

LECTURES
ON
THE DISEASES OF
THE NERVOUS SYSTEM.

DELIVERED AT LA SALPÊTRIÈRE

BY

J. M. CHARCOT,

PROFESSOR IN THE FACULTY OF MEDICINE OF PARIS; PHYSICIAN TO LA SALPÊTRIÈRE; MEMBER OF THE ACADEMY OF MEDICINE, OF THE CLINICAL SOCIETY OF LONDON, OF THE CLINICAL SOCIETY OF BUDA-PESTH, OF THE MEDICAL SOCIETY OF NATURAL SCIENCES OF BRUSSELS; PRESIDENT OF THE ANATOMICAL SOCIETY, AND EX-VICE-PRESIDENT OF THE BIOLOGICAL SOCIETY OF PARIS, ETC.

SECOND SERIES.

TRANSLATED AND EDITED BY

GEORGE SIGERSON, M.D., CH.M.,

LICENTIATE OF THE KING AND QUEEN'S COLLEGE OF PHYSICIANS OF IRELAND; DEAN OF THE FACULTY OF SCIENCE, C.U.I., MEMBER OF THE ROYAL IRISH ACADEMY; FELLOW OF THE LINNEAN SOCIETY OF LONDON; MEMBER OF COUNCIL OF STATISTICAL SOCIETY, DUBLIN; MEMBER OF THE SCIENTIFIC SOCIETY OF BRUSSELS; CORRESPONDING MEMBER OF THE CLINICAL AND ANTHROPOLOGICAL SOCIETIES OF PARIS; ETC.



THE NEW SYDENHAM SOCIETY,
LONDON.

—
MDOOCLXXXI.

o

IV.

TWO CASES OF LATERAL SYMMETRICAL AMYOTROPHIC SCLEROSIS.

(See Lecture, XII, p. 180.)

WE reproduce here two cases which completely confirm the descriptions traced by M. Charcot in his lectures on *deutero-pathic amyotrophy*. They were published by M. Charcot, M. Joffroy¹ assisting in the preparation of the first, and M. Gombault in that of the second.²

CASE I.

Progressive muscular atrophy, especially marked in the upper extremities. Atrophy of the muscles of the tongue and orbicularis oris. Paralysis with rigidity of the lower extremities. Atrophy or disappearance of the nerve-cells of the anterior cornua in the cervical and dorsal regions. In the bulbous, atrophy and destruction of the nerve-cells of the hypoglossus nucleus, atrophy of the anterior spinal roots, of the roots of the hypoglossus and of the facial nerve. Symmetrical ribbon sclerosis of the lateral columns.

Catherine Aubel was admitted to the Salpêtrière (M. Charcot's wards), in the month of June, 1865; she then presented, in a marked degree, the symptoms of progressive muscular atrophy, the beginning of which dated back for about nine months at that time.

Her relations, brothers and sisters, five in number, had had no disease worthy of notice, and all enjoyed good health. Of a lymphatic temperament, she had glandular enlargements in her childhood; some glands even suppurated, and her neck is marked by numerous characteristic scars. Her menses have been regular since the age of eleven.

Her state of health does not offer anything noticeable until the age of 28, from which time she dates the beginning of the present affection. On the 2nd September, 1864, having gone her full time,

¹ 'Archives de Physiologie normale et pathologique,' 1869, p. 356.

² Ibid, 1871—1872, p. 509.

she was delivered of a child, which has ever since enjoyed good health. On the 6th September, the patient says that, having tried to get up, she found it impossible, as her legs were too weak to support her, and appeared paralysed. On the 12th, a new attempt to rise from bed had the same fate; walking and standing are almost impossible, owing to the weakness of the lower extremities. About the 20th September, she felt pains in her hands, and from this time forth her upper extremities in their turn became progressively weaker.

Towards the 1st of October, she was "taken in the tongue," according to her own expression, and her utterance began to grow very much embarrassed. The patient then went on foot, as well as she could travel, to the Hôpital Saint-Antoine. Sent away because there was no vacancy, she returned on the 11th, but this time the lower extremities had become too weak to allow her to walk and she was obliged to go in a car. Admitted on the same day, she was at once put under a course of nitrate of silver, administered in pills. This treatment was suspended at the end of three weeks. It had not impeded in the least the course of the disease; on the contrary, the weakness of the upper and lower extremities had rapidly advanced; walking had become quite impossible; the voice had taken a peculiar nasal sound (*nasillarde*),¹ her utterance was embarrassed, difficult, almost unintelligible.

It was impossible for us to ascertain from the patient the epoch at which began the characteristic atrophy and deformation of the upper extremities which she presented, in a marked degree already, when she entered the asylum. However this may have been, at the time she was admitted to the Salpêtrière, the affection seemed to have entered on a stationary period, and no aggravation of the symptoms were observed from the month of June to the 11th September, 1865, at which date the following note was taken: "The face is still covered with a very marked mask. The physiognomy has a singular expression: whilst the brow, the eyebrows, and the upper part of the cheeks have retained their mobility, it is remarked that, except at the moments when the patient experiences a somewhat lively emotion, the lower part of the face remains, as it

¹ The voice is said to be *nasillarde* when, the mouth being open and the exterior nares closed, it appears to sound within and throughout the nasal cavities. It is *nasonnée* when, mouth and nostrils remaining free, it resounds in the posterior portion of the nasal cavities into which it is directed.—S.

were, motionless and lifeless. But, when she laughs or weeps, the labial commissures are very strongly drawn back, the mouth opens very widely, and the naso-labial furrow appears exaggerated. The patient, however, can shut her mouth firmly enough, and pout, but she cannot whistle, blow, or simulate the act of kissing.

She seems very intelligent, and appears to understand all the questions put to her; but she only answers with the greatest difficulty, and in an almost unintelligible manner. The voice is nasal (*nasonnée*): speech is accompanied by a sort of grunting, and the articulation of most words is accomplished slowly, laboriously, with extreme trouble. Speech becomes somewhat less indistinct when the patient's nostrils are closed.

The tongue is small, shrunken, as if covered with convolutions on the dorsal surface, which is the seat of almost incessant fibrillary and vermicular movements. It cannot be raised towards the palate, but it can be put out between the teeth, but with difficulty. It is almost impossible for the patient to elongate it to a point, or to hollow it like an augur. The saliva gathers in the mouth, and is continually flowing out. The velum palati, the uvula, present their normal appearance, and when a spoon is pushed back into the throat, the palate rises, but indeed rather slowly.

For some days past, Catherine experiences a sensation of constriction in the pharyngeal region, though direct examination does not discover any redness in the mucous membrane, nor any swelling of the amygdalæ.

Deglutition is sometimes difficult, and it happens that portions of the food enter the larynx and cause fits of suffocation; but neither drink nor food ever return by the nostrils, nor does solid food accumulate between the cheeks and the dental arch.

The movements of the chest seem normal. Auscultation shows nothing pathological neither in the heart, nor in the lungs, and all the functions of organic life are accomplished in a normal manner.

State of limbs.—The upper extremities are, taken altogether, remarkably emaciated and weakened, they hang down beside the body; but, in addition, at the shoulder, forearms, and hands, there is predominant atrophy in certain muscles, or sets of muscles. The deltoid, on either side, is much wasted, and the shoulder prominence is lacking. In the forearms, the atrophy affects both the flexor and extensor muscles of the fingers; in the hands, the thenar and hypothenar eminences are remarkably effaced; the palmar

hollow is excavated owing to wasting of the interossei; moreover, the fingers are rather strongly and permanently flexed, especially at the joints of the first phalanges; so we have a fine example of the deformation known as a claw or talon hand (*main en griffe*). The movements of the different parts of the upper extremities are, besides, extremely restricted. The patient can scarcely raise her hands from her knees, where they usually rest almost inertly; this movement of elevation, which seems to require much effort, cannot long be maintained, and is accompanied by a sort of trembling of the hands, especially in a lateral direction, which is very singular. The movements of flexion and extension of the fingers are very restricted. Since the month of January, the patient, who knows how to write, cannot hold a pen; her hands, besides, are of no use to her, and it is wholly impossible for her to lift her food to her lips. The movements of her shoulder, those of the forearm, and those of the arm are also much restricted. Generally speaking, the left upper limb is perhaps a little less weak than the right. There is no sign of any alteration of *sensibility* whatever throughout the whole extent of the upper extremities.

The patient can neither walk nor stand alone. Assisted by two persons, if she tries to take a few steps, her legs stiffen, cross each other, and, at the same time, her feet turn in, owing to an involuntary movement of forced adduction.

The lower limbs are, also, greatly emaciated; but this is a general emaciation. We do not find, as in the upper limbs, deformations owing to predominant wasting of certain sets of muscles. The feet are a little rigid, in semi-extension, and strongly turned in.

There is also rigidity, contracture, in the knees, which are half flexed, and in adduction; the hips likewise appear a little rigid. Muscular strength, however, is not completely abolished in the lower extremities, and the patient can flex a little and extend her legs. These movements, which are very limited in extent, are not accompanied by tremulation.

No sensory disorders exist in the lower limbs, where the patient feels neither pains, nor cramps, nor formication. Electro-muscular sensibility appears normal, whilst it seems rather exaggerated in the upper extremities.

A large number of muscles, especially those of the superior extremities, are the seat of extremely marked fibrillary contractions. These are particularly noticeable in the forearms and hands. They

come on, sometimes spontaneously, sometimes under the influence of a touch. They are strong enough to produce very marked extension movements of the fingers, and of the whole hand. When a slight tap is given with the finger to the dorsal surface of the forearm, an extension movement is made, which is soon succeeded by a flexion movement, and this is repeated three or four times, after a single stimulation.

If the forearm be placed in pronation, by striking the supinator muscle a slight blow, we may determine a movement of supination, owing to which the hand is turned over on its posterior surface. Electric exaltation determines these same fibrillary contractions in a still more marked manner. These spontaneous or provoked fibrillary contractions are also remarked in all the muscles of the upper part of the trunk. They are, likewise, very marked in the muscles of the neck, but they are most frequent and most marked in the sterno-cleido-mastoid muscles, particular in that of the left side.

No trace of fibrillary movements is seen in the various muscles of the lower extremities. We have already mentioned that they are very evident in the tongue. The most emaciated muscles, those of the forearm, for instance, have preserved electric contractility in a high degree. Some of the lower extremities also contract under the influence of faradisation.

Such was the state of the symptoms in the month of September, 1865, one year after the beginning of the disease. From that period to the month of February, 1869, no noteworthy change took place. The numbness of the upper limbs simply increased, but impotence was not complete, and the patient could still move her fingers a little. Contracture of the lower limbs has also made progress, but never to any excessive extent. Finally, atrophy of the muscles, becoming more and more marked, rendered still more characteristic the deformations of the upper limbs, and particularly those of the hands.

The motor impotence and atrophy have, likewise, only proceeded very slowly as regards the face, and sub-hyoidean region. Nevertheless difficulty of pronunciation and all the other phenomena, recalling the picture of labio-glosso-pharyngeal paralysis, had become worse, whilst no noteworthy disturbance of the respiratory functions were superadded.

In the trunk no new symptoms had appeared. The emaciation was considerable, but without any evident sign of muscular atrophy.

The respiratory muscles acted normally, and, in particular, there was no sign of diaphragmatic paralysis.

The lower extremities exhibited the same weakness, the same emaciation already described. No atrophic deformation of different sets of muscles, nor fibrillary contractions were observed. The feet still retained their vicious attitude, they were turned in and slightly extended on the leg. It had been remarked that the patient was growing weaker, and was coughing for some time, when on the 5th of February, 1869, during the evening visit of the house physician, she was found in a rather grave state of asphyxia, which had almost suddenly shown itself. The pulse was at 136, there were 50 inspirations per minute. A moist laryngo-tracheal râle appeared, extending to a great distance. The upper part of the respiratory tubes was the seat of a considerable accumulation of mucous matter, which the patient could not get off. Next day these symptoms appeared to be partially dissipated; but, in the evening, they returned with all their gravity. The patient succumbed in the evening of the 11th February.

Autopsy.—February 13th, 1869. *A. a.* Cadaveric rigidity was several times observed in this case; it was complete twelve hours after her death, when the first examination of the body was made. It persisted thus throughout the entire day, on the 12th, and still very manifestly existed on the morning of the 13th. It was very strong even in the upper limbs, where atrophy was most marked. Before making an autopsy, the circumference of her wrists, arms, and legs was measured, and the following figures were the result:

Circumference of wrist	0·125 m.
„ arm	0·17
„ mid-thigh	0·365
„ leg, a little above the malleoli	0·175

There was no difference between the members on the right side and those of the left.

b. Thoracic cavity.—The *lungs* present tubercular granulations, in the inferior lobe of each, and nuclei of incipient caseous pneumonia. The summits were healthy. The *heart* weighed 185 grammes. Its tissue was red, firm, and it appeared entirely sound. There was no valvular lesion.

The other *viscera* offered nothing noticeable.

c. Muscular system.—Dissection of the muscles gave the

following results: 1°. *Face*.—The muscles of the cheeks and chin, but chiefly the buccinato-labial muscles were atrophied, pale, yellow, reduced to thin muscular slips. The orbicularis palpebrarum, the frontal, temporal, and masseter muscles presented nothing abnormal.

2°. *Neck*.—The sterno-cleido-mastoid muscles appeared healthy. The muscles of the supra-hyoidean region are very small. They present a yellow dead-leaf colour at the point of the tongue. They are, on the contrary, rather red, but manifestly wasted, at the base of this organ.

3°. *Upper extremities*.—The deltoid is atrophied in a very marked manner; it is thin, of a pale yellow dead-leaf hue. The muscles of the arm are small, but of an almost normal red colour. In the forearm, the muscles are exceedingly slender, but the red colour is sufficiently well preserved. The muscles of the hand are a dead-leaf yellow, and much wasted, especially the interossei. The muscles of the hand are certainly, with those of the tongue, the most altered.

4°. *Trunk*.—The sacro-lumbar muscular mass, in its lower part, seems to have undergone a certain degree of atrophy. Its colour is yellowish. The muscles of the abdomen present the same characters; and with respect to them, as well as those of the back, the lesions seem to diminish, and even to disappear, as we approach the breast. The pectorals are red, and do not exhibit much marked atrophy. The interossei are rather thin, and somewhat yellowish. The diaphragm appears healthy, at least, to the naked eye.

5°. *Lower extremities*.—The emaciation is rather marked; the muscles are not large, but yet their emaciation is not excessive, if we consider the general emaciation of the subject. On the whole, there seems here to be no atrophy properly so called. The muscles are red, and their tissue appears healthy.

d. *Peripheral nerve system*.—Viewed with the naked eye, one is struck by the considerable changes which are produced in the size and colour of the anterior roots. They are formed by the union of nerve-bundles, reduced almost to filaments, so that they are exceedingly slender. Their colour has assumed a very marked greyish hue, without, however, exhibiting that semi-transparence which is seen in nerves which have undergone complete atrophy. These changes of size and colour are all the more striking, because nothing of the kind is found in the posterior roots, which have pre-

served their normal volume and their white colour. In the cervical region, especially, these lesions are most marked, however they are seen throughout the whole height of the dorsal region; but they tend to become effaced, as we go away from the cervical region. In the lumbar region, the anterior roots have resumed their normal size and colour.

The facialis and hypoglossus, also, present a greyish hue, analogous to that of the anterior cervical and dorsal roots. This change in colour becomes particularly manifest, when we compare these nerves to the others, such as the lingual, for instance, which have preserved their whitish lustre. No diminution in the size of these nerves is remarked, analogous to that exhibited by the anterior roots. The other peripheral nerves do not show any perceptible modification.

e. Central nerve system.—The encephalon shows no alteration. We have mentioned, in speaking of the peripheral system, those of the cranial nerves which presented any change in colour. The *cord*, examined in the fresh state, has not revealed any alteration, perceptible to the naked eye, in the greater part of its extent, but for about 5 centimètres above the dorso-lumbar enlargement, it exhibited excessive diffuence. Large vessels, gorged with blood, and a diffuse red tint, were observed in the softened portion. The ramollissement principally affected the left side and the posterior part of the cord. It is possible that, in spite of all the care taken in removing the cord, this ramollissement may have been produced artificially; we shall see that a microscopic examination seems to lend support to this view.

B. Microscopic examination: Muscular system.—We shall begin the account of the microscopic examination of the muscular system we made by the description of the muscles of the hand; these, indeed, are the muscles which exhibit the most advanced lesions. The muscles of the thenar and hypothenar eminences, and the interossei had reached the same degree of degeneration, and gave the same results, on microscopic examination. The preparations were made in the fresh state. We shall take as type of our description the changes observed in the right opponens pollicis.

On shredding the muscular substance with needles on the glass slip, it is found that the consistence of the fibres is somewhat greater than usual; it recalls that of connective tissue. In most of the muscular bundles there exist fine dark granulations, becoming brilliant and pearly at a certain focus, which seem to be

fatty granulations; neither acetic acid nor potash dissolves them. We have repeated these tests several times, and the result has been always the same. These granulations vary much in number and size, in different fibres. The transverse and longitudinal striæ, which are very distinctly marked in certain atrophied but only slightly granulated fibres, are more or less completely masked in those where the granulations exist in abundance.

The striæ have entirely disappeared in a certain number of muscular fibres, which resemble cylinders filled with transparent matter, and which enclose a more or less considerable number of granulations that are generally large in proportion to their fewness. These granulations are no more dissolved by acetic acid nor potash than were those of the fibres which have retained their striæ.

The size of a number of the muscular fibres seems normal, but mostly we remark an often considerable diminution. Thus, beside a muscular fibre of normal size, we see others the cross diameter of which is reduced to a third or a half. Certain fibres even present a diameter four and sometimes five times smaller than the normal. And it is a noticeable and important peculiarity to see a large number of fibres, which have undergone an atrophy so complete, still exhibiting very distinct striation, and being scarcely or even not at all granular.

Among the most altered muscular fibres, only a small number have shown fragmentary division of the muscular substance. In the fibres where we observed this division, the lumps of muscular substance were pressed against each other; very rarely they have an interval between, and, then, in these points, the sarcolemma had shrunk back. We have not found any multiplication of nuclei in the tubes of the sarcolemma, as recently remarked by M. Hayem in a case of progressive atrophy lately published.

The *vessels* in the affected muscles did not reveal any alteration. We have several times succeeded in very distinctly seeing the *little nerves* of the muscles; we did not, in these cases, remark that they contained any degenerated nerve-fibres. The *interfibrillary connective tissue* appears more abundant than in the normal state, and an exaggerated proportion of rounded or fusiform nuclei are perceived.

In addition to the preceding alterations, most of the muscular bundles show a finely shredded appearance, which is very remark-

able at the broken ends of the fibres; this shredded appearance is, however, also met with in alterations of the muscle which have nothing in common with progressive atrophy; these are commonly observed in the muscles of the lower extremities in the case of individuals who have long remained motionless.

To sum up: in the muscles of the hand, that is, where the lesions were most marked, we have observed what follows: 1°, a diminution of volume in the muscular mass; 2°, a pale yellow hue of the muscles; 3°, greater consistency of the muscle, recalling that of connective tissue; 4°, granular fatty alteration, little marked in certain fibres, very evident in others; 5°, fragmentary division of the muscular substance; 6°, atrophy of certain muscular fibres, simple and independent of all fatty or waxy degeneration; 7°, proliferation of interfibrillary connective tissue.

We shall conclude this abstract by pointing out that, in one and the same preparation, all these alterations might be seen simultaneously.

Side by side, with an entirely healthy or but slightly granular muscular fibre, a fibre might be remarked whose striæ were almost completely masked by fatty granulations. Beside these, others had wholly undergone vitreous degeneration; others, again, showed every degree of atrophy. Some presented division in lumps of the muscular substance. In the intervals between these fibres was seen a large quantity of connective tissue and rounded or fusiform nuclei.

With respect to the *muscles of the tongue*, we may confine ourselves to repeating the foregoing description. Let us only observe that the lesions were most marked in the intrinsic muscles of this organ. The *muscles of the forearm* have nearly preserved their normal colour. However, we find in the intervals of the fibres a marked increase in the connective tissue; there also are granular fatty fibres, vitreous fibres, and others considerably wasted, but, generally speaking, all these lesions are much less marked than in the hand. In the *deltoid*, we discover all the most advanced alterations which we have described.

The *sterno-cleido-mastoid* muscles have been specially examined. It will be recollected that, in the observation, they were mentioned as being, especially the left, subject to fibrillary contractions, which are remarkable for their spontaneity, frequency, and intensity. The preparations of muscular substance, taken from the left sterno-

cleido-mastoid, to our great astonishment, presented absolutely no alteration whatever. The fibres were remarkable for their comparatively considerable size, their distinct striation, and the absence of all degeneration. We did not even remark in these muscles that shredded appearance which was well-nigh general in the muscles of the upper and lower extremities.

The *pectorales* did not exhibit any alteration.

The *intercostales* showed only a slightly marked granular fatty degeneration, and the shredded appearance. The same is to be said of the *diaphragm*, where we only met with a small number of fibres in which the granulations were abundant enough to mask the cross striæ.

The *muscular elements in the lower extremities* enclosed few or no fatty granulations. They are not perceptibly atrophied; the striæ are clearly marked, and they offer no alteration other than the shredding.

2°. *a. Anterior spinal roots. Examination in the fresh state.*—

The number of the nerve-tubes which have preserved their normal character, in these roots, is greater than might be supposed, to judge by the diminution of their size, and the greyish hue which they exhibit. However, in at least one half of the tubes, we can note every degree of atrophy, from simple emaciation to complete disappearance of the medullary cylinder. In these tubes, we nowhere met with trails of fatty granulations. What we have said relates especially to the cervical region of the cord; in the dorsal region, the atrophic lesions are less marked, especially in the lower parts of this region; and, on a level with the lumbar enlargement, they are completely absent.

b. The posterior spinal roots have been examined in comparison with the anterior; no trace of the nerve-tubes was observed.

c. Cranial nerves.—The facial and hypoglossus, examined in the fresh state, in different parts of their course, presented, especially the last, lesions comparable to those which have been mentioned in reference to the anterior spinal roots. But the number of healthy tubes was relatively greater. The lingual and the pneumogastric nerves have been the subject of a special examination; they did not appear to offer any alteration.

d. Rachidian nerves.—The two phrenic nerves, especially that of the right, have seemed to us to enclose a certain number of nerve-tubes atrophied in different degrees. Analogous alterations

were remarked in the median and ulnar nerves, examined in the forearm; in the latter nerves, some atrophied nerve-tubes presented evident granular degeneration. The examination of the *great sympathetic*, in the neck, and inferior ganglia, did not yield any decisive result.

e. Spinal cord. Examination of softened portion in the fresh state.—It will be recollected that, immediately above the lumbar enlargement, the cord showed a remarkable diffuence over a certain extent; fragments of nerve-tissue, coming from this softened spot, were placed under the microscope immediately after the autopsy; the nerve-tubes exhibited the characters of the normal state; in the intervals which they left between them we saw neither granular bodies, nor fatty granulations, neither did the sheaths of the vessels enclose any granular elements.

This negative result ought to make us think either that the ramollissement was of quite recent date, or that it was artificially produced.

Examination of preparations hardened by chromic acid and coloured by carmine. Cervical region.—The examination of transverse sections, taken at different heights, shows alterations, some of which affect the antero-lateral fascicles of the cord, and others the grey substance, particularly the anterior cornua—they are nearly the same throughout the whole extent of the region.

On every point of the antero-lateral columns, the septa of connective tissue have assumed considerable importance; they are remarkably thickened, and they appear to have multiplied. In the spaces circumscribed by them, as they anastomose and cross, we readily recognise the section-surfaces of nerve-tubes which, on a level with the anterior fascicles and in the anterior portion of the lateral fascicles, have almost entirely preserved their normal diameter. But, in a part, which corresponds to the most posterior part of the latter fascicles and in the whole extent of a region which, internally, bounds the posterior cornua, whilst externally it extends almost to the cortical layer, the connective matrix has become quite predominant. The nerve-tubes, which have retained their normal diameter, have here become very rare; most of the tubes are atrophied in different degrees, and a large number of them are only represented by an axis-cylinder. When the sections are examined under a low power, the points where the sclerous alteration of the lateral columns thus predominate appear under the

form of two little red, transparent, irregularly rounded patches, which are placed symmetrically towards the most posterior parts of these columns, immediately external to the posterior grey cornua. The posterior white columns exhibit no alteration.

In the examination of the *grey substance*, the high degree of atrophy which most of the nerve-cells have undergone in the anterior cornua first strikes the eye; it is, also, evident that a certain number of these cells have disappeared without leaving any trace. The cells of the inner or anterior group are those, especially, which have undergone the deepest alterations; here, all the cells that remain are more or less wasted, whilst in the outer group, in most of the preparations, we see one, two, three, and even sometimes four of them, which have nearly completely preserved their dimensions and all the other characters of the healthy state. Among the wasted cells some, though six or seven times smaller than in the normal state, have still retained their stellate form, their prolongations, and still possess a distinct nucleus and nucleolus. Others are only represented by small irregular angular masses, without prolongations, yellow, brilliant, vitreous looking. In such cases the nucleus is generally no longer distinct. All these alterations may be clearly discriminated when the injured parts are compared with corresponding parts in sections of the healthy cord. As a standard of comparison, we have taken the beautiful preparations which we owe to the kindness of Dr. Lockhart Clarke.

The connective matrix of the anterior cornua showed itself under the appearance of a finely granulated mass; we did not remark that the nuclei of the neuroglia were more abundant than in the normal state. Matters were different in the anterior and posterior commissures; here the nuclei appeared numerous, especially in the neighbourhood of the central canal. The latter was completely obliterated by a mass of epithelial cells.

In the substance of the commissure, as in the anterior cornua, the vessels exhibited walls manifestly thickened, at times covered with numerous nuclei. The *posterior cornua* of grey substance appeared to possess all the conditions of the healthy state.

Dorsal region.—Only the upper two thirds of this region could be examined. The sclerosis of the lateral columns was seen throughout its height, at least as well marked as in the cervical region; as in the latter, though to a lesser degree, the cells of the anterior cornua were atrophied, and reduced to a few.

Lumbar region.—The symmetrical sclerous alteration of the lateral columns is also very distinctly marked here, but yet less extensively than in the other regions of the cord; it occupies the same position. The cells of the anterior cornua are almost normal in number; they generally present the dimensions of the healthy state. Only a few exhibit well-marked atrophic lesions.

Bulbar region: Sections made above the calamus.—By means of cross-sections, taken at different heights, in the olivary region and beneath, we have been able most distinctly to observe that the *cells of the origin-nucleus of the hypoglossus* are generally throughout the entire extent of these nuclei, profoundly altered, atrophied, or even destroyed. This alteration recalls exactly that which was noted in reference to the cells of the anterior cornua of the cord, in the cervical and dorsal regions. We have taken, as a standard for comparison in this department of our investigation, some very fine sections of healthy bulbi, prepared by Dr. Lockhart Clarke. We have also utilized the yet unpublished plates of the 'Iconographie photographique' of M. Duchenne (de Boulogne), relative to the structure of the bulbus. Now, on Clarke's sections, made at about half a centimètre above the point of the *calamus scriptorius* and representing the normal state, one could count from 40 to 50 tripolar or quadripolar large cells, in the nucleus of the hypoglossus, which in this region is voluminous and well defined everywhere; on the other hand, on sections taken from our patient, we could only find 3 or 4 at most of these cells, which were nearly normal; shorn the others had, for the most part, totally disappeared.

Some, which were considerably wasted, could still be discerned under a high magnifying power; others were only represented by small irregular masses, of an ochreous yellow colour, brilliant, and of their prolongations.

In addition, it could be seen that the delicate tracts (cell prolongations, probably), which, in the normal state, cross and recross in a thousand directions in the intervals between the cells, were completely effaced here; and between the cells nothing now was found save an amorphous, finely granular mass; finally, the nucleus of the hypoglossus, considered as a whole, appeared to have lost its rounded outlines; it presented an oval form transversely, and had evidently diminished in all directions.

On the same sections, immediately external to the nucleus of the hypoglossus, could be recognized the little group of cells which

Clark connects with the *inferior origins of the facial*. All the cells were healthy, and seemed normal in number.

Still more external is found the *origin-nucleus of the pneumogastric*. Most of the cells of the group were untouched, a few of them only (7 or 8 in each nucleus, and each preparation), and these the most anterior, exhibited yellow degeneration to a very marked extent, or else had undergone a very remarkable black pigmentation.

Sections taken at the point of the calamus.—In front of each side of the central canal the nuclei of the hypoglossus are found. There, also, the cells are wasted or degenerated. Behind the canal and on either side, the nuclei of the spinal nerve may be studied; both of them show some cells which have undergone yellow degeneration or black pigmentation, and they are at the same time deformed. The other cells of these nuclei are normal.

Section made above the olivary bodies.—The origin-nuclei of the facial, external oculo-motor, and auditory nerves, appeared to us to present all the characters of the normal state.

CASE II.

Symmetrical sclerosis of the lateral columns of the cord and anterior pyramids in bulbus. Atrophy of the cells of anterior cornua of the cord. Progressive muscular atrophy. Glosso-laryngeal paralysis.

Elizabeth P—, aged 58, entered, July 11, 1871, the infirmary of the Salpêtrière (wards of M. Charcot).

Data supplied by her son.—The affection with which she is stricken does not seem to have begun suddenly. In the month of July last, P— was still able to walk, though with some difficulty. Her left hand was already useless, and was kept close to the body. She also complained of finding her right hand becoming weak for some time, which was a hindrance to her taking food. She had, likewise, a slight difficulty in speaking, but deglutition was performed with ease.

Present state: 29th September, 1871.—The physiognomy is stupid; from the mouth, which is always wide open, the saliva is constantly flowing.

It seems as if all the muscle of the face were in a state of per-

manent contracture, which becomes exaggerated whenever the patient laughs or weeps; the sort of grimace which is then produced only passes away with extreme slowness.

The movements of the orbicularis oris are notably impeded. The lips cannot meet as in the act of whistling or blowing. In blowing out a candle, the mouth is half open; she succeeds in extinguishing it even when it is placed at some distance from her mouth. Diduction-movement of the maxillæ appears impossible. Contraction of the masticatory muscles is of but little strength, hence she can only triturate food when it is soft.

Articulation of words is abolished; the efforts of the patient only result in the production of a sort of grunting, which is quite incomprehensible. Intelligence seems preserved to some extent, and the patient seems to understand all the questions put to her.

The tongue is stricken with almost absolute motor impotence, whilst it also presents all the characteristics of an already far advanced atrophy. Small, shrunken, stirred by fibrillary movements, ploughed with furrows, and habitually covered with a blackish fur, it remains glued to the floor of the mouth, and it is with difficulty carried forward and a few millimètres beyond the lips. As to the movement of elevating the tip towards the palatine arch, this is totally abolished.

Difficulty of deglutition, though a little less incomplete, is yet very noticeable. It is only in the last few days that it became suddenly marked. When a liquid is introduced into the mouth, the greater part of it flows out between the lips; then a series of deglutition-movements follows, with considerable ascent of the larynx and very sonorous pharyngeal noise. If the liquid be carried on a spoon to the fauces, the deglutition takes place in a more complete manner, but it brings on a state of extreme anxiety. Whatever may be the mode of introduction of the alimentary substance, its entrance into the œsophagus seems to take place with extreme slowness, and some minutes after, noisy pharyngeal movements, provoked by liquid remaining at its upper orifice, are still remarked. The fluids never return towards the nasal fossæ, and, moreover, direct examination of the velum palati shows that it is symmetrical, and that it has retained the perfect freedom of its normal movements.

Up to the last few days the patient could still be got out of bed, she passed the hours of daytime seated in an arm-chair. But

the symptoms having become suddenly worse, she is now completely confined to bed.

Motor impotence, complete in the left upper limb, is a little less marked in the left. This paralysis is accompanied by a certain degree of contracture; the fingers are flexed on the palm; the wrist is in pronation; the half-flexed elbow resists when one tries to straighten it. The muscular masses are wasted, and stirred with fibrillary movements. The atrophy, which is more marked on the left than on the right, is probably more advanced at the root of the limb than at its extremity. Whilst the muscles of the shoulder, particularly the deltoid, have nearly disappeared, leaving the bony projections bare, the thenar and hypothenar eminences, though lessened, have still preserved a considerable thickness.

In the thorax, the pectorales majores are affected in the same degree as the deltoid muscles; the least touch brings up fibrillary motion, when it does not show itself spontaneously.

The lower limbs, which are much less deeply affected, are equal in size. They present a noticeable emaciation over the whole limb; no group of muscles seems more specially taken than the others. They can execute some movements on the bed-level. The muscular masses, those of the calves especially, are the seat of abundant fibrillary contractions. Faradaic examination of the muscles enables us to state that they all contract under the influence of electricity, though the lower limbs react with greater force than the upper. The orbicularis oris in particular seems very sensitive to electric excitation. But muscular contraction does not everywhere take place with its normal character, and, in many muscles, it assumes the form of fibrillary motion.

Sensibility seems to be preserved in all its modes. The pulse is 104. Respiration regular.

1st October.—P. 100. Commencement of bed-sore.

2nd.—P. 108; R. 26.

6th.—P. 100; R. 20.

7th.—P. 120.

10th.—P. 130. Extremities cold. Urine turbid, containing neither sugar nor albumen. Retention of urine.

13th.—P. 124.

14th.—P. 120.

23rd.—Debility has made considerable progress. The patient has scarcely strength to cry out. Feeding has become impossible.

Extremities cold. Pulse imperceptible. The bed-sore has spread over a great breadth.

25th.—Death.

NECROPSY: State of viscera.—The *heart* is small; no valvular lesions exist; the walls have their normal thickness and colour. No lesions in the *lungs*. The *liver*, normal in size, exhibits no cicatrices; same thing as regards *spleen* and *kidneys*. The *vesical mucous membrane* is red, covered with mammillated projections, lined with purulent exudation.

State of muscles.—The muscles of the face are very slender, but their colour is perceptibly near the normal hue. The *masseter*, red on the surface, is yellowish within. The *sterno-mastoid*, *scalene*, and *trapezius* muscles are well nourished, and present a fine red colour.

The *pectorales* and the muscles of the left upper limb are yellow, discoloured, thinned, and their appearance strikingly contrasts with that of the muscles of the neck; the *deltoid* is especially altered. In the hand, the muscles of the *thenar* and *hypothenar* eminences are discoloured. The *serratus magnus*, like the *pectoralis major*, is pale and wasted. It is the same thing, but to a less degree, as regards the abdominal muscles. The *diaphragm* has preserved its normal colour, consistence, and thickness.

In the lower extremities, the muscles, although slender are scarcely discoloured—a certain number of them have been examined. The *sartorius*, the *rectus femoris*, for the thigh—in the leg, the *gemelli*, the *tibialis anticus*, the *extensor communis digitorum*—but none of them presented even that dead-leaf colour which long confinement in bed so frequently gives to muscles.

State of nerve centres.—The *brain*, the *cerebellum*, and the *isthmus* of the encephalon do not present any perceptible alteration; the arteries of the base are healthy. The *bulbus rachidicus* presents all the signs of the normal state. The tissue of the *cord* is firm in consistence throughout; there is no evident atrophy affecting the different columns of the organ. The originating filaments of the *bulbar nerves*, situated below the facial, namely, the *hypoglossus*, *glosso-pharyngeal*, *pneumogastric* and *spinal*, contrast, by their fineness and their grey colour, with the nerve-roots situated above; the facial in particular is free from all alteration. This extreme tenuity and this grey tint are again met with in a certain number of the anterior roots of the cord.

Histologic study: Muscles.—Examination of the muscles of the

tongue, several times repeated, has always given an almost negative result. At least, we have never found that granular condition of the muscular fibre, nor that abundant nuclei proliferation which characterises atrophic degeneration of the muscles, arrived at an advanced degree of evolution. In the muscles of the *face*, on the contrary, numerous fibres had lost their cross striation, and presented a very marked granular condition of the contents of the sheath.

In the *muscles* of the *upper limbs* which, to the naked eye, exhibited a yellow colour and a very evident diminution in size, microscopic examination revealed the presence of a large number of degenerated primary bundles. In the thenar and hypothenar eminences, particularly the fibres had undergone very marked simple atrophy; in other places, they had largely lost their cross striation, and the nuclei of the interstitial connective tissue were extremely multiplied. On certain preparations, examined in glycerine after the addition of acetic acid, we could see the contents of broken sheaths, forming islets arranged in parallel series, separated from each other, and partly masked by clusters of nuclei. The muscles of the *trunk* and *lower limbs* presented the same alteration, but, especially the latter, to a much less advanced degree.

Nerves.—The originating filaments of most of the bulbar nerves have been examined, and all exhibited histologic characters closely akin to the normal state. We could barely distinguish a few fibres with granular contents, whilst some others, deprived of their medullary cylinder, were reduced to their sheaths and covered with more numerous nuclei than usual. The trunks of these nerves were not, any more than their roots, notably altered in their ulterior course. In particular, the integrity of the fibres of the *hypoglossus* at the base of the tongue have been observed; the same holds good as regards the *spinal*, *pneumogastric*, and *facial* nerves.

The *anterior roots* of the *rachidian nerves*, examined on a level with the cervical enlargement, showed some degenerated fibres in the midst of a large number of healthy fibres.

The left *median nerve* examined, after being hardened, in transverse sections was found healthy.

Nerve centres.—Preparations made after hardening in chromic acid and coloured by carmine:

Bulbus rachidicus.—Examination of transverse sections of this organ, taken at different heights, enables us to discern lesions of the white and grey substances.

1°. *Grey substance*.—The *origin-nuclei* of the *bulbar* nerves are the seat of alteration here. The latter, which is essentially characterised by pigmentary alteration and consecutive atrophy of the nerve-cells which enter into the composition of these nuclei, is especially marked in that of the hypoglossus nerve. Beside some cells which have remained healthy, we can see in the others the characters of the lesion at all stages of its development. Most of them, already invaded by yellow degeneration, refractory to the action of carmine, and notably diminished in volume, have assumed a globular form. They give birth to rare prolongations, pale and thin, which it is impossible to follow, as in the normal state, for a certain distance from their point of origin.

The *neuroglia* does not appear to take any part in the morbid process, it has preserved its normal transparency, and it is impossible to discover any evident augmentation in the number of its nuclei.

The cell groups, belonging to the several other nerves of the region, are less severely smitten. The cells are here in considerable number, and if some appear to have undergone a decrease in size, we find but very rare examples of that pigmentary invasion which is so distinct in the hypoglossus-nucleus.

The *olivary bodies* are normal in all the sections.

2°. *White substance*.—The lesion of the white substance here occupies the whole extent of the anterior pyramids, which are the seat of very manifest sclerosis, and are vividly coloured by carmine. It may be traced, in the fascicles, from the point where they emerge from the protuberantia to a level with their decussation. It is easy, on the same sections, to perceive the perfect integrity of the nerve roots in their intra-bulbar course. It is especially very evident as regards those of the hypoglossus, and contrasts in a striking manner with the very marked atrophy of their origin-nucleus.

The decussation-region possesses particular interest; whilst, in the anterior part, what remains of the pyramid stands out distinctly under the form of a transverse red band, we see the sclerosis advance, like a wedge, the broad end of which is behind, into the decussation-region, and proceed to invade, passing from the opposite side, the reticulated formation and the superior part of the lateral columns. The anterior cornua which, at this level, are represented by two islets of grey substance completely isolated from the central substance, contain a notable proportion of degenerated cells.

LESIONS OF THE SPINAL CORD.

Cord.—The cord is the seat of very extensive alterations which bear both on the anterior cornua of the grey substance, and on the antero-lateral columns. It is, also, to be remarked that, at least, in the cervical region, the lesions appear to have reached a more advanced period of their evolution in the left than in the right side of the organ, which has consequently become unsymmetrical (Plates IV and V).

Antero-lateral columns.—These present, on transverse sections of the cord, all the characters of sclerosis of the white substance. The great connective tracts, which extend from the periphery of the organ to the grey substance, are thickened. The meshes of the reticulum, considerably broadened, exhibit numerous nuclei. They bound very unequal spaces, in which sections of the axis-cylinder are seen. The latter are mostly more slender than in the normal state; in some places, and on the contrary, they appear hypertrophied. The altered regions are vividly coloured by carmine.

If we study the distribution of this sclerosis, it is seen to occupy, throughout the whole length of the cord, symmetrical points in each of the halves of this organ. It also recalls by its mode of distribution the descending degenerations, consecutive on certain circumscribed lesions (*en foyer*) of the encephalon, though it differs in certain particulars.

In the entire cervical region, it occupies, in the innermost part of the anterior columns, a sort of triangle, the base of which rests on the white commissure; one of the sides of the triangle borders the anterior sulcus, whilst its apex tapers to an end towards the middle part of this sulcus. This triangle, broader on the right than on the left, is seen no more towards the lower part of this region.

In the *lateral columns*, commencing in front at the outer angle of the anterior cornu, it follows, within and behind, the contour of the grey substance without penetrating its interior; whilst, on the outside, it is separated from the periphery by a narrow band of healthy tissue.

The superior portion of the region, that which is situated immediately below the collar of the bulbus, diverges a little from this description. Here, in fact, the anterior cornu is surrounded on all sides by a sort of crown of sclerosed tissue. If, from the upper portion, we descend towards the dorsal and lumbar regions, we see the sclerosis leave the anterior column and progressively diminish in

extent in the lateral column. In the dorsal region, the peripheric circle of healthy tissue enlarges notably, whilst the sclerosis leaves the contour of the anterior cornu. In the lumbar region, it has gone off from the posterior cornu and forms a sort of islet situated in the posterior part of the column, and surrounded on all sides by normal tissue, except behind, where it sends a prolongation towards the periphery and the entrance point of the posterior roots. All the rest of the white substance, and particularly the posterior columns, is exempt from alterations. The same thing holds good for the anterior roots in their intra-spinal course.

Grey substance.—Here, exactly limited to the area of the cornua of grey substance, and symmetrically disposed in the two halves of the cord, we again meet with the cellular lesion which has been described in reference to the nucleus of the hypoglossus. Striking indiscriminately and at hazard, as it were, different groups of these cornua, it gradually diminishes in extent, in proportion as it approaches the inferior region of the cord. Whilst, at the cervical enlargement, we can hardly compute the number of cells spared at one fifth of the total number, in the lumbar region more than a half have preserved the characters of the normal state. The vesicular column of Clarke has not been spared; but all the elements of the posterior cornua have escaped degeneration.

The *neuroglia* has not here, any more than in the bulbus, taken an active part in the morbid work; and, in all the sections, we may see cells reduced to a few pigmentary granulations in the midst of a perfectly normal tissue. However, the grey substance has, in certain spots, been disorganised in its entirety, and we can observe, in the upper region of the cord, the presence of genuine foci. Vertically elongated, they occupy symmetrically the two anterior cornua, the limits of which they do not exceed. The sections which were made across their middle portion show only a thick mass of tissue becoming strongly coloured by carmine, projecting above the surface of the section, in which it is difficult to distinguish any element. But these foci, swollen in their middle part, taper off at both ends, and it is in these points we should examine them. We then see that they begin by a certain number of little rounded islets, the tissue on a level with which is evidently thickened and rendered less transparent without any manifest multiplication of neuroglia-nuclei being remarked.