

The Classic

The First Description of the Spinal Fluid

DOMENICO COTUGNO

Domenico Cotugno (Fig. 1) was born in 1736 near Bari, on the Adriatic coast of southern Italy. He was given a good education in the local Jesuit school and proceeded to the medical school in Naples. He spent his entire medical career in Naples, becoming a professor of anatomy and surgery at the University of Naples at the age of 30 years and holding these positions until his death in 1822.

His initial anatomic studies dealt with the ear. He became familiar with the works of Valsalva and DuVerney and was the first to describe the aqueducts connecting the cochlea and vestibule. Of greatest importance was his observation that these ducts as well as the labyrinth were filled with fluid.

His major work was *De Ischiade Nervosa Commentarius*, published in Naples in 1764. He dedicated this work to van Swieten, the founder of the modern school of medicine in Vienna. Although the clinical aspects of this work were considered important at the time, it is remembered now for the first complete description of the cerebrospinal fluid, which was first briefly noted by Valsalva in 1692. It also contains, almost in passing, the first description of albuminuria, which was noted in a patient with acute kidney disease.

The following extract is from an English translation of Cotugno's book, made by a student of van Swieten, Heinrich Johan Nepomuk Crantz (1722-1799), who became a professor of obstetrics in Vienna.

LEONARD F. PELTIER, M.D., Ph.D.

At first, therefore, it is necessary to premise, that the hollow of the spine, which, from the great *Foramen* of the *Occiput*, reaches to the extremity of the *Os sacrum*, through which the spinal marrow descends, is larger in men than in other animals; for it is so large, that it not only affords a convenient passage for the marrow, as it does in other animals; but although the marrow, in proportion to the brain, which is larger in men, is also fuller than in other animals; the capacity of the spine far exceeds the size of the marrow; so that around the marrow descending in the spine, there is a considerable

space remaining. This space is not entirely devoid of matter; for through it descends the *Dura Mater*, which being formed into a tube, from the great *Foramen* of the *Occiput*, encloses the spinal marrow like a sheath. This tube of the *Dura Mater* is not so large as to touch the surrounding enclosure of the spine on all sides, nor so narrow as to embrace the included marrow closely: but it is somewhat distant from the hollow of the spine, chiefly backwards towards the seat of the spinal *Apophyses*, and is separated from the *Am-bitus* of the enclosed marrow by a considerable space. These two spaces, when a man is in health, are not empty, but each is filled with a matter peculiar to itself; for all that space, which is between the *Dura Mater* and the enclosure of the hollow of the spine, is

Extracted from Cotunnius, D.: A Treatise on the Nervous Sciatica, or, Nervous Hip Gout. Translated by Crantz, N. London, J. Wilkie, 1775.

always filled with a cellular kind of substance, replete with a soft and fluid kind of fat; in the room of this, in consumptive persons there is a mucid vapour, and a true mucus in dropsical persons, and in foetuses suffocated in difficult labours, a sanguineous vapour. But, also, all that space which is between the Vagina of the Dura Mater, and the spinal marrow, is always found to be filled, not as some eminent men imagine (because the fact is as yet immersed in obscurity) by the marrow itself, which is more full in living, than in dead subjects, not by a thick vapour; but with water, like that which the Pericardium contains about the heart; or such as fills the hollows of the ventricles of the brain, the labyrinth of the ear, or other cavities of the body, which are impervious to air.

This water, which fills the tube of the Dura Mater even to the *Os sacrum*, does not entirely enclose the spinal marrow, but even abounds in the cavity of the skull, and fills all the spaces which are between the brain and the *ambitus* of the Dura Mater. Some of these spaces are always to be met with about the basis of the brain; and it is not uncommon to find a considerable space between the *ambitus* itself of the brain, and the surrounding Dura Mater. This is principally to be found in consumptive persons, and old men. In such the brain is found to be considerably wrinkled up, or contracted; and that which the skull, naturally, can hardly contain, is hardened by old age, or the power of the consumption, and gradually diminishes in its size. But here, as much as the brain diminishes in its size, so far is it withdrawn from contact with the Dura Mater, and whatever space is left between, is all filled up with a watery vapour; therefore, in the dissection of old men, and consumptive persons, if we carefully open the *Fornix* of the skull, and stir the sound Dura Mater in any part, we shall find a watery stream immediately burst forth, and when this is exhausted, see the whole fall relaxed upon the brain, and wrinkle up. This does not only hold true, in



FIG. 1. Domenico Cotugno (1736–1822). (Reproduced from Viets, H. R.: Domenico Cotugno: His description of the cerebrospinal fluid. *Bull. Inst. Hist. Med.* 3:701, 1935.)

regard to the brain, but also to the spinal marrow, which in the same subjects is smaller, and leaves a larger space between itself and the Dura Mater, which the water occupies, so that it seems we may lay it down as a certain truth, that the space which is filled with water around the spinal marrow in men, increases by age; for this space, which is not to be found in a foetus, where the marrow is embraced by the tube of the *Dura*, especially in the neck, increases by age, and grows considerably larger.

The reason that anatomists have never yet observed this collection of water about the brain, and in the spine, is owing to the common preposterous method of dissecting; for, when they are about to examine the brain, they commonly cut off the head from the neck; by this means the tube of the Dura Mater, which descends by the spine of the neck, being cut through, all the water that is

collected about the brain, and the spinal marrow, flows out, and is foolishly lost; so that, when the skull is opened, all the spaces between the brain and the Dura Mater, which were before filled with water, are now found empty, and deceive the anatomist with the appearance of empty cavities, which, perhaps, some dissipable vapour filled. Here then, nothing scarce at all is to be found, either in the cavities at the base of the skull, or in the chief vaginal sinuses of the Dura Mater, to prove that they were occupied before by some fluid. So that, by this irrational method of dissecting, all the fluid collected around the marrow and brain being lost, air enters in, and supplies its place. This is the reason, that, in examining the brain, we find a number of little bubbles of air, under the *Membrana Arachnoides*, on the top of the *Sulci* or furrows of the brain. The number, indeed, is greater or less, in different subjects, according to the greater or less distance or partition of the *Pia*, and *Arachnoides* membrane. To these partitions there is an open passage, where the *Arachnoides*, in its descent to the spine, makes its greatest recession from contact with the *Pia Mater*: through this passage, on cutting off the head, as the fluid of the *Sulci* of the brain flows out, the air rushes in and occupies its room. Therefore, in those heads which I have carefully opened, without separating them from the trunk, I have never found these little bubbles of air under the *Arachnoides*.

As, therefore, such a collected fluid may be plainly observed about the brain, and spinal marrow, we must carefully make the following experiments. Let the head of the undivided body be put into an erect position; the integuments being dissected, and the bones bared, proceed to separate the bony *Fornix* of the skull by a horizontal section. But in beginning thus, great care must be taken in cutting the bone, or separating it, not to perforate the adjoining Dura Mater. If this rule is observed; when the bone is taken off, if it be the body of an old man, or consumptive person, we shall find, wherever it is pricked,

that water will flow out: if not, it will appear to be exactly filled with the brain. But after this, let the Dura Mater be dissected, and the brain bared, and then it will plainly appear under the *Arachnoides*; where not the smallest bubble must make its appearance. After this, lift up gently the anterior lobes of the brain, and you will see each of the cribose cells of the *Ethmoides* abounding with water: and, upon raising the rest of the brain, you will find, at the conjunction of the optic nerves, and the sides of the oval protuberance, all those parts, that in decollated bodies are found empty, full of water. This water may fill the vaginal Sinus of the fifth pair, and the whole auditory Meatus. All that space that is around the trunk of the *Medulla oblongata* is filled with water; and if, after the trunk is cut through, the *Cerebrum* and *Cerebellum* be taken away, and the body put in an erect position, the tube of the Dura Mater will be found to be exactly full of this water all around the spinal marrow. After this, if you cut through any part of the *Vertebrae* of the loins, and the lower part of the tube of the Dura Mater, where it embraces the *Cauda equina*, you will find a limpid stream flow out, and the water that was before observed around the spinal marrow will gradually descend, until it is all emptied by the aperture at the bottom. If you open the *Vertebrae* of the loins before the head is touched, and cut the enclosed tube of the Dura Mater, a great quantity of water will burst out, and after all this spontaneous flux of water is spent, if you lift up the head, and shake it towards the aperture, a more plentiful stream will burst out, as if a new fountain was unlocked. In these experiments, which I made on the bodies of near twenty adults, and which I repeated at different times, I could draw off freely from the hollow of the spine, four, and even sometimes five ounces of water: I commonly found it very clear in such subjects, although it sometimes inclined a little to a yellow colour; but in foetus's strangled in difficult labour, little as it was, I observed it to be always red and opaque.

It may not be absurd, indeed, to entertain some doubt whether this quantity of water about the brain, and the spinal marrow, is not in consequence of a man's death; and whether a man, when living, has not these spaces empty, or filled with a kind of vapour, or more turgid marrow. But I think we have not much reason to imagine there are void spaces in living, when these spaces are found full in dead subjects; for the law of nature tells us the contrary,—*Nuspiam vacuum in animantium esse corpore, in que quicquid libere exterior aer solidumve non replet, impleat humor*;—and that there can be no void space in the bodies of living animals, for if a space is not occupied by some solid substance, or is impervious to the air, it must be filled with some fluid. Neither, if we suppose a vapour to occupy these spaces in living, can it seem very probable, that it should be so condensed in dead men, as to fill them entirely with water. But besides, the dissection of some living animals confirms me in my opinion, that this water which we doubt of, is also to be found in a living man: for in those fishes which I have dissected when alive, or immediately after death, (and especially in the sea-tortise of about fifteen pounds weight) I have found the brain to be very small, in proportion to the skull, and a considerable space remaining on the inside between them; and it appeared that all this space was filled with water all around the Medulla Spinalis, which took up the other part of the space remaining. But I did not find it to be the same in living dogs, or flying fowls, as the brain and spinal marrow here were so large, whether the subjects were alive or dead, that the cavity in which they were contained, was entirely filled up. But though these animals were not so proper to prove the existence of the fluid, yet they exhibit a clear proof that the brain and spinal marrow are not diminished in their size by death. Al-

though there are some who imagine that the spinal marrow is larger in life, and that it is sufficient of itself to fill up all the surrounding space: they ought, however, to take notice, that the branches of the nerves, proceeding from the spinal marrow, which in a dead body run along that space unfolded, would, by their supposition, be entangled, and compressed in a living subject. All that space, therefore, which is around the spinal marrow, is filled with water naturally, and in this respect, a dead body varies little, or nothing from a living one.

But it seems a wonder that many famous men, who have diligently examined the fluids of the cavities of the human body, should pass over in silence, or have taken no notice of this large and capital cavity of the spine, which abounds so plentifully with a fluid. It seems beyond a doubt, that this fluid of the spine, as well as every other that moistens the rest of the cavities of the human body, oozes out from the extremities of the small arteries, and is again resorbed by the small inhaling veins, so as to be in a continual state of renovation: I myself can entertain no doubt of this, as I have before proved experimentally that some of the inhaling mouths of the small veins of the *Dura Mater* opened upon the internal surface; of the truth of which *Abraham Kaavius*, the grandson of the illustrious *Boerhaave*, formerly doubted. But I have no doubt that the great Physician *Haller's* opinion is founded on fact; that those waters, which the ventricle of the *Cerebellum* received, either from the greater ventricles of the brain, by the *Lacunae*, or *Sylvius's* aqueduct, or the proper exhaling arteries, were afterwards mixed with those of the spine; as here, their perpendicular position, and the free passage that is about the cavity of the spine, sufficiently prove to us that there is a defluxion of humours to the spine.