ON THE VALUE OF ELECTROLYSIS IN THE EUSTACHIAN TUBE.*

BY NORVAL H. PIERCE, M. D., CHICAGO, ILL.

Since 1839 electrolysis has been used by Crussel, Tripier, Mallez, Brenner, Clymer, Rockwell, Newman and others in the treatment of strictures of the urethra, the rectum, the esophagus, the nasal duct and, latterly, of the Eustachian tube. Its employment in tubal disease has gained fresh impetus since the publication of Duel's paper in 1897,[1] though his efforts, as he himself discovered, were anticipated by Cumberbatch and Steavenson,[2] who published a series of seven cases so treated, in 1888. The honor of first using electrolysis in the Eustachian tube does not belong to these gentlemen, however. Steavenson, in a note to the editor of *The Lancet* (December 8, 1888) acknowledges the priority of Mercie,[3] Miot,[4] Bartoux,[5] all of whom published papers on this subject in 1884. Robert Newman,[6] in a paper published in 1898, mentions using electrolysis in the Eustachian tube in December, 1894, and refers to the work done in this direction by Mercier and Garricon-Desarines[7] and published in 1884. By substituting a gold bougie for the more or less cumbersome electrodes of his predecessors, Duel greatly improved instrumentation.

Since Duel's papers appeared, several other otologists have published their results, some of which were remarkable for their brilliancy and others not quite so much so. In the discussions which followed the reading of these papers, too, a great dissimilarity of ideas was expressed as to the worth of the procedure. In order to estimate the efficacy of the electrical bougie in the treatment of tubal disease and the removal of those pathological conditions which might be connected with diminished audition and tinnitus, the writer subjected twenty-one cases during the past twelve months to this mode of treatment.

The electrical current was taken from the Edison street circuit of 110 volts, and led through a Victor shunt-controller. From fifteen to thirty volts were necessary to obtain from two to five milliamperes with the negative pole attached to the Eustachian bougie, while the positive pole in contact with the sponge electrode was held in the hand opposite to the tube operated on. The wrist-clamp, de-

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vised by Wendell C. Phillips for connecting the positive electrode with the wrist, may well be recommended, as annoying variations of the current may be caused by inconstant pressure when the sponge is held in the hand. The gold electric bougies made by Meyrowitz were employed. Contact lasted from three to ten minutes. Length of contacts and strength of current varied according to the electrical resistance of the patient and the resistance offered to the passage of the electrode in the tube and the subjective sensations of the patient. Both the plain rubber catheter and the silver catheter were used. The silver catheter, insulated by means of rubber tissue is more easily kept clean and more readily adapted by bending to the peculiar topography of each case than the rubber catheter. The procedure was nearly always carried on under cocain, all active inflammatory processes having been first allayed and the strictest cleanliness observed.

A brief review of the tuba auditiva will not only refresh memory, but may explain certain points observed in the use of the electrical bougie in the tube, which have been otherwise interpreted or understood. In its passage from the tympanum to the post-nasal space, the tube pursues a course from before, downwards and inwards (medial) obliquely backwards; upwards and outwards (lateral). The axis of the tube forms with the axis of the external auditory canal, an angle of 150°; with the septum narium, an angle of 45° to 50°; and with the horizontal plane of the head, an angle of 30°. Its tympanal ostium is situate 2.5 cm. higher, and 1.6 to 1.8 cm.[8] further posterior than its opening in the post nasal space. It is composed of two portions, a membrano-cartilaginous and an osseous portion, which join at a more or less obtuse angle. This part of the canal is the most constricted, and is, therefore, called the isthmus. From this point the calibre of the canal gradually but continuously increases towards both the pharyngeal and tympanal ostia, where it reaches its greatest diameters. The measurements of the tube must be maintained in the memory of one using the bougie. Its length, as given by different authors, varies from 34 to 44 mm., or circa in minimum, 34.4 mm., of which three-quarters, or about 24 mm. belongs to the membrano-cartilaginous portion, and one- third, or 12 mm., to the osseous. Therefore the isthmus, or the most constricted part of the tube, at which the osseous and membrano-cartilaginous portions join at a more or less acute angle, lies 24 to 28 mm. from the ostium pharyngeum; it has a horizontal diameter at 2 to 4.5 mm., while its longitudinal diameter is less than 1 mm.[9] The ostium pharyngeum has a longitudinal diameter of 4.5 mm.[10] and a horizontal of 5 mm. The ostium tympanicum has a longitudinal diameter

of about 4.5 mm. and a horizontal of about 3.3 mm. The surface is slightly spiral, so that the anterior and outer wall of the cartilaginous portion becomes the inferior wall of the osseous portion, and the posterior inner wall becomes the superior.[8]

The relationship of the mesial wall of the osseous portion to the carotid is most important, inasmuch as only a thin layer of bone separates the two, and in this, dehiscences are occasionally found[11]—facts not to be forgotten by those who use wire bougies in this region. The mucosa of the tube is continuous from that of the pharynx, and, in the region of the ostium pharyngeum and for a short distance inwards, is loose, vascular and lies in large folds which tend to disappear toward the isthmus. These folds form a prominence on the floor of the tube near the pharyngeal opening, which acts as a valve to close the tube when in a state of rest. The part making up the floor is richly supplied with mucous and follicular glands; with these in the middle of the cartilaginous portion, lymphoid follicles are found in such abundance, especially in children, as to warrant the name of "tubal tonsil."[12] The mucosa of the osseous portion more closely resembles that of the tympanum, and at, or near the isthmus, is thin and closely adherent to the bone; as it approaches the ostium tympanicum it becomes thicker and contains tubular glands.

Anomalies of direction have been observed in both the osseous and cartilaginous portions of the tube. Voltolini[13] mentions acute bendings of the osseous portion and according to Schwartze[14] these anomalies are not of infrequent occurrence. Anomalies of lumen may be due to congenital or acquired pathological changes. Moos[15] relates the case of a deaf mute with osseous obliteration of the tympanum in which the opening of the tube admitted only the point of a needle. Toynbee[16] mentions as one of the causes of diminished lumen, the protrusion of the osseous walls; and the same author reports a case in which an enlarged carotid canal so encroached on the tube that only a bristle could with difficulty be passed through. Zuckerkandl[17] instances abnormally spacious canalis pro musculus tensor tympani encroaching on the lumen of the tube. The same author mentions the frequent occurrence of clavate projections at the ostium tympanicum which diminish the lumen of the tube. Congenital narrowing of the ostium pharyngeum has been observed by Urbantschitsch and others. Acquired stricture of the tube may be due to pressure from without its walls, or to disease of the mucosa or submucous tissue, such as occurs in the course of an acute or chronic catarrhal inflammation.[18] Such inflammations may lead to adhesions between the walls of the tubes,

which may completely, or incompletely destroy its patulency, or may lead to the formation of strands or threads of tissue reaching from one wall to the other and binding them more or less closely together. Inflammation of the submucous connective tissue most frequently leads to stricture at the isthmus, but an inflammatory exudate unorganized or organized in the pars membrano- cartilaginous may, by interfering with circulation, produce passive congestion of the rest of the tube and of the cavum tympani.

In contradistinction to these commonly accepted views, Siebenmann[19] and Bezold,[20] speaking in a symposium on the treatment of tubal disease, declared that they had never, in an enormous number of observations on the cadaver, observed stenosis of the Eustachian tube occurring anywhere but at the pharyngeal or tympanic openings of the tube.

In order to get this paper within the time limits, I shall be unable to read the case histories of the twenty cases, but will give a terse résumé which will answer all practical purposes.

Ten were in the class of oto-sclerosis, or rarefaction of the labyrinthine capsule. Eight were catarrhal. Of the remaining two, one was due to disease of the nervo-muscular apparatus of the tube; the other was one of almost complete obliteration of the membranous portion, due to syphilis.

All the other cases had been treated by other methods by myself, before treatment was begun with the electrical bougie. Before beginning with the electrical treatment, all the tubes were explored by means of a celluloid bougie (Urbantschitsch's). In six of the cases of oto-sclerosis, the bougie was arrested at about the isthmus. In two of these six cases the electrical bougie passed through the osseous portion after the fourth seance. They were all treated for two months, at intervals of a week, with catheterization every other day. In none was audition improved to a noteworthy extent, nor were the entotic sounds diminished. The tuning fork tests for upper and lower limit remained unchanged.

In six of the eight cases of catarrhal disease, the bougie was arrested from 4 to 23 mm. from the pharyngeal opening. In five of them, after two months' treatment, the bougie failed to pass further than the isthmus, or a few millimeters beyond. In two cases in which the bougie passed directly into the middle ear, there were extensive adhesions between the tympanic membrane and the promontory. In none of these cases was there any improvement, that is, further than the improvement gained by the other methods of treatment previously pursued, nor was there any change to be observed in the adhesion of the middle ear. The case of syphilitic stenosis remained unchanged.

In only two of the twenty cases could any results be ascribed to the electric bougie. These were both cases of sub-acute disease with recurrent attacks of defective audition and tinnitus with diminishing intervals. In these cases there were, in all probability, soft infiltrations in the membrano-cartilaginous tube near the isthmus. In both of them, the benefit to audition and the subjective symptoms was marked, immediate and lasting and these results were obtained after the usual methods of injection, the catheter, inflation and massage had been tried. Occasionally in other cases marked improvement to audition was observed immediately after the application of the electrode; that is to say, whereas the patient could hear a whisper at but a few inches before the use of the electrical bougie, immediately thereafter a whisper could be heard at as many feet. But we cannot ascribe this to the influence of the electricity, inasmuch as we occasionally observe as great improvement following the use of the ordinary celluloid bougie. The explanation of this phenomenon is difficult, but probably takes place by way of stimulation of the reflex nervous apparatus of the ear.[21]

In illustration of how one may be led to erroneous conclusions as to the value of electrolysis when used in this particular, permit me to introduce a case which came to my notice not long since.

A. F., aet., thirty-six, merchant, residing in a town in central Illinois. He complained of diminished audition and tinnitus in the left ear. No pain, no discharge.

Status presents.—Weber left R + (a') bone conduction + 5": (a') canal conduction — 15"; lower tone limit a whisper 9 ft.

Otoscopy.—Mt. ham colored, otherwise negative. Urbantschitsch's bougie No. 3 arrested 2.6 cm. from pharyngeal opening, which prolonged manipulation failed to pass farther. Auscultation immediately thereafter gave evidence that the tube was fairly patulous, and of the presence of tenacious mucus. After inflation, hearing distance for whisper was increased to twenty feet. On the following day, bougie No. 4 passed to the tympanium without difficulty.

The case illustrates:

(a) That the bougie was arrested by the vertex of the angle of the tube, by a natural projection into its lumen, or by one of those minute fissures or depressions mentioned by Zuckerkandl;

(b) That there was no stricture;

(c) That had the electrical bougie been employed its passage might have been ascribed to the influence of the electrical current.

It has been said that the use of the electrical bougie is accompanied by less pain than accompanies the use of the ordinary bougie;

I have not found this so. On the contrary, I regard the electrical bougie as more painful. The use of the wire bougie in the Eustachian tube is not without danger. Several instances of acute otitis media following the use of the electrical bougie have come to my notice, one, at least, of which necessitated an external operation for inflammation of the mastoid cells. I have known of two instances where the electrical bougie was broken off in the tube, and when last heard of the patients were carrying around the remains of the bougie in their tubes.[22] When we remember the relationship between the carotid artery and the tube, and when we further recollect that dehiscences in the bony wall are not of frequent occurrence, we must realize that accidents of a very unpleasant nature may take place through wounding the carotid by the sharp end of a metal bougie.

CONCLUSIONS.

1. In otosclerotic disease, electrolysis is useless.
2. In the great majority of cases of catarrhal disease it has no advantages over other methods of treatment.
3. In a certain few cases where there is probably a soft exudate near the isthmus, it may be regarded as of some value.

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