

Case Report

Trigemino-cardiac reflex in neurosurgical practice: Report of two new cases

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Abstract

Background: Systemic hypotension, cardiac dysrhythmia especially bradycardia, apnea, and gastric hypermotility occurring presumably after stimulation of any of the sensory branches of trigeminal nerve are coined as trigemino-cardiac reflex (TCR). Neither enough is known about the predisposing factors in relation with the intraoperative occurrence of this life threatening reflex, nor about the exact pathophysiology of its brain stem pathway.

Encountering two cases of bradycardia and hypotension during surgery encouraged the authors to: (1) report these two cases and review similar reports in the relevant literature, (2) discuss the suggested mechanisms for such an event, and (3) report the result of a prospective cohort of precisely checked cases in a sister article, to remind the younger neurosurgical community of a possible and bothering even mortal, but avoidable complication in their everyday practice.

Case Description: The first case was a 71-year-old male who developed bradycardia and hypotension while packing his large sella tursica with autologous fat after removing a large nonfunctional pituitary adenoma transsphenoidally to prevent cerebrospinal fluid leakage. The changes in his vital signs were detected and controlled rapidly.

The second case was a 52-year-old female who underwent right pterional craniotomy for right clinoidal meningioma. She developed severe bradycardia and hypotension after skin closure completed and just when the subgaleal drain was connected to the aspirating bag and negative pressure maintained in the subgaleal region.

Both cases could be managed successfully after on time detection of such life threatening complication and proper management.

Conclusion: We do not intend only to add two new cases of TCR occurring in the perioperative period in neurosurgical practice, but we wish to raise the question: (a) what could be the predisposing factors for development of such issue for better handling of the problem and (b) stress upon careful continuous mapping of the vital signs during surgery and even till very late after operation.

Key Words: Bradycardia, craniotomy, diving reflex, hypertension, oxygen-conserving reflex, trigemino-cardiac reflex

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INTRODUCTION

The trigeminocardiac reflex (TCR) is a well-recognized entity even though not a fully explained phenomenon, consisting of arterial hypotension, bradycardia, apnea, and gastric hypermotility.^[25] To define the occurrence of TCR, drop in mean arterial blood pressure (MABP), and heart rate (HR) more than 20% in comparison with basal ranges, maintained during the operation is considered as significant. Reproducibility of TCR by cessation of the manipulation leading in normalization of MABP and HR and reappearance of the changes after reinitiation of the manipulation is the main characteristics of this event. The occurrence of bradycardia alone without a considerable amount of hypotension cannot be coined as TCR. The TCR was first described confidentially by Schellar *et al.* in 1999 and the validity of the case reports^[2,4,10,11,14,25] and researches performed in the domain of the physiology of TCR have added to our knowledge about the development of this phenomenon during brain surgeries.^[20,22,24] The main question would be how to predict and to prevent it?

We intend to present two cases encountered recently in our practice, stressing on the rarity but trouble making nature of TCR happening in the perioperative period and suggest the possible predictive factors either the attending neurosurgeon or neuro-anesthesiologist should consider to prevent and/or properly manage the event.

CASE REPORTS

Case 1

A 71-year-old male presented with remarkable decrease of vision during the previous 6 months (down to 2/10). The pituitary function tests were compatible with hypo-functioning pituitary gland. The magnetic resonance imaging (MRI) revealed a large pituitary adenoma with remarkable supra-sellar extension [Figure 1]. The basic

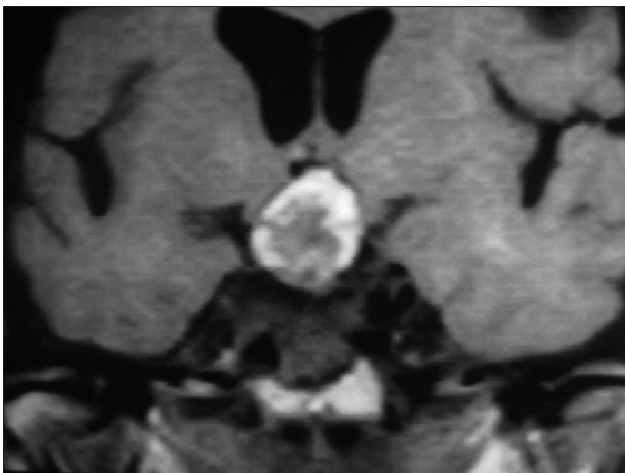


Figure 1: Contrast enhanced T1W coronal MRI showing a large pituitary adenoma with supra-sellar extension

cardiac evaluations were reported to be in the average normal range. He was on aspirin for long period of time, which was discontinued 10 days prior to operation, and mild antihypertensive Thiazide type medication. It was decided to approach the tumor transsphenoidally. The patient fasted for morning hours prior to surgery. The perioperative antibiotic was given as usual, Cephalexin Lupin Pharmaceuticals, Inc. 2 g IV. Routine monitoring during surgery included electrocardiography (ECG), noninvasive blood pressure (NIBP) end-tidal (ET) concentration of CO₂, and pulse oximetry.

Anesthesia was induced with midazolam (2 mg total dosage), fentanyl (150 µg total dosage) and propofol (2.5 mg/kg), and followed by atracurium (0.5 mg/kg). After intubation, the lungs were ventilated on volume controlled ventilation mode (S/5Aespire Config; Datex-Ohmeda Inc., Madison, WI, USA) with a mixture of medical air and O₂ (50-50%). Anesthesia was maintained using isoflurane (1-1.5%). An additional dosage of 50 µg fentanyl was applied every one hour during the intervention. The sella was approached via sub-mucosal transseptal dissection entering the sphenoid sinus by the rhinologist. The soft, pinkish gray tumor evacuated gross totally applying microscopic illumination (KA). Considering leakage of cerebrospinal fluid (CSF) in this stage, it was decided to pack the sella by autologous fat taken from the wall of his abdomen. While packing the sella, his BP dropped to 50/20 mmHg and HR to 38/min. Removing more than two-thirds of the implanted fat, the BP raised to 95/65 mmHg and HR to 88/min. It was preferred to apply surgical absorbable hemostat, Ethicon Inc., and cover it with mucosal flap. Since the bradycardia and hypotension were normalized gradually no excess medications were administered. The postoperative course was uneventful except for CSF leakage, which could be managed with repeated lumbar punctures.

Case 2

A 52-year-old female was admitted because of decreased vision of about 8 months duration. She had no preoperative comorbidity. She was operated for a right clinoidal meningioma [Figure 2 a and b]. General anesthesia was given in usual standard manner (using medications as in the previous case). A right standard pterional craniotomy was performed and tumor could be resected totally using micro-dissection technique. Hemostasis was achieved and bone flap fixed and skin closed in routine fashion. Bandage was applied while the patient was still intubated. Attaching the subgaleal drain to the suction bottle, her HR dropped from 86/min to 45/min and BP from 110/85 to 75/43 mmHg. The suction was disconnected and the patient was taken to the recovery room and extubated. All the vital signs were normal in the recovery room but when connecting the drain to the vacuum bag, HR and BP dropped again.



Figure 2a: Contrast enhanced T1W coronal MRI showing a clinoidal meningioma

Lastly, she could not tolerate the vacuum drain and we had to attach it to the bag without negative pressure. No extra medications were administered and drain was removed the day after operation. The postoperative course was otherwise uncomplicated.

DISCUSSION

Incidence

The incidence of TCR in ophthalmic surgery has been reported as high as 65% in craniofacial surgery, 1-2% and 8-18% during skull base surgeries.^[5,13,16,18,21,25,30] There are varieties of case reports in neurosurgical literature regarding the occurrence of TCR; during surgery within cerebellopontine angle (CPA),^[25] around the brain stem^[16] and the territory of the trigeminal nerve,^[3] during transsphenoidal pituitary surgery,^[4] while removing a falx meningioma,^[2] during draining of a subdural empyema,^[26] when working around the eye and face especially in children,^[5] during fixation of the stereotaxic frame,^[27] with LeFort I osteotomy,^[12] during embolization of intradural, dural or extradural highly vascular pathologies,^[13,14] while elevating the skin for craniotomy^[17] or closing the skin at the end of the procedure,^[6] and when connecting negative pressure to the subgaleal drain.^[10]

In this report we added a case of TCR while packing the sella with homologous fat and another case of TCR when connecting negative pressure to a subgaleal drain.

Physio-pathology – Reviewing the relevant literature, the TCR has been considered as an example of a group of reflexes defined as oxygen conserving reflexes^[22] even though it may become exaggerated and put the patient at risk. Trigeminal nerve rootlets evoke a polysynaptic excitatory glutamatergic pathway to the central cardiac vagal nuclei. The sensory nerve endings of the trigeminal nerve send sensory signals via the Gasserian ganglion to the trigeminal nucleus, forming the afferent pathway of the

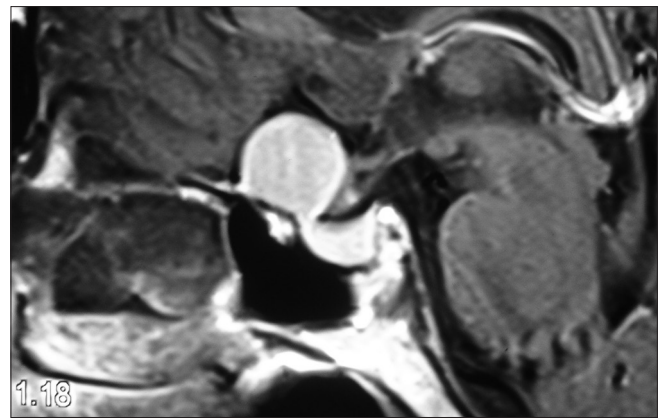


Figure 2b: Contrast enhanced T1W sagittal MRI showing the same clinoidal meningioma

reflex arc. Second-order neurons are located mostly lateral and slightly dorsal to the nucleus ambiguus in the ventral trigeminal nucleus.^[1] The pathway continues from the ventral trigeminal nucleus through the short internuncial nerve fibers in the reticular formation in the brainstem and synapse on efferent cholinergic premotor parasympathetic cardio-inhibitory neurons in the nucleus ambiguus.^[1]

Mechanical, electrical, or any kind of stimulation of the branches of the trigeminal nerve can evoke a dramatic decrease in HR, marked fall in MABP, and even apnea in both experimental animals and human being.^[1] A direct stimulation of parasympathetic endings in or around the cavernous sinus may be prompted by compression or traction of the oculomotor nerve. Yet, there is controversy about the oculomotor nerve carrying afferent parasympathetic fibers at this location being able to induce TCR.

A subset of the TCR is the diving reflex (DR).^[23] Stimulation of the DR by activation of naso-trigeminal sensory nerve fibers evokes a pronounced bradycardia, mediated by increased parasympathetic cardiac activity.^[23] The DR is highly pronounced in infants, while HR may decrease down to 51% on a single facial submersion.^[9] The DR is normally elicited when the nasal mucosa is stimulated with chemical irritants and can be prevented by anesthetizing the nasal mucosa with local anesthetics.^[7,28] However, this protective response could be detrimental if exaggerated. Sudden Infant Death Syndrome (SIDS) is the leading cause of infant death in the postneonatal period occurring in 0.3 cases per 1000 live births.^[15] What differs between DR and TCR is that in TCR there is a MABP decrease, whereas in DR the MABP gradually increases.

It has been stressed that the most important factor involved in the occurrence of the TCR is the stimulation intensity during manipulation of the trigeminal pathway. Traction is more likely to elicit the TCR when performed rather abruptly and sustained than when undertaken

smoothly and gently.^[1] Intracranial manipulation of the trigeminal nerve is possible without inducing the reflex when this maneuver is performed gently.^[1]

Our cases

The incidence of occurrence of TCR in patients who underwent resection of invasive pituitary adenomas, in whom the surgeon was working near the trigeminal nerve at the cavernous sinus has been reported 10-12% in some retrospective case series.^[25,21] It happened in our case when the tumor was removed and when pieces of autologous fat were being laid gently within the pituitary fossa without almost any compression.

The possible mechanism for encountering TCR or any kind of hemodynamic instability after application of negative pressure either to the epidural, epicranial, or subgaleal drain has been proposed to be: (a) due to decrease in intracranial pressure (ICP) and/or (b) stimulation of the nerve endings of the epicranium after closure of the skin.^[10] In our patient, the procedure was uneventful till the episode of bradycardia and remarkable hypotension occurred following attachment of the drain to the vacuum-suction after skin closure. This phenomenon was repeated several times after the patient was taken to intensive care unit (ICU) also.

Most of the reported cases of hemodynamic instability with similar scenario, presented as bradycardia, without any changes in MABP. The TCR after intracranial hypotension might lead in reverse brain herniation that bears a relationship with the intensity of the applied negative pressure.^[10] One would like to recommend application of negative pressure suction better to be avoided during skin suturing and applied gradually, after bandage is completed.

Management strategies

Several anesthetics and analgesics have been reported to alter the incidence and strength of the TCR, the mechanisms for which are yet unclear. The factors postulated as predisposing patients to the TCR on the basis of some clinical case reports to which we have added our two cases can be enumerated as: preoperative b-blockers and calcium channel blockers, hypercapnia, hypoxemia, susceptible individuals such as children with high vagal tone, narcotics such as sufentanil and alfentanil, rapid drainage of CSF in patients with hydrocephalus and light anesthesia.^[8,19,29] None of these variants could have any impact in the two presented cases, although we have not controlled the depth of anesthesia in these two cases.

CONCLUSION

1. We reported two new cases of TCR encountered unexpectedly in a single busy neurosurgical department
2. We reviewed narratively the literature on this topic

and raised questions regarding the pathophysiology of this phenomenon

3. Further study of this phenomenon is needed to advance our knowledge about risk factors and the underlying physiological mechanisms. On these basis, we designed a prospective study to elucidate the incidence of the occurrence of TCR in a general neurosurgical operating room while the depth of anesthesia was controlled tightly by special devices and all the known risk factors contributable to the TCR phenomenon have been considered meticulously, the result is reported in the following sister article
4. It is certainly necessary to design more complete controlled trials for cumulating data for TCR in the literature.

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