

**Concerning the positions of paralyzed vocal bands : (from the Physiological Laboratory, Harvard Medical School) / by Franklin H. Hooper.**

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**Publication/Creation**

[New York] : [publisher not identified], [1886]

**Persistent URL**

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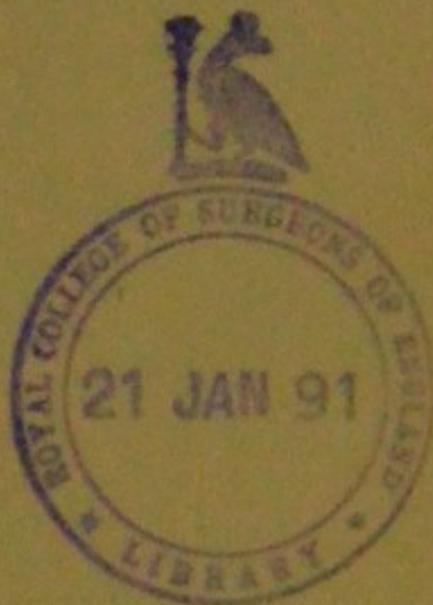
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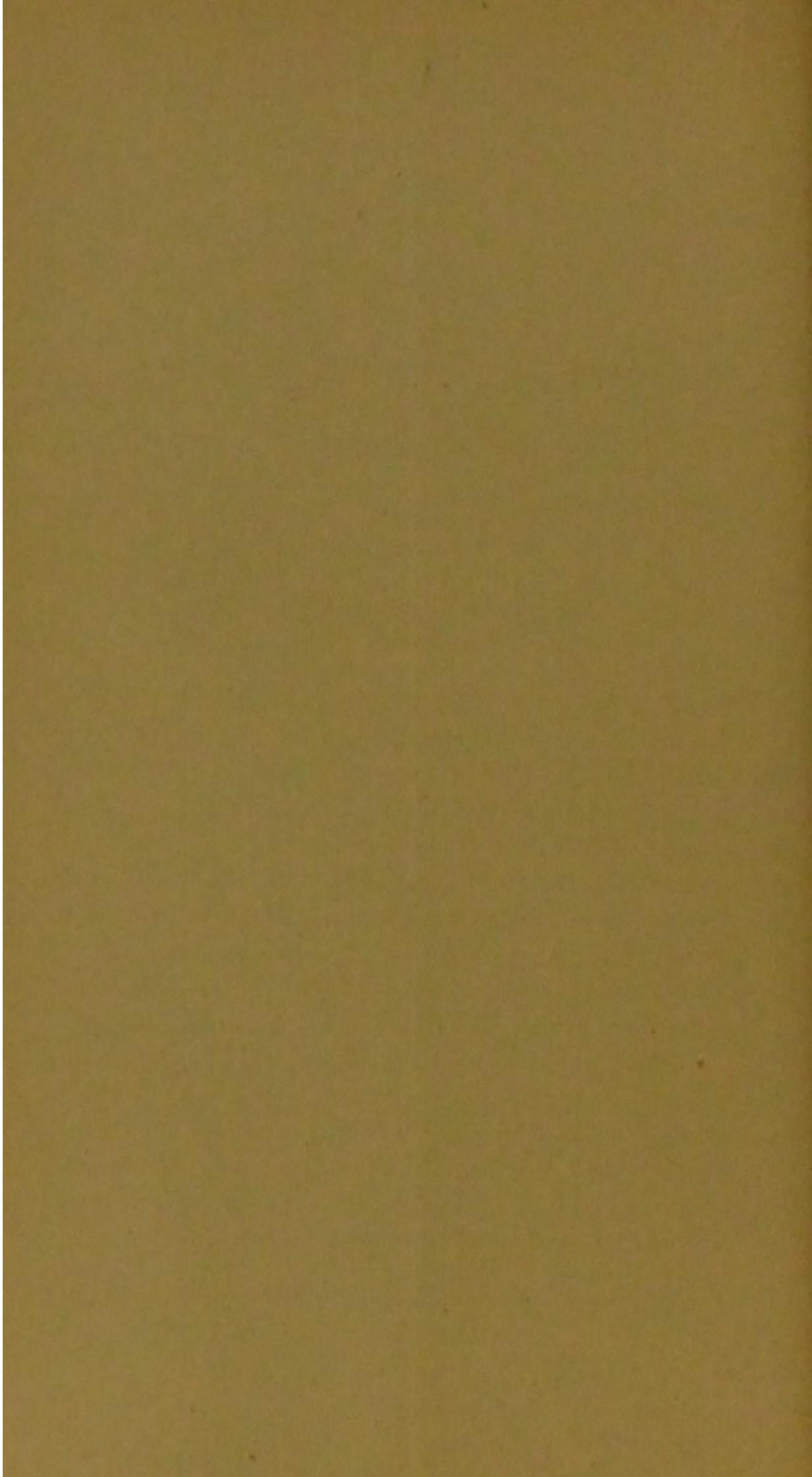
BY

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REPRINTED FROM

*The New York Medical Journal*  
for June 5, 1886.





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CONCERNING THE POSITIONS OF  
PARALYZED VOCAL BANDS.\*

(FROM THE PHYSIOLOGICAL LABORATORY, HARVARD  
MEDICAL SCHOOL.)

BY FRANKLIN H. HOOPER, M. D.,  
BOSTON.

It is the purpose of this paper to inquire into certain influences which may combine to determine the positions of paralyzed vocal bands, and to ask whether we are always justified in assuming that a given position of an immobile vocal band is indicative of the arrested function of this or that muscle of the intrinsic laryngeal group. In other words, are there not some anatomical factors besides the arrest of what we suppose to be the action of a laryngeal muscle, as well as certain physical causes, which may contribute toward producing the position in which a paralyzed vocal band may happen to be when we see it reflected in the laryngeal mirror? For instance, supposing we could take one hundred individuals of different age, size, and sex, and in each of them cut one or both of the recurrent laryngeal nerves, should we find the vocal bands in all of them occupying the same, or relatively the same, position? Undoubtedly we

\* Read before the American Laryngological Association, May 27 1886.

should not, and for the reason that there are other factors besides the arrest of the nerve-supply which are not without their importance in influencing the different shapes and positions of paralyzed vocal bands. The shape of the glottis should be taken into consideration, whether it is large or small, round or oblong. Peculiarities in the external form of the thyroid cartilage should also be noted. The elasticity of the soft parts of the larynx, the degree to which the arytenoid cartilages are developed, and the possible presence of anomalous bundles of muscular fibers which one not infrequently meets with in dissecting larynges, should be borne in mind. The strength and the development of the intrinsic muscles themselves, especially of the arytenoideus transversus, should not be lost sight of. Finally, as we know that the vocal bands move through a wonderfully complex and co-ordinated action of many muscles, it is still an open question what effect a paralysis of any one of them, the functions of the others remaining unimpaired, would have upon the position and shape of the vocal band.

It has often been experimentally demonstrated that after section of both recurrent laryngeal nerves new-born animals soon die from asphyxiation consequent upon closure of the glottis. Old, and especially large, animals do not die after the same operation, because the glottis remains sufficiently open to permit the passage of air. The reason of this is obvious. During the inspiratory act there is a constant movement of the air down the larynx to the lungs. This movement, naturally, is the same at all stages of life; but the larynx differs greatly according to the age of the animal. In the young it is small and elastic, and the cartilages are soft and slightly developed. If at this period of life the nerves going to it are cut, its delicate walls, being no longer held in position, close during inspiration with a valve-

like action, thus preventing the entrance of air and producing death by asphyxia. This is not the case in advanced years, when the larynx has become spacious, its cartilaginous portions hard, and at times even ossified, and when the soft parts have lost much of their elasticity. Quiet respiration progresses under these conditions after the recurrents are cut as well as before. The positions of the vocal bands are altered, it is true, but sufficient space remains between them for the ingress of air.

If atmospheric pressure produces such an effect as this upon the glottis and larynx after section of both recurrents, we must admit that when one of those nerves is paralyzed the half of the larynx supplied by it may be influenced in some way by this same force acting upon its motionless parts. The section of one of the recurrent nerves in kittens is followed by marked laryngeal dyspnoea. We have seen the larynx of a full-grown cat instantly close after both recurrents had been cut, and she succumbed asphyxiated in three minutes. This is not the case, however, with all adult animals. We remember an enormous dog, old and decrepit, that, after both of the recurrents had been divided, showed very slight change in the positions of the vocal bands from their normal state, and, as far as the respiratory function of the larynx was concerned, the dog could have lived indefinitely.

In cases of unilateral paralysis of a vocal band we not infrequently see that the immobile band looks shorter than its fellow. Sometimes it is slightly bowed, half-moon shaped; at other times not. Again, the ary-epiglottic fold of the affected side, especially the cartilage of Santorini and the parts immediately about it, appears to stand forward and in advance of the arytenoid cartilage of the healthy side. It has occurred to us that gravity may be a factor in causing these appearances. One half of the larynx being

no longer stimulated by nerve-currents, the posterior flexible parts fall slightly forward under the influence of gravity; the bowing and apparent shortening of the vocal band are due to the tilting forward and downward of the arytenoid cartilage. We have not yet had an opportunity of testing this hypothesis by experiment. It may be urged that if this is true we should invariably have the same picture in all cases of recurrent paralysis. But, whatever the explanation may be, we do not. We know, from our own experiments on dogs and cats of different age and size, that, after section of one recurrent nerve, the vocal band does not invariably assume the same position. In the great majority of cases the paralyzed vocal band remains in the intermediate, the so-called "cadaveric," position, but sometimes it is motionless nearly in the median line; again, it may be tense, its free edge sharply defined, or it may be apparently curved, an appearance caused, perhaps, in part, by a prominent vocal process, or an unusually large amount of yellow elastic tissue in that region. The appearance of the arytenoid cartilage and ary-epiglottic fold of the affected side standing in front of that of the opposite side has not been observed as yet in any of our experiments on the lower animals. This forward position of the arytenoid cartilage and of the parts surmounting it is not seen in every case of unilateral paralysis of the larynx, and it may depend upon the nerve-supply, which differs in different individuals, or upon the seat of the cause of the paralysis, or perhaps upon some anomaly of the distribution of the muscular fibers of the ary-epiglottic fold. Bundles of muscular fibers are not infrequently found in this region, running this way or that, which we take to be the stylo-laryngeus and the thyro-arytenoideus superior of Luschka, and which, probably, have no particular office unless it be to strengthen the ary-epiglottic fold.

If one will look at this drawing, made by Dr. H. P. Quincy from a recent dissection of a human larynx in which the thyro-arytenoidei superiores muscles were very well developed, we think it will appear plain how this muscle, when present, may alter the position of the arytenoid cartilage. Running as it does from the inner superior surface of the thyroid cartilage on to the arytenoid, and being innervated from other sources besides the recurrent, it may, by its action, pull the arytenoid forward. The same may be said of the ary-epiglottic and the ary-membranosus muscles, both of which are subject to considerable variation. The oblique bundles of fibers composing the constrictores vestibuli laryngis muscles, we have also noticed, as pointed out by Luschka, vary greatly in size, and may even be much less developed on one side of the larynx than on the other.

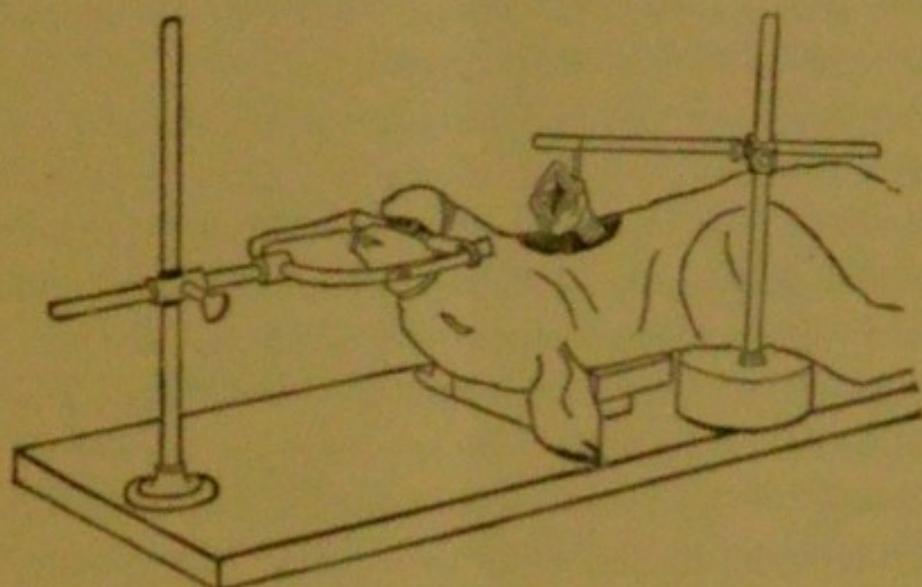


Leaving now this more or less speculative ground, let us turn to the arytenoideus transversus muscle and consider how it may influence the position of the vocal band in relation to the median line of the glottis. In order to have a clear conception of the function of this muscle, the peculiarities of the parts upon which it exerts its influence should be borne in mind. The crico-arytenoid articulation is unique. Where do we find in the body another joint that permits such a variety of movements? The articular facet of the cricoid cartilage is convex, that of the arytenoid concave. The facet of the cricoid cartilage, elliptical in outline, has a surface very nearly cylindrical, the axis of the cylinder being directed forward, outward, and downward. The longest diameter of the elongated convex facet of the

cricoid cartilage being almost at a right angle to the longest diameter of the concave facet of the arytenoid cartilage, an extensive sliding movement of the latter cartilage on the cricoid is made possible. The movements of the arytenoid cartilage upon the cricoid appear to be either a rotation around the axis of the cylinder above described, or a sliding movement in the direction of the axis, or a combination of these two movements. The exact part played by the different muscles of the larynx in producing these movements has not yet been determined with perfect accuracy.

We are concerned here only with the lateral excursions of the arytenoid cartilages as brought about chiefly by the contraction of the transverse muscle—a muscle which is also unique, being, as mentioned long ago by Krishaber (*Trachéotomie. De son opportunité dans les anévrysmes de la crosse de l'aorte* ; *Mémoires de la soc. de biologie*, 1866, p. 132), the only muscle in the economy “qui étend simultanément son action sur les deux côtés d'un organe symétrique.” This muscle belongs to the phonatory group. Well developed in man, it is comparatively rudimentary in the lower animals. In some of the dogs on which we have experimented it has been found to be very imperfectly developed, yet the oblique fibers which cover it externally and run up in the ary-epiglottic folds are always prominent, and comparatively larger, we should judge, than in man. The crico-arytenoid articulation in the dog does not admit of nearly so much lateral movement of the arytenoid cartilage as is the case in more highly developed animals, and, consequently, the action of the transverse muscle is not so marked. But by arranging a dog, thoroughly etherized or chloralized, as is shown in the accompanying figure, we can have the larynx directly under our eyes, and the function of this muscle, as well as that of the other muscles of the intrinsic laryngeal group, can be studied at leisure.

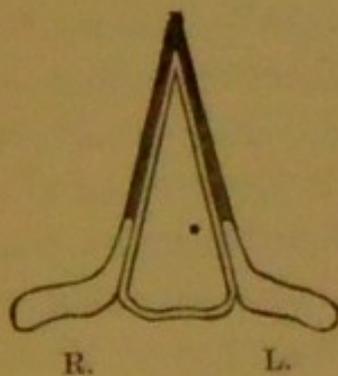
It will be seen that the larynx has been turned out of the neck, and is supported in a perpendicular position by a cord attached to a horizontal cross-bar above. It has been sepa-



rated from the hyoid bone, and the soft parts laterally have been divided. No large blood-vessels have been cut, and the recurrent laryngeal nerves are intact. The respiratory movements of the vocal bands go on as normally and as rhythmically as if the larynx had not been touched. This method was employed by Longet, and we have been surprised to see it referred to as a "grausame Erfahrung." Properly performed, it is not such, and we know of no better way of studying the actions of the intrinsic laryngeal muscles. It is a method, moreover, that can be utilized for class demonstration, and we venture to think that, if more would study these muscles in this manner, there would be greater unanimity of opinion in regard to their functions. The sides of the thyroid cartilage can be cut away, so that all the muscles are easily reached. Even after the death of the animal the muscles retain their contractility for about half an hour. The mucous membrane having been stripped from them, each one can in turn be stimulated by means of an electrode arranged like a forceps, so that its platinum

points may be separated widely enough to touch both vocal bands at the same moment, or they can be brought so near together as to stimulate any part of a single muscle.

We are concerned at present only with the arytenoideus transversus. Unlike most other muscles of the body, we can not speak of this as having an origin and an insertion. It has no tendon. It is simply a bundle of muscular fibers attached to two freely movable parts, being imbedded in, and occupying most of, the entire extent of the posterior concave surface of each arytenoid cartilage. Its office is to tend to draw the arytenoid cartilages together. For in the emission of every vocal sound there is always a lateral movement of these cartilages inward, in addition to the inward rotation of the vocal processes. Now, this single muscle of double attachment receives its nerve-supply from at least four different sources. In case one of the recurrent nerves is paralyzed, it is still bountifully supplied with nerve-force from the recurrent on the opposite side, and from the two superior laryngeal nerves. The position of a paralyzed vocal band, in relation to the median line of the glottis, is governed greatly by the position of the vocal process of the arytenoid cartilage. If, say, the left vocal



process is seen in the position represented by the dot in the diagram, it may have come there either by a lateral movement of the arytenoid cartilage inward *as a whole*, or it may have been rotated inward. But it is the lateral movement, as brought about by the transverse muscle, that we wish to insist upon here. It is a physiological fact that, if one of the pneumogastrics is injured, the nerve on the opposite side gradually takes upon itself the work previously performed by both nerves. The arytenoideus transver-

sus muscle is plentifully innervated, even though one of the pneumogastrics be paralyzed above the point of origin of the superior laryngeal nerve, and we regard this muscle as being a very important factor in determining the position of an immobile vocal band through the contraction of its remaining healthy fibers pulling the arytenoid cartilage of the paralyzed side inward. A vocal band may assume different positions in cases of complete paralysis of the recurrent nerve, and if we judge, from the position alone of a paralyzed vocal band, that a certain muscle is at fault, we shall, in many instances, draw mistaken inferences.

We have, probably, all of us, the same mental picture of the so-called "cadaveric" position, and the appearances of the glottis after death are so constant that this term is amply justified. But any one may convince himself, by examining a large number of cadavers, that there are exceptions to the general rule of post-mortem glottic appearances. The drawing herewith submitted, made by Dr. Quincy from a specimen taken from the dissecting-room of the Harvard Medical School, is one such exception which we have recently met with.



There was also an anomalous distribution of the left superior laryngeal artery in this subject, inasmuch as it passed through the foramen thyreoideum. On the right side of the thyroid cartilage the foramen was of only about the size of a pin, and the artery on that side pursued its normal course. It was subsequently ascertained that the subject from whom this larynx came was a woman sixty years of age, who had been demented for the last few years of her life. There had been no affection of the voice. We have seen in the living subject a bilateral paralysis of the

vocal bands where the positions corresponded almost exactly with those figured in this drawing, but we are at a loss to account satisfactorily for the appearances.

It has been remarked by Ruskin that hundreds of people can talk for one that can think, but thousands can think for one that can see. In our work with the laryngoscope it is our task in the first place *to see*, and then to interpret correctly what we have seen. How many of the recorded cases of bilateral paralysis of the posterior crico-arytenoid muscles were really contractions of the adductors, or perhaps paralysis of both recurrenents? Who is justified, from the picture in the laryngeal mirror, in diagnosing an uncomplicated spasm of the lateral crico-arytenoidei? Why should not marked relaxation of the internal thyro-arytenoidei, or of the elastic fibrous tissue connected with them, give us the same wavy outline that we expect to find in paralysis of the thyro-cricoids? If we see a triangular opening in the posterior portion of the glottis, let us be sure that there is no mechanical obstacle to the approximation of the arytenoid cartilages before we pronounce it a paralysis of the transversus. If we could only know the unknowable, most of the reported cases of unilateral paralysis of the posterior crico-arytenoid muscle would, in all probability, turn out to be instances of recurrent paralysis. There are certain pathological factors also, such as paralysis with contracture, that may affect the shape and position of a motionless vocal band, but we reserve the pathological and clinical aspect of this question for a future study.

In conclusion, we wish to repeat that in our judgment the larynx is such a complicated organ anatomically, it is subject to such changes at different stages of life, its shape is so different in different people, its nerve-supply is so great, the arrangement of its muscles so liable to anomalies, that as surely as one attempts to formulate theories on the posi-

tions alone of paralyzed vocal bands—positions which may be controlled by intrinsic muscles of the larynx that are *not* paralyzed as well as by those that are—just so surely will one be led unconsciously into erroneous mental inferences.

