these layers, the outer or superficial is in the plane of the external oblique muscle of the abdomen, which forms a part of it. Traced upwards, it extends, over the thorax, upon the neck and head, and spreads upon the shoulders and arms. Traced downwards, it is partially interrupted by the pelvis, but spreads to a considerable distance upon the lower limbs. The middle stratum is in the plane of the internal oblique muscle of the abdomen. Traced upwards, it extends between and upon the ribs, and forms the deeper sheet of muscles passing from the thorax to the shoulder-girdle, and from the shoulder-girdle to the neck. Traced downwards, it is interrupted by the pelvis, but may be regarded as continued from the pelvis into the perinaeum, as well as over the hip-joint upon the femur. The internal or deep stratum is in the plane of the transversalis abdominis, and is continued from it downwards as the levator ani, and upwards as the diaphragm and the internal intercostals.

This division, to which I shall subsequently have occasion to refer, it will be apparent to every one, is to a great extent artificial. It is in several instances difficult to specify to which of the several strata a particular muscle should be referred. It is clear, with regard to some, that they cannot strictly be referred to either stratum; forasmuch as they are continuous with, or closely related to, more than one. Indeed, they are, as I have before said, all members, and, in some instances, they

are imperfectly segmented members, of the one stratum which represents the unstratified ventro-lateral muscle of the Fish.

In the abdominal region, near the middle line, in front and behind, the fibres of the ventral muscle, or some of them, retain their primitive vertical direction for the purpose of effecting, or assisting in, the flexion and extension of the trunk, and thus constitute the rectus in front, and the quadratus lumborum and the psoas muscles behind. The rectus is traversed by four or five transverse septa, which resemble the septa in the mesial part of the ventro-lateral muscle in the Fish and Urodelan. It is not quite correct to say that they are representatives of abdominal ribs. They should rather be regarded as the persistent skeletal or intermuscular septa in which ossification does, in some animals, lead to the formation of ribs. In such cases, however, the rib-bones, or intermuscular bones as they are sometimes called, are usually found in the superficial stratum—a stratum superficial to the plane in which the ribs and ventral cartilages lie, and superficial to the plane of the rectus of man. Such bones should therefore be designated epicostals rather than costals.

These intermuscular septa in the rectus abdominis serve the same purpose as their correspondents in the Fish—viz., that of dividing muscles transversely into pieces.

The object gained by it is probably as follows. The shortening of a muscular fibre is effected, as we know, by means of a series of waves of contraction travelling along its length. A part only of a fibre is, therefore, usually in a state of contraction at a given time; and the amount which is so, varies according to the intensity and, perhaps, the character of the nerve-influence bearing upon it, and also according to the susceptibility of the fibre itself to that influence. We know, also, that a muscular fibre offers greater resistance to tension when in a contracting than when in an uncontracting state. Hence, in the case of a long fibre, any stimulus which induced contraction through a considerable part of its length would be liable, by the force so exerted, to cause rupture of the remaining part which was not in a contracting state, and was, therefore, not a state of sufficient resistance to bear the traction exerted upon it. Muscular fibres accordingly are rarely of great length. Provisions, such as the insertion near the centre of motion already mentioned, are made to lessen the range of contraction and the length of muscular fibre required. When the muscles, on the other hand, are long, as in the case of the sartorius, it may generally be observed that no great efforts are required of them, and that the strain upon the individual muscular fibres is not at any time serious. In the case of the rectus abdominis, however, it is necessary that the muscle should occupy the whole interval between the pubes and the sternum, and that the fibres should contract to the utmost of their capacity, in order that the extensive movements of the sternum to and from the pubes may be effected. The strain, as we know, is a severe one, and sometimes suddenly made; and these muscles have proved themselves capable of contracting, under intense and rapidly applied nerve-influence, with sufficient force to fracture the sternum. It is therefore most probable that, if the continuity of the muscular fibres were unbroken, they would frequently be the subject of self-rupture. By means of the tendinous intersections, however, the force of any contracting fibre, or part of a fibre, is distributed, through the intersections, among many fibres, some of which will be in a sufficiently contracting, and therefore resisting condition, to bear the strain and prevent its acting injuriously upon those fibres or parts of fibres which are in an uncontracting state. In short, the portion of any fibre not in a state of contraction has only to bear the force exerted upon it by the contracting remnant which lies between it and the next intersection.

The transverse septa serve the further purpose of binding together the layers of the abdominal wall which they traverse. All these layers are essentially parts of the great lateral muscle; and in Fishes and Urodelans the septa extend through all the layers. In man, the septa extend only through the rectus muscle and the superficial wall of its sheath—the aponeurosis of the external oblique and the superficial layer of the internal oblique—but they are not retained in the hinder wall of the sheath. With this, the rectus is connected only by loose areolar tissue, which permits the fibres of the muscle to play up and down upon the hinder wall of the sheath, and prevents any dragging of the peritoneum or injurious friction upon the subjacent viscera.

It is worthy of remark that, though there are usually three of these septa above the umbilicus, they are commonly absent, or represented only by a single septum confined to the median part of the muscle, between the umbilicus and the pubes; so that the muscular fibres in this situation present a much longer unbroken course than they do above the umbilicus. The advantage of this is not quite obvious; but we may associate it with two facts. First, the muscle is here more cone-shaped, the fibres, especially those of the outer part, into which the septum, if present, rarely extends, converging to an insertion near the symphysis

pubis. Secondly, in the early foetal state, the pubic region and the umbilicus are closely approximated, and the embryonic tissue for the rectus is here of small extent, including at most one of the septa. During the subsequent growth of this part of the trunk, and that revolution of the pelvis* upon a transverse axis, whereby its angle is altered and the symphysis pubis is carried downwards and backwards—that is to say, is distanced from the umbilicus—the fibres of the rectus which lie below the umbilicus are elongated, and the septum, supposing it to have existed, is partially or wholly obliterated.

We often wonder at the little pyramidalis, and think that the amount it contributes to the strength of the abdominal walls is scarcely worthy of its presence as a distinct muscle, separated from the rectus by a layer derived chiefly from the transversalis, and partly from the internal oblique—that is to say, occupying a position, with regard to the aponeuroses of the abdominal muscles, corresponding with that of the rectus in the upper parts of the abdomen. When we meet, and are puzzled with, such a fragment, as it were, we feel that its presence will probably be, to some extent, explained by reference to comparative anatomy. We find, accordingly, two facts in relation to this muscle. First, it is of large size in Marsupial animals, passing from the edge of the marsupial bone, superficially with regard to the rectus, towards the linea alba; and we associate its individuality as a muscle in those animals with the individuality of that bone; and we may connect its presence in ourselves with the representative of that bone in the spinous process of the pubes. Secondly, we learn that it is large and strong, reaching even to the sternum and ribs in animals, as Bats—in which (in the females, at least) the pubic bones are separate at the symphysis, and the recti muscles are wide apart near the pubes. It there performs an important service in occupying the gap between the recti; and we can perceive that a similar function, though in much slighter degree, may explain its frequent persistence in ourselves. We thus see in it an interesting example of the combination of tendency to morphological similarity with special teleological adaptation.

In the remainder of the abdominal wall, the muscles are so modified from the simple primitive disposition which obtains in the rectus and the quadratus lumborum, that we are scarcely prepared to recognise them as having a derivation, in common with these, from the great lateral muscle. Yet the gradations of their deviation from the simple arrangement of that muscle are so clearly shown in Cryptobranch, Lepidosiren and others, that there can be no doubt this is the case. Or, to put it in other words, the obliqui and the transversalis, as well as the rectus and the quadratus, are evolved from those elements which in lower animals are developed into the rectilinear unstratified and transversely segmented masses of the lateral muscles; and different animals present various gradations between the two forms. As the abdomen becomes expanded, and its wall is, in consequence, stretched and thinned, the lateral movement of the trunk, acting upon the tail, ceases to be the great agent in propulsion. Limbs are superadded for this purpose; and the muscles of the lateral parts of the abdomen are modified so as to enable them to retain and compress the viscera as well as to act upon the limb-girdles and thorax, and, through them, to effect the oblique or rotary movements of the trunk and pelvis. The fibres at three depths assume different directions, so forming the three planes of obliquus externus and internus and transversalis; and they lose their transverse septa. The action of each plane is thus permitted to a certain extent to take place independently of the others, while the protrusion of the viscera is effectually prevented.

Near the lateral margin of the rectus, the three planes become tendinous and cohere, and then separate into two planes embracing the rectus. Behind, there is a somewhat similar enclosure of the quadratus lumborum. In this manner, the differently disposed factors of the abdominal wall, before and behind, are combined into a very resisting structure.

The remarkable deviation from this arrangement at the lower part of the abdomen in front, where the hinder layer of the internal oblique, together with the transversalis, accompanies the anterior layers in front of the rectus, is rather difficult of explanation. The change takes place suddenly, so that the hinder wall of the sheath of the rectus, formed by the transversalis with the posterior layer of the internal oblique, has a distinct edge, though that edge is eased off by its connexion with the fascia transversalis. The line in which the change of disposition thus suddenly takes place corresponds with a line drawn across between the anterior superior spines of the two iliac bones. This suggests that the purpose served is that of giving to the fibres of the deeper, as well as of the superficial, planes which arise from these projecting osseous points, a better action upon the abdomen by throwing them in front of

the rectus. Had they passed behind it, they would have presented, in thin persons especially, a convex surface to the bladder and other viscera here situated; and their contraction would have tended rather to cause a vacuum than to compress these organs in the manner requisite for the expulsion of their contents. In this region, the diminished area of the soft part of the abdominal wall renders unnecessary that provision for strengthening it which is afforded by the disposition of its layers near and above the umbilicus. I may observe that the disposition varies in different animals. Not unfrequently the internal oblique passes altogether superficial to the rectus in its whole length; and in such cases the transversalis passes deeper than the rectus, except towards the pubes, where it joins the internal oblique: this is so in the Dog, Cat, and Hippopotamus. In the Cat, the transversalis is muscular nearly up to the linea alba; and the change in its direction is sudden, so that the rectus passes through a buttonhole-like opening between its fibres.

In some of the lower animals (Urodelans), the internal or transversalis layer of the abdominal wall—the layer next to the fascia transversalis—extends over nearly the whole visceral cavity, forming a continuous sheet which covers the bodies of the vertebræ as far as the skull, lines the ribs, and is continued, within the pelvis, into the tail. In higher animals and Man, it extends for a short distance only upon the bodies of the vertebræ; and it is interrupted by the pelvis, though it reappears, in the levator ani, as an inferior or pelvic diaphragm, through which the alimentary and urino-genital tubes pass to their destination. Superiorly, it, or a layer of it, is reflected inwards from the whole circumference of the abdominal wall as a middle or post-cardiac diaphragm. I say from the whole circumference, because the crura of the diaphragm, lying upon the fore part of the bodies of the vertebræ, represent a portion of that tract of it which I have called “subvertebral rectus” in the Cryptobranch.

The internal intercostals and the triangularis sterni present, in their relations to the nerves, a claim to be regarded as parts of the same stratum; and the longus colli and rectus capitis anticus major are pretty clearly continuations of its vertebral portion, that is to say, are serial representatives of the crura of the diaphragm, and, together with them, are representatives of parts of the “subvertebral rectus.”

It is thus perceived that, though the stratification of the abdominal wall is caused by the different direction of its fibres at different depths, yet that the direction of the fibres of any particular stratum is by no means uniform, but varies considerably in the different regions of that stratum. This is further exemplified in the disposition of the fibres of the several strata towards the middle part of the abdominal wall, where they become tendinous and deviate from the direction which they held in the part of their respective strata in which they are muscular. Moreover, we see that the disposition of the strata themselves is here altered, and that it is not the same in the lower part of the abdomen, where the transversalis and hinder layer of the internal oblique pass on the superficial aspect of the rectus, as it is higher up. These, and other varieties of stratification and disposition of fibres in different parts of the abdominal wall of man and other animals, are merely the resultants of differences in the manner of development of the component elements of the lateral muscle, which are wrought into their simplest form in Fishes and depart from it most in Mammals. They prepare us for greater deviations in other regions of the body—in the pelvic and thoracic, and still more in the cervical regions.

All the components of the lateral muscle in Man are interrupted by the pelvis, with the exception of some tendinous prolongations of its dorsal portion upon the coccyx. Some of the elements of the ventral portion reappear within and behind the pelvis, forming from its inner stratum, as just mentioned, the levator ani; and elements from its other strata form the coccygeus, the sphincter ani, the erector penis, accelerator urinæ, and transversus perinei.

In the thorax the ribs are ossifications in the deeper parts of the intermuscular septa of the lateral muscle, which, in lower animals, are traceable into continuity with them; and the intercostal muscles are the intervening divisions of the lateral muscle, with the disposition of their fibres modified to suit the requirements of respiration. The mode in which the modification employed does fulfil the requirements of respiration, in other words, the action of the intercostal muscles, is a historic subject of discussion, and one upon which physiologists are even at the present time not agreed. It is one that must be approached with care, as it is not a simple problem, many points requiring to be taken into consideration.

First, it must be remarked that each succeeding rib, from the first to the eighth, is not only less fixed, but describes a larger circle, or part of a larger circle, than the one above it. It therefore affords a better leverage and is more easily acted upon than the one above, by muscular fibres passing between them. Hence the aggregate tendency

* This revolution is remarkably well exemplified in the pelvis of the Frog, which, in the larval state, lies at right angles to the spine, but subsequently becomes placed almost horizontally.

of all the intercostal fibres is to raise the ribs towards the first, which, as we know, is raised by the scaleni. When I say to raise the ribs, I mean to cause their movable parts or shafts to revolve upwards upon axes drawn, from before backwards, through their sternal and vertebral joints, which are the fixed points. This, forasmuch the ribs slant downwards from these points, enlarges the circumference of the thorax, and, more particularly, its transverse diameter. The effect culminates upon the seventh, eighth, and ninth ribs, because they describe the largest circles, and the several points of each are farther from the centre of motion and offer better fulcra for the action of the muscles than do the corresponding points of the ribs above them. Thus the intercostal muscles may practically be regarded as composed of fibres passing from the first to the ninth rib, attached to the several ribs *en route*, and producing an effect upon each rib proportionate to the length of the fibres, that is, proportionate to the distance of the rib from the first. We know that the size of the lung beneath, the size of the thorax, and the obliquity and mobility of the ribs increase in like proportion. Hence the capacity of the intercostal muscles for moving the ribs, the capacity of the ribs for movement, the effect of a given movement of the ribs upon the capacity of the thorax and the transverse sectional area of the lungs, all attain their maximum at the same level.

It is further to be observed that this culmination of intercostal action operates most upon that projecting part of the chest formed by the extremities of the seventh, eighth, and ninth ribs—the extremities of the osseous parts—upon which several counteracting influences are bearing, so as to render the full formation and throwing out of this part of the thorax a work of some developmental difficulty in infancy and childhood. Of these influences, I may name particularly the diaphragm, which, arising here, owes the fixity of its point of attachment, and its influence as an agent in inspiration, in no small degree to the action of the intercostal muscles. Thus, these two sets of muscles—the intercostals and the diaphragm—though they are to some extent antagonists, co-operate in the work of respiration. The value of this agency of the intercostals is forcibly impressed upon us in the instances of sickly ill-developed children, where, in consequence of the imperfect outgrowth of this region of the thorax, the intercostals fail to exert their proper influence, and each inspiratory effort is attended by a drawing in of the ribs under the contraction of the diaphragm, instead of by an expansion of it under the action of the intercostals.

The questions, however, still remain: Why do the external intercostals not extend into the intervals between the costal cartilages? Why do the internal intercostals not extend into the spaces between the angles of the ribs and the vertebræ? Why do both sets of intercostal muscles exist in the lateral regions of the thorax? These have been partly answered by Dr. Hutchinson, in his valuable article "Thorax" in the *Cyclopædia of Anatomy*; but I think his explanation is not quite complete, in consequence of his regarding the ribs rather too exclusively as planes and lines instead of arcs of circles, and from his not sufficiently taking into account the fact that each rib is part of a larger circle than the one above it. Hence he has been led into what is probably the error of supposing that "the intercostales interni have a double action"; that the "portions between the ribs depress the ribs and are expiratory muscles"; and that the "portions between the costal cartilages are elevators of the cartilages, and associates with the external intercostals, and, thence, inspiratory muscles." According to this view, different fibres of the same layer of intercostal muscle have diametrically opposite actions, which is certainly, under the circumstances, improbable, especially as there is no reason to suppose that

Fig. 5.

the several fibres of the muscle are not in action at the same time. The real solution of the matter is furnished by the simple diagram given in fig. 5. The two curved lines v s and v' s' represent two ribs

attached, at one end to v v', to the vertebral column, and, at the other end, to s s', to the sternum, upon which points they revolve on horizontal axes passing from before backwards. A B represents an external intercostal fibre. Any alteration in the position of the ribs which shortens this fibre will indicate the effect which its contraction has, or tends to have, upon the ribs. Let a line, B C, fall from the point of attachment of the fibre to the upper rib, in a vertical plane, to the rib below. We thus get, with the lower rib, a triangle A B C, of which the line A B is the base. Now it is clear that the line A B will be shortened by any change that has the effect of lessening the angle A C B, which it subtends. This effect is caused by raising the ribs, as shewn still more clearly in the accompanying diagrams (6 and 7) of

Fig. 6.

Fig. 7.

parallel bars moving upon a vertical rod. In Diagram 6, where the bars slant obliquely downwards after the manner of the ribs, the angle A C B is much more than a right angle, and is subtended by the long base or intercostal fibre A B. In Diagram 7, where the bars are raised to the horizontal position, the angle A C B is reduced to a right angle, and the line A B, or base of the triangle, is proportionately shortened.

It is obvious that, where the slant of the ribs is in the opposite direction, as it is near the sternum, the conditions being reversed, the effect would be reversed also. Hence the internal intercostal fibres take the place of the external between the costal cartilages. But, as already observed, the ribs are not simple planes; they are curves, and each rib describes a larger curve than the one above. Hence the intercostal fibres do not slant simply from the upper ribs downwards and forwards or backwards, but they also slant outwards. They are oblique, that is to say, in two directions; and, if viewed in a transverse vertical plane, as represented in Diagram 8, where A and B indicate the cut ends of

Fig. 8.

the ribs, it is evident that the intercostal fibre A and B, passing between the ribs, will be shortened by the rolling of the ribs upwards upon the axes D and E, which may represent either the vertebral or the sternal joints. As shown in the former diagrams (6 and 7), which represent the change that occurs in a lateral view, the angle A C B will be diminished when the ribs are raised, and the subtending line or fibre will be proportionately shortened. It will be observed that this influence, depending as it does upon the wider curve of the lower rib, operates along the whole length of the rib. It operates also upon both sets of intercostal fibres, and accordingly would cause both to act as elevators of the ribs or inspiratory agents throughout the intercostal

spaces. There are thus the two influences represented by the two diagrams at work; the first affecting the fibres differently in different parts of the space; the second affecting both sets of fibres equally throughout the space. In the hinder part of the space, the first influence is, with regard to the external intercostals, at its maximum; in the lateral part, it diminishes; and in the anterior part it is reversed. At the point in this last region where the reversed influence preponderates so as to counterbalance the influence represented by Diagram 8, and where it would accordingly render the external intercostals depressors of the ribs, there these fibres cease to exist. In like manner, with regard to the internal intercostals: throughout the anterior and lateral regions of the spaces, the two influences combine to render the fibres elevators of the ribs; but at the point behind, where the inclination of the ribs so far reverses the first influence that it ceases to be counterpoised by the second, and where, accordingly, the fibres would become depressors of the ribs and expiratory agents, they cease to exist, and the external intercostals alone are present.

Hence it follows that there is really no antagonistic action in the intercostal fibres at different parts, but that both sets are, throughout their whole extent, inspiratory muscles, and do not in any region act as depressors of the ribs or muscles of expiration.

I am not aware that this *rationale* of the action of the intercostals has been before given. For the accompanying diagram (Fig. 9), and

Fig. 9.

the more exact mode of explaining it given in the footnote,* I am indebted to a mathematician, a Fellow of St. Peter's College, Cam-

* The ribs are very nearly semicircles; and as they move up and down in the action of breathing, rotate about their ends, which we may consider fixed points at the vertebral column and at the sternum. Each rib forms a larger semicircle than the one above it. Let us imagine certain planes. One, near the medial plane of the body, in which the ends of the ribs are situated; secondly, two planes, containing the ribs, and which we may suppose to remain parallel to each other as the ribs rotate; and, thirdly, a plane vertical, and perpendicular to the medial plane, drawn anywhere in the body. This plane is, of course, perpendicular to the parallel planes. In the accompanying figure (9), the planes of the paper is the medial plane, the ends of the ribs are A B, A' B'. The perpendicular plane will intersect the ribs in some points C C', the medial plane in a vertical line D D', and the parallel planes in the lines D C, D' C'. These two lines are always parallel as the ribs move up and down. We have said that the lower rib A' C' B' is the larger, hence the line D' C' is greater than the corresponding line D C. Let M be a point in D' C', so placed that D' M is equal to D C, and joins C M, then C M is always equal and parallel to D B'. We might perhaps expect that the fibre of the muscle attached at the point C would have its other end attached to the lower rib at the point C' directly below C; but it is really attached to a point E, nearer to the sternum A A', so that it occupies a slanting position, C E. Our business for the present is to show that, by raising the ribs, keeping their planes parallel, C E is decreased. Consider the small triangle C C' E. Evidently C E will be shortened by diminishing the side C C' or the angle C C' E. We shall see that, by raising the ribs, both these causes are at work in diminishing C E. First, C C' is diminished; for C M, we have said, is always equal and parallel to D B', which is constant, and therefore C M is itself constant; also M C' is the difference between D' C' and D C, and is, therefore, constant. But the angle C M C' evidently decreases as the ribs rotate upwards; consequently C C', the base of the triangle C M C', is diminished. We must now particularly observe that this result—namely, C C' being diminished as the ribs rise—is equally true in whatever part of the rib we take the point C. Secondly, consider the change in the angle C C' E as the ribs rise. As the ribs rise, the inclination of the line or small arc C' E to the perpendicular plane D C C' D', remains always the same. Draw in this perpendicular plane a line at right angles to C' E; then it is evident that the angle C C' E, which C' E moving about in the perpendicular plane makes with C' E, will decrease or increase as C C' approaches the perpendicular line according as the angle is greater or less than a right angle. But as the ribs rise, the line C C' does approach the perpendicular. This is evident, for if we raise them far enough, we see that C C' becomes perpendicular to C' E. Now the angle C C' E is greater than a right angle, for every point of the rib from the spine to the middle of the rib F, at the middle it is a right angle, and from the middle to the sternum A it is less than a right angle. Consequently, as the ribs are raised, the angle C C' E decreases for all points from the spine to the middle F; it is constant at F, and it increases from F to the sternum A. We have already shown that, as the ribs are raised, C C' decreases at every point of the rib; hence we arrive at the following result. As the ribs are raised, every fibre C E' between the spine B and the middle F is diminished, because C C' and the angle C C' E are both diminished. The fibres at the middle F are diminished, because C C' is diminished, and the angle C C' E is constant. From the middle F to the sternum A, C E is diminished, because C C' is diminished and increased because the angle C C' E is in-

crease, who is commencing the study of anatomy. In it, the lines C E and C C' represent the two directions of obliquity of each external intercostal fibre; the line C E representing the slant downwards and forwards, and the line C C' representing the slant downwards and outwards. By the rolling of the ribs upwards, the intercostal fibre is lessened in the direction of line C E by the diminution of the angle C C' E; and it is also lessened in the direction of the line C C' by the diminution of the angle C M C'.

The more superficial layers of the thoracic and abdominal muscles, which pass to the upper limb-girdle and limb, I will leave till I come to the consideration of the muscles of that limb; and I pass on now to the muscles of the neck and head. They are in three layers. The outermost layers consist of the platysma myoides, the facial and auricular muscles, and the occipito-frontalis. These are derivatives or representatives of a superficial cutaneous stratum, which in man is confined, or almost confined, to this part of the body. The independent movements of the skin which they confer here are needed chiefly for the purpose of regulating the oral, ocular, and auricular apertures, under the influence of the facial nerves, and partly for the more free movement of the skin where it is covered by the long hairs, which, in consequence of their relation to the impressible fifth pair of nerves, minister to the highly developed sentient apparatus of this region. The extension of the platysma over the lower part of the neck upon the front of the chest serves a further purpose in preventing the indrawing of the lower triangle of the neck, and the consequent undue pressure upon the veins, during inspiration. All these muscles, with one or two exceptions, have osseous attachments; and the bones with which they are connected are not the deeper or cartilaginous bones, but the superficial or subdermal membrane bones. Not that this is a necessary or universal feature of cutaneous muscles: some of them, in the lower animals, especially the Bats, dip deeper, and reach parts of the inner or cartilage skeleton. Indeed, there is not any other group of muscles the members of which vary so much in their extent and connections in different animals, as do these cutaneous or pannicular muscles.

The next layer consists partly, as will presently be shown, of the digastric and mylo-hyoid, and partly of the sterno-cleido-mastoid. This muscle is a continuation of that sheet of the lateral muscle from which the external oblique, the pectoral, and the trapezius are developed, and which I have elsewhere described as the brachio-cephalic sheet. The better to perform the rotary movement of the head, the range of which is peculiar to man, and has relation to the erect attitude and the mode in which the head is balanced upon the spine, the sterno-mastoids of two sides diverge, from their origin near the median line, to the back part of the most lateral projection of the skull, which acquires peculiar prominence in man. The cleidal fibres are less oblique than the sternal, ascend more vertically beneath them, and are more concerned in effecting the lateral inclination of the head. They have less range of action, and are shorter. In the simple condition, these more lateral fibres, instead of crossing beneath the sternal fibres, would pass more laterally to their insertion between the fibres of the sternal portion and those of the trapezius. They occasionally do so in man, as a variety, constituting the muscle named cleido-occipital.

The deepest layer consists of the sterno-hyoid and sterno-thyroid, with the muscles passing from the hyoid bone upwards to the tongue, pharynx, and skull. These are continuations of a deeper plane of the lateral muscle than the sterno-mastoid, of that which I have described as the middle plane, or the plane from which, in the abdomen, the internal oblique is developed. They are interrupted by the hyoid, which may be regarded as an ossification in the deeper parts of one of the intermuscular septa, and therefore as a serial homologue of the sternum and ribs. The sterno-hyoid is also often interrupted by an inscription near the sternum, which answers serially to the inscriptions in the rectus abdominis. The tip of the tongue is the anterior median termination of this set or plane of muscles, part of which—the genio-hyo-glossus—is attached to the under surface of the mandible on the side of the symphysis menti, while lateral portions pass to the pharynx and skull.

My dissections of lower animals indicate that the anterior portion of the digastric and the mylo-hyoid, with perhaps the genio-hyoid, are derivatives from the superficial or external oblique, rather than from the deeper or internal oblique, stratum of the ventral muscle, from a layer

creased. Hence between the middle and the sternum the fibres C E will be increased or diminished on the whole according to which influence preponderates. From F up to about the middle of F A the increment in the angle is small, and the other influence preponderates; hence C E is diminished on the whole. From about the middle up to A the increment in the angle becomes considerable, and this influence preponderates; hence C E is increased. Thus the fibres, if they existed here, would have a contrary effect to the fibres in the other parts; and, consequently, they do not exist.

lying close beneath the subcutaneous colli, and in the same plane with the superficial parts of the sterno-mastoid. In the Hippopotamus and some other animals, a superficial hyo-mental muscle extends from the hyoid bone, or rather from the subhyoidan septum—that is, the septum in which the hyoid is formed—to the lower jaw near the symphysis. It is connected behind with the stylo-hyoid muscle; and its lateral part, attached to the side of the jaw and continuous behind, through the medium of the septum, with the posterior belly of the digastricus, forms the anterior belly of that muscle. In ourselves it is the more median portion of the hyo-mental, the portion attached near the symphysis of the jaw, which forms the anterior belly of the digastric, and which is continued, by means of the subhyoidan septum, into the hinder belly of the digastric. Thus the digastric muscle is compounded of parts of two strata—a superficial part, on the level of the external oblique, the pectoral, and the sterno-mastoid, and a deep part, on the level of the internal oblique, the sterno-hyoid, and the scaleni; and the septum, by which these two parts are retained in continuity, becomes the intermediate tendon between the two bellies and also the bond of connexion with the hyoid.*

The purpose served by the peculiar disposition of the digastric muscle appears to be the fixing of the hyoid bone and the securing a steady basis to the tongue during the opening of the mouth and during the movements of the jaw in mastication. Had it not been for the influence of the posterior belly of the digastric and the stylo-hyoid in tending to draw the hyoid upwards and backwards, and so counterpoising the influence upon that bone of the sterno- and omo-hyoid, and the genio-hyoid, the retiring angle behind the chin would have been obliterated, the tongue would have been depressed, and the various parts about the pharynx and fauces would have been displaced during the act of opening the mouth. All this, however, is avoided; and the hyoid, the larynx, and the adjacent structures are admirably poised and steadied during the movements of mastication and of opening and shutting the mouth. In the lower animals, where this retiring angle is less marked, the provision just mentioned for preventing its alteration is less needed; and the digastric, not unfrequently, runs straight from the skull to the jaw. Still, it is usually interrupted, more or less, by a non-muscular interval, which, in such cases, presents nearly or quite the ordinary appearance of an inscription or septum; proving, if such proof be required, the septal nature of the intermediate tendon in man.

THERAPEUTIC MEMORANDA.

EFFECTS OF BELLADONNA PLASTER.

I AM reminded by a notice in a recent number of the JOURNAL, of the local action of belladonna absorbed into the system, upon one eye, of a similar occurrence which fell under my own observation in the case of a lady for whom I applied a belladonna plaster over the heart. A day or two afterwards she came to me to say that she found that the sight of her left eye had become very indistinct, but the right eye was unaffected. The left pupil was much dilated, and also somewhat irregular; the right pupil was quite natural. This appearance naturally suggested to me some serious apprehensions; but, remembering the belladonna plaster, I told her to have it removed and the skin washed. The next day the pupil had regained its proper size and form, and the defect of sight was removed, and has not returned. The same suggestion had occurred to me as to some of the correspondents of the JOURNAL, that a portion of belladonna might have been accidentally brought by the hand into direct contact with the eye; but the result of particular inquiry was entirely opposed to this supposition.

Claremont, Leeds.

J. D. HEATON, M.D.

GUARANA IN SICK-HEADACHE.

IT is in the congestive forms of headache that guarana most frequently succeeds; thus it will sometimes relieve the throbbing headache of the man who "got exceeding drunk yesterday," and whose "brain is still sticking to the ceiling," with startling rapidity. In such cases, the action of the medicine may be seen, for the large injected conjunctival vessels become small by degrees and beautifully less as the drug is absorbed and the cephalalgia departs. This seems to suggest its action as being stimulant to the sympathetic system: if further trial prove this to be so, we must regard it as the opposite in action to nitrite of amyl.

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* For further particulars respecting the digastric, see *Journal of Anatomy*, vi, 324; and *Observations on Myology*.

ON

THE SCIENTIFIC VALUE OF THE LEGAL TESTS OF INSANITY.*

By J. RUSSELL REYNOLDS, M.D., F.R.S.,

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[Concluded from page 664 of number for June 22nd.]

II. I pass now to the second part of my subject—viz., the legal test of insanity that is employed when one accused of crime is defended on the ground of his being insane. On this point the legal dogma is very explicit, and consists in the knowledge of right and wrong, and of the consequences of an act or acts.

Referring to the work of Sir Oldnall Russell (*A Treatise on Crimes and Misdemeanours*, 4th edition, by C. S. Graves, Q.C., 1865), it is easy to discover the recognised doctrine of the court of justice. I find the following illustrative examples. Lord Ferrers was hung for murder, it having been urged "that it was sufficient if the party had such possession of reason as enabled him to comprehend the nature of his actions and discriminate between moral good and evil" (p. 15). Parkes, for entering the French service, was condemned, although weak from a child, because it could not be shown that he "did not really know right from wrong". Bowler, an epileptic maniac and melancholiac, was sentenced on the same grounds. In the case of the King v. Offord, Lord Lyndhurst said the question was, "did he know that he was committing an offence against the laws of God and Nature". Again, in the prosecution of Oxford, Lord Denman said, "If some controlling disease was, in truth, the acting power within him which he could not resist, then he will not be responsible"; but the same learned judge goes on to say to the jury, the question is "whether he was labouring under that species of insanity which satisfies you that he was quite unaware of the nature, character, and consequences of the act he was committing; or, in other words, whether he was under the influence of a diseased mind, and was really unconscious at the time he was committing the act that it was a crime" (p. 17.) Still further, let me quote the questions put to the learned judges on the acquittal, by the Lords, of M'Naghten.

"Q. I. What is the law respecting alleged crimes committed by persons afflicted with insane delusion in respect of one or more particular subjects or persons; as, for instance, when, at the time of the commission of the alleged crime, the accused knew he was acting contrary to law, but did the act complained of with a view, under the influence of insane delusion, of redressing or revenging some supposed grievance or injury, or of producing some supposed public benefit?"

"A. I. Assuming that your lordships' inquiries are confined to those persons who labour under such partial delusions only, and are not in other respects insane, we are of opinion that, notwithstanding the accused did the act complained of with a view, under the influence of insane delusion, of redressing or revenging some supposed grievance or injury, or of producing some public benefit, he is nevertheless punishable, according to the nature of the crime committed, if he knew at the time of committing such crime that he was acting contrary to law, by which expression we understand your lordships to mean the law of the land.

"Q. II. What are the proper questions to be submitted to the jury where a person alleged to be afflicted with insane delusion respecting one or more particular subjects or persons, is charged with the commission of a crime (murder, for example), and insanity is set up as a defence?"

"Q. III. In what terms ought the question to be left to the jury as to the prisoner's state of mind at the time when the act was committed?"

"A. II and III. As these two questions appear to us to be more conveniently answered together, we submit our opinion to be, that the jury ought to be told in all cases that every man is to be presumed to be sane, and to possess a sufficient degree of reason to be responsible for his crimes, until the contrary be proved to their satisfaction; and that to establish a defence on the ground of insanity it must be clearly proved that, at the time of committing the act, the accused was labouring under such a defect of reason, from disease of the mind, as not to know the nature and quality of the act he was doing, or, if he did know it, that he did not know he was doing what was wrong."

With regard to this test, I may say, and most emphatically, that it is utterly untrustworthy, because untrue to the obvious facts of Nature.

* Read before the Metropolitan Counties Branch, June 5th.