Case Reports

Journal of
INTERNATIONAL
MEDICAL RESEARCH

Journal of International Medical Research
2023, Vol. 51(1) 1–6
© The Author(s) 2023
Article reuse guidelines:
sagepub.com/journals-permissions
DOI: 10.1177/03000605221148618
journals.sagepub.com/home/imr
SAGE

Prolonged asystole induced by trigeminocardiac reflex accompanied with abnormal heart rate variability during percutaneous balloon compression: a case report

Huanhuan Zhang, Jinhua He, Yanru Du, Meinv Liu and Jianli Li

Abstract

Trigeminocardiac reflex (TCR) can result in bradycardia and even cardiac arrest, and is reversible with elimination of the stimulus. Here, we report the case of a 68-year-old man who experienced cardiac arrest during percutaneous balloon compression for the treatment of trigeminal neuralgia. In this patient, sinus rhythm did not recover after stimulation removal, causing us to successfully perform cardiopulmonary resuscitation (CPR). The patient regained a sinus rhythm and was pretreated with atropine 0.5 mg, allowing the operation to be started again. The operation was completed successfully and the patient experienced no complications. Subsequent heart rate variability (HRV) analysis showed that parasympathetic activity predominated before anesthesia induction and after tracheal intubation. It further elevated during foramen ovale puncture, leading to prolonged asystole. Fortunately, sympathetic activity predominated after atropine was administered, which manifested as an increase in sympathetic activity and a decrease in parasympathetic activity. This could be beneficial for patients with TCR. This case indicates that TCR-related cardiac arrest might not be reversed with stimulus cessation, and atropine played a key role in preventing TCR. Moreover, HRV analysis might be essential for preoperative screening for high-risk patients. We also reviewed the literature for cases of TCR with prolonged asystole.

Department of Anesthesiology, Hebei General Hospital, Shijiazhuang City, Hebei Province, China

Corresponding author:
Jianli Li, Department of Anesthesiology, Hebei General Hospital, 348 Heping Road West, Shijiazhuang City, Hebei Province 050051, China.
Email: hblijianli@163.com

Keywords
Trigeminal neuralgia, trigeminocardiac reflex, heart rate variability, percutaneous balloon compression, asystole, cardiac arrest, cardiopulmonary resuscitation

Date received: 2 October 2022; accepted: 14 December 2022

Introduction

The trigeminocardiac reflex (TCR) is a brainstem reflex, characterized by bradycardia, hypotension, cardiac arrhythmias, and even cardiac arrest.[1] As reported in previous studies, TCR was defined as a sudden decrease in heart rate of 20% or more compared with baseline, and/or asystole, which was provoked by the stimulation of any branch of the trigeminal nerve, occurred without any signal, and could be reversed with stimulus cessation.[2] TCR has been widely reported for decades, but no studies have reported an analysis of heart rate variability (HRV) in a patient with prolonged asystole during percutaneous balloon compression (PBC).

Here, we report a case of prolonged asystole at the moment of foramen ovale puncture and present the HRV changes during PBC. Additionally, we review TCR cases with prolonged asystole. The reporting of this study conforms to CARE guidelines.[3]

Case Report

A 68-year-old man (66 kg, 168 cm, American Society of Anaesthesiologists status II) with a 1-year history of left trigeminal neuralgia was scheduled for PBC. He had a history of hypertension and hepatitis B virus infection. Medications included nifedipine tablets (10 mg, bid) and oxcarbazepine (450 mg, tid). His blood pressure was controlled around 150/90 mmHg and his daily nifedipine tablet treatment was continued on the day of the surgery. The preoperative electrocardiogram (ECG) showed sinus rhythm with an HR of 60 bpm and abnormal ST-T segment (Figure 1). The preoperative echocardiography, computed tomography (CT) of the chest, and laboratory tests showed no obvious abnormalities. Cranial magnetic resonance imaging (MRI) revealed a tumor of unknown type in the left cistern of Merkel's cavity.

While signing the informed consent for anesthesia, we obtained verbal consent from the patient and his family to provide treatment if any emergency or unexpected event occurred during the operation. Before the patient entered the operating room, Holter ECG (Shenzhen Biomedical Instruments, Shenzhen, China, BI6812) monitoring was initiated. In the operating room, 3-lead ECG (3-ECG), noninvasive blood pressure, oxygen saturation (SpO2), and bispectral index (BIS) were monitored. Before anesthesia was administered, his vital signs included a HR of 78 to 80 bpm and blood pressure of 178/100 mmHg.

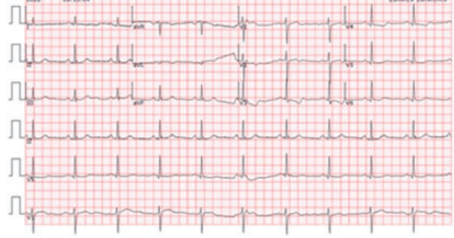

Figure 1. The preoperative 12-lead electrocardiogram (ECG) showed sinus rhythm with a rate of 60 bpm and abnormal ST-T segment. There was a slight ST-segment depression in leads V1, V2, and V3.

Anesthesia was induced by sufentanil (20 μg), cisatracurium besylate (12 mg), and etomidate (14 mg). Anesthesia was maintained with remifentanil (0.1 to 0.15 μg/kg/minute) and propofol (2 to 6 mg/kg/hour), keeping the BIS between 40 and 60. The hemodynamics were stable prior to surgery.

After anesthesia induction, the patient was positioned supine with his head in the natural median position. The operation was performed with radiation monitoring. Cardiac arrest occurred suddenly when puncturing the foramen ovale. Manipulation was ceased quickly, but his HR did not return within 17 s. We immediately performed cardiopulmonary resuscitation (CPR), and his sinus HR returned to 66 to 68 bpm. Atropine 0.5 mg was administered intravenously to prevent recurrence of cardiac arrest. When the hemodynamics became stable (HR: 74 bpm, blood pressure: 113/83 mmHg), the operation was continued. There was only a slight decrease in HR (HR from 74 to 65 bpm) and a slight increase in blood pressure (blood pressure from 113/83 to 135/103 mmHg) at the time the foramen ovale was punctured again. The balloon was inflated to compress the trigeminal ganglion for 1 minute and 40 s, and the operation was completed. During trigeminal ganglion compression, his HR fluctuated between 67 and 80 bpm and blood pressure ranged from 135/103 to 163/97 mmHg.

The patient was transferred to the post-anesthesia care unit after the operation and was returned to the wards when he was fully awake. The patient showed no discomfort and was discharged one day after surgery.

The results of the Holter ECG showed that asystole lasted 17 s (Figure 2). HRV data analyzed by the Ambulatory ECG System (Shenzhen Biomedical Instruments) were obtained at five timepoints: before anesthesia induction (T_1), after tracheal intubation (T_2), during foramen ovale puncture (T_3), after atropine was administered intravenously (T_4), and during ganglion compression (T_5) (Table 1).

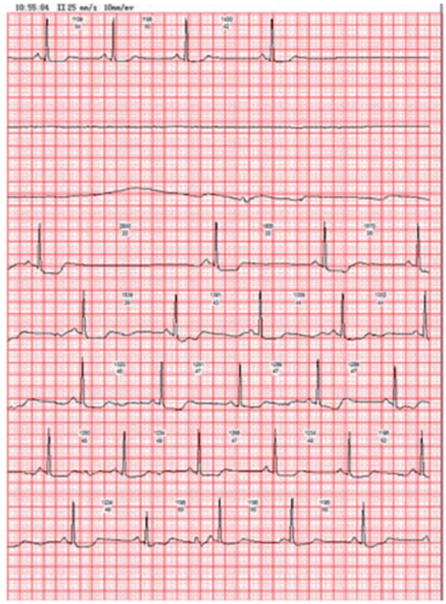

Figure 2. The results of Holter electrocardiogram (ECG) showed that asystole lasted 17 s.

Table 1. The results of Holter electrocardiogram (ECG) at five timepoints.

Timepoint	LF	HF	LF/HF ratio
T_1	129.42	159.59	0.81
T_2	188.99	318.89	0.59
T_3	207.02	484.01	0.43
T_4	499.94	127.14	3.93
T_5	308.49	199.38	1.55

LF, low-frequency; HF, high-frequency; T_1, before anesthesia induction; T_2, after tracheal intubation; T_3, during foramen ovale puncture; T_4, after atropine was administered intravenously; T_5, during ganglion compression.

Discussion

TCR manifests as significant fluctuations in hemodynamics, which was in accordance with the stimulation of the trigeminal nerve.[4] TCR can usually be terminated by eliminating the eliciting stimulus.[2]

Table 2. Previous cases of trigeminocardiac reflex with prolonged asystole.

First Author	Procedure	Time of Asystole Occurrence	Duration of Asystole	Treatment
Potti[11]	Percutaneous embolization of a juvenile nasopharyngeal angiofibroma	After the injection of dimethyl sulfoxide	30 s	Atropine
Meuwly[12]	Functional nasal septum plastic, bilateral endoscopic submucosal turbinoplastic, tonsillectomy, Fairbanks incision of the palatopharyngeal pillar, and radiofrequency ablation of the soft palate for mild obstructive sleep apnea	Application of local anesthetic in the nasal mucosa	10 s	Chest compressions Ephedrine Atropine
Baronos[13]	Elective Le Fort I osteotomy, bilateral mandibular osteotomy, and genioplasty	When a bite block was placed after the new jaw positions were secured with plates and screws	10 s	Glycopyrrolate

Anticholinergic drugs, such as atropine, were proposed to prevent TCR-related bradycardia.[4,5] In extreme cases of cardiac arrest where sinus rhythm was not restored after stopping the stimulus, prompt CPR should be performed to avoid fatal hemodynamic instability.[6] The details of this case were consistent with the definition of TCR,[2] so we performed CPR and sinus HR returned to 66 to 68 bpm.

Although there are extensive literature reports on TCR, its precise mechanism remains ambiguous.[7] Numerous studies have demonstrated that both the sympathetic and parasympathetic nervous systems are involved in TCR.[7] The efferent pathway of the reflex originates largely from parasympathetic nerves in the motor nucleus of the vagus nerve.[8] Activation of the parasympathetic nervous system can result in bradycardia and even cardiac arrest.[9] In recent decades, HRV analysis has frequently been used to evaluate the activities of the sympathetic and parasympathetic nervous systems.[10] Previous reports have presented three cases of TCR with prolonged asystole, and these results are shown in Table 2. Among these three cases, the asystole duration was 30 s in one case[11] and 10 s in the other two cases.[12,13] However, none of these case reports mentioned analyzing HRV.

Fortunately, we monitored the HRV in this case before entering the operation room, which was used to evaluate the cardiac autonomic nervous system activity.[14] The high-frequency (HF) component reflected parasympathetic activity and the low-frequency (LF) component reflected sympathetic and parasympathetic activity, with sympathetic predominance.[15] The LF/HF ratio represents the balance between the sympathetic and parasympathetic nervous systems.[16] In this case, the parasympathetic activity (HF) predominated at T1 and T2, but unfortunately further elevated at T3. Interestingly, sympathetic activity (LF) predominated after 0.5 mg atropine was injected, which ensured successful completion of the surgery.

Because of the potentially devastating outcomes of TCR, it was critical for anesthesiologists to quickly recognize this phenomenon in the patient. Predisposing risk factors for TCR include mechanical stimulation, hypercapnia, hypoxemia, light (insufficient) general anesthesia, young age, and medications, such as beta blockers and calcium channel blockers.[17] In this case, preoperative parasympathetic activity (LF vs. HF: 129.42 vs. 159.59, LF/HF: 0.81) predominated. It increased (LF vs. HF: 188.99 vs. 318.89, LF/HF: 0.59) after anesthesia induction, which is possibly related to the anesthetic agents. One study reported that propofol could inhibit sympathetic activity more than parasympathetic activity, resulting in parasympathetic dominance.[18] Another study reported that sufentanil and remifentanil could increase the incidence of TCR by decreasing the threshold for parasympathetic nerve excitation.[19] Although these medications influenced the sympathovagal balance, not only these medications elicited TCR in our case. Direct stimulation of the trigeminal branch further enhanced parasympathetic activity (LF vs. HF: 207.02 vs. 484.01, LF/HF: 0.43), ultimately leading to sudden cardiac arrest.

If severe TCR occurs, the mechanical stimulus should be stopped immediately and anticholinergic agents should be administered to mitigate it.[20] Additionally, CPR should be performed to avoid catastrophic outcomes in cases where asystole persists despite cessation of the stimulus and administration of anticholinergic drugs.[6] Furthermore, preoperative HRV analysis might be necessary for patients at high risk of TCR.

Conclusions

Here, we presented a case of prolonged asystole induced by TCR accompanied by abnormal HRV during PBC. Our case suggests that TCR might not always terminate with removal of the triggering stimulus, so anesthesiologists must remain vigilant during PBC. Preoperative HRV analysis could provide further reliable support for identifying high TCR-risk patients. In addition, our case can supplement information on TCR in the literature and provide new ideas for preventing TCR.

Acknowledgements

The authors thank Shuang Han for analyzing the HRV data. We also thank the patient described in this report for providing permission to use his data for scientific purposes.

Author contributions

All authors made significant contributions to the design, acquisition, and analysis of data, and participated in writing or revising the article.

Data availability statement

All the original research data to support the results/tables/figures presented in our manuscript will be available. Email: hblijianli@163.com

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

Ethics statement

This study has been approved by the ethics committee of the Hebei General Hospital (Ethics Approval No. 2022-08). The patient provided written informed consent for publication of this case report.

Funding

The authors disclosed receipt (pending publication) of the following financial support for the research, authorship, and/or publication of this article: This study received funding from the Key Research and Development Program of Hebei Province (No. 19277714D).

ORCID iDs

Huanhuan Zhang https://orcid.org/0000-0002-1056-987X

Meinv Liu https://orcid.org/0000-0003-1367-4621
Jianli Li https://orcid.org/0000-0001-6867-7825

References

1. Leon-Ariza DS, Leon-Ariza JS, Nangiana J, et al. Evidences in Neurological Surgery and a Cutting Edge Classification of the Trigeminocardiac Reflex: A Systematic Review. *World Neurosurg* 2018; 117: 4–10.
2. Meuwly C, Golanov E, Chowdhury T, et al. Trigeminal cardiac reflex: new thinking model about the definition based on a literature review. *Medicine (Baltimore)* 2015; 94: e484.
3. Gagnier JJ, Kienle G, Altman DG, et al; CARE Group. The CARE guidelines: consensus-based clinical case reporting guideline development. *Headache* 2013; 53: 1541–1547.
4. Wang CM, Guan ZY, Zhao P, et al. The Effect of Atropine on Trigeminocardiac Reflex-induced Hemodynamic Changes During Therapeutic Compression of the Trigeminal Ganglion. *J Neurosurg Anesthesiol* 2022; 34: e40–e45.
5. Chen CY, Luo CF, Hsu YC, et al. Comparison of the effects of atropine and labetalol on trigeminocardiac reflex-induced hemodynamic alterations during percutaneous microballoon compression of the trigeminal ganglion. *Acta Anaesthesiol Taiwan* 2012; 50: 153–158.
6. Recinos MA, Hsieh J, Mithaiwala H, et al. A rare appearance of the trigeminocardiac reflex during resection of posterior parasagittal meningioma. *Surg Neurol Int* 2021; 12: 183.
7. Meuwly C, Chowdhury T, Sandu N, et al. Definition and Diagnosis of the Trigeminocardiac Reflex: A Grounded Theory Approach for an Update. *Front Neurol* 2017; 8: 533.
8. Lang S, Lanigan DT and Van der Wal M. Trigeminocardiac reflexes: maxillary and mandibular variants of the oculocardiac reflex. *Can J Anaesth* 1991; 38: 757–760.
9. Schaller B, Cornelius JF, Prabhakar H, et al. Trigemino-Cardiac Reflex Examination Group (TCREG). The trigemino-cardiac reflex: an update of the current knowledge. *J Neurosurg Anesthesiol* 2009; 21: 187–195.
10. Tapiainen AA, Zaproudina N, Lipponen JA, et al. Autonomic responses to tooth clenching and handgrip test. *Acta Odontol Scand* 2022; 80: 389–395.
11. Potti TA, Gemmete JJ, Pandey AS, et al. Trigeminocardiac reflex during the percutaneous injection of ethylene vinyl alcohol copolymer (Onyx) into a juvenile nasopharyngeal angiofibroma: a report of two cases. *J Neurointerv Surg* 2011; 3: 263–265.
12. Meuwly C, Leibundgut G, Rosemann T, et al. Sinus arrest with prolonged asystole due to the trigeminocardiac reflex during application of local anaesthetic in the nasal mucosa. *BMJ Case Rep* 2018; 2018: bcr2018226427.
13. Baronos S, Fong W, Saggese NP, et al. Asystole in Orthognathic Surgery: A Case Report. *A A Pract* 2019; 12: 249–251.
14. Ernst G. Heart-Rate Variability-More than Heart Beats? *Front Public Health* 2017; 5: 240.
15. Catai AM, Pastre CM, Godoy MF, et al. Heart rate variability: are you using it properly? Standardisation checklist of procedures. *Braz J Phys Ther* 2020; 24: 91–102.
16. Tiwari R, Kumar R, Malik S, et al. Analysis of Heart Rate Variability and Implication of Different Factors on Heart Rate Variability. *Curr Cardiol Rev* 2021; 17: e160721189770.
17. Khatibi K, Choudhri O, Connolly ID, et al. Asystole During Onyx Embolization of a Pediatric Arteriovenous Malformation: A Severe Case of the Trigeminocardiac Reflex. *World Neurosurg* 2017; 98: 884.e1–884.e5.
18. Liu Q, Kong AL, Chen R, et al. Propofol and arrhythmias: two sides of the coin. *Acta Pharmacol Sin* 2011; 32: 817–823.
19. Arnold RW, Jensen PA, Kovtoun TA, et al. The profound augmentation of the oculocardiac reflex by fast acting opioids. *Binocul Vis Strabismus Q* 2004; 19: 215–222.
20. Meng Q, Yang Y, Zhou M, et al. Trigeminocardiac reflex: the trigeminal depressor responses during skull base surgery. *Clin Neurol Neurosurg* 2008; 110: 662–666.