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The Bicentenary of Bell's Description of the Neuroanatomical Basis of Facial Paralysis: Historical Remarks

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Abstract

Charles Bell was a talented and versatile Scottish anatomist, neurophysiologist, artist, and surgeon. On July 12, 1821, he reported his studies regarding facial innervation in the essay "On the Nerves," read before the Royal Society in London. Since then, idiopathic peripheral facial paralysis has been named "Bell's palsy." He was the first author to describe the neuroanatomical basis of facial paralysis, in an essay enriched by beautifully self-made illustrations. The aim of this article is to trace the history of Bell's description of the neuroanatomy of the facial nerve, reexamining his 1821 article, in which he stated that the lower facial expression muscles were dually innervated by both the fifth and seventh cranial nerves. In 1829, he rectified this conclusion, recognizing the exclusive role of the facial nerve, which he defined as the "respiratory nerve." We offer a tribute to this polymath scientist on the bicentenary of his 1821 publication.

Keywords

facial innervation, Bell's palsy, facial palsy, facial nerve, trigeminal nerve, respiratory nerve, Charles Bell

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Charles Bell was a brilliant Scottish anatomist, physiologist, artist, and surgeon. He is regarded as the first to describe the neuroanatomical basis of facial paralysis in 1821.[1]

The aim of this article is to trace the history of Bell's description of the neuroanatomy of the facial nerve, reexamining the conclusions drawn by the author in his 1821 article about the dual innervation of the lower facial muscles responsible for facial expression by both the fifth and seventh cranial nerves. He later rectified this conclusion in his second article published in 1829 on the same topic.[2]

Tracing the History of Bell's Palsy Description

Charles Bell was born in Edinburgh (Scotland) in November 1774. He had access to drawing and painting lessons, and he obtained a degree in medicine at the University of Edinburgh. In 1804, he moved to London, where he established a well-attended school of anatomy and surgery. He became a fellow of the Royal Society, a prestigious scientific society. He was appointed head surgeon at Middlesex Hospital in London and later at the University College. He was not only an esteemed surgeon but also a talented anatomist, physiologist, artist, and prolific writer. He published extensively on a wide number of medical subjects. He had a specific interest in neuroanatomy and, being a skilled artist, was able to accurately draw the anatomical illustrations in all his publications.[3-6]

Throughout the period he spent as an army surgeon during the Napoleonic wars, he had the opportunity to gather experience about the relationships existing between facial injuries and impairment of motility of the facial muscles. On the basis of his clinical practice as a military surgeon, and with experience derived from experimental anatomical dissection, he was able to thoroughly trace the course of facial innervation. He is considered the first to describe the etiology of peripheral facial paralysis as related to lesions of the seventh cranial nerve, which he named the ''respiratory nerve.'' Several descriptions of facial paralysis were reported in ancient Greek and Roman times, such as those by Hippocrates (460-375 B.C.) and Galen (129-199 A.D.)[4,7] and later by the Persian physician Rhazi, regarded as the first to distinguish facial paralysis from facial spasm.[4] In 1683, the Dutch Cornelis Stalpart van der Weil (1620-1702) first described a case of facial paralysis ''*a frigore.*''[7] Nevertheless, Bell was the first author to supply a detailed description of the anatomical basis of facial paralysis, which was illustrated by the author depicting the anatomical course of the smallest facial branches.

On July 12, 1821, he reported his neuroanatomical studies in ''On the Nerves,'' published in the *Philosophical Transactions of the Royal Society in London*,[1] which he read before members of the Royal Society (**Figure 1**). Since then, idiopathic peripheral facial paralysis has been named Bell's palsy.

In his article,[1] he explained the reason why he named the seventh cranial nerve the ''respiratory nerve'' as follows: the

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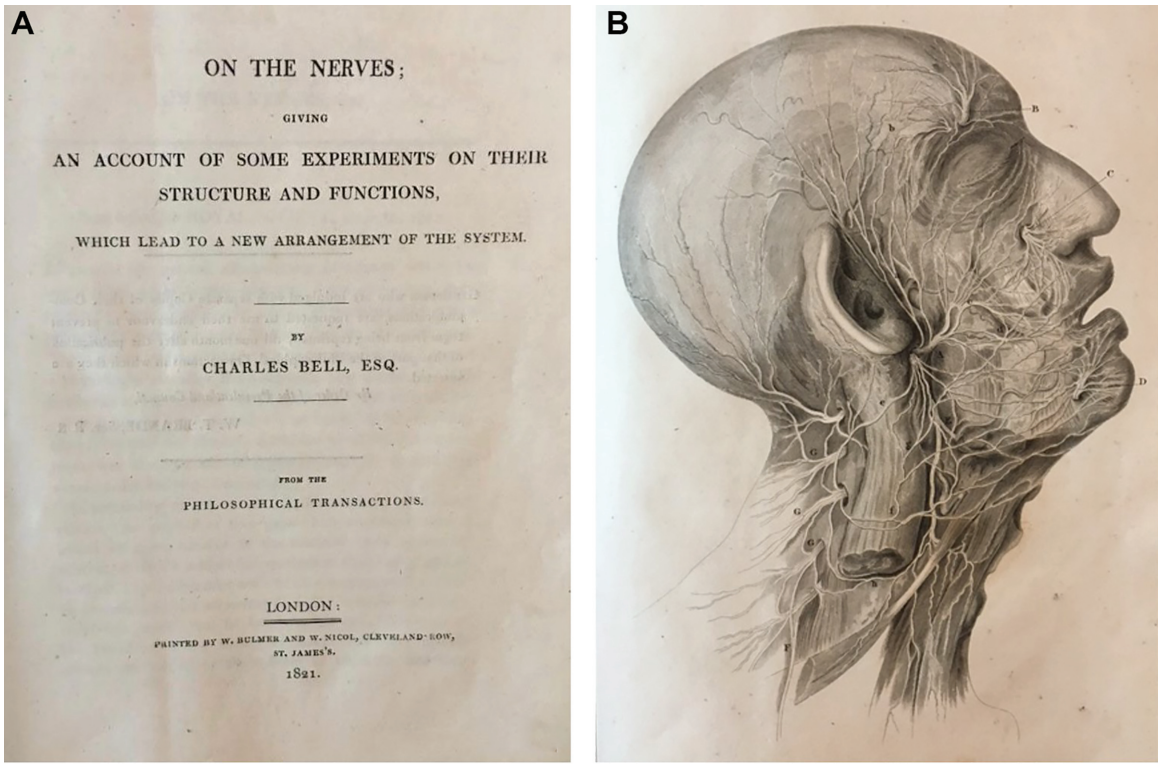

Figure 1. (A) Title page of Charles Bell's 1821 essay[1] about facial innervation. (B) Anatomical plate, drawn by the author in 1821, illustrating facial innervation: the finest branches of the seventh and fifth nerves are depicted.

''nerves of respiration'' are ''all the nerves which serve to combine the muscles employed in the act of breathing and speaking.'' He then clarified that ''the respiratory nerve of the face . . . goes off from the lateral part of the medulla oblongata, and, escaping through the temporal bone, spreads wide to the face. All those motions of the nostril, lips, or face generally, which accord to the motions of the chest in respiration, depend solely on this nerve. By the division of this nerve the face is deprived of its consent with lungs, and all expression of emotion.''

This statement clearly expresses his knowledge about facial innervation. Nevertheless, further on in the same article, he noted some doubts about the sole innervation by the seventh nerve and stated, ''If we were barely to consider this distribution of the portio dura of the seventh . . . we should be forced to conclude, that it is not alone sufficient to supply anyone part with nervous power, for every one of its branches is joined by divisions of the fifth. The question then naturally arises, whether these nerves perform the same function? Whether they furnish a double supply of the same property or endowment, or whether they do not perform different offices?''

Then, he reported his experimental studies on an animal model in the section dedicated to ''experiments on the nerves of the face.'' He transected the ''superior maxillary branch of the fifth nerve'' of an ass and detected that ''the side of the lip was observed to hang low and it was dragged to the other side. The same branch of the fifth was divided on the opposite side, and the animal . . . could no longer pick up his corn; the power of elevating and projecting the lip, as in gathering food, was lost.''

Later, in the section about ''experiments on the function of the trigeminus,'' he reaffirmed the role of the fifth nerve in the innervation of the lower face. The caption of ''Plate 30'' (**Figure 1**) described (C) as ''the infra-orbital division of the same fifth nerve . . . its subdivisions form a plexus before finally dividing to supply the muscles of the nostril and lip'' and (D) as ''the third grand division of the fifth nerve, or mandibulo-labralis, to the muscles and in teguments of the chin and lower lip.''

On May 28, 1829, Bell read before the members of the Royal Society in London a new dissertation entitled ''On the Nerves of the Face; Being a Second Paper on That Subject''[2] (**Figure 2**). In this report, he corrected the error made when he previously considered the fifth cranial nerve to be responsible for the motor innervation of the muscles of the nostril and lip and clarified its role.

He affirmed, ''On presenting a second paper on the same part of the nervous system . . . there will be some novelty both in facts and in the illustrations.''

''In short, the motor portion of the fifth nerve sends no twigs with ophthalmic division, nor the superior maxillary nerve, but only with the lower maxillary nerve. To the muscles of the lower jaw alone, which are in action during mastication, and to the muscles necessarily associated in that action, the manducatory nerve is distributed.''

''By experiments on the nerves of the face these three things were proved: First, that the sensibility of the head and

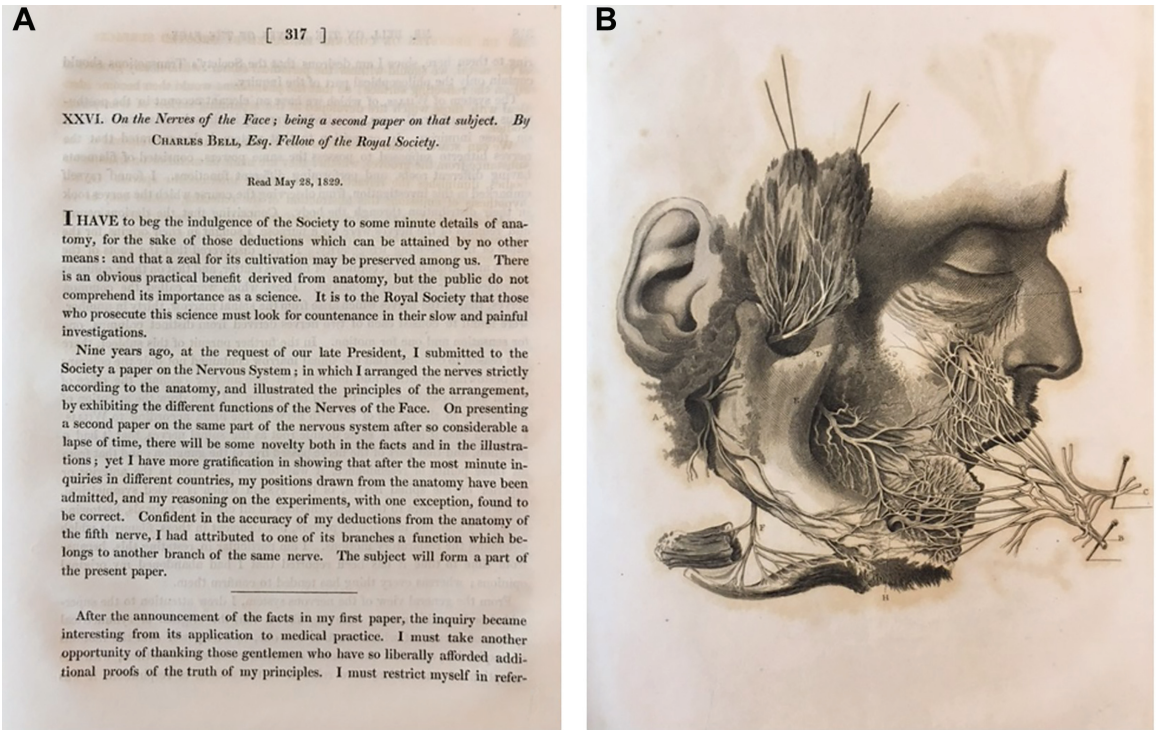

Figure 2. (A) Front page of Bell's 1829 essay.[2] (B) Anatomical plate drawn by the author in 1829. The main branches of the facial nerve have been "dissected off the face and pinned out."

face depend on the fifth pair of nerves. Secondly, that the muscular branches of the fifth were for mastication: and in the third place, it was proved that the portio dura of the seventh . . . controlled the motions of the features, performing all motions, voluntary or involuntary, which are necessarily connected with respiration: - such as breathing, sucking, swallowing and speaking."

Thus, in 1829, he clarified that the trigeminus has no role in the innervation of muscles of facial expression but innervates the masticatory muscles and that innervation of masticatory muscles derives from the mandibular branch of the trigeminus and not from the maxillary branch, as he had previously stated in the 1821 report.

In conclusion, by few remarks on Bell's original dissertations about the neuroanatomy of the facial nerve, we offer a tribute to this talented scientist on the bicentenary of his first 1821 publication.

Author Contributions

Giovanna Cantarella, contributed to conception and design of the article and to acquisition and interpretation of the historical data, contributed to drafting and revising critically the manuscript and approved the version to be submitted, agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved; **Riccardo F. Mazzola**, contributed to conception and design of the article and to acquisition and interpretation of the historical data, contributed to drafting and revising critically the manuscript and approved the version to be submitted, agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work were appropriately investigated and resolved.

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