Clinical Anatomy 27:14–19 (2014)

REVIEW

The Naming of the Cranial Nerves: A Historical Review

MATTHEW C. DAVIS,[1] CHRISTOPH J. GRIESSENAUER,[1] ANAND N. BOSMIA,[2] R. SHANE TUBBS,[2,3,4*] AND MOHAMMADALI M. SHOJA[3]

[1]*Division of Neurosurgery, Department of Surgery, University of Alabama, Birmingham, Alabama*
[2]*Department of Anatomical Sciences, St. George's University, Grenada*
[3]*Pediatric Neurosurgery, Children's Hospital, Birmingham, Alabama*
[4]*Centre of Anatomy and Human Identification, Dundee University, United Kingdom*

The giants of medicine and anatomy have each left their mark on the history of the cranial nerves, and much of the history of anatomic study can be viewed through the lens of how the cranial nerves were identified and named. A comprehensive literature review on the classification of the cranial names was performed. The identification of the cranial nerves began with Galen in the 2nd century AD and evolved up through the mid-20th century. In 1778, Samuel Sömmerring, a German anatomist, classified the 12 cranial nerves as we recognize them today. This review expands on the excellent investigations of Flamm, Shaw, and Simon et al., with discussion of the historical identification as well as the process of naming the human cranial nerves. Clin. Anat. 27:14–19, 2014. © 2013 Wiley Periodicals, Inc.

Key words: cranial nerve; history; naming

INTRODUCTION

Galen's notes on the cranial nerves are found in *On Anatomical Procedures* (Lyons and Towers, 1962). By the descriptions, it is clear to which cranial nerves Galen is referring, even though they are not assigned names. Galen generally preferred an ordinal classification for identifying anatomic structures, and his system would prove difficult to break.

Although he identified the olfactory tracts, Galen considered them 'exactly like that of the brain' and, therefore, did not classify them among the cranial nerves (Lyons and Towers, 1962). As a result, the optic nerves make up Galen's first pair of cranial nerves. He also identified the optic chiasm, a term originating from the Greek *khiasma*, meaning two things arranged crosswise, which itself is derived from the letter chi or χ (Paluzzi et al., 2012). Galen was adamant, however, that there was no intermingling or crossing of the fibers.

Galen also identified the oculomotor nerve as terminating in the "muscles which move the eye," however he did not identify the trochlear or abducens nerve. The sensory root of the trigeminal makes up Galen's third pair, whereas the motor root of the trigeminal nerve is his fourth. He combined the facial and vestibulocochlear nerve into his fifth pair, though he correctly deduced the vestibulocochlear to be the nerve "through which the auditory sensations are conveyed," and the facial nerve that which "arrives on the face." Galen's sixth pair is a combination of the glossopharyngeal, vagus, and spinal accessory nerve, which he combined due to their exit through a common foramen. However, he identified the glossopharyngeal as the "special pharyngeal," and the vagus as "lying next to the artery of stupor (internal carotid artery) along the whole of the neck." Galen also identified the hypoglossal nerve as terminating in "the tongue muscles," making this his seventh and final pair (Lyons and Towers, 1962; Flamm, 1967).

Following the collapse of the Western Roman Empire, the balance of medical science shifted to the East, and Galen's works were translated from Greek into Arabic. Avicenna, Rhazes, and other Persian writers based their own advancements on the system

*Correspondence to: R. Shane Tubbs, Pediatric Neurosurgery, Children's of Alabama, Birmingham, AL 35233, USA.
E-mail: shane.tubbs@chsys.org

Received 28 August 2013; Revised 5 October 2013; Accepted 16 October 2013

Published online 9 December 2013 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ca.22345

© **2013 Wiley Periodicals, Inc.**

Fig. 1. Rhazes' *Liber Continens*, Ottaviano Scoto Press, Venice, 1529

created by Galen. It was not until the 13th century that an Arabic translation of Galen's work was translated into Latin, and again made available to European writers (Singer, 1952).

Prior works on the history of the cranial nerves have, on the whole, moved directly from Galen to the late Medieval and early Renaissance anatomists, with only brief reference to the Persian scholars who maintained Galen's works and ultimately reintroduced them to European writers. It is worth noting that these great physicians were more than just Galenic transcriptionists, adding their own observations to the corpus of medical and anatomic knowledge.

Rhazes (864–930 AD), born Abu Bakr Muhamed Ibn Zakaria Al-Rhazes, was, along with Avicenna, arguably the greatest physician of the medieval period. A Persian physician with prodigious skill in neurologic localization for his time, he authored *Liber Continens*, the preeminent medieval medical text (Souavah and Greenstein, 2005) (Fig. 1). Rhazes identified seven pairs of cranial nerves as did Galen, but he did not hesitate to criticize Galen where he found inaccuracy or incompleteness, such as Galen's theory of visual rays projecting outward from the eye (Richter-Bernburg, 1994). Avicenna (980–1037 AD) is perhaps better known for his approach to the theory of medicine than the nuances of human anatomy, and his most significant contribution was the first description of the importance of the optic chiasm to binocular vision. The Persian physician, Esmail Jorjani (1042–1137 AD), followed the system of Rhazes and Avicenna, and was likely the first to recognize the crossing of fibers at the optic chiasm, in addition to the functional significance (Shoja et al., 2007).

Early and Mid Renaissance (14th to 16th century) advancements came principally from Italian anatomists. Mundinus de Luzzi (1270–1326 AD) performed dissections in 1315, and produced *Anathomia* in 1316, the definitive dissection guide in medieval medical schools (Choulant, 1852). His classification of the cranial nerves was identical to Galen's. Alessandro Benedetti (1445–1525 AD) was the first to label the olfactory tracts as cranial nerves, though they comprised his third pair, and Nicolo Massa (1489–1569 AD) was the first to consider them as the first pair in his *Liber introductorius anatomiae* in 1536 (Lind, 1975). Working in Bologna over 100 years following the death of Mundinus, Alessandro Achillini (1463–1512 AD) was possibly the first to describe the trochlear nerve, though his description is vague and he did not include it among the pairs of cranial nerves (Lind, 1975).

Andreas Vesalius (1514–1564 AD) is generally revered as the man who overturned centuries of Galenic tyranny. Unfortunately, his contributions to the understanding of cranial nerve anatomy are limited. He continued the Galenic practice of ordinal numbering of cranial nerves, and like Galen listed seven, albeit slightly altered, pairs of cranial nerves. He did, however, clearly identify the trochlear nerve (Shaw, 1992) (Fig. 2).

Vesalius was succeeded as Professor of Anatomy and Surgery at Padua by Matteo-Realdo Colombo (1516–1559 AD) and Gabriele Falloppio (1523–1562 AD), both of whom produced their own variations on the ordinal system (O'Malley, 1966). Thus, by 1562, with the publication of Falloppio's *Observationes anatomicae*, a half-dozen highly regarded Italian anatomists had produced independent and often conflicting classification systems for the cranial nerves (Mortazavi et al., 2013).

This debate and confusion would continue for the next 100 years, with numerous anatomists producing their own variations on the Galenic system. The next consensus would await Thomas Willis of Oxford in 1664, with his *Cerebri anatome*. Willis' system of nine nerves closely resembles the modern classification, with the only differences being his combination of the facial and vestibulocochlear nerve into his seventh pair, and the glossopharyngeal/vagus/accessory nerves into his eighth pair (Rengachary et al., 2008) (Fig. 3). Although Galen had recognized the glossopharyngeal/vagus/accessory complex as innervating the trapezius and sternocleidomastoid muscles, Willis was the first to identify clearly the accessory nerve as a distinct entity (Hierons and Meyer, 1962).

Willis' magnum opus was also the first meaningful contribution to the understanding of cranial nerves by an English anatomist. As pointed out by Shaw and others, anatomy was not generally emphasized by English physicians, and the training of surgeons

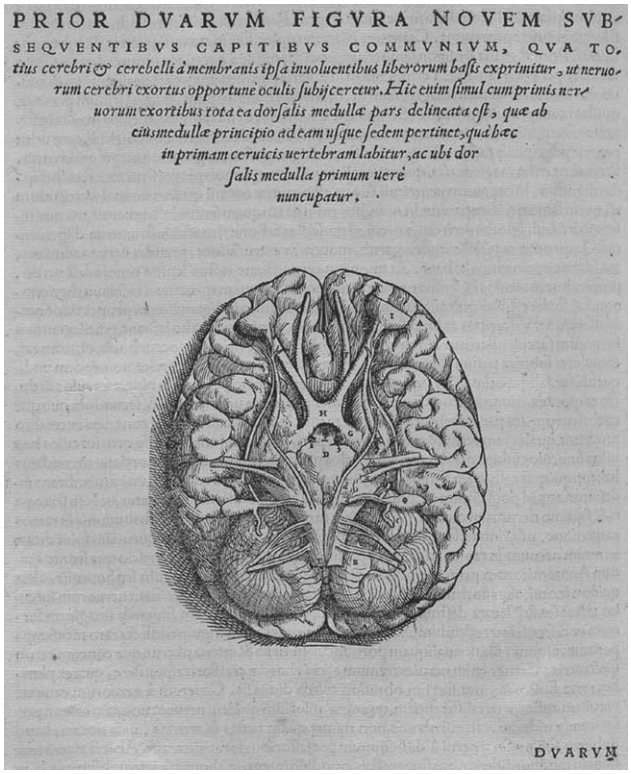

Fig. 2. Vesalius' illustration of the seven cranial nerves, *De humani corporis fabrica*, 1543

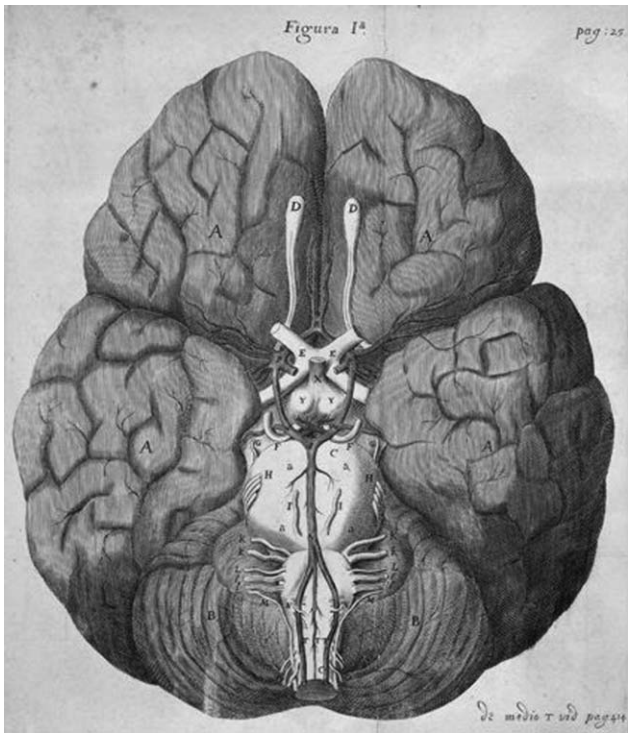

Fig. 3. Willis' system of nine nerves, *Cerebri anatome*, 1664

followed the apprenticeship model (Russell, 1973; Shaw, 1992). As a result, meaningful anatomic investigation lagged behind continental Europe.

The popularity of Willis' text cemented his system of nine nerves for the next 124 years. Indeed, his work was so popular in England, some British texts continued to classify only nine pairs of cranial nerves until the end of the 19th century.

Following Willis, a number of anatomists expanded on the branches and origins of the various cranial nerves, including Monro, Winslow, Haller, Andersch, Hunter, and Meckel. The work of these anatomists laid the foundation for the doctoral thesis of German anatomist Samuel Sömmerring (1755–1830 AD), who in 1778 classified the twelve cranial nerves as we recognize them today (Flamm, 1967; Shaw, 1992). In his thesis, Sömmerring made no meaningful anatomical discoveries, and his classification is essentially no less arbitrary than that of his predecessors (Sömmerring, 1778) (Fig. 4). Nonetheless, the Sömmerring system was rapidly adopted across continental Europe, although it was only slowly accepted in England, not appearing until the 11th edition of Gray in 1887 (Pick, 1887).

While standardization of ordinal numbering of cranial nerves has not changed in 230+ years, consolidated naming of the individual nerves would await the Nomina Anatomica in 1895. Ordinal numbering of anatomical structures was frequently confusing and not conducive to learning, and thus gradually gave way to descriptive naming in the 16th and 17th centuries. By the end of the 19th century, a large number of synonyms for any given structure had accumulated, and the description of anatomy had become perhaps even more confusing than in the time of Galen. As a result, leading European and British anatomists came together in 1895 to create the Nomina Anatomica, a standardized listing that reduced the number of approved anatomic terms from over 50,000 to just over 5,000 (Shaw, 1992). The Nomina Anatomica underwent several revisions and was replaced in 1998 by the Terminologia Anatomica.

Even the descriptive "cranial nerve" has undergone a series of transformations. Galen spoke of the "nerves issuing from the brain," while Vesalius and his intellectual descendants frequently use the expression nervi cerebri, i.e., nerves of the brain. The group was called the nervi cerebrales in the Nomina Anatomica of 1895, and in the current Terminologia Anatomica, only a single term is provided—the nervi craniales. The only other significant change to terminology of the cranial nerves following the Nomina Anatomica was in the naming of the vestibulocochlear nerve, which was called the acoustic nerve in the original Nomina Anatomica. As it was noted that the vestibular component had been neglected in the name, later iterations gave rise to the nervus statoacusticus, and then the nervus statoacusticus sive octavus, before settling on the nervus vestibulocochlearis in 1960.

NERVUS TERMINALIS

The nervus terminalis was first described by Gustav Fritsch in 1878 in dogfish (Vilensky, in press). The

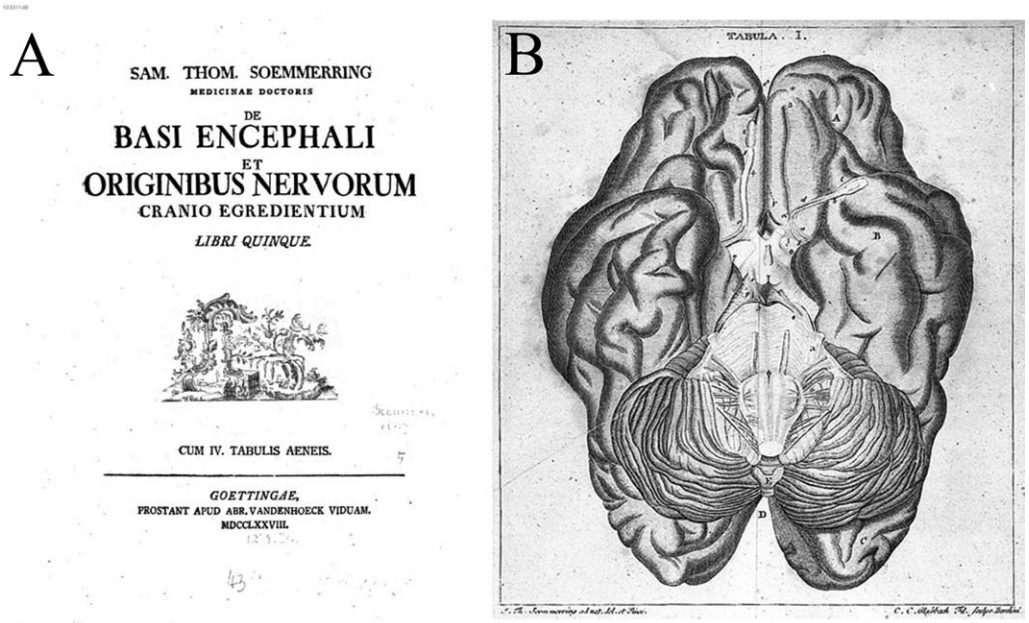

Fig. 4. Sömmerring's thesis (Panel A) on the classification of the 12 cranial nerves (Panel B), 1778

descriptive "terminal nerve" or nervus terminalis was suggested by Locy in 1905, due to its physical proximity to the lamina terminalis (Locy, 1905). The first reference to the nervus terminalis as cranial nerve 0 came in 1987 (Demski, 1987), and since that time, various attempts have been made, without success, to re-number the cranial nerves with the nervus terminalis as cranial nerve I. Vilensky notes that there is not a Roman symbol for zero, and suggests an N for the Latin nulla as a better designation (Vilensky, in press).

OLFACTORY NERVE

Galen identified the olfactory tracts but excluded them from the list of cranial nerves (Lyons and Towers, 1962). Jorjani noted their importance for the sense of olfaction, and followed Rhazes and Avicenna in combining them with the optic nerves to form the first pair. Vesalius, Columbo, Eustachius, Falloppio, and Bauhin often called them the mammillary processes. Benedetti listed them as his third pair of cranial nerves, and Massa considered them the first pair, though he was alone in this designation until the classification of Willis cemented them as the first pair (Rengachary et al., 2008). The linking of the function and the name would await Danish anatomist Caspar Bartholin in 1611 (Porzionato, 2013). Simon et al. state that the Latin term olfactorius was first used by Thomas Bartholin in 1651 (Simon, 2011). However, Caspar Bartholin the Elder had used the term primum par olfactorium (first pair, olfactory) in his first edition of *Institutiones Anatomicae* in 1611, which was later published in a revised form by his son in 1651 (Porzionato, 2013).

OPTIC NERVE

Opticus is a Latin derivation of the Greek optikos, referencing "optics", a term found in Aristotle's Metaphysica. The optic nerve was known essentially as such since even before the time of Galen. While Galen used an ordinal system, he did note, "some authors name them optic nerves" (Lyons and Towers, 1962). Jorjani identified the crossing fibers, and Vesalius, Eustachius, and Estienne all showed the chiasm clearly in their illustrations. Vesalius used the term nervi visorri, but later authors returned to some variation of the pre-Galenic descriptive, whether nervi optici, pars opticum, nervis opticis, or various others.

OCULOMOTOR NERVE

Oculomotoris is a composite Latin term composed of oculus "eye", and motor "prime mover". Although Galen described the oculomotor nerve as responsible for the movement of the eye, the compound word did not appear until 1783 in Pfeffinger's *Structura nervorum* (Simon, 2011). As with most of the cranial nerves, consensus naming would await the Nomina Anatomica.

TROCHLEAR NERVE

Trochlea comes from the Greek trochileia, and references a "pulley" or "reel". Unsurprisingly, given its singular exit from the dorsum of the brainstem, and that proper fixation of cadavers was unavailable before the 18th century, the trochlear nerve was the last of the twelve cranial nerves to be recognized

(Tompsett, 1956). It was likely first described by Achillini in 1520, though Vesalius was the first to clearly show the nerve, which was included by Falloppio in his classification of 1561 (O'Malley, 1966; O'Rahilly, 1988). Aranzi was the first to use the term in reference to the now superior oblique muscle in 1587 (Hyrtl, 1880; Flamm, 1967). Realdo Colombo assigned the name of "pathetic nerve" or nervos oculorum patheticos to the trochlear in 1559, a name which was popularized by Willis in 1666 (Columbo, 1559; Hierons and Meyers, 1962). Nervus trochlearis first appeared in 1670 by Molins, and both names were used up to the Nomina Anatomica.

TRIGEMINAL NERVE

Trigeminus in Latin means "triple", and Winslow first applied it to the 5th pair in 1732 (Olry, 1996). The greatest gains in appreciation of the fifth nerve came from Meckel, who named the three branches of the fifth nerve the ophthalmic, superior maxillary, and inferior maxillary (Meckel, 1748). However, it was actually Winslow in 1732 who first coined the term nerf trijumeaux, 16 years before Meckel's seminal thesis (Flamm, 1967; Bellary et al., 2012). Wrisburg, mentor to Sömmerring, was the first to assign names to two separate roots of the fifth nerve, naming them portio major and portio minor.

ABDUCENS NERVE

Similar to the case of the trochlear nerve, for the abducens the action of the associated muscle was transferred to the naming of the nerve. It appears that Sömmerring himself was the first to use the term nervus abducens in 1778.

FACIAL NERVE

Facialis derives from the Medieval Latin term facies, indicating "facial." Haller referred to the facial branch of his seventh pair as the ramus facialis, but once again, the first anatomist to use the term we use today was Sömmerring. Until the time of Sömmerring, the facial and vestibulocochlear nerves had been classified as a single pair, often with the moniker of portio dura and portio mollis (Sömmerring, 1778; Flamm, 1967). Of note, in tribute to his teacher, Sömmerring attached the eponym "nerve of Wrisberg" to the nervus intermedius, which was first described by Wrisberg in 1777, and called the portio intermedia by him in 1780.

VESTIBULOCOCHLEAR NERVE

Even to Galen, the eighth pair was special. He gives a specific name—to "akustikon" neuron, referencing the auditory function (Lyons and Towers, 1962). Hearing continued to be emphasized in later naming—the instrumentum auditus by Benedetti, the nervus auditorius by Falloppio, and the nervus acusticus throughout the 19th century. As the separate cochlear and vestibular branches were increasingly recognized, the branches nervus cochleae and nervus vestibuli were presented (Hyrtl, 1863). However, in the original Nomina Anatomica of 1895, the more broadly recognized nervus acusticus was chosen. Later iterations in 1936 and 1956 produced the nervus statoacusticus and the complex nervus stato-acusticus sive octavus, respectively, with the revision of 1961 ultimately settling on the nervus vestibulocochlearis.

GLOSSOPHARYNGEAL NERVE

Glossopharyngeus comes from the Greek glóssa meaning "tongue", and "pharynx". In 1753, Haller classified the eighth pair of cranial nerves as comprising of three divisions: the glossopharyngeal, the vagus, and the spinal accessory nerves (Haller, 1762; Flamm, 1967; Simon, 2011). Sömmerring split up the nerves but kept the names used by Haller.

VAGUS NERVE

The vagus is Classical Latin for "wandering" and it appears that Bartholin was the first to associate the evocative adjective with the tenth nerve (as part of his ninth pair) in 1611. As with naming of the olfactory nerve, it was actually Caspar Bartholin the Elder, not his son Thomas Bartholin, who first applied the name to the nerve (Porzionato et al., 2013). The vagus nerve has also been referred to as the pneumogastric nerve.

ACCESSORY NERVE

Willis was the first to identify the spinal accessory as an independent nerve, and he gave it the name nervus accessorius, from the Medieval Latin meaning "accessory" (Hierons and Meyer, 1962; Rengachary et al., 2008). The original implication was that the nerve was accessory to the vagus.

HYPOGLOSSAL NERVE

The Greek hypoglóssios means "sublingual", and was known even to Galen as the nerve responsible for movement of the tongue. Willis called it the nervus linguae motus, and the term nervus hypoglossus was first used by Winslow in 1732 (Olry, 1996).

CONCLUSIONS

The majority of cranial nerve names have their origin in descriptive terms of antiquity, but modern terms were largely settled in the 17th and 18th centuries. Galen himself acknowledged only two independent names (optic and acoustic), preferring his own ordinal system. The cranial nerve names we use today are based most commonly on localization, followed by appearance, and least frequently, function (Simon,

2011). The accessory nerve is unique in that its name is based on a historical misunderstanding regarding its function.

The listing of 12 cranial nerves has proven a stable convention for over 230 years. Willis' system was generally accepted for over a century, and Galen's classification stood largely unchallenged for well over a millennium. As pointed out by O'Rahilly and others, inclusion of the nervus terminalis, the nervus intermedius of the facial nerve, and alternative subdivision of the divisions of the trigeminal could have easily resulted in 16 rather than 12 cranial nerves (O'Rahilly, 1988). Additionally, as tracts rather than true nerves, the optic and olfactory nerves could arguably be removed from the list. Given the pace of modern anatomical research, it seems unlikely that the current convention of 12 cranial nerves will last another 230 years. However, the names of these nerves, often steeped in thousands of years of linguistic history, will likely live on far longer than their systems of classification.

REFERENCES

Bellary SS, Walters A, Gielecki J, Shoja MM, Tubbs RS, Loukas M. 2012. Jacob B. Winslow (1669–1760). Clin Anat 25:545–547.

Choulant L. 1852. History and Bibliography of Anatomic Illustration. (M. Frank., Trans). Chicago: University of Chicago Press. p 88–96, 169–204.

Columbo R. 1559. De re Anatomica Libri xv. Nicolò Bevilacqua: Venice. p 194–199.

Demski LS, Schwanzel-Fukuda M. 1987. The terminal nerve (nervus terminalis): Structure, function and evolution. Ann NY Acad Sci 19:ix–xi.

Flamm ES. 1967. Historical observations on the cranial nerves. J Neurosurg 27:285–297.

Haller A. 1762. Elementa Physiologiae Corporis humani. Lausanne, Sumptibus M. M. Bousquet et Sociorum. p 231–237.

Hierons R, Meyers A. 1962. Some priority questions arising from Thomas Willis' work on the brain. Proc R Soc Med 55:287–292.

Hyrtl J. 1863. Lehrbuch der Anatomie des Menschen. 8th Ed. Braumüller, Wien.

Hyrtl J. 1880. Onomatologia Anatomica. Braumüller, Wien. Wilhelm Braumuller.

Lind LR. 1975. Studies in Pre-Vesalian Anatomy. The American Philosophical Society. Wilhelm Braumuller, Philadelphia. p 58–60, 117–118, 219, 240–242.

Locy WA. 1905. On a newly recognized nerve connected with the forebrain of selachians. Anat Anz Bd 26:111–123.

Lyons MC, Towers B. (eds.) 1962. Galen on Anatomical Procedures; The Later Books. (WLH Duckworth, Trans). Cambridge: University Press. p xii, 185–208.

Meckel JF. 1748. Dissertatio inauguralis medica anatomico physiologica de quinto pare nervorum cerebri. Goettingae: Vandenhoeck.

Mortazavi MM, Adeeb N, Latif B, Watanabe K, Deep A, Griessenauer CJ, Tubbs RS, Fukushima T. 2013. Gabriele Fallopio (1523-1562) and his contributions to the development of medicine and anatomy. Childs Nerv Syst 29:877–880.

Olry R. 1996. Winslow's contribution to our understanding of the cervical portion of the sympathetic nervous system. J Hist Neurosci 5:190–196.

O'Malley CD. 1966. Gabriele Falloppio's account of the cranial nerves. In: Rath G, Schipperges H, editors. Medizingeschichte in Spektrum, Sudhoffs Arch Z Wissenschaftsgesch. Franz Steiner, Wiesbaden, Germany 7:132–137.

O'Rahilly R. 1988. On counting cranial nerves. Acta Anat 133:3–4.

Paluzzi A, Fernandez-Miranda J, Torrenti M, Gardner P. 2012. Retracing the etymology of terms in neuroanatomy. Clin Anat 25: 1005–1014.

Pick TP. (ed.) 1887. Anatomy, Descriptive and Surgical. 11th Ed. Philadelphia: Lee Brothers + Co. p 649–674.

Porzionato A, Macchi V, De Caro R. 2013. The role of Caspar Bartholin the Elder in the evolution of the terminology of the cranial nerves. Ann Anat 195:28–31.

Rengachary SS, Xavier A, Manjila S, Smerdon U, Parker B, Hadwan S, Guthikonda M. 2008. The legendary contributions of Thomas Willis (1621–1675): The arterial circle and beyond. J Neurosurg 109:765–775.

Richter-Bernburg L. 1994. Abu Bakr Muhammad al-Razi's (Rhazes) medical works. Med Secoli 6:377–392.

Russell KF. 1973. Anatomy and the barber-surgeons. Med J Aust 1: 1109–1115.

Shaw JP. 1992. A history of the enumeration of the cranial nerves by European and British anatomists from the time of Galen to 1895, with comments on nomenclature. Clin Anat 5:466–484.

Shoja MM, Tubbs RS, Ardalan MR, Loukas M, Eknoyan Garbed, Salter EG, Oakes WJ. 2007. Anatomy of the cranial nerves in medieval Persian literature: Esmail Jorjani (AD 1042–1137) and the treasure of the Khwarazm Shah. Neurosurgery 61:1325–1331.

Simon F, Mareckova-Stolcova E, Pac L. 2011. On the terminology of cranial nerves. Ann Anat 193:447–452.

Singer CJ. (ed). 1952. Vesalius on the human brain. London: Oxford University Press: p xx–xxi, 70–76, 123.

Sömmerring ST. 1778. De basi encephali et originibus nervorum cranio egredentium libri quinque. Gottingae: Vadnehoeck. 184 p.

Souayah N, Greenstein J. 2005. Insights into neurologic localization by Rhazes, a medieval Islamic physician. Neurology 65:125–128.

Tompsett DH. 1956. Anatomical techniques. Edinburgh and London: E. and S. Liningstone Ltd., p ix–xiv.

Vilensky JA. 2012. The neglected cranial nerve: Nervus terminalis (cranial nerve N). Clin Anat doi: 10.1002/ca.22130.