

IRON INFILTRATION IN THE FIXED AND WANDERING CELLS OF THE CENTRAL NERVOUS SYSTEM.

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In a contribution to (a) iron infiltration in ganglion cells and (b) forced movement due to cellular degeneration of the cerebellum following rattlesnake poisoning,¹ I pointed out the existence of iron infiltration in the cortical ganglion cells both as an end result and as an intermediate process of the absorption of hemoglobin. The ganglion cells gave the biochemical tests for hemosiderin. The microchemical reactions in the large pyramidal cells in the cortex were striking and characteristic. In the Weigert-hematoxylin method the entire cell with its processes took a deep black stain. In thin sections this pigmentation seemed to consist of fine black granules; these black granules could be followed into the dendrites and produced an appearance of fragmentation. With the slow eosin stain the ganglion cells gave the same brilliant red reaction as did the red-blood corpuscles. With the potassium ferrocyanide and alcohol differentiation, the ganglion cell as a whole gave a diffuse blue reaction without, however, the granular arrangement of the hematoxylin stained cell. This microchemical reaction in the ganglion cells was not obtained throughout the entire cortex, but only in the neighborhood of the diseased vessels.

Weber² has described iron infiltration in the cortical ganglion cell with similar changes to those here noted, but no other contribution, so far as I have been able to determine, has been made to this subject. This condition must indeed be a rare one, as I have noted it, as a complete reaction, only in the case above noted, reported by me. It is not a constant reaction in hemorrhage into the cortical tissues. I have looked for it in a large number of brains showing cortical hemorrhage, with degeneration of the red cells in various stages, but have not been able to find it. In a series of experiments on young puppies an artificial thrombosis of the venous sinuses was produced in an attempt to simulate the venous capillary hemorrhage observed in some cases of the cerebral palsies of childhood. Capillary hemorrhages in the tissues were produced, but no end reaction of hemosiderin was noted. What might be considered an intermediate reaction was the rule. Cells took a deep black stain with hematoxylin and a deep red stain with eosin, but no blue reaction with potassium ferrocyanide was obtained. The results of this series of experiments were inconclusive in

¹ Contributions from the William Pepper Laboratory of Clinical Medicine, 1900, vol. i.

² Monats. f. Psychiat. u. Neurol., 1898, No. 3.

demonstrating a structural change in the ganglion cell as a result of long-standing venous stasis or thrombosis occurring at the time of delivery. The experiments have not yet been completed, but so far as they have been carried, an artificial infiltration of hemosiderin in the ganglion cells has not been produced. In line with this work a careful investigation of ganglion cells was made in the brain from a patient who suffered from an extensive hemorrhagic encephalitis in the cortex. The iron reaction was not demonstrated in the cortical ganglion cells in this case, but was obtained in a striking cell reaction in the plasma-like cells of the pia mater and in the elastic coats of the smaller cortical arteries. The case was as follows:

The patient, R. L., a white male, was admitted to the hospital, June 1, 1910 in a semi-unconscious condition, in which he remained for four days. On admission his neck was rigid, his pupils contracted and his reflexes exaggerated, and since the stuporous condition had been present, any attempt to move his neck or bend his back caused him to cry out as if from pain. Pressure upon the muscles also caused him pain. He had incontinence since his admission. Owing to the noise he made during any attempt to examine his heart and lungs an accurate knowledge of their condition could not be ascertained. There was, however, apparently no valvular lesions of the heart. In the left lung many dry rales could be heard in front. The patient had an old, depressed fracture near the Rolandic area on the left side. There was a large discolored area over the right temporal region; and just below the left deltoid muscle, on the outer side of the arm, was a large bruise. He had been operated upon shortly before coming into the hospital for a tuberculous fistula in ano, which was still unhealed. His wife later stated that he had been operated upon for fracture of the skull in September, 1908, which explained the depression.

On June 25, an examination of the eyes showed the eye-grounds to be normal, though the optic nerves were very small. A lumbar puncture revealed nothing abnormal macroscopically or microscopically, but a Noguchi (Butyric acid) test was positive. The urine had a specific gravity of 1026, and contained in trace of albumin; the microscope revealed granular casts, triple phosphates, and amorphous urates. The temperature was normal except for a slight rise during the fortnight preceding his death. The patient died July 25.

The autopsy on July 26 permitted the following diagnosis: Dilatation of the left ventricle; fibroid myocarditis; congestion and edema of the lungs; an old fracture of the skull; a chronic internal hemorrhagic pachymeningitis. The general postmortem examination showed nothing more than the above diagnoses suggest. The man was fairly well-nourished; the lungs were free and crepitant throughout, but contained frothy bloody fluid, while the pleural

cavities were empty. The heart was flabby, with the muscle pale in color, but no lesion was found in the valves, and the coronary arteries were smooth. The papillary muscles were slightly fibroid at the tips, and the aorta showed a few yellowish patches. The liver contained an excess of blood, and the spleen was large and soft. The pancreas, adrenals, ureters, and bladder were normal. The kidneys showed no noteworthy change. There was no gross lesion of the intestines, but these with the stomach, which presented a dark reddish mucosa, were distended. In the abdominal aorta were a few calcareous patches.

The skull showed a fracture partly linear in type, extending from the right posterior fossa just behind the foramen diagonally across the median line to the left fossa, and running superiorly and anteriorly close to the juncture of the parietal and temporal bones and terminating anteriorly at the base of the skull, just posterior to the orbital plate of the frontal bone on the left side. There were two small circular deficiencies in the frontal bone of the left side near the median line.

The brain showed slight excess of fluid. The inner surface of the dura, over practically the entire hemisphere, but especially posteriorly and superiorly, was thickened and darkened in color. At points the thickening appeared to be due to fibrin. At other places it appeared to be newly formed tissue. Posteriorly the superior surface of the brain showed a distinct depression underneath the thickest portion of the dura. The cord presented no gross lesions.

The gross examination of the brain, after hardening, showed at the base an advanced grade of arteriosclerosis of all the vessels composing the circle of Willis. There was a slight trace of chronic leptomenigitis over the base of the frontal lobes, and there were evidently adhesions between this and the dura of the base, which were torn away when the brain was removed. There was a yellowish pigmentation of the pia arachnoid over the base of the frontal lobe on the left side and the tip of the left temporosphenoidal lobe. Pons and medulla were normal. There was an extensive hemorrhagic internal pachymeningitis involving the dura over the convexity of the left hemisphere. On this side of the brain the pia arachnoid was adherent to the dura over the anterior half of the frontal lobe. The pia arachnoid as far back as the midparietal area had a yellowish red appearance, as if infiltrated with an old transformed blood pigment. Here and there throughout the frontal lobe, and more particularly where the pia arachnoid was adherent to the dura, the cortex was friable and softened as if from a recent thrombotic lesion. Sections of the cortex showed that the reddish-yellow pigmentation extended into the gray cortical matter, while the underlying white matter had the appearance of yellow softening. The dura over the right hemisphere was the seat of a localized pachymeningitis (6 cm. long by 3 cm. broad) situated over the

inferior parietal area. The internal surface of the dura was perfectly normal, both in color and texture. The external surface of the dura was roughened, indurated, and of an orange-brown to black color. Section of this area showed this condition for the most part to be extradural. The pia arachnoid on the right side was normal in texture and color, as was also the cortex. Transverse section of the brain showed nothing abnormal.

Microscopic Examination of the Brain Cortex. The left cerebral cortex showed here and there throughout the frontal area capillary hemorrhages, both old and relatively recent. The cortex in sections taken from the frontal lobe showed necrotic areas extending from the surface into the subcortical tissue in the form of pyramids. At the apices of these pyramidal areas of degeneration there was proliferation or neuroglia, while the body of the pyramids was composed of partially degenerated cortical substance and, partially organized cortical scar tissue. New-formed capillaries were scattered throughout this area, and here and there capillary hemorrhages were present. A large number of a vesicular type of cell, containing an orange-brown pigment, was scattered through the areas of degeneration.

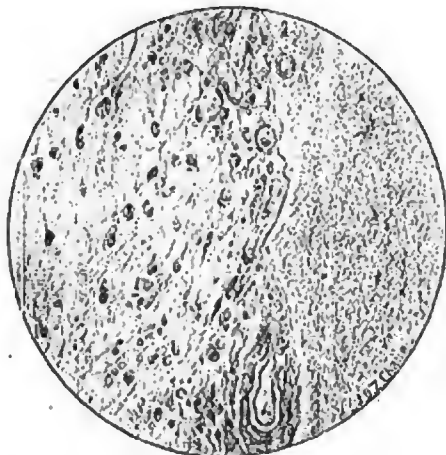
The dura mater over the left side of the brain was composed of laminae of fibrous tissue, containing a great number of cells, mostly with connective-tissue nuclei, and containing pigment varying in color from light yellow to black. On the inner surface there was a layer of pseudomembrane, composed of trabeculae of connective tissue, new-formed capillaries, and a great number of red-blood corpuscles. The connective-tissue cells contained yellow and black pigment.

Throughout the motor cortex on the left side there was a proliferation of neuroglia cells in the tangential and subtangential layers. The pyramidal cells showed a mild grade of chromatolysis, and appeared to be fewer in number than in the normal cortex. The left parietal and occipital areas were normal in structure. The cortical tissues of the right side revealed no abnormal change.

The pia arachnoid of the frontal and motor area of the left side showed a proliferation of the connective-tissue trabeculae with an infiltration of red-blood cells, in various stages of degeneration into the interstices. Scattered through the arachnoidal spaces were found a great number of cells of a large vesicular type, filled with pigment varying in color from a light yellow to an orange-brown. The relative number of these cells in the sections depended upon the degrees of hemorrhagic infiltration in the meninges and neighboring tissues.

All the tissues showing this condition were stained for hemosiderin. The Berlin-blue reaction was not obtained in any of the cortical cells. A well-defined, clear-cut, blue reaction was obtained, however, in many of the vesicular type of cells in the pia arachnoid.

The elastic tissue in the small arteries of the pia arachnoid and superficial areas of the cortex took the same clear-cut, blue color as did the plasma cells above mentioned. None of the other tissues gave this reaction. Sections of the bloodvessels gave a microscopic picture, very much as that seen in the sections stained with a selective elastic stain. While the cortical ganglion cells did not give the stain reaction for hemosiderin in the sections stained with iron hematoxylin, both the neuroglial nuclei and the partially degenerated cortical ganglion cells in the neighborhood of the pyramidal areas of necrosis, gave a jet-black reaction, which I have already pointed out in a previous contribution to this subject may be considered as a partial or transitional stage between hemoglobin and hemosiderin.



Section through cortex and pia arachnoid. The small cells with hard granules gave the typical hemosiderin reaction. The small vessels also presented the Berlin-blue reaction.

Sections from the spinal cord showed a degeneration in the cross-pyramidal tract of the right side.

The area of external pachymeningitis on the right side was found, under the microscope, to be composed of (a) a normal dura somewhat thickened, and (b) external to this a thick layer composed of fibrous tissue, but relatively looser in consistence than that of the normal dura, containing a large number of connective-tissue nuclei and here and there large areas in which red-staining nuclei the size of red-blood corpuscles, but irregular shape, were found arranged in columns and nests. Connective-tissue nuclei and large

irregular cells scattered here and there contained masses of dark pigment having the appearance of melanin.

The biochemical microscopic reactions here noted threw some light on the minor changes in the nerve cells, leading to a disturbance of function, without apparent structural change. The partial reactions to iron infiltration shown in the ganglion cells, together with the complete reaction noted in the arachnoidal free cell, and in the coats of the capillary vessels were evidently only temporary in nature. These changes may entirely disappear, and studies of these tissues in after life would leave us without any evidence of these previous pathological lesions. In a complete stage of iron infiltration in the cortical ganglion cells, complete chromatolysis with disintegration of the cell occurs. In the minor grades of iron infiltration, relatively little structural change is noted in the cell. Granted such a transitory process, extensive disturbance of the function may result without leaving any changes evident in the histological picture. In cases of mental retardation, high-grade imbecility, etc., the brain structure not infrequently presents a normal histological picture. There is no reason, in this group of cases, why the functional activity of the brain cells should be subnormal. In conditions of prolonged passive congestion at birth, and more particularly in those cases where the microscopic examination of the newborn children, dying at or shortly after birth, reveals an osmotic extravasation of red-blood cells in the tissues, a medium grade of iron infiltration may well have taken place, leaving the brain structure normal, but with deficient functional power.

The meaning of the hemosiderin reaction in the elastic coats of the capillary vessels is not altogether clear. None of the other coats of the vessels gave this reaction. It is evidently a selective reaction, due to some changes in the elastic fibres. It was not present in the larger vessels within the area of blood extravasation and degenerating blood cells.

The extensive vascular changes noted in this case are of considerable interest from the standpoint of legal medicine. As a result of traumatism of the head, with a linear fracture, the following series of changes are presented: Extensive cerebral necrosis with hemorrhagic extravasation into the cortex on the side of the lesion, internal hemorrhagic pachymeningitis on the opposite side, together with an area of external hemorrhagic pachymeningitis on the posterior part of the dura on the side opposite to the bone lesion. There is a history of the excessive use of alcohol. How far are these changes due to the original trauma? It has been held by experts in court that concussion with a prolonged period of unconsciousness, without evidence of focal lesion or lesions, produces disturbances of the physical or nervous health of the individual, from which he practically never recovers. The lack of

resistance to stress and strain in such cases, a matter of clinical observation, not only in medicolegal cases but also in cases without a cause for legal action is probably due to relatively minor changes in the cerebrovascular system as compared to those here noted.

In the history of this case, it is shown that the patient apparently recovered from the cerebral injury after the operation. A succession of vascular accidents beginning with the cerebral injury and possibly influenced by the excessive use of alcohol took place, leading finally to his death. It is reasonable to suppose that these changes would not have taken place in the absence of any such injury. Certainly, the exact nature of the changes was determined by the extensive laceration of the brain tissue incidental to the original brain injury. Extravasating hemorrhage into the pia arachnoid is a relatively rare pathological phenomenon. I have seen it in one other case affecting approximately the same distribution in the brain in a case of locomotor ataxia.

The necrosis of the cortical and subcortical tissue is difficult to explain. It is possible that the inflammatory adhesions of the pia arachnoid to the dura produced partial or complete obstruction of the cortical capillary or both the capillary and the cortical venous circulation. The pyramidal shaped areas would be more in favor of a subcortical capillary destruction.

A PRACTICAL APPARATUS FOR THE PRODUCTION OF THERAPEUTIC PNEUMOTHORAX: WITH SOME NOTES ON THE MODUS OPERANDI, INDICATIONS, AND CONTRA-INDICATIONS.¹

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In presenting this new apparatus, originally the Forlanini apparatus, which was modified by Saugman, again by Muralt and Nebel, and then upon my suggestion made by the Kny-Scheerer Company in a little more substantial form, more easy to transport, more clearly graduated, and with glass tubes inserted in the rubber hose connecting the apparatus with the thoracic cavity, I do not wish to claim any credit for bringing out what I believe to be a very superior apparatus. The credit is due to the original inventors, Professors Forlanini and Saugman, and also to the Kny-Scheerer Company, who, as above stated, have made the apparatus compact, safe, and transportable.

¹ Read by invitation before the meeting of the Association of Physicians attending the Tuberculosis Clinics of New York City, October 8, 1913.