

THE MORBID ANATOMY OF A CASE OF INFANTILE PARALYSIS.

BY E. F. TREVELYAN, M.D.LOND., B.Sc., M.R.C.P.

*Assistant Physician to the Leeds General Infirmary. Professor of Pathology
in the Yorkshire College.*

(From the Laboratory of the Leeds General Infirmary.)

THE following is an outline account of the case for the notes of which I am greatly indebted to Dr. Chadwick and Mr. Brown, under whose care the patient was.

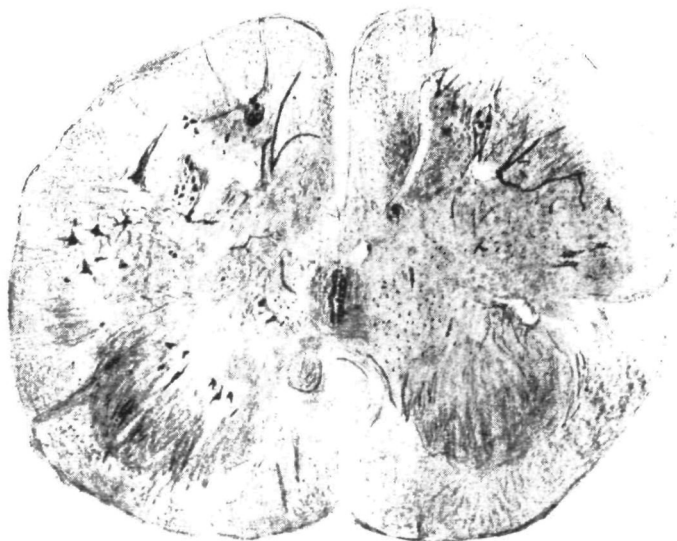
A girl, aged 6 years, was suddenly seized, nine months before admission, with fever, nausea and vomiting. Paralysis appeared on the second day, involving all four extremities. The fever ceased in nine days. The urine and fæces were passed into the bed for three weeks. The arms began to recover three weeks after the onset. On admission there was almost complete paraplegia with contracture in the calf muscles. The right arm was weak. Hardly any wasting was noted. The plantar and patellar reflexes were absent, the abdominal present. The reaction to faradism was absent, that to galvanism weak. K.C.C. = A.C.C. Sensation was intact. Later some improvement occurred in the legs, apparently under massage. Death took place about eleven months after the onset of the disease from independent causes.

At the necropsy there was slight diffuse nephritis with marked fatty changes in the glomeruli of the kidney. There was no obvious naked eye changes in the cord or brain. Unfortunately, I omitted to obtain any of the peripheral nerves or muscles.

A word may perhaps be said here in respect to methods. The rapid method of hardening in Müller's fluid in a hot oven at body temperature was adopted. In two and a-half



GENERAL VIEW.—(a) Lumbar region. $\times 2$ in.



GENERAL VIEW.—(b) Lower sacral region. $\times 2$ in.

days the material was taken out and put through alcohol of increasing strengths. In five days it was quite ready for embedding in paraffin. Sections were cut with the rocking microtome and were stained after Weigert's method, in aniline blue black, logwood and eosin, borax carmine or picro-carmine and logwood. A few sections were stained after Pal's method, and a few without much result in Rosin's triple stain.

Numerous sections were examined from both ends of the spinal nerve segments, longitudinal and sagittal sections through the horns being taken in the intervening parts. Sections were also examined from the M.O., pons, crura, internal capsule and motor cortex, but no lesions were found in these situations.

It may save space to summarise the morbid changes found in the various elements such as have been ascertained to exist in considerably over 200 stained specimens carefully examined and systematically noted.

Ganglion Cells.—The ordinary changes in these cells are readily seen. Alteration in and disappearance of the processes, as well as shrinking of the cell into an amorphous looking mass were observed. An indistinctness in the outline and a breaking up of the cell were occasionally seen. Only very exceptionally were round cells found in the perigangliar space. Spaces where former ganglion cells had been were fairly numerous. A stippling of the general protoplasm of the cell was only obvious at times. There was no distinct evidence obtained of pigmentation or calcification of the cell. The changes in the nucleus and nucleolus were very interesting. It is often said that the nucleus and nucleolus disappear early, but there would appear to be circumstances under which these structures are more resistant to such changes. Shapeless masses of protoplasm were here sometimes recognised as the remains of ganglion cells solely by the presence of a distinct circular nucleus often with nucleolus obvious only on careful focussing. Some little time ago I was much struck when studying sections from a dog's cord with a spontaneous acute myelitis of five days' duration, to find that the nucleus of these cells could

at times be seen almost shorn of all trace of surrounding protoplasm.

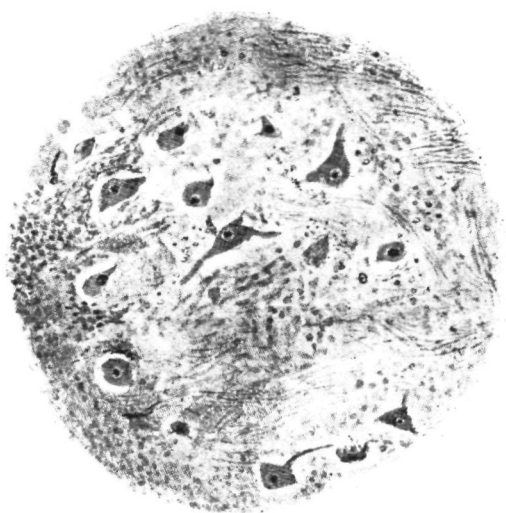
The above-named changes in the ganglion cells were best studied in the material from this case in the upper cervical and lower dorsal regions, and especially perhaps in Clarke's column (fig. 1). Groups of minute and perfectly formed ganglion cells were here and there seen chiefly in the parts corresponding to the lateral horns. Kohnstamm (*Zeitschr. f. klin. Med.*, 1893) has specially drawn attention to these cells. Once, and perhaps twice, a ganglion cell was seen to have two nuclei. In no part of the cord could the destruction of ganglion cells be said to be limited to one or more groups in the sense insisted upon by v. Kahlden.

The *nerve fibrils* in the grey matter were greatly changed. They had often entirely disappeared. When present they were mostly reduced to fine lines, and frequently they were distinctly varicose (fig. 2). These changes were readily studied in the anterior commissure. This fact is not so much to be wondered at if the median and hinder group of ganglion cells are to be looked upon as commissural cells (Lenhossek), for these latter were greatly involved throughout.

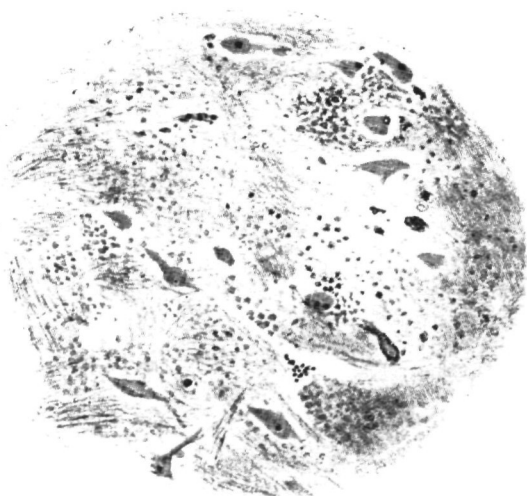
The *anterior nerve roots* as they passed out through the white matter seemed to be less well represented than usual, the individual fibres being fewer in numbers and thinner. Only in a few specimens did they appear to be degenerate. The posterior roots were intact.

The *neuroglia* of the grey matter was considerably altered, chiefly in the direction of overgrowth and infiltration. In many sections taken from the lumbar and cervical enlargements translucent areas were visible in the grey matter. These were unquestionably due to the destruction of the numerous nerve fibrils and ganglion cells. If such a translucent patch was examined under a high power, the overgrowth in the neuroglial element became obvious. It consisted of a fairly open rich network of thick fibres, with the presence here and there of enormous spider cells (fig. 3), whose processes could be distinctly seen to form this neuroglial network. In parts of the cervical region these

FIG. 1.



(a)



(b)



(c)

Ganglion cells healthy and in various stages of degeneration in Clarke's columns.
The cellular infiltration is very well marked. Upper dorsal region.

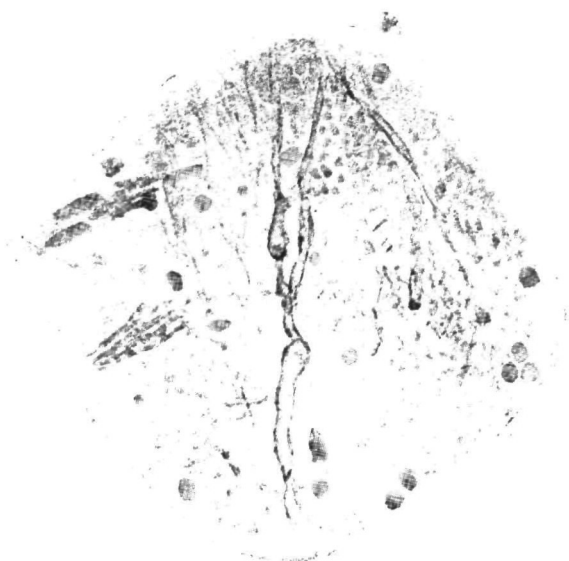


FIG. 2.

Varicose and wasted nerve fibrils from the upper lumbar region. $\times \frac{1}{4}$.

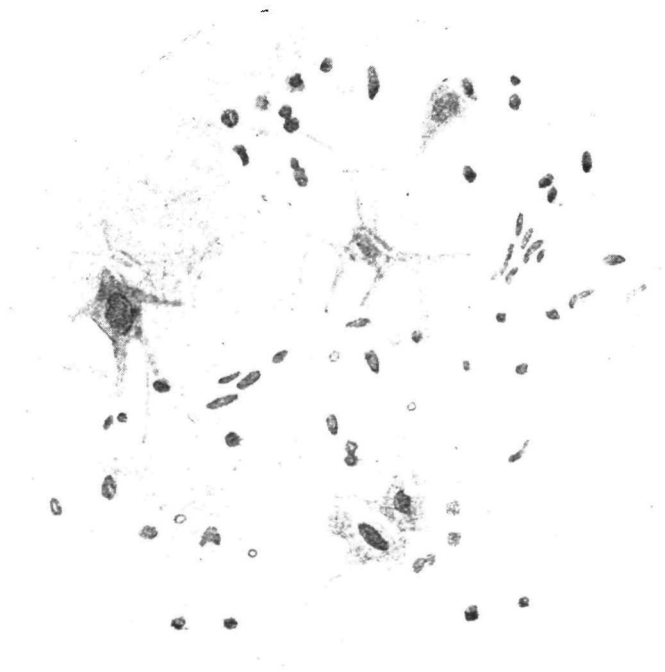


FIG. 3.

Enormous spider cells (lumbar enlargement). $\times \frac{1}{5}$.

spider cells were present in great numbers. In Edinger's admirable *Vorlesungen*, 1893, the opinion is still expressed that these spider cells are really thin cell plates and that fibres only appear to arise out of the cells because they lie in close relation to them. That the fibres in question do arise from the cells in these specimens there can be no manner of doubt, and indeed, researches with Golgi's method seem to have set this question definitely at rest. (Lenhossek, *Der feinere bau des Nervensystems*, 1893.)

The *central canal* is pervious almost throughout the cord. In its neighbourhood are a number of large epithelial-looking cells clearly derived from the cells lining the central canal.

There are two further pathological processes in the neuroglia now to be considered, namely, the increased vascularity and cellular infiltration.

Vascularity.—In many parts of the cord there is obviously greatly increased vascularity. Here a few remarks may be made on the vascular supply of the cord especially as the vascular and interstitial origin of the disease is adopted here. It consists of central and peripheral components. The central artery penetrates into the anterior fissure at the bottom of which it divides. From this central supply Clarke's column is provided. These branches of the central artery can fairly readily be made out if a number of sections are examined.

The peripheral supply is chiefly limited to the white matter. It is very obvious, however, that the outermost parts of the grey matter also receive blood from the peripheral as well as the central arteries. In some of the sections such a branch can be seen to penetrate the anterior horn. As will be pointed out later, some of the advanced perivascular changes lie in a zone in which the central and peripheral arteries would appear to meet. Any distinct disease of the arterial wall itself I have not been able to make out except in a few doubtful instances. Once a capillary appeared varicose. The lymphatic sheath, however, was frequently found crowded with round cells.

Cellular Infiltration.—In most parts of the cord, and most marked in the mid-cervical region, there was very

considerable cellular increase. These cells may roughly be divided, as has been done by Dauber and others, into (1) round cells with a very large nucleus, and (2) cells with many processes, namely Deiter's or spider cells. These latter would appear to vary very considerably in size. The cell infiltration is distinctly of two kinds: (1) patchy, (2) general. The patchy infiltration is frequently seen to be distinctly perivascular. The original specimen from which the drawing (fig. 4) comes, strangely reminds one of a recent infiltration. In another longitudinal section from the lumbar enlargement (fig. 5) the change would appear of a more chronic character, the neuroglia round these vessels being unquestionably considerably altered.

There is yet another infiltration, if it may be so called, round about the central canal and penetrating at times deeply into the surrounding parts. It consists of very large, often irregular, cells with no distinct processes. They have all the appearances of being derived from the cells lining the central canal. Since these cells have a similar origin to Deiter's cells, their increase and multiplication is hardly to be wondered at (see Lenhossek).

White Matter.—The changes here are much less obvious but yet distinctly present. In the neighbourhood of the diseased horns the neuroglial element is denser and its cells more numerous than usual. In one specimen an unmistakeable patch of round-celled infiltration was seen, and in another logwood eosin preparation a curious staining which looked exactly like the remains of an old hæmorrhage. No corpora amylacea were present. In longitudinal sections (logwood and eosin) the cellular increase could be distinctly made out. Similar sections stained according to Weigert's method showed slight changes in the myelin of the nerve fibres. In a few specimens in which the pia mater and subarachnoid tissue remained, no evidence of any inflammatory change was forthcoming. This is noted, as some observers seem to have found such a lesion present (Goldscheider).

As regards the distribution of the lesion, it extended undoubtedly throughout the whole length of the cord. It

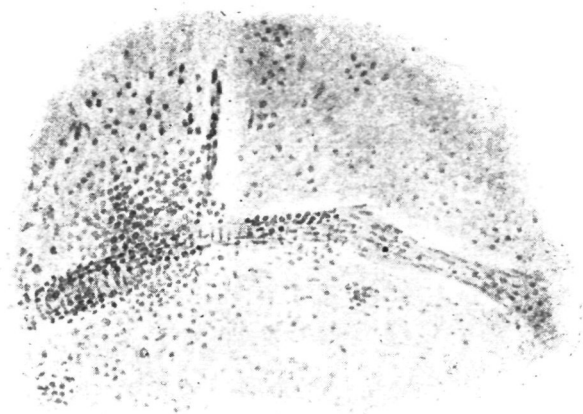


FIG. 4.

Perivascular infiltration (lumbar enlargement) about a vessel quite in the periphery of the grey matter. $\times \frac{1}{10}$.

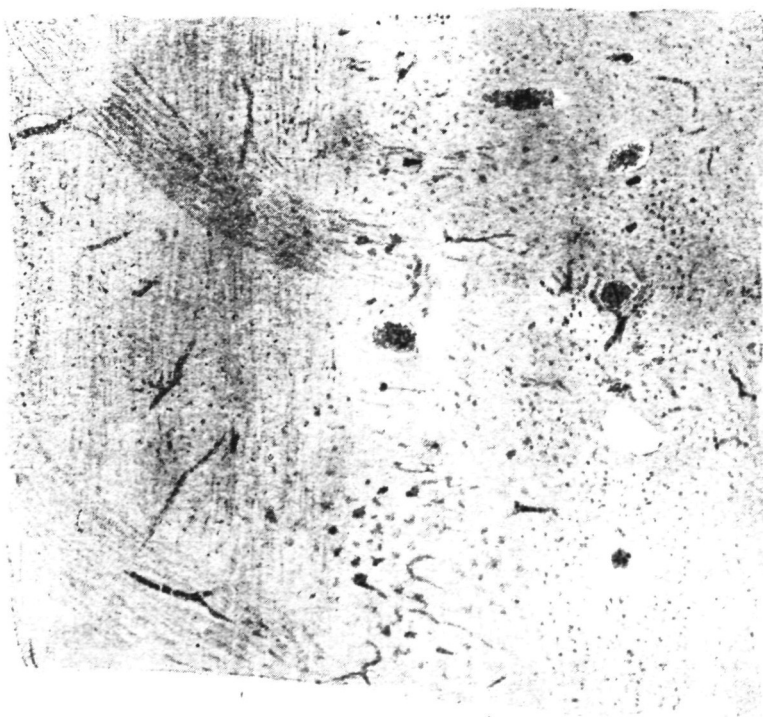


FIG. 5.

Longitudinal section, showing cellular infiltration and perivascular changes.

was present in the lowest sacral segments and reached as high as the decussation of the pyramids. The lesion was unquestionably intense in the *lowest* part of the cervical region (C6 to D1). It gradually diminished in an upward direction. It was also less intense in the upper dorsal region to become more marked in the mid-dorsal region and less pronounced in the lower dorsal cord. In the lumbar region it was very intense, especially about L 2, 3 and 4. Below L 5 it tended to become less marked, but did not altogether disappear even in the lowest sacral segments. It was somewhat less marked, especially in the cervical enlargement, on one side than on the other.

It is proposed briefly to attempt an explanation, however inadequate, of the clinical features of the case, by the morbid lesions found.

The paralysis in the lower limbs is amply accounted for by the disease in the lumbar cord. The improvement noted in the legs in the tenth or eleventh month, so that the child could just lift them from the bed, is curious. In one longitudinal section, however, from the upper lumbar enlargement quite a number of healthy ganglion cells were found. In no other section from this region was a similar appearance noted. It is almost surprising that there was any power at all in the right arm, and yet the patient could move the fingers of the corresponding hand. The amount of power possessed by the left arm is also remarkable, for the child could feed itself with this left arm. It would be a hardihood to attempt to explain the above noted improvement by a regeneration of ganglion cells. Yet those small and perfect ganglion cells noted above suggested such a possibility. Tumours have been found in the central nervous system composed in great measure of ganglion cells, showing that the division and multiplication of these cells is sometimes possible.

The absence of wasting was a striking fact; it was noted clinically, and in the pathological report. The absence of the plantar reflex could sufficiently be accounted for by the disease in the sacral segments, and the absent knee jerk by the intense disease in the lumbar enlargement. The

abdominal reflex was present, and the disease was certainly less intense in the corresponding part of the cord (lower dorsal). Unfortunately there is no note about the other reflexes. The epigastric reflex should have been absent on account of the marked lesion in the mid-dorsal region.

The question of the nature of the lesion in infantile paralysis has been so fully debated of recent times, and the disease so clearly shown to be of vascular and interstitial origin—that is, the changes in the neuroglia including vessels, are primary, those in the nerve cells secondary—that it is unnecessary to discuss it at length. Goldscheider (*Zeitschr. f. klin. Med.*, 1893) and even more specially Siemerling (*Arch. f. Psychiatrie*, xxvi. Bd. i., 1894) have strongly advocated this view. v. Kahlden (*Ziegler's Beiträge*, 1893) has, however, vigorously supported Charcot's opinion that the disease starts in the nerve cells, the changes in the neuroglia being secondary only. Siemerling's rejoinder seemed unanswerable. v. Kahlden has again quite recently returned to the subject in the *Centralbl. f. allg. Pathol.*, Sept., 1894 (Epitome, *Brit. Med. Jour.*, Oct. 20, 1894, par. 292) in a review of recent writings upon this question. He discounts, perhaps hardly pertinently, some of the cases which have been brought forward in favour of the interstitial and vascular origin of the disease, by treating them as atypical cases.

Most of the cases upon which the above authors have based their conclusions are of very recent origin. In the old cases the changes are so advanced as almost to preclude an opinion as to the starting point of the disease. The case recorded above stands in a middle group between these two classes of cases. The changes seem to be entirely in favour of the disease being primary in the neuroglia including the arteries. The infiltration, and especially its perivascular localisation, may be here especially referred to. On the other hand, there is no definite localisation of the disease to any one or more groups of ganglion cells. The overgrowth in the neuroglia, including the spider cells, is certainly striking. This may be due to the irritation of the poisonous products (toxines), escaping from the blood

according to the infective theory of the disease, and this view certainly appears to offer the best explanation of the etiology of the disease. In more chronic cases the overgrowth of the neuroglia might be looked upon to some extent as supplementary (*vacatswucherung*), that is, the permanent vascularity being certainly not diminished and often increased, whereas the nerve elements have perished, there remains less tissue to nourish, hence the increased nourishment to the neuroglia leads to its overgrowth. Changes have been found in the neuroglia in quite recent cases, so that the irritation theory would appear best to account for the changes in the neuroglia, certainly in the earlier cases. In respect to etiology, it is interesting to note that micro-organisms have not been found in the cord. Yet the possible occurrence of epidemics of infantile paralysis as recorded by Medin (*Centrabl. f. klin. Med.*, 1891), and the experimental evidence as given by Roger (*Rev. de Méd.*, 1893), and more recently by Thoinet and Masselin (*Rev. de Méd.*, June, 1894), strongly support the view that the disease is an infective one. Thoinet and Masselin injected preparations of the *B. coli communis* and *Staphylococcus*, and determined spinal lesions at varying intervals after the inoculation, the peripheral nerves remaining intact. It is the poisons excreted by the micro-organisms that set up the disease, and this accounts for the early vascular phenomena found in the cord.