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CASE REPORT

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Connection between V2 and V3 parts of the trigeminal nerve at the internal cranial base

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Anatomical variations can occasionally result in unexpected findings on physical examination. Here, we report two cases of seemingly unique connections between V2 and V3 parts of the trigeminal nerve. In these two cadaveric specimens, at the foramen ovale, small neural connections, confirmed with histology, were identified joining V2 to specifically, the motor root of V3. The findings of these two cadaveric specimens and the potential clinical ramifications are discussed. (Folia Morphol 2023; 82, 2: 382–385)

Key words: skull base, anatomy, surgery, trigeminal nerve, interconnections, complications

INTRODUCTION

The fifth cranial nerve, also referred to as the trigeminal nerve (TGN), is the largest cranial nerve. It is a mixed nerve that provides motor input to the muscles of mastication and carries sensory input from the face, the oral and nasal cavities, and a large portion of the scalp [7]. Its peripheral portion is divided into three divisions: ophthalmic (V1), maxillary (V2), and mandibular (V3) [1]. V1 travels anteriorly through the cavernous sinus before exiting the skull through the superior orbital fissure and conveys sensory fibres from various anatomical locations including the orbit, paranasal sinuses, and upper face [7]. V2 travels alongside V1 through the cavernous sinus, exits the skull through the foramen rotundum, and enters the pterygopalatine fossa. This branch transmits sensory information from primarily the middle third of the face and the upper teeth [7]. V1 and V2 join V3 posteriorly in Meckel's cave after traveling through the cavernous sinus [1]. V3 carries both sensory and motor fibres. Its sensory branches coalesce just below the skull base. These merged sensory branches, the largest division of the TGN, are now considered the V3 trunk, which enters Meckel's cave via the foramen ovale [1]. V1, V2, and the sensory portion of V3 merge to form the trigeminal or Gasserian ganglion within Meckel's cave. V3 brings sensory input from the lower face and the anterior two thirds of the tongue, jaw,

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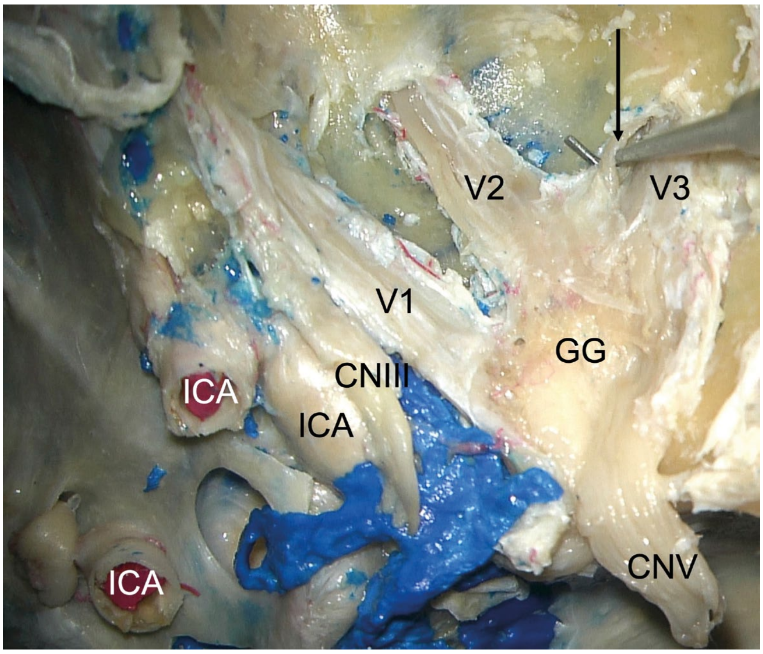

Figure 1. Right-sided cadaveric dissection noting the connecting nerve (under the hook and at the arrow) between V2 and V3. Also, note V1, the oculomotor nerve (CNIII), internal carotid arteries (ICA), Gasserian ganglion (GG), and trigeminal nerve (CNV).

and lower teeth. The motor portion of V3 originates from the motor nucleus in the floor of the fourth ventricle. It travels medially to meet the sensory portion of V3 and enters Meckel's cave, where its fibres bypass the trigeminal ganglion [1]. The motor and sensory portions of V3 coalesce at the internal cranial base. In addition to its sensory innervation, V3 supplies motor innervation to the mylohyoid muscle, muscles of mastication, the anterior belly of the digastric muscle, the tensor tympani muscle, and the tensor veli palatini muscle [4].

Adjacent peripheral nerves, including cranial nerves, are known to often and sometimes normally have intercommunicating branches. Although the exact role of such communicating branches is often unknown, some (e.g., Martin-Gruber connections in the forearm) have found that these connections can serve a functional role [2]. Cranial nerves, especially the lower cranial nerves, have known intercommunicating branches that occur both intra- and extracranially [6]. Therefore, knowledge of such interconnections is important to the clinician who finds unusual findings on physical examination of their patients and to surgeons who encounter these fibres at surgery. Here, we report the unusual finding of cadaveric specimens found to have connections between V2 and V3 prior to the two nerves exiting the internal cranial base. This anatomy and related literature are reviewed.

CASE REPORT

During the routine dissection of the skull bases in a 78-year-old male cadaver and a 67-year-old at death male cadaver, a connection was identified between the V2 and V3 parts of the right TGN. A surgical microscope (Zeiss, Germany) was used to perform the dissections. Both connections between V2 and V3 were identified on right sides. In the first specimen (Fig. 1), the connection was 11 mm long and 1.59 mm wide. The fibres connected V2 at is origin from the Gasserian ganglion to the motor root of V3 just inferior to the foramen ovale. In the second specimen, a similar band that was 5.4 mm long by 1.7 mm wide joined V2 to V3, and again, specifically to its motor root, just at the foramen ovale (Fig. 2). Both connections were submitted for histological analysis (H&E, Masson trichrome, Nissl) and reviewed using a microscope. Both histological samples revealed normal nerve tissue, and due to the size of the nerve fibres, these were consistent with sensory nerve fibres (Fig. 3). No additional gross anatomical variations were noted on ipsilateral or contralateral sides of the two specimens.

DISCUSSION

Fibres of the TGN have been shown to mix at the brainstem level. Two separate groups of rootlets contribute to its motor portion. One of these groups

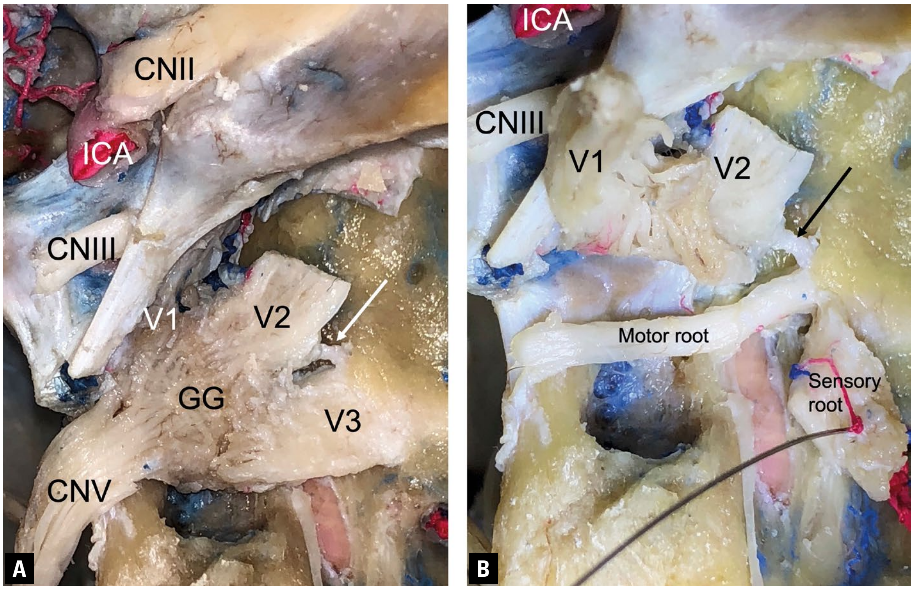

Figure 2. Right-sided cadaveric dissection noting the connecting nerve (arrow) between V2 and V3; **A.** In normal position, note the optic nerve (CNII), oculomotor nerve (CNIII), V1, internal carotid artery (ICA), Gasserian ganglion (GG), and trigeminal nerve (CNV); **B.** Following reflection of the Gasserian ganglion and showing the motor and sensory roots of V3 and the nerve connection (arrow) between V2 and the motor root of V3.

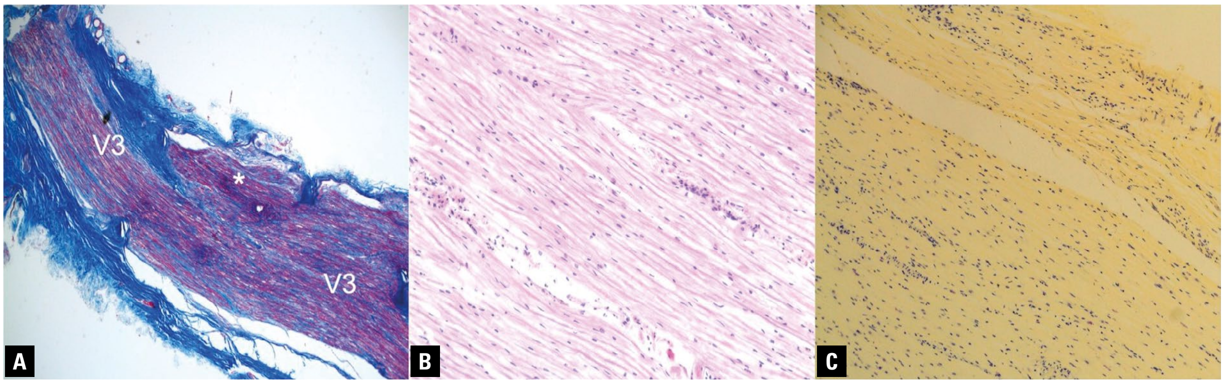

Figure 3. Histological sections of the nerve connections between V2 and V3. The left image (**A**, Massson trichrome 40×) shows the connecting nerve (*) joining V3. The blue stained connective tissue sheaths of the nerves are visible. The middle (**B**, H&E 200×) and right images (**C**, Nissl 200×) verify the nerve quality of the connecting branch.

is superior and the other inferior to the main sensory root [6]. The superior group is considered the origin of the motor root, as it is consistently located in an isolated position superior to the main sensory root. The origin of the inferior rootlets usually contacts the inferior anterior aspect of the main sensory root. The cadaveric study of Saunders and Sachs [5] also revealed several anastomoses between the inferior rootlets and the main sensory root. The superior and inferior rootlets followed the expected course of the motor root of the TGN. They merged within 1 cm of the pons before continuing through Meckel's cave and exiting through the foramen ovale. It was hypothesized that these so-called inferior rootlets are accessory rootlets carrying sensory fibres to the motor root.

Such anatomical findings such as those of Saunders and Sachs [5] suggest some mixing of sensory and motor fibres within the motor tract of the TGN. The two case reports presented herein further strengthen the mixing of fibres and in these cases, at the skull base and not near the brainstem. This becomes clinically significant in view of reports of people who maintain facial sensation after complete sensory root dissection at the pons, which spares the small motor rootlets [5]. A different study showed that 12–20% of the fibres in the motor root of TGN are unmyelinated [8]. It is likely that these unmyelinated fibres are afferent and that they originate in sensory ganglion cells in the Gasserian ganglion. The sensory and motor root fibres are likely to merge at these accessory trigeminal fibres [8]. Again, this notion is supported by persistent trigeminal neuralgia after a complete trigeminal rhizotomy. These unique findings associated with the nerve pathways and the clinical scenarios strongly suggest that there are afferent fibres among the TGN motor root.

We previously published a comprehensive review regarding the intercommunications between the cranial nerves with one of these focused on such neural connections between the trigeminal, facial and vestibulocochlear nerves [6]. In this review, all previously reported neural interconnections of the TGN were reported peripherally and primarily between it and adjacent facial nerve branches. Intracranial connections between two parts of the TGN and specifically, its divisions, has, to our knowledge, not been previously reported. Future anatomical and clinical studies will be necessary to further elucidate such connections and their functions.

CONCLUSIONS

We report two cases illustrating gross anatomical connections between V2 and V3 at the skull base, specifically between V2 and the motor root of V3. Such connections should be appreciated during physical examination of patients with unexpected findings and during surgical approaches to the middle cranial fossa near the foramen ovale.

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Conflict of interest: None declared

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