

A contextual thematic analysis of the accessory nerve in Scottish historical medical collections of the Royal Colleges of Edinburgh and Glasgow

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Abstract

Introduction: The classification of the accessory nerve (CN XI) remains a source of debate; its exact function has not been fully elucidated having also an atypical morphology for a cranial nerve. A better insight into its anatomical and physiological features is of clinical relevance. The aim was to conduct a review of 18th and 19th century books from the Royal Medical/Surgical Colleges in Scotland, United Kingdom. A contextual historical analysis of the depictions and descriptions of the accessory nerve could provide insight into the disparity in the current descriptions.

Materials and Methods: Online archive catalogues were systematically searched and, during site visits, resources were formally and contextually analyzed, with the information then thematically analyzed. The themes were discussed against a widely known reference textbook of the era.

Results: Based on the thematic analysis, the resources were categorized either as practical anatomy books or field-specific anatomy books including neuroanatomy atlases. This intended use, along with the target audience, influenced the scope and detail of information, typically with general anatomy for students in the practical resources, and specialist information in the field-specific resources. The authors' professional background also influenced the way the accessory nerve was described and/or depicted, with surgeons/physicians placing emphasis on the clinical aspects. Content variations could also be attributed to communication restrictions of the era, and associated purchasing costs.

Conclusions: Although scientific advances are nowadays disseminated at a faster pace, actively bridging the gap between anatomical sciences and clinical research is still needed when considering the accessory nerve to further elucidate the mysteries of this structure.

KEYWORDS

accessory nerve, CN XI, history of medicine, rare books

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1 | INTRODUCTION

At present the accessory nerve, also known as the eleventh cranial nerve (CN XI), remains a source of debate as to its exact function and classification (Johal et al., 2018). In terms of the latter, the accessory nerve has been named as a cranial nerve, yet it comprises two roots arising from the upper cervical spinal cord and the medulla oblongata, respectively (Binder, Sonne, & Fischbeim, 2010). This atypical morphology has made it unique among the cranial nerves with a component originating out with the human skull; this has also created challenges in relation to its classification. Our understanding of the accessory nerve has potential surgical implications; one of the clinically relevant features of the accessory nerve is the risk of iatrogenic injury during surgery on the posterior triangle of the neck (Benninger, 2015). It is important to fully elucidate this nerve's anatomical and physiological features to limit such risks. Alas, there is still disagreement as to the classification of the accessory nerve. Some textbooks omit the cranial root as a component of the accessory nerve (Agur & Dalley, 2017; Moore, Dalley, & Agur, 2017). Other authors note the possibility of a cranial root, that contributes to the vagus nerve, to supply the muscles of the soft palate and larynx (Sinnatamby, 2011; Standring, 2016). Analyzing the historical descriptions of the accessory nerve could provide insight into the disparity relating to this nerve's current descriptions.

The aim of this work was to complete a review of 18th and 19th century books, housed at the Royal College of Surgeons of Edinburgh and the Royal College of Physicians and Surgeons of Glasgow in Scotland, United Kingdom. The purpose was to identify and contextually review the descriptions and/or depictions of the accessory nerve within the text and/or illustrative plates. An analysis of relevant resources within their historical context could provide us with a fresh outlook into the background of the modern descriptions of the accessory nerve.

2 | MATERIALS AND METHODS

The first methodological step involved standardized searches of the online archive catalogues, guided by a set of inclusion–exclusion criteria (Table S1), using consistent search terms. Once relevant resources were identified, site visits were undertaken by one of the authors (H. M.). During these, each resource was formally and contextually analyzed using a standardized data collection sheet developed according to D'Alleva (2010). The collected information was then thematically analyzed by two of the authors independently (H. M. and O. V.) (Figure 1). This step involved descriptive and in vivo coding, grouping into categories, and construction of overarching themes (Saldaña, 2014). Three authors (H. M., F. C., and O. V.) independently reviewed all final themes (i.e., anatomical descriptions and depictions, physiological descriptions, and scope of resources) to ensure that no patterns of significance were accidentally missed. The themes were discussed against the *Anatomy, Descriptive and Surgical* by Gray and Carter (1858), as this is a widely known reference

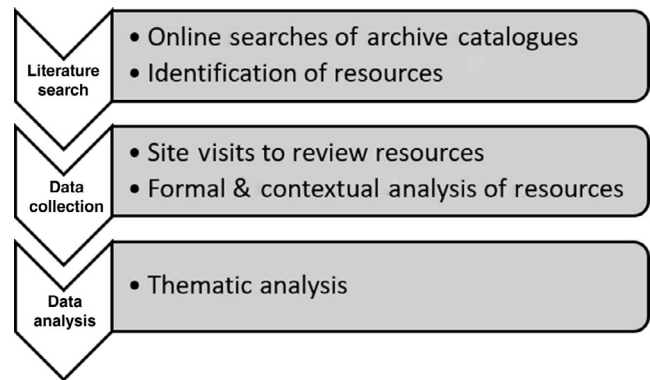


FIGURE 1 Summary of research methodology

textbook of the era with a broad target audience and enduring recognition.

3 | RESULTS

In total, 19 relevant resources were retrieved from the standardized searches of the online archive catalogues. The date of production ranged from 1783 to 1899 with all having been printed in the United Kingdom.

4 | ANATOMICAL DESCRIPTIONS AND DEPICTIONS

There is little disparity in the descriptions of the accessory nerve's course. It is uniformly described as dividing into an external and internal branch. The external branch distributes to the sternocleidomastoid and, by passing through this, to the trapezius. The internal branch unites with the vagus and glossopharyngeal nerves on their courses. Both branches are described as exiting the skull via the jugular foramen before dividing. In some of the surgical and practical anatomy books more detail is given in relation to the nerve's course. This includes complex relations to structures of surgical importance such as the jugular bulb (Macewen, 1893), the course of the nerve through surgical regions such as the posterior triangle of the neck (Cunningham, 1894), and the relations of the nerve to the layers of the dura and arachnoid mater as it passes through the jugular foramen (Deaver, 1899). The description of the accessory nerve, as given in *Anatomy, Descriptive and Surgical*, separates the spinal and "accessory" roots more explicitly (Gray & Carter, 1858). It also adds information about the passage of the nerve in proximity to surgical structures such as the internal jugular vein and suprahyoid muscles (Figure 2) (Gray & Carter, 1858).

Regarding the morphology of the accessory nerve, all resources follow traditional descriptions, with a spinal root arising from the spinal cord and a cranial root arising from the medulla oblongata; these unite and then branch into an internal and external branch (Binder et al., 2010). However, there are a few resources that include details

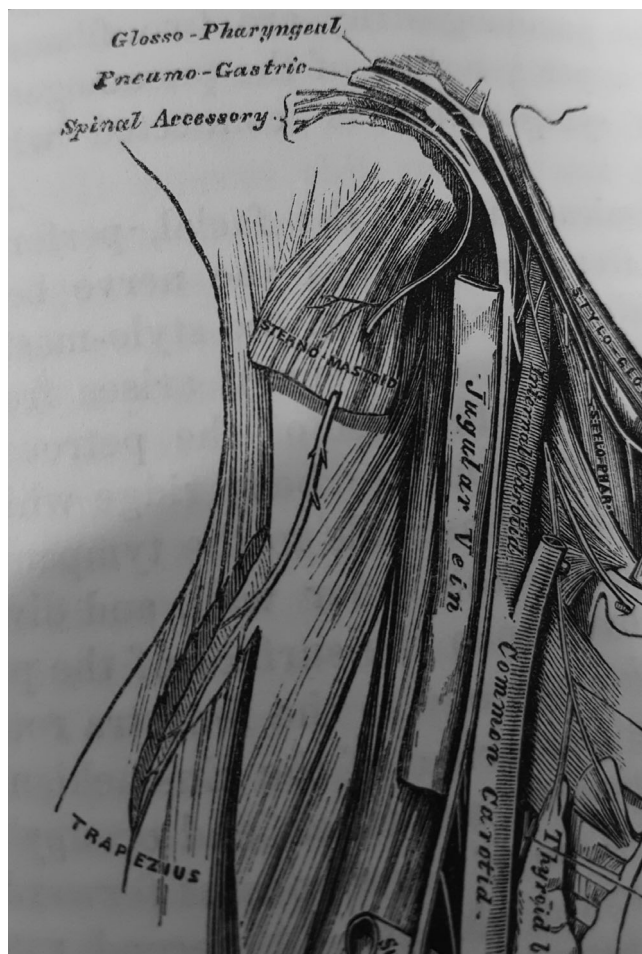


FIGURE 2 Illustration of the course and distribution of the accessory nerve, Plate 261 (Gray & Carter, 1858). Reproduced with permission from the Royal College of Surgeons of Edinburgh

such as connections with the suboccipital nerve (Bell, 1803; Swan, 1853) and cervical nerves (Bell, 1803; Monro, 1783). The nucleus of the cranial root is also discussed as a prolongation of the vagus nerve nucleus and labeled as “accessory” as it lies in the posterior spinal cord (Ranney, 1888). *Anatomy, Descriptive and Surgical* agrees with the described morphology, but the authors note that the accessory branch of the eleventh cranial nerve joins with the upper ganglion of the vagus nerve within the jugular foramen (Figure 3) (Gray & Carter, 1858).

With respect to the nomenclature of the accessory nerve, there is extensive variation. Given that Samuel Soemmerring (1755–1830) (note that Soemmerring was spelt Sommerring in the paper by Davis, Griessenauer, Bosmia, Tubbs, and Shoja [2014]) developed the modern classification of the cranial nerves in 1778 (Davis et al., 2014), it was anticipated that many of the resources would have adopted this 12-pair naming system. However, the oldest resource to use this system was from 1888 (Ranney, 1888) and the oldest to mention it was from 1826, in which the authors acknowledged that this system was not yet widely accepted (Spurzheim, 1826). All resources preceding the work by Ranney in 1888, group the accessory nerve alongside the

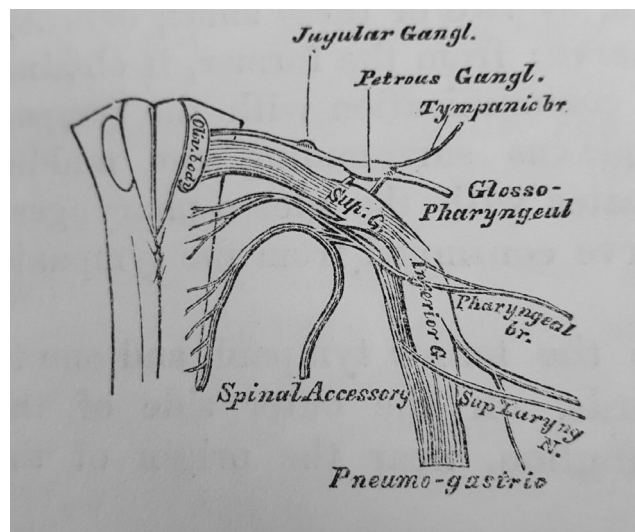


FIGURE 3 Illustration of the origin of the accessory nerve and its union with the vagus nerve, Plate 260 (Gray & Carter, 1858). Reproduced with permission from the Royal College of Surgeons of Edinburgh

glossopharyngeal and vagus nerves as the eighth pair of cranial nerves (Bell, 1803, 1836; Gray & Carter, 1858; Mayo, 1827; Monro, 1783; Spence, 1842). Despite this grouping, the accessory nerve was always identified as a distinct entity to the other two nerves. In most cases, it was identified as the spinal accessory or accessory to the vagus. Only two resources named it differently as the superior respiratory nerve (Bell, 1836) and as the spinal accessory of Willis (Bell, 1803).

The majority of the anatomical descriptions and/or depictions of the accessory nerve are in keeping with its modern accounts. There is only a small number of discrepancies in the identification of certain landmarks and in the actual naming of the nerve—the latter probably being due to the slow adoption of the naming system developed by Soemmerring in 1778.

5 | PHYSIOLOGICAL DESCRIPTIONS

The different physiological accounts of the accessory nerve are contradicting, which may be due to their basis on case studies and small-scale empirical observations. The earliest resource to describe the accessory nerve's function is by Sir Charles Bell (1803), who acknowledges its role in the innervation of shoulder muscles with the trapezius and sternocleidomastoid as examples. However, in a later work, Sir Charles Bell (1836) describes the accessory nerve as a “respiratory nerve.” The author argues that the nerve's fibers join the vagus nerve, which travels to the larynx, and the role of the trapezius and sternocleidomastoid is in “fixing the head” to permit respiration (Bell, 1836). This theory is also supported by Ranney (1888) who describes the external branch as innervating the trapezius and sternocleidomastoid and the internal branch innervating the muscles of the larynx apart from cricothyroid. Ranney (1888) proposes that

due to this innervation the accessory nerve has a role in phonation, deglutition, and cardiac regulation. This is contrasted by the experiment of John Reid (1809–1849), as explained by Spence (1842), in which the accessory nerve in a sheep was irritated with no effect on the vocal cords but movement occurring in the trapezius and sternocleidomastoid. Reid concludes that the accessory nerve gives no motor function to the larynx (Spence, 1842). Finally, de Morgan (1866) discusses a case study of a man, who dropped a ladder on his neck causing neck spasms arising from the sternocleidomastoid and trapezius. de Morgan (1866) explains that excision of the accessory nerve, proximal to sternocleidomastoid (at “the common trunk above the division into the trapezial and sterno-mastoid [sic]”), resulted in wasting of the lower part of the sternocleidomastoid, suggesting that the accessory nerve is not the sole source of innervation for this muscle. To contrast other descriptions, *Anatomy, Descriptive and Surgical* describes the accessory nerve as having mixed motor and sensory function (Gray & Carter, 1858). It states that sensory supply is received from the pharyngeal and superior laryngeal branches of the vagus nerve, and motor function is given to the laryngeal muscles, sternocleidomastoid, and trapezius (Gray & Carter, 1858).

6 | SCOPE OF RESOURCES

The first group of resources consists of the three regional anatomy books by Burns and Pattison (1824), Cunningham (1894), and Deaver (1899), which all share a common emphasis on the practical anatomical aspects of the accessory nerve. These focus on providing pertinent information relating to the gross anatomy of the accessory nerve for dissection, or surgical approaches with the target audience being students or specialists.

Burns and Pattison (1824) place a large importance on understanding how to reveal the nerve in the dissection room for the purposes of teaching. The dissections that they detail are modest, yet effectively outline the gross anatomy of the accessory nerve, including descriptions such as the following:

[it lies] between the transverse process of the atlas and the internal jugular vein...[and] lies such that it can be exposed by an incision made along the anterior margin of the SCM, just opposite the transverse process of the atlas. (Burns & Pattison, 1824)

Their approach gives an appropriate level of detail for the education of medical students without any undue difficulty in the dissection technique, while using clearly identifiable landmarks. This would have allowed students to undertake the dissection with minimal supervision. The effective use of language in the text makes even more sense when considering that Burns was a well-renowned lecturer in anatomy in Glasgow, having lectures that were “overflowingly attended” (Geyer-Kordesch & MacDonald, 1999).

Similarly, Cunningham (1894) also places an emphasis on the practical description of the accessory nerve. However, his content is

focused more on the details relevant to the clinician rather than the student of anatomy. Where Burns and Pattison (1824) make no mention of the morphology of the accessory nerve, Cunningham (1894) describes its cranial and spinal roots, and the uniting of the accessory nerve with the vagus nerve. Additional information includes the description of a few “twigs” between the accessory nerve and the ganglion of the vagus nerve. This structural description would have provided most of the details that were needed to identify it during surgery. Cunningham also describes its course in relation to surgical landmarks. He states that

[the accessory nerve] crosses the posterior triangle of the neck obliquely and disappears under the anterior border of trapezius. (Cunningham, 1894)

He also mentions, in a later passage, that the nerve crosses the carotid triangle (Cunningham, 1894). The posterior triangle of the neck and carotid triangle, as landmarks, would have been for the benefit of surgeons who would have needed a way of identifying the nerve when dissecting this region of the neck. The reputation of Cunningham as a demonstrator and practical anatomist, in addition to his prominence as Professor of Anatomy in both Dublin and Edinburgh, also helps to explain the use of visual aids in identifying the accessory nerve—he would have used such landmarks himself to prepare anatomical specimens and educate others (Kaufman, 2008).

In the most recent of the practical anatomy books, John Blair Deaver's (1855–1931) intent to aid the education of anatomists and surgeons is evident in his foreword:

To surgeons and students of surgery and anatomy, whose labors [sic] it is intended to lighten in a field where labor alone is the price of attainment, this work is respectfully dedicated by their friend and fellow student. (Corman & Deaver, 1987)

From this, it is also apparent that Deaver viewed himself (or wished to be viewed) as a peer to surgeons and their students. The intent to educate surgeons is equally reflected in the text, with specialist details provided about the structures enveloping the accessory nerve. Specifically, the nerve is described as leaving the skull via the middle compartment of the jugular foramen, and that it is found in the same sheath of the dura mater as the vagus nerve, but a separate sheath of the arachnoid separates them (Deaver, 1899). Such information would have been relevant to surgeons separating the two nerves or precisely localizing the accessory nerve and separating it from other structures. Deaver was known as an aggressive and radical surgeon, a great “slasher,” (Corman & Deaver, 1987); his own professional background influenced his descriptions of the accessory nerve.

Gray and Carter (1858) provide similar surgically useful details, with little emphasis upon dissection. They describe the “accessory part” in sufficient detail that its path could be traced by a surgeon; from its origin—the “lateral tract” of the spinal cord, inferior to the fibers of the vagus nerve—to its union with the vagus nerve within

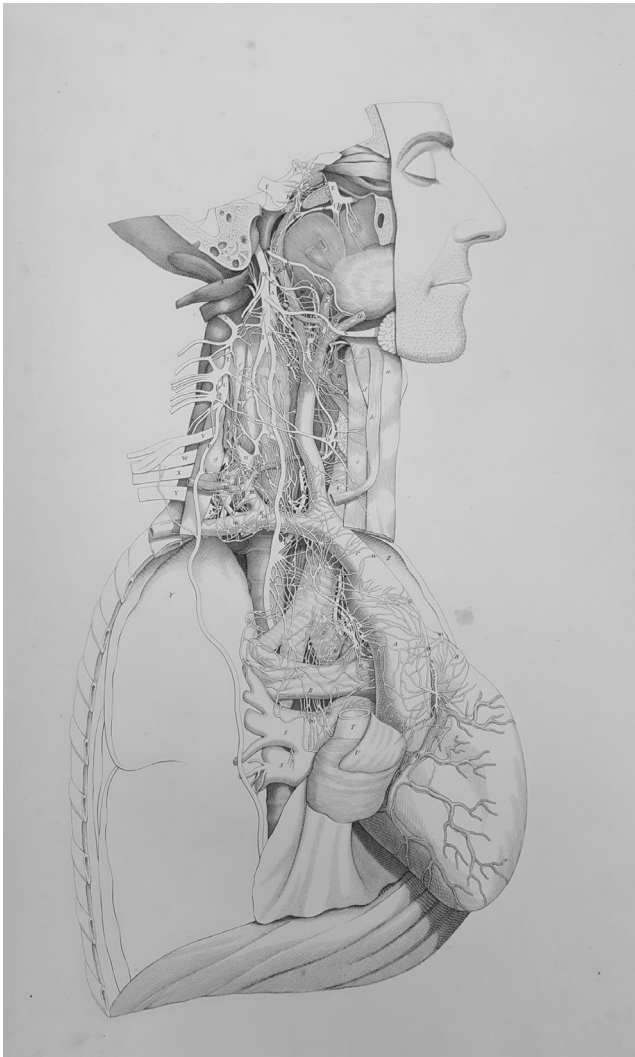


FIGURE 4 Sagittal view of the head and thorax, Plate I (Swan, 1830). The letter M indicates the accessory nerve. Reproduced with permission from the Royal College of Physicians and Surgeons of Glasgow

the jugular foramen (Gray & Carter, 1858). The “spinal part” is described in similar detail, with emphasis upon its course once it has exited the jugular foramen. Details of the relations of the spinal root with the internal jugular vein, digastric, and stylohyoid are given, as well as the branches of the spinal root in the posterior triangle of the neck (Figure 2) (Gray & Carter, 1858). Familiarity with these structures would be important in surgery on the accessory nerve, or posterior triangle of the neck. The intent to provide surgically relevant details is made evident in the foreword by Gray and Carter, who state that they wish to “educate the student and practitioner...with a focus on practical application to surgery” (Gray & Carter, 1858). The goal of making the text comprehensible is made evident by the clear and concise descriptions given in the text.

The second group of resources consists of the field-specific anatomy books/journal articles by Monro (1783), Bell (1803), Spurzheim (1826), Mayo (1827), Spurzheim (1830), Swan (1830),

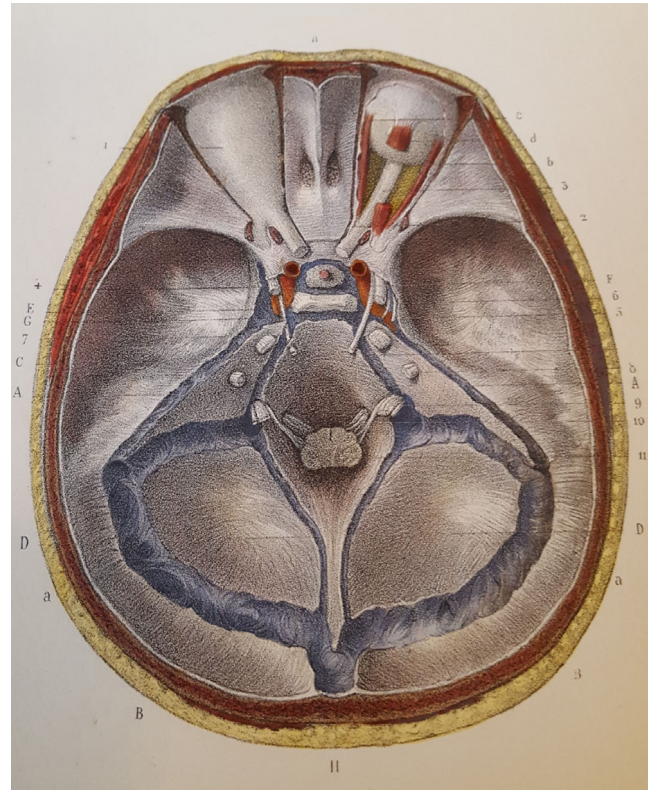


FIGURE 5 Transverse view of the head, Plate 5, Figure 3 (Hirschfield & Léveillé, 1890). Number 9 indicates the glossopharyngeal nerve, vagus nerve and accessory nerves. Reproduced with permission from the Royal College of Surgeons of Edinburgh [Color figure can be viewed at wileyonlinelibrary.com]

Monro (1831), Walker (1834), Bell (1836), Quain and Erasmus (1839), Spence (1842), Swan (1853), de Morgan (1866), Ranney (1888), Hirschfield and Léveillé (1890), and MacEwen (1893). Their purpose was to give in-depth descriptions of the accessory nerve for those interested in the nervous system. As such, they provide complex dissection descriptions and elaborate preparation methods when compared to the practical anatomy books. This approach gives greater insight into the nerve's anatomy which, due to its target audience, does not cause undue challenges in terms of understanding the content. An example of the specialist detail is noted in the localization of the spinal rootlets. The practical books state that a portion of the spinal accessory arises from the cervical spinal cord. In the field-specific books, there are more descriptions of the rootlets arising from “behind the dentate ligaments and...posterior bundles of some of the spinal nerves” (Monro, 1783) or that the roots are “located dorsally and are asymmetrical” (Spurzheim, 1826). The increased intricacy of observations is also evident in the description of the accessory nerve nuclei. The main nucleus is described as a prolongation of the vagus nerve nucleus, and accessory nuclei of the accessory nerve were noted posterior to this main nucleus (Ranney, 1888). Such details would have been pertinent to specialist anatomists or

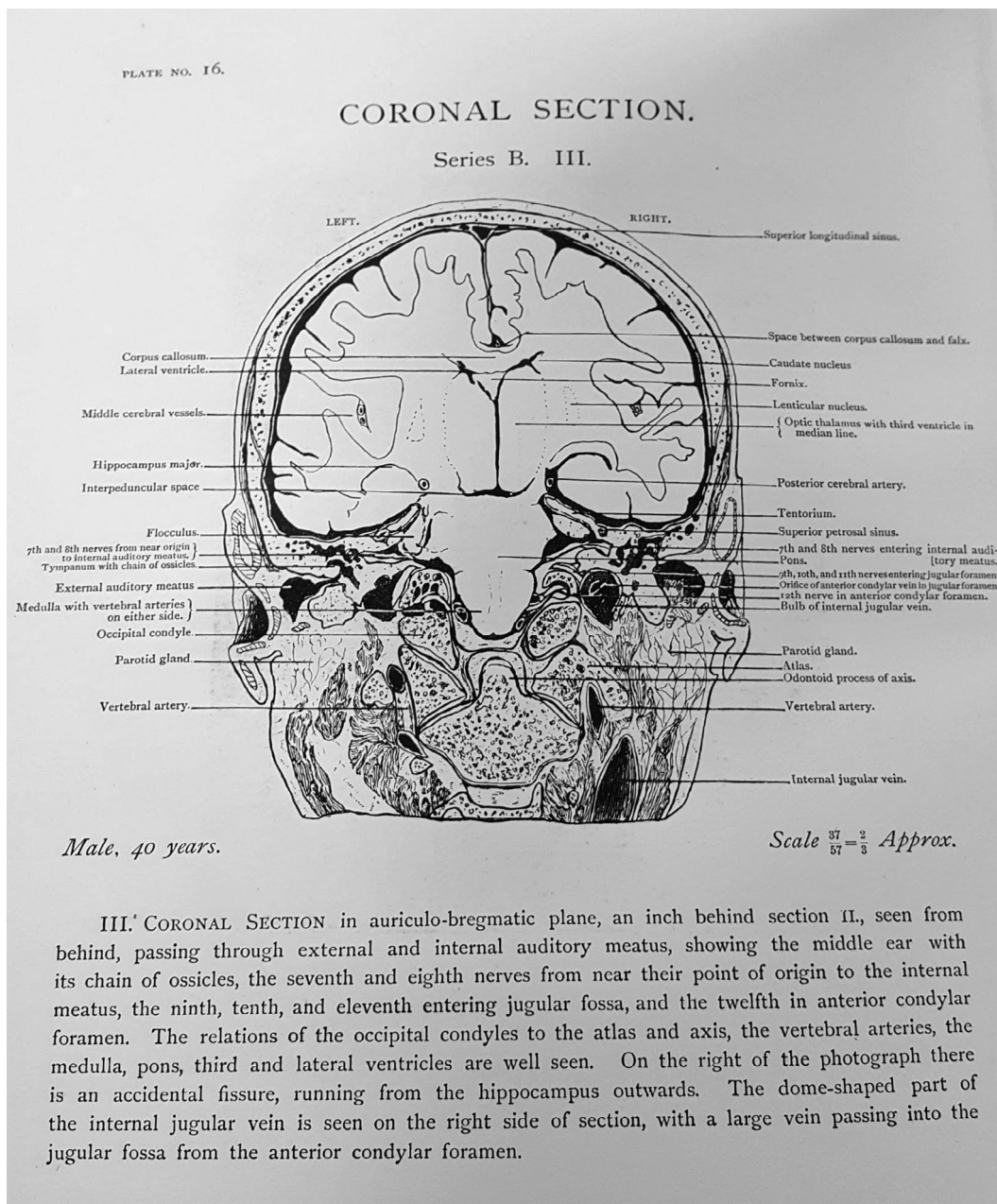


FIGURE 6 Coronal section of the head, Plate 16 (Macewen, 1893). The 9th, 10th, and 11th cranial nerves are collectively labeled as they enter the jugular foramen. Reproduced with permission from the Royal College of Physicians and Surgeons of Glasgow

neurologists, but not to academics or clinicians seeking a general understanding of the accessory nerve.

The neuroanatomy books, within the field-specific resources, also differ from the practical anatomy books in their depiction of the accessory nerve. The atlases by Swan (1830), Hirschfield and Léveillé (1890), and Macewen (1893) as shown in Figures 4–6, respectively, have highly detailed depictions of the accessory nerve on their illustrative plates with accompanying labels of the nerve and its surrounding structures. The most recent of these was written by Sir William Macewen (1848–1924), who was a renowned innovator in surgery and credited as the founder of neurosurgery (James, 1974). The

author's surgical background is reflected in his preparations and labeling of the accessory nerve with the cross-sections closely resembling modern imaging scans. These head sections, which are drawn at ½-inch intervals, would have been useful in gaining an understanding of the three-dimensional anatomy of the whole head and the complex anatomical relations found within it. Macewen (1893) describes the accessory nerve in relation to the jugular bulb and the inferior petrosal sinus, which are clinically relevant structures for surgeons in terms of avoiding excessive hemorrhage when operating in that area. The reputation of Sir William Macewen as a great surgeon was also accompanied by a reputation as a patient and fastidious teacher (James, 1974). This is evident in his

text and plates that contain a great level of detail coupled with clinical content which would have been useful in the education of surgeons.

Anatomy, Descriptive and Surgical (Gray & Carter, 1858), was intended to be used as a practical anatomy book. However, it does contain a high level of detail in the anatomical structures that it describes; it mentions the suboccipital triangle, relations to specific suprahyoid muscles and details branches with the cervical plexus in the neck that are not present in many of the practical anatomy books. All of these descriptions would have been very understandable by any audience and require much less specialist knowledge to understand than the field-specific anatomical texts.

7 | CONCLUSIONS

The intended use, and target audience, influenced the scope and detail of information contained within different resources; typically, with general, gross anatomy knowledge for the students in the practical books, and highly specialist, detailed information in the field-specific resources, including the neuroanatomy atlases. The authors' professional background also played a role in the way the accessory nerve was described and/or depicted, with surgeons/physicians placing greater emphasis on the clinically pertinent aspects. The limitations in communication, in comparison to the present, and the associated purchasing costs would have made it difficult to readily disseminate new advances in knowledge. This most likely led to a slower uptake of new information by the scientific community. For example, the first mention of the eleventh cranial nerve—the current naming of the accessory nerve—is by Ranney in 1888, which is 110 years after the conception of the 12-pair naming system by Soemmerring (Davis et al., 2014). The above factors contributed to content variations and perhaps fueled the debate regarding the structure and function of the accessory nerve, which is still on-going to the present day. But, what has this historical review taught us? Although scientific advances are disseminated at a much faster pace nowadays, actively bridging the gap between pure anatomical sciences and clinical research is still needed when considering the accessory nerve, as such collaborations will undoubtedly be invaluable in further elucidating the mysteries of this structure and minimizing disparities relating to the nerve's descriptions.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Henry Marles: Structured searches of online catalogues; data collection; data analysis; formal object interpretation; contextual object interpretation; thematic analysis; manuscript write up; manuscript review. Fraser Chisholm: Contextual object interpretation; thematic analysis; manuscript review. Ourania Varsou: Study conception; study design; data analysis; formal object interpretation; contextual object interpretation; thematic analysis; manuscript write up; manuscript review.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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