

When acute pulmonary tuberculosis is complicated by any form of laryngeal tuberculosis, the prognosis is always grave. These patients, even under the best hygienic conditions, seldom live more than a few weeks. Laryngeal tuberculosis manifesting itself in the late stages of pulmonary tuberculosis is a very grave complication, and, even with the best hygienic surroundings and most skilful treatment, contributes to an early demise.

Let us consider laryngeal tuberculosis developing in a patient who has pulmonary tuberculosis with infiltration and slight softening of a portion of one lung. If such a patient can afford to seek a climate in which the pulmonary process is often arrested, and will consent to do so, then with proper local medication he will have a good chance for a cure of the laryngeal tuberculosis. If, however, he has to remain in a large city and toil at work which undermines his strength, the prognosis is bad. In other words, we feel that the influence of nutrition in a given patient and the arrest of the pulmonary process are of the very first importance in effecting a cure in laryngeal tuberculosis.

In the tumor-like form of laryngeal tuberculosis appearing in the interarytenoid commissure, which often shows little or no tendency to ulceration, and is frequently found in the more slowly developing forms of pulmonary tuberculosis,—that is, the so-called fibroid phthisis,—the prognosis, if the patient can be put under proper hygienic surroundings and treatment, is good.

In the cases of laryngeal tuberculosis that begin with intense redness and are soon followed by considerable infiltration and early ulceration, the prognosis is bad.

TREATMENT.—The treatment of laryngeal tuberculosis may be considered under three heads: (1) Local; (2) constitutional; (3) hygienic.

In the local treatment of laryngeal tuberculosis, in the last few years, considerable reaction has taken place in the direction of the employment of less radical and harsh measures. The application of medicaments to the larynx upon swabs has been dispensed with by many because it is believed that the traumatism caused by the pressure of the swab and the spasm of the parts on being touched do more harm than the application does good. Inhalations and sprays therefore are more frequently used now than ever before.

In the stage in which infiltration alone is present I am in the habit of prescribing as a spray:

R Menthol.....gr. xx.
Ol. eucalyp.....3 ss.
Ol. pini pumilionis.....℥ xv.
Benzoinol.....q. s. ad ʒ ij.
M. Sig.: Use in oil atomizer.

This may be used in any one of the oil atomizers, the patient being instructed to take a deep inspiration, while the bulb is being compressed, so as to draw the finely divided oil into the larynx.

When the infiltration is excessive, producing dysphagia, as occasionally happens, one of the forms of cutting instruments for the removal of such growths—as, for example, Schroetter's tube forceps or the writer's modification of the same, or Heryng's curette—must be employed.

When ulcerations are present the treatment should consist in cleansing the ulcer with a non-irritating solution, such as the following:

R Sod. chlorid.....gr. xij.
Sod. bicarb.....gr. xx.
Aque.....q. s. ad ʒ iv.
M.

This is best carried out by using a down-tube spray with a compressed air apparatus, the patient's tongue being forcibly pulled out and the degree of air pressure employed being very slight—say five pounds. In this manner the larynx is sprayed so as thoroughly to cleanse it. A powder blower is then filled with

R Iodoform.....gr. ij.
Orthoform.....gr. i.
Co. stearate of zinc.....gr. i.
M.

and the interior of the larynx is thoroughly dusted with it. In place of the iodoform, when the taste is objectionable, chinosol gr. ij., or paraform gr. ij., may be used. In fact it is sometimes best to vary these three powders in order that the healing action of any one of them may not be lessened by too continuous use. A nurse or some member of the family can be taught to do this, as in some cases it is often necessary to apply it twice daily, to afford relief.

When much pain is associated with the laryngeal ulcers it is well to add to the above powder gr. ʒ of cocaine and gr. ʒ of morphine. Intralaryngeal injections with a specially constructed syringe are employed by some in the ulcerative stage. Creosote and guaiacol are used for this purpose, ℥ v. of creosote in ℥ xv. of olive oil or alboline being injected into the larynx once, twice, or three times daily. The spasm produced is considerable, and it is well to begin with a smaller amount and gradually to increase the quantity of the injection. Scheppegrell²⁶ advocates the use of electrolysis in the treatment of laryngeal tuberculosis and reports some good results. The submucous injections of carbolic acid, creosote, or guaiacol, which were in favor a few years ago, have practically been abandoned on account of the severe reaction, with intense oedema of the glottis, that followed their use.

If the epiglottis is enormously swollen and ulcerated so as markedly to interfere with deglutition, beneficial results follow its excision with cutting forceps. This is not done with the idea of curing the tuberculous process, but simply to remove a cause of great distress to the patient and to allow him to take food.

Lactic acid has been and still is employed with beneficial results in the treatment of laryngeal tuberculosis. It is usually advisable to begin with a twenty-five-per-cent. solution of lactic acid and gradually to increase the strength until the pure acid can be tolerated. The application should be made every day on a cotton-wound applicator.

The constitutional treatment of the patient should be the same as that for tuberculosis in general.

Hygienic Treatment.—The feeding of these patients in the ulcerative stage, and especially when the epiglottis and aryepiglottic folds are ulcerated, demands considerable attention on the part of the physician. Soft and semi-solid materials seem to be more easily swallowed than either solids or liquids. Scraped beef, either raw or partially cooked, can usually be swallowed with a little difficulty as any form of nourishment and is very nutritious. Custards, the whole raw egg, and oysters are also substances taken with as little discomfort as any. Mark Hovell has suggested a plan by which deglutition in these cases can sometimes be made very comfortable; namely, by having a nurse stand behind the patient with the hand resting on the side of the neck and the fingers inserted on either side of and just above the thyroid cartilages and making firm pressure on the sides of the neck during each act of swallowing. The object of this is to steady the larynx and prevent the compression of the aryepiglottic folds which occurs normally with each act of deglutition. Another method of taking nourishment which seems to act well is this: Let the patient lie, face down, on a couch, the head hanging over the end, and suck up liquid food through a tube.

As a usual thing patients suffering from laryngeal tuberculosis do best in a climate where the temperature is moderate, the air dry but not dusty, and the altitude not too great. Parts of Arizona, New Mexico, southwest Montana, and the Redlands district of California are, on the whole, the parts in this country in which the greatest number of my own cases have been most benefited. I know, however, that it is very difficult to pick out any one locality for a patient with laryngeal tuberculosis and advise him to go there and stay until he is cured. Local-

ities favorable to one patient are not so to another, and it is therefore best to tell the patient frankly to go to a place, and, if he grows worse instead of improving, to go to another, in the hope of finally getting relief.

Cornelius G. Coakley.

- De Sedibus et Causis Morborum, lib. xv., 13, 14, Lugdunum Bat., 1767.
- Dissertatio de Phthisi Laryngea, Montpellier, 1790.
- Recherches sur la phthisie laryngée, Paris, 1802.
- Recherches sur la phthisie, Paris, 1825.
- Traité de la Phthisie Laryngée, Paris, 1827.
- Clinique Médicale, t. iv., p. 183.
- Dictionnaire de Méd. et de Chir., 1834, art. Laryngite.
- Die Kehlkopfkrankheiten, p. 261, Berlin, 1861.
- Archives Générales de Médecine, t. v., p. 142, Paris, 1839.
- Mémoire sur la phthisie laryngée, p. 20, Paris, 1849.
- Handbuch der pathologischen Anatomie, Bd. v., p. 435, Wien, 1845.
- Klinik der Kreislaufs- und Athmungsorgane, p. 288, Breslau, 1856.
- Die chronischen Kehlkopfkrankheiten, p. 65, Berlin, 1866.
- Vorlesungen über Geschwülste, Bd. II., Berlin, 1865.
- Dictionnaire des Sciences médicales, art. Larynx, Paris, 1868.
- Die Kehlkopfschwindel nach Untersuchungen im pathologischen Institute der Universität Leipzig, 1879.
- Pathologische Anatomie des Larynx und der Trachea, Berlin, 1880.
- Laryngeal Phthisis, 1901.
- Deutsche med. Wochenschrift, 1886, p. 490.
- Petersburg med. Woch., 1888, p. 137.
- Deutsche med. Woch., 1891, No. 31.
- De la Phthisie Bacillaire des Poumons, Paris, 1892, p. 282.
- Archiv für Laryngologie, Bd. v., p. 210.
- Charcot: Traité de Médecine Interne, t. iv.,
- American Journal of the Medical Sciences, May, 1895.
- Electricity in Diseases of the Nose and Throat.

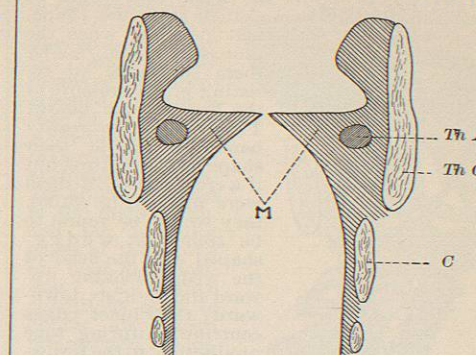


FIG. 3156.—Th A, Thyro-arytenoid muscle; Th C, thyroid cartilage; C, cricoid cartilage; M, vocal shelves.

LARYNX, PHYSIOLOGY OF THE.—I. The larynx is that portion of the respiratory tract which is situated in the median line of the neck between the trachea and the pharynx. It may be regarded merely as a prolongation upward of the trachea, with such modifications of structure as are required for the performance of its various specialized functions. A comparative study of the larynges of animals indicates that the extent of the modifications of structure is proportional to the variety of the specialized functions. Following this law, the structure of the human larynx differs very considerably from that of the trachea, and its mechanism is interesting and complex (Figs. 3153, 3154, and 3155). The framework of the trachea is composed of incomplete cartilaginous rings, bearing a close resemblance to one another, and bound together by fibro-muscular tissue, and while the cartilages of the larynx are for the most part irregular in shape, a scheme somewhat similar to that of the trachea is carried into its structure.

The cricoid, the first cartilage above the trachea, differs from all the others in that it is complete throughout its entire circumference, and it thus serves as a firm base for the superstructure of the larynx. The thyroid, like the cartilages of the trachea, is open posteriorly, thus giving room for the two arytenoids which articulate with the

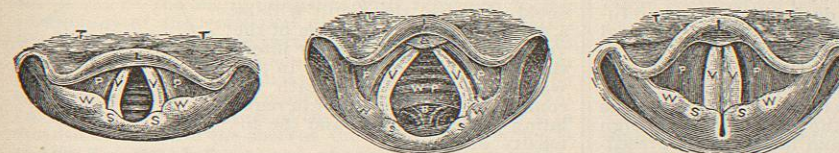


FIG. 3153.—Showing the Position of the Vocal Bands during Passive Inhalation. FIG. 3154.—Showing the Position of Vocal Bands during Forced Inhalation. FIG. 3155.—Showing Position of Vocal Bands during Phonation.

FIG. 3153, 3154, AND 3155. T, Tongue; L, epiglottis; P, P, ventricular bands; W, W, cartilages of Wrisberg; S, S, cartilages of Santorini; V, V, vocal bands; W, P, wind pipe or trachea; B, bifurcation of the trachea. (From Lennox Browne and E. Selenke.)

elevated posterior portion of the cricoid. The hyoid bone, which is closely related to the larynx, is also open posteriorly to make room for the anterior portion of the pharynx. The other cartilages of the larynx are the cornicula laryngis, the cuneiform cartilages, and the epiglottis. These nine cartilages form the framework of

the larynx, and they are so jointed and connected by ligaments as to be freely movable when acted upon by their respective muscles. The object of this motion is threefold: (1) to control the breath, (2) to furnish the bands the vibrations of which cause the sound of which

voice is made, and (3) to assist in voice production. The three highly specialized functions of the larynx, therefore, may be described under the following heads: (1) Respiration; (2) Phonation; (3) Articulation.

Respiration.—The respiratory function of the larynx is an important one and it includes more than would appear at first thought. Air could be made to pass to and from the lungs without the intervention of this complicated structure, therefore the mere act of breathing may be regarded as purely incidental to the larynx. It was necessary to place somewhere in the respiratory tract a structure that not only would furnish a free passageway for the breath, but would also, at the same time, serve other important purposes. Of these purposes phonation, to be described later, is the most important, but this requires some kind of temporary obstruction in the air channel, and this is provided by the two muscular bands with their membranous covering, that run from the thyroid to the arytenoid cartilages. Moreover, these bands must obstruct respiration as little as possible and only at those times when the obstruction is necessary for the phonatory act. Provision is therefore made for their removal from the lumen of the larynx when not required for this purpose, and this is accomplished by the contraction of the posterior crico-arytenoid or so-called respiratory muscles. These abductor muscles are supplied by the external branch of the superior laryngeal nerve, and so important are their functions in maintaining the patency of the larynx for respiratory purposes, contracting as they do for every act of inspiration (about eighteen times a minute), that they seem to be endowed with greater strength and are less susceptible to disease than the other muscles of the larynx. Life itself depends upon their health and tone (Figs. 3153, 3154, and 3155). But the larynx

has another important function that should be described under this head, and that is the closure of its upper portion during the vigorous muscular acts which are performed by the hands and arms, and also during the acts of defecation, coughing, laughing, etc. This strong closure of the upper portion of the larynx

takes place above the vocal bands, and not so much in the glottis as has been supposed. The glottis, it may be remarked, is merely the aperture formed by the vocal bands, the vocal processes, and a portion of the transverse arytenoid muscle (Fig. 3153). The vocal bands are too slender and delicate to endure the strain that would be put upon them by this action, and their structure, shape, and position, when the glottis is closed, render them incapable of resisting much pressure of the breath from below. They are not in reality bands at all in their shape and structure, but if a cross section of them were made (Fig. 3156), they would be found to be somewhat wedge-shaped with the head of the wedge looking upward and the apex downward; their inner edges contribute, during tone production, to the formation of the vibrating portion of the glottis, and their inner surfaces gradually taper downward

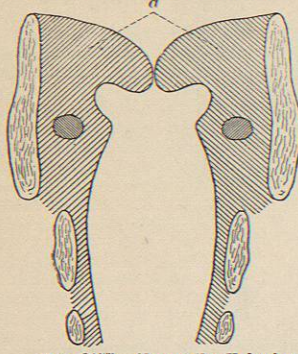


FIG. 3157.—Shows the Valvular Action of the Ventricular Bands. a, Ventricular bands.

along either side of the larynx. Better names for them have been suggested, namely, cushions or shelves, and the latter is the one to be preferred because it more accurately describes their shape and functions. It will be observed that when the glottis is closed the gradual tapering of the vocal shelves downward makes the lower portion of the larynx somewhat cone shaped with the apex pointing upward, and that this approach to the glottis adapts it not for checking but rather for favoring the egress of air (see Fig. 3153). When the breath is forcibly held for purposes mentioned above, the true glottis is not closed at all, but the pseudo-glottis is closed by the approximation of the ventricular bands, and the ventricles, the shape of which is so well adapted to this purpose, become inflated and unite to form a more or less perfect valve capable of resisting great pressure with a minimum amount of effort (see Fig. 3156). The upper surface of the closed glottis to a lesser degree acts like a valve in checking the ingress of air. This function, however, is not so important, for the amount of air taken into the lungs is controlled largely by the great respiratory muscles of the thorax.

In addition to this valvular action the upper portion of the larynx closes at times in much the same way as do the sphincters in other parts of the body. It was formerly supposed that the epiglottis, serving as a lid to the larynx, was the only means of preventing the food from entering this cavity during deglutition, but, in refutation of this theory, it was found that the entire removal of the epiglottis, either by operative procedure or by disease, in no respect interferes with deglutition. It appears, therefore, that nature has not entrusted to the epiglottis alone the important function of guarding the gateway to the lungs against the intrusion of foreign substances, but, in addition to and immediately preceding the falling of the epiglottis over the larynx during deglutition, there is a complete closure of the entire upper part of the larynx. This is effected by the approximation of the ventricular bands, the upper part of the arytenoid cartilages, the aryepiglottic folds, and the lower portion, or so-called cushion, of the epiglottis. The muscles causing this closure of the upper portion of the larynx have been called the sphincters of the larynx. They are the thyro-aryepiglotticus, the thyro-arytenoideus externus, and the arytenoideus posticus.

In the act of deglutition the sphincter muscles contract, and over the closed gateway of the larynx the epiglottis falls of its own weight, or rather as a result of the relaxation of the hyo-epiglottic ligament, incident upon the

elevation of the larynx. The theory formerly held, that the epiglottis is drawn over the larynx by muscular action, is rendered improbable by the fact that the muscular fibres running from the epiglottis to the hyoid bone, in the human subject, are very small and but slightly developed.

Phonation.—The chief purpose of the larynx and the one to which it is especially adapted is phonation, but this function is so closely related to the action of certain other organs, notably those of respiration and articulation, that it will be necessary to take these into account also, at least to some extent.

Voice, as I have defined it elsewhere, is a moving column of breath, set in vibration by its own impact upon the vocal shelves and re-enforced by its diffusion through the various resonant chambers into the surrounding atmosphere, and therefore it follows that phonation is the process by which the column of breath is formed, set in vibration, and diffused, and a description of this process must include the necessary respiratory movements, and at least a reference to the resonant chambers, as well as a description of the action of the larynx itself.

The respiratory movements of phonation are different from those of ordinary breathing. The one is active, and the other is passive. The breathing of phonation supplies the system with oxygen, and carries off the effete products, in the same manner as does ordinary breathing, but it does this only incidentally, its special function being to cause impaction of air upon the vocal shelves, which impaction causes the necessary vibrations. Moreover, the character of this impaction of the column of breath upon the vocal shelves is an important factor in the regulation of their vibrations. It has been shown by actual demonstration that the rapidity of the vibratory excursions of the vocal shelves is increased and the pitch of the voice heightened by an increase in the rate of motion of the column of breath. This is true, in part at least, because the increase in the rate of motion is attended by an increase of expiratory effort, and a corresponding increase of pressure within the column of breath; the tracheal tube being somewhat elastic, this pressure tends to enlarge the column of breath in the trachea, and as this is forced through the smaller opening of the cricoid cartilage it carries its anterior portion upward toward the thyroid, and its posterior portion downward, thus increasing the distance between the anterior and posterior attachments, and becoming a direct longitudinal tensor of the vocal shelves. On the other hand, if this tendency of the column of breath to render the vocal shelves tense during its rapid and forcible movement is resisted by the contraction of the internal thyro-arytenoid muscles, the result will be a wider vibratory excursion of the vocal shelves and a greater intensity or loudness of voice. In this way the column of breath becomes an important factor in regulating both the pitch and the intensity of voice.

The respiratory movements of phonation, therefore, are definite and active. The base of the column of breath rests upon the diaphragm, and it is surrounded laterally by the walls of the thorax with their enveloping ligaments and muscles. The muscles may be divided into two sets, those which elevate the ribs and those which depress them, the former tending to enlarge the thoracic cavity, and the latter to diminish its capacity. It will be observed that the depressor muscles exert a force which is directly opposed to the action of the levator muscles, and

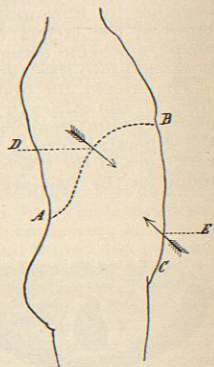


FIG. 3158.—Diagram showing the Opposing action of the Diaphragm and Abdominal Muscles. A-B, Diaphragm; B-C, abdominal muscles; D, direction in which the diaphragm acts; E, direction in which the abdominal muscles act.

It is by means of these two opposing forces that the column of breath may be controlled with the necessary accuracy, and that the requisite tension may be given to the drum-like walls of the thorax for the purpose of giving resonance to the voice (Fig. 3158). The column of breath is, therefore, compressed and its rate of motion through the glottis regulated with great precision. The tracheal, pharyngeal, oral, and nasal cavities are also resonators, and serve to re-enforce the tones produced by the vibration of the vocal shelves.

The framework of the larynx, as already mentioned, is composed of irregularly shaped cartilages articulating at the several points of contact by means of freely movable joints. The muscles having their attachments only to these cartilages, and whose function it is to assist in the regulation of their relative positions, are called intrinsic muscles; those running from the cartilages to various points without the larynx are called extrinsic muscles. The extrinsic laryngeal muscles, like the thoracic muscles, may be divided into two sets, according as they elevate or depress the larynx. The levator muscles are the palatopharyngeal, the stylopharyngeal, digastric, stylohyoid, geniohyoid, and the hyoglossi. The depressor muscles are the omohyoid, sternohyoid, and sternothyroid. The function of the extrinsic muscles is (1) to determine the position of the larynx in its relation to the adjacent structures, and (2) to determine the position of certain important parts of the larynx in their relation to other parts. The position of the larynx in its relation to adjacent structures varies with the variation in the quality and pitch of the voice, and the importance of a correct position cannot be overestimated. When both the levator and depressor muscles are brought into action, the larynx becomes fixed, and an additional result of these two forces (as will be observed in Fig. 3155) is to draw the larynx backward against the spine. If these two sets of muscles are strongly contracted, the posterior surface of the plate of the cricoid cartilage will be fixed against the anterior surface of the fifth cervical vertebra, and thus vocal resonance may be transmitted through the spinal column to all parts of the body.

Moreover, with the cricoid cartilage in contact with the fifth cervical vertebra, it is evident that if the force of the contraction of the depressor muscles is greater than that of the levator, the result will be a forward tilting of the thyroid upon the cricoid cartilage and a stretching of the vocal shelves. In this way it is quite possible that the extrinsic muscles of the larynx may assist the intrinsic muscles in rendering the vocal shelves tense, at least during the production of tones of unusually high pitch. Opinions differ, however, with reference to this important point, some claiming that the extrinsic muscles are the sole cord stretchers of voice production, others thinking that this function comes entirely within the province of the intrinsic muscles. While this is one of the many questions with reference to the physiology of the voice that are difficult of demonstration, it is quite probable that there may be some truth in both theories and that unusual results in voice production may be attained by a judicious combination of both the extrinsic and the intrinsic muscles in the control of the vocal shelves. The function of the larynx in phonation is to furnish and control the shelves, the vibration of which is the first cause of the sound of which voice is made. These shelves are merely reduplications or folds of the lining membrane of the larynx reflected over the thyro-arytenoid or so-called vocal muscles, the lining membrane of that portion of the shelves which forms the rima glottidis having been transformed, by the exercise of its function, into white fibrous tissue. The various changes in the laryngeal tones of the voice depend upon certain changes in the physical condition of the vocal shelves. The laws governing the vibrations of the vocal shelves are somewhat similar to those governing the vibrations of strings, the three physical changes in them which govern the pitch of the tone being changes in length, weight, and tension. The length and weight of the vocal shelves

vary somewhat in different larynges. Those in the larynx of the male, for instance, are longer and heavier than those in the larynx of the female, and the pitch is correspondingly lower. The length of the vibratory portion of the shelves, however, may be changed in each larynx by certain changes in the action of its muscles. This phenomenon may be observed by means of the laryngoscope. When a tone of high pitch is produced, the vocal processes of the arytenoid cartilages appear to meet in the middle line, and the posterior edges of the glottis are held in apposition. The same conditions seem to obtain also with reference to the anterior edges (although in many cases, especially during the emission of low tones, they are partially hidden from view), and thus the vibrations may be limited to scarcely more than the middle third of the glottis (Figs. 3153, 3154 and 3155). The shortening of the glottis posteriorly is brought about by a vigorous contraction of the arytenoid and the lateral crico-arytenoid muscles, causing the vocal processes to come into close apposition and possibly to overlap slightly. At the same time the thyroid tilting muscles, the crico-thyroid and the sterno-thyroid, serve to stretch further the vocal shelves; and the latter muscles when the levator laryngei muscles are in action serve also to compress the axis of the thyroid cartilage, which compression would naturally bring into closer apposition, not only the posterior but also the anterior edges of the glottis. Moreover, it has been shown by Willis that the approximation of the anterior portion of the cricoid cartilage to the thyroid, which is made evident by placing the finger in this region during the emission of a high tone, has a tendency to push the tapering portions of the vocal shelves upward, and to bring into close contact the anterior edges of the glottis. This theory of the regulation of the glottis by forced muscular action during the production of the higher notes of the falsetto voice is demonstrated not only by the laryngoscope, but also by the conscious increase of the muscular effort required for the production of these tones. The mechanism that shortens the vibratory portions of the shelves, at the same time diminishes the width of their vibrating surfaces and increases their tension. As the internal thyro-arytenoid or vocal muscles contract more and more when their attachments are fixed both anteriorly and posteriorly, as above described, the result is a lateral diminution of the vibrating portions of the vocal shelves. When these vocal muscles are contracted to their utmost, only the very thin edges of the shelves are available for vibration. The internal thyro-arytenoid muscles throw out numerous small muscular fibres into the bodies of the shelves, the function of which is to regulate the extent of the lateral vibratory surfaces of the shelves, and probably also to assist in regulating the longitudinal vibratory surfaces.

Articulation.—Thus far we have considered the larynx in its relation to tone production. It must be borne in mind that the tone produced by the laryngeal mechanism above described differs from what we hear as the human voice, but this difference is not apparent because it is impossible for the human ear to differentiate the two. If

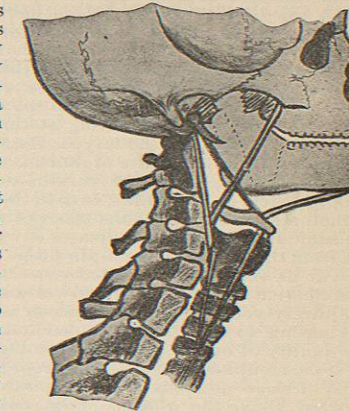


FIG. 3159.—Diagram Showing the Direction in which the Levator and Depressor extrinsic Muscles Act in Holding the Larynx Against the Spine. (From Howard.)

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