

receiving a current, the pain of which is wellnigh insupportable. I then reversed the whole apparatus, applying the electric current to the left thigh. Upon this the patient started with a shriek of unmistakable pain, and nearly fell from his seat. The result of this experiment showed conclusively that, to the electric current at least, there was anæsthesia of the right thigh, and removed at once our doubts of the patient's credibility. Further examination confirmed this view. A thermometer left five minutes in each axilla marked 98.1° on the right side, and 97.9° on the left. Careful measurement showed that the right thigh, 6 in. above patella, was $\frac{5}{8}$ in. less than the left; and the right leg, 6 in. below patella, was $\frac{3}{8}$ in. less than the other. The arms were equal. Electro-motility was good everywhere except in the thumb muscles of the right hand. Asked to raise his right leg, the foot "dropped" as it was lifted from the ground. I should say here that the fingers of the affected hand were quite flaccid.

On June 13th, measurement showed that the right upper extremity had wasted since last examined. The right arm, 6 in. above olecranon, was $\frac{1}{2}$ in. less than the left; the right forearm, 6 in. above lower end of ulna, $\frac{1}{4}$ in. less than the other. The disparity between the lower extremities had increased. The right thigh, 6 in. above patella, was now $\frac{7}{8}$ in. less than the left; the right leg, 6 in. below patella, $\frac{1}{2}$ in. less than the other. An important change, too, had taken place in the right hand. The middle, ring, and little finger were rigidly contracted upon the palm, and could not, by any exertion of force on my part, be extended. The tendons could be seen and felt projecting and hard in the palm.

On November 20th, the patient walked freely, and there was no dragging of the right leg. The measurement of the thighs and legs was now found to be equal. The wasting of the right upper extremity had increased. The right arm was $\frac{5}{8}$ in. less than the left; the right forearm $\frac{3}{8}$ in. less than the other. The rigidity of the fingers was still more marked than at the last examination. Sensibility was much improved in the right limbs, but was still apparently defective.

At the end of November the case was tried in court, and the plaintiff recovered damages, the testimony of Dr. Slight and myself being to the effect that the plaintiff was permanently disabled in the right hand. The man had been examined, on the part of the defendants, by two eminent surgeons, who were not called, and no opposition was offered to the medical testimony.

The very careful examination to which this patient was subjected, and his gradual progress to recovery (except in the use of certain fingers), make it evident that he did not pretend his symptoms. The wasting of the limbs and the rigid contraction of the fingers he *could* not simulate. As regards the nature of the nervous lesion, one can only suggest the probability that blood was effused, a part of which became gradually removed by absorption, and a part converted into a cyst or hæmatoma, which encroached upon and destroyed a small portion of nerve-substance. Its exact situation, and whether, as is quite possible, there was more than one lesion, are points which necessarily remain doubtful.

Green-street, Grosvenor-square, December, 1868.

ON THE TREATMENT OF THE PARALYTIC FORMS OF STRABISMUS.

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THE forms of strabismus that depend not only upon contraction of one rectus muscle, but also upon paralysis of its opponent, have been long recognised as sources of much embarrassment to the surgeon. The paralysis is sometimes the primary affection, and sometimes, I believe, it is merely a secondary one, due to the enforced inactivity of a muscle that has been long overpowered by its antagonist. In the former case, the paralysis itself being often traceable to some rheumatic or syphilitic cause of pressure upon the motor nerve, and vision being unaffected, there will usually be much diplopia as well as much disfigurement. In the

latter case, where the strabismus was originally caused by hypermetropia, and where vision is much impaired, disfigurement alone will be present. In both, after the lapse of a certain time, we may find the eye almost fixed in an abnormal position: one muscle contracted and perhaps structurally shortened, and its antagonist so far paralysed that it will not respond at all to the influence of the will. However successfully we may then address remedies to the removal of the original cause of the paralysis, our success will be fruitless, because the natural balance of power between the opponents is too much disturbed for the weaker muscle to have any chance of reasserting itself; and if we divide the tendon of the contracted muscle, the paralysed one will yet be too feeble to bring back the eyeball to its proper position. Surgical ingenuity has been taxed to devise compound operations, by which the weakened muscle has been brought forward or shortened, and the contracted one divided or put back; but the results have seldom been satisfactory, and the last state of the patient has often been worse than the first. Some two or three years ago, Professor Moritz Benedikt, of Vienna, published on the effects of the direct galvanic current in paralysis of the ocular muscles; and my very rough translation of his paper appeared almost by accident, and without my having any opportunity of revising it, in the second volume of the *Ophthalmic Review*. Benedikt's results seemed to me capable of being improved upon, and I determined in the first suitable case to try a combination of tenotomy with faradisation.

A patient soon afterwards presented herself with complete paralysis of the right superior rectus. She was a respectable, middle-aged woman, the affection was of many years' standing, and I could not ascertain its cause. The inferior rectus was strongly contracted, the cornea rolled down, the supra-corneal region of the sclerotic bulging forward from the loss of support, the diplopia very distressing, and the deformity extreme. Voluntary power of upward rotation was wholly lost.

In order, in the first place, to test the electric contractility of the paralysed muscle, I obtained a pair of small rheophores, terminating in discs of not more than a line in diameter. These discs were covered with very fine white leather, well wetted. The upper lid being lifted, and completely controlled by a large retractor, governed by the left hand, the discs were applied to the supra-corneal region of the conjunctiva, as far back as possible, with the right hand, and about a line apart. When fairly placed, they were connected with the primary current of a Stöhrer's battery, in very feeble action. At first, the only effect produced was irritation of the fifth nerve, as shown by pain, lachrymation, and redness; but, after three or four applications of the current on successive days, some very slight effort of contraction in the weakened superior rectus became manifest. I then divided the tendon of the inferior rectus; and continued the use of the current daily. Day by day the paralysed muscle recovered strength; and, in about three weeks from the commencement of the treatment, the cure was complete, as well of the diplopia as of the deformity.

The second case that came under my notice was one of hypermetropia, with extreme convergent strabismus of the right eye, the vision of which was so much impaired that there was no diplopia. The patient was a young man of nineteen, a domestic servant; and his squint was a serious hindrance to his prospects in life. Paralysis of the external rectus appeared to be absolute; and the most complete possible tenotomy of the internal rectus, by Liebreich's method, was followed by little if any improvement in the position of the eye. The eyelids were then held apart as widely as possible, and the rheophores used for the former case were applied in the same manner to the conjunctiva covering the external rectus. Little by little, the weakened muscle responded to the current; and after a short period of treatment the squint was entirely removed. The patient was then instructed to exercise the eye daily by reading through a lens of short focal length; and it seems probable that he will ultimately regain useful vision.

I have taken these two cases as types of different forms of paralytic strabismus; and the results obtained in them, and in others of a less marked character, induce me to believe that paralysis of a rectus muscle, due to any of its more frequent causes, is seldom beyond the reach of recovery by electric treatment. But in such paralysis, as indeed

in some other forms, the contraction of the opponent is a formidable impediment to the functional restoration of the muscle that is weakened; and the anatomical relations of the recti tendons to the capsule of Tenon are fortunately such that an effectual tenotomy, if carefully performed, will not involve any loss of power likely to produce displacement in an opposite direction. It is always satisfactory to obtain some evidence of reaction to the current before the tenotomy is performed, because then eventual success may be considered certain; but there will be some cases in which the paralysed muscle will be too feeble to react until released from the tension of its antagonist.

I am disposed to attach importance to the small rheophores, and to their application on the conjunctival surface, immediately over the affected muscle; so that "localised electrification" may be practised after the manner of Duchenne. There can be no doubt that an induced or faradaic current is more generally applicable than the direct current to the cases under consideration, because less potent in its effects upon the optic nerve and retina; and, as a rule, for the same reason, I should use the primary induced current before having recourse to the secondary. The latter, as the more penetrating, may be used if the former should fail; but on account of the very superficial situation of the recti, only a small power of penetration will usually be required. Furthermore, since it has been shown that in some cases paralysed muscles will react to the direct current when they are insensitive to the induced, the former should in all cases be tried, but with due caution, as a last electrical resource, and prior to the performance of any operation for shortening the weakened muscle.

Princes-street, Hanover-square, Dec. 1868.

ON SOME OF THE FUNCTIONS OF THE MIDDLE AND INTERNAL EAR: AND THEIR ANALOGIES.

By PETER ALLEN, M.D., F.R.C.S. EDIN.

WHILST attention has of late been increasingly bestowed upon the mode of investigating and treating diseases of the ear, and great advance made in aural pathology, there can be little question that our present *physiological* knowledge of the more important parts of the organ of hearing, is neither comprehensive nor accurate. The space allowed me in THE LANCET will not admit of even cursory reference to the laborious researches and experiments on physiological acoustics pursued by German and other continental aural surgeons; it must, therefore, be presumed that my readers are somewhat acquainted with the results of their inquiries, as recorded in the several periodicals devoted to their *spécialité*. It is much to be regretted that more unanimity of opinion does not prevail; indeed, it is curious to observe how importantly one writer will modify the ideas of another investigator without himself arriving at more exact or satisfactory inductions.

The somewhat contradictory and, at present, irreconcilable views entertained by both English and German physiologists in reference to the actions of parts within the tympanum and internal ear, seem to have suggested to the late learned President of the Medico-Chirurgical Society (Dr. Alderson) the following observations, which were consequent upon a discussion on the last paper ever presented by Mr. Toynbee, May 8th, 1866:—

"He (the President) thought much more would be gained by the close study of physiology as introductory to pathological investigation. Whilst we were fully acquainted with the mode in which light was impressed upon the retina, and so communicated to the brain, notwithstanding that doubt still existed as to the true theory of the nature of light; yet, on the other hand, whilst the vibrations of the air were fully understood, very little that was positive had been ascertained as to the mode in which those vibrations were communicated to the brain."—*Vide THE LANCET*, June 16th, 1866.

Under these circumstances, I have undertaken to en-

deavour to indicate, with as much perspicuity and brevity as are in my power, some of the more important offices which the various parts in the tympanum perform in transmitting sonorous vibrations to the fluid in the internal ear.

The manner in which the terminal extremities of the auditory nerve spread out upon the delicate membranes of the labyrinth, receive the undulations of sound, and communicate their effects to the sensorium, has lately been elucidated by the minute dissections and microscopical investigations of Kölliker, Schultze, Henle, Czermák, Hulschke, and others, and will be subsequently adverted to. The advance in knowledge of the structure and functions of the labyrinth seems necessarily to lead to the conclusion that the great end and intention of the tympanum (its more immediate accessory part) are to modify, extend, and multiply the various sounds which are conducted through it; whilst by its position, form, communications, and contents, it acts as a protective organ, and renders the internal ear quite independent of the vicissitudes of atmospheric temperature. Incidentally I may remark that this last preservative office is not sufficiently regarded by aural surgeons in their therapeutic treatment. To relieve a catarrhal obstruction in the tympanum, I have frequently witnessed the introduction of cold air and lotions into its cavity, through the Eustachian tube catheter, both being, according to my views—in which I am glad to find myself supported by the eminent aurist, Dr. Von Tröltzsch,—injurious rather than curative agents. If we put the pathological anatomy of the ear under strict examination, we shall, I think, be soon convinced that the greatest number of cases of deafness arise from disease of the cavity of the drum and its appendages. The hindrances to sound-conduction may be occasioned by simple mucous accumulation, by thickening of the lining mucous membrane (which is also a periosteum, and every inflammation of it therefore constitutes a periotitis) lessening the degree of motion in the chain of ossicles, and giving rise to adhesions between each other, or to the parietes of the tympanum. If these conditions be neglected, further morbid alterations will take place: rigidity of the whole ossicular chain, extending to the membrana tympani externally, and to the fenestra ovalis internally, causing the base of the stapes to become more or less fixed to its articulating surface, may result. This last affection, *anchylosis* of the stapes, which is so likely to supervene upon repeated attacks of aural catarrh, advances insidiously with the patient's age, until no vibrations are able to be transmitted to the vestibule by the ossicular course, and the tympanic air ceases to influence the labyrinthine fluid, in consequence of the necessarily fixed condition of the membrane of the fenestra rotunda. This disease was always formerly, and is frequently now, confounded with affections of the auditory nervous apparatus; and Dr. W. Kramer, at one period of his practice, estimated that his cases of nervous affections exceeded fifty per cent., whereas now, owing to our advance in pathological science, their frequency is reduced to four in a thousand.* We cannot, however, yet quite credit such marvellously increasing powers of diagnosis. Nevertheless, we assuredly may diagnose rigidity of the ossicles, or anchylosis of the stapes, by careful attention to the symptoms accompanying their progressive stages, by the history of the case, and by observing the degree of loss which the patient has sustained over, what I term, the *power of adjusting* the ear to receive certain vocal or other sounds. I shall subsequently point out that this power of adjustment results from the mode of attachment, position, and *voluntary* action of the stapedius muscle, affording to my conception a most close analogy to the ciliary muscle of the eye, especially when, as in predaceous birds, that muscle is inserted into osseous plates in the sclerotic, as strong and massive as are the crura of the stapes.

To return to our more immediate subject. An accurate study of the functions normally performed by the tympanum and its contents, will therefore be the only safe guide in determining the exact locality of the diseased alteration. It is not my intention at the present time to enter upon a detailed anatomical or physiological description of the middle and internal divisions of the hearing apparatus. I am now simply desirous of throwing additional light upon certain important points which have hitherto escaped notice, or have not been sufficiently elucidated.

* "Ohrenheilkunde der Gegenwart," p. 39. Berlin, 1861.