

Case Reports & Case Series (CRP)

A reminder about the trigeminocardiac reflex in surgeries at the posterior third of the falx cerebri



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ABSTRACT

The trigeminocardiac reflex (TCR) is defined as a reproducible hypotension and bradycardia coinciding with the manipulation around the trigeminal nerve. Here, we report a case of sudden bradycardia with falcine manipulation. As the falx cerebri is innervated by the nervus tentorii, which is a recurrent branch of the ophthalmic nerve, the observed asystole is highly possible to be caused by TCR. Anesthesiologists and neurosurgeons should be fully aware of the anatomical innervation of the falx cerebri and that the posterior third of the falx cerebri is one of the highest risk structures for TCR induction for safe operation around this region.

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Introduction

Trigeminocardiac reflex (TCR) is defined as sudden onset of parasympathetic dysrhythmia, sympathetic hypotension, apnea, or gastric hyper-motility during stimulation of the sensory branches of the trigeminal nerve. Brown and Preul were the first to report a trigeminal depressor response in human beings, and Schaller summarized these reflexes under the term TCR [1,2]. Many cases of possible TCR have since been reported during intracranial or extracranial procedures and it has been demonstrated that TCR can be triggered by mechanical stimulation of both central and peripheral branches of the trigeminal nerve. Although cerebello-pontine angle, petrosal sinus and orbital contents are known to be high-risk structures for TCR, there is only one report that illustrates falx cerebri as possible anatomical structure for TCR induction, a possible bradycardia induced during meningioma removal at the junction of the falx and tentorium [3]. Here we present a case of possible TCR which was triggered during falx cerebri resection in the course of brain tumor removal and discuss the anatomical background of falx cerebri induced TCR and necessary precautions that should be taken for avoiding fatal complications.

Case report

A 38-year-old Japanese man with a history of lung cancer underwent surgical removal of a metastatic lesion located at the

right parietal lobe. The tumor showed direct contact with falx cerebri near the straight sinus extending to the contralateral hemisphere (Fig. 1A). General anesthesia was induced with a combination of intravenous (i.v.) propofol (2 mg/kg) and rocuronium (0.6 mg/kg). Anesthesia was maintained with 1% sevoflurane, remifentanyl (0.2 $\mu\text{g}^{-1} \text{kg}^{-1} \text{min}$), and intermittent i.v. Injection of rocuronium. Transcortical approach was used with the patient placed in the left lateral position and the tumor was removed with use of a neuronavigation system (iNtellect Cranial Navigation System, Stryker, Kalamazoo, Michigan) loaded with contrast-enhanced T1-weighted 3T MRI. During detachment of the tumor from falx cerebri, the patient went into cardiac asystole, which spontaneously resolved upon cessation of falcine manipulation (Fig. 1B,C). Repeated asystole was observed during falx cerebri resection (Fig. 1B). Gross total removal of the mass was achieved with no neurological deficit after operation. The removed tumor turned out to be a lung cancer compatible with adenocarcinoma.

Discussion

A TCR-like reflexive response of bradycardia, hypotension, and gastric hypermotility triggered by mechanical stimulation of the trigeminal nerve territories was first observed during neurostimulation experiments on rabbits and the first documentation of a trigeminal depressor response in human beings was reported by Brown and Preul in 1988 [1]. According to this report, balloon compression of the mandibular nerve or the trigeminal

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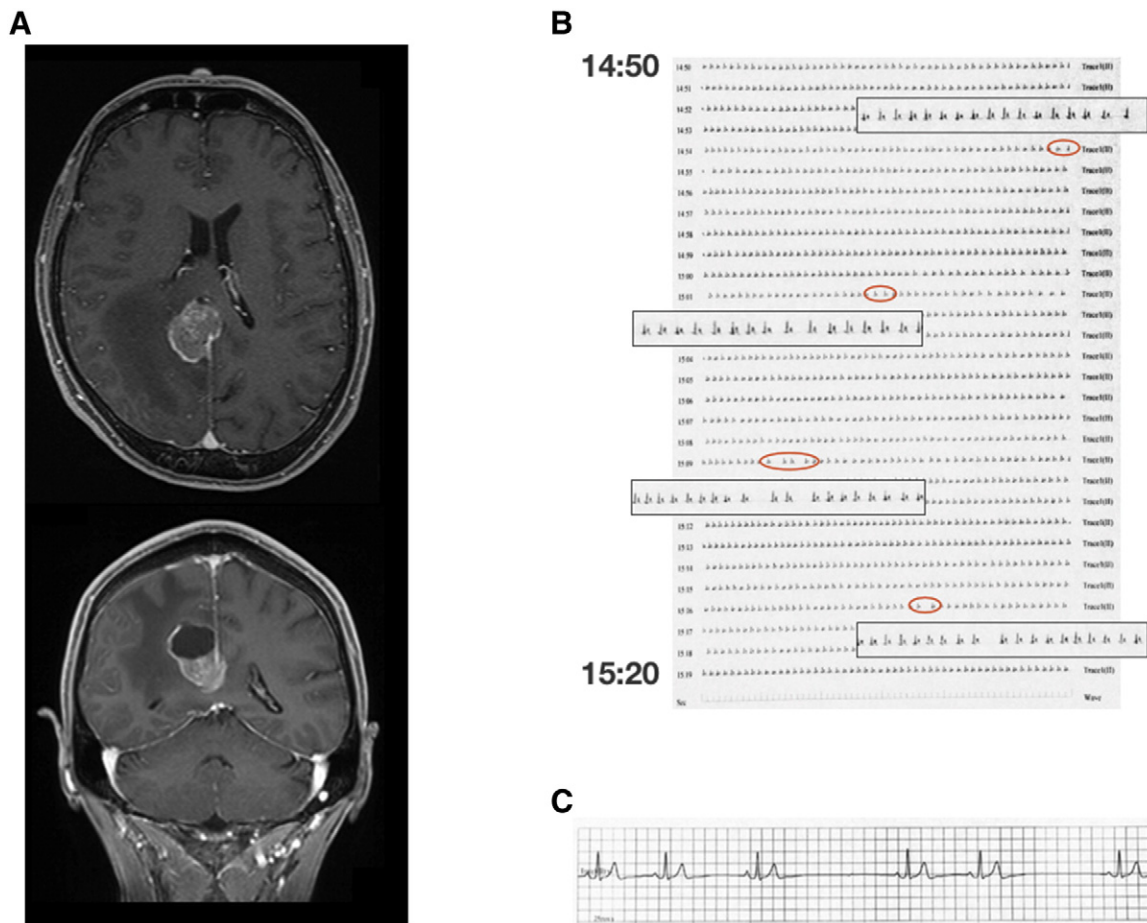


Fig. 1. A. Preoperative magnetic resonance imaging showing location of the metastatic tumor. The tumor was located at the right parietal lobe showing direct contact with falx cerebri near the straight sinus. B. Intraoperative electrocardiogram showing reproducible asystole coinciding with manipulation of the posterior third of the falx. C. Intraoperative electrocardiogram showing max RR interval of 2.6 seconds while falx cerebri resection.

nerve induced hypotension and bradycardia during trigeminal neuralgia treatment. An observational prospective study for revealing the incidence of TCR in neurosurgical procedures was conducted later on and the term TCR was defined as all episodes of bradycardia and hypotension during surgery (sudden decrease of more than 20% from baseline) coinciding with simultaneous surgical manipulation in the territory of trigeminal nerve endings.

On the other hand, falcine innervation was described by Penfield and McNaughton in 1940 [4] concluding that many parts of the falx is innervated by branches of the trigeminal nerve. The superior sagittal sinus is supplied anteriorly by the branches of the anterior ethmoid nerve, a branch of the first division of the trigeminal nerve and fine nerves arising from the second and third divisions of the trigeminal nerve reach the sinus particularly in its middle third. The posterior third of the sinus shows nerve fibers in great numbers derived from the nervus tentorii (Fig. 2), a recurrent branch of the ophthalmic branch of the trigeminal nerve. The nervus tentorii can sometimes be followed as far as the midpoint of the falx, but it is impossible to identify any nerves in the falx beyond this point in gross dissection. Pain sensitivity of intracranial structures was also investigated and the falx was found to be most sensitive in its posterior third [4].

In our case, severe bradycardia was reproducibly observed coinciding with manipulation of the posterior third of the falx similar to a previously reported one case [3]. As the patient's vital signs returned to baseline immediately after cessation of manipulation, it was highly possible that bradycardia was TCR. In fact,

postoperative MRI revealed that the location suspected responsible for TCR induction was indeed located at the posterior third of the falx cerebri (Fig. 2). As mentioned above, this part of the falx is innervated by bilateral nervus tentorii, which is reasonable enough to induce TCR. Taking all into account, posterior third of the falx cerebri may be a high-risk structure for TCR induction.

Treatment of TCR consists of ceasing manipulation of the tissue with correction of light anesthesia, hypoxia, hypercardia, and acidosis. It should be strongly reminded that use of fentanyl to block pain receptors does not prohibit TCR. If dysrhythmia continues, anticholinergic drugs such as atropine or glycopyrrolate should be administered. It cannot be stressed enough, however, that there are some reports of death due to TCR [5]. If anticholinergic drugs fail to cease arrhythmia, cardiac life support such as external heart pacing could be necessary. In the present case, easier surgical access to the lesion was given priority to and the patient was placed on lateral position. As lateral or prone positions could be problematic when external heart pacing is necessary, supine or semi-sitting position could be safer when approaching the posterior third of the falx. The knowledge that the posterior third of the falx is one of the highest risk structures for TCR induction should be shared among neurosurgeons and neuroanesthesiologists when performing neurosurgical procedures involving this anatomical structure. Care should be taken from patient position to anesthesiologic preparation for critical events during surgery.

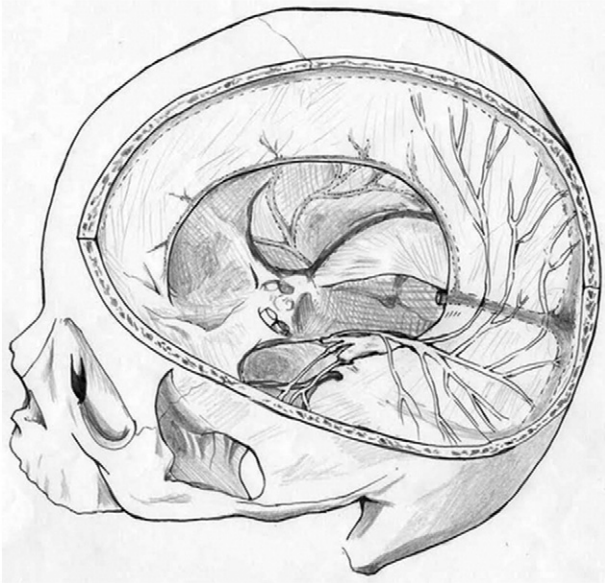
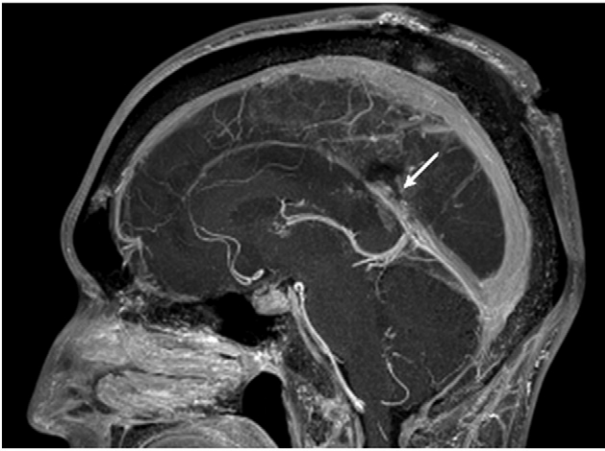


Fig. 2. (Upper image) Postoperative magnetic resonance imaging. Arrow shows the point suspected to be responsible for TCR induction. (Lower image) Atlas for the innervation of the falx cerebri, modified from Penfield and McNaughton's report [4]. The nervous tentorii or tentorial nerve is a meningeal branch arising in a recurrent fashion from the intracranial portion of the ophthalmic nerve supplying the tentorium cerebelli and supratentorial falx cerebri.

Conclusion

Anesthesiologists and neurosurgeons should be fully aware of the anatomical innervation of the falx cerebri and that the posterior third of the falx cerebri is one of the highest risk structures for TCR induction for the safety operation around this region.

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