ON THE INFLUENCE

OF THE

CERVICAL PORTIONS OF THE SYMPATHETIC NERVE AND SPINAL CORD

UPON

THE EYE

AND ITS APPENDAGES,

ILLUSTRATED BY CLINICAL CASES, WITH OBSERVATIONS.

BY

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Of late years direct and rigorous experiment has done much in placing us in possession of more correct ideas respecting many parts of the human frame, and especially of the nervous system. Objections, however, have been entertained against the conclusiveness of experiments upon healthy animals as illustrative of morbid actions in man; and these objections may be reduced to three in number. First, the supposed essential difference between results obtained experimentally and those consequent upon disease in man; secondly, the great and almost insuperable liability to implicate numerous and important parts in the attempt to arrive by operation at any given structure, thus complicating the very subject which we are striving to render clear; and thirdly, the modification of results obtained, owing to unavoidable hæmorrhage and the exhaustion of sensibility. It is as regards the comparative freedom from the last two objections that experiments upon the sympathetic nerve in the region of the neck, the properties and anatomical con-

stitution of which have ever divided the opinions of physiologists, may be most favorably considered, and their results accepted as trustworthy. The large size of the vessels and nerves of this region, the ease with which they may for the occasion be dislocated without injury or danger to the animal, rendering the sympathetic, as it were, quite superficial and accessible, the simple arrangement and the ready dissection of the parts, all these particulars have caused our knowledge of the influence exerted by the cervical sympathetic upon the heart, lungs, and eye, to be much added to of late.

The main points which I propose to bring before the notice of the Society in the following paper, may be summed up as follows:

In the *first place*, I shall commence with certain prefatory observations and a short historical review of the most important results obtained as regards the eye and its appendages, by experiments which have from time to time been performed upon the cervical parts of the sympathetic, and the spinal cord with which it is connected. I shall then proceed to relate the histories of clinical cases, old and new, in which a *contracted* state of the pupil had become a subject of interest, induced apparently by the pressure of thoracic aneurisms, equivalent in degree to the experimental section of the sympathetic in animals.

In the *second place*, I shall bring forward clinical cases in which a similar result had been observed in connexion with aneurism of other arterial branches than those within the thorax.

In the *third place*, I shall adduce instances in which pressure upon the sympathetic (but from other causes than aneurism) had produced a like effect, as in the case of enlarged glands, carcinomatous and other deposits, &c.

In the *fourth place*, bearing in view the intimate connexion between the sympathetic main branches in the neck and the cervical part of the spinal cord, I shall draw attention to certain cases in which a contracted pupil had been observed in injuries of the spinal cord itself.

In the *fifth place*, I shall bring forward clinical cases in which a *dilated* state of the pupil was apparently produced by pressure, from various causes, upon the sympathetic, the pressure being so slight or transient as merely to act as a stimulus to the dilator fibres of the pupil, enabling them to overbalance the resisting contractors.

In the *sixth place*, and lastly, calling to mind one or two points in the anatomy of the sympathetic in the neck and within the cranium, I shall relate cases in which symptoms arose from pressure upon the sympathetic or certain nervous structures with which it is connected, such as might, in addition to these effects upon the iris already alluded to, have been anticipated from anatomical considerations. These symptoms are strictly analogous to the various phenomena produced in the lower animals by section of, or extreme pressure upon, the sympathetic.

The influence of the "sympathetic" portion of the nervous system on the modifications of sensibility and vascularity, and of the temperature of external parts supplied by it, has been within the last few years abundantly proved experimentally by Brown-Séquard,[1] Claude Bernard,[2] Schiff,[3] A. Kussmaul, and A. Tenner,[4] &c., although these authors differ in some important respects as to their interpretation of several phenomena witnessed by them. Moreover, Bernard[5] ascertained that, in addition to alterations of the temperature of external parts, division of the cervical part of the sympathetic induced a much increased temperature within the cerebral hemisphere on the side upon which section of the nerve had been made;[6] and also that the blood in the jugular vein was rendered warmer on the side operated upon

[1] 'Mémoire lu à l'Académie des Sciences,' Janvier 16, 1854.

[2] 'Comptes rendus de l'Académie des Sciences,' Mars 29, 1852.

[3] 'Untersuchung. z. Physiologie des Nervensystems,' Von Moritz Schiff, Frankfurt, 1855.

[4] J. Moleschott's 'Untersuchung. z. Naturlehre d. Mensch. u. d. Thiere,' i, 90, 1857.

[5] 'Mémoires lus à la Société de Biologie,' 1853, p. 94..

[6] See also Henle's and Pfeuffer's 'Zeitschrift,' vii, p. 206, 1855.

than on the opposite one. But, in addition to modifications of vascularity and temperature, experiment shows that an altered state of muscular parts may be effected by interference with those branches of the sympathetic system which are distributed to them. For instance, Valentin and Henle, and, still later, Budge,[1] have demonstrated that contractions of the heart and larger blood-vessels are producible by stimulation of the sympathetic branches derived to them. E. H. Weber,[2] of Leipzig, Arnsperger,[3] and others, made many observations on the decided effects of the pneumogastric (a nerve considered, I believe, by Brown-Séquard and others as being to a great extent a sympathetic one) upon the movements of the heart; and E. P. Pflüger[4] shows that arrest of the movements of the small intestine follows galvanic irritation of the splanchnic nerves.

Now, although it is only in quite recent times that the physiological relation between the sympathetic and the various vessels and muscular parts to which it is extensively distributed has become at all adequately appreciated, yet for a number of years many observers have at times instituted experiments tending to show the effects of the sympathetic upon the eye. I will here pass in very brief review some of the most interesting results which have been arrived at by various observers in this direction, so far only as they have relation to the present communication, a passing consideration of which will best lead to a full understanding of the cases which I now present to the notice of the Society.

The first experimenter who appears to have recognised, amongst other effects of injury to the sympathetic nerve in the cervical region, those upon the pupils of the eyes, was Pourfour du Petit. Experimenting as he did between the years 1712 and 1727, upon animals in which the sympathetic nerve in the neck and the pneumogastric are so intimately connected as to be incapable of separation, as in the dog, for example (unlike the rabbit or the cat, in which these

[1] Frerich's 'Tages-bericht,' 1852, No. 441.
Wagner's 'Handwörterb. d. Physiol,' 1846, Bd. iii, Abth. ii, p. 45.
Virchow's 'Archiv.,' vol. ix, 1856.
Quoted in Schmidt's 'Jahrbücher,' vol. lxxxix, No. 1, p. 15, 1856.

two nerves lie together in one sheath, but are disjoined), he found[1] that when the united cord of the vagus and sympathetic was divided, the following phenomena were observable.[2] In many animals he noticed on the side operated upon a most marked contraction of the pupil, partial closing of the eyelids, with protrusion of the cartilaginous third eyelid at the inner angle of the eye, and also a redness and apparent swelling of the eye, with, subsequently, the secretion of pus from its surface. It is at once obvious that these effects are very similar to those of section of the fifth pair of cranial nerves, when divided near the Gasserian ganglion, as they were first described by Fodera[3], Herbert Mayo[4], Majendie[5], and Sir C. Bell. They however differ materially in the following particulars, viz., in their accession at a much earlier period after injury of the nerve, and in their greater limitation, inasmuch as the cornea very seldom indeed becomes ulcerated, and the inflammation appears to be confined to the conjunctiva, whilst in section of the fifth pair within the cranium, as described by Valentin,[6] the iris, after profuse suppuration of the surface of the eyeball, becomes distended with blood, the chambers of the eye and the pupil become filled with exudations, and the cornea ulcerated. Petit, aware of the anatomical connexion between the sympathetic in the neck and the pneumogastric, sagaciously perceived that it was in regard of the section of the sympathetic alone that these phenomena were

[1] 'Memoirs on the influence of the so-called Intercostal Nerve on the Eye,' 1727 ('Histoire de l'Académie Royale,' avec les 'Mémoires,' &c.)

[2] Emmert ('Archiv. f. d. Physiolog. Von Reil und Autenreith,' Bd. xl, p. 117), who experimented much upon the necks of animals, found that in the dog, wolf, and foumart, this connexion between the vagus and the sympathetic in one sheath was most intimate, whilst, on the other hand, in the cat, goat, sheep, bull, horse, ass, and pig, he found that it was only very slight, although it did exist. In the hare, rabbit, and guinea-pig, the two nerves are quite separate, as in man.

[3] 'Journ. de Physiologie expérimentale,' tome iii, p. 227, 1823.

[4] 'Anatomical and Physiological Commentaries,' No. 2.

[5] 'Journal de Physiologie experimentale,' tom. iv, p. 178, 1824.

[6] 'De functionibus Nervorum Cerebralium, &c., pp. 109-114, Bernæ et Sangalli, Helvetiorum, 1852.

called forth. After Petit, a number of experimenters more or less confirmed his observations. The chief of these were Peter Mollinelli,[1] who has recorded five observations describing the results of ligation and section of the sympathetic and par vagum, as united in the neck of the dog, Justus Arnemann,[2] Cruikshank,[3] Dupuy,[4] Cammerer,[5] Mayer of Bonn,[6] Brachet,[7] Reid,[8] and Valentin.[9] But on reading their productions, several discrepancies are manifest, and it is evident that they experimented with very different powers and with very varied intentions of observation.

Dupuy, Professor of Veterinary Surgery at the College of Alfort, made a number of experiments along with Breschet, and under the eye of Dupuytren, upon the cervical sympathetic in the horse.

Like Petit, he also noticed that division of the nerve was followed by *contraction* of the pupil, *descent of the upper eyelid*, and redness of the conjunctiva, &c. In addition, he observed a peculiar dryness and adherence of the skin, swellings of the eyelids, and general emaciation; moreover, he noticed an *increased temperature* of the ears, with augmented perspiration and eruptions upon the skin, thus anticipating in a remarkable manner much that has more recently been brought forward as regards the influence of the sympathetic upon the capillaries of the skin and other parts. Brachet also found section of the sympathetic cervical nerves to be followed by cerebral congestion, agitation, somnolence, and stupidity.

[1] 'Commentarii Academiæ Bononiensis,' tom. v, pp. 280-297, 1755.

[2] 'Versuche über d. Regeneration der Nerven,' Göttingen, 1787.

[3] 'Philosophical Transactions,' part i, 1795, but written in 1776.

[4] 'Observations and Experiments communicated to the Medical Society of Emulation,' and published in the 'Journal de Médecine Chirurg. et Pharm.,' p. 340, December, 1816.

[5] 'Versuche über d. Natur der Krankhaften Magen-erweichung,' 1828.

[6] 'Journal der Chirurg. ü. Augen-heilkunde,' Von Gräfe and P. von Walther, Bd. x, S. 418, 1827.

[7] 'Recherches expérimentales sur les fonctions du Système Nerveux Ganglionnaire,' 1830 and 1837.

[8] 'Edinburgh Med. and Surgical Journal,' Jan. 1838, and Aug. 1839.

[9] Op. cit.

I need not in this place proceed with any minuteness to detail the various phenomena connected with the eye, or other parts, as called forth by the experiments of the above-mentioned observers on the sympathetic. It suffices to state that the following were the most prominent aggregate results so obtained, which I will notice as having special relation to the object of this paper;—a contracted condition of the pupil, an inward rolling of the eyeball (convergent *strabismus*), and a lowering of the upper eyelid to a greater or less degree (partial *ptosis*). The various experimenters differed in their observations, but although most interesting, it would here be out of place to tarry and show in what particulars they differed or agreed, or upon what circumstances their discrepancies depended.

These various effects (as well as others which I will not now particularise) followed division of the cervical part of the sympathetic in the middle of the neck of the dog, in which animal, as well as in the horse, it is found that the motor fibres of the iris contained in the cervical cords of the sympathetic, and (following Valentin) the vagus, are not confined to the upper ganglia, but pass through a larger extent of the trunks of the sympathetic cords. Reid, however, found that in the case of rabbits operated upon at the same part of the neck, neither did decided redness of the conjunctiva, nor yet any alteration in the state of the pupil, take place at all; and this fact has since been confirmed by others. But if, in the case of the rabbit, instead of dividing the sympathetic at the middle part of the neck, we remove the superior cervical ganglion, or its communications with the cervical nerves, or its branches ascending to form the plexus around the carotid artery; or if, again, we remove the ganglion of the pneumogastric or the communications between the cervical nerves and this ganglion, then these results do follow, the pupil becoming small, oblong, and angular. These phenomena are to be explained, according to Reid, by the difference in the distribution and connexion of the nerves in the region of the neck in different animals. For instance, whilst the nervous filaments which in the rabbit pass from the spinal cord into the sym-

pathetic, and thence into the iris, come from the superior cervical nerves only, they are found, on dissection, in the case of the dog and horse, to come from the *lower* cervical nerves in addition. Other differences also in the distribution and connexions of the sympathetic fibres in the neck are found to exist in mammals. It will be remembered that in man the communicating branches between the cervical nerves and the sympathetic pass from all the cervical nerves, and join the sympathetic at their ganglia as well as in the course of their prolongations, and branches also pass from the cervical nerves to the ganglion of the pneumogastric.

Valentin, considering the effects of these and other experiments not here mentioned, as well as the acknowledged influence of the third pair of cranial nerves upon the iris, in the lenticular ganglion, came to the following conclusion. He determined that the movements of the membranous iris were under the control of a double nerve-force, emanating from two distinct portions of the nervous system. He demonstrated that that branch of the inferior division of the third pair which is distributed to the inferior, and probably involuntary, oblique, or rotating muscle of the eye, and which contains sensory as well as motor fibres, presides, by means of its connexion with the lenticular ganglion through its short root, over the actions of the circular muscular fibres, viz., those drawing the veil towards a central point; whilst the pupil-dilating fibres, viz., those radiating from the margin of the pupil towards the attached or circumferential edge of the iris, were under the dominion of the sympathetic branch or branches passing from the cavernous plexus which also contain motor as well as sensory fibres.[1] These latter branches are derived secondarily from one or more of the cervical sympathetic, and (according to Valentin) from the vagus-nerve ganglia, but primarily and essentially from the cervical

[1] This proposition of Valentin's as to the part played by a double nerve-force in the movements of the iris, so far as the subject of this paper is concerned, is not affected by the views of Schiff, who thinks that the dilator-fibres of the pupil, enjoy both a cerebral and a spinal source of nerve influence.

nerves and spinal cord by branches of junction between them. Thus the iris enjoys a double innervation; the one cerebral, the other spinal; each antagonising and balancing the other. This counterpoise of the opposing fibres of the iris is well illustrated by the dilatation of the pupil which, as a general rule, occurs along with ptosis and abducent squint, when the third cranial nerve is divided experimentally, or much pressed upon by an intracranial tumour, &c., the iris-dilating or extensor fibres being then unopposed by the sphincter or flexor fibres. It is also well exemplified by the following circumstances. When a longitudinal opening is made into the iris of a rabbit, the artificial pupil becomes shorter and rounder, so long as the eye is healthy and the opposing flexors and extensors of the iris are not prevented from duly balancing each other; but if in the same animal the "nervi molles" be divided, or, as Valentin terms it, the "fons spinalis" be destroyed, then the artificial orifice, formerly round in form, becomes no longer so, but greatly elongated and arched, assuming a direction more or less parallel with the margin of the natural pupil.

Such being the state of our knowledge in regard to this matter, Budge and Waller, confirmed by experiments,[1] in 1841, the fact that those branches of the sympathetic which control certain motions of the iris have not their real origin from the main trunk or the ganglia of the cord in the neck, but that they arise from the spinal cord, passing through the spinal nerves to the cervical sympathetic; and in those conclusions Wagner and Ruiter[2] agreed.

By following the nerves step by step until they found a place where irritation produced no effect, and by gradually removing portions of the cervical cord and watching the results on the pupils, they went on to prove, as it appeared to them, that in certain animals those branches which control these movements of the iris were connected solely with that portion of the spinal marrow itself as a centre which

[1] Vierordt's 'Archiv für Physiol. Heilkunde,' 1852; Ergänz. Heft.

[2] 'De actione Belladonnæ in Iridem,' Dissert. Traj. ad Rhenum, 1849.

reaches from the sixth cervical to the fourth dorsal or thoracic vertebra.

Within the above limit any stimulus, chemical, galvanic, or mechanical, applied to the cord, if not too great, produces dilatation of the pupil, just indeed as if applied to the cervical branches of the sympathetic or to the branches passing to the sympathetic from this portion of the spinal cord. To this part, therefore, of the spinal cord, they gave the name of "regio cilio-spinalis." It should be stated, that Majendie had previously mentioned disorganization of the eyeball as following division of the cervical part of the spinal cord, although he did not bring forward any explanation of it.

Budge determined that the anterior and middle columns of the spinal cord are to be considered as the truest seat of influence to the iris, the influence of the motor roots of the nerves on the iris being infinitely greater than that of the sensory. He experimented largely upon mammalia, fishes, and frogs, as to the movements of the iris, and found that the latter animals were most useful as regards many experiments, partly because they bore a larger amount of chloroform than the others, and partly because in their case the influence of the sympathetic upon the eye was most clearly shown. In addition to the above-named centre of nervous influence to the iris from the lower part of the cervical cord, which Budge terms the "untere central-stelle," that observer[1] has lately described a second one, called by him the "obere central-stelle," situated high up in the neighbourhood of the so-called hypoglossal, or ninth pair of cranial nerves, the branch or branches anastomosing between this nerve and the upper cervical ganglion of the sympathetic being the medium of the influence or communication.[2]

[1] 'Ueber die Bewegung der Iris für Physiologen und Ärzte,' Braunschweig, 1855, p. 109.

[2] Dr. Brown-Séquard has lately informed me that, in his belief, injury of almost any portion of the spinal cord will to a certain extent affect the pupil corresponding to the side injured. It seems, however, that if this be so, the influence of such an injury upon the pupil diminishes in pro-

Bidder and Volkmann found that in frogs[1] that part of the cord from which the iris-influencing nerves proceed corresponds to the second and third cervical nerves.

Budge, and, to a certain extent, Ruiter also, conclude that the first division of the fifth cranial nerve has specific branches of motion to the iris, but that the vagus nerve and the communicating branches of the upper cervical with the sympathetic have no possible influence upon the iris. The motor influence of the fifth upon the iris is thought by Budge to be proved by the contraction of the pupil, which is seen to follow division of the fifth, even although the third pair be divided so as to remove the possibility of any reflex action through that channel.

Valentin, moreover, thinks he proves that in the rabbit an antagonism between various parts of the spinal nervous origin itself exists, and that the innervation supplied through the vagus ganglion (which this observer looks upon as having an influence upon the movements of the iris) controls the muscular fibres nearest to the lower end of the pupil, whilst that from the upper cervical ganglion presides over the muscular fibres nearest the upper end. It appears to him to be so from the fact that, on dividing the ganglion of the vagus and its roots, the margin of the pupil, which is rendered oblong, becomes sharp and angular above, and the inferior margin rounded; but if the upper cervical ganglion of the sympathetic be divided, the sharp margin of the pupil is below and the rounded one above.

In addition, Budge and Waller found that any injury to the whole or half of the central parts of the spinal cord, alluded to above, or to the entire nerves issuing thence, or to the anterior branches only of these nerves, removed all power of action from the extensor or dilator muscles of the pupil, leaving the pupil-contracting fibres to the active and unfettered influence of such fibres of the third cerebral

portion to its distance from the cervical region; and for practical purposes, the "cilio-spinal regions" of the neck must be considered to exist.

[1] 'Die Selbständigkeit des Sympath. Nerven-Systems,' Leipzig, 1842.

nerve as preside over them, and (as they think) to the motor influence of the ophthalmic division of the fifth.

Brown-Séquard and Bernard came to the same conclusion as to the general details of these experiments mentioned by Budge. In addition to other phenomena, they found[1] that in cases where contraction of the pupil and vascularity of the conjunctiva, &c., had resulted from division of the sympathetic in the neck, galvanism of the upper end of the divided nerves produced a *dilatation* of the pupil and opening of the eyelids, as also cessation of the conjunctival vascularity, and diminution of the increased temperature, &c. These effects are in some particulars not so strongly marked when they follow galvanism of the sympathetic nerve, which has not been previously divided. Schiff[2] agrees with Bernard and R. Wagner in stating that this galvanizing induces positive protrusion of the eyeballs.

H. Müller[3] has also described dilatation of the pupil as following galvanism of the cervical sympathetic after decapitation at the sixth cervical vertebra (less, however, than that produced by belladonna), and its continuance so long as the stimulus was applied, the pupil of the side opposite that on which galvanism was used being at the same time not at all affected.

Corroborations of the above-made statement as to the effects of section and galvanism of the sympathetic, &c., are to be found in the writings of Schiff (loc. cit.) of Callenfels, and others.[4] It is worthy of remark that Ruiter[5] found the size of the pupil on the side operated upon, to be, in comparison with that of the opposite eye, exactly as two to three in the rabbit, and in the dog as one to three. In accordance with this statement, another of Valentin's is interesting, viz., that in the dog the cerebral influence upon the iris, exercised through the third cranial nerve, as op-

[1] See Brown-Séquard's 'Memoir,' 1854; also Gaz. Médicale, 1854.
[2] Op. cit., p. 148.
[3] Verhandlung. d. Würzburg Gesellschaft.
[4] Henle's and Pfeuffer's 'Zeitschrift,' vii, 1855, p. 157.
[5] 'De actione Belladonnæ in Iridem,' Op. cit.

posed to the spinal which acts through the channels of the sympathetic, is greater than in the rabbit.

It ought to be added, that Professor Reid found that pressure also upon the cervical part of the sympathetic produced contraction of the pupil, which, on the removal of the pressure, completely regained its natural size.

The above particulars comprehend, as I believe, the sum of our present information with regard to the peculiar dependency of the movements of the iris on certain branches of the sympathetic and that portion of the spinal cord from which they emanate, as shown by experiment.

The question is naturally suggested as regards the contracted state of the pupil in connexion with the ptosis and strabismus which in so many cases followed division of the cervical sympathetic,—What is the signification or physiological purpose, of these changes in the eye and its appendages? I believe these phenomena may be looked upon as having some final reference to the condition of the retina, just as we find that in early life the pupil is generally contracted, and thus adapted as a screen to the delicacy of this tender nervous expansion; or again, as in old age, when, as Bichat observes, the pupil is generally dilated in proportion to the insensibility of the retina or to the opacity of the originally transparent refracting media, by which the entrance of light is hindered. And why in these experiments the retina should require such careful protection, such a tendency to contraction of the pupil and closure of the eyelids in order to exclude a superabundance of light, may easily be conjectured when we call to remembrance the anatomical constitution of that structure, a most delicate nervous sheet, the integrity of whose capillary vessels as to tone, &c., is of the very utmost necessity to that of its function; and when we also bear in mind the numerous examples which we possess of disturbance to the capillary circulation produced by injury to the sympathetic, whose ultimate branches are distributed along with the vessels.

A better instance of this capillary disturbance, by way of illustration, we cannot have than in the distension of the

pericardial blood-vessels and the exudations poured from them out around the heart after injury to the thoracic ganglia of the sympathetic, as shown by Bernard and Schiff.

We may not then injudiciously or unreasonably suppose that in the matter of the retina the very numerous and closely packed capillary vessels of this membrane become affected, whenever, by experiment or disease, the sympathetic nerves from which they are supplied become seriously injured, and that a distinct relation exists between the unnatural condition so produced and the experimental phenomena above mentioned, which are, as regards the retina, protective in their aim. Pathological instances of this kind of confederate or consensual action for conservative purposes might, if needful, be quoted in abundance. A case in point, which I have lately fallen in with, is so notable that I will briefly describe it.

A man, æt. 45, experienced the effects, during the night, of a very vivid flash of lightning.[1] He was at once struck down and unable to rise for some seconds, but was not at all deprived of consciousness. At the time he felt great pain in the eyes, but this soon went off, leaving him blind and unable to open them. He continued blind for seven months, at the end of which time the form of the eyes was found to be good and the corneæ clear, but the pupils were exceedingly contracted. The moment the eyelids were forcibly raised from before the pupil the patient cried out in ecstasy that he saw the light, but added that it gave him such acute pain that it could be no longer borne, and begged that the eyelids might be allowed to close. In the course of time the patient regained his sight, the retina, as it is observed, still retaining excessive sensibility. It appears to me that in the above case the firm spasmodic closure of the eyelids and the contracted pupil possessed a definite relation to each other, and had special reference to some particular condition of the blood-vessels of the exquisitely sensitive retina, induced by the impress of the over-strong light.

[1] 'Memoirs of the Medical Society of London,' vol. ii, p. 503.

The above-mentioned phenomena may be concomitant only with the unwonted condition of the retinal capillaries,[1] but it is also possible that they may stand in relation to that condition as reflex movements, according to the suggestion of my friend Dr. Baly.

As a summary of the various particulars contained in the previous part of this communication, I would say that there seem to exist anatomical and experimental grounds for the subjoined statements.—That certain movements of the iris (the contraction and dilatation of the pupil) are under the control of certain fibres of the sympathetic nerve emanating from the carotid and cavernous plexus, as are also frequently to some degree, at least in lower animals, the movements of the levator of the upper eyelid and the external rectus muscle of the eyeball.[2] That these sympathetic nervous twigs are derived secondarily from the great sympathetic trunks in the neck, but primarily from certain parts of the spinal cord, by communication between these grand trunks and the spinal nerves. That consequently, the same effects produced upon the iris, the levator palpebræ, and external rectus, by interference with the sympathetic in the neck, will follow if the communications passing between it and the cervical part of the spinal cord, or the cord itself, be similarly affected. That, as a rule, paralysis of the dilator fibres of the iris (permitting contraction of the pupil), and, in many animals, partial paralysis of the levator palpebræ and external rectus muscle, follow section of, or extreme pressure upon these

[1] In connexion with this supposition, I would allude to the experiments, before quoted, of Brachet, who found cerebral congestion and somnolence to follow division of the sympathetic in the neck—phenomena doubtless resulting from some unnatural capillary condition; and to those of Bernard and Callenfells, who determined by actual experiment that the temperature of the brain, and of the blood returning from it, and the size of the meningeal vessels, was increased by the experiment.

[2] It may here be stated, that it is not in all the experiments that contraction of the pupil, or even elevation of superficial temperature, follows division of the sympathetic; and much more variable appears to be the influence of the sympathetic upon the upper eyelid and external rectus muscle. Upon what this difference depends is not known.

parts of the nervous system, whilst mere irritation by electricity, and stimulating, chemical, and mechanical agents, induce a dilatation of the pupil.

Bearing in mind the results of the above-mentioned experiments upon healthy animals, it is to be expected that under disease any pressure or lesion of the cervical sympathetic or its ganglia, or its connexions with the spinal cord, would tend to produce effects on the iris similar in kind at least to those arrived at by experiment.

With the beautiful physiology of this subject in view, it was that Dr. Gairdner, of Edinburgh,[1] shrewdly interpreted the rationale of contraction of the pupil, which he found to occur in certain cases of thoracic aneurism in which the enlarged vessel pressed upon some parts of the ganglia or branches of the sympathetic. He has brought before the Medical and Chirurgical Society of Edinburgh, cases in which the contracted state of the pupil existed, apparently owing to interference with the sympathetic in the upper part of the thorax. These cases of his I will briefly allude to along with those placed on record by others, numbering them so as to include in a series those which I shall myself bring forward in which the pupil of the eye only had become affected, or in which, in addition to this symptom, other symptoms also appeared, apparently arising from interference with the sympathetic nervous supply. In Dr. Gairdner's cases the only symptom dwelt upon by him as being produced by such interference is the *contraction* of the pupil.

Case 1 was that of a quarryman, æt. 40,[2] affected by aneurism of the arch of the aorta, involving the sympathetic

[1] Since writing the above, Dr. Gairdner has sent me a pamphlet written by Dr. Robert MacDonnell, of Montreal, and reprinted from the 'Montreal Medical Chronicle,' June, 1858, entitled, "On Contraction of the Pupil, a symptom of Intra-thoracic Tumours," containing the history of a case observed by him as early as 1850, in which pressure on the sympathetic at the root of the neck had produced contraction of the pupil, and also *ptosis*. To this case I shall refer further on, at p. 432.

[2] 'Edinburgh Monthly Journal,' August, 1855, p. 143.

nerve, as shown by *post-mortem examination*, and in all probability the lower cervical ganglion, as also the various spinal nerves and the vertebral artery. During six weeks of observation the left pupil was seen to be much smaller than the right one, but both of them acted under the influence of light. It is stated that "for a good many weeks before death the difference in the size of the pupils had become scarcely recognisable." This case terminated fatally by hæmorrhage into the œsophagus.

Case 2 was one recorded by Dr. Walshe[1] of aneurism of the aorta, greatly compressing the innominate artery, and causing the right radial pulse to be almost imperceptible. In Dr. Walshe's account I find it stated that "the left pupil during life was observed to be one eighth of an inch in diameter; the right one was not more than half the size, and both round and moderately brisk. *After death* both were larger than during life; the right one, that which during life was so notably the smaller, was very distinctly larger than the left one."

Case 3 was one described by Dr. Gairdner, of a journeyman shoemaker, who, along with signs either of thoracic aneurism or disease of the aortic valves, with hypertrophied heart, had contraction of the left pupil. He acquainted me with the particulars of this case in December, 1856, and I have lately heard from him that in this patient, who is still in improved health (May, 1858), there exists a "remarkable irregularity of temperature,—cold sweats followed by flushing, accurately limited to that half of the face on which the pupil is affected." Dr. Gairdner also tells me that recently he has had the opportunity of seeing "*another* case of unilateral sweating in connexion with contraction of the pupil on the same side and signs of heart disease or aneurism."[2]

[1] 'Diseases of the Lungs, Heart, and Aorta,' 2d edit., p. 759.

[2] Since writing the above, Dr. Gairdner has informed me that the first of these two patients affected with unilateral sweating, has lately died,

Case 4 was under Dr. Gairdner's own treatment, and was one in which a contraction of the pupil was associated with thoracic aneurism.

Case 5 was also under Gairdner's observation, and was a "well-marked case of innominate aneurism." The right pupil was contracted as compared with the left. The patient, a woman, is probably still alive.

Case 6 is published at large[1] by Dr. Williamson, of Leith. In this the contracted pupil (a symptom which continued to exist *even after death*) along with certain neuralgic symptoms was considered during life to be the means of diagnosis between an aneurism and aortic valve disease. After death, intra-thoracic aneurism was found on the same side as the contracted pupil. This case has lately been alluded to in connexion with the subject of contracted pupil as consequent upon aneurismal pressure, at p. 482 of the 'Archives générales,' April, 1858.

Case 7, published by Dr. Banks, of Dublin, King's Professor of Physic,[2] was that of a woman, æt. 24, who had a contracted pupil in connexion with a supposed aneurism in the upper and left part of the chest. The sight of the affected eye was good, and the contraction of the pupil, though constant as compared with the pupil of the other eye, was susceptible of change, like its fellow, according to the amount of light permitted to fall upon the eye. The patient left the hospital in the same condition, and from a letter kindly sent to me, April 23d, 1857, I learnt from Dr. Banks that he had seen nothing of the patient since her dismissal from the hospital.

but that a post-mortem examination could not be obtained. He also states that in this case the peculiar symptoms were at the last in abeyance, the pupils being equally small.

[1] 'Edinburgh Monthly Journal,' January, 1857, p. 614.

[2] 'Dublin Hospital Gazette,' January 15th, 1856. This case has been quoted in the 'Dublin Quarterly Journal of Medical Science,' vol. xxv, p. 438.

Case 8 is one related by Dr. Willshire,[1] of a supposed enormous dilatation of the ascending aorta and arch, with the vessels arising therefrom, occurring in a woman, æt. 60. The right pupil was always more contracted than the left one, but it quickly dilated on the application of atropine to the eye.

Case 9 is that of a man, æt. 58, related by Dr. Hope,[2] who was affected by aneurism of the ascending aorta, of the size of a cocoa-nut, with general dilatation of the aorta, and who died of pneumonia. He had had headaches for about six weeks, and, in addition to other symptoms, complete blindness of the right eye and incomplete blindness of the left one. Both of the pupils were contracted. No special brain symptoms existed, and after death the brain was found healthy, but there was thought to be slight dwindling of the left optic nerve.

The above-named cases are the only ones, excepting one quoted by Dr. Reid (here numbered as Case 25), which are, so far as I yet know, placed upon record, or privately noticed by others, wherein an alteration had been observed as a presumable result of interference with the sympathetic branches supplied to the iris, by pressure from intra-thoracic aneurisms.[3] It will be remembered that the only symptom

[1] 'Lancet,' 1856, vol. i, p. 678.

[2] 'Diseases of the Heart and Great Vessels,' 3d edit., 1839, p. 608.

[3] In a letter quite recently received, and since the writing of the above, Dr. Gairdner informs me that he has met with four other cases in which a contracted state of the pupil was connected with intra-thoracic aneurism. In the *first* the symptoms were "clear." This case was seen with Dr. Simpson. In the *second* a *small* aneurism pressed towards, but did not directly involve the sympathetic on the right side. On the same side the pupil was contracted. In the *third* case Dr. Gairdner was called to the patient the night before he died suddenly. Both the pupils were remarkably contracted, and on this phenomenon, combined with other symptoms, a diagnosis of aneurism was founded. On post-mortem examination a large aneurism was discovered encroaching on both sides of the vertebral column all the way down the thorax. In the *fourth* case,

of interest in connexion with these aneurisms, which are all of the thoracic aorta, was a *contracted* state of the pupil. It occurred to me that aneurisms of other arteries than those in the thorax might, by exercising similar pressure, produce similar results as regards the pupils of the eyes. I thought it might be so with the subclavian or the carotid in the neck; and I was fortunate enough to find one or two instances recorded in which alteration of the pupil was produced by aneurism of the carotid.

The following forms a very striking instance:

Case 10.—A man, æt. 41, had an aneurism of the left carotid artery measuring five and a half inches by four. Headache, cough, dyspnœa, and dysphagia were induced. The pupil of the left eye was particularly noticed by his attendants as being contracted, and vision of the left eye was impaired. Mr. Coates, of Salisbury,[1] tied the artery, and on the eighth day after the operation the pupil, which had been contracted, was observed, according to the published notes, as "having almost recovered its natural state of dilatation and sensibility."

The above case, although meagre as to particulars, seems to me to afford a remarkable illustration of the connexion between injury of the sympathetic in the neck by aneurismal pressure, and altered conditions of the iris; the latter recovering its natural state in proportion as the aneurism lessened after the operation, thus relieving the nerve of the unwonted pressure.

It also suggested itself that probably pressure from other

one seen with a pupil of St. Andrew's, at the Dispensary, the signs were "all pretty clear." The patient died, but no post-mortem examination could be obtained. He also mentions two or three other cases in which a contracted pupil was found and a thoracic aneurism guessed at, but not proved to exist; and also several other cases in which, along with this modification of the pupil, there was "no reasonable ground to suspect pressure on the sympathetic."

[1] Johnson's 'Medical Journal,' vol. ii, 870, March, 1822.

sources than aneurisms might in a similar way affect the pupil. This might be so in certain cases where the lymphatic glands were greatly enlarged and indurated by inflammatory processes or occupied by specific products, as the scrofulous or carcinomatous; or where the general tissues about the main course of the sympathetic in the cervical or upper thoracic region were similarly affected; or again, it might be the case where abnormal bony growths existed in certain parts of the thorax or neck, or even of the cranium, as of the basi-cranial bones, involving the neighbourhood of the cavernous sinuses.

Here I am bound to mention, that in my hopes of finding such cases I was in a degree anticipated by Dr. Reid, who mentions a case (one which I shall insert as my 25th) in which a contraction of the pupil was produced by pressure from malignant deposit in the neck.

Whilst on the watch for cases such as I have just alluded to, one presented itself to my notice in St. George's Hospital in the course of the year 1856. It was as follows:

Case 11.—A man, æt. 22, was admitted with a great enlargement of the cervical lymphatic glands on the left side, forming a painful tumour of the size of a small orange. There was cough, with occasional stridulous breathing, and, subsequently, great dyspnœa and bloody expectoration. Extensive disease also of the axillary glands came on. The pupils of both eyes were noticed as being dilated and equal in size, but on the twenty-first day after his admission the cervical glands had enormously increased, and the pupils were seen to be very unequal, that of the *left* eye being much the smallest. Both pupils contracted when the eyes were directed either inwards or outwards, and only after a short space of time did the right pupil regain its comparatively large size. On the twenty-third day the tumour was of the size of a swan's egg. There was no difference as detected by the hand (the thermometer unfortunately was not used) in the temperature of the ear or side of the head, &c. As before, the left pupil was much smaller than the

right one, but both pupils contracted when the eyes were turned outwards or inwards, and this was the case independently of the varied access of light. Oftentimes they were seen to become equal when the eyes were kept very widely open, and when suddenly turned to the bright light of a window.

On the patient's looking about or withdrawing the eyes from the light, the right pupil would again become dilated, and thus the two pupils again became unequal. After death I found the left lung, and the mediastinal, cervical, and axillary glands, all occupied by firm carcinomatous deposit, effecting considerable pressure upon the sympathetic and its connecting branches, the trachea and œsophagus being greatly pushed to the right side.

Further on I shall adduce, as Case 19th, an instance of scarlet fever in which the pupil was affected by pressure from enlarged glands in the neck.

I may here mention that I have notes of a case in which there was extensive inflammation of the pleural membranes and mediastina passing up the neck, and involving all the deeply placed tissues about the vessels and nerves, with great effusion of firm inflammatory products as high as the base of the cranium, in which the pupils became remarkably contracted. This condition appeared to be owing to interference with the sympathetic; but as the patient was taking calomel and opium, which might have affected the pupils, I am constrained to have some doubts about it, and therefore will not include it amongst this set of cases.

Judging from our knowledge of the connexions between the sympathetic and the spinal cord, and from the various experiments upon the consequences of injury to the spinal cord itself in animals, to which at an earlier part of this communication I alluded, I thought it probable that similar symptoms to those which we have seen to follow mechanical interference with the sympathetic in animals, might arise when the upper part of the spinal cord was suffering from disease or injury in man. I have not been disappointed in my search for cases related, in which exactly such symptoms

as I anticipated were exhibited. One or two such cases I will quote, as follows, merely selecting such details as bear on the point in question:

Case 12 was that of a man who was the subject of extravasation of blood into the substance of the spinal cord corresponding to the fifth and sixth cervical vertebræ. Both the pupils were noticed as becoming greatly contracted. The patient died in forty-eight hours after the attack, remaining quite sensible to the last, and showing no cerebral symptoms whatever. This case is related by Sir B. C. Brodie.[1]

Case 13 was one of fracture and dislocation of some of the lower cervical and dorsal vertebræ, owing to a fall from a haystack, and is also related as under the care of Sir B. C. Brodie.[2] The patient, æt. 71, had oppressed breathing and noticeable contraction of both pupils. His senses were entire and collected, and he remained quite conscious to the last, gradually sinking. *After death* the centre of the medulla spinalis opposite to the injury was remarkable as being of a brownish-red colour, and highly congested.

It is not expressly said that the spinal cord was softened, but such a change in colour would most probably not have taken place without some amount of disorganization.

Case 14 was that of a man, æt. 45, the subject of fracture of the fourth and fifth cervical vertebræ, related by Mr. Vincent, of St. Bartholomew's Hospital.[3] Diminished sensibility and power of motion existed in all the limbs, and there was priapism. The respiration was mainly diaphragmatic. Both of the pupils were noticed as being contracted. On post-mortem examination the spinal cord at the affected part was found much swollen and softened, and blood was extravasated outside the theca vertebralis.

Case 15 was that of a man, æt. 39, who by a fall had

[1] 'Transactions of the Royal Medical and Chirurg. Society,' vol. xx, p. 149.

[2] Johnson's 'Medical Journal,' 1828, vol. ix, p. 477.

[3] Johnson's 'Medical Journal,' vol. viii, p. 452.

fractured one or two cervical vertebræ, and was brought into St. George's Hospital in 1849. On the day after admission he was found to have lost power in the right leg, and partially also in the left leg; and on this day it was noticed that both pupils were contracted, but especially the right one. No other mention is made of the eyeballs or pupils. The spinal cord, *after death*, was found to be considerably encroached upon and softened, both as to its anterior and posterior columns, the central part being very vascular. The brain was quite healthy.

Case 16 was that of a man, æt. 48, who was admitted into St. George's Hospital in June, 1849, having fallen from a considerable height against a piece of timber. There was loss of sensibility and power of motion in the lower limbs, with numbness of the arms and diaphragmatic breathing.

In the evening of the day of admission it was noticed that the patient moved his arms less easily, and that the pupils of both eyes had become contracted. Two days after admission his pupils were observed as being very highly contracted, and great pain and numbness were complained of by the patient. No brain symptoms came on, and on the day of his death, which was the fourth after the accident, the patient spoke quite rationally to the nurse. *After death*, fracture of the lower cervical and upper dorsal vertebræ with displacement, was found, and much blood was seen extravasated within and around the cervical cord of the part; the entire circumference of the cord, from a point corresponding to the fifth cervical as far as the second dorsal vertebræ—almost exactly coinciding with Budge's "regio cilio-spinalis" (see reference at former part of the paper, p. 406)—being greatly softened. The cranium and its contents were quite natural.

In all the above cases quoted from other authorities, or newly related, the special symptom brought prominently forward, as resulting from a certain degree of interference with the sympathetic and its branches in the neck, or that

part of the spinal cord with which it is connected, was a *contracted* state of the pupil. (*See* Note A in Appendix.)

This pathological phenomenon in the human body quite accords with the contraction of the pupil produced by division, ligation, or extreme pressure of these parts of the nervous system, in experiments upon the lower animals.

But in the description of many of the experiments to which I have alluded (p. 408) it was stated that a certain amount of stimulus, mechanical, chemical, or galvanic, applied to the cervical sympathetic, would produce not a *contraction*, but a *dilatation* of the pupil, and moreover, that when contraction of the pupil and other symptoms had been already produced by section or extreme pressure of the nervous structures before described, they could be reversed, as it were, on the application of galvanism to that part of the nerve or spinal cord still holding unbroken connexion with the iris; and in the place of contraction, a dilated state of the pupil could be at once established. Galvanism, also, of the upper part of the spinal cord, which was otherwise whole and untouched, would produce the same dilated state of the pupil.

The knowledge of these facts helped me to account for certain pathological instances in which, under apparently similar circumstances to many of the cases which I have already enumerated, *not* a contracted state of the pupil was produced, as in them, but, on the contrary, a *dilated* state. This dilatation of the pupil in the human subject is analogous in its causation, I believe, to the dilatation produced in experiment by the application of certain stimuli to the sympathetic nerve. We know that if a stimulus applied to a motor nerve be carried only to a certain pitch, the nerve is irritated, and we have, as a result, contraction of the muscle to which the nerve is distributed; but if the stimulation be carried to an extreme, then, on the contrary, it produces paralysis of that muscle. (*See* Appendix, Note B.) In like manner, in the cases which I am about to describe, I would seek to explain the *dilatation* of the pupil, on the supposition that the pressure upon the sympathetic trunks and fila-

ments and the interference with the spinal cord were so slight, comparatively, that it merely acted as an irritant, just as gentle galvanism might have done, the sympathetic fibres to the dilator pupillæ being stimulated. Should the pressure in such cases remain in so slight a degree, the dilatation of the pupil would also continue, but should it increase so as to paralyse the sympathetic or spinal fibres, then the action of the sphincter of the pupil would preponderate and contraction of the pupil ensue. The quickness with which contraction will follow dilatation of the pupil in such cases will depend most likely, in part, upon the general character as to susceptibility of the nervous system in any given person;[1] but chiefly upon the exact position at which the pressure may be exercised, whether it be of an aneurism or other tumour; and also upon the rapidity of increase in size of the object effecting the pressure and its consistency. For example, it appears likely that the same growth situated low down in the thorax (as, for example, an aneurism in the lower part of the arch of the aorta) would not be nearly so harmful to the sympathetic as if it were close to the upper outlet of the chest, where the grand sympathetic trunks on either side are large, more prominent, and confined within a narrow bony circle, and where also they are more elaborate in their connexions.

Again, modifications as to interference with the sympathetic by aneurism or tumour, &c., might well be expected, according to the number and anatomical arrangement of the sympathetic fibres around the part affected, which may vary considerably in man, as we know they do in animals.

I will now proceed to give one or two cases which seem to illustrate the occurrence of *dilatation* of the pupil, owing to a slight amount only of pressure upon the sympa-

[1] In connexion with the susceptibility of external impressions made upon portions of the nervous system, the fact ascertained experimentally by R. Miquel ('Archiv d. Vereins f. Gemeins. Arbeiten,' &c., 1853, Hgt. iii. p. 386) is interesting, that the results of pressure upon the sciatic and median nerve are more decided and persistent in proportion to the general exhaustion of the nervous system.

thetic, or to some slight change in the spinal cord, serving to stimulate and not to paralyse such fibres as pass eventually through the spinal nerves and sympathetic to the iris.

Case 17 was that of a woman, æt. 40, whom I watched closely in the wards of St. George's Hospital, in the year 1856. She was admitted with a pulsating tumour, of the size of a hen's egg, situated at the third intercostal space on the right side. There was a sharp diastolic click audible over both scapulæ behind, and specially at the middle of the right one; and subsequently a systolic murmur was heard over the tumour, and dyspnœa, with cough, came on. Afterwards, the tumour was found to have appeared on the left of the sternum, and stridulous breathing occasionally occurred. The pupils were noticed as having become slightly dilated. Later on in the history of the case the "right pupil became still more increased in size, so as to contrast notably with the left one." Death took place shortly afterwards. On *post-mortem examination*, an aneurism of the size of a cocoa-nut was found destroying a part of the right side of the sternum, and the contiguous portion of the third rib, and arising from the upper part of the ascending aorta, this vessel itself being also greatly dilated.

Case 18 was that of a man, æt. 57, who was brought into St. George's Hospital with extensive occupation of the *left* side of the neck by "scirrhous infiltration," the skin being tuberculated, indurated, and discoloured. He lay in a state of indifference, and it was noticed that the pupil of the *left* eye was dilated, that of the right one being natural. He sank, owing to dysphagia. In addition to the skin, most of the structures of the entire depth of the left side of the neck were found after death to be affected by the deposit, and there can be no doubt that the sympathetic filaments would fall in for their share of pressure, although but slight in degree.

Case 19 was one which lately I observed at St.

George's Hospital, of a young man affected by scarlet fever. He had ulcerated sore throat, and extensive enlargement of both sides of the neck, but particularly of the *left* side. The pupils of both eyes were fixed, but very dilated, the *left* one being much the more so. After death, the cervical lymphatic glands were found to be very greatly enlarged, and in one or two places suppurating; and most of the deep tissues, with vessels and nerves at the sides of the neck, were indurated, and matted together by inflammatory products. These changes were especially observable on the *left* side of the neck.

Case 20 was one which, by Dr. Sibson's courtesy, I saw under his care at St. Mary's Hospital. An abstract of the notes which he gave me is as follows:—Rosetta James, æt. 42, was admitted Oct. 18th, 1857, with swelled and congested face and neck, distended jugular vein on the right side, and pulsation at the second intercostal space on the right side of the chest, with fulness and dulness of this region, extending from the edge of the sternum about one inch outwards. Other symptoms existed, leading to the diagnosis of an intra-thoracic aneurism. No mention exists of any peculiarity in the appearance of the pupil until December 11th, when it is stated that the left pupil was more dilated than the right. On the 12th February, it is stated that the impulse of the aneurism was stronger, and felt over an area of three inches from the second to the fourth costal cartilages; and that both pupils were dilated, *but the left one much the most so*. On exposing the eyes to the light of a candle, "both pupils contracted, but the left one still remained the largest." Attacks of giddiness were also complained of, and the patient felt at times "as if she were going out of her mind." On March 8th, it is recorded that "whilst asleep, the pupils were contracted, but the left one was the largest." "Both of them speedily dilated when she awoke."

Case 21 was one under the care of Dr. Cockle, who

kindly gave me the following abstract of it[1]:—The patient suffered from a very large aneurism of the ascending and transverse part of the aorta, as was found after death; and on dissection it was ascertained that, besides other structures, the sympathetic nerve on the left side was involved to a considerable extent. During life, it was observed that, in addition to pain, cough, dysphagia and dyspnœa, one of the pupils (unfortunately it is not particularised) was much larger than the other, the vision being at the same time dimmed. Moreover, before death *a peculiar state of mortification was set up in the side of the nose, corresponding to the side chiefly affected by the aneurism.* In the early part of the history, the pupils are described as being found contracted, and no difference between them was observed. It may therefore be concluded that one of them became altered during the course of the disease, and whilst the patient was under notice. The aneurism, still showing distinctly the implication of the main sympathetic branch, is now in the museum of St. Mary's Hospital, where I had the opportunity of inspecting it.

Case 22 was that of J. M—, æt. 57, who was brought into St. George's Hospital May 30th, 1849, with infiltration of most of the textures of the left side of the neck, and the cervical glands with carcinoma. On admission he was in a state of half stupor, caused, as it was thought at the time, by pressure upon the cervical blood-vessels. It was noticed, that the pupil of the left eye was considerably dilated, whilst that of the other one was natural. Pressure by the hand on the right side of the neck induced syncope.

On *post-mortem* examination the external jugular vein was found to be obliterated by coagulum, and the carotid artery, internal jugular vein, and pneumogastric nerve, on the left side, were found surrounded by the cancerous growth, so that it can hardly be conceived that the sympa-

[1] This case will be seen related in vol. ix of the 'Pathological Society's Transactions.'

thetic trunk behind could altogether escape some pressure which might yet not suffice to paralyse it.

Case 23 was that of P. O. H—, æt. 61, who was brought into St. George's Hospital September 21st, 1857, having fallen down backwards in the act of lifting a heavy load of hay. He was at the time collapsed, and suffering pain at the upper part of the dorsal region, where the spinous processes appeared more than usually prominent. He had lost all power of movement in both lower and upper limbs; and it was noticed, when he was admitted, that both pupils were unusually dilated, but that the pupil of the right eye was more dilated than the left. On a further observation, the same state of the pupil was noticed. The patient died in eight days, and, on *post-mortem examination*, "minute points of ecchymosis were seen in the substance of the spinal cord, at the lower part of the cervical region, which was also softer than in other parts," and it was noticed that the "white matter had, in parts, a pinkish hue."

The last five cases show simply a dilated state of the pupil, owing, I believe, to a comparatively slight interference with the cervical sympathetic, or that part of the spinal cord with which it is connected, no further change in the pupil being observed. It is presumable, that this dilation, should the pressure have been increased, would have been exchanged for contraction, on the supposition which I have previously advanced.

The next case which I will adduce is a very remarkable one, inasmuch as a dilatation and contraction of the pupil were noticed as succeeding each other in a rapid and somewhat inexplicable manner. The phenomena were, I think, clearly traceable to the extraordinary condition of the subfascial tissues of the neck.

Case 24 was that of a German lady in Dublin, æt. 25, who, in August, 1856, suffered from phlegmonous in-

flammation in the neck. In consequence, a tumour formed on the right side of the neck, extending from the ear to the lower border of the thyröid cartilage, and seated beneath the cervical fascia. Great pain existed, and suppuration came on, marked by repeated rigors. It was now observed that the pupil of the right eye was greatly dilated, so much so, indeed, that but a very little of the iris was to be seen. Soon after this dilatation of the pupil was noticed, the patient got relief from the pain and slept, and, on awaking, the pupil hitherto so much dilated, was found to be of the natural size. In the evening a rigor again came on, and the pupil was now contracted; a paroxysm of pain followed the rigor, and the pupil became dilated as before. These alterations in the size of the pupil were observed several times; and, moreover, during this time, the iris, which naturally was of a gray colour, *acquired a dark brown tinge*.[1] The abscess in the neck was now opened, the rigors ceased, and the pupil remained dilated, but would contract under the stimulus of light, the power of vision being apparently entire. As the state of the neck improved, the affected pupil returned to its natural size. In the summer of 1857, whilst in London, this lady again suffered from an abscess in the same region, and is reported to have had a similar return of the affection of the pupil. In 1858 another abscess formed on the same side of the neck, but at a lower part. The pupil became again dilated, and so continued until the abscess was nearly healed. The dilatation was not, however, nearly so extreme as in the earlier attack.

For the history of the above case I have to thank Dr. Kidd, of Great Brunswick Street, Dublin, who, in a most generous way, has placed it, hitherto unrecorded, at my service.

For the general effect of dilatation of the pupil, as resulting from the stimulus of a moderate pressure, analogous to that produced by galvanism, we are in a measure prepared

[1] This change of colour was no doubt the result of an alteration in the amount of blood in the capillary vessels of the iris, and was due to interference with the vaso-motor nerves of these capillaries.

by a knowledge of the frequency of similar dilatation in cases of mere irritation, as by worms, of the intestinal tract whose innervation is from the sympathetic;[1] as also by the frequency of such dilatation in cases of burns, scalds, lacerations, and other mechanical injuries, physiologically comparable to the influence of the sympathetic on the heart causing palpitation, &c., as in certain diseases of the abdominal viscera; as also in cases of general debility, when we know the cerebral influences to be impaired, and, by comparison, the sympathetic and spinal ones to be intensified.

Hitherto, all the cases and observations brought forward have had reference simply to some altered state, a dilatation or contraction of the pupil, phenomena parallel to similar ones, induced in the eyes of the lower animals by direct experiment. This altered condition of the pupil in disease resembles that established in animals by section of the sympathetic, &c., inasmuch as the dilatation or contraction is not absolute and complete, but may still be modified by the action of light, atropine, &c. Thus, in Case 20 the pupils are mentioned as both of them contracting, although the left one remained still the largest, and, in the same case they were contracted whilst the patient was asleep, but dilated on her awaking. Again, the same response to the impression of light was exhibited in Cases 7 and 24; and to that of atropine in Case 8; and the same effect will be seen hereafter, as in Case 25, to have followed the application of belladonna.

So also in the lower animals. Dr. Reid observed that in a dog, whose sympathetic and vagus nerves he had completely divided (second experiment), the contracted pupil still continued to be affected by light; and when the dog was dying, poisoned by prussic acid, the pupils of both eyes became equal, and very much dilated. Mollinelli[2] also, in his third observation, speaks of the pupil being made to contract still further, even when already contracted by division of the sympathetic.

[1] Dr. Waterfield has lately informed me of a case in which almost total blindness was apparently produced by the presence of a tape-worm, and at once remedied by its expulsion.

[2] Op. cit.

In one or two of the cases which I have watched, I have found that the contraction or dilatation of the pupil varied in a remarkable and unaccountable way at various times; and it is interesting, in connexion with this fact, to remember, that in certain cases of disease of the brain, rapid and well-marked variations in the size of the pupils are wont to occur at times most unexpectedly. It may here be called to mind, that in dilatation of the pupil from paralysis of the oculo-motor nerve, as by a tumour pressing upon it, and consequent want of contractile power of the sphincter of the iris, there is, of course, no change in the pupil on the increased admission of light upon the eye; and this is the case also, I believe, in complete dilatation of the pupil from the use of belladonna, as resorted to for the purposes of couching.

It will be remembered, that I pointed out other symptoms besides the contracted pupil, as following experimental interference with the cervical sympathetic or spinal cord in animals, and these were chiefly ptosis and convergent strabismus. These phenomena I believe may be accounted for rationally, and on anatomical grounds. (*See* Appendix, note C.) I thought it, therefore, probable, and was very wishful, that I should find instances in which either of these symptoms had been associated and noticed in man, along with a contraction of the pupil, owing to interference with the sympathetic. Such a combination of circumstances I find in the case which I before mentioned, page 415, as being alluded to by Professor Reid, and more fully described by Mr. Hare, house-surgeon at the general infirmary at Stafford.[1] This was not a case in which the sympathetic nerve was affected by an aneurism, but by a malignant tumour; and, as Reid only spoke of it as respects the contracted pupil, I will here give a general summary of the particulars.

Case 25, was that of a man, æt. 40, who was attacked by

[1] 'Medical Gazette,' September 29, 1838, p. 16.

pain down the left arm and shoulders, across the chest, and up to the left eye and side of the face. A tumour was observed in the inferior triangular space of the left side of the neck, resembling an enlarged and scrofulous gland. The left pupil was contracted, and the left eye "*partially closed*," but no inflammation of the conjunctiva seems to have been observed.

After a time weakness, and eventually paralysis, of sensation and motion in the lower limbs came on, followed by trismus and dysphagia, and death by suffocation, the growth in the neck having become much larger, and very hard. The contracted pupil could be dilated on the application of belladonna around the orbit. After death the tumour was found to be of a scirrhous nature. It had implicated the large vessels and the spinal nerves with the great sympathetic at the lower part of the neck, the lower cervical ganglion of the sympathetic, the thoracic duct, and the recurrent laryngeal nerve. It was also found lying on the brachial plexus; and having penetrated the foramina, by which the last cervical and the first dorsal nerves escape from the spinal canal, it had become attached to the external surface of the spinal dura mater. The ptosis, the trismus, and the contracted pupil, caused the observers of this case to anticipate some disease of the central nervous structures; but no disease whatever, either of the brain or spinal cord was found, and the above-mentioned symptoms were spoken of as having been essentially sympathetic in character. Whatever may be the interpretation of the trismus, dysphagia, &c., there is, in my mind, no doubt of the connexion between the ptosis, as well as the contracted pupil on the one hand, and the interference, by pressure, with the cervical nervous structures on the other hand.

One or two more cases I will quote, illustrative of a more or less complete paralysis of the upper eyelid, along with some interference with the sympathetic nervous structures.

Case 26. Was that of a man, æt. 50, under Sir Astley Cooper's care, affected by aneurism of the internal carotid

artery, which produced distressing throbbing pain in the left side of the head, and giddiness, with almost total loss of consciousness and sight, on stooping; also cough, dyspnœa, and hoarseness.[1]

It was noticed that ptosis of the eyelid on the affected side "*gradually*" came on until the eye was fully half closed, the sight of the eye remaining good, and no other special symptoms arising.

The common carotid was tied, with absolute success, and the peculiar pain in the head was quickly relieved, but unfortunately no history of the state of the eyelids after the operation has been recorded, although I think we may very fairly and reasonably conclude that the eyelid resumed its natural position, as the patient is reported to have become in all respects perfectly well.

Of course, the importance of the ptosis was not at the time recognised, or it would have received special attention. There is no mention of the condition of the eye-ball or pupil during the whole course of this case, but it was, however, noticed that the ear of the patient on the side implicated, was frequently affected by a feeling of coldness, succeeded by heat.

I consider this case to be of special interest, as showing the gradual accession of paralysis of the levator of the eyelid, as the aneurism of the carotid increased.

Case 27 related by Mr. Butcher, of Dublin,[2] was that of a man, æt. 56, affected by extensive carcinoma of the glands of the axilla, and of the neck, on the left side, displacing the trachea, and compressing the œsophagus. Dyspnœa and dysphagia came on, and by degrees, indeed almost imperceptibly, a *drooping of the upper eyelid* on the affected side, which Mr. Butcher states that he watched for many days. On being much roused or spoken to, the eyelid was tardily raised and kept open. In a letter, dated December 7th, 1856, Mr. Butcher informed me that he had not

[1] 'Transactions of the Royal Medical and Chirurg. Society,' vol. i, p. 22.

[2] 'Dublin Medical Journal,' November, 1856, p. 259.

perceived that the action of the iris or the axis of the eye on the side affected had in any way differed in this case from those on the other side.

With regard to this case, it might be asked how the ptosis can be explained, whilst, at the same time, no affection of the pupil was recorded? In reply, it might be stated that possibly the pupil was affected, although it might be so only to a slight extent. An amount of difference in the pupils, even considerable, often passes unnoticed, unless specially looked for, whilst ptosis is very obvious.

It is to be remarked that, in none of these cases have we any strabismus noted, such as existed in several of the experiments on animals, illustrating the effects of interference with the sympathetic, &c.: but the possibility of the occurrence of strabismus, as a clinical result of such interference, is well illustrated by the cases mentioned by Sir C. Bell, in which[1] squinting in children was produced by over-eating. This squint was at first temporary, and only observed on occasions of distended stomach; but at times became confirmed.

Such are some of the cases, in which, along with injury to the cervical sympathetic, or cervical part of the spinal cord in man, a more or less complete condition of ptosis has been noticed, suggesting a comparison with those experiments on animals, in which the same symptom was produced by section of or extreme pressure on, the sympathetic.[2]

[1] 'The Nervous System of the Body, with an Appendix of Cases and Consultations,' 1844, 3d edit., p. 389.

[2] In the case of carcinoma within the thorax and neck, before alluded to (p. 412), as being described by Dr. Robert MacDonnell, of Montreal, there was in addition to a contracted state of the pupil, *ptosis* of the upper eyelid and frequent epistaxis from the nostril on the side affected by the malignant growth. The contracted pupil (as in Case 20, and others before mentioned) nevertheless answered to the influence of light. In his remarks on this case, the author alludes to the connexion between the sympathetic and the third nerve as the probable cause of ptosis; and this conjecture, made so completely apart from, and independent of my own solution of the subject, I look upon as being of essential service in support of my view in question.

I have described, as briefly as I could, all the pathological facts which, at this opportunity, I have thought fitting or necessary to bring forward, as indicating the results upon the eye, and its appendages, of interference with the sympathetic thereto distributed, as occurring in the neck, or of injury to that part of the spinal cord with which the sympathetic branches or ganglia are connected.

Of course I have been careful to exclude cases in which the pupils might become affected by other causes, and which we ought to estimate before deciding upon the clinical importance of a contracted or dilated pupil in any given case of supposed pressure upon the sympathetic or its tributaries.

Setting aside those cases in which disease or injury of the brain, intra-cranial irritation or effusion, uræmia and various poisonings are accompanied by an irregular condition of the pupil, we must not overlook the effects of such remedies as are well known to influence the pupil, and by which one might easily be deceived. In some people, also, a contracted or dilated state of the pupil is habitual, but it is very rare, although such cases do exist, to find that the pupil of one eye is contracted or dilated without the other being likewise so, unless some previous disease or injury have caused this difference.

We may also be misled by the fact of the pupil having been injured by mechanical or inflammatory lesions of the eye, or by alterations in its size, in adaptation to cataract, opacity of the lens, &c. Of course, all doubt of such complications becomes out of the question, almost to a certainty, when the progress of alterations in the pupil is actually watched at the bed-side, as it was in several cases which I have just adduced.

It is out of the scope of this paper to dwell at length upon the subject, but I cannot close it without alluding to the possibility of alterations in the size of the pupils as a result of injury to other and more distant parts of the sympathetic system than those immediately in the cervical or thoracic regions. This appears to be not improbable, from many facts. For instance, the temperature of the entire body

was found by Bernard to be affected[1] by injury to the sympathetic in the neck; and Arnemann mentions persistent diarrhœa as a result of wounding of this nerve. Moreover, Budge found that galvanism of the posterior part of the lower extremity of the spinal cord produced a very striking increase in the number of the heart's contractions, a circumstance coinciding with those cases of disease in which pressure upon various parts of the back produces syncope and palpitation of the heart, &c. Romberg speaks also of tabes dorsalis, an affection strictly of the spinal cord, and generally of its lumbar portion, as being accompanied at times by a contracted state of one or both pupils; and recently, also, Brown-Séquard has stated[2] that injury and removal of the supra-renal capsules pretty often produce, amongst other effects, decided contraction of the pupil of the eye on the side corresponding to that on which the operation is performed; a fact no doubt due to implication of the sympathetic connected so freely with these small viscera.

May it not be that the contraction of the pupil, accompanying lesions of certain parts of the brain also, may exist by virtue of injury to such nervous strands as pass between those portions of the brain and such parts of the spinal cord as are (according to our knowledge obtained experimentally,) central points, as it were, to branches joining the cervical sympathetic. Some encouragement to this view is afforded by the fact, that diseases of *cranial* centres appear to induce disease of *spinal* centres, by depriving them, as it were, of a wonted impulse, thus throwing them more or less out of activity. And Türck[3] has shown how secondary changes, as seen by the microscope, may be produced in the spinal cord, merely by intra-cranial causes, as in certain cases of hemiplegia.

It may be, and this idea may here be suggested with propriety, that the pain in the head and eyes, the giddiness, unusual sensations, deafness, double sight, dimness of sight,

[1] 'Mémoires de la Société de Biologie," 1853.

[2] 'Archives générales,' vol. ii, 1856, p. 587.

[3] 'Weiner Zeitsch,' vol. vi, 1850, p. 6, and vol. viii, 1852, Bd. ii., p. 511.

or even blindness, which are so very often coincident with thoracic aneurisms, most frequently existing on the same side, and which are independent of any visible cerebral change after death, are owing to some interference with sympathetic nerve-influence to the intra-cranial capillaries. In accordance with the above suggestions is the fact that, in case 26, that of Sir A. Cooper, the peculiar pain in the head, which had existed along with the carotid aneurism, was quickly relieved by the ligation of the vessel, and consequent diminution of the aneurism. The relief which followed the removal of the pressure upon the sympathetic, as it appears to me, yielded sufficient evidence that the cerebral distress was not dependent upon any inherent disease of the blood-vessels, apart from their connexion with the sympathetic, accredited to them, and to which they are subordinate.

Before closing this communication, I would draw attention to a point which, connected as the subject is with several of the experiments before quoted, naturally presents itself on consideration of the cases which I have just detailed. The question might well be put, whether, during observation of any of those clinical cases, any undue heat or sensibility of the skin, or any visible altered vascular action in the eye or elsewhere, ensued from pressure exercised upon the sympathetic? The only clear indication of this appears in case 3, in which it will be remembered that flushings following cold sweats were noticed, exactly limited to that half of the face on which the altered state of the pupil existed. We have, however, something of the kind also, I think, in the 21st case, in which an unaccountable "mortification" of the integument of the nose took place on the side corresponding to that of the aneurism, an effect no doubt due to the interception of such nervous influence as presides over the capillaries of this portion of the face.[1] Just as in the experiments on the lower animals, the vessels

[1] In Case 26, also, that in which ptosis was noticed in connexion with a carotid aneurism, it is stated that, on the side affected, the patient's ear was frequently affected by a feeling of coldness succeeded by heat, phenomena most likely due to sympathetic disturbance.

of the ear become affected, do I infer that the vessels of the retina become influenced; its tolerance of light being subverted in those cases of sympathetic interference wherein a contraction of the pupil is caused in man. But of this I have no distinct proof, as the parts are so removed from view.

In all observations laying claim to accuracy, upon such cases as have been alluded to in the foregoing pages, it will in future, be necessary to notice, as carefully as possible, by instrumental means, the temperature of the various parts of the body, especially the face and head; but, although we may anticipate deviations from the natural state of temperature in many cases, ~~especially~~ particularly if very fine and delicate instruments be used, yet it must not be expected that such alterations will be in all cases manifested, especially if any considerable time have elapsed since the commencement of sympathetic interference. Of course we may well foresee, that in this respect, the effect of suddenly cutting off the influence of the sympathetic by section, in the lower animals, would differ strikingly from the results obtained by such gradual pressure as would generally be exercised by an aneurism or growing tumour in man. Moreover, in a much higher degree would anatomical differences between man and the lower animals be likely to account for variety in results; but this variety in results ~~might~~ may exist without at all affecting the validity of parallelism between the class of pathological phenomena above examined, and the experiments quoted. Even in dogs experimented upon, Valentin found that the effects upon the iris of dividing the sympathetic, varied considerably in extent according to the colour of this muscular curtain. Schiff also states, that in the rabbit, a manifest difference regarding the modifications of temperature in the ears, as produced by sections of the sympathetic exists, according as the rabbit be of the long or short-eared variety.

Such are the applications theoretical and practical, which I have ventured to make of the experiments entered upon by several observers, with the view of determining the

effects of injury to the sympathetic upon the pupil and certain appendages of the eye. I have not sought to establish the dictum, that either contraction or dilatation of the pupil is to be considered as *pathognomonic*, or as a test of intra-thoracic aneurism, cancer, or other tumour, or of any specified disease whatever. On the contrary, I have carefully examined several cases both of aneurism and other causes of pressure in the thorax and in the neck, and I confess that I have found several in which no unnatural condition whatever of the pupil was to be noticed. All I have desired to do, is to establish the fact, that alterations in the movements of the iris and other phenomena connected with the eye may be produced by, and become symptoms of pressure, exercised in various ways on certain parts of the sympathetic, or by pressure upon, or structural alterations of those portions of the spinal cord with which the sympathetic is connected. That these changes do not always accompany the various phenomena above alluded to, is only to say, that they are not invariable criteria, just as vomiting, for instance, or pain in the head, are not the *necessary* attendants of cerebral disease; but yet they are so frequent as to merit the character and denomination of symptoms thereof, and to have become a means of diagnosis. I will not now occupy time by inquiring why these pupil symptoms are variable, appearing in some cases, and not in others. Most likely the solution is to be met with in the anatomical connexions of the nerves about the cause of pressure, the character of the growth, and the rate of rapidity of its formation, and in the stage of the disease,[1] as well as upon other circumstances yet to be made out.

In these observations, it has been my endeavour to render experimental physiology subservient to practical medicine, to give what assistance was in my power, towards the edification of pathological science upon such a foundation as alone is legitimate and truly scientific. If it shall be

[1] It will be remembered that in the history of one or two of the cases before detailed, the amount of alteration in the pupil varied at different periods of observation.

thought that I have in any degree succeeded in enriching or enlarging the boundaries of a field which the labours of others had in their degree cleared, I shall have reason to congratulate myself, in that my efforts will not have been fruitless.

APPENDIX.

Note A. (See page 421.)—I have no doubt, that if I had had the requisite time to scrutinise all the cases recorded in the various periodicals, or, if it had been desirable to multiply examples, I should have found several other cases in which some affection of the pupil had been noted, though, at the time, not understood, in connexion with aneurisms, tumours, injuries, &c., about the neck, so situated as to interfere with the sympathetic and the cervical region of the spinal cord. I do not, however, think that a very great number of cases would be so met with, having this implication of the pupil, seeing, indeed, how little attention is ordinarily paid at the bed-side to the exact state of the eye, except in cases of disease of the brain. Unless specially looked for, the condition of the pupil has been, hitherto, in a marvellous manner disregarded in disease, even in disease of the brain itself, and, in support of this observation, I cannot resist stating, that it was not until the year 1818 that any positive notice was taken by the profession of the poisoning by opium being attended by any alteration of the pupil.[1] The first distinct report of this fact was by Dr. Kinnis, who spoke of the pupils "being fixed" "and contracted to the size of a pin's head," when relating a case of recovery from the effects of opium.[2] Now, considering how many observers, long before that period, must have watched the results of poisonous doses of opium, is it not a little curious that none had described either contraction, or what sometimes occurs, dilatation of the pupil in connexion therewith? I have looked in vain

[1] See the statements by Dr. Sibson in the 'Medical Gazette,' 1848, p. 268.

[2] 'Edinburgh Medical Journal,' 1818, p. 603.

through the writings of several authors who wrote before the period above mentioned, for evidence of any knowledge of a relationship between the phenomenon in question and opium-poisoning; and even for some years subsequent to the case related by Dr. Kinnis, I find no mention of the fact in the writings of various medical men who wrote on practical subjects.

Note B. (See page 421.)—The fact of spasms of a muscle preceding a condition of paralysis, or *vicé versâ*, is often illustrated in cases of disease where pressure is exerted on the nerves of the extremities. We also have experience of it in the pupils of the eyes, as when a contracted pupil precedes dilatation, consequent upon pressure, as by a tumour upon the third cranial nerve. And a notable instance exists in the spasm of the facial muscles, which not infrequently precedes facial paralysis of the same side—a state which may also *follow* the paralysis, when the muscles and nerves are returning to their natural condition.

Note C. (See page 429.)—It will be remembered, that in man the cervical sympathetic trunks on both sides, whose connexion with the spinal nerves has been previously alluded to, send up processes (varying in number, according to the statement of Weber, even in the same animals) which, surrounding the internal carotid artery whilst in the carotid canal of the temporal bone and before its division within the cranium, form a large network, the carotid and cavernous plexus. From this plexus, besides sundry branches to other parts, which are not to my present purpose, we find communications joining the third and the sixth pair of cranial nerves, as well as the ophthalmic or lenticular ganglion. The branch to the ganglion is of course the medium of innervation to the dilator of the pupil. The communications between the plexus and the *sixth* pair of nerves in man has been found by Valentin, to be effected by several important branches. Cuvier, who made observations on the calf, sheep, wolf, and porcupine, speaks of this communication as consisting of 'a number of filaments;" but, in some animals, accord-

ing to Weber, the branches to the sixth pair are entirely absent, and this may be the case at times in man also.

In man, the communication between the sympathetic plexus and the third cranial pair, is ordinarily effected by two or three branches which join this nerve just before its division into its two major branches, and consequently before the subdivision is given off, destined to the elevator of the upper eyelid and superior rectus.

All these branches, *i. e.*, the one to the lenticular ganglion, that to the external rectus or abducent muscle, and that to the third pair, will be no doubt affected in a similar manner, though possibly in a different degree, by section of, or extreme pressure upon the sympathetic main branches or trunks in the neck, &c. Just as we get paralysis of the dilator of the pupil, and consequently *contracted* pupil, produced by virtue of the branch of the carotid plexus, given off to the ophthalmic ganglion, so have we more or less paralysis of the abducent muscle, by virtue of the twigs furnished to the sixth pair, which supplies that muscle, allowing thus of convergent *squint;* and more or less paralysis of the elevator of the upper eyelid by virtue of the twigs to the third pair, producing *ptosis,* the orbicularis palpebrarum still acting and overcoming that muscle. Possibly, in some cases, more or less of the strabismus may also be caused by virtue of an implication of sympathetic twigs distributed to other branches of the third and the fourth pairs, from which nerves the oblique muscles are supplied.

We have other instances in the human body, besides the external rectus and levator palpebræ, of a single muscle being supplied by different nerves, of which good illustrations are found in the buccinator, the muscles at the angles of the mouth, and the sterno-cleido-mastoid muscles; and, since in such a case both sets of nervous branches must operate upon the muscular fibre, it cannot be doubted, that in proportion as either nervous source becomes weakened, the muscle loses power, and so becomes overbalanced in action by any antagonising muscles. It is most probable also that the sympathetic twigs distributed to the muscle, or joining the nerves of the eyeball, are only concerned in involuntary and consensual movements.