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CASE REPORT

Trigemino-Cardiac Reflex During Orbital Floor Reconstruction: A Case Report and Review

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Abstract Trigemino-cardiac reflex is occurrence of hypotension and bradycardia upon surgical manipulation of areas supplied by the trigeminal nerve, and has been reported during craniofacial maxillofacial and ocular surgeries. Communication between the anaesthetic and surgical team is essential, and cessation of the precipitating stimulus is the first and most important therapeutic step. We report a case of immediate, reproducible, and reflexive response of Bradycardia and dysrhythmia upon manipulation of orbital fracture during orbital floor reconstruction in a 65-year-old man. Upon recognition of the reproducible relationship between falcine stimulation and increased vagal tone, the patient was given atropine in an effort to block cholinergic hyperactivity. After atropine administration, no further dysrhythmias occurred and surgery was carried uneventfully.

Keywords Occulo-cardiac reflex · Trigemino-cardiac reflex · Cardiac reflex · Vagal reflex · Bradycardia

Introduction

Trigemino-cardiac reflex is the sudden onset of parasympathetic dysrhythmia, sympathetic hypotension, apnea or gastric hyper motility due to the stimulation of any of the sensory branches of the trigeminal nerve [1]. Stimulation of the trigeminal receptors in its innervated regions provides an important stimulus for the initiation of the trigeminorespiratory reflex and cardiac arrhythmias which could arise with it [2].

It is more common with ophthalmic division of trigeminal nerve and it may also be elicited by stimulating the maxillary and mandibular divisions of the trigeminal nerve during craniomaxillofacial surgeries [3], temporomandibular joint arthroscopies [4], manipulation at the maxillary tuberosity [5], Le Fort I osteotomies [6], nasal fracture reconstructions [7], zygomatic arch fracture elevations [8], midface disimpactions [9] and neurosurgical procedures [10].

Here, we report the occurrence of trigemino-cardiac reflex during orbital floor reconstruction in a 65-year-old man with pan facial fracture under general anesthesia. The present paper reports a case, its intraoperative diagnosis and management update.

Case Report

A 65 year old male patient presented with loss of consciousness and bleeding from the nose following a head injury in a motorcycle accident. Patients' Glasgow Coma Scale (GCS) was 9 and immediate tracheotomy was done to restore the breathing. Pupils were reactive to light. There was bruise and swelling over the maxillary, frontal and temporal areas with subconjunctival ecchymosis and exophthalmos on the right side. Coronal CT scan (Fig. 1) examination revealed multiple fractures involving frontal, temporal, zygomatic and maxillary bones with fracture of orbital floor on the right side with soft tissue herniation into the maxillary antrum. The diagnosis of multiple bone fractures involving right frontal, temporal, zygomatic and Lefort I fracture along with blow out fracture-right orbit was established. Open reduction and internal

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fixation was planned along with reconstruction of orbital floor with silastic under general anesthesia.

Before the induction of general anesthesia, his heart rate was 84 bpm, blood pressure was 140/60 mm Hg, and arterial oxygen saturation (SaO_2) was 98%. 5 mg dexamethasone was given intravenously to reduce postoperative swelling. General anesthesia was induced with the intravenous administration of fentanyl (150 μg), and propofol (150 mg). Anesthesia was maintained with 2% enflurane in a mixture of 40% oxygen and 60% nitrous oxide. Tubocurarine (20 mg) was administered for muscle relaxation, and the patient's lungs were mechanically ventilated. The ventilation was adjusted to maintain an end-tidal carbon dioxide concentration (EtCO2) of 30–35 torr. The ECG, pulse oximetry, and $EtCO_2$ were measured continuously, and the blood pressure was measured non invasively at 3-min intervals.

Orbital floor was approached through infraorbital incision. The infraorbital nerve was identified and protected. The herniated periorbital content including inferior rectus muscle and fat was disengaged from the bony defect. At this time, a sudden drop of heart rate, bradycardia with a flat ECG (Electrocardiogram) was detected followed by asystole. The surgeon was informed immediately, and the surgical stimulus was stopped. The inspiratory oxygen concentration was changed to 100%, and the enflurane vaporizer was switched off, atropine (0.6 mg) was given intravenously, after which the heart rate increased to 106 beats/min and the blood pressure increased to 110/70 mm Hg. Nitrous oxide and enflurane were restarted, and the operation (Fig. 2) was completed uneventfully. The pulse remained stable at 80–96 beats/min. At the end of the procedure, muscle relaxation was reversed with 2.5 mg neostigmine and 0.6 mg atropine. The patient woke up 15 min after surgery had finished and recovered uneventfully.

To the best of our knowledge, there have been four cases reported about this reflex in the literature during the management of orbital blowout fracture by Chesley and Shapiro [11] in 1989, Ziccardi et al. [12] in 1991, Hirjak et al. [13] in 1993 and Sires [14] in 1999. This was the fifth report we encountered during orbital floor fracture reconstruction in our case.

Discussion

First step in the historic development of trigemino-cardiac reflex was considered with descriptions by Joseph Breuer [15] about self regulation of breathing through the vagus nerve in 1868. Kratschmer [16] showed sudden development of hypotension, asystole, cardiac dysrhythmia and gastric hypermotility in animals on manipulation of nasal mucosa. Further studies [17] confirmed that these reflexes were abolished when local anesthetics were applied to the trigeminal nerves branches. Later, the first description about trigemino cardiac reflex was given by Bernard Ascher [18] and Guiseppe Dagnini [19] in 1908 as oculocardiac reflex because of its cardiac response (mainly bradycardia) associated with stimulation of the ophthalmic division of the trigeminal nerve during ocular surgeries. They described this response as pressure induced neural reflex which stimulate vagus nerve that causes cardiac depression.

However, several other reports [9, 20] showed occurrence of this bradycardia by stimulating non ocular sources.

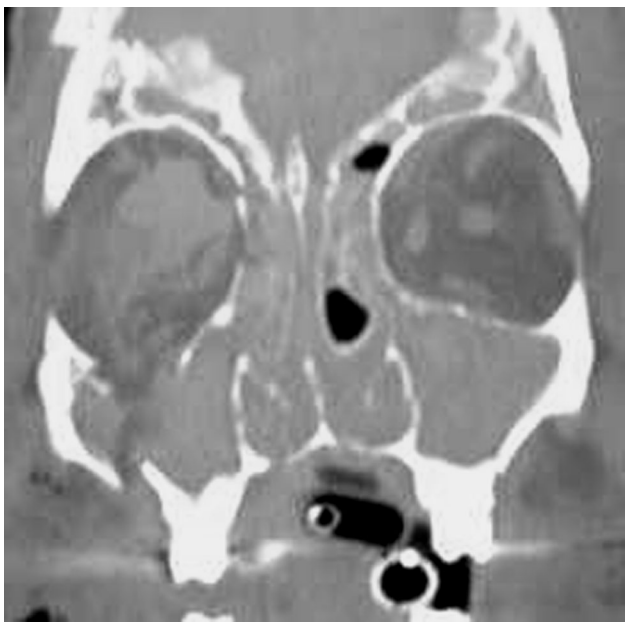

Fig. 1 CT scan-coronal view

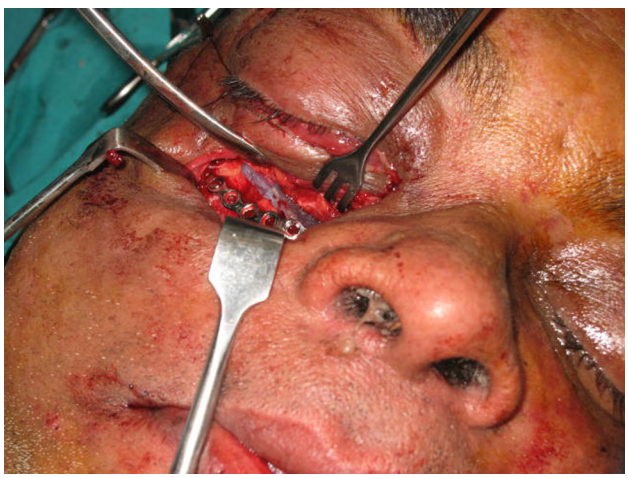

Fig. 2 Orbital reconstruction with sialastic

There after it is termed as trigemino-cardiac reflexes in 1988 as suggested by Shelly and Church [21].

Literature Review in Maxillofacial Surgery

Trigemino-cardiac reflex during maxillofacial surgical procedures has been described on several occasions [3–9]. The reason is due to stimulation of maxillofacial structures innervated by the trigeminal nerve. The trigeminal nerve provides sensory supply to the face, scalp, and mucosa of the nose and mouth [2, 16, 22]. Trigemino-cardiac reflex during maxillofacial procedures reported first in 1978 by Roubideaux [9] who documented a sudden decrease in heart rate with surgical disimpaction of a fractured maxilla in a 22-year-old healthy male. Overview of reports of TCR in maxillofacial procedures is given in Table 1. In 1987, Loewinger et al. [8] Shearer et al. [20] and Bainton [23] reported the episodes of bradycardia or asystole during elevations of zygomatic fractures. Gillespie [24] reported bradycardia during elevation of zygomatic fractures again in 1988. Reaume and MacNicol [25] also reported same phenomena during Lefort I osteotomy in the same year. Later Shelly and Church [22] reported bradycardia during facial surgery and suggested the term "trigeminocardiac reflex". In 1989 Ragno et al. [6] described several episodes of ventricular asystole in a single patient during the downfracturing of a maxilla as part of Le Fort I osteotomy. Stott [3] reported this reflex in facial surgery and described that traction or stretching of any structure innervated by trigeminal nerve might be associated with slowing down of pulse. In the same year the first case of bradycardia during treatment of an orbital blowout fracture was reported by Chesley and Shapiro [11]. In 1990 Precious et al. [26] reported first series of patients a 1.6% incidence (8/502 cases) of either asystole or bradycardia in patients undergoing maxillofacial orthognathic or temporomandibular surgery and Bainton et al. [27] reported sinus arrest complicating a bitemporal approach to the treatment of panfacial fractures. In 1991 Lang et al. [15] reported 3 cases of reflex bradycardia responses that occurred during orthognathic procedures and illustrated the existence of afferent pathways via the maxillary and/or mandibular divisions, in addition to the commonly reported pathway via the ophthalmic division of the trigeminal nerve. In 1996 Morey and Bjoraker [28] reported a case of asystole during temporomandibular joint arthrotomy. Schaller [2] demonstrated that this reflex occurs with stimulation of the intracranial portion of the trigeminal nerve and it occurs in 10–18% of the patients operated for tumors of the cerebello-pontine angle. Several others reported similar reflex during thyroid resection [29], endoscopic forehead lift surgery [30] etc.

The factors [31] known to increase the risk of this reflex include hypercapnia, hypoxemia, light general anesthesia, age (more pronounced in children), nature of the provoking stimulus (strength and duration) and drugs like narcotic agents [32], beta-blockers and calcium channel blockers [33]. Lübbers et al. [34] classified risk factors into low, medium and high risk depending on the surgeries involving trigeminal course and its prevention. These factors were ruled out in our case and other possibilities were considered. Hypovolaemia was ruled out, as the patient had received an infusion of one liter of fluids and intra-operative blood loss was also minimal. Electrolyte imbalance was excluded, as an arterial blood gas analysis prior to the event was within normal limits. The bradycardia that occurred was not preceded by either hypoxia or hypercarbia. Myocardial ischemia was ruled out, as the post-operative ECG was normal.

The most important factor involved in the occurrence of this reflex is the stimulation intensity during manipulation of the trigeminal pathway. In surgeries involving orbit, traction on the extra ocular muscles is particularly prone to cause reflex bradycardia [35] which is directly related to the tension applied to the extraocular muscles. However, the period of time to reach the minimal heart rate decreases as tension applied increases [12, 36]. Even intracranial manipulation of the trigeminal nerve is possible without inducing the reflex when this maneuver is performed gently [37]. Removing the triggering factor can cause cessation of the reflex, raising hemodynamic parameters to normal levels.

In our case, pressure applied over orbital floor during floor elevation, before placing silastic [38, 39] graft material must have triggered the trigemino-cardiac arc involving the neuronal transmission from the orbital structures to the ciliary ganglion, the ophthalmic division of the trigeminal nerve. When excessive pressure impulses are transmitted, the efferent pathway of the vagus nerve running alongside is stimulated, and the tonus in the parasympathetic nerve increases, resulting in Bradycardia. Previous studies [40, 41] reported development of trigemino cardiac reflex due to compression and contusion during ocular surgeries. Other possibility in our case could be the non pre-operative administration of a local anesthetic agent which might have prevented the reflex due to the blockade of the afferent pathways because similar reflex arises [23] without prerequisite manipulation of areas supplied by ophthalmic branch but during maxillary osteotomies [5–9]. Many authors [42–44] also reported intraoperative deaths possibly due to this reflex which demonstrate the (clinical) importance of the TCR which causes severe bradycardia that leads to death if not detected early. In addition, hypotension which occurs during reflex

Table 1 Review of trigemino cardiac reflex in maxillofacial cases

Author	Year	Maxillofacial procedure
Robideaux	1978	Midface disimpaction
Bainton R, Lizi E	1987	Management of zygomatic fracture
Loewinger J, Cohen M, Levi E	1987	Management of zygomatic fracture
Shearer et al.	1987	Management of zygomatic fracture
Reaume and Mac Nicol	1988	Lefort I osteotomy
Shelly and Church	1988	Facial surgery
Gillespie	1988	Zygomatic fracture
Ragano JR, Marcoot RM, Taylor	1989	Lefort I osteotomy
Baxandall et al.	1989	Nasoethmoidal fractures
Stott D.G	1989	Facial surgery
Chesley and Shapiro	1989	Orbital blowout fracture
Bainton, Barnard, Wiles	1990	Panfacial fracture
Precious, Skulsky	1990	Facial surgery
Gomez	1991	TMJ arthroscopy
S. Lang, Lanigan, M. vander Wal	1991	Orthognathic procedures
Ziccardi et al.	1991	Orbital fracture
Hirjak, Zajko, Satko	1993	Orbital fracture
Cambell	1994	Orthognathic procedure
Seo.K, Takayama, Araya	1995	Opening mouth under GA
Morey, Bjoraker	1996	TMJ arthrotomy
Roberts RS, Best JS, Shapiro	1999	TMJ arthroscopy
Locke MM et al.	1999	Nasal fracture
Sires BS	1999	Orbital trapdoor fracture
Kosaka, Asamula	2000	Management of zygomatic fracture
Webb, Unkel	2007	Mesiodense removal
Osborn et al.	2008	Periorbital laciration manipulation
Arekere et al.	2010	Extractions

may lead to myocardial and cerebral infarction in those who are at risk for these conditions.

Management of patients with TCR can be directed in identifying risk factors especially areas supplied by trigeminal nerve. If any mechanical stimulation to the nerve is necessary, it should be as gentle as possible. If working in the vicinity of the nerve or its branches, the anesthesiologist should be notified by the surgeon. Prophylaxis of this reflex is better accomplished with local anesthetic infiltration or block of the nerve. Several [45, 46] studies showed that peribulbar blocks with local anesthetic agents significantly reduced the incidence of trigemino cardiac reflex. As soon as sudden bradycardia or asystole is detected, the surgery should be stopped immediately and any traction on soft tissues released. Usually cessation of the stimulus will enable the patient to regain a sinus rhythm. In severe cases of bradycardia and asystole, administration of vagolytic agents [47] such as atropine which blocks the peripheral muscarinic receptors at the heart or glycopyrrolate is considered. Anticholinergic drugs use is logical as the reflex is precipitated by parasympathetic stimulation, anticholinergic drugs [17, 47] may prevent further episodes of the reflex. When used, time should be allowed for the drug to take effect. At least one recurrence was ascribed to the fact that the drug had not had time to act before a fresh stimulus was given. Treating the initial episode with anticholinergics does not guarantee protection from further episodes and the use of atropine is also questioned [48] because cholinergic blockage reduces but not totally prevent either bradycardia or hypotension and may cause serious cardiac arrhythmias itself.

In such cases that are refractory to atropine and other vagolytics may rather need to be managed with epinephrine [49]. Cardiac massage [11] should be reserved for cases where conservative measures have failed to reestablish cardiac output, as there is serious morbidity associated with it.

Conclusion

In summary, we described the occurrence of trigemino-cardiac reflex during the reconstruction of orbital floor in a panfacial fracture case and its management. Communication between the anaesthetic and the surgical team is essential, and

cessation of the precipitating stimulus is the first and most important step. Prevention of trigeminovagal reflexes requires awareness of the anatomical structures involved, cooperation between the surgeon and the anaesthetist, and knowledge of factors known to evoke these reflexes.

References

1. Gharabaghi A, Koerbel A, Samii A, Kaminsky J, Samii M (2006) The impact of hypotension due to the trigeminocardiac reflex on auditory function in vestibular schwannoma surgery. J Neurosurg 104:369–375
2. Schaller B, Probst R, Strebel S, Gratzl O (1999) Trigeminocardiac reflex during surgery in the cerebellopontine angle. J Neurosurg 90:215–220
3. Stott DG (1989) Reflex bradycardia in facial surgery. Br J Plast Surg 42:595–597
4. Roberts RS, Best JS, Shapiro RD (1999) Trigeminocardiac reflex during temporomandibular joint arthroscopy: report of a case. J Oral Maxillofac Surg 57:854–856
5. Campbell R, Rodrigo D, Cheung L (1994) Asystole and bradycardia during maxillofacial surgery. Anesth Prog 41:13–16
6. Ragno JR, Marcoot RM, Taylor SE (1989) Asystole during Le Fort I osteotomy. J Oral Maxillofac Surg 47:1082–1083
7. Locke MM, Spiekermann BF, Rich GF (1999) Trigeminovagal reflex during repair of a nasal fracture under general anesthesia. Anesth Analg 88:1183–1184
8. Loewinger J, Cohen M, Levi E (1987) Bradycardia during elevation of a zygomatic arch fracture. J Oral Maxillofac Surg 45:710–711
9. Robideaux V (1978) Oculocardiac reflex caused by midface disimpaction. Anesthesiology 49:433
10. Kuchta J, Koulousakis A, Decker A, Klug N (1998) Pressor and depressor responses in thermocoagulation of the trigeminal ganglion. Br J Neurosurg 12:409–413
11. Chesley LD, Shapiro RD (1989) Oculocardiac reflex during treatment of an orbital blowout fracture. J Oral Maxillofac Surg 47(5):522–523
12. Ziccardi VB, Russavage J, Sotereanos GC, Patterson GT (1991) Oculocardiac reflex: pathophysiology and case report. Oral Surg Oral Med Oral Pathol 71(2):137–138
13. Hirjak, Zajko J, Satko L (1993) Bradycardia after orbital injury. Case report. Int J Oral Maxillofac Surg 22:26–27
14. Sires BS (1999) Orbital trapdoor fracture and oculocardiac reflex. Ophthal Plast Reconstr Surg 15(4):301–302
15. Lang S, Lanigan DT, vander Wal M (1991) Trigeminocardiac reflexes: maxillary and mandibular variants of the oculocardiac reflex. Can J Anaesth 38:757–760
16. Schaller B (2004) Trigeminocardiac reflex: a clinical phenomenon or a new physiological entity? J Neurol 251:658–665
17. Blanc VF (1991) Trigeminocardiac reflexes. Can J Anesthesia 38:696–699
18. Aschner B (1908) Ueber einen bisher noch nicht heschriebenen reflex vom auge auf k.reislauf und atmung: verschwinden des Radialispulses bei Druck auf das Auge. Wien Kiln Wochenscr 21:1529–1530
19. Dagnini G (1908) Intemo ad un riflesso provocato in alcuni emiplegici collo stimolo della come e colla pressione sul bulbo oculare. Bull Sci Med 8:380–381
20. Shearer ES, Wenstone R (1987) Bradycardia during elevation of zygomatic fractures. Anaesthesia 42:1207–1208
21. Shelly MP, Church JJ (1988) Bradycardia and facial surgery (letter). Anaesthesia 43:422
22. Schaller B, Cornelius JF, Prabhakar H, Koerbel A, Gnanalingham K, Sandu N et al (2009) Trigemino-Cardiac Reflex Examination Group (TCREG) The trigeminocardiac reflex: an update of the current knowledge. J Neurosurg Anesthesiol 21:187–195
23. Bainton R, Lizi E (1987) Cardiac asystole complicating zygomatic fracture. Oral Surg 64:24–25
24. Gillespie IA (1988) Bradycardia during elevation of zygomatic fractures. Anaesthesia 43(7):608–609
25. Reaume CE, MacNicol BM (1988) Complications encountered during LeFort I osteotomy in a patient with mandibulofacial dysostosis. J Oral Maxillofac Surg 46:1003–1004
26. Precious DS, Skulsky FG (1990) Cardiac dysrhythmias complicating maxillofacial surgery. Int J Oral Maxillofac Surg 19:279–282
27. Bainton R, Barnard N, Wiles JR, Brice J (1990) Sinus arrest complicating a bitemporal approach to the treatment of pan-facial fractures. Br J Oral Maxillofac Surg 28:109–110
28. Morey TE, Bjoraker DG (1996) Asystole during temporomandibular joint arthrotomy. Anesthesiology 85:1488–1491
29. Delap TG, Kaberos A, Grant WE, Stearns MP (1995) Asystole during thyroid resection. Arch Otolaryngol Head Neck Surg 121:1068–1070
30. Slade CS, Cohen SP (1999) Elicitation of the oculocardiac reflex during endoscopic forehead lift surgery. Plast Reconstr Surg 104(6):1828–1830
31. Starr NJ, Sethna DH, Estafanos FG (1986) Bradycardia and asystole following rapid administration of sufentanil with vecuronium. Anesthesiology 64:521–523
32. Rivard JC, Lebowitz PW (1988) Bradycardia after alfentanil-succinylcholine. Anaesth Analg 76:907
33. Schmeling WT, Kampine JP, Warltier DC (1989) Negative chronotropic actions of sufentanil and vecuronium in chronically instrumented dogs pretreated with propanolol and/or diltiazem. Anaesth Analg 66:4–14
34. Lübbers HT, Zweifel D, Gratz KW, Kruse A (2010) Classification of potential risk factors for trigeminocardiac reflex in craniomaxillofacial surgery. J Oral Maxillofac Surg 68(6):1317–1321
35. Hurwitz PJ, Ogilvie M (1995) Reflex bradycardia in out-patient surgery done/under local anesthesia. Eur J Plast Surg 18:76–78
36. Ohashi T, Kase M, Yokoi M (1986) Quantitative analysis of the oculocardiac reflex by traction on human extraocular muscles. Invest Ophthalmol Vis Sci 27:1160–1164
37. Cha ST, Eby JB, Katzen JT, Shahinian HK (2002) Trigeminocardiac reflex: a unique case of recurrent asystole during bilateral trigeminal sensory root rhizotomy. J Craniomaxillofac Surg 30:108–111
38. Kummoona R (2009) Management of injuries of the orbital skeleton. J Craniofac Surg 20(3):762–767
39. Emily JK, Brad JT, Daniel LD, Henry CV (2011) Orbital floor fractures: outcomes of reconstruction. Ann Plast Surg 66(5):508–512
40. Strortebecker TP (1953) Post-traumatic oculocardiac syndrome from a neurosurgical point of view. J Neurosurg 10:682–686
41. Habal MB, Beart R, Murky JE (1972) Mediastinal emphysema secondary to fracture or orbital floor. Am J Surg 123:606–608
42. Fayon M, Gauthier M, Faria Blanc V et al (1995) Intraoperative cardiac arrest due to the oculocardiac reflex and subsequent death in a child with occult Epstein-Barr virus myocarditis. Anesthesiology 83:622–624
43. Sorenson EJ, Gilmore JE (1956) Cardiac arrest during strabismus surgery. Am J Opthalmol 41:748–752
44. Krisch RE, Samet P, Kugel V, Axelrod S (1957) Electrocardiographic changes during ocular surgery and their prevention by retrobulbar injection. Arch Opthalmol 58:348–356
45. Gupta N, Kumar R, Kumar S, Sehgal R, Sharma KR (2007) A prospective randomised double blind study to evaluate the effect

of peribulbar block or topical application of local anesthesia combined with general anesthesia on intra-operative and post-operative complications during paediatric strabismus surgery. Anaesthesia 62:1110–1113
46. Shende D, Sadhasivam S, Madan R (2000) Effects of peribulbar bupivacaine as an adjunct to general anesthesia on peri-operative outcome following retinal detachment surgery. Anaesthesia 55:970–975
47. Hunsley E, Bush GH, Jones CJ (1982) A study of glycopyrrolate and atropine in the suppression of the oculocardiac reflex in strabismus surgery in children. Br J Anaesth 54:459–464
48. Schaller B, Sandu N, Filis A, Buchfelder M (2008) Peribulbar block of topical application of local anesthesia combined for paediatric strabismus surgery. Anaesthesia 63:1142–1143
49. Prabhakar H, Ali Z, Rath GP (2008) Trigemino-cardiac reflex may be refractory to conventional management in adults. Acta Neurochir (Wien) 150:509–510