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PART I.

ORIGINAL COMMUNICATIONS.

ART. VIII.—*On the Action of the Posterior Crico-arytenoid Muscles.*^a

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THE action of the posterior crico-arytenoid muscles presents some points of interest to the anatomist and physiologist, as well as to those who make a special study of matters relating to laryngology.

The full action of these muscles, which take so important a part in the function of respiration, does not appear to be generally recognised, and as a case has lately come under my observation, which appears to me to furnish clinical illustration of what might otherwise be considered devoid of practical bearing respecting the action of these muscles, I offer a few observations on the subject.

In text-books of anatomy and physiology, recognised as standard works, the action of the posterior crico-arytenoid is described as a single one. In Quain's^b *Anatomy* the following account is given:—"The posterior crico-arytenoids pull backwards the outer angles of the arytenoid cartilages, and thus draw asunder the posterior extremities of the vocal cords, and dilate the glottis to its fullest extent; they are likewise the elevators of the arytenoid cartilages."

Foster,^c in his *Physiology*, says, under "Widening of the Glottis:—"The crico-arytenoideus posticus, passing from the posterior surface of the cricoid cartilage behind the attachment of

^a Read before the Dublin Biological Club. Nov. 23, 1880.

^b Quain's *Elements of Anatomy*. London, 1876. Vol. II. P. 292.

^c Text-book of *Physiology*. London, 1878. P. 529.

the lateral crico-arytenoideus, pulls back this outer angle, and so causing the processus vocalis to move outwards, widens the glottis."

Hermann^a gives a similar description of the action of these muscles, and also makes the very doubtful assertion that the posterior edges of the cartilages are approximated by them, by which he explains the normal rhombic aperture of the glottis during deep inspiration. Other well-known works on anatomy and physiology give similar descriptions.

Ziemssen,^b in the anatomico-physiological introduction to his article on "The Neuroses of the Larynx," says: "The pair of muscles most important to life are the posterior crico-arytenoids, inasmuch as they are the only openers of the glottis. By drawing on the muscular processes of the arytenoids, they rotate these cartilages upon their articular surfaces outwards and backwards, separate the vocal processes from one another, and open the chink of the glottis to its well-known rhomboidal form."

The foregoing extracts show clearly that the only action of these muscles usually recognised and taught is that of outward rotation of the vocal processes of the arytenoid cartilages.

It has lately been pointed out by Rühlmann^c that the posterior crico-arytenoid muscle may be regarded as consisting of two parts, an outer thin and broad portion, the fibres of which run in an almost vertical direction, and an inner thicker portion, whose fibres pass in a direction approaching the horizontal at its innermost border.

I may here mention that Luschka^d thus describes the nervous supply of the muscle:—"As the trunk of the inferior laryngeal nerve passes close to the posterior crico-arytenoid muscle two branches come off which slip beneath its external edge—one below, the other above the crico-arytenoid articulation." This arrangement of the nerves supplying the muscle is also noticed by Schech as normal, and I have myself observed it in a few dissections made some time since.

In accordance with this anatomical division of the muscles Rühlmann^e has described them as possessing a double function, the

^a *Elements of Human Physiology.* London, 1875. P. 306.

^b *Cyclopædia of the Practice of Medicine.* Vol. VII. P. 918.

^c *Untersuchungen über das Zusammenwirken der Muskeln bei einigen häufiger vorkommenden Kehlkopfstellungen.* Sitzb. der k. Akad. d. Wissenschaften. Wien. 1874. Bd. LXIX. 1-5 Heft.

^d *Kehlkopf des Menschen.* Tübingen, 1871. P. 165.

^e *Loc. cit.*

outer thin portion acting in a vertical direction, and thus causing the arytenoid cartilages to glide laterally from within outwards over the articulating surfaces of the cricoid, the inner thicker and more horizontal portion acting on the outer angle of the arytenoid draws it inwards, and thus rotates the *processus vocalis* outwards.^a

Here, then, we have two distinct actions of these muscles on the arytenoids; these cartilages are drawn apart from each other by the outer portions of the muscles independently of any movements of rotation. This latter effect, which is usually described as the only function of the muscles, could not be in any way produced by the outer fibres, as is evident from their vertical direction, but is wholly performed by the inner part.

The fact that the movements of the arytenoids upon the cricoid are not limited to simple rotation has been recognised by other observers.

Ellis^b thus describes them:—"From the flatness of the articular surfaces the arytenoid cartilage glides forwards and backwards, inwards and outwards; and if its horizontal movements are controlled by muscular action, it can be rotated around a vertical axis, the anterior spur being moved inwards and outwards. Obviously the state of the vocal cords will be changed by the movements of the cartilages—when the arytenoids glide in and out the cords will be approximated and separated; when from front to back these will be tightened and relaxed; and in rotation the cords will be moved away from and brought towards each other."

An examination of the articulating surfaces of the cricoid and arytenoid cartilages shows that they are formed so as to permit very free movements in addition to that of rotation; that of the arytenoid is concave and almost circular; it is much less in size than that of the cricoid. The latter is markedly oval, its length being double its breadth; it is doubly convex, from within outwards and from behind forwards.^c It is this much larger articulating surface of the cricoid which allows the very free movements of the joint.

The position occupied by the arytenoid cartilages during deep inspiration as contrasted with that during phonation, as seen in the laryngoscopic mirror, shows clearly that the outward gliding of the arytenoids must take place.

^a This view has been adopted by Oertel (*Ueber den laryngologischen Unterricht*, Leipzig, 1878) and the double action shown in his ingenious apparatus for demonstrating the action of the laryngeal muscles.

^b *Demonstrations of Anatomy*. London, 1874. P. 189.

^c In a specimen in the writer's possession a well-marked groove divides this surface into two equal parts.

In the adult male larynx during phonation the arytenoids are seen to be closely approximated, while in inspiration they are drawn apart a distance of at least one centimetre; in this movement the most posterior parts of the cartilages participate, so that if it were the result of a pure rotation the axis of rotation should occupy a position quite posterior to the larynx itself, in order to allow so wide a separation of the cartilages.

Any one at all familiar with the movements of the arytenoids will admit that in ordinary quiet inspiration they do not show any movement of rotation, the glottis appearing quite triangular in shape, the base being shorter or longer as the cartilages approach or recede from each other, and that the outward rotation of the vocal processes only becomes apparent during a deep inspiration, when the glottis assumes its fully expanded pentagonal^a form.

The consideration of the function of the arytenoideus proprius furnishes further evidence that the action of the posterior crico-arytenoids is not confined to that of rotation. It is universally admitted that the arytenoideus draws together the arytenoid cartilages. In doing so it clearly does not act as the inward rotator of the cartilages, this being the special function of the lateral crico-arytenoids; and its position rendering such an action impossible, it must then approximate the cartilages previously drawn asunder by the outer fibres of the posterior crico-arytenoids.

In that rare affection—complete bilateral paralysis of the posterior crico-arytenoids—the glottis is permanently reduced to a mere slit, the only change taking place during inspiration being a drawing downwards of the free edges of the cords.

It has been observed in a very few cases of this paralysis that, instead of the glottis presenting the usual slit extending the whole of its length, this slit-like opening was confined to the anterior two-thirds—that is, the part corresponding to the “glottis vocalis,” but that the remaining portion of the glottis showed during deep inspiration a triangular opening, the apex of which was formed by the approximated vocal processes of the arytenoid cartilages, and its base by the interval normally found between the arytenoids in deep inspiration.

^a I say “pentagonal” advisedly, as the term “rhomboidal” or lozenge-shaped,” usually applied, cannot be considered strictly accurate. The rima, when fully dilated, presents five easily recognisable sides; two formed by the fibrous cords meeting at an acute angle at their anterior insertion into the thyroid, two formed by the internal edges of the arytenoid cartilages, and the fifth—the inter-arytenoid fold—lying between the separated arytenoid cartilages.

In these cases the glottis during *deep inspiration* presents an appearance identical with that seen during attempted *phonation* in cases of bilateral paralysis of the thyro-arytenoids, complicated by paralysis of the arytenoideus proprius.

My friend, Dr. Semon, in whose practice one of these anomalous cases occurred, was, I believe, the first to offer an explanation (quoted by Dr. Morell Mackenzie^a) of this peculiar condition.^b After referring to Rühlmann's observations, he explained the condition by supposing that the *outer* portion of the muscle was paralysed, and that the subsequent paralytic contraction of the antagonist muscles produced the triangular opening.

The explanation of the mechanism of these cases given by me further on is a corrected form of the foregoing. It will be shown that it is the *inner* portion of the muscle which is paralysed and not the outer part, this latter still retaining its power of action.^c

My attention was directed to this peculiar condition of the glottis by a case under my care some time since. The following are a few particulars of it:—

W. S., aged fifty-eight, was first seen by me 19th March, 1880. He complained of great difficulty in swallowing solids; fluids passed easily. He occasionally felt a dart of pain passing from his throat to the right ear, and suffered from very profuse secretion of saliva and mucus. Steady pressure on the cricoid cartilage caused slight pain, but no further information was obtained from a careful examination of his throat and neck externally. Heart and lungs were healthy.

I made a minute examination of the pharynx and larynx, and found the parts healthy with the exception of a slight laryngeal catarrh. The vocal cords moved naturally.

Cautious attempts to pass a small œsophageal sound failed, but I succeeded in passing a No. 12 gum elastic catheter. I did not persist in the use of instruments in consequence of the appearance of some streaks and small clots of blood in the expectoration.

I continued to see him at intervals of a few days, the only change in his condition being increasing dysphagia.

On 15th April laryngoscopic examination showed on the posterior pharyngeal wall, just above the left arytenoid cartilage, a yellowish-white patch about two millimetres in diameter, and close beside it a smaller spot not quite so distinct. The mucous membrane around them was red and swollen.

^a Diseases of the Throat and Nose. London, 1880. Vol. I., p. 454.

^b Trans. Clin. Soc. 1879. Vol. XII.

^c On my drawing Dr. Semon's attention to the matter a short time since, he at once admitted the correctness of my view as to the portion of the muscle paralysed.

I also observed that during inspiration the anterior two-thirds of the cords did not separate, while the arytenoids moved apart widely posteriorly, leaving a triangular opening.

A few days subsequently there appeared just behind the arytenoids an elevated spot, the surface of which was bright red and granular, which I thought was probably the edge of an ulcer progressing upwards from the œsophagus. This proved to be the case, for in a few days it extended upwards until it reached the spots previously noted; they appeared to break down and join what was now an angry-looking ulcer with thick, elevated edges—its floor covered with greyish pus. It reached quite across the posterior pharyngeal wall, and extended a considerable height above the arytenoids, the mucous membrane covering which was a good deal inflamed and swollen. The diagnosis previously made of malignant disease was now placed beyond question. I may here remark that previous to this the patient had been ordered iodide of potassium in considerable quantity, in view of the possibility of syphilitic disease.

On May 6th I found that the posterior part of the glottis no longer showed the triangular opening during deep inspiration, as formerly, but that the condition was now that present in ordinary cases of complete paralysis of both abductors. The patient now also presented the symptoms peculiar to such cases—viz., severe attacks of inspiratory dyspnoea and a loud snoring noise during sleep, without any loss or alteration of voice.^a

For relief of the dyspnoea I proposed tracheotomy, but his wife refused to allow it. Shortly afterwards S. began to complain of severe pains in the stomach, and had extensive hæmorrhages from the bowels. The pharyngeal ulceration continued to progress slowly, and he gradually sank, and died on 12th June. I was unfortunately unable to obtain a *post mortem*.

The successive positions of the cords during deep inspiration, with the respective dates beneath them, are shown in the woodcuts, which are from drawings made by me from the case.

15th April, 1880.

6th May, 1880.

^a See a case reported by the writer in this Journal, Jan., 1880.

The appearances of the glottis in this case and the order of their occurrence seemed to demand for their explanation the acceptance of the views above expressed as to the actions of the posterior crico-arytenoid muscles on the arytenoid cartilages, which actions, if limited to simple rotation, must evidently be inadequate to account for the condition represented in the first of the two drawings, and in similar cases observed by others. The following appears to me to be the only method of explaining the matter:—

If we take the first position of the cords (15th of April) we find the arytenoid cartilages drawn apart at their bases, this would be effected by the external portions of the posterior crico-arytenoids; if the whole muscle were acting normally we should also find (during deep inspiration) each vocal process drawn outwards by the internal part of the muscle, but evidently this part was not acting, for the vocal processes, so far from being rotated outwards, met in the middle line.

The ulceration first appeared in the centre of the posterior pharyngeal wall, just behind those portions of the muscles which first became inactive, probably through inflammation, or perhaps destruction of their substance; as a consequence of the paralysis of these parts of the abductors, those muscles having an antagonistic action—viz., the lateral crico-arytenoids and internal thyro-arytenoids, underwent a paralytic^a contraction, causing a permanent condition of inward rotation of the vocal processes.

Later on, as the ulceration progressed laterally, the hitherto healthy outer parts of the posterior crico-arytenoids also became injured and inactive, and, as a consequence of the paralytic contraction of their antagonist, the arytenoideus proprius, we find the arytenoids no longer separating posteriorly, even in deep inspiration, and the glottis presents the appearance peculiar to complete bilateral paralysis of the abductors.

This case appears to furnish conclusive evidence as to the true nature of the action of the posterior crico-arytenoids, as proved by the destruction of the function first of one and subsequently of the other portion of the muscles; for in the earlier stage of the case we clearly had the power of outward rotation abolished, while the movements of gliding in, to, and out from the middle line in phonation and inspiration respectively continued quite active until the parts of the muscles by which the outward gliding was produced became attacked by the disease.

^a Ziemssen. Loc. cit. Vol. XI., p. 378.

But those cases are much more interesting in which one portion only of the muscle is paralysed, and there being at the same time no destructive processes going on in the neighbouring parts the paralysis must be referred to a lesion in some part of its course of the nerve supplying that portion of the muscle or to central disease.

In connexion with these cases the fact of there being two distinct nerve branches passing into the muscle seems to point to the existence of a certain divisibility of the complete action of the muscle, so that while in health both portions act in concert, yet, in case one part becomes from any cause inactive, the other can still retain its power of motion. Of course, the complete proof of this could be furnished only by the observation of a case in which the opposite condition to that already described existed—*i.e.*, paralysis of the outer portion only, when we should find during deep inspiration outward rotation of the vocal processes, while the arytenoid cartilages remained permanently drawn together posteriorly.

I would even go so far as to consider the universally recognised outward rotatory action of the muscles in question as occupying a secondary position, and am inclined to regard the outward drawing of the arytenoids as the usual and ordinary function of the abductors. In observing the movements of these cartilages in the living subject it will be found, as before remarked, that during ordinary quiet respiration the glottis is distinctly triangular in shape; and, further, that with each inspiration the cords may often be observed to move slightly further from the middle line, and to return towards it during expiration—these slight movements being brought about by the outer portions of the posterior crico-arytenoids and the arytenoideus proprius respectively. In this connexion these outer portions of the abductors may be considered as coming under the head of muscles of ordinary inspiration, while the inner portions which only come into play and act as external rotators of the cartilages during deep inspiration might be included amongst the muscles of extraordinary inspiration, since by means of the combined actions of both portions of the muscles the area of the rima is accommodated to the varying volumes of air passing through it at different periods of time to satisfy the demands of quiet or laboured respiration.

In conclusion, I think we may fairly define the action of the posterior crico-arytenoids as follows:—Firstly, a limited but still

distinct drawing of the arytenoid cartilages laterally outwards from the middle line, and, secondly, the arytenoids being held in that position, an outward rotation of the vocal processes in order that the glottis may be fully dilated.

ART. IX.—*Thoughts arising from the perusal of Sir W. Jenner's latest Essay on Typhoid Fever.*^a By HENRY KENNEDY, A.B., M.B.; Physician to Simpson's Hospital and the Whitworth Hospital, Drumcondra; formerly connected with Cork-street and Sir P. Dun's Hospitals.

A LITTLE more than a year since an essay on typhoid fever, by Sir William Jenner, appeared in nearly all the London periodicals of the time. This essay is a *résumé* of a large experience of the disease, and is a very able and well-digested address, and exhibits in a clear light the author's views on the subject. It is, however, one of such great moment, and appears to different minds in such varied aspects, that I have thought it would not be out of place to bring it forward once more; and the more so as there are some points of a general character which, in the consideration of the matter, seem to me to call for more attention than they have hitherto received. As I do not wish, however, to advance anything in a dogmatic spirit, I shall throw into the form of queries the several points to which I would ask attention; and, without further preface, will now proceed to do so. It is to be remembered that it is of general principles only I would speak here.

And, in the first place, has the constitution of individuals in whom typhoid fever occurs been sufficiently recognised?

I think not. For a long period I have had the impression, which of late years has become a conviction, that this type of fever occurs chiefly in persons who, if not of a strumous constitution, are closely allied to that state. This opinion has not been hastily taken up, nor, as far as I know, has it been specially advanced in any of the standard works of the day, and yet it appears to me that a number of facts can be advanced in strong corroboration of it. Thus the number of individuals suffering from typhoid fever who have a very fine skin and a high colour in their cheeks is very remarkable. I think, too, it will be observed that their frame, and particularly the chest, are not what is considered as robust. Of course I speak only of the majority of instances, for exceptions do occur, but I

^a Read before the Medical Society of the King and Queen's College of Physicians in Ireland, Wednesday, February 2, 1881. [For the discussion on this paper, see p. 240.]