Clinical Anatomy 27:94–96 (2014)

ORIGINAL COMMUNICATION

Neural Interconnections Between Portio Minor and Portio Major at the Porus Trigeminus: Application to Failed Surgical Treatment of Trigeminal Neuralgia

R. SHANE TUBBS,[1,3] CHRISTOPH J. GRIESSENAUER,[3] ELIZABETH HOGAN,[1] MARIOS LOUKAS,[2] AND AARON A. COHEN-GADOL[4]*

[1]*Department of Pediatric Neurosurgery, Children's Hospital of Alabama, Birmingham, Alabama*
[2]*Department of Anatomical Sciences, St. George's University, St. George's, Grenada*
[3]*Section of Neurosurgery, University of Alabama, Birmingham, Alabama*
[4]*Department of Neurological Surgery, Goodman Campbell Brain and Spine, Indiana University School of Medicine, Indianapolis, Indiana*

Recalcitrant trigeminal neuralgia following surgical treatment can be a life-altering condition. To explore alternative anatomic reasons for such a complication, the authors examined the potential for nerve connections between the sensory and motor roots of the trigeminal nerve at the opening of Meckel's cave (porus trigeminus). In 15 embalmed adult cadavers (30 sides), the authors performed microdissection of the skull base and specifically at the opening of Meckel's cave. Two sides (6.67%) were found to have interneural connections between the sensory and motor roots at Meckel's cave. These occurred in one male and one female cadaver, both on right sides. Both connections were histologically verified to be neural and were 0.5 mm in diameter and 2.2 and 3.2 mm in length, respectively. Both connections traveled in an oblique fashion from the portio major to the portio minor. On the basis of authors' findings, the sensory and motor components of the trigeminal nerve at the opening of Meckel's cave may be interconnected with a neural anastomosis. Such findings may be of use during the surgical treatment of trigeminal neuralgia or other surgery of the posterior fossa so that inadvertent transection or traction does not occur. Clin. Anat. 27:94–96, 2014.

Key words: anatomy; trigeminal neuralgia; neurosurgical procedures; neural pathways

INTRODUCTION

The neural anastomotic network between the lower cranial and upper cervical nerves shows individual variability. Knowledge of the anatomy of these neural connections is particularly important during neck surgery, including various nerve transfer procedures, skull base surgery, and for understanding the pathophysiology of various skull base and neck disorders. Moreover, clinical presentations and exams following nerve injury may have unanticipated findings based on such neural interconnections.

During the formation of the skull, no rigid separation of the fibers of the nerves of the posterior cranial fossa exist (Downman, 1939). Therefore, it is not

*Correspondence to: Aaron A. Cohen-Gadol; Department of Neurological Surgery, Goodman Campbell Brain and Spine, Indiana University School of Medicine, 355 W. 16th Street, Suite 5100, Indianapolis, IN 46202. E-mail: acohenmd@gmail.com

Received 12 March 2013; Revised 7 June 2013; Accepted 21 June 2013

Published online 13 August 2013 in Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/ca.22299

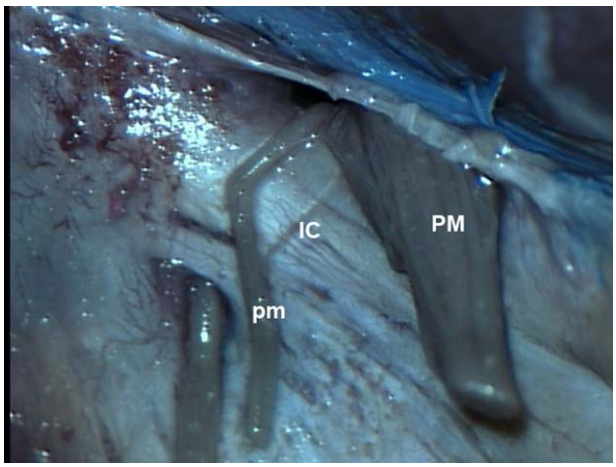

Fig. 1. Right-sided porus trigeminus noting an interneural connection (IC) between the portio minor (pm) and portio major (PM). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

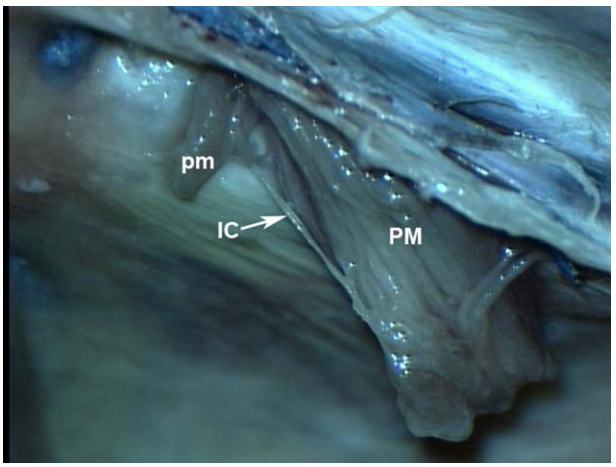

Fig. 2. Right-sided porus trigeminus showing an interneural connection (IC) between the portio minor (pm) and portio major (PM). [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

surprising that these nerves may communicate with each other in the adult. For example, we have previously reported such connections between the glossopharyngeal and vagus nerves in the posterior fossa at surgery and in cadaveric specimens (Tubbs et al., 2011).

To our knowledge, studies aimed at identifying such interneural connections between the sensory and motor parts of the trigeminal nerve have not been performed. Therefore, we performed this study to further elucidate this anatomy. We selected to focus on the trigeminal nerve at the opening of Meckel's cave; which is a recess formed by the evagination of the meningeal layer of the dura of the posterior cranial fossa into the posteromedial portion of the middle cranial fossa (Mafee et al., 2012).

MATERIALS AND METHODS

In 15 embalmed adult cadavers (30 sides), microdissection was performed on the skull base and specifically at the opening of Meckel's cave (porus trigeminus). After removal of the supratentorial brain, the tentorium cerebelli was removed and the trigeminal nerve severed at its emergence from the pons. Microdissection of the trigeminal nerve was then carried out with aid of a surgical microscope (Zeiss, Germany). Measurements were made with microcalipers (Mituoyo, Japan). Small specimens were then examined under a microscope for histological features.

RESULTS

Two sides (6.67%) were found to have interneural connections between the sensory (portio major) and motor (portio minor) roots at Meckel's cave (Figs. 1 and 2). These occurred in one male and one female cadaver, both on the right sides. Both connections were histologically verified to be neural and were 0.5 mm in diameter and 2.2 and 3.2 mm in length, respectively. Both connections traveled in an oblique fashion from the portio major to the portio minor. On the right side of the male cadaver (Fig. 1), the neural interconnection traveled from the portio major proximally to the portio minor distally. On the right side of the female cadaver (Fig. 2), the neural interconnection traveled from the portio minor proximally to the portio major distally. The routes for these interconnections are illustrated in Figure 3.

No specimen was found to have gross intracranial pathology.

DISCUSSION

Wrisberg in the 1700s was the first to mention the interneural connections between the portio minor and major components of the trigeminal nerve at Meckel's cave. Since then, the interneural connections have not been expounded on and are widely unknown (Tubbs et al., 2012). To our knowledge, no study has examined such connections. We found such connections on two right sides (6.67%) in two adult cadavers. Both connections were oriented obliquely and were small. Due to their size, these neural connections could be missed during partial neurectomy of portio major for trigeminal neuralgia. Of interest and potentially germane to this study, Dandy (Dandy, 1929) reported that even after complete transection of the portio major near the pons, facial sensation could still be perceived in some patients. Such preservation of facial sensation might be attributed to neural connections between the portio minor and major at Meckel's cave. Additionally, other studies have demonstrated the presence of a substantial number of unmyelinated fibers in the portio minor that have been theorized to play a role in persistence of

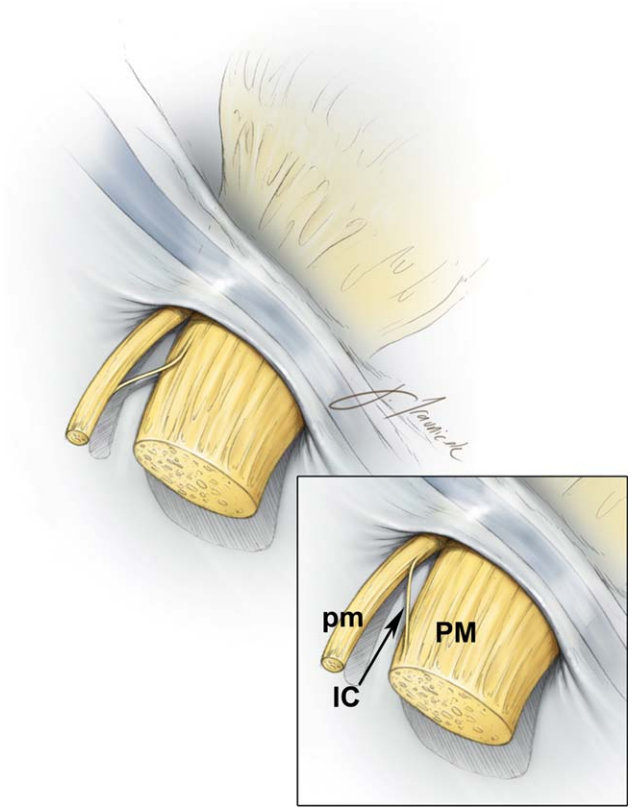

Fig. 3. The routes for the discussed interconnections are illustrated. Portio minor: pm; portio major: PM; and interneural connection: IC. © The Neurosurgical Atlas, Aaron A. Cohen-Gadol, MD, MSc. [Color figure can be viewed in the online issue, which is available at wileyonlinelibrary.com.]

pathological facial pain after a trigeminal sensory rhizotomy (Young, 1978; Young and Kruger, 1981).

Although the trigeminal nerve is known to have connections between other nerves in the periphery, connections between adjacent intracranial cranial nerves have not been reported. Such peripheral connections include those with the facial nerve on the face (e.g., buccal branches of the trigeminal nerve to buccal branches of the facial nerve) and with branches of the cervical plexus (Namking et al., 1994; Diamond et al., 2011; Shoja et al., 2013). In fact, such peripheral connections between the trigeminal and facial nerves have been proposed as continued facial sensation when the trigeminal nerve has been sectioned intracranially (Diamond et al., 2011).

CONCLUSIONS

Intracranial neural interconnections between portio minor and portio major should be considered as a potential reason for failure to provide pain relief after partial portio major neurectomy. Furthermore, microvascular decompression of the portio minor should be considered during trigeminal nerve decompressive procedures. Additionally, future studies should be conducted on a larger scale to ascertain what percentage of the population has these interconnections. Once the percentage and precise anatomy of these connections are obtained, surgical intervention can be modified to look for these interconnections and possibly decrease the failure rate of trigeminal sensory rhizotomy.

REFERENCES

Dandy WE. 1929. An operation for the cure of tic douloureux: Partial section of the sensory root at the pons. Arch Surg 18:687–690.

Diamond M, Wartmann CT, Tubbs RS, Shoja MM, Cohen-Gadol AA, Loukas M. 2011. Peripheral facial nerve communications and their clinical implications. Clin Anat 24:10–18.

Downman CBB. 1939. Afferent fibers of the hypoglossal nerve. J Anat 73:387–395.

Mafee MF, Valvassori GE, Becker M. 2012. Valvassori's Imaging of the Head and Neck. New York: Theime.

Namking M, Boonruangsri P, Woraputtaporn W, Guldner FH. 1994. Communication between the facial and auriculotemporal nerves. J Anat 185 (Pt 2):421–426.

Shoja MM, Radcliff V, Benninger B, Loukas M, Miller JH, Rozzelle CJ, Tubbs RS. 2013. Anastomoses between lower cranial and upper cervical nerves: A comprehensive review with potential significance during skull base and neck operations. Clin Anat, in press.

Tubbs RS, Mortazavi MM, Loukas M, Shoja MM, Cohen-Gadol AA. 2011. Intraoperative and anatomical descriptions of intracranial connections between the glossopharyngeal and vagus nerves: Clinical implications. J Neurosurg 115:179–181.

Tubbs RS, Padmalayam D, Shoja MM, Loukas M. 2012. Heinrich August Wrisberg (1736–1808): Physician and anatomist. Clin Anat 2012 Mar 19. doi: 10.1002/ca.22067. [Epub ahead of print]

Young R. 1978. Unmyelinated fibers in the trigeminal motor root. J Neurosrug 49:538–543.

Young R, Kruger L. 1981. Axonal transport studies of the trigeminal nerve roots of the cat. J Neurosurg 54:208–212.