Baron Larrey at the Dawn of Correlative Neuroanatomy

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\textbf{Abstract}

In 1820, a young soldier was accidentally injured by a splinter of a fencing sword that penetrated through the right orbit into the brain. Examination by the French military surgeon Baron D.-J. Larrey revealed nominal aphasia, right hemiplegia, and monocular temporal hemianopia with an altitudinal component in the right eye only. In this paper, we aimed to reconstruct Larrey's contribution to neurology in the eve of correlative neuroanatomy. Larrey predicted that the blade passed from the roof of the right orbit to graze the root of the right optic nerve at the chiasm and from there, into the vicinity of the left Sylvian fissure. This course was verified posthumously 3 months later. Larrey's previous experience with galvanic currents enabled the adoption of Samuel von Sömmering's idea of regarding the brain as a telegraphing system made of a multitude of galvanic piles sending and receiving messages from distant points. Larrey's description is a very early diligent study of the tracks of penetrating head injuries. It correlates the symptoms with the injured cerebral tissues together with autopsy verification. Here are the beginnings of the construction of human correlative neuroanatomy, which lingered until flourishing in the first decades of the 20th century.

\textbf{Introduction}

Baron Dominique-Jean Larrey (1768–1842) is hailed as one of the foremost role models in the history of military surgery. The introduction of the rapid evacuation of the wounded from the battlefield by horse-driven special “flying ambulances,” the practice of sensible triage, together with innovating surgical ideas saved many lives and continues to serve as a guide in emergency medicine. His bravery under fire, the unlimited dedication to the wounded, whether friends or foes, and the courageous ethical conduct in preventing the execution of soldiers alleged of self-mutilation – bravely opposing his raging emperor – brought him immediate fame and long-lasting popularity all around the Western World [1]. The number of books and articles written about him is immense; it thus seems redundant to redraft a detailed biography here. Larrey recounted in his writings his vast experience in treating the various kinds of military injuries and diseases. His books were immediately translated [2].
Larrey was endowed with scientific curiosity and being well-read, was aware of the most recent medical and surgical discoveries as well as theories concerning the nervous system. At the age of 26 years, amid the intense French Revolutionary Wars of 1792, he turned a common lower limb amputation into an innovative scientific experiment, in which, he used the severed leg to affirm in the human being the recent observations made by Galvani on frogs. The muscular contractions induced by the galvanic current led him to foretell, much ahead of his time, that this mode of stimulating denervated muscles may facilitate rehabilitation of the paralyzed [3]. Larrey abandoned his plans to continue and study galvanic currents because of the improper use of galvanic stimulations to evoke muscle contractions in decapitated heads [4]. The experiments were carried out in the laboratory of the German polymath Samuel von Sömmering (1755–1830) though in his absence. Larrey esteemed Sömmering’s contributions to the study of the nervous system [5], established a good rapport with the scientist, and used to discuss with him pathologic specimens brought by him from the battlefields. He embraced Sömmering’s idea of regarding the brain as a telegraphing system comprised of a multitude of galvanic piles sending and receiving messages from distant points by insulated wires similar to the nerve fibers [6, 7]. Upon returning to Paris, Larrey showed Sömmering’s telegraph to a medical society, attended by several French luminaries, and portrayed an image of the brain as made of many piles from which nerves, perfectly insulated, originate or terminate in different, though corresponding, organs of the brain [8] thus spreading Sömmering’s concepts. The audience remained unimpressed and the idea faded without recorded discussions.

Ten years later, Larrey encountered a head-injured soldier with peculiar neurologic and visual symptomatology. Between the lines of his detailed discussion of the case, the abandoned idea of insulated wires carrying information between designated points that injury, may disrupt, can be heard echoing from a distance.

**The Patient**

“The subject of this case is an individual in whom, under the separate consideration of the cerebral organs and of the characteristic features of their respective injuries, the most extraordinary anomalies and the most curious phenomena have been exhibited.”

Larrey felt that the encounter with a remarkable case merited a very detailed description and furnished an exhaustive report. It had thus to be truncated.

“While fencing in training, on November 19th, 1820, Lecœur, a 22 years old fusilier (rifleman) was struck in the right eye by a foil (fleuret), and the splintered blade penetrated the superior eye-lid, below the eye-brow, and on the internal side of the orbit, and deeply into the cranium in an oblique direction from right to left and from before backward. The wounded soldier did not fall or lose his senses, he was conducted to the barracks, complaining of painful numbness along the whole right side of the body, and was not brought to the hospital of the guards until the next morning when the paralysis had already extended over the whole right side of the body, especially the hand. There were no complains on disturbed sensations but respiration and deglutition were difficult, and the patient could hardly articulate.”

Larrey administered to the patient all the known and recommended treatments such as bloodlettings, purgation, blisters, and ice to the head and mustard cataplasms to the legs [9 p. 120]. After 19 days – “All the functions were gradually restored. The intellectual faculties had never been impaired. For, although laboring under the impaired mechanism of speech, the patient replied precisely to the questions put to him, and even answered for the orderlies, whose conversations he used to follow, and played cards with his comrades, with success. However, he lost the faculty of recollecting proper names. He could not tell me the names of either his parents or any of his friends. He had even forgotten his own.”

“Another remarkable peculiarity presented itself, in the optic functions of the right eye. Whenever the patient kept his head still, he would see with that eye only the horizontal half of any object before him in the axis of the pupil which admitted through the optic cone. Whenever they digressed from this axis inwards, and beside the nose, they became fully perceptible; if, on the contrary, they moved outwards nearer to the temple, the head of the patient remaining always unmoved, these objects would disappear in the same way.” The eye movements remained full and precise as those of the fellow eye.

Notwithstanding the improved condition, the patient sank into depression but repeated application of moxa, an old variant of acupuncture in which certain herbs are slowly burned on the needles, significantly ameliorated his mood [10]. Larrey presented the patient to the Faculty of the Military Hospital and explained how the clinical findings enabled him to reconstruct the path of the sword’s splinter from its penetration into the cranium.
through the roof of the right orbit. In correlation with the visual symptoms, the sword grazed the right optic nerve at its junction with the chiasm, disrupting only a part of its filaments and continued into the left hemisphere causing only a minor bleed into the region, resulting in transient hemiplegia. He declared “That organs of different kinds have not merely distinct properties, but those very organs may experience partial alterations in their functions and the filaments which, in connection with the encephalon, compose the nervous trunks, have a distinct origin, and receive from that organ a particular stimulus in proportion to the functions over which these elementary filaments preside.”

The patient improved and began to promenade in the yards of the hospital and even in the streets, but this recuperation did not last. About 10 weeks after the injury, he sank suddenly into a coma and despite Larrey’s efforts succumbed to what would be diagnosed today as fulminant meningitis and fatal septic shock.

Postmortem Examination

After opening the skull, Larrey noticed very near to the nasal side of the ethmoidal groove an aperture in the skull base into which scarred brain was adhering. “From this point proceeded a canal along the internal margin of the pole of the right hemisphere, passing over the olfactory nerve of the same side and penetrated the substance of the left hemisphere by passing along the left optic nerve and its root of the right side. This root had been injured by the point of the instrument near its origin (from the chiasm) and beneath the anterior cerebral artery, which had been abraded there and much dilated. Finally, the end of the broken foil had been arrested at the inferior wall of the lateral ventricle very near to the left branch of the medulla oblongata (the middle cerebral peduncle). This oblique canal was lined with a layer of bloody coagulum.”

The autopsy findings matched Larrey’s clinical diagnosis that was presented to the Medical Society of the Faculty about 8 weeks earlier.

Discussion

Several years ago Roux and Reddy [11] compiled and reviewed Larrey’s neurosurgical works and contributions and drew attention to his interest in galvanism and the attention to traumatic aphasia due to left hemisphere injuries. Among these patients, Lecœur stands out because of the rare post-traumatic symptoms. The deliberations on the possible pathological anatomy and physiology of the clinical picture are a tribute to Larrey’s attempts to integrate his anatomical knowledge and the new physiological concepts into the clinical discipline.

The autopsy findings confirmed Larrey’s prediction of the path of the broken sword. The findings demonstrated not only the deep left temporal lesion but also its extension to the vicinity of the motor bundles in the left internal capsule. The frontal lobes remained uninjured, hence the preserved intellectual functions.

The association of right hemiplegia, involving mainly the hand, and loss of speech were observed already in Biblical times [12]. Larrey was the first to report in detail traumatic aphasia due to left temporal injury already in 1809 [13] and identified more cases of aphasia due to left frontotemporal penetrating injuries and referred or reported them to Franz Joseph Gall (1758–1828) for further studies [14]. The importance of these cases was recognized by Gall ([15], but it did not cause him to reconsider the concept of the bifrontal location of the speech faculty. Larrey did not challenge the concept, and only in 1861 could Broca localize the speech center in the left hemisphere, and severe and isolated anomia is nowadays considered a sign of deep temporal damage in the dominant hemisphere [16].

The 22-year-old Lecoeur, who did not lose his power of attentive observation, reported to Larrey that whenever he fixed his gaze, he saw with his right eye only the horizontal half of any object which would disappear from the temporal field of that eye. Lecœur’s report is very reliable because as a rifleman, he was trained to aim with the right eye while closing the left one. In this setting, he was attentive to any change or defect in the visual field of his right eye. Alas, he did not tell Larrey whether the temporal field defect was above or below the horizon and the latter did not question him.

Monocular temporal field defect, i.e., loss of the lateral visual field in one eye only, is quite a rare symptom of damage to the intracranial anterior visual pathways. Hershenfeld and Sharpe reported [17] 24 patients and reviewed the literature in 1993. Superior quadrantanopia dominated the clinical picture. Most of the patients had various para chiasmatic tumors, some had optic disc division, and nearly a tenth was functional. The more recent literature is dotted with a few had para chiasmatic lesions or nonorganic visual loss. Larrey’s patient is the earliest reported case of monocular temporal hemianopia with a horizontal component and unique, by being caused by a transorbital penetrating head injury. Larrey states,
ahead of his time, that the field defect is due to injury to only a portion of the filaments of which the optic nerve is made and that each one of these filaments represents a specific point in the retina.

To propose in 1820 a clinical diagnosis of partial injury to the right optic nerve at its chiasmal junction on the ground of visual field defect was a bold attempt. The elucidation of the course of the optic nerve fibers by histological methods began only toward the turn of the nineteenth century [18], much ahead of the introduction of the visual field examination into routine ophthalmologic and neurological practice by von Graefe in 1856 [19].

Larrey presented the unique case of self-described monocular hemianopia in 1820 to the limited audience of a local faculty of military surgeons, and his message did not resound further to the Parisian academic circles. A decade later, Larrey included this exceptional patient in his memoirs of military surgery ([9], p. 122). There, he furnished the full case report, the validation of his in vivo diagnosis in autopsy together with his ideas about the nervous filaments which have a distinct origin in the retina and are connected to the encephalon by the optic nerve. Larrey’s book and its English translation gained great popularity and was cited even decades later due to its important surgical information [20], but the message which could signify the budding functional neuroanatomy remained hidden from an academic-oriented audience and was resurrected only nowadays.

Quite in parallel, Wollaston [21] (1766–1828) reported in 1824 to the Royal Society of London his observations made during recurrent events of transient homonymous hemianopia and offered an anatomic background. The learned audience and the worthy society credited him to be the first to describe his own hemianopic field defect. Larrey’s no less important observation did not permeate the right audience.

The importance that surgeons attributed to the anatomy and physiology of the nervous system became evident only by the end of the 19th century when brain surgery began to be guided by neurological symptoms and signs and not by external landmarks [20]. The immense numbers of penetrating head injuries in the great wars of the first decades of the 20th century together with the utilization of skull X-ray imaging enabled the development of correlative neuroanatomy into an important diagnostic tool, as heralded by Larrey.

Dedication

In memory of William F. Hoyt, MD, master of Neuro-ophthalmology, great teacher, and dear friend.

Conflict of Interest Statement

We declare no conflict of interest.

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Author Contributions

M.F. conceived of the idea and collected the data; M.F., A.M., and R.B. analyzed the case and prepared the article; and M.F., A.M., and R.B. approved the final manuscript.

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