OBSERVATIONS ON THE CRANIUM AND BRAIN OF A HYDROCEPHALIC PATIENT, AGED NINETEEN YEARS.

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The cranium and brain about to be described belonged to a hydrocephalic male, who died at the age of 19 years, in the end of March, 1880, in the vicinity of the Asylum of Reggio.

The little which could be ascertained as to the history and the functional state of the parents, from the physician who had seen him several times during life, and from a short visit made by us a few days before death, may be reduced to the following detail:

F. S. was born in 1861, of healthy and robust parents, who had other children, healthy and well organized. The mother remembers no notable circumstance in the period of her gestation of F. S. At birth, according to the statements of the parents, the cranium was of normal dimensions and form, and he had commenced to walk when one year old; his intelligence appeared to be regularly developing. At the age of two years the parents first observed that his head had commenced to enlarge, especially in the frontal region, and gradually to become heavier, so as to drop towards the chest, and to render walking difficult.

At the age of five years, when the distinguished Dr. Bonasi, medical adviser of the village, who called our attention to this important case, visited him for the first time, he found him with the cranium already of nearly the present size, the vertebral column distorted, as will
be hereafter described, the muscular structure slight, but far from that general atrophy in which we found it shortly before death; he then still preserved a certain capability of movement of the lower limbs, and could also walk a little, though with much effort. The head, however, was still drooping, so that his parents, keeping him always in a sitting posture, procured for him a sort of supporting frame for the head, which they had gradually increased in height according to his growth. The mental faculties proceeded in observable development until his seventh year, when they remained stationary, so that he afterwards had not much more intelligence than a child. Speech, which had begun to be developed at one year old, was arrested at his fifth year, or rather became deteriorated. His sight, after his thirteenth year, gradually weakened; strabismus appeared; and first, at intervals, afterwards continuously, nystagmus.

At the age of eight years, from falling down stairs, he had a severe wound on the left region of the head, with fracture in the fronto-parietal portion of the skull, which was almost immediately followed by convulsive movements of the limbs, especially on the right side, and most markedly in the upper ones. He continued very ill for twenty-five days, but the convulsive movements ceased after the first day. From this time onward the motility of the lower limbs became so much enfeebled that he was incapable of walking, even when held up. Three years later, from a second fall, he sustained a wound in the same region, and the convulsive seizures again occurred, and continued till his eighteenth year, when they disappeared, but were followed by general contracture of the limbs.

When we visited him, we found him sitting; his head was very large, and was bent down, and sup-
ported on a sort of scaffold placed in front of him. His physical condition was reduced to the lowest extremity, so that a complete, objective and functional examination was impossible; however, from the examination made by us, in association with the distinguished Drs. Riva, Seppilli, Buccola, Venanzio, and Altana, and from another made by Dr. Venanzio at another visit, we were able to collect the following data, from which we exclude those relative to the cranium and the skeleton and general frame, which will be reported in the autopsy.

Objective Examination.—The emaciation is of the highest degree; the musculature atrophic; the skin all over very pale; the abdomen much depressed; many eschars and phlyctena on those parts which had been in contact with outer substances; oedema of the hands and forearms, and of the lower limbs.

Voluntary movement in the lower limbs and the whole of the trunk, is absent, but is yet preserved, though much enfeebled in the upper limbs. The limbs are, however, in a state of permanent contracture. The sterno-cleido-mastoid of the right side is contracted, and the face is turned to the left, with the head inclined towards the right shoulder. The mouth is held half open, and the saliva flows from it. The right eye is divergently strabismal; the ocular bulbs are turned much downwards, and are permanently held in this position. It is impossible to elevate them; they are usually turned towards the right (in conjugate deviation), and frequent nystagmus is observed. The dolorific sensibility is tardy, but is still present; the tactile can not be estimated with exactitude, because of the grave condition of the patient. Vision is imperfect, hearing is sufficiently normal, and so are the other senses.
Spontaneous mental extrinsication in the present state is almost nil; yet from the monosyllables with which he makes feeble replies, it is perceived that he well understands the questions. As to the rest, so far as stated to us, though his intelligence has but a little exceeded that of childhood, it was yet of such a degree as to enable him to feel affection towards his family, and to comprehend that he was, in his misfortune, "their cross" (la croce dei suoi); he gave attention to whatever was done or said around him, and took part in the conversation, if not directly, in at least following the discourse and participating in the sentiments; for example, those of gaiety, when such aroused him. He was usually calm, tranquil and apathetic; he had no maniacal periods. The functions of nutrition were always sufficiently normal; the digestive forces were sufficiently energetic; defecation was rather difficult. Nutrition was of late much altered, and he labored under dyspnoea; his limbs had become oedematous. Respiration is heavy and rhonchal; the pulse small, and very frequent 130. He died on 25th March, 1880.

Autopsy.—Cadaver much emaciated, eschars and oedema in various parts of the body. Stature m, 1,580 (about 5 feet 3 in.)

The cranium very voluminous and throughout equally developed, but markedly so in the frontal region. The face, although fairly developed, yet appears as if hidden under the cranium. We shall hereafter give the measurements and the exact description of the cranium as observed after maceration. In the meantime we may say that we noted, on first view, vascular sulci, very superficial; that of the middle meningeal almost completely wanting on the left; the skull in some points very transparent, as in the frontal region and the right
parietal eminence. At other points some circular areas were observed, in which the skull appeared as if wasted away and reduced to a single osseous table, entirely deprived of diploë, along the coronary suture on the left, and in other points corresponding to cystic hernias of the dura mater. In the left fronto-parietal region, a linear empyment was observed, certainly corresponding to the old fracture, five centimetres long, crossing in an oblique direction the coronary suture, eleven centimetres distant from the sagittal, and describing a light semicircular line, with its convexity downward.

In the examination of the body, we observed the right upper limb more developed in length and size than the left; and so in length the inferior limb. In the vertebral column a hump and distortion in the cervical and dorsal regions; distortion with convexity towards the right in the cervical, and towards the left in the dorsal region. Curve in the lumbar region, in which the bodies of the vertebrae were directed towards the left and forward, so that they came very near to the anterior wall of the abdomen. We shall now give the description of the brain, as it appeared to us in the autopsy itself, and in the later examinations, in which Dr. Seppilli rendered valuable assistance.

Cerebrum.—The cranium having been removed, an abundant quantity of liquid escaped, at first sero-sanguineous (rendered so by the blood issuing from the cut vessels), afterwards serous. The two cerebral hemispheres, yet covered by the dura mater, appeared like a large bladder filled with a fluctuating liquid. The dura mater of the left hemisphere presented in the fronto-parietal region some large patches of tendinous thickness, and in correspondence with the wasted part of the cranium described, a small cyst accommodated
to it, which appeared to be the dura mater extruded at this part.

The dura mater being removed, which was detached with some facility, the two hemispheres, appearing much dilated, remained still full of their liquid, as two large fluctuating bladders, and on their surface the convolutions were seen to be distended, flattened, of enormous length and breadth, and with sulci very shallow. In the left fronto-parietal region, corresponding to the old fracture described, as also to the tendinous thickening and the small hernial cyst of the dura mater, we observed, over an extended area, almost circular, about seven centim. in diameter, the cortical substance had entirely disappeared, and there remained only a very thin covering, which appeared solely of the arachnoid and the pia mater, enclosing here the internal cavity filled with liquid. This extensive destruction of the cortical substance included a great portion of the second and third frontal in their posterior and external parts; the margins limiting the destruction presented a notable consistence. The surface of this membranous covering, as also for a certain extent that of the surrounding convolutions, was discolored by patches of a dull, yellow color. Similar patches were discovered here and there on the right fronto-temporal region.

The convolutions which appeared the most enlarged and distended, were those of the frontal lobe (excepting the third in its lowest part) and the central bordering on the fissure of Rolando; the parietal were also distinctly so, but those of the occipital and temporal little or not at all. The greatest antero-posterior diameter of the ascending frontal, on the right, was 45 mm., and on the left 30; that of the ascending parietal 32 on the right, and 34 on the left.
The fissure of Rolando was much to the rear, and had a length of 14 centim. The fissure of Sylvius was much elongated backwards, of little depth, and wanting its anterior branch; the convolutions of the island were small, much compressed, especially on the right. The pia mater was everywhere much attenuated, and was adherent to the cortical substance, from which it could not be detached without abrasion of the latter. In removing the brain from the cavity of the cranium, there flowed from the lacerations of the attenuated and destroyed parts of the cerebral parietes, little by little, all the liquid, of which we were able to collect 1,630 c.c., and we might calculate at full 30 grammes that which escaped in the first opening of the cranium and the removal of the brain; we may therefore reckon at about two litres the liquid which this hydrocephalic cranium contained, and which was, for the greater part, held in this totally excavated cerebral mass, which formed merely the walls of a great bladder. The brain, when removed and almost completely emptied of liquid, weighed only 1,150 grammes. The corpus callosum was reduced to a very thin covering (velamento), which was lacerated with great facility, especially in its posterior part; anteriorly it was somewhat thicker. The corpus callosum being lacerated, we looked into two enormous bladders, which represented the cavities of the two lateral ventricles; these measured each (at the cerebral walls somewhat crushed) 250 millim. in length and 135 in breadth, and at the walls elevated and replaced, as when they were adapted to the skull, 185 mm. in their antero-posterior direction, and 78 in the transverse. On examining the various parts of these great cavities, it was seen that the dilatation was paramountly at the expense of the anterior-cornua of the ventricles. In fact, while normally the corpora
striata are situated in the anterior extremity of the lateral ventricles, in such a way that the anterior margin of their head is ordinarily in immediate contact with the wall of the anterior cornu, or is separated from it by a space of hardly 5–10 mm., instead of which, in this brain, the corpus striatum was situated half-way in the length of the ventricle, so that between the anterior margin of the corpus striatum and the anterior wall of the ventricle, there was a distance of fully 8 centim., which therefore presented in all the enormous length of the anterior cornu.

The corpora striata were both of normal volume and form, but completely displaced from their proper direction; each of them, instead of having, as in the normal state, a direction longitudinal and almost rectilinear in antero-posterior relation, with the head touching the anterior wall of the ventricle, and the tail prolonged so as almost to touch the external margin of the thalamus opticus, had, on the contrary, a direction almost completely transverse, with a slight obliquity from within outwards, and from before backwards, the head bent inward and the tail outward, semicircularly, with the concavity inward and its extreme point nearly touching the external surface of the thalamus. The corpus striatum was coasted by a large blood vessel, which sent its branches almost perpendicularly from behind forwards.

The thalamus opticus was not, as in the normal state, in immediate contact with the corpus striatum and separated from it superficially merely by the striate cornua; the thalamus and the corpus were separated by a white substance, of a maximum diameter of two centim., which, to the naked eye, appeared evidently constituted of fibres radiating as a fan from the thalamus towards the corpus striatum. The thalami were much smaller than
normal; the right was a little larger than the left, but quite consistent, with nodules of evident sclerosis of leathery firmness. The pineal gland was notably augmented in size, above double the normal, and was formed of a hard and compact texture. An equal hardness was observed in the bigeminal eminences, especially in the superior, where, on the left in particular, a cartilaginous consistence was apparent. All the sclerosed region, the upper wall of the right thalamus, the pineal gland, the commissure of the thalami as far as the aqueduct of Sylvius, and the superior bigeminal eminences, (also a small portion of the left thalamus,) presented on their surface a dull, reddish, yellow color, which at some points passed into coffee color. This deepened color was particularly noticed at the point between the internal part of the right thalamus, the pineal gland, and the right superior bigeminal eminence. There then existed an area of decided softening, where the cerebral substance was reduced to a pultaceous consistence, and by introducing, for a short distance, a probe, it was perceived to enter a sort of small cavity, containing a semi-fluid matter of gelatinous aspect and dark, reddish, yellow color. A stratum of gelatinoid substance of color analogous, investing the surface, was the material which gave the dark red appearance to the posterior part of the pineal gland and the other parts mentioned.

The middle cornu of the lateral ventricles, cornu Ammonis, was much dilated, and the pes hippocampi was greatly stretched; but no hardening was noticed. The posterior cornu was dilated, but much less than the anterior; this was the only part where there was, between the grey substance and the great ventricular cavity, a stratum of white substance of fair quantity; the point of the occipital lobe appeared, in comparison with the rest of it, thick and rather indurated.
The third, or middle, ventricle was considerably elongated, but narrower than normal, especially in its posterior part, in consequence of the two internal faces of the thalami being very close to each other. The arachnoid and the choroid plexus, between the two thalami, were much thickened, and of fibrous consistence. The anterior part of the fornix was thickened, and the septum lucidum was notably increased in volume. It is also to be noted that while the point of descent of the anterior pillars is ordinarily on a level with the anterior extremities of the thalami, in this brain, on the contrary, it is on a level with the head of the corpora striata; so that it may be said that while these bodies had undergone a separation in their posterior ends, the pillars remained in their true position. Their origins, however, did not proceed exactly around the internal margin of the thalamus, to their descent into the middle cornu, to reach the mamillary eminences, but were expanded in fibres, as a fan, between the corpus striatum and the thalamus. The whole ependyma investing these parts was evidently thickened and granulous. There did not exist any trace of the middle commissure.

On the base of the brain it was seen that the chiasm of the optic nerves was formed of minute cords, very slender, and the X of the chiasm was much splayed transversely; the small bands were very slender. The olfactory nerves appeared normal, and they followed their continuation well to the convolutions of the hippocampus. The other cerebral nerves appeared normal. The tubercinereum and the mamillary corporcles were very small. The cerebral peduncles were much elongated in the parts nearest to the hemispheres. The pons Varolii was very small, and so was the medulla oblongata, especially below the olivary bodies,
which were distinctly developed. The arachnoid and the pia mater, which involve the inferior portion of the medulla oblongata, were of an obscure grey color. The fourth ventricle was not at all distended.

In trying to pass a probe into the aqueduct of Sylvius, both from the fourth and from the third ventricle, we could not penetrate, though it is very easy to do so in normal brains. This aqueduct was equally impervious to the passage of water in either direction, while it is easily accomplished in any normal brain. This fact leads to the conclusion that the aqueduct was morbidly closed.

The cerebellum presented nothing abnormal on its surface.

The thickness of the grey substance of the cerebrum was in all parts normal; the dilatation was wholly at the expense of the white substance. The thickness of the upper skull varied from 3 mm. to 20; it was greatest in the occipital region, and least in the frontal and parietal; the bone had totally disappeared in the area of destruction before mentioned.

The sulci between the convolutions were deepest in the occipital (11 mm.); less so in the parietal (6 mm.); and still less in the frontal (5 mm.)

On cutting into the basal ganglia, we observed as follows: The intraventricular nucleus of the corpus striatum was reduced to a broad stratum, very thin, 1–3 mm.; in correspondence with the head of the corpus striatum, only, did the thickness of the grey substance approach the normal. Below this very thin grey stratum the internal capsule was seen, also reduced to a very thin white stratum; next the lenticular nucleus, somewhat thick, but much elongated; and then the external capsule also thin, the nucleus of the thalamus much elongated, and finally the white substance be-
between the nucleus of the tenia and the cortex of the island much attenuated.

On making incisions into the right optic thalamus, it was seen to be formed of a very resisting texture, and of a grey color; the left was less consistent, and of a pale rose color, from an apparent diminution of the internal grey substance.

On cutting the bigeminal eminences, it was observed that the nodules of induration were formed of a texture of lardaceous aspect. The pineal gland, being cut in the middle, appeared nearly circular, in diameter 11 mm., and formed of three concentric layers—one external, pale and less consistent; one intermediate, darker, and one deep, whitish, very consistent.

The medulla spinalis presented nothing abnormal, save a slight dilatation of the central canal corresponding to the lumbar enlargement. The central grey substance was well developed and formed, through the whole length of the medulla. The rest of the autopsy showed nothing abnormal, excepting hypostasis and edema of the lungs.

The microscopic examination of the brain, by Dr. Seppilli, showed scarcity of the ganglion cells in the grey substance of the frontal convolutions; in these and in the central also, the nuclei and nucleoli were rather indistinct. The size of the cells was small, particularly in the frontal region. The nuclear and connective substance abounded everywhere.

(Note by the Translator: Prof. Tamburini now gives very minute details of the capacity and measurements of the cranium, which, though very creditable to the industry and exactitude of the learned gentleman, Dr. Amades, by whom they were ascertained, we do not regard as essentially important for a proper under-
standing of the pathological and psychological merits of the case; we therefore, desiring to devote our available space to the more interesting portion of Prof. Tamburini's valuable article, pass forward.)

“This large head is particularly notable for the development of the cranial part, which, enormous, spheroidal, and overhanging the face in such a manner, (although this part is not small,) threatens to suffocate it. The cerebral cranium, on external inspection, appears in every part globose, it is symmetrical, if we note only a length somewhat greater in the oblique diameter, between the right frontal projection and the left occipital. A fact worthy of notice is that the extraordinary extension of the brain-case was not furnished almost entirely, as usually happens even in slighter cases of hydrocephalus, by an amplification and outward curvature of the squamous parts, (frontal, temporal and occipital,) and by duplex sutures of these, with the parietal, and ossicula Wormiani, but rather by a very great extension which had taken hold of all the bones, and in a preponderating manner the frontal and parietal. This fact led us to believe that the hydrocephalus had commenced before the period assigned to it by the family. The capacity of c.c. 3,090, and the other measurements give the idea of great volume. The general form of the cranium differs widely from common, by its notable rotundity, which, by augmenting the transverse and vertical diameters, renders it ultra-brachycephalic, and excessive in height.

The frontal bone proceeds from a large base, but not much beyond the ordinary, it rises perpendicularly, and is symmetrical, with delicate superciliary arches and distinct projections, and it bends backwards with a gentle curving on its middle, while at the sides it expands much, giving place between the belly and wing to a very perceptible bulging, especially on the left. The parietals are much extended, convex and rounding, with full protuberances and a rather marked antero-posterior curvature. The temporal squamous portions but little exceed the normal; they are flat and slightly sloping from above downwards and inwards. The mastoid epiphyses are of great size, and are rough and without trace of the squamosa-mastoidean suture. The great wing of the sphenoid was much extended, especially in height.
The sutures were open, except in the vicinity of the sagittal, and were generally very simple; part of the coronal, however, was complex, and had long and slender teeth.

The muscular insertions were very little indicated, and from this appearance and the delicacy of the orbital border of the forehead, the cranium had the appearance of that of a young woman."

(Note.—We pass over a few paragraphs devoted to measurements and comparisons, which are not essential to an adequate comprehension of the case.)

The special interest of this case is presented in the fact that the life of F. having been prolonged to his twentieth year, we are enabled to depict with exactitude the alterations of development, form and direction, which the distension, produced by the hydrocephalic liquid, has induced in the various parts of the brain; and in the additional fact, that there remained the traces of other alterations, which, with the greatest probability, had a great part in the primordial pathogenetic process, productive of the hydrocephalus. In fact, all the alterations met with in this brain may, in my opinion, be divided into three categories:

1st. Those which were the effect more or less direct of the distension produced by the liquid exudate.

2d. Those which very probably represented the posthumous results of the primitive alteration which produced the hydrocephalic process.

3d. Those which represented complications that more or less contributed to the principal morbid state.

1st. To the first category belong the enormous dilatation of the lateral ventricles; the thinning away of the cerebral mass, with disappearance of the oval centre, to such an extent as to form merely the thin walls of a great bladder; the considerable length and flattening of the convolutions, especially the central and the frontal, and the shallowness of the sulci; the
abnormal position and direction of the corpora striata, and their distance from the thalami; the attenuation and elongation of the grey and white strata which run from the corpora to the insula, etc. All these alterations found their direct cause in the enormous distension which the parts must have gradually undergone, as the liquid was being effused into the ventricle—a process ending in the usurpation of the whole hemisphere. This dilatation, however, was not equal in all the sections of the cavity; it was undoubtedly paramountly at the expense of the anterior section of the ventricle, and precisely of the anterior cornu. This is proved by the enormous distance (over 8 centim.) at which the anterior margin of the corpus striatum was found from the anterior wall of the ventricle, the considerable volume acquired, through distension, by the convolutions which constitute the frontal lobe, the greater thinning of the cerebral walls in the frontal region, and also the proportional greater development of the anterior section in comparison with the median and the posterior of the cranium. It is, therefore, necessary to admit, either that the pressure exerted by the effused liquid acted specially against the anterior part of the lateral ventricle; that is, from behind forwards, or that, acting with equal force on all parts of the ventricle, it found the anterior parts of the brain and the cranium more yielding, or that both these circumstances concurred to favor the greater distension in the anterior part. It is necessary to give an analogous explanation also of the singular splaying of the corpora striata, both as respects their relative position and direction to each other, and to the optic thalami. This anomaly of position, which we have before described, can not be explained unless by admitting that the corpora had been acted on, in a continuous and uniform
manner, by a force from behind forward, which, distending thus the base of the brain, forced these bodies to widen out from the thalami, and being carried forward thus causing the tails of the corpora to turn forward and outward, so that instead of the direction which they normally have, almost rectilinear (slightly oblique from within outward), they came into the almost transverse direction presented by them.

All this leads us to hold that the exuding liquid had acted in a postero-anterior direction in the distension of the cerebral walls; and thus obliges us to admit:

(a.) That if the exuding surface was limited, it was in the posterior part of the ventricles, rather than in the anterior;

(b.) That the anterior and posterior regions of the brain were found in different conditions of distensibility—greater for the former than for the latter.

Let us see whether in the facts of the second category we may find confirmation and explanation of these corollaries.

2d. To the second group should appertain all those alterations which, while they do not at all appear as effects of the distension produced by the liquid, on the other hand carry the traces of a slow irritative process, which may have been the cause, more or less direct, of the very abundant exudation. These are: the thickening and the granular appearance of the ependyma which invests the thalami, the eminences and the pineal gland; the sclerosis of these parts; the gelatinoid stratum of dark, yellowish red color, which covered several of these parts, and at one part deepened into a true focus of softening; the constriction of the third ventricle; the closure of the aqueduct of Sylvius. We have here wholly a region limited by the base of the brain, offering analogous alterations; the thickened
ependyma, granulous and covered by an exudate mixed with residua of old hemorrhage, which appeared more evident in the excavation between the right thalamus and the pineal gland, where there was all the appearance of an old hemorrhagic focus; the sclerosis, with atrophy of the right optic thalamus, and hypertrophy of the pineal gland; the compressed cavity between all these parts—this is the third ventricle, squeezed and constricted; finally, below these the canal of communication between the third and fourth ventricles—the aqueduct of Sylvius—closed.

All these lesions are evident signs of a slow, prolonged, irritative process, or better to say, of an inflammatory process with hemorrhagic exit, of which all these parts must have been the seat. We have, in fact, the characteristic traces of it in the exudates, and in the connective hyperplasia (sclerose) as well of the ependyma as of the interstitial texture, from which proceeded the coarctation of the related cavity.

What part could this localized ancient irritative process have had in the production of the hydrocephalus?

It is generally held that the pathogenic process of hydrocephalus usually consists in a slow exudative ependimitis; now all the parts described offer manifest characters of this. It is, therefore, rational to admit that this had been the point of departure of the liquid transudation. But could a surface so limited give origin to an exudate so abundant as to produce, as happened in this case, a dilatation of the two ventricles so notable? Admitting a slow and continuous production of exudate liquid, from even a limited surface, we may comprehend how, in a long time, so large a quantity of it might accumulate. And this accumulation so abundant, and its dilating effects on the parts, may be so much the better comprehended when we consider the
fact of the closure of the aqueduct of Sylvius, as a natural consequence of the superficial and interstitial slow irritative process, of the parts which constituted its limits, and very probably it was diffused into the ependyma lining the aqueduct. If the inflammatory process, at the same time that it produced the copious transudation within the lateral ventricles, also produced, by means of hyperplasia of the interstitial connective and adhesive exudates within the canal itself, first its narrowing and subsequently its closure, it is natural that all the liquid which was furnished by the superficial transudation, being unable to flow out through the aqueduct of Sylvius, from the third to the fourth ventricle, and from the latter into the medullary canal, must necessarily be accumulated in the lateral ventricles, and must continuously distend their walls, until they become two great bladders filled with liquid. And that the distension should be much more felt in the anterior of the ventricles than in the posterior, was a necessary consequence of the different resistance which, at least in a remote period of the irritative process, the parts behind the corpora striata must have presented, when already there had been produced in these that sclerosis of texture which we met with, and which certainly prevented them from yielding to further distension. Though, however, everything conduces to the belief that the chief point of outset of the hydrocephalic process and of the consecutive lesions was the region of the base of the brain, which we found most altered and Paramountly sclerosed, the idea can not be absolutely discarded that, at least in the early period of the process, all the ependymal surface participated in it and contributed to the production of the liquid.
The fact of the atresia of the aqueduct of Sylvius explains to us, also, the non-dilatation of the fourth ventricle and the medullary canal, except in the lumbar region of the latter, where there was observed a slight dilatation, which might very well be regarded as the effect of a distension produced by a certain quantity of liquid, which in the inception of the hydrocephalic process, when the aqueduct of Sylvius was yet pervious, had passed through it, but was not followed by any more after the closure of the aqueduct.

All yet offered has regard to the nature, and, presumably, to the seat of the morbid process that produced the hydrocephalus. Now arises the question: in what epoch of life did this process commence? Is it to be held that it was congenital, or must we give credit to the assertion of the parents, that it commenced only at the age of two years?

When hydrocephalus commences at an epoch somewhat distant from birth, that is, when ossification of the cranial walls has already, in part at least, set in, then distension of the cranial walls does not take place in a uniform manner, but the parts yet thinnest, those not yet completely ossified, yield most to the pressure of the liquid, and become distended and form prominences (bumps?) which completely change the form of the head; the squamous bones—the frontal, parietal, temporal, occipital—are those which give these deforming saliences; thus also the sutures, at the points where they have not yet become completely ossified, undergo distension, which afterwards, in the period of complete ossification, gives place to sutures much more complicated, and interrupted by ossicula Wormiana. On the contrary, when the hydrocephalus is produced soon after birth, and no closed sutures oppose any obstacle to the distension of the cranial walls, their dilata-
tion is uniform, and the cranium appears equally spherical.

Now it is undoubted that the cranium of F. presented rather the characters of this second form of hydrocephaalus—that is, the congenital, or that of the early period after birth, since the development of the cranium was uniform, and there was only one point of complicated suture—in the coronal.

But setting aside any importance to be attached to the statement of the parents, who assured us that the head of F. did not commence to enlarge till after his second year, and that also before this epoch his intelligence and his senses proceeded in normal development, there is a certain other consideration to be entertained, which might prove that the assertion of the parents merited more credence than might be supposed under a strict application of the above specified general principles. When expansion by liquid occurs before the ossification of the sutures—that is, when the bones of the vault are separated merely by membranous spaces (fontanelles)—then the latter, and not the former, present the less resistance, and hence they widen and permit a notable divarication of the bones. But when, after cessation of the hydrocephalic process, there happens that which is called the cure of the hydrocephaalus, or that, while the quantity of liquid exuded remains unchanged, the cranial walls gradually undergo the process of ossification, it thence happens that in the dilated membranous spaces, new points of ossification are most frequently formed; thus are developed supplementary bones—the Wormiana—which unite among themselves, and with the bones of the cranium. Now, in our case there was no indication, in the points of in-granation of the cranial bones, of divarications undergone, nor were there any ossicula Wormiana whatever.
There is still another consideration. We have seen how great was the distension undergone by the cerebral mass, how great the attenuation of the walls, how marked the consequent alteration of form, position, direction, etc., of many parts of the brain. All this shows that very strong must therefore have been the pressure which, from within outwards, the liquid exerted on the ventricular walls, in order to carry to such a point the distension, as finally to separate the parts from one another, not on the convexity, but at the base of the brain—the great basilar ganglia. Now, if a pressure so strong had acted centrifugally on the cerebral mass, when, in the early period after birth, no suture, no complete ossification offered any obstacle to the distension of the cranial walls, it is very natural that these would have felt much more than they did the dilating action of the liquid, and would have undergone a much greater distension, and much more proportioned to the distension of the cerebral mass than was found by us.

Without then excluding absolutely, that even before the epoch indicated by the parents, a certain degree of ventricular hydropsy may have been initiated, we should hold that the hydrocephalus, true and proper and so copious, was produced only when the bones of the cranium presented a certain resistance, and the sutures already solidified did not permit further divari-
cation of the bones. Nevertheless, the cranium had undergone a certain degree of distension, as its uniform enlargement proved. This may be explained by admitting that the bones, either because the epoch in which the hydrocephalus was produced was not very remote, or because there was present in them a pathological process, (of which we may find the analogue in curvatures of the spinal column,) and they may not
yet have been completely ossified, may have presented a limited but uniform yielding tendency, which permitted the uniform enlargement of the cranium. Perhaps, too, the bones themselves did not remain free from irritative process of which the brain was the seat; this is proved by the premature synostosis of the sagittal suture, the spongy aspect of the bones (a certain indication of slow osteitis) in the apex along the median line of the frontal, in the wings of the sphenoid, in the sella turcica, in the mastoid epiphyses, and finally the augmentation in the number and calibre of the vascular foramina in various points of the cranium, especially in the frontal and the temporosphenoidal fosse. These diffused and localized hyperplastic processes of the bones of the cranium in cases of hydrocephalus, have been before observed with some frequency.

3d. We have, finally, some complicating facts—lesions—which, as well by their nature as by the epoch in which they were produced, could not have had part in giving origin to the hydrocephalus, or at the most only an aggravating influence over it. We would speak especially of the lesions found in the left frontoparietal region of the cranium, as well as the brain, which could certainly represent only the residua of the fracture suffered at the age of eight years, when F. fell down stairs. We, in fact, found in the left of the cranium, at the point where the superior temporal line meets the coronary, a solution of continuity involving the whole thickness of the bone, with ragged and thinned margins, half a centimeter wide in the middle, and continuing forward with traces of healing of the bone. In correspondence with this region, there was seen on the brain an extensive area in which the cerebral substance was completely destroyed, in
correspondence with the posterior part of the second and third frontal convolutions, and a portion of the ascending frontal, and in consequence the walls of the great ventricular bladder were here formed of only a very thin covering, constituted solely by the arachnoid and the pia mater, which at this point presented on their surface patches of a dark yellow color, having the aspect of old hemorrhagic spots.

The genesis of this cerebral lesion is easy of explanation. Whether by the direct and immediate action of the fracture, or by a slow inflammatory process with softening, undergone in consequence of this, the corresponding cerebral surface, already per se much thinned by the dilatation produced by the liquid, finally yielded, the margins were separated, and hence there remained that large solution of continuity in the cerebral wall, which was closed merely by the thin meninges. This rupture, or destruction as we should say, may be the more easily conceived, in this region, as this was one of the parts upon which, as we have seen, the pressure of the liquid was most felt, acting from the interior outward and from behind forward; and it is very natural that on walls so stretched by the dilating force of the liquid, either the immediate traumatic action, or the slower one, of consecutive softening, might readily have produced their rupture, and their emptying and destruction.

We have thus tried to explain to ourselves all the multiplex lesions which we found in this interesting hydrocephalic brain. It now only remains to us, in order to complete the study of the case, to bring into relation some of the principal symptoms observed during life, with the anatomo-pathological lesions discovered in the autopsy.
And first of all we have seen that the intelligence, despite the great pressure felt by the internal cerebral mass, and especially by the frontal lobes, was still neither of the degree of idiotism, nor even of absolute imbecility. He was capable of certain notions, conversations and affections, which though they made up but a limited and almost infantile life, yet permitted him to take part in certain social enjoyments. This fact is explained (and there is at the same time in it an additional proof of the doctrine,) on the principle commonly to-day admitted, that the principal seat of psychical acts is the grey cortical substance of the hemispheres. In this case, in fact, while the white substance was everywhere thinned away, in some parts absolutely gone, and the dilatation of the ventricular cavities was effected at the cost of the white substance, the grey cortical substance was, on the contrary, of a considerable thickness, and the convolutions, although not deep, were still well defined and developed in breadth.

We have seen that the fracture in the left frontoparietal region was followed by convulsive movements of the limbs, especially on the right side, and chiefly by the superior; and by the convulsive movements which reappeared after the second fall with a wound in the same region, and lasted from his eleventh to his twelfth year, in which they disappeared, to give place to permanent contracture of the limbs. The explanation of these convulsive phenomena is easy, when we observe that the lesions produced by the fracture on the cerebral cortex, involved actually a part of the so-called motor zone, whose influence in the production of epilepsy is now placed beyond doubt.

The same lesion, which included the inferior part of the ascending frontal and a portion of the third frontal,
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explains in like manner the fettering of speech, which constantly increased in his last years, since this includes exactly the center for speech—that from which emanates the motor impulse for the muscles serving verbal expression.

We ought also to note, without however attributing to the fact too much importance, that in this individual in whom there was complete paralysis and contracture of the lower limbs, paresis of the upper, less development of the left limbs, especially of the upper, we had the fact that while the corpora striata, although displaced and elongated, yet presented a conformation and texture apparently normal; on the contrary, the thalami optici were both diminished, and the right notably sclerosed. This observation might lead us to the same conclusion as another case, not long ago illustrated, (Contributo alle Localizzazioni Cerebrali, 1879,) in which there corresponded to a conspicuous atrophy and paralysis of the left upper limb, in continuation of an extensive lesion of the motor cortical zone on the right, no lesion of the corpus striatum, but a strong atrophy and sclerosis of the right optic thalamus; that is to say, the conclusion that the thalami optici are not estranged from motor function, but that they are in some relation with the motility of the limbs of the opposite side, especially of the upper ones.

Finally it deserves to be noted that, in spite of so great a permanent lesion (compression) of the cerebral mass, life was protracted up to the twentieth year. It is true that it is well known to what a degree the brain is capable of bearing lesions of slow course; it is also true that the cases of hydrocephalus of a medium degree, which permit continuance of life for a certain number of years, are not rare; cases are recorded of moderate hydrocephalus that became stationary, and
reached to the age of 50 years. Topinard speaks of an individual who, with a circumference of 87 centimetres, (say 36 1/2 in.,) reached the age of 23 years. This, however, does not set aside the fact that our case was one of great rarity, when it is remembered that already, at the age of five years, the volume of the head of F. was very nearly the same as we found it. In this case we can not but ascribe an influence, in the maintenance of life, to the fact that, by the closure of the aqueduct of Sylvius, the pressure of the liquid which was exerted on the hemispheric masses, those parts were withdrawn from dangerous action, which, as the fourth ventricle and the other regions of the medulla oblongata, are most essential to the accomplishment of the vital functions.