THE RESULTS OF SECTION OF THE TRIGEMINAL NERVE,¹

WITH REFERENCE TO THE SO-CALLED "TROPIC" INFLUENCE OF THE NERVE ON THE CORNEA.

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It has long been held, chiefly as a result of the experiments of Majendie and others, that progressive destructive changes occurred in the eyeball after intracranial section of the fifth nerve, and more especially of its ophthalmic branch. But the reason of this destruction has been a moot question. The corneal and conjunctival anæsthesia accompanying division of the nerve or its ophthalmic branch was regarded by some as aiding the retention of irritating extraneous matter, for it was observed that, if the eye were protected from the effects of such external irritants, no inflammation followed. But this view did not receive corroboration at the hands of other observers; and disorganisation of the eye was also seen, even though there was not complete corneal anæsthesia. There are on record numerous cases of anæsthesia of the cornea in which no "trophic" corneal alteration was detected; nor was the view that the ocular changes differed according as the lesion was in front of or behind the Gasserian ganglion altogether acceptable; hence much divergence of opinion still exists on the subject.

The most recent experimental work bearing on this matter is that of Gaule.² The general conclusion at which he arrived as a result of his observations upon rabbits was that the "trophic" alterations in the cornea which he described were due to lesion of the ophthalmic branch, or of the Gasserian ganglion, while they did not follow lesion of the nerve behind the ganglion. These changes consisted of numerous spots, some of which showed atrophy, others hypertrophy of the superficial corneal epithelium, hypertrophy of Descemet's membrane, necrosis and atrophy of the corneal ground substance, and the production of a fibrin-generating material in the aqueous humour. When it is also stated that these changes occurred from a few minutes to a few hours of the actual division of the nerve, it is difficult to believe that they were entirely due to the lesion thus practised.

In the series of experiments performed by Dr. Ferrier and myself the fifth nerve trunk, its ophthalmic branch, and the intramedullary roots were divided. The series consisted of four experiments involving destruction of the tubercle of Rolando, two of section of the restiform body including the "ascending" trigeminal root, four of section of the trunk of the nerve between the Gasserian ganglion and the surface of the pons Varolii, eight of the ophthalmic branch alone, and two of the "descending" or trophic root of Merkel.

Of the eighteen experiments in which anæsthesia of the cornea was the prominent symptom, two only showed symptoms of destructive change and panophthalmitis. In both there was evidence of septic irritation—elevation of temperature and localised foci; and in one the *post-mortem* examination showed commencing septic meningitis. The other case is somewhat more complicated, for during the first week, in which the temperature was raised and several convulsive attacks were noticed, the cornea became distinctly opaque. From this time on till the sixth week the animal was perfectly well and the cornea clear; but at about this time the temperature again rose and panophthalmitis ensued. Another feature noticed in these two cases was the diminution of the ocular tension which occurred before there was any evidence of perforation of the corneal ulcer or prolapse of the iris.

We have also observed in many of the cases a slight corneal opacity, which showed no tendency to progress, but rather to diminish as time went on after the operation. Owing to the corneal anæsthesia the lids did not approximate so closely as on the sound side; and it was in the small space corresponding to the lower pupillary margin that this opacity was detected. It was no doubt due to drying of the

corneal surface and the retention upon it of extraneous matter, which was not swept away by the movements of the lids. In the remaining fifteen cases, with the exception in some of the slight drying of the corneal surface already noticed, no opacity or ulceration was detected, although the duration of life varied from forty-eight hours to four months after the section of the nerve.

Looking more especially at the cases in which the ophthalmic branch was divided, we find that of the series of eight, one only showed destructive corneal change, and in that, as already pointed out, there was *post-mortem* evidence of septic meningitis. In one case, on the fifth day after section of the right ramus ophthalmicus, both corneæ were touched with a point of lunar caustic, resulting from which a slight central corneal ulcer formed in both eyes, but no progressive change ensued, and the process of repair proceeded as well in the cornea on the side on which the ophthalmic branch had been divided as on the healthy side.

In another case, in which the nerve was divided behind the Gasserian ganglion, on the eighth day after section an irritant, probably collodion, entered the anæsthetic eye. This was shortly followed by conjunctivitis, œdema of the lids, and a milky-white corneal opacity. Increasing in severity for a week, the inflammation then began to subside, and eventually disappeared at the end of a fortnight, the cornea regaining its transparency with the exception of a small central ulcer, which remained until death. In Mr. Gunn's opinion this condition was due to the shedding of the superficial corneal epithelium, and was analogous to that observed in the human eye after irritation by lime.

The two last-mentioned cases are especially instructive, for they show that whether the trunk of the nerve be divided behind the Gasserian ganglion, or whether the ophthalmic branch alone is divided, the processes of healthy nutrition and repair may go on notwithstanding the anæsthetic state of the cornea.

The corneæ in those cases in which the ramus ophthalmicus was divided were submitted to careful microscopical investigation. Dr. Bulloch, who made the examinations, was unable to detect any change whatsoever, either in the epithelium, the corneal corpuscles, or the ground matrix.

In two cases the "descending" trigeminal root, or trophic root of Merkel, was divided in conjunction with the superior cerebellar peduncle. In neither of these experiments was any "trophic" effect noticed upon the eye or its appendages.

The general conclusion to be drawn from a study of these experiments is that there is no evidence of trophic influence exerted by the Gasserian ganglion upon the cornea; and that, provided septic organisms are excluded, the ophthalmic branch may be safely divided or the Gasserian ganglion removed without fear of the disorganisation of the eye. The destructive changes which occur with inflammatory conditions of the basal meninges, without the existence of an external wound, would seem on this hypothesis to be due to the presence of conditions causing inflammatory irritation of the nerve.

We may look briefly at the clinical cases, in which the Gasserian ganglion has been extirpated, with special reference to the so-called trophic influence of the fifth nerve upon the cornea.

In the series of five cases reported by Rose,³ only one showed panophthalmitis and disorganisation of the eye, but there was reason to suspect that this was due to the destructive effects of the antiseptic or anæsthetic used at the operation. In a second case some small, subepithelial, corneal vesicles appeared two or three weeks after the operation, but they resolved under suitable treatment.

In two others in which the cornea was protected during the operation no change was detected; while in the fifth case, in which the cornea also remained clear, there was reason to suspect that the trunk of the nerve was divided chiefly behind the ganglion. In one of these cases Dr. Ferrier found, six months after the operation, several minute pin-point depressions in the anæsthetic cornea, which were not detected on the sound side. During the course of this investigation we have seen such small depressions not infrequently on the

¹ Read in the Section of Physiology at the Annual Meeting of the British Medical Association, held in London, July-August, 1895.

² *Centra b. f. Physiol.*, 1891, p. 409.

³ *Me. Soc. Trans.*, 1892, p. 210.

anæsthetic cornea, but they appear to arise in places where the superficial corneal epithelium has been denuded.

In a case recorded by Richardson,⁴ one week after the operation a slight haziness of the cornea was observed, but as this is stated to have been present before the operation, we cannot regard it as of much significance.

In Krause's case⁵ two months after the operation the cornea remained perfectly clear, although there was complete anæsthesia both of the cornea and conjunctiva.

Doyen⁶ one year after ablation of the Gasserian ganglion found the cornea quite anæsthetic and without any evidence of trophic disturbance.

It is, therefore, seen that, with the exception of the accidental panophthalmitis in one of Rose's cases, no progressive destructive change occurred in the cornea after operation for ablation of the Gasserian ganglion. It should be borne in mind that in none of these cases has the actual position of the lesion been definitely determined by *post-mortem* examination.

It may be stated in conclusion, therefore, that the so-called neuromyolytic phenomena associated with lesion of the trigeminal nerve are evidence of irritation of the nerve, and not of paralysis. This statement holds good, whether the lesion is situated so as to implicate the ophthalmic branch, the nerve trunk, or the intramedullary root.

ON THE INFLUENCE OF THE USE OF SUGAR ON MUSCULAR WORK.⁷

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THE influence of sugar on muscular work is so very important, from a physiological, a dietetic, an economical, and a social point of view, that I was anxious to repeat in the Pathological Laboratory of Amsterdam the well-known experiments of Professor U. Mosso and Dr. V. Harley. I invited my pupil, Dr. Langemeyer, to examine this question in view of his inaugural dissertation, and the results he arrived at by a long-continued and skilful examination, I now take the liberty to communicate to this Section.

Professor Angelo Mosso's ergograph is so well known that it seems quite superfluous to give a description of this ingenious instrument, by means of which the total amount of work done by the muscles of the middle finger in lifting a fixed weight till fatigue set in can be measured exactly, and the time during which the muscular work is done can be determined most easily. It is also known that if the separate experiments with the ergograph are repeated too frequently, exhaustion may follow to such an extent that the whole ergographic work is reduced to a minimum, and no further work can be done. Now, Professor U. Mosso and Dr. Pavletti found that in this period sugar taken in not too great quantities and not too concentrated was able to lessen the fatigue, so that a further rather considerable amount of muscular work could be done. On the other hand, Dr. Vaughan Harley stated that a great quantity of sugar taken in addition to the ordinary food increases the amount of muscular work in a most evident manner. The result of the publication of these researches was that the question is now often considered as decided, and that already in popular papers and journals the wages and food of workmen are treated as if the beneficial effect of the use of sugar on muscular work were a well-established scientific fact. Now Dr. Langemeyer's experiments prove that this beneficial effect does not exist, or, if it exists at all, can in no way be demonstrated by the ergograph. In his first series of experiments, which are to be considered as preliminary, ergographic work was done twice a day by Dr. Langemeyer and the assistant of the Pathological Laboratory, Dr. Lechensen, with the left and the right hand, over a period of eight weeks, in order to find out the physiological variations occurring during a regular mode of life, in respect to different hours of the day, to different individuals, to different

days, etc. We shall have afterwards to return to the results of this series of experiments.

In the second series of experiments, different kinds of sugar—sweet-tasting and not sweet-tasting sugars (cane sugar, grape sugar, milk sugar), and sweet-tasting substances not belonging to the carbo-hydrate group, for example, saccharin and dulcin—were taken before doing ergographic work, in order to ascertain if the beneficial effect of sugar should be considered as the effect of a palatable condiment and due to the excitation of the nervous system produced thereby, or as the effect of a muscular food.

The result of these experiments was, in reference to the researches of Dr. Harley, which we believed quite exact up to that time, a most unexpected one. In none of the experiments was there any evidence of a beneficial effect of the use of sugar or sweet-tasting substances on the ergographic work. I have here in view the general conclusion of this series of experiments that lasted over forty days, not the conclusion which could be drawn from one single experiment, for it happened often that the amount of ergographic work was greater after taking sugar, or milk sugar or saccharin, but as often the amount of work was diminished, and in many experiments the right hand was the only one which had gained, whereas the left had lost. Yet, the total amount of ergographic work done in this series showed a real and marked increase, in reference to the total amount of work of the first series, but as this increase was a gradual one, independent of the substances that were taken, it was most natural to consider it as a simple effect of training. And so indeed it proved, for when for a control the experiments were pursued daily during more than a fortnight, in exactly the same way, but without taking any sugar or palatable sweet condiment at all, the amount of muscular work still showed the same gradual increase, so it became obvious that the normal course of training is in no way influenced by the use of sugar.

The third series of experiments was perhaps the most interesting of all. In accordance with the experiments of Professor Ugolino Mosso and his pupils the effect of the use of sugar on almost exhausted muscles was examined in this series. It is not so easy as it seems to provoke exhaustion of the muscles engaged in ergographic work by often repeated single experiments. Even if the successive experiments done with the same hand follow each other with full speed, say after six minutes, and the weight to be lifted is a heavy one—that is, 6 to 7 kilogrammes (ordinary work is done with 3 kilogrammes)—the amount of muscular work done by trained persons still represents, after two or three hours of working, one-fourth or one-fifth of the work done in the beginning. These experiments lasted from five to six weeks, and were made by four different individuals. One of them, a tall well-grown lad of 16 years, who did not understand in the least what the experiments meant, was the only one who exhibited in the beginning of the experiments all the peculiarities of real exhaustion. After sixteen or seventeen single experiments he could not do more ergographic work. Of all, he was the most fit subject for demonstrating the beneficial effect of sugar on the exhausted muscle. Yet in his case, as in all the others, the alleged beneficial effect failed completely, at least in the first weeks, for in later weeks, training still being continued, it happened from time to time that this boy, as well as another untrained young man, after exhaustion seemed to have set in, exhibited most unexpectedly a great gain of muscular work. Once there was a gain of 3 kilogramme metres without anything being eaten, another time there was a gain of 2 kilogramme metres after the use of sugar; and, finally, an extraordinary gain of 18 kilogramme metres was found after a draught of fresh water. Without being able to decide the question whether these variations are to be considered as a mere accident or as a consequence of training, it is obvious that reliable results could not be obtained by experiments of that kind in untrained individuals. And in regard to the trained ones who took part in these experiments, I can only repeat that no effect whatsoever of the use of sugar was seen on their exhausted muscles.

In the second and third series of Dr. Langemeyer's experiments the doses of sugar were moderate ones. In his fourth and last series large doses were taken in order to examine their influence on the non-exhausted muscle, as in the experi-

⁴ *Bost. Med. and Chi. Journ.*, 1894, li, p. 429.

⁵ *Deut. med. Woch.*, 1893, p. 341.

⁶ *Flandre Méd.*, No. 3, 1894.

⁷ Read in the Section of Physiology at the Annual Meeting of the British Medical Association, held in London, July-August, 1895.