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On a Perfected Method of
Photographing the Larynx.

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ON A PERFECTED METHOD OF
PHOTOGRAPHING THE LARYNX.*

By THOMAS R. FRENCH, M. D.,

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It is now more than two years ago that, with the assistance of Mr. George B. Brainerd, of Brooklyn, I made my first attempt to photograph the larynx of the living subject. The results obtained at that time were far from satisfactory, yet we were sufficiently encouraged to continue our experiments, and, though meeting at times with difficulties which seemed almost insurmountable, these experiments have finally been brought to a successful termination. Our object has been not only to obtain good photographs, but to devise an easy method by which any expert laryngoscopist can photograph the larynxes of his patients in every-day practice. This we have accomplished.

The assistance rendered by Mr. Brainerd has been invaluable. This gentleman, who is an extremely skillful amateur photographer, is a civil engineer by profession, and his interest in this work has been purely of a scientific character. He became interested in these experiments while under my care for the treatment of an acute affection of the larynx, nearly two years and a half ago. Having volunteered his services, he entered into the work with great enthusiasm, which has continued unabated until the present time.

Prior to the beginning of our experiments, though many had

* Read before the Section of Laryngology, International Medical Congress, Copenhagen, August 15, 1884.

tried, all had failed to produce a good photograph of the larynx. Since then Mr. Lennox Browne and Mr. Emil Behnke, of London, have been successful in obtaining some excellent photographs of Mr. Behnke's larynx. In a paper on "Photography of the Larynx and Soft Palate," by Mr. Lennox Browne, read at the annual meeting of the British Medical Association, held in Liverpool, August, 1883, the writer says: "I do not anticipate that photography of the larynx can be extended beyond the boundary of physiology. To expect photographs from life of pathological conditions is plainly unreasonable, since those we have seen could only have been obtained by elaborate and costly machinery, and, above all, from a subject possessed of unusual, indeed, in my experience, of unequaled knowledge of what was our goal, and skill and endurance necessary for its attainment." I make this quotation to show how great were the difficulties which presented themselves to one who had been successful in obtaining some very good photographs of one subject.

Not only have we succeeded in devising a method for photographing the larynges of those accustomed to the presence of the mirror in the fauces, but, as some of the photographs in Portfolio I will show, of those upon whom the laryngoscopic mirror was used for the first time, and who were ignorant of the object of the procedure. Allowing that the fauces are moderately tolerant, with the method which I am about to describe there is, as a rule, no greater difficulty in obtaining photographs of pathological than of normal conditions.

Not only can the larynx be photographed, but it can be done with ease and without assistance. Five minutes are enough for the preparation and arrangement of the instruments, and in another five minutes from three to five exposures may be made; so that, after one has become familiar with this method, allowing that the instruments are ready for use, not more than five minutes will be needed to secure a good photograph of the larynx, which can afterward be developed and printed at leisure.

The obstacles encountered in bringing this method to its present state of perfection were both numerous and great. The first difficulty we met was with the camera. The stationary camera was found impracticable, for reasons which must be apparent to all. This difficulty was overcome by devising a small camera which could be held in the hand while the photograph was being taken. The next difficulty which presented itself was the source of illumination. Plain sunlight was not powerful enough; the oxyhydrogen light did not

give good results; the arc electric light used with the reflector was not satisfactory, and direct illumination with a modified "photophore électrique frontale" of Trouvé, of about twenty-candle power, was only strong enough to make a faint impression on the most sensitive plate. This difficulty was surmounted by a device for use with sunlight, which will be described hereafter. It being necessary, in order to obtain sufficiently large pictures for practical purposes, to place the lens of the camera close to the mouth of the subject, another difficulty was encountered in the condensation of the vapor of the breath upon the lens, and so obscuring or blotting out the impression. This was overcome by placing a diaphragm in front of the lens, which not only prevented the lens from becoming fogged, but also increased its focal depth.

In order to illuminate and expose the entire larynx in the throat mirror, it was found necessary to use a mirror with a slightly convex surface, the illumination being sufficiently strong to allow the loss of light occasioned by the dispersion of the rays from the convex mirror.

The minor difficulties encountered were too numerous to mention; suffice it to say that all have been overcome. About fifteen hundred exposures were made before satisfactory results were obtained.

The apparatus for photographing the larynx, which I now take pleasure in presenting to you, consists of (1) an instrument which I shall term a sunlight concentrator; (2) a camera with throat mirror attached; and (3) a perforated forehead reflector. The sunlight concentrator consists of a hollow truncated cone of metal, ten inches long, in the large end of which is a double convex lens five inches in diameter, which has a focal length of thirteen inches. At the outer end of a short movable tube, fitted into the small end of the cone, is a plano-concave lens of $1\frac{1}{8}$ inch diameter, with its plane surface outward; this is placed an inch or so inside of the point of focus of the double convex lens, and in that position intercepts the converging rays and makes them parallel or divergent, according to its distance from the first lens. With this device a powerful light is obtained, and that, too, without material heat. The cone is mounted on a rod by means of a universal joint, the rod being fastened to the frame of a window into which the sun shines.

The camera (Fig. 1) consists of a box $10\frac{1}{2}$ inches long, $1\frac{1}{2}$ inch wide, and $\frac{7}{8}$ of an inch in thickness. The back opens upon hinges,

and allows the introduction of the ground glass or plate-holder. The plate-holder is long enough to admit of five pictures being taken. On the front face of the camera a telescopic tube, $3\frac{1}{4}$ inches long when run out to its full extent, is attached, and at the outer end of this tube the lens is placed. The lens is made up of two achromatic meniscus lenses of one half-inch diameter, and has a focal length for

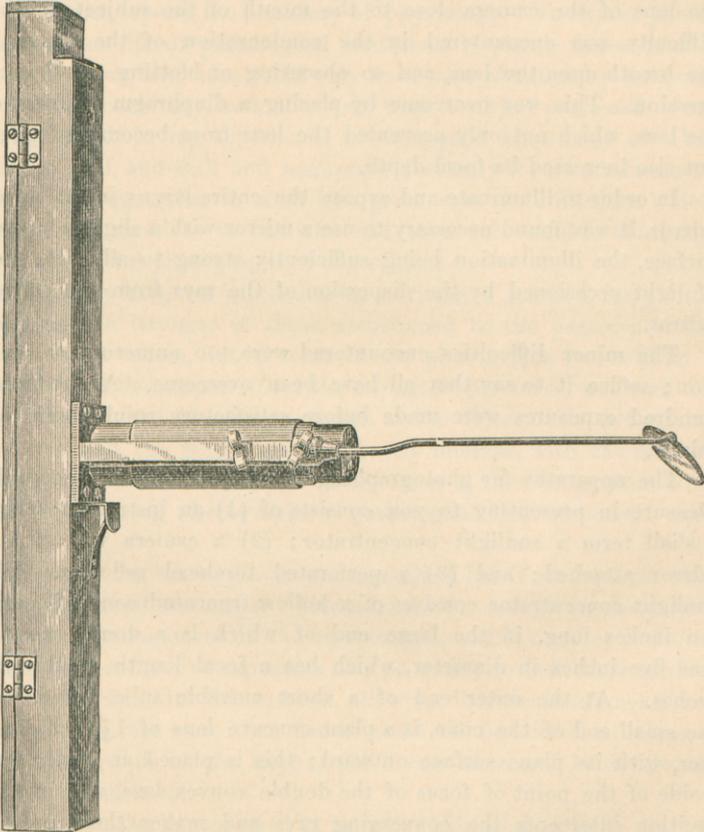


FIG. 1.

parallel rays of $1\frac{3}{8}$ inch. In the front part of the camera is a narrow compartment in which slides a drop-shutter of hard rubber. The shutter is released by means of a key on the front face of the camera. At the side of the tube holding the lens is a hollow handle of brass, into which the shank of the throat mirror is passed and fixed by a thumb-screw. The shank is attached to the right side of the frame

holding the mirror. The object of this is, mainly, to allow of the lens being held opposite any part of the opening of the mouth. I have already stated that the mirrors used are slightly convex, the radii of their spherical surfaces varying from twelve to twenty-four inches, twelve inches radius being as small as can be used without danger of distortion.

The manner in which the apparatus is used in taking photographs of the larynx is as follows:

I have here a sketch (Fig. 2 shows sketch reduced) which will, perhaps, aid you in understanding the description. A concave reflector attached to a head-band is so arranged over the left eye that the beam of sunlight will be received upon it and thrown into the mouth of the subject. It is important that the beam of light should be thrown from the inner side of the reflector, that nearest the nose, for in this way the angle between the reflected beam and the axis of the lens is reduced to a minimum. As a rule, the tongue must be protruded and held well out between the thumb and forefinger of the subject's right hand, though in exceptional cases the tongue may be allowed to remain in the mouth. The throat mirror with camera attached, held in the right hand of the observer, is now placed in position in the fauces. *The mirror and light should be so adjusted that with the observer's left eye only the central portion and left side of the larynx can be seen, and be seen to be well illuminated.*

On account of the parallax, or displacement of the image, due to the difference in points of view between the eye and lens, some skill is necessary in managing the illumination and camera, so that the parts which it is desired to bring out will be exposed to the lens if not to the eye. The image as seen by the eye is not exactly the same as that exposed to the lens. Allowance must therefore be made for this fact, the mirror being held in such a position in the fauces that a straight picture will be insured.

If, now, the tongue does not mound up above the level of the lower edge of the lens and the lower edge of the mirror, it may be taken for granted that, when the plate is exposed, the picture received upon it will be nearly the same as that seen with the left eye in the throat mirror. The plate is exposed by pressing upon the key with the index-finger; this releases the shutter, which in falling makes an instantaneous exposure, amounting, perhaps, to one sixth of a second.

Some of the results obtained with the method just described are

contained in these portfolios.* The original photographs are of about one third the size of the larynx. Enlargements will be found

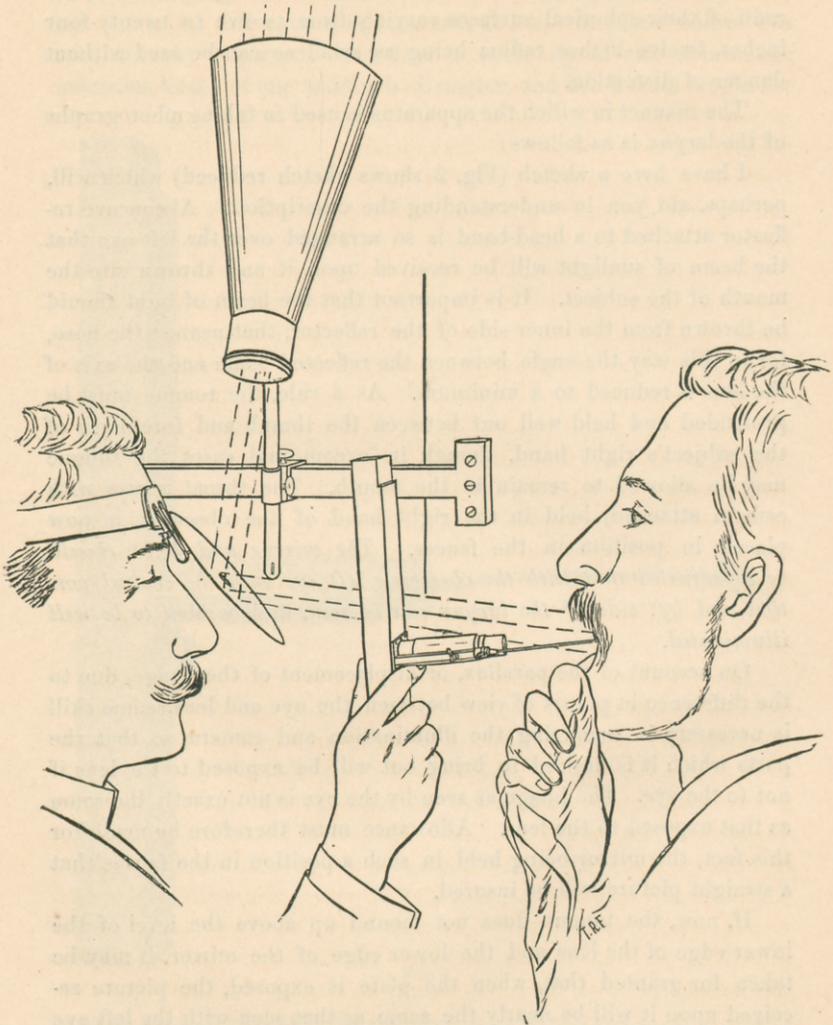


FIG. 2.

opposite most of them, though the originals are very clear and distinct. Portfolio 1 contains forty-one photographic pictures of nor-

* Two portfolios were exhibited at the meeting at which this paper was

mal and diseased larynges of twenty-four subjects, and three photographs of the posterior nares of one subject.* In the laryngeal photographs the positions occupied by the various structures in phonation, inspiration, and expiration are clearly shown. In many of the photographic pictures the rings of the trachea are shown, and in one photograph even the bifurcation of the trachea can be seen. The diseases shown are: chronic catarrhal laryngitis; chronic laryngitis with hypertrophy of the mucous membrane; paralysis of the arytenoideus muscle; swelling of the tissues overlying the arytenoid cartilages in laryngeal phthisis; and papillomatous growths in the larynx.

Portfolio 2 contains four series of photographs, showing the positions of the various structures of the larynx in the production of tones in the different classes of voice. Extremely high and extremely low notes are not shown, but all of the registers of the human voice are represented. The first series shows the positions of the various parts in the production of each note in the soprano voice, from C, treble clef, first line below staff, to A, treble clef, first line above staff, while the tongue was in its natural position in the mouth, as well as while it was protruded. The second series shows the positions of the laryngeal structures in each note of the contralto voice, from D, bass clef, third line, to A, treble clef, first line above staff, also while the tongue was not protruded, as well as while it was held out.

In some of the photographs of the third series more or less mucus is to be seen in the chink of the glottis. This is accounted for by the fact that the subject was suffering from a mild attack of acute laryngitis at the time the photographs were taken. As the photographs were obtained at the last moment, the exhibition of this condition could not be well avoided. This series shows the positions of the various structures of the larynx in the production of each note of the tenor voice, from C, bass clef, second space, to A, treble clef, second space, while the tongue was held out. The fourth series shows the positions of the structures of the larynx in the production of each note of the bass voice, from E, bass clef, first line below

read. A few of the photographs contained in Portfolio 1 have been reproduced, by the artotype process, by Mr. Edward Bierstadt, of New York. (See Plate.)

* All of the photographs of the posterior nares show one or the other of the pharyngeal orifices of the Eustachian tubes. In the past few weeks the author has succeeded in photographing the membrana tympani.

staff, to C, bass clef, first line above staff, while the tongue was protruded.

It would be inappropriate, neither is it my intention, in this paper, to discuss the conditions which exist in the singing voice. I desire, however, to call your attention to several noticeable features to be observed in these photographs. In all of the series it will be seen that the epiglottis is not shown to be gradually raised as the voice ascends the scale. It is generally conceded that, all other conditions being the same, the higher the note sounded, the higher the epiglottis will rise. The position of the epiglottis is dependent, largely, upon the position of the tongue, and the position of the tongue varies according to the vowel sounded.

While obtaining these photographs, great pains were taken to secure the production of the same sound, the vowel *e* being used in all upper notes, but, as the results prove, in a few instances I was not entirely successful. So you will observe that in some of the low notes in the series the epiglottis is shown to be as high as in notes an octave above. This, I repeat, must be attributed to the fact that the subject was not successful in sounding the same vowel in each note. Had my subjects been practiced beforehand, better results might have been obtained in this particular. There is, however, no doubt about the accuracy of the positions of the vocal bands as represented.

Again, it will be observed that there is very little difference in the positions of the structures of the larynx, whether the tongue was held out or remained in the mouth. In all of the series the vocal bands can be seen to be shorter, wider, and less closely approximated in the lower than in the upper notes, becoming gradually narrower and longer as the voice ascends the scale. In the lower notes of the soprano voice the chink of the glottis is widest in its posterior part, but becomes linear at about B, treble clef, third line, and continues so throughout the upper portion of the range. In the contralto voice the chink is wider than in the soprano. It will also be observed that throughout the entire range the chink is widest between the posterior vocal processes, the aperture being wider in the lower than in the upper notes. That this aperture is present in other contralto voices is shown by a photograph of another larynx, in the production of a note in the contralto voice, to be found in Portfolio 1.

In the lower notes of the tenor series the chink of the glottis is widest in its posterior part. At about B, bass clef, first space above staff, it becomes linear, and continues so to G, treble clef, first line,

in which note, as well as the one above it, the falsetto mechanism may be seen to have begun. In the photograph representing the lowest note of the bass series a triangular aperture exists between the posterior vocal processes. This soon becomes elliptical in shape, and, gradually diminishing, has nearly, though not quite, disappeared in the photograph representing the highest note of the range, C, bass clef, first line above staff.

While these series of photographs of the singing voice must prove of interest, and probably of value, I do not offer them as proving conclusively the positions always occupied in the production of tones in the different classes of voice, for they are of only one individual of each class. Before they can be accepted they must be verified by other series of a similar character, but this, unfortunately, I have omitted to do, not having had sufficient time.

None of the photographs taken in any of our experiments have been retouched, even in the slightest degree.

While satisfactory photographs may, as a rule, be obtained at the first sitting, two sittings are sometimes required. In the first the focus is to be found. In the second, the focus being known, if all the other conditions are fulfilled, we can feel quite certain of obtaining as many good pictures as are desired.

Now let me explain to you the manner in which the focus of any subject is found. The distance from the position occupied by the mirror in the fauces to the vocal bands varies markedly in males and females, and to a less extent in individuals of the same sex. Without going into details as to the manner in which the method of focusing was arrived at, I will only state that, as a matter of fact, with this instrument, with the throat mirror eight inches from the front face of the camera, in men, with the tongue in or out, the lens must occupy a position of from $2\frac{2}{3}\frac{6}{8}$ of an inch to $2\frac{2}{3}\frac{3}{8}$ of an inch from the face of the camera. In women, from $2\frac{2}{3}\frac{2}{8}$ of an inch to $2\frac{2}{3}\frac{1}{8}$ of an inch from the face of the camera. The difference in the focus, whether the tongue is protruded or not, is about $\frac{1}{3}\frac{1}{2}$ of an inch.

These figures being known, in order to find the exact focus, three exposures should be made, varying the position of the lens $\frac{1}{3}\frac{1}{2}$ of an inch within the limits indicated above. By following these directions, one or more pictures of the larynx or trachea, in good focus, can almost invariably be obtained in three exposures.

If, in taking several photographs of the larynx, care be exercised to vary the position of the mirror slightly, pictures may be obtained which, when viewed with the stereoscope, will present an appearance

of greater depth of the cavity of the larynx than can be obtained in any other way.

I am confident that the method of photographing the larynx described in this paper is one of practical utility, and must prove of great service in facilitating the study of the functions and diseases of the larynx.

