

Physiology and Pathology of the Sympathetic System of Nerves.
By Dr. A. EULENBURG, Prof. of Medicine, Univ. of Greifswald, and Dr. P. GUTTMANN, Privat Docent in Medicine, Univ. of Berlin. Translated by A. NAPIER, M.D., Glasgow.*

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PART II. PATHOLOGY.

In this second part of our Essay we shall discuss a number of diseases which are certainly or probably connected with the sympathetic nervous system.

This connection may result—

1st. From the presence of symptoms which resemble, or are identical with, those which we recognise as expressions of the physiological function of the sympathetic, and which we have enumerated and explained in the former part of this essay.

2ndly. From pathological anatomical changes in the sympathetic nerve.

Those conditions usually go together, but not invariably; thus, the pathological alterations may be completely wanting, or, on the other hand, they may be found in cases which were not before suspected to have any connection with the sympathetic system.

We begin with the consideration of the affections of the cervical sympathetic, afterwards taking up those which probably have relation to some change in the thoracic and abdominal portions of that nerve.

I.—FUNCTIONAL DISTURBANCES IN THE DOMAIN OF THE CERVICAL SYMPATHETIC.

These belong to the most sharply defined group of phenomena met with in the otherwise somewhat obscure pathology of the sympathetic nervous system. The appearances are sometimes those of irritation, sometimes those of paralysis—

* It should be stated that it was for this Essay that the Astley Cooper Prize for 1877 was originally awarded to Drs. Eulenburg and Guttmann—a decision, however, which was subsequently overthrown on the technical ground that the paper was the work of *two* authors, and not of one only—as the terms of Sir A. Cooper's will seem to require. This essay having been handed in in October, 1876, there are no references to any papers on the subject written since then.

approaching in character the symptoms either of experimental stimulation or of division of the cervical sympathetic, the latter* being more common than the former. The symptoms of paralysis of the sympathetic in men are rarely so pronounced as those artificially produced in animals by division, as paralysis seldom attacks *all* the fibres of the nerve, vasomotor as well as oculo-pupillary, as is the case in division.

The conditions which give rise to disturbances of function in the cervical sympathetic may, so far as they are known to us, be arranged as follows:—

- (a) Compression of the cervical sympathetic by tumours.
- (b) Injuries to the cervical sympathetic.
- (c) Injury or disease of the cervical part of the spinal cord.

Besides, there occur simple functional disturbances in the cervical sympathetic, either alone or accompanying some other disease, and without any objectively-demonstrable cause.

In the above order we will now shortly submit the following observations:—

A. Compression of the Cervical Sympathetic Nerve by Tumours.—Willebrandt† observed, in cases of glandular swelling in the neck, a contraction of the pupil, which returned to its normal size when inunction of iodide of potassium had caused the tumours to subside. In cases reported by Ogle,‡ Héineke,§ and Verneuil,|| contraction of the pupil was brought on by large carcinomatous growths in the neck. In the last quoted case there were also symptoms showing that the vasomotor filaments were involved—elevation of temperature and increased secretion of perspiration on the whole of one side of the face. In another case recorded by Ogle,¶ the vasomotor and oculo-pupillary symptoms were very well marked, the compression of the sympathetic being caused by a cicatrix on the right side of the neck. There were here, on the right side, contraction of the

* In Poiteau's comparative observations ("Archiv. gen. de Med," 1869, Août) there are nineteen cases of paralysis and nine of irritation of the cervical sympathetic.

† Willebrandt, "Archiv. für Ophthalmologie," 1855, Bd. I., p. 319.

‡ Ogle, "Medico-Chirurgical Transactions," T. xli., p. 398.

§ Heineke, "Greifawalder med. Beiträge," 1860, Bd. ii.

|| Verneuil, "Gaz. des hôpitaux," 1864, 16 April.

¶ Ogle, "Lancet," 17 April, 1869.

pupil, flattening of the cornea, injection of the conjunctiva, congestion of the ear and cheek, dilatation of the temporal artery, and elevation of temperature in the cavities of the mouth and nose. The same phenomena occurred in a case reported by du Moulin.* B. Fränkel† has lately put on record a case of compression of both sympathetic nerves and of both vagi by a large glandular swelling in the neck, in which the vasomotor and oculo-pupillary fibres were incompletely paralysed. Compression of the sympathetic is also sometimes caused by aneurism of the aorta, of the innominate arteries, and of the carotid: such cases have been observed by Gairdner, Coates, and others, and in one of them the contraction of the pupil disappeared after ligature of the carotid.

Those causes which bring about a state of paralysis in the sympathetic may also produce a condition of irritation, together with all the phenomena dependent on such a condition; and according as only the oculo-pupillary, or also the vasomotor fibres, are irritated, we have dilatation of the pupil alone, or also pallor and a decrease of temperature on the corresponding side. Ogle‡ has published several such cases, especially one communicated to him by Kidd, which is interesting on account of the varying character of the phenomena—at one time those of irritation, at another those of paralysis. It was a case of acute abscess in the neck in which, simultaneously with the formation of pus, and accompanied by acute pain and shiverings, there was an extreme degree of *dilatation of the pupil*, which disappeared after the patient had had a quiet sleep. On the following day the shiverings were renewed, and accompanied by *contraction* of the pupil: this was succeeded by a paroxysm of pain, in which, as at first, the pupil became *dilated*. The same variations were repeatedly observed; and when the abscess had been opened, and was progressing towards cure, the pupil assumed its normal dimensions. In the following year the lady had another abscess in the same region, and in the year after that a third, more deeply situated in the tissues, and all accompanied, but to a less degree, by the same train of symptoms. The phenomena in this apparently complicated case are easily explained. The compression, occasioned by the inflammatory exudation and suppuration,

† Du Moulin, "Bullet. de la Soc. de Méd. de Gand.," 1872.

‡ Fränkel, "Berliner klinische Wochenschrift," 1875, No. 3.

§ Ogle, "Med. Chir. Transactions," T. xli., p. 398.

acted first as a stimulant to the pupillary fibres of the sympathetic, hence the mydriasis; on returning, or on being increased in intensity, this compression had the effect of a force which lessens conducting power—thus causing myosis. Possibly also the rigors may be traced to an occasional abnormal excitation of the vasomotor filaments in the cervical sympathetic. When the bloodvessels of one side of the head contract, less blood flows to the medulla oblongata; this temporary anæmia stimulates its vasomotor nerve-centres, by which means the phenomena attending rigors (contraction of the smallest arteries of the skin) are developed.

H. Demme* noticed mydriasis and slight exophthalmos in a man suffering from cystic goitre. At the examination *the cervical part of the sympathetic on the left side was found abnormally red*, and surrounded by a serous exudation in the connective tissue. No changes were found on microscopic examination. Clearly the swelling here had irritated the oculo-pupillary fibres of the sympathetic. We have met with a very similar case—that of a patient suffering from a vascular goitre almost entirely confined to the right side. The symptoms were extreme mydriasis, complete immobility of the iris, considerable exophthalmos, and loss of accommodation power, in the right eye; in addition to these there was a persistent lowering of the temperature of the auditory meatus of the same side, amounting to 0·3-0·4° C. compared with the healthy side. The pulse was much accelerated. Calabar bean effected a temporary improvement in the mydriasis and the accommodative paralysis; local galvanopuncture, also, was followed by a slight decrease in the size of the tumour and in the frequency of the pulse.

We have thus cited instances, first of paralysis, then of irritation, of the sympathetic, brought on by the pressure of tumours. In both groups the phenomena in the domain of the oculo-pupillary fibres (myosis, connected with paralysis, and mydriasis with irritation) are of a constant and persistent nature, while in the domain of the vasomotor fibres (reddening or pallor) they are inconstant and transient; the reasons for this are yet unknown. Vulpian† supposes that there are vasomotor symptoms in every case of affection of the sympathetic, but only at the beginning; that they sometimes disappear in a few days, or even hours. If such

* Demme, "Würzburger med. Zeitschrift," 1862, Bd. iii., p. 262 and 269.

† Vulpian, "Leçons sur l'appareil vasomoteur." Paris, 1875, p. 142.

patients come under medical observation only at a later period, the vasomotor symptoms may no longer be recognizable, and this, thinks Vulpian, has led to the erroneous conclusion that these symptoms are frequently entirely wanting. There are many considerations in favour of such a view; we would also add that the vasomotor symptoms, when they have disappeared, may periodically reappear.

B. Injuries to the Cervical Sympathetic.—The number of exact observations bearing on this point is very small; there are, especially, almost no recorded cases in which we can assume with confidence the existence of a direct, uncomplicated injury, confined to the cervical part of the trunk of the sympathetic.

We will first allude to the following case, which has been published by three American practitioners (Weir Mitchell, Morehouse, and Keen) in their interesting monograph on injuries of nerves.* It was a case of *gunshot wound of the right sympathetic*. The ball had entered on the right side of the neck, 4 centimeters behind the ramus of the jaw, at the anterior margin of the sterno-mastoid muscle; it had passed through the neck, and emerged immediately below, and about $1\frac{1}{2}$ centimeter in front of the angle of the jaw on the left side. The wounds were healed in six weeks, but it was only at the end of ten weeks that the patient came under the observation of these writers, though a comrade of the wounded man had already noticed *the unusually small size of the right pupil* one month after the injury. Besides this, when the patient was first seen, there were observed in the *right eye myopia, slight ptosis, apparent sinking of the outer angle, decrease in the apparent size of the eyeball, and redness of the conjunctiva*. Further, it was repeatedly noticed that, after violent exercise, *the right half of the face was unusually red*, while the left side remained pale; this was accompanied by pain and reddish flashes of light in the right eye. When the temperature was taken after the patient had rested, there was found to be no difference in the mouth and ear on both sides; no observation was made when the patient was excited by exertion. He was able to return to service five months after receiving the injury.

This case, while it probably indicates bruising (or laceration?) of the right sympathetic by the projectile, gives rise to several remarks regarding the symptoms. We find in it

* S. Weir Mitchell, George R. Morehouse, and William Keen—"Gunshot Wounds and other Injuries of Nerves." Philadelphia, 1864.

nothing which does not receive a sufficient explanation in the results of experimentally injuring the sympathetic in animals and from other pathological observations in men. The ptosis, the sinking of the outer angle of the eye, the apparent small size of the right eyeball, all arise from loss of power in certain of the muscles of the eye, which have their nerve-supply from the cervical sympathetic, and whose special functions we have already discussed. The reddening of the conjunctiva and the flow of tears depend on functional derangement of vasomotor nerve fibres which pass from the sympathetic to the first of the branches of the trigeminus, and which supply the conjunctival vessels: paralysis of these is followed by partial relaxation of the vessels, and increase in the flow of blood and of the conjunctival mucous secretion. The altered refractive power of the eyeball, the myopia, is, in the first place, the necessary consequence of the persistent paralytic myosis, and, secondly, may be regarded as produced by the presumed direct influence of the sympathetic on the muscle of accommodation (M. tensor choroidea), or on detached fibres of that muscle.

Alongside of this case may be put one of Kämpf's.* He brought before the Society of Physicians in Vienna a soldier with myosis paralytica in the right eye, following a *wound of the cervical part of the sympathetic of the same side*. This soldier, in the battle of Orleans, received a stab in the right side of the neck, the direction of which was clearly marked by a cicatrix lying on the outer edge of the sterno-mastoid muscle. The myosis, evidently due to paralysis of the fibres of the sympathetic and to the preponderating influence of the sphincter iridis, was in no way improved by the repeated employment of electricity. Kämpf's communication contains no further reference to anomalies in the domain of the cervical sympathetic.

Here, also, should be mentioned a case recorded by Seeligmüller,† in which, as the result of a *gunshot wound*, there was *paralysis of the left cervical sympathetic*, and of the ulnar nerve. During the Franco-Prussian war an officer, twenty-five years of age, was wounded in the left shoulder by a chassepot bullet. The orifice of entrance was on the clavicular portion of the left sterno-mastoid muscle, 3 centimeters above the upper edge of the collar bone; the orifice

* Kämpf, Sitzung der K. K. Gesellschaft der Aerzte in Wienam, 8 März. 1872.

† Seeligmüller, "Berliner klin. Wochenschrift," 1872, No 4.

of exit was to the left of and close to the spinous process of the fourth dorsal vertebra: the first was cicatrized in six weeks, and the latter in eleven. Nine months after receiving the wound, the following appearances were noted: the left palpebral fissure was smaller than the right; the left pupil more contracted than the right, and dilating to a less degree when shaded; injection of the vessels of the conjunctiva and redness of the cheeks, usually equal on both sides, but sometimes more marked on the left side after mental disturbance; the temperature in the left auditory meatus 0.1° C. higher than in the right; a flow of tears from the eyes; *striking emaciation of the left cheek, which appeared flatter than the right*; besides all this a paralysis of the ulnar nerve.

The flattening and emaciation of one side of the face observed in this case, which also occurred in some others to be mentioned further on, appear to occur more frequently at a later stage in paralysis of the sympathetic. At least, Nicati* states, as the result of some original investigations, that to the first stage of the paralysis a second succeeds, characterised by atrophy, pallor, lowering of temperature, and arrest of the transpiration, on one side of the face. We will again refer to this atrophy when discussing unilateral, progressive, facial atrophy, and its relations to lesions of the cervical sympathetic.

Continuing the argument regarding injuries of the sympathetic, we quote a case described by Bernhardt†. On the 4th day of August, 1870, in the war with France, a German soldier was wounded in the left side of the neck by a bullet. Two years after the injury there was rather a large cicatrix, painful on pressure, situated on the front of the neck, at the inner edge of the left sterno-mastoid muscle, and about two fingers'-breadth above the left sterno-clavicular articulation; this was the orifice of entrance of the bullet. The orifice of exit was behind, at the level of the fourth dorsal vertebra, and to the left of the spinous process; here, also, the scar was very tender.

Besides various phenomena depending on a simultaneous injury sustained by the spinal cord, and of which we need give no particular account here, there were the characteristic signs of *paralysis* of the sympathetic, clearly caused by *injury*. The left eye appeared smaller, and less widely open;

* Nicati, "La Paralysie du nerf sympathique cervical." Lausanne, 1873.

† Bernhardt, "Berliner klin. Wochenschrift," 1872, No. 47 and 48.

the left pupil more contracted, and acting more sluggishly, than the right. The left side of the face was more emaciated, at times redder, and always warmer, than the right. Lachrymation was more easily excited in the left eye, and the temperature in the left auditory meatus was $1\frac{1}{4}^{\circ}$ C. higher than in the right.

Occasionally, though rarely, one meets with the same symptoms resulting from injury that are observed to follow experimental *irritation* of the cervical sympathetic. Seeligmüller* has described such a case. A smith sustained a very severe blow with an iron implement in the left supra-clavicular region, so that he lay stunned several hours. Two days later, on coming under medical treatment, it was seen that the left pupil was much dilated, at least one half wider than the right, but still responding quite as readily to the stimulation of light. The left palpebral fissure was somewhat wider than the right, and the left eyeball pushed a little forward. The whole left side of the neck and head (the latter being bald) and the left ear were markedly paler than the corresponding regions on the right side. Pulsation in the right temporal artery was well marked, that on the left scarcely perceptible. The temperature in the left auditory meatus was lower than in the right, the difference sometimes amounting to $0.15-0.9^{\circ}$ C. In the left supra-clavicular region was a doughy swelling, which disappeared in a short time. The cervical part of the sympathetic at the inner edge of the sterno-mastoid muscle was, from its middle to the ganglion supremum, very tender. On exercising pressure on the ganglion, and on galvanic irritation of the left sympathetic, the pupil became still more dilated, while pressure on the right sympathetic gave no result. Refraction and accommodation in the left eye remained normal, which proves that the dilatation of the pupil was caused by irritation of the sympathetic, and not by paralysis of the oculomotorius. In about five weeks all the symptoms had passed off, the vasomotor phenomena having lasted only a few days.

A second case, having a bearing on this part of our subject, was reported, in Flensburg, in 1864. In the war with Denmark at that time a soldier was wounded in the neck by a rifle bullet, and immediately afterwards there was decided dilatation of one pupil. Whether, in this case (of which we

* Seeligmüller, "Archiv. für Psychiatrie und Nervenkrankheiten," 1875, Bd. v., p. 885.

have received but a very imperfect report), there were other appearances indicating a state of irritation of the sympathetic, we do not know. The patient died of exhaustion, after prolonged suppuration; at the post-mortem examination it was impossible to find the sympathetic on account of the great destruction of soft parts in the neck.

C. Injury to the Spinal Cord in the Neck and to the Brachial Plexus.—Disturbances of function in the domain of the cervical sympathetic, associated with injuries of the cervical part of the spinal cord possess no special or peculiar character, as both the oculo-pupillary and vasomotor nerve filaments run some distance in that part of the spinal cord, leaving it through the anterior roots and the rami communicantes, and so passing over to the trunk of the cervical sympathetic. As in cases in which the cervical sympathetic itself is wounded, so after injury of the spinal cord in the neck myosis paralytica is often met with, from an interruption (of traumatic origin) of the conducting power of the oculo-pupillary fibres in the medullary part of their course: more rarely this is followed by irritative dilatation of the pupil—mydriasis spastica. The number of observations relating to this point is indeed few, as, in most recorded cases of injury of the spinal cord in the neck, the pupillary symptoms and the local disturbances of the circulation have received no special attention. In about one hundred cases of such injury Rendu* found but sixteen in which notice was taken of the state of the pupil. He has published two of Desormeaux' cases in which, coincident with injury of the spinal cord in the neck, there were various changes in the pupil. In the first case the spinal cord was completely disorganised by dislocation of the sixth cervical vertebra: during life both pupils were greatly contracted, the face and neck of a purplish red hue, the ears very red, while there was no change in the colour of the rest of the body. Thus, in this case, the vasomotor fibres for the vessels of the head were also probably paralysed. In the second case there was hæmorrhagic softening of the spinal cord at the level of the seventh cervical vertebra, produced by fracture in that situation; the patient showed great pallor, *one pupil widely dilated*, and the other somewhat contracted. Here the irritative phenomena seem to

* Rendu, des troubles fonctionnels du grand sympathique, observés dans les plaies de la Moëlle cervicale. "Archiv. gen. de méd.," 1869, Sept., p. 286-297.

have predominated, as may be inferred from the facial pallor and the mydriasis.

In one case of injury of the spinal cord, by a fracture of the seventh cervical vertebra, Hutchinson* observed contraction of the pupil—a symptom which was wanting in two otherwise similar cases.—Finally, we quote a case of injury of the spinal cord, recorded by M. Rosenthal,† which occurred in the person of a tradesman who had been stabbed in the neck, in the neighbourhood of the sixth cervical vertebra. Besides paralysis of the upper and lower limbs of the right side, he found *dilatation of both pupils*, especially of the left, and a *strikingly slow pulse* (48 per minute), which phenomena lasted four weeks. The patient eventually completely recovered. Here, as in the second of Rendu's cases, mentioned above, there existed a condition of irritation in the pupillary filaments of the sympathetic, accompanied also by a similar affection of the cardiac fibres of the vagus.

Paralytic myosis occurs not uncommonly, also, in non-traumatic diseases of the cervical portion of the spinal marrow, when the oculo-pupillary fibres are affected. Thus, Ogle has observed contraction of the pupil in five cases of disease of the spinal cord in the neck; and lately Bærwinkel‡ has described paralysis of the oculo-pupillary sympathetic fibres as a symptom in sclerosis of the medulla oblongata. In certain forms of tabes dorsalis, especially in that called tabes cervicalis by Remak, contraction of the pupil, on one or both sides, is a very characteristic symptom. It has been shown that paralysis of the oculo-pupillary filaments takes place in some cases of progressive muscular atrophy; to this we will again refer. On the other hand, it happens less frequently that irritative phenomena (such as dilatation of the pupil) result from non-traumatic affections of the spinal marrow in the neck. We ourselves have met with a case of that nature—mydriasis spastica from caries of the vertebræ. The patient was a boy of eight years, suffering from Potts' disease of the last cervical and three upper dorsal vertebræ. The right pupil was always wider than the left, and responded but very feebly to the stimulus of light, while the left still preserved its normal sensibility. The diameter of the right pupil was $3\frac{1}{2}$ lines, that of the left only 2 lines. The degree of mydriasis present was not the greatest pos-

* Hutchinson, "Lancet," 1875, 21 and 29 May.

† M. Rosenthal, "Oesterr. Zeitschrift für pract. Heilkunde," 1866, No. 46.

‡ Bærwinkel, "Archiv. für klin. Medicin," Band xiv., p. 545.

sible, as instillation of atropine dilated the left pupil to the extent of more than 4 lines; the immobility of the pupil, also, was not complete, as a very powerful light still produced a slight contraction. A low degree of hypermetropia was found on both sides, especially the right; accommodation and definition were normal. No constant or important differences in the action of the vasomotor nerves of the two sides of the head could be recognised. On ophthalmoscopic examination it was found that in the fundus of the eye, otherwise normal, there was a complete equality in the size of the arteries and veins. The spastic mydriasis remained about four weeks, and then gradually disappeared. When the patient was dismissed, after three months' treatment, both pupils were again nearly equal, the right, however, acting more sluggishly than the left.

The cause of the mydriasis in this case can be sought only in a morbid change in the spinal cord and its immediate surroundings, and consequent irritation of the pupillary sympathetic fibres; it is to be looked for particularly in the inflammatory processes in the bodies of the vertebræ, involving just those vertebræ (the lower cervical and upper dorsal) which correspond to the *centrum ciliospinale inferius*. Whether it is from simple compression, or from inflammation going on in the cord and its membranes, with thickening of the latter, and with circumscribed softening, are questions which must remain undecided.

Hutchinson* first observed also that in cases of *traumatic paralysis of the brachial plexus* there is usually a simultaneous *paralysis of the cervical sympathetic*, manifesting itself by myosis with loss of mobility of the pupil, by narrowing of the palpebral fissure, and by a rise in the temperature of the corresponding side of the face. Seeligmüller† afterwards confirmed Hutchinson's statements. Two instructive cases of traumatic paralysis of the brachial plexus with functional disturbances, especially in the domain of the oculo-pupillary fibres, of the cervical sympathetic came under his observation. In the first case, that of a child aged nine months, who had sustained a fracture of the clavicle and of the neck of the scapula in the act of birth, there was complete paralysis of motion and sensation in the right forearm; there were, moreover, some differences observable in the eyes. Much

* Hutchinson, "Med. Times and Gaz." 1868, p. 584.

† Seeligmüller, "Ueber Sympathicus-Affectionen bei Verletzung des Plexus brachialis," Berl. klin. Wochenschrift, 1870. No. 26.

less of the eyeball was seen through the palpebral fissure on the right side than on the left, in consequence of a marked difference in the vertical diameter of these fissures; the right pupil was at least one half smaller than the left, and was on some days contracted to the size of a pin's head, but still acting normally under the influence of light and shade. With respect to the colour and temperature of the skin, the two sides of the face were alike, but in the course of the disease a slight but perceptible atrophy of the right side of the face presented itself. The paralysis improved under the use of electricity; after three months the right pupil, too, was not so contracted as formerly, but with that exception the state of the pupils and of the atrophied parts remained unchanged. The second case was that of a man of 34 years, who was run over by a railway waggon, sustaining an injury to the left breast and shoulder, and fracture of the left forearm. Three months afterwards there were paralysis and emaciation of the left arm, with considerable disturbances of nutrition, and complete anæsthesia of the whole forearm. The left pupil was only half as widely dilated as the right, but quite sensitive to light, and the palpebral fissure on that side was only a very little shorter than that on the right. On instillation of atropine the contracted pupil became dilated almost as widely as possible, and in the following 48 hours contracted but slightly, though the paper prepared with Calabar bean was used. Galvanic irritation of the cervical sympathetic, though repeatedly tried, was followed only once by a transient dilatation of the pupil; whilst under this treatment, however, the left ear was usually warmer to the touch than the right, a sensation which was felt by the patient himself. He was a long time under observation, but the differences between the pupils remained unchanged.

The phenomena in the two last-mentioned cases correspond to a paralysed condition of the cervical sympathetic, but only in the sphere of the oculo-pupillary fibres, whilst the vasomotor fibres appear to be quite unaffected. Whether the trunk of the sympathetic itself, or the middle cervical ganglion, or the twigs passing from that ganglion to the brachial plexus, were injured, remains unknown.

Further, Bærwinkel,* in two cases of traumatic paralysis of the brachial plexus, (produced, in one instance, by fracture

* Bærwinkel, "Zur Pathologie des Sympathicus." *Deutsches Archiv. für klinische Medicin.* Bd. xiv., p. 545.

of the clavicle, in the other by a gunshot wound), observed paralysis of the oculo-pupillary sympathetic filaments, indicated by narrowing of the palpebral fissure, ptosis, and contraction of the pupil.

As far as we know there are no other published cases of the occurrence of paralysis of the sympathetic attendant on traumatic paralysis of the brachial plexus. Hutchinson errs in stating that this coincidental relation is *invariable*. We ourselves have, with this point in view, examined a considerable number of isolated, usually traumatic, cases of paralysis of the brachial plexus, both recent and of long standing, but without finding any trace of paralysis of the cervical sympathetic.

There may be disturbances of function in the cervical sympathetic which are not referable to any of the causes already mentioned, and these may appear in the domain of the sympathetic alone, and not in connection with any other complaint. In such cases also, as we formerly stated, the paralytic condition is more common than the irritative, and the oculo-pupillary fibres are more frequently and more persistently affected than the vasomotor fibres.

Several cases in point will be mentioned in the next section.

II.—UNILATERAL HYPERIDROSIS.

Among the symptoms following division of the sympathetic there is sometimes, as Cl. Bernard has stated with reference to horses, an abnormally profuse secretion of perspiration on the side of the head operated on. This has also been observed in the human subject in paralysis of the cervical sympathetic, and sometimes to such a degree that it was regarded as the principal symptom, and, as such, first attracted the patient's attention to his condition. Different cases of paralysis of the sympathetic, in which this was the predominating symptom, have been described under the special name Hyperidrosis or Ephidrosis unilateralis. On the other hand, cases of unilateral secretion of perspiration have been recorded, some being confined to one side of the head, some extending over greater part of one side of the body, but in which other indications pointing to disorder of the sympathetic were entirely wanting. Setting aside some very old observations on this point, which have been brought together in a work by Nitzelnadel,* the above statements refer

* Nitzelnadel, "Ueber nervöse Hyperidrosis und Anidrosis," Jena, 1867, Inaug. Dissert.

specially to the more modern contributions of Meschede,* Berger,† Wiedemeister,‡ and others. Cases of Ephidrosis, however, which are with certainty known to be dependent on paralysis of the sympathetic, are rare. Verneuil and Ogle met with some, quoted in the former part of this work. Otto§ and Nitzelnadel|| mention one such, Bærwinkel¶ several. Kulz** describes two cases of Ephidrosis accompanying diabetes mellitus, though only the vasothermic, and not the oculo-pupillary, phenomena were present. Very aggravated cases, in which, besides the hyperidrosis, the other symptoms of paralysis of the sympathetic were unmistakably manifested, have been observed by Chvostek,†† Pokroffsky,‡‡ and ourselves. Our case was that of a man 44 years of age, who, after even very moderate exercise, perspired profusely on the left side of the face, and occasionally also on the left side of the throat and neck. Simultaneously with the breaking out of the perspiration the left side of the face and the left ear became red, and the temperature in the left external auditory meatus rose several tenths C. above that in the right. There was also considerable injection in the vessels of the left conjunctiva, while lachrymation was sometimes more easily excited in the left eye than in the right. The left pupil was constantly more dilated than the right, but responded to the stimulus of light. Accommodation remained normal, and there was no interference with nutrition. In the neighbourhood of the left cervical sympathetic there was some tenderness on pressure, perhaps the indication of a state of chronic inflammation of that nerve. It is worthy of note in this case that, while the vasomotor fibres were in a state of paralysis the pupillary fibres were in a condition of irritation.

Only two opportunities have presented themselves for investigating the nature of the pathological changes which take place in sympathetic hyperidrosis. In one case, Seguin¶¶ found no difference between the cervical sympathetic

* Meschede, "Virchow's Archiv," Bd. xliii., p. 139.

† Berger, "Virchow's Archiv," li., p. 427.

‡ Wiedemeister, "Virchow's Archiv," Bd lii., p. 437.

§ Otto, "Archiv. für klin. Medicin." Band xi., Heft 6.

|| Nitzelnadel, L. c.

¶ Bærwinkel, "Archiv. für klin. Medicin," 1874. Bd. xiv., p. 550.

** Kulz, "Beiträge Zur Pathologie und Therapie des Diabetes," 1874, pp. 23 and 27.

†† Chvostek, "Wiener med. Wochenschrift," 1872. No. 19 and 20.

‡‡ Pokroffsky, "Berliner klin. Wochenschrift," 1875. No. 13.

¶¶ Seguin, "American Journal of Medical Sciences," Oct., 1872.

nerves of the right and left sides. The ganglionic cells seemed to be filled with an unusually abundant granular pigment, but this was equal on both sides. To the naked eye also they were alike. Ebstein* has recorded the case of a man, 60 years of age, who suffered from hyperidrosis of the left side, which appeared suddenly after a paroxysm of angina pectoris, and subsequently invariably accompanied each attack. On examination with the unaided eye no change was found in the sympathetic or its ganglia; but microscopic examination of thin sections of the ganglia of the *left* sympathetic revealed the presence of extremely varicose and dilated vessels, while on the right side no trace of such a structure was found. On the basis supplied by this discovery Ebstein explains hyperidrosis. He believes that these varicosities receive, at different times, a blood supply of varying amount. When the quantity is abnormally great, some of the sympathetic nerve elements must be temporarily compressed, and so paralysed—exactly as, in very vascular new formations in the brain, various paralytic phenomena occur in different parts of the nervous system, all of which disappear when the quantity of blood in circulation is reduced.

III.—HEMICRANIA.

Our conception of the proper nosological position of Hemicrania was, till lately, very obscure. Old authors (as Wepper, Tissot) have identified the disease with Prosopalgia, especially that form occurring as supra-orbital neuralgia; and Schönlein, who classifies hemicrania among the neuroses of the genital system, calling it "Hysteria Cephalica," places the seat of pain in the ramifications of the frontal and temporal nerves. Even at the present time there are not wanting pathologists (Lebert, Stokes, Anstie, Clifford Albutt) who look upon hemicrania as a simple neuralgia, affecting the first division of the trigeminus. Believing in this doctrine many men have somewhat arbitrarily distinguished between various forms of hemicrania, according to the presumed or actual causes giving rise to it. Thus, Sauvages speaks of ten varieties of hemicrania, and Pelletan of "Migraine stomacale, irienne, utérine, pléthorique." Monneret and Fleury recognise "Migraine idiopathique" and "sympathique," a classification which is adopted also by Valleix. An important step was taken by Romberg when

* Ebstein, "Virchow's Archiv.," 1875. Bd. lxii, p. 435.

he associated hemicrania with the "Hyperæsthesiæ of the brain," with painful affections of the brain, thus defining it sharply from the peripheral neuralgias, calling it "Neuralgia cerebialis." Later pathologists took the same view; thus Leubuscher calls hemicrania *the* neuralgia of the brain. The fact that we are able to localise the seat of the pain in the brain, or in the parts of it endowed with sensation, does not much advance our knowledge of the pathogeny of the disease, and Romberg's conception of hemicrania as one of the cerebral neuroses is open to the same objection. Romberg was, as it appears, specially led to that conclusion by the sympathetic connections existing between the trigeminus and the nerves of special sense, and by the favourable effect produced by physical and mental exercise. But Hasse has remarked, with justice, that deciding according to the analogies offered by other neuralgias, the sympathetic connection of several cranial nerves, and the reflex phenomena resulting therefrom, give no ground for assuming the ramifications of the trigeminus within the cranium as the seat of the disease.

Sixteen years ago Du Bois-Reymond,* from personal observation, inferred that his migraine was caused by *tetanus of the muscular coat of the vessels on the affected side of the head*, or, in other words, *tetanus in the region supplied by the cervical part of the (right) sympathetic nerve*. He found that during the attack the temporal artery of the painful side was hard and cord-like to the touch, while that on the left side was in its normal state. The face was pale and sunken; the right eye small and injected. The pain was increased by everything which raised the blood-pressure in the head (as stooping, coughing, &c.), this increase being synchronous with the pulse in the temporal artery. Towards the end of the attack the right ear became warm and red. These phenomena, the state of the temporal artery, the bloodlessness of the face, the sunken appearance of the right eye, show that the muscular coat of the vessels of the affected side of the head was persistently contracted. On removal of the cause which produces this condition of tonic spasm, relaxation follows the overaction of the unstriated muscular fibres, and the walls of the vessels yield more than usually to the lateral pressure. This secondary relaxation explains the congestion of the conjunctiva, and the redness and in-

* Du Bois-Reymond, "Zur Kenntniss der Hemikranie, Archiv. für Anat. und Phys.," 1860, p. 461-468.

creased temperature of the ear, which occur when the violence of the attack begins to subside. The vomiting and the flashes of light before the eyes which frequently accompany hemicrania are caused by sudden changes in the intracerebral blood-pressure; and these variations obviously correspond to the irregular contraction and relaxation of the unstriated muscular coat of the vessels.

Such a pre-supposed tonic vascular spasm of one side of the head can, as we know from physiological facts, have its origin only in the sympathetic nerve of the same side, or in the medullary centre of the sympathetic fibres involved; that is, in the corresponding half of the regio ciliospinalis of the spinal cord. Hemicrania is thus to be regarded, not as a neuralgia of peripheral nerves or of the brain, and generally not as a primary cerebral disease, but as an affection of the cervical sympathetic nerve, or of a certain part of the spinal cord. This apparently rash assertion receives strong support from a further observation by du Bois-Reymond. He noticed, in the course of the attack, a dilatation of the pupil on the affected side. A medical visitor confirmed this observation: and the more shaded the eyes were, the more decided was the difference in the size of the pupils, exactly as in tetanus of the cervical part of the sympathetic. Latterly, during and after the attack, the spinous processes corresponding to the regio ciliospinalis were painful to pressure.

Whether, at the end of the paroxysm, there was decrease in the size of the pupil in conjunction with the elevation of temperature and the redness, was not stated; but in several instances, otherwise identical in type with that quoted, we have observed a decided contraction of the pupil on the affected side of the head as the attack was passing off. Brunner* remarked in his own case, besides the symptoms mentioned by du Bois-Reymond, pain on pressure in the neighbourhood of the upper, and sometimes also of the middle cervical ganglion. This tenderness disappeared slowly, usually on the following day, and palpitation of the heart and acceleration of the pulse were frequently observed at the close of an attack.

Brunner noticed the same symptoms also in the case of his mother. We ourselves and some other authors have seen, in several analogous cases of migraine, a more or less considerable increase in the quantity and tenacity of the saliva.

* Brunner, "Zur Casuistik der Pathologie des Sympathicus." Petersburger med. Zeitschrift, N. T. Bd. ii., 1871, p. 260.

In one case, Berger* found that two pounds of tough saliva had been discharged. This symptom, also, is to be classified with those already mentioned, since secretory fibres for the salivary glands are included in the cervical sympathetic, and irritation of these in animals produces similar effects. The question arises, in what relation the tetanus of the region supplied by the right sympathetic stands to the hemicranial pain, whether it is only a concomitant symptom, or the cause of the migraine, that is, of the paroxysmal attacks of pain. With regard to this, du Bois-Reymond has suggested that the state of tonic spasm of the unstriated muscles of the vessels may itself be that which causes the pain: just as it is felt in striped muscular fibre, in cramp of the calf of the leg, and in tetanus; or in unstriated muscular fibre, in the uterus during labour-pains, in the intestines during an attack of colic, and in the skin during rigors. Probably this pain comes from pressure on the nerves of sensation distributed within the muscular tissue; this pressure, and consequently the pain, will be augmented when the tetanic muscles are more strongly exerted, as, for instance, in the case of cramp in the calf when the muscles are extended, either by means of the antagonistic muscles, or by the weight of the body, the ball of the foot being supported. This also is produced in tetanus of the muscular coat of the vessels when the lateral blood-pressure is increased. Thus a reasonable explanation is found for the observation that pain is increased along with the blood-pressure, and synchronously with the pulsations of the temporal artery.

Besides du Bois-Reymond's explanation of the pain, another one appears to us worthy of mention, being perhaps more probable and less forced. In the variations in the flow of arterial blood, especially in the temporary anæmia of the affected side of the head, a shock may be given which irritates the sensory nerves of the head, whether those in the skin, the pericranium, the membranes of the brain, the sensitive parts of the brain itself, or in all these at once, and thus causes the hemicranial pain. Sensory nerves are brought into a state of great excitement by changes in the diameter of the accompanying and surrounding bloodvessels, especially when these changes occur with a certain degree of suddenness. This condition is met with in very different cases of neuralgia, as in facial neuralgia and sciatica, &c.

* Berger, "Zur Pathogenese der Hemicranie." *Virchow's Archiv*, lix., Heft 3 and 4, 1874.

Those neuralgias, also, which usually follow herpes zoster—which occur most commonly in the body, but sometimes in the face and extremities—are very probably to be referred to this source. Anomalies of the circulation generally, and anæmia specially, have been long ago recognised as important causes of neuralgic affections in different parts of the body. The aggravation of the hemicranial pain in stooping, coughing, &c., and the peculiar effect of compressing the carotid, originate in this way. In many cases of migraine the pain ceases on compressing the carotid on the painful side, but is increased by compression of the carotid on the sound side. In one case, however, we observed the opposite—that the pain became decidedly worse on exercising pressure on the carotid of the same (the right) side, while compression on the left side at once alleviated it. This case strikingly demonstrates the good effects of local anæmia. Probably the direct cause of migraine is to be found in the local alterations in the circulation, while the state of the muscular coat of the vessels, being the most common cause of these variations, can be regarded as playing only a secondary part in the origination of the affection. The inequality and inconstancy of the pupillary and vasomotor phenomena are strongly in favour of this view.

The objection raised by Brown-Séguard* and Althann† against du Bois-Reymond's theory, that, according to the experiments of Kussmaul and Tenner, the occurrence of epileptic convulsions should be expected in unilateral vascular tetanus in the brain, is not defensible, since it is proved, both by the formerly-quoted experiments of Fischer, and by those performed by ourselves, that in unilateral experimental irritation of the cervical sympathetic convulsions do not occur, but always contraction of the vessels and lowering of the temperature on one side. The same symptoms occur also in pathological cases of unquestionable (mechanical) irritation of the sympathetic in men, as has already been in part described in the foregoing section. That there is a certain genetic relation existing between migraine and epilepsy is beyond a doubt; suffice it to state that in hereditarily and constitutionally predisposed epileptics migraine is one of the most frequent accompanying symptoms, both in early life

* Brown-Séguard, "De l'hémicranie ou migraine, par le Dr. du Bois-Reymond," *Journal de Phys.* 1861.

† Althann, "Beiträge zur Physiologie und Pathologie der Circulation." *Dorpat*, 1871.

and afterwards with fully-developed epilepsy, and that in families prone to be affected with constitutional neuropathic complaints some members often suffer from migraine, others from epilepsy, and various affections belonging to the same group.

Du Bois-Reymond has remarked that by no means all cases of migraine present the above-mentioned symptoms during the attack; that especially the difference in the size of the pupils in many otherwise very pronounced cases of periodic unilateral headache is not observed. He has therefore proposed the name *Hemicrania Sympathico-tonica* for those cases resembling his own, in which one may assume the existence of tetanus in the cervical part of the sympathetic as a patho-genetic force. More recently, Möllendorff,* apparently without any knowledge of du Bois-Reymond's paper, has set up a theory of migraine which really amounts to this—that hemicrania is due to a unilateral *loss* of energy in the vasomotor nerves governing the carotid artery, whereby the vessels are *relaxed*, and permit of an increased flow of arterial blood towards the head. In the case recorded by Möllendorff the rate of the pulse was reduced to 56—48 per minute, the radial arteries were small and contracted, and the pulse in the carotid and temporal arteries of the painful side was soft and wavy. Compression of the carotid of the affected side during the attack instantaneously dissipated the pain, which returned with the first beat of the pulse on slackening the pressure. On the other hand, the pain was aggravated by pressure on the carotid of the other (sound) side.

Ophthalmoscopic examination of the eye on the painful side, in a patient suffering from migraine, showed during the attack dilatation of the central vessels, the art. and vena centralis retinae, the latter being knotted and convoluted, and of much darker colour than usual; the choroidal vessels also were enlarged, so that the fundus of the eye was of a bright scarlet colour instead of its usual dark-brownish red. Sometimes there was considerable injection of the episcleral vessels as far forward as the edge of the cornea, disappearing on subsidence of the attack. The fundus of the other eye was normal, the art. and vena centralis having their usual appearance. It is, unfortunately, not stated at what stage of the attack the examination was made, though probably it was towards the end. In a similar case Berger and H. Cohn

* Möllendorff, "Ueber Hemicranie," Virchow's "Archiv. für path. Anat." Bd. xli, p. 385-395.

found the fundus of the eye normal. In several analogous cases of migraine we ourselves observed a more or less marked *contraction of the pupil*, sometimes a diminution in the size of the palpebral fissures, retraction of the globe of the eye, partial ptosis in, and difficulty of moving, the upper lid. The ear on the same side was red and hot, and the temperature in the external auditory meatus was raised 0·2-0·4° C. The secretions of the skin were increased, and sometimes ephidrosis unilateralis occurred.

It thus follows that there are cases of hemicrania which are entirely opposed in character to that of du Bois-Reymond—that is, in which the striking symptoms are not those of *spasm* in the vessels, of arterial tetanus in the parts supplied by the cervical sympathetic, but those of *relaxation* of the vessels, of arterial hyperæmia caused by a loss of energy in the vasomotor nerves. These are cases that one might designate *Hemicrania Neuroparalytica*, or *angioparalytica*, as opposed to du Bois-Reymond's *H. Sympathico-tonica*. In such circumstances the occurrence of the pain can certainly not be explained in the same way as in the former class of cases.

Our interpretation of the phenomena, however, is applicable here, as the temporary increase of the blood-pressure, the greater quantity of blood in the small arteries and veins, gives rise, by irritation and compression of the nerve elements, to the pathognomonic symptoms of hemicrania in exactly the same way as in the opposite case—arterial anæmia and decreased blood-supply from spasm in the vessels. We know, further, from other sources, that increased or diminished blood-supply, anæmia or hyperæmia, agree closely in their action on the brain; that, for instance, epileptic seizures take place both in anæmia of the brain (according to the Kussmaul-Tenner experiments) and in hyperæmia of the brain (through retardation of the return of venous blood by closure of the vena cava superior*), and that the effect on the action of the heart and the frequency of the pulse is quite analogous in both conditions. †

The lowering of the rate of the pulse, which Möllendorff does not explain, has been noticed by Landois in hyperæmia of the brain and medulla oblongata, produced artificially by compressing the superior vena cava; he has observed it also after extirpating both cervical sympathetic

* Hermann und Escher, Pflüger's "Archiv. für Physiologie," 1870, p. 3.

† Landois, "Centralblatt für die med. Wissensch.," 1865. No. 44; 1867, No. 10.

nerves, but not when the spinal marrow had been previously destroyed or the vagi divided. This decrease in the frequency of the pulse, which, in congestion of the brain, may proceed to arrest of the heart's action, and may be complicated with epilepsy, is dependent on a *direct*, not a reflex, *irritation of the medulla oblongata and of the vagi*; division of the latter, whilst there is hyperæmic retardation of the pulse, is at once followed by acceleration of the pulse.

Since the centres for most of the vaso-motor nerves of the body are situate in the medulla oblongata, irritation of that important part of the nervous system furnishes a full explanation of the fact that the radial arteries are small and contracted in hemicrania, of the occurrence of icy coldness of the hands and feet and cold shiverings over the whole body, and of the suppression of perspiration during the paroxysm. The last-mentioned symptom, however, is often absent on the affected side of the head. This contraction of the peripheral arteries is followed by dilatation, by secondary relaxation. It may be this which gives rise to the augmentation of the secretion of saliva and urine occurring towards the end of an attack, and also to the swelling of the liver and hypersecretion of bile, to the gradually developed plethora of the abdominal organs, the tendency to bronchial catarrh and emphysema of the lungs, which, Möllendorff alleges, eventually appears in persons affected with hemicrania.

The views advanced by du Bois-Reymond and Möllendorff appear to us to be of some importance in the *therapeutics of hemicrania* but in a way quite different to that claimed for them by these authors. Du Bois-Reymond merely hints that in the form described by him remedial measures should be directed specially to the regio ciliospinalis. Möllendorff says absolutely nothing concerning local treatment; and yet it is specially to local measures, as opposed to the hitherto fruitless general treatment and empiricism, that we should look for most benefit. It is, further, on local experimental evidence that we found the doctrine that migraine is a periodically recurring neurose of the vessels of the head, an affection of the cervical sympathetic, or of the central origin of the vasomotor filaments of the vessels of the head—the regio ciliospinalis of the spinal cord. Bernatzik * ascribed the well-known effects of caffeine and quinine in cases of migraine, in the stage of relaxation which follows the primary spasm

* Bernatzik, "Wiener med. Presse," 1867. No. 28.

of the vessels, to decrease in the quantity of blood in the vessels of the brain; he represented the operation of these remedies as depending really on irritation of the vasomotor nerves, on increase of the arterial tone. It is possible that the above-mentioned remedies may be of special use in those cases of migraine that we distinguished as neuro-paralytic or angio-paralytic, in which, during the attack, the most prominent symptoms are those of relaxation of the vessels and of arterial hyperæmia.

We ourselves met with a case clearly belonging to the last category, in which quinine had a rapid and surprising effect. The case was that of a boy, eight years of age, who suffered from a daily attack of hemicrania in the left side of the head; it began usually about midnight, and lasted till the forenoon of the following day, gradually declining in intensity. The boy had previously recovered from what was said to be "Scarlatina sine exanthemate," and was, besides, affected with torticollis spasticus from contraction of the left sternomastoid muscle; no further etiological indications were found. Both sides of the face were usually the same in colour; at the height of the attack, however, the left side of the face and the left ear were of a deep red colour and (especially the ear) warm to the touch, while, on subsidence of the pain, this relation often appeared reversed. The upper part of the face, the forehead and orbital region, took no decided part in these changes, and no difference in the size of the pupils was observable. On the exhibition of 0·5 gramme of sulphate of quinine his usual nightly seizure did not occur, but returned next night as before. A second similar dose was followed, first by a slight relapse, and then by complete recovery, which has lasted till the present time, five months from the appearance of the last attack.

In accordance with the preceding view, another drug recommends itself for further trial in cases of the angio-paralytic variety of migraine—the *extractum secalis cornuti aquosum*—which, we know, causes contraction of the blood-vessels, an action which, according to Wernich, Holmes, Vogt, and others, probably takes place partly through the vasomotor nervous centra in the medulla oblongata. We ourselves, Berger, and others have used this remedy, which has already been highly praised by Woakes,† in cases of hemicrania that were decidedly of an angio-paralytic

† "British Med. Journal," 1868, vol. ii., p. 360.

character. We administered it both internally (0·6-0·9 gramme daily, in the form of pill) and subcutaneously, with very considerable relief to the symptoms.

Another remedy, lately employed for the first time, appears destined to play an important part in the treatment of cases of the sympathico-tonic variety of migraine—at least, as a palliative. This is *nitrite of amyl*, introduced by Guthrie in 1859. The indication for its use is based on the fact that it dilates the bloodvessels, whether by directly acting on their contractile elements (Richardson, Lauder Brunton, Wood, Pick), or by paralysing the vasomotor nervous system (Bernheim, Filehne), is still undecided. When inhaled, it provokes coughing, and occasions intense redness of the face, a sensation of heat in the face and head, and injection of the conjunctiva; it quickens the pulse by 20-30 beats per minute, lessening the tension in the radial artery. Further inhalation may even cause syncope. O. Berger* used it in a case of migraine of the sympathico-tonic type with an almost instantaneously successful result. The patient, an unmarried lady of 24 years of age, suffered many years from a migraine of the left side of the head, occurring regularly at the otherwise normal catamenial periods, and occasionally, also, in the intervals. The attacks usually began in the morning, reached their greatest intensity about dinner-time, and lasted with still considerable severity till late in the evening. There was also a feeling of exhaustion on the following day. During the attack the left side of the face was pale and sunken, the temporal artery very prominent, hard to the touch, and pulsating so strongly as to be almost audible to the patient. There were frequent shiverings over the whole body. There was no very evident reddening of the face or ear of the affected side, and the appearance was pretty much the same throughout the whole day. On the other hand, she noticed that now and then, in the intervals when she had no pain, sometimes without any assignable cause, and occasionally when emotionally affected, the left side of the face and the left ear became intensely red, contrasting with the colour of the right side. On inhaling five drops of the nitrite, the pain was as if charmed away. She first felt as if the blood were rising to her face, and had a certain confused sensation in the head, but the violent, boring pain of the migraine itself had disappeared. Vomiting did not occur. She was

* Berger, "Das Amylnitrit, ein neues Palliativmittel bei Hemikranie," *Berliner klin. Wochenschrift*, 1867. No. 2.

able to take dinner, but towards evening had to retire to rest, as she was in a not unpleasant state resembling intoxication. At this time she was strikingly pale, but showed no further evil after-effect, and next day was perfectly well. Berger directed her to use only three drops on being again attacked, to repeat the inhalation in a quarter of an hour if she thus obtained no good effect, and even to increase the dose to 6-8 drops.

Besides Berger, Vogel and Holst* extol the virtues of nitrite of amyl in migraine. Holst made some experiments on himself and on five patients who presented typical symptoms of spasm in the muscles of the vessels. Inhalation of 3-5 drops produced a sensation as if the blood were rushing to the head, the face became red, and if the inhalation were not suspended, momentary insensibility occurred. At the same instant, however, the pain in the head vanished. In the case of Holst himself, and in that of one patient, motion caused the pain to return in a few minutes with all its former violence; two other patients, who remained quiet, had a relapse in an hour; another, who kept perfectly still, was not only relieved of that paroxysm, but the next remained absent longer than usual, and was also removed by the nitrite of amyl.

Holst also observed in himself that in well-marked attacks of migraine drinking freely of anything warm gave instant relief when a general perspiration broke out. This he explains by relaxation of the vascular system, which was previously in a state of tonic contraction.

The beneficial influence of the inhalation of carbonic acid, much lauded by A. Mayer,† may be traced to the fact that this gas, by paralysing the vasomotor nerves, removes a temporary state of spasm.

The constant galvanic current is another remedial measure that may lay claim to great importance in the different forms of migraine. It appears to be better adapted for the treatment of this affection than any other means we know of, inasmuch as we can exercise a real and powerful influence, strictly localised, and exactly regulated as to quantity and quality, on the cervical sympathetic nerve and the upper part of the spinal

* Holst, "Ueber das Wesen der Hemikranie und ihre electro-therapeutische Behandlung nach der polarne Methode." *Dorpater med. Zeitschrift*, 1871. Bd. ii, p. 261-228.

† "Wiener med. Presse," 1865, No. 46, p. 1123.

cord. Benedikt,* Trommhold,† Fieber,‡ M. Rosenthal,§ Althaus,|| and others, have written on this subject; it was Holst,¶ however, who first introduced the really methodical and rational use of the constant current, on Brunner's polar system, in the different forms of migraine. His practice is to put one electrode on the cervical part of the sympathetic, at the inner edge of the sterno-mastoid and in contact with a considerable surface, and to establish communication with the other electrode, which is held in the palm of the hand. In hemicrania sympathico-tonica the anode is placed on the sympathetic, and a battery of 10-15 elements used; the circuit is suddenly closed, and the current, after being passed 2-3 minutes, is gradually reduced in strength. This is copied from Brunner's mode of proceeding in irritable conditions of the auditory nerve. In hemicrania neuro-paralytica the cathode is applied to the sympathetic, and the circuit is not simply closed, but is made to produce a more powerful effect by repeated interruptions or by reversing the current. The first-mentioned method, which directly diminishes irritability, was most often resorted to by Holst, especially in cases in which the condition of the muscular coat of the vessels was doubtful, as he regards an abnormal irritability of the vasomotor nervous system of certain parts of the head as the primary cause in every hemicrania, even in those which are characterised secondarily by a paralytic state, and he believes that by lessening this abnormal irritability the tendency to secondary relaxation of the walls of the vessels is probably overcome. Holst's own results, in about thirty cases, are, on the whole, in favour of this method of treatment. For details we must refer to the original work, only remarking that in all cases in which there is spasm of the vessels there is considerable improvement a few seconds after passing the current, the anode being placed on the sympathetic, and that this is often conjoined with a sensation of warmth in the head and heat and redness in the ears.

In one very obstinate case of hemicrania of the neuro-paralytic type (the face being flushed and hot during the

* Benedikt, "Elektrotherapie." Wien, 1868.

† Trommhold, "Die Migraine und ihre Heilung durch Electricität." Pest, 1868.

‡ Fieber, "Compendium der Elektrotherapie." Wien, 1869, p. 120.

§ M. Rosenthal, "Handbuch der Diagnostik und Therapie der Nervenkrankheiten." Erlangen, 1870.

|| Althaus, "Treatise on Medical Electricity," 3rd edition. London, 1873.

¶ Holst, *l.c.*, p. 275.

paroxysm), which never entirely intermitted, but took the form rather of a series of exacerbations and remissions, occurring in the person of a girl of 17, treatment by the interrupted galvanic current, the cathode being applied to the sympathetic, gave marked relief; though this did not last long, perseverance in the use of the same means for weeks was thus far successful that the painless intervals gradually became longer than the attacks, and subsequent treatment by reversing the current was followed by still more decided improvement.

IV.—GLAUCOMA. NEURORETINITIS. OPHTHALMIA. NEUROPARALYTICA.

In this section we discuss the imperfectly known connection which exists between certain diseases of the eye on the one hand, and functional disorders in the domain of the cervical sympathetic on the other.

We will first consider:—

Glaucoma.—This disease consists, as is proved in v. Gräfe's celebrated works, of *an increase of the intraocular pressure*. Inflammatory changes (choroiditis and disorders of nutrition in the vitreous body) may, as a rule, be regarded as the causes of this increased pressure. Remak, however, expressed the opinion, unaccompanied by any very convincing arguments, that glaucoma may have its origin in primary disease of the spinal cord. Adamük and Wegner have observed, in their investigations on the dependence of intraocular pressure on the agency of the cervical sympathetic, that the latter has a great influence on the glaucomatous process. Adamük believes that the ultimate cause of glaucoma is not increased pressure, but obstruction to the return of venous blood, produced by loss of elasticity in the sclera, which, again, is the result of inflammation; and that the sympathetic is only thus far involved—that irritation of it is followed by contraction of the arteries and overloading of the veins in the fundus of the eye, and by increase of tension.

Wegner, who examined two cases of glaucoma simplex, accompanied by neuralgia of the trigeminus, has come to the conclusion that the sympathetic vascular nerves may, in three ways, take part in the production of glaucoma: they are either directly concerned in the inflammatory process, or irritated by pressure, or stimulated, reflexively, by the sensory trigeminus nerve; he referred to the latter cause the two cases mentioned.

Hippel and Grünhagen reject this explanation, being of opinion that both acute glaucoma and glaucoma simplex, without any inflammatory symptoms, proceed directly from the trigeminus, irritation of which occasions, according to them, an increase of the intraocular pressure. They state that the less the vascular tone (which is dependent on the sympathetic), the more readily does this increased pressure appear, as tonicity counteracts the tendency to such increase. (We think ourselves justified in omitting to mention here the numerous theories of glaucoma not directly connected with the sympathetic.)

Illustrative clinical instances of the disease are very rare. In various cases of mechanical irritation, or compression of the cervical sympathetic, we noticed no glaucomatous phenomena; in one case, formerly described (irritation from goitre on the right side), there was a considerable degree of tension of the globe, which, however, never assumed any other than a physiological character; after being some months under observation no arterial pulse or excavation of the papilla appeared.

Horner,* Bärwinkel,† and Schmidt-Rimpler,‡ have, in some cases in which there was presumably paralysis of the sympathetic filaments, observed increased tension in the eye. According to Schmidt-Rimpler§ the existence of an influence exerted by the sympathetic on increase of intraocular pressure, and thus on the occurrence of the glaucomatous process, is not to be denied; nevertheless, this state is found more seldom, and to a slighter degree, than that resulting from disease in the trigeminus.

Neuroretinitis.—Benedikt|| teaches that the sympathetic system often plays an important part in causing those *intracranial, limited regional diseases* ("Heerderkrankungen") which lead to secondary affections of the optic nerve, or retina.

The forms of disease under consideration are those described as Neuritis, Atrophia descendens, and "engorged papilla." Benedikt declares that it is an unsatisfactory explanation of the phenomena to assert the existence of a "neurore-

* Horner, "Ueber eine Form von Ptosis." *Klin. Monatsbl. für Augenheilkunde.* 1869, vii., p. 193; Nicati, "La paralysie du nerf sympathique cervical," 1873.

† Bärwinkel, "Archiv. für klinische Medicin." 1874, Bd. xiv., p. 549.

‡ Schmidt-Rimpler, "Klin Monatsbl. für Augenheilkunde," xii., p. 398.

§ "Handbuch der Ophthalmologie," Bd. v. (1875), p. 98 and 99 (Capitel "Glaucom").

|| Benedikt, "Elektrotherapie." Wien. 1868, p. 253 ff.

tinitis," and an engorgement of the retinal vessels (v. Gräfe)* arising from increase of intracranial pressure. He advances the theory that in the local diseases within the cranium one has often to do with antecedent or accompanying neuroses of the sympathetic vasomotor fibres; that the symptomatic neuroretinitis, in most cases, depends on a morbid condition of the sympathetic, which is, further, a symptom observed in various other cerebral disorders. In the same way also he endeavours to explain the occurrence of other symptomatic phenomena—such as functional derangements of the auditory nerve in diseases of the brain, secondary affections in parts of the brain which are situated at a distance from the original limited diseased area (such as the sympathy shown in the cortical substance of the brain in cases of tumour in the pons), and hydrocephalus in those cases in which the idea of the extension of the morbid action to the walls of the ventricles by continuity of tissue is out of the question. These views, so ingeniously worked out by Benedikt, may, doubtless, greatly help us in understanding the causation of many secondary disturbances of the circulation in local cerebral diseases; as regards specially his conception of "neuroretinitis," however, as a secondary, sympathetic neurose, it seems to us to be very deficient in positive, confirmatory evidence—at least his presumed sensibility of the sympathetic in the neck, and the therapeutic success following galvanization of the sympathetic in chronic diseases of the brain, are of little value in this respect.

H. Schmidt's† experiments have lately demonstrated a direct communication between the subarachnoid space and the lamina cribrosa, and supply a good explanation of the occurrence of the engorged papilla and simple white atrophy when the intracranial pressure is increased. The former difficulties in the way of giving a reason for engorgement of the retinal vessels‡ are thus removed; while, on the other hand, in most cases of engorged papilla and simple white atrophy, they render superfluous Benedikt's supposition that the neuroretinitis is a secondary sympathetic neurose.

* v. Gräfe, "Ueber Neuroretinitis," *Archiv für Ophthalmologie*, 1866. Bd. xii. p. 114.

† H. Schmidt, "Zur Entstehung der Stauungspapille bei Hirnleiden," *Archiv für Ophthalmologie*, 1869. Bd. xv., p. 193.

‡ Seseman (*Archiv für Anat. und Phys.* 1869, p. 154) showed that compression of the cavernous sinus is not followed, as v. Gräfe believed, by great engorgement in the retinal veins, as the return of blood, by direct communication with the superficial veins of the face, is quite free enough.

With respect to the influence exercised by the cervical sympathetic on the occurrence of

Ophthalmia neuroparalytica (an influence the existence of which is not improbable, bearing in mind the fact that vasomotor fibres pass from the sympathetic to the trigeminus) we quote an observation made by Walther,* and mentioned by Henle.† Here, after division of the sympathetic in extirpating an aneurism of the carotid, ophthalmia appeared; the disturbance of the circulation, however, following such an operation, may, perhaps, alone suffice to account for the ophthalmia. According to Sinitzin's formerly-quoted (somewhat untrustworthy) experiments, division of the sympathetic should rather ward off ophthalmia, as it lessens the irritability of the globe of the eye; he states, nevertheless, that ligature of the carotid on the corresponding side equalises the difference in irritability, and does away with the consequences of extirpating the sympathetic.

V.—PROGRESSIVE FACIAL HEMIATROPHY.

In a former part of this paper we mentioned some cases in which mechanical injury of the cervical sympathetic was followed by emaciation of the corresponding side of the face. There is a well-known disease which is characterised by atrophy of one side of the face, usually first attacking the superficial soft parts, and then the deeper tissues—a disease which has been called *Prosopodysmorphia* by Bergson, *Neurotic facial atrophy* by Samuel and Bäerwinkel, "*Aplasia lamineuse progressive*" by Lande, and *progressive facial hemiatrophy* by others. Romberg and Bergson, and, at a later date, Samuel, regarded it as connected with the nerves of nutrition; while Stilling believed it to be the result of disturbed function in the vasomotor nerves, especially in those filaments included in the trigeminus, and destined for the vessels of the head. Stilling's view, that there is diminished reflexion from the sensory nerves of the vessels to the corresponding vasomotor nerves, is somewhat strained, and it might easily be shown that the vasomotor nerves of the face take a *direct* share in the morbid action, especially those which form part of the trigeminus, as in the cases recorded by Axmann, Hüter, and others.

Bäerwinkel endeavours to show that in the cases observed by him, in which there was atrophy in the region supplied by

* "Gräfe's und Walther's Journal," xxix, 1840, p. 549.

† "Nervenlehre," p. 570.

the infraorbital nerve, we must admit the existence of disease in the sphenopalatine ganglion. But Lande has lately denied that the disease has a neurotic origin, and maintains that we have to do with a genuine and primary atrophy of the fatty tissues, that the elastic tissue remains unaffected, its retraction causing the falling in of the other soft parts and contraction of the capillary vessels, the latter leading to further disturbances of nutrition. Nevertheless, many considerations render this hypothesis doubtful; it would not exclude, as Lande himself admits, the co-operation of nerves of nutrition (the existence of which he erroneously regards as demonstrated) in the production of the disease, since the primary shrinking of the fatty cellular tissue might possibly itself depend on a lesion of the vasomotor nerves of nutrition.

We will not here further discuss these relations, but only state that till very lately we were in possession of so few facts that would justify us in believing the disease to be in any way related to the sympathetic, that attention had been turned rather to the vasomotor nerves of nutrition included in the trigeminus. Since, however, these fibres, before joining the trigeminus, are for the most part contained in the cervical sympathetic, there is still some possibility of the latter being involved, and the possibility is indirectly rendered more probable by the circumstance that slight atrophy of one side of the face is observed in some cases of injury of the sympathetic in the neck. Brunner* has lately recorded one striking case of unilateral atrophy of the face, which he believes points to a diseased state, a condition of permanent irritation, of the cervical sympathetic. The case occurred in the person of a Jewish lady, 27 years of age, who, during pregnancy, had an attack of convulsions with loss of consciousness, and afterwards repeated epileptic seizures. For a long time these attacks followed regularly on each faradisation of the facial muscles, and were ultimately associated with difficulty of breathing and palpitation. In the course of four years an atrophy of the left side of the face was gradually developed, the hair of the head and the eyelashes became grey, and several yellow and white spots appeared on the skin, which afterwards assumed a yellowish brown, or brown colour. There was also a feeling of pressure and cold in the left eye, pain in the whole left side of the face, and in the jaw and throat; violent pain in the neck and chest, as

* Brunner, "Zur Casuistik der Pathologie des Sympathicus." *Petersburger med. Zeitschrift*, N. F. Bd. ii., 1871, p. 260.

far down as the region of the stomach, the latter sensations presumably only on the left side. The frontal and temporal muscles were found to have almost quite disappeared, and the zygomatici and the other muscles of the angle of the mouth, of the nose, and lips, more or less atrophied, and some of them at the same time contracted; their electro-muscular contractility was intact. The external part of the left ear was, on the whole, much thinner, smaller, and cooler than that of the right. The left eye appeared larger than the right, *the palpebral fissure wider, and the eyeball more prominent, the pupil more dilated and sluggish in its action.* The conjunctiva was rather pale, its vessels being sparingly filled with blood; the secretion of tears and mucus was diminished. The skin of the whole face was very thin and dry, and the subcutaneous fatty cellular tissue almost entirely absent. One side of the face was always paler, even when reddened by heat, cold, or mental changes; it took almost no part in perspiration, only the nasal fold being somewhat moist. The temperature in the right side of the mouth was $\frac{1}{2}^{\circ}$ C. higher than in the left, and in the right auditory meatus about 1° higher than in the left. There was pain on pressure on the left ganglion cervicale supremum, but none on the right; pressure on the ganglion cervicale medium on both sides produced slight pain. The heart sounds were clear, but irregularly accentuated, the same being the case in the carotid sounds; frequency of pulse variable, 86—100 in the minute.

Brunner thinks that the symptoms in this case correspond to the state experimentally produced in animals by galvanization of the divided cervical sympathetic, or its ganglion supremum. The dilatation of the pupil, its sluggish action, the widening of the palpebral fissure, the exophthalmos, the scanty secretion of tears and mucus, the feeling of tension in the eye (as in glaucoma), the lowering of temperature on the whole left side of the face, the absence of perspiration, &c., are to be explained in this way; and the formerly mentioned cases of Ogle and others show that very similar symptoms accompany pathological irritation of the sympathetic. Brunner concludes that a more lasting, or constant irritation of the sympathetic (perhaps of inflammatory character, or caused by a tumour) gave rise to a persistent state of spasm in the blood vessels, and to the train of symptoms already described in his case. The palpitation of the heart is also to be referred to deficient innerva-

tion by the sympathetic; and the same may be said of the epileptic seizures which follow spasm of the vessels of the medulla oblongata or the basilar parts of the brain, and, possibly also, according to Benedikt and Meynert, of the left hippocampus major. Brunner further believes he has proved that the trigeminus and facial nerves have no connection with it, and that the slight pains in the atrophied side of the face are perhaps to be explained by muscular sensation, or disturbance of nutrition. In accordance with his view of the case, Brunner cautiously employed the galvanic current, long continued, of weak tension, of few elements, and as *constant* as possible, confining its action to the two upper cervical ganglia. Galvanization practised in that manner was at once followed by quieting of the heart's action and slight dilatation of the pupil, while the affected side of the face became red and covered by a profuse perspiration. Brunner reckons on obtaining successful results from this method of treatment on the supposition that, as is probable from the persistence of the symptoms of irritation and the pain on pressure on the upper ganglion, we have to do with an irritation or chronic inflammation of the latter, not with a malignant degeneration.

In one case, observed by us, galvanization produced reddening of the affected side, which lasted some hours, yet, after having used the constant current some months, we could not boast of any permanent good result. In this case, however, we had no decided symptoms of an affection of the sympathetic.

VI.—PROGRESSIVE MUSCULAR ATROPHY.

Although Cruveilhier and Aran are usually regarded as the original discoverers of progressive muscular atrophy, and, to a certain extent, with justice, the celebrated work of Sir Charles Bell* contains not merely a record of several cases of it, but also the first attempt at a physiological explanation of its cause. Especially interesting is one observation (No. lxxxvi.), under the heading "Local paralysis of the muscles of the extremities."† "These affections of particular muscles, or classes of muscles, imply a very partial disorder of the nerves. A disease of the brain, or a disease in the course of the nerve, must influence the whole limb, or that portion of it to which

* Bell, "Physiologische und pathologische Untersuchungen des Nervensystems;" übersetzt von Romberg, Berlin, 1832.

† *L.c.*, p. 364.

the nerve or nerves are distributed. But in these cases particular subdivisions of the nerves, included in the same sheath, or running the same course, are affected. I am inclined to attribute such partial defects to the influence of visceral irritation. In that case *it must still be the influence of the sympathetic nerve which produces it*; and, yet, on the other hand, it seems impossible to account for such entire loss of motion without the intermediate influence of the brain." Insufficient as Bell's argument must appear to us now, the first reference to the sympathetic nerve as the seat of the primary lesion, is not without interest. This allusion appears, nevertheless, to have met with but little attention, as Abercrombie describes the disease as a local nervous affection, and Romberg as a spinal paralysis, while the later authors regard it as of myopathic origin (Aran), or as an atrophy of the anterior roots of the spinal nerves (Cruveilhier). Besides these, various other theories have been propounded, tracing it principally to changes in the spinal marrow, especially in the anterior columns (Lockhart Clarke, Charcot, &c.); these views are more or less generally accepted, and we will not now further discuss them.

To Schneevogt* belongs the merit of first drawing attention to the accompanying affection of the sympathetic, which, in earlier examinations, appears to have escaped observation. In the case investigated by him the brain and spinal cord were normal as far downwards as the fourth cervical nerve, and considerably softened, and extensively infiltrated with finely granular fat and granulation cells, from the fifth cervical to the second dorsal nerve; the posterior roots of the cervical nerves were unchanged, the anterior strikingly thinned, especially the five upper, which consisted only of some very slender filaments. The cervical part of the sympathetic was converted almost into a cord of adipose tissue, in which the nerve-fibres were replaced by flat cells containing crystals. The cervical ganglia had almost completely degenerated into fatty tissue, while the thoracic part of the sympathetic likewise contained some fatty matter. The spinal ganglia and vagus were normal. Amongst the peripheral nerves the left ulnar especially showed striking changes. Schneevogt accordingly feels bound to support the doctrine that the disease is of a central origin, and includes both an

* "Niederl. Lancet," Sept. und Okt., 1854, p. 218. See Schmidt's "Jahrbücher," 1855; 87^{ter} Band, p. 179

affection of the anterior roots and a disturbance of the sympathetic, or of the innervation of single ganglia.

Whilst in most of the later cases, with the sole exception of Schneevogt's, the examination of the sympathetic and ganglia seems to have been neglected, Jaccoud,* on the contrary, undertook this investigation in two cases, and attained positive results.

The two patients in question died in August and September, 1864, the one of asphyxia, from paralysis of the inspiratory apparatus, the other of gangrene of the lungs. In both there was atrophy of the anterior roots in all the cervical and the three or four upper dorsal nerves. On microscopical examination the white and grey substances of the spinal medulla were found unchanged. *On the other hand the sympathetic in both cases showed a fibro-fatty degeneration. The whole cervical part was transformed into fibrous connective tissue of decidedly old standing, in which were seen many spots of fatty infiltration: the nerve fibres were secondarily atrophied, and that to a greater degree than in the spinal roots. The ganglion cervicale supremum was only in the first stage of the process, there being considerable hyperplasia of the cortical and interstitial connective tissue, but no atrophy of the nerve elements, the fibres, as well as the ganglionic cells, appearing intact. In the rami communicantes was found atrophy of a nature corresponding to the condition of the anterior roots; the median nerve contained, amongst many healthy fibres, also some that were pathologically changed (simple atrophy, absence of the medullary sheath, and even of the axis cylinder). Jaccoud regards it as unquestionable, from the stages of the different processes, that the disease began in the cervical part of the sympathetic, and spread thence both centripetally (by the rami communicantes and the anterior roots) and centrifugally (as is indicated by the partial affection of the median nerve).*

Changes in the sympathetic are also mentioned by Swarzenski (atrophy of the trunk and of both upper ganglia), and by Duménil (fibro-fatty degeneration of the cervical and thoracic parts, considerable hyperplasia of the connective tissue, atrophy of the nerve-fibres, and regressive metamorphosis of the ganglionic cells).

In the greater number of recorded cases no accurate examination of the sympathetic system was made; its integrity,

* Jaccoud, "Bulletin de la soc. méd. des hôpitaux de Paris;" Union méd. 1865 (T. xxv.), No. 4, p. 60. See also "Leçons de clinique médicale," p. 361.

however, is specially affirmed by many good observers—Landry, Frommann, Menjaud, Hayem, Charcot and Joffroy, Duménil (in three cases). and Friedrich (in six cases).

Lubimoff,* on Charcot's suggestion, thoroughly examined the sympathetic—the cervical and thoracic parts, and abdominal ganglia—in two cases, one of protopathic progressive muscular atrophy, and one of a secondary nature, connected with lateral amyotrophic sclerosis. In the first case only the intervertebral ganglia exhibited appreciable changes, which, nevertheless, as the patient had at the same time suffered from tuberculosis, were probably due to this complication; the state of the sympathetic was a negative one. Also in the second case only some intestinal ganglia showed similar changes affecting the nerve and connective tissue cells, namely granular pigmentation of the latter.

Thus, to the five positive results are opposed at least sixteen completely, or almost completely, negative statements with respect to the sympathetic.

Let us now see if the clinical course of progressive muscular atrophy permits us to draw more positive conclusions regarding the eventual implication of the sympathetic than the few and contradictory items of information supplied by the autopsies hitherto made.

Remak† discovered that, in treating patients suffering from progressive muscular atrophy by galvanism, he could produce spasmodic movements in the atrophied muscles when the positive electrode was placed in an "irritable zone" reaching from the first to the fifth cervical vertebræ (especially in the fossa carotica, or in the triangle between the lower jaw and the external ear), and the negative electrode below the fifth cervical vertebra. Concerning these well-described, very remarkable phenomena, we will merely observe that the movement always took place on the side opposite to that on which the positive electrode was placed; when both were placed on the middle line the movements appeared on both sides; and when the current was very weak they occurred only in the most paralysed muscles. Remak regarded these spasmodic movements, which he afterwards named "Diplegic,"‡ as of reflex origin, produced

* "Archiv. de Phys. normale et pathologique," I. Sér., 1874, p. 889.

† Remak, "Oesterr. Zeitschrift für praktische Heilkunde," 1862, p. 1 and 29. See also "Application du courant constant au traitement des névroses," Paris, 1865, p. 26.

‡ Remak, "Application du courant constant," p. 28.

through the ganglion cervicale supremum of the sympathetic, more especially as the entrance of the current was felt by the patient behind the eyeball. He holds that progressive muscular atrophy is a disease of the sympathetic ganglia, or also of the cervical part of the spinal cord. In that way may be explained the irregular progress of the muscular atrophy, inasmuch as in the centres the ganglionic cells, on which the nutrition of the muscles depends, have an arrangement different from that of the nerve-fibres in the peripheral trunks which are connected with them; further, this also explains the frequently simultaneous occurrence of "neuro-paralytic inflammation," which consists particularly in painful swelling of the joints (arthritis nodosa), and which yields to galvanic treatment of the sympathetic. Remak also includes the so-called reflex paralysis amongst the paralyses of the sympathetic; probably also certain forms of hysterical, saturnine, and diphtheritic paralyses.

We pass over Remak's other statements which refer more particularly to therapeutics, as we are now more especially treating of the pathogeny of the disease, and will again discuss, at the end of this sketch, its treatment by means of the so-called galvanization of the sympathetic.

Remak's observations regarding "diplegic movements" were confirmed by M. Meyer* and Drissen† in a case of progressive muscular atrophy. Fieber,‡ on the contrary, could not produce these movements in a similar case by following Remak's method. Benedikt§ also states that in the cases treated by him the diplegic movements were wanting, but, nevertheless, recommends galvanization of the sympathetic, in connection with other methods of galvanization—a plan of treatment the importance of which is fully proved by his valuable record|| of cases. Erb¶ also states that he has not been able to obtain the diplegic contractions in the manner described by Remak; it does not appear, however, that he experimented on actual cases of *progressive* muscular atrophy. Though in most of our cases of this disease the diplegic movements could not be excited, we were able, with little difficulty, to demonstrate them in *one* single case. With

* M. Meyer, "Die Elektrizität in ihrer Anwendung auf praktische Medicin," 3^{te} Auflage, 1868, p. 219.

† Drissen, quoted in above book, p. 219.

‡ Fieber, "Berl. klin. Wochenschrift," 1866, No. 25, p. 261 (ix. Versuch).

§ Benedikt, "Elektrotherapie," ii. Abth. (Wien, 1866), p. 389.

|| "Ibidem," p. 389-412.

¶ Erb, "Arch. für klin. Medicin," 1867, iii. Band, p. 356.

regard to the conditions which give rise to these movements, and their symptomatic explanation, we differ entirely from Remak. The relation, affirmed by Remak and adopted by Fieber and M. Meyer, of these motor phenomena to the sympathetic ganglia, appears to us, both on physiological and empirical grounds, to be in no way warranted. In none of the cases in which diplegic movements were observed by us (in progressive muscular atrophy, saturnine paralysis, and hysterical atrophy), did we find that they occurred specially or exclusively in the way stated by Remak, and we thus do not consider ourselves justified in adducing them as evidence of abnormality of function or condition in the sympathetic nerve.

More important in this relation is the occurrence of disturbances of the innervation of the eye, which can be traced to diseased action in the oculo-pupillary fibres distributed in the cervical sympathetic. In this category may be included some cases of progressive muscular atrophy recorded by Bærwinkel,* Voisin† (from Bouillaud's Clinique), and Menjeaud.‡

Voisin's case was that of a man aged 44, who had suffered from the disease seven or eight years, first in the left, and then in the right arm. For three or four weeks he felt slight spasmodic movements in the upper eyelid, frequently having the sensation as if a grain of sand were in the eye; during this time also his sight became weaker. The left pupil was only half as large as the right, both responded normally to the stimulus of light, and dilated on pinching various parts of the body. The left cornea was flattened so that its highest point lay 1mmtr. nearer the iris than on the right side. After some months the same changes appeared also in the right eye; both pupils were then equally small and sluggish in action, the cornea in both eyes equally flattened, and vision on both sides weak.

In Menjeaud's case,* in which the atrophy was confined chiefly to the region supplied by the median and ulnar nerves on both sides, there was considerable contraction of the left pupil. Post-mortem examination revealed the existence of atrophy of the anterior roots of the lowest cervical and

* Bærwinkel, "Prager Vierteljahrschrift für pract Heilkunde," 1858, lix., p. 133.

† Voisin, "Gaz. hebdomadaire," 1863, No. 37; "Gaz. des hôp.," 1863, No. 110, p. 437.

‡ Menjeaud, "Gaz. des hôp.," 1866, No. 3, p. 10.

* L. c.

uppermost dorsal nerves, especially on the left side. The sympathetic and its ganglia were normal.

In explanation of the phenomena occurring in the eye in his case, Voisin refers to Claude Bernard's experiments, in which division of the anterior roots of the two lowest cervical and the two uppermost dorsal nerves was followed by contraction of the pupil and flattening of the cornea. As in the case observed by him the muscles affected were principally those supplied by the median and ulnar nerves, and as these take their origin in part from the spinal nerves just named, he infers that the disturbance of nutrition proceeded centripetally from the peripheral nerve fibres to the anterior roots, and gave rise to secondary atrophy of the latter. The non-participation of the sympathetic in causing the oculo-pupillary phenomena in the above case is to be inferred, according to Voisin, from the circumstance that vaso-motor disturbance, especially increase of temperature in the affected parts, had not been noticed; he thus adopts Bernard's view, that the nerves controlling the vessels of the extremities have their origin entirely in the ganglia of the sympathetic and join the nerve trunks only outside the vertebral column.

From the occurrence of oculo-pupillary phenomena in progressive muscular atrophy, without simultaneous increase of temperature of the paralysed upper extremity, one cannot draw a just conclusion either regarding the participation of the anterior roots or the non-participation of the sympathetic, even if Voisin's record were on all points less inexact than it really is.

The occurrence of oculo-pupillary symptoms in the affection in question, however, is rare, if not quite exceptional. We find it mentioned only in a few instances by Bergmann, M. Rosenthal, and Friedreich. Duchenne states expressly, in discussing Voisin's case, that he had not once met with these phenomena. We also, in all our cases, which were a long time under observation, failed to discover disturbance of innervation in the eye.

It is only in Schneevogt's case, among all those in which degenerative changes in the cervical sympathetic were found, that contraction of the pupil is mentioned as a symptom. Here, as we have seen, there was not only fatty degeneration of the sympathetic, but atrophy of the anterior roots, involving specially the five upper cervical; there was also softening of the spinal cord from the fifth cervical to the second dorsal nerves—exactly in the region of the centrum

cilio-spinale inferius. The contraction might thus arise either from the diseased sympathetic or from the central medullary affection. Jaccoud's record of the cases in which he had a post-mortem examination, unfortunately contains nothing about the symptoms and course of the disease as they came under his notice only a few days before death.

We thus, in the meantime, get little aid, either from anatomical research or physiological analysis of symptoms, in our inquiry regarding the nature of progressive muscular atrophy. We can give, therefore, no definite opinion as to the part (though it is probably a not unimportant one) played in it by the sympathetic system. *Is the sympathetic usually affected at all? And if it is, is it through centripetal conduction of the primary muscular disease to the peripheral nerves, the spinal roots, and the rami communicantes? Or, contrariwise, is the sympathetic affection the primary one, spreading centrifugally to the peripheral nerve trunks and muscles, and centripetally to the spinal centres?* So run the questions which will have to be answered in the future. It is to be hoped that, should opportunity offer for making post-mortem examination, the investigation of the sympathetic may not be neglected, and that it may lead to more definite results; very specially should its condition be compared with that of the other central and peripheral nervous apparatuses, with particular reference to the nature and date of the disease; and, as is also indicated above, greater attention must be paid to the occurrence of oculo-pupillary and vasomotor phenomena.

With reference to therapeutics, we will, in conclusion, mention that in one case of severe progressive muscular atrophy reported by Neseemann,* galvanization produced a temporary improvement; but later a relapse took place, which did not yield to the same treatment. As by Remak, so by Benedikt, M. Meyer, Guthzeit, Erb (according to Friedrich) and others, favourable results have been obtained from galvanization of the sympathetic. M. Rosenthal and we ourselves have never seen much good follow from this treatment.

Muscular Hypertrophy.—This disease is known under various names, such as "*Muscular hypertrophy*," "*Lipomatosis musculorum luxurians progressiva*" (Heller); "*Atrophia musculorum lipomatosa*" (Seidel); "*Paralysie musculaire pseudo-hypertrophique*," or "*Paralysie myosclérotique*" (Duchenne).

* Neseemann, "Berl. klin. Wochenschrift," 1868, No. 37.

Like progressive muscular atrophy, which is often combined with it, it has sometimes been regarded as a primary myopathic affection, and at other times as a neuropathic disease. The first-mentioned opinion was held by Spielman,* whilst Duchenne,† and after him Stoffella,‡ without very obvious reasons, argued that it was of cerebral origin. Griesinger§ assumed that it was a disease of the vasomotor nerves, and Benedikt|| mentions it among the "*trophoneuroses*," and believes one of his cases to have been of the nature of a *paralysis of the sympathetic*. In this case the hypertrophy affected principally the muscles of the right shoulder (the deltoid, pectoralis major, teres major and minor, serratus anticus major); moreover, *the right side of the face was redder, and perspired more freely than the left, the pupil was dilated, and the sympathetic tender to pressure*. Besides Menjon's¶ case, which was brought under this category by Seidel, we have only three detailed accounts of post-mortem examinations in this disease. The first is one recorded by Eulenburg,** in which Cohnheim made the examination. The result, with respect to the nervous system was perfectly negative; microscopic examination revealed no pathological changes in the brain, spinal medulla, peripheral nerves, or sympathetic system. Barth,†† on the other hand, found changes in the spinal cord and peripheral nerves which he believes are only secondary. Unfortunately no examination of the sympathetic was made. In a case investigated by Charcot, the state of the spinal cord and peripheral nerves was entirely a negative one. Therapeutically it may only be mentioned that Benedikt thinks he obtained considerable improvement in three cases by galvanization of the sympathetic. In one of the cases already quoted, not only the symptoms in the head, but also the hypertrophy disappeared, so that the patient could resume work. Chvostek‡‡ states, however, that the prolonged use of electricity is followed, at most, merely by arrest of the

* Spielmann, "Gaz. méd. de Strasbourg," 1862. Mai, No. 5, p. 85 ff.

† Duchenne, "Electrisation localisée." 2 edit., 1861, p. 334.

‡ Stoffella, "Zeitschrift der Gesellschaft der Aertzte," in Wein, 1865, Heft. 1, p. 85 ff.

§ Griesinger, "Archiv. der Heilkunde," 1864 (6ter Jahrgang), p. 171.

|| Benedikt, "Elektrotherapie," Wien, 1869, p. 186 ff.

¶ Menjon, "Med. Chir. Transactions," Vol. liii., 1852, p. 73 ff. See also Seidel, "Die Atrophia musculorum lipomatosa." Jena. 1867, p. 64.

** Eulenburg, "Berl. klin. Wochenschrift," 1865. No. 50; *ibidem* 1866, No. 37.

†† Barth, "Archiv. der Heilkunde," 1871, Bd. xii., p. 121.

‡‡ Chvostek, "Oesterr. Zeitschrift für practische Heilkunde," 1871. No 38-40.

morbid process. We ourselves got no successful result from the galvanic method of treatment in one case; it was, however, very severe and of old standing. But in two cases (in two young girls), which were some time under our observation, faradaic electrization of the atrophied and of the pseudo-atrophied muscles was followed by improvement, which was not apparent on galvanizing the sympathetic. O. Berger,* who also considers the disease a trophoneurose, faradised the hypertrophied muscles and galvanised the cervical sympathetic for weeks in two cases without making any impression on the disease. Erb records the same experience.

VII.—EXOPHTHALMIC GOÏTRE.—(BASEDOW'S DISEASE.)
(GRAVES' DISEASE.)

This name is given to a group of symptoms, discovered by Parry in 1825, but first accurately described by Basedow† in 1840, including palpitation of the heart, swelling of the thyroid gland, and protrusion of the eyeball (exophthalmos). These three cardinal symptoms are usually found together, but any one of them may be wanting. The order in which they are usually developed is—first, palpitation of the heart (with or without atrophy), then goître, and finally exophthalmos; it seldom occurs that all the symptoms appear suddenly and simultaneously, or that the tumefaction of the thyroid body is noticed before the heart affection. Other disturbances, especially in the nervous system and the female generative organs, are occasionally observed, but they are merely of secondary importance.

Concerning the nature and origin of this disease, many different theories have been promulgated. It was at first most naturally regarded as a special form of chlorosis or anæmia; but this idea must be given up, as it is often met with in men and in children, and in women beyond the climacteric period, and frequently in those whose catamenia are quite regular. The palpitation of the heart has been thought to be the cause of the other symptoms—a theory that is negatived by the simple fact that the accelerated and more powerful action of the heart in cases of lesion of the cardiac valves never leads to goître and exophthalmos. The seat of the disease has further been placed in the nervous system, especially in the spinal cord. When Claude Bernard made known

* Berger, "Deutsches Archiv. für klin. Medicin," 1872. Band ix., p. 363.

† Casper's "Wochenschrift," 1840. No. 13 and 14.

the phenomena produced by division of the cervical sympathetic in animals, it was noticed that there were certain resemblances between them and the symptoms of exophthalmic goitre, and the inference was drawn that the disease was caused by functional disturbance in the cervical sympathetic (Koeben,* Aran,† Trousseau,‡ &c.) Since that time this theory has found wider acceptance for the reason that, in a small number of cases of Graves' disease anatomical changes have actually been found in the cervical sympathetic. Before we relate these cases individually, we will try to show in what manner the principal symptoms of this disease may be compared with the phenomena occurring after division of the cervical sympathetic in animals. Division of the cervical sympathetic produces dilatation of the vessels, and, in consequence of there being more blood in the parts, a considerable elevation of temperature on the corresponding side of the head. Analogies for both of these experimental facts are found in Basedow's disease. The dilatation of the vessels indicates its presence in the strongly pulsating, frequently tortuous and prominent little arteries in the region supplied by the carotid, but especially in the swollen thyroid gland. The sudden occurrence of the goitre in the course of a few days, the softness of the swelling, the perceptible pulsation of the thyroid arteries, the loud blowing sounds heard over the same, the rapid increase and decrease of the tumour, according to the force of the contractions of the heart, and the engorged veins frequently seen on the surface of the gland—all these facts point to the conclusion that we have to do chiefly with a dilatation of the vessels distributed in the thyroid body, a conclusion fully borne out by anatomical investigation. §

Although we find, in the enlargement of the thyroid vessels, a resemblance to the dilatation of the vessels after division of the cervical sympathetic, yet this similarity is not evidence of a complete analogy; for then proof would be required that division of the sympathetic also leads to swelling of the thyroid gland. That animals, as well as men, may be the subjects of swelling of this gland is well known. In districts in which goitre occurs endemically amongst the people, Bail-

* "De exophthalmo a struma cum cordis affectione." Inaugural Dissert., Berlin, 1855.

† "Gaz. hebdom.," 1860. No. 49.

‡ "Gaz. Med.," 1862, p. 474.

§ Naumann, "Deutsche Klinik," 1853. No. 24. F. Banks, "Dublin Hosp. Gaz.," 1855, No. 9. Fournier et Ollivier, "Union Méd.," 1868, p. 95.

larger* has observed it amongst the animals, especially in mules, seldomer in horses and dogs. Boddaert† has also produced a swelling of the thyroid body in rabbits and guinea-pigs by ligaturing the internal and external jugular and inferior thyroid veins. Regarding the second of the constant phenomena appearing after division of the sympathetic in the neck—the elevation of temperature—something similar has been found in exophthalmic goitre, since special attention has been directed to the subject; thus, Paul‡ has found an increase of $\frac{1}{2}$ -1° C., Teissier§ of 1-2° C.; and Cheadle|| states, in a record of eight cases, that he has always observed a rise in the temperature. We ourselves, in nearly all our cases, have noticed an increase (at least temporarily) of $\frac{1}{2}$ -1° C.; and in one case, that of a girl 20 years of age, who was under treatment about nine months, the temperature in the axilla always amounted to 38·2-38·8° C. Nevertheless there are cases in which the temperature is normal, as recorded by Charcot¶ and Dumont,** It is evident that this elevation of temperature is of comparative value as a proof of pathological analogy to that occurring after division of the cervical sympathetic only when observed in an uncomplicated case of Basedow's disease, and not caused by any concomitant febrile affection. Those suffering from this disease feel the rise in temperature subjectively as heat, even when objectively it is very slight; this is often accompanied by increased secretion of perspiration.

With reference to the cause of this increased temperature, nothing is opposed to the idea that it is to be sought in the increased blood-supply resulting from dilatation of the vessels; it is not, however, locally confined, like that produced experimentally by dividing the sympathetic, but is equal in both axillæ and in both auditory meatuses. The sympathetic is clearly involved on both sides, as is shown by the facts that the vessels on both sides are equally filled, and that the exophthalmos is bilateral.

The second principal symptom in exophthalmic goitre

* "Du goître exophthalmique chez les animaux domestiques." Comptes rendus, 1862. Tome lv., p. 475. See also Virchow, "Die krankhaften Geschwülste," 1867, Bd. iii., p. 57.

† "Extrait du Bulletin de la Soc. de Méd. de Gand," 1872.

‡ "Berliner klinische Wochenschrift," 1865. No. 27.

§ See Trousseau, "Clinique méd.," T. ii, p. 540.

|| "Lancet," 1869. No. 25.

¶ "Gaz. méd.," 1856, p. 600.

** "De Morbo Basedowii." Inaug. Dissert., Berlin, 1863, p. 27.

which we have to compare with the results of division of the sympathetic is exophthalmos. It is seldom unilateral, but usually appears in both eyes at once, though not always with equal intensity.*

After division of the cervical sympathetic no exophthalmos occurs, but rather a sinking of the eyeball within the orbit. But if the central end of the divided nerve be subjected to electrical stimulation the eyeball is protruded, and we have genuine exophthalmos. It has already been explained in the physiological part of this work, that this proptosis is due to the action of Müller's unstriated ocular muscles and of some other unstriated muscles discovered in the upper and lower lids and in the orbital aponeurosis, all these being supplied by the sympathetic nerve, and thrown into contraction on irritating it. The occurrence of exophthalmos in this disease might be explained, if we were to assume the existence of a condition of irritation in the oculo-pupillary fibres of the cervical sympathetic. Thus, as we had to assume a state of paralysis of the vasomotor fibres of the cervical sympathetic (analogous to division in animals) to explain the dilatation of the vessels in the thyroid gland, and the rise in temperature, we have to do with two opposite conditions—paralysis of the vasomotor and irritation of the oculo-pupillary fibres of the cervical sympathetic. This assumption contains nothing arbitrary. We know, as we formerly explained, that the vasomotor and oculo-pupillary nerves have entirely different centres, and that we can experimentally educe independently of each other the appearances depending on disturbance of one or other class of fibres. If we now suppose that Graves' disease rises from an affection of the nerve centres, we may well conceive that the centre for the oculo-pupillary fibres of the cervical sympathetic (*centrum cilio-spinale*) is in a condition of irritation while, on the contrary, the centre for the vasomotor fibres is in a state of paralysis. Even though we regarded the cause of exophthalmic goitre as not central, but peripheral, and situated in the cervical sympathetic, there is nothing forced in the above supposition, that the oculo-pupillary fibres are in a

* Such cases have been observed by Mackenzie, quoted by Fischer, "*Archives générales de Méd.*," 1859, p. 652; by Förster, quoted by Lebert, "*die Krankheiten der Schilddrüse und ihre Behandlung*," Breslau, 1862, p. 309; by Schnitzler, "*Wiener, Medicinal-Halle*," 1864, No. 27; by Chisholm, "*Med. Times and Gaz.*," 1871, No. 1: by Emmert, "*Archiv. für Ophthalmologie*," 1871, Bd. xvii., p. 218.

condition of irritation, and the vasomotor fibres in a state of paralysis. We find many analogies in the pathology of the peripheral nervous system. Thus, in neuritis a state of irritation in the motor part of a nerve (spasm) may co-exist with one of paralysis in the sensory portion (anæsthesia); or, on the other hand, we may have paralysis of the motor and hyperæsthesia of the sensory filaments. Even in the same fibres we may often find opposite conditions; in sensory fibres for example, both diminished and increased sensibility (anæsthesia dolorosa), and in motor fibres diminished and increased motor power (paresis, or paralysis associated with slight spasmodic movements).

We have endeavoured to show the relation existing between Basedow's exophthalmos and the cervical sympathetic, inasmuch as we pointed out that in animals exophthalmos follows irritation of that part of the sympathetic system. The question now rises whether we are justified in regarding this exophthalmos as due *entirely* to a state of irritation in the sympathetic, and thus genetically the same as the exophthalmos produced experimentally. Such an assumption we cannot make. Permanent exophthalmos, such as that of Basedow's disease, is only possible when the unstriped ocular muscles, which have their innervation from the sympathetic, are in a state of persistent tetanic contraction, that is, when there is a permanent state of irritation in the nerve fibres supplying these muscles. There is, however, no physiological analogy to warrant the adoption of such an opinion. Every state of irritation in a nerve passes gradually into the opposite condition, that of paralysis. We cannot, therefore, unconditionally claim the exophthalmos occurring in animals on irritating the cervical sympathetic by an electric current as an explanation of Basedow's exophthalmos. It is also not easy to conceive that the effect of spasm of these muscles, so slightly developed in man, should be to produce such an extreme degree of proptosis as is often met with in exophthalmic goitre; for even with the strongest electrical stimulation of the cervical sympathetic, a degree of irritation which can never occur under physiological conditions, there is never produced such marked exophthalmos as we find in this affection. Thus we may fall back on the view of the earlier authors, that the *congestion* (venous hyperæmia) and *development of fat* in the cellular tissue of the orbit tend to aid in causing protrusion of the eyeball. That there is con-

gestion in the orbit during life is indicated by the broad and tortuous retinal veins,* and by the facts that when the palpitation of the heart abates the exophthalmos becomes less marked, that on increase of the heart's action the eyeball becomes again more prominent, and further, that the eyeball sinks into the orbit on slight pressure with the finger and after death. There are also various reasons for supposing that the eyeball is pressed forward by a cause of a mechanical nature. In persons who have died from strangulation there is exophthalmos in consequence of venous engorgement, and the same is produced in animals by ligature of the jugular vein. Further, new-born children whose birth has been accomplished only after prolonged labour, or by aid of instruments, present a slight degree of exophthalmos, the result of the pressure on the head, which prevents the free return of blood. The same is observed in women in severe labour—a fact which was well known to the ancients. Exophthalmos may arise from various other mechanical causes which lead to serous infiltration of the retrobulbar connective tissue (as in dropsy), and from congestions in the head. Many conditions (not including tumours of the brain), such as violent and prolonged bodily exertion, and convulsions, may also give rise to exophthalmos by increasing the pressure in the veins. Demarquay† has collected several such cases from general medical literature. As regards the abnormal development of fat as a factor tending to produce exophthalmos, it has often been demonstrated‡ in at least double the normal quantity, and sometimes even more. Thus, it is extremely probable that all three conditions—spasm of the unstriated orbital muscles, venous hyperæmia, and increase of the fatty tissue in the orbit—co-operate in the production of exophthalmos.

We have still to consider a peculiar phenomenon to which v. Gräfe§ was the first to direct attention, and which unquestionably indicates the participation of the sympathetic in the production of the disease. In health when the plane of vision is altered, when the eye is turned upwards or down-

* v. Gräfe, "Archiv. für Ophthalmologie," 1857, p. 292.

† "Traité des Tumeurs de l'orbite." Paris, 1860, p. 157-223.

‡ Basedow, "Casper's Wochenschrift," 1848, p. 775; Heusinger, "Casper's Wochenschrift," 1851, p. 52; Brück, "Deutsche Klinik," 1862, p. 207; Naumann, "Deutsche Klinik," 1853, p. 269; Laqueur, "De Morbo Basedowii," Inaug. Diss., Berlin, 1860, p. 12; v. Recklinghausen, "Deutsche Klinik," 1863, p. 288; Peter, "Gaz. hebdom," 1864, p. 181; Fournier et Ollivier, "Union méd.," 1868, p. 95.

§ "Deutsche Klinik," 1864, p. 158; and "Berliner klinische Wochenschrift," 1867, No 81.

wards, the upper eyelid follows closely the movements of the eyeball; in exophthalmic goitre this consentaneous movement of the eyelid is wanting. According to v. Gräfe it is not caused by the prominence of the eye, as the movements of the lid remain intact in exophthalmos from other causes (from tumours of the orbit, for instance); on the other hand, this mobility is lost even in the slightest degrees of the exophthalmos of Basedow's disease. This symptom, too, may disappear in the course of the disease, both spontaneously and on using narcotic injections without any improvement in the proptosis. Gräfe regards it as of great importance in the recognition of the slighter forms of the affection, those cases in which the prominence of the eye does not exceed physiological bounds and in which the goitre is wanting. The cause of this deficient mobility of the eyelid is, according to him, to be sought for in disturbed innervation (spasmodic contraction) of Müller's unstriped orbital muscles.

Another symptom in exophthalmic goitre which tends to connect it with the sympathetic is the occurrence of various inflammatory and ulcerative affections of the eye, which fortunately appear but seldom, principally among men,* but also occasionally amongst women.†

v. Gräfe considers the above-mentioned insufficiency of the eyelid as the chief cause of these inflammatory affections: on account of the deficient mobility of the upper eyelid when looking down, as in reading, a part of the cornea remains uncovered, the conjunctival sac becomes dry and the veins dilated, and thus inflammation and even chemosis are produced. But this affection of the lids cannot be regarded as the sole cause of the dry state of the eyeball and the consequent inflammatory symptoms, since the same circumstances in paralytic lagophthalmos (as in facial paralysis) generally leave the eye unaffected. v. Gräfe thus holds that Basedow's ophthalmia is principally of a neuroparalytic character, caused by disordered function of the sympathetic fibres of the trigeminus. This notion receives confirmation

* Basedow, "Casper's Wochenschrift," 1840, p. 222; Praël, "Archiv. für Ophthalmologie," 1857, Bd. iii, p. 201; Naumann, *loco citato*, p. 286; v. Gräfe, "Archiv. für Ophthalmologie," 1857, p. 285; and "Berliner klin. Wochenschrift," 1867, No. 31.

† Lawrence, "Gaz. des hôp." 1858, p. 198; Tatum, "Med. Times and Gaz.," 1864, 23 January, p. 89; Teissier, "Canstatt's Jahresbericht," 1864, Bd. iv., p. 173; Patchett, "Lancet," 1872, June 15.

by the observation that in severe cases of Basedow's disease the sensibility of the cornea is lowered.

In comparing the symptoms of Basedow's exophthalmos with the phenomena following division of the cervical sympathetic, we have still to advert to the pupil. Dilatation of the pupil accompanies every case of exophthalmos experimentally produced; in that of exophthalmic goitre, on the contrary, it is entirely absent. v. Gräfe has recorded its absence in about two hundred cases. When, opposed to this large number, some observers* state that they *have* seen dilatation of the pupil in a few cases, this symptom can scarcely be considered as having any pathological connection with Basedow's disease; most likely these patients were myopic. From the absence of dilatation or other abnormality of the pupil, we conclude that the pupillary fibres of the sympathetic are not involved in this affection.

The third principal symptom in exophthalmic goitre is the increased action of the heart, which may certainly be regarded as depending on functional disturbances in the cervical sympathetic. That nerve contains fibres whose function is to accelerate the heart's action, and electrical irritation of these increases the number of the heart's contractions. For further details on this subject we refer to the physiological part of this essay. The increased action of the heart in Graves' disease may be explained by assuming the existence of irritation of the cervical sympathetic; but, as we have already pointed out, while discussing exophthalmos, the assumption of such a *persistent* state of irritation in order to explain the permanency of the heart affection is physiologically inadmissible, as this condition must soon pass into that of paralysis. The increased action of the heart, however, may be interpreted as due to a variety of *paralysis* in the cervical sympathetic; paralysis of the cardiac sympathetic nerve fibres leads to dilatation of the cardiac vessels (the coronary arteries), and therefore to a greater flow of blood to the muscular tissue of the heart, and thus to stimulation of the cardiac ganglia.

* Romberg and Henoch, "Klinische Wahrnehmungen und Beobachtungen," Berlin, 1851, p. 182; Reith, "Med. Times and Gaz.," 1865, p. 521; Friedrich, "Lehrbuch der Herzkrankheiten," Erlangen, 1867, p. 312; Trousseau, "Clinique méd.," Paris, 1868, Tome ii., p. 536; Fournier et Ollivier, "Union méd.," 1869, p. 93; Gildemeester, "Archiv. für die holländischen Beiträge zur Natur und Heilkunde," Utrecht, 1864, Bd. III., p. 416 and 420; Cheadle, "Lancet," 1869, No. 25; Emmert, "Archiv. für Ophthalmologie," 1871, Bd. xvii, p. 203.

Having gone over the principal symptoms of Basedow's disease, and shown their relation to the phenomena observed in certain experiments performed on the cervical sympathetic, we come now to the description of the pathological anatomical changes which have been found in the sympathetic after this disease. The number of facts is certainly small; but it must be remembered that the opportunities for making post mortem examination have been comparatively few, and that it is only lately that attention has been directed to the sympathetic system as connected with the affection. The cases which have come to our knowledge are the following:—

1.—A case from Trousseau's Clinique, described by Peter.* It was that of a woman who, seven years before coming under observation in the Clinique, had received a violent shock by the sudden death of her father, this being followed, in one night, by exophthalmos, goitre, and palpitation of the heart. Five months later she died comatose, after an apoplectic seizure. At the examination the upper and middle cervical ganglia were found normal, but the lower, especially on the right side, considerably enlarged and injected. Microscopic examination showed a marked development of connective tissue in the lower cervical ganglion, whilst the nerve tissue (ganglionic cells, and nerve filaments) had become considerably atrophied.

2.—A case described by Archibald Reith.† A man, 24 years of age, who had suffered some time from Graves' disease, died two days after being taken into hospital. The autopsy, performed by Dr. Beveridge, 22 hours after death, showed principally, as regards the cervical sympathetic a hypertrophy of the middle and lower ganglia; they were hard and firm, and were seen, under the microscope, to be infiltrated by greyish matter. The trunk of the sympathetic and the branches of the inferior thyroid and vertebral arteries were increased in size and tuberculous.

3.—In a case examined by Cruise and M'Donnel, and recorded by Moore,‡ the lower cervical ganglion was almost obliterated, and replaced by cellular and fatty tissue.

* "Notes, pour servir à l'histoire du goître exophtalmique," *Gaz. hebdom.*, 1864, No. 12, p. 180.

† Reith, "Exophthalmos—Enlargement of Thyroid Gland—Affection of Cervical Sympathetic," *Med. Times and Gaz.*, 11 Novr., 1865, p. 521.

‡ William Moore, "Some remarks on the Nature and Treatment of Pulsating Thyroid Gland, with Exophthalmos," *Dubl. Quar. Jour. of Med. Science*, 1865, p. 344-352.

4.—In the case of a girl treated by Traube* during life, and examined by v. Recklinghausen, there was *remarkable thinning of the sympathetic and its ganglia.*

5.—Biermer† found, in the case of a man, considerable atrophy of the sympathetic on both sides of the neck, especially the right.

6.—Virchow‡ mentions having observed an increase of size, and interstitial thickening, of the cervical sympathetic, especially in the upper and lower ganglia.

7.—In the case of a scholar, 48 years of age, who had died in Würzburg of Basedow's disease, Geigel§ states that both cervical sympathetics were surrounded by a thick sheath of fatty and connective tissue; the microscope, however, showed no change either in the nerves themselves or in the ganglia, except intense brown pigmentation of the latter; there was also no increase of the interstitial connective tissue.

8.—Knight|| found, in examining the body of a man of 33 years of age, who had died of Graves' disease, that *the left lower cervical ganglion of the sympathetic was larger than the right, the connective tissue increased in quantity, while the nerve-cells appeared much smaller and less pigmented. In the middle and lower left cervical ganglia the nerve-cells were smaller than on the right side, while the nerve filaments in the left sympathetic were only half the size of those in the right.*

9.—Ganghofner¶ relates the case of a servant, 43 years of age, who was under his treatment for exophthalmic goitre, and whose body, after death, was examined by Klebs. The *left sympathetic* in the neck appeared *extremely atrophied in its lower part*, measuring scarcely $\frac{1}{2}$ mm. in thickness; in the upper part it was thicker, about $7\frac{1}{2}$ mm.; above the middle ganglion it was normal in point of size, but *unusually red*. The atrophied spot was about 2 centimeters long. Below this was found the lower ganglion, about the size of a pea, from which emerged two very thin nerves, one passing forwards, the other backwards. Under the jaw and on the sympathetic lay a lymphatic gland, swollen and much reddened. The upper ganglion was normal.—On the *right* side the upper cervical ganglion was normal, the middle ganglion somewhat broader; below this the *sympathetic became very thin*, and

* Traube and v. Recklinghausen, "Deutsche Klinik," 1863, No. 29, p. 286.

† This case was communicated to us by letter.

‡ Virchow, "Die krankhaften Geschwülste," Bd. iii., p. 81.

§ Geigel, "Würzburger med. Zeitschrift," 1866, Bd. vii., p. 84.

|| Knight, "Boston Med. and Surg. Journal," 1868, 19 April.

¶ Ganghofner, "Prager Vierteljahrschrift," 1876, Bd. cxxx.

passed into a small ganglion, from which issued some exceedingly slender filaments which followed the course of the vessels. *Microscopic examination of the atrophied part of the sympathetic revealed the presence of atrophy of the nerve elements.* This case, so valuable because so carefully examined, is, as regards the condition of the sympathetic, analogous to those of Traube and Biermer, and partly also to Knight's, inasmuch as here also the prominent change is atrophy of the sympathetic.

Opposed to these positive statements are four cases in which no change was found in the sympathetic.

1.—In Paul's* case there was nothing abnormal in the thoracic and cervical parts of the sympathetic, nor in both lower cervical ganglia. Microscopic examination of longitudinal and transverse sections of the right lower ganglion, both fresh and after carmination, showed that the nerve filaments and ganglionic cells were of normal dimensions, with clearly marked nuclei and nucleoli, partly colourless, and partly pigmented.

2.—In a case recorded by Fournier and Ollivier,† and most carefully dissected by Ranvier, no alteration was found in the sympathetic, either on examination with the microscope or by the naked eye. The case is specially remarkable, as death occurred by gangrene of the extremities; no cause for the gangrene was found.

3.—Rabejac‡ has described a case of exophthalmic goitre in a woman 37 years of age, which also ended fatally through gangrene of the extremities. Bouvier examined the sympathetic microscopically, and could discover nothing abnormal.

4.—We have to quote only one other case, that of Wilks;§ in it the ganglia of the sympathetic showed no change, except that they were strikingly white in colour; microscopically there was nothing abnormal, except some increase in the quantity of the connective tissue fibres.

These negative results prove nothing against the assumption that Basedow's disease may be connected with functional disturbances in the sympathetic, because these may exist without being necessarily accompanied by any anatomically demonstrable change.

With respect to treatment, we mention only the effects of

* Paul, "Berliner klin. Wochenschrift," 1856, No. 27.

† Fournier et Ollivier, "Union méd.," 1868, No. 8 and 9.

‡ Rabejac, "Du goître exophthalmique," Thèse, Paris, 1869.

§ Wilks, "Guy's Hosp. Reports," 1870, Bd. xv., p. 17 ff.

galvanization of the sympathetic. In 1867 we performed our first experiments on this subject, and found that, on using a very weak ascending current of only 6-8 elements, the frequency of the pulse fell from 120 to 90 per minute.

More lately Chvostek,* M. Meyer,† and others, got good results by galvanizing the sympathetic, especially as regards the exophthalmos and the goitre, whilst the influence on the heart was but slight and transitory. The improvement in the goitre and the exophthalmos, which was permanent, was also accompanied by improved general health, showing itself in abatement of the chlorotic symptoms, and reappearance of normal menstruation.

On Thought without Words, and the Relation of Words to Thought. By WILLIAM W. IRELAND.

(Continued from page 224.)

Naturally, if a child be dull or stupid, he will be slower to learn the use of the senses or the muscles, and, accordingly, we find that some idiots of the lowest type are not able to learn to walk or grasp. I remember one case distinctly where the only acquired motions were receiving food into the mouth, and following with the eyes the spoon with which he was fed.

Imbecile children are slower in learning to walk or execute other movements than those of normal intelligence, even after they have learned to walk, their gait is slow, uncertain, and awkward, they are clumsy in the use of the hands, and it is difficult to teach them any exercise or handicraft requiring method and dexterity. An easy but superficial way of explaining this deficiency, is to say that it is owing to want of nervous power, deficient sensation, to weakness, or to want of motor capacity. This may hold good in some cases, but in many it is simply owing to the want of the guiding power of the intellect. It would be difficult to say how far idiots are deficient in the proper estimation of size and distance, as their answers to questions are little to be depended on; but I have seen instances in those of a low type, where they grasp at objects obviously beyond their reach. Even imbeciles who can speak, and have a decent degree of intelligence, are generally very inexpert at such exercises as catching a ball, or aiming at anything, and it is difficult to teach them greater

* Chvostek, "Wiener med. Presse," 1869, No. 19; 1871, No. 41; 1872, No. 23.

† M. Meyer, "Berliner klin. Wochenschrift," 1872, No. 39.