It has been shown that increasing central cholinergic tone may play an important role in the mechanism by which general anaesthetic drugs produce unconsciousness.\(^1\)\(^2\) It has been shown that increasing central cholinergic tone with the anticholinesterase physostigmine antagonizes the hypnotic effect of propofol or sevoflurane shown by the return of consciousness.\(^3\)\(^4\) In contrast, passage of neostigmine across the blood–brain barrier (BBB) is limited.\(^5\) Therefore, it is reasonable to suppose that neostigmine does not possess arousal effects like physostigmine. However, we experienced an elderly neurosurgical case in which neostigmine probably reversed prolonged recovery from general anaesthesia.

A 70-yr-old woman was undergoing an elective removal of a left temporal lobe tumour. Before operation, she had no neurological deficit, her medical history included hypertension, and her physical examination and laboratory analyses were essentially normal.

No premedication was given. Bispectral index (BIS) was recorded using the Aspect A-2000 EEG monitor (BIS version 3.4; Aspect Medical Systems, Newton, MA, USA) with electrodes (Zipprep; Aspect Medical System) positioned around the lateral corner of the right eye.\(^6\) Anaesthesia was induced with propofol 100 mg and fentanyl 100 \(\mu g\) and the trachea was intubated after rocuronium 30 mg. The ventilatory frequency was adjusted to maintain normocapnia. The rectal temperature was monitored and maintained at normothermia. Anaesthesia was maintained with 1–2% sevoflurane in oxygen/air to keep BIS at 50–60. Remifentanil was given by continuous infusion to achieve adequate analgesia (0.1–0.2 \(\mu g\) kg\(^{-1}\) min\(^{-1}\)). No further rocuronium was given during the operation. During craniotomy, 300 ml of 20% mannitol was infused to prevent cerebral oedema. After uneventful surgery (4 h), the patient was asleep, but spontaneous ventilation was sufficient. Repeated measurements of train-of-four ratio with acceleromyography (TOF-WATCHTM, Schering-Plough, Kenilworth, NJ, USA) were 1.0 or more, indicating no residual neuromuscular block.\(^7\) She remained deeply sedated without response to verbal or tactile stimulation. BIS score was still around 60, although the expiratory sevoflurane concentration was almost zero. The BIS sensor was relocated in the commercially recommended position; however, BIS score was unchanged. As consciousness was still not present after 65 min, a presumptive diagnosis of alteration of central cholinergic transmission by general anaesthesia was proposed. We had to use neostigmine as physostigmine is not available in Japan. Immediately after the administration of neostigmine (2 mg), BIS score increased 60–95, spontaneous eye opening occurred, and she became responsive to verbal commands. A transient decrease in heart rate from 80 to 60 beats min\(^{-1}\) was observed, but no treatment was necessary. The patient was transferred to the intensive care unit for further postoperative treatment with no evidence of persisting neurological deficit. Additional neostigmine was not required. A single administration of physostigmine is usually efficient for treatment of central anticholinergic syndrome after general anaesthesia.\(^8\)

Central cholinergic transmission can be inhibited to some degree after general anaesthesia.\(^9\)–\(^11\) Therefore, it is recognized that postoperative sustained deep sedation is occasionally caused by reduced central anticholinergic transmission.\(^8\) Postoperative respiratory depression due to opioids and residual neuromuscular block were not presented in our case, and the expired sevoflurane concentration was almost zero. As the recovery from deep sedation relates to the time of neostigmine administration, it is reasonable to consider that central cholinergic transmission played an important role in developing postoperative sustained deep sedation in this case.

Neostigmine given peripherally is thought to be ineffective at reversing central cholinergic inhibition. However, mannitol was given in this case, and this has been used to deliver drugs into the brain parenchyma through its osmotic effect on the BBB.\(^12\) In addition, BBB may have been damaged during the neurosurgical procedures. Therefore, the neostigmine may have entered the brain through a disrupted BBB and restored cholinergic transmission.

The elapsed time (65 min) could itself be an important factor in the recovery from anaesthesia in this case. However, it is not unreasonable to suggest that neostigmine was the pivotal factor in recovery, taking the recovery profile and timing of neostigmine administration into consideration.

In conclusion, we describe a case showing rapid awakening in a patient with prolonged recovery from general anaesthesia after administration of neostigmine. It is proposed that restoration of central cholinergic transmission by neostigmine was responsible for this.

Conflict of interest
None declared.

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Rapid awakening after administration of neostigmine in an elderly neurosurgical patient with prolonged recovery from general anaesthesia

Editor—It is postulated that alteration of central cholinergic transmission may play an important role in the mechanism by which general anaesthetic drugs produce unconsciousness.\(^1\)\(^2\) It has been shown that increasing central cholinergic tone with the anticholinesterase physostigmine antagonizes the hypnotic effect of propofol or sevoflurane shown by the return of consciousness.\(^3\)\(^4\) In contrast, passage of neostigmine across the blood–brain barrier (BBB) is limited.\(^5\) Therefore, it is reasonable to suppose that neostigmine does not possess arousal effects like physostigmine. However, we experienced an elderly neurosurgical case in which neostigmine probably reversed prolonged recovery from general anaesthesia.

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Conflict of interest
None declared.

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Automated perioperative QT monitoring in a patient with long QT syndrome 2

Editor—The perioperative treatment of patients with long QT syndrome (LQTS) is increasingly recognized as being challenging. This is in part due to the risk of inducing severe ventricular arrhythmia by unopposed sympathetic stimulation and also the risk posed by drug-induced Torsade de Pointes (TdP). As a consequence, standardized management including perioperative QT monitoring has been recommended. However, despite the current recommendation and increasing awareness of the perioperative implications of LQTS, continuous automated perioperative monitoring of the QT time or the QTc interval has not been established. In this report, we describe the feasibility of automated continuous perioperative QT monitoring in a 57-year-old female patient suffering from congenital LQT2 syndrome. The patient had a family history of severe cardiac events and sudden cardiac death. QT prolongation resulted from A2069G mutation in the KCNH2 gene. This mutation results in LQT2 through amino acid exchange N629S in HERG channel proteins. The patient was undergoing tibial implant removal after tibial and fibular plate osteosynthesis.

Recording of continuous perioperative 12-lead electrocardiograms included automated QT and QTc analysis (12 SL algorithm, GE Medical Systems, Milwaukee, WI, USA). The QTc interval immediately before induction was 619 ms (Fig. 1). Anaesthesia was induced with fentanyl (0.1 mg) and propofol (150 mg). Ventilation was secured by the placement of a laryngeal mask airway. Balanced anaesthesia was maintained by the combination of fentanyl and end-expiratory concentrations of desflurane of between 4% and 6%. Heart rate, arterial pressure, pulse oximetry, and end-expiratory carbon dioxide were kept within normal ranges. The maximal deviation of any QTc interval from the median QTc interval duration (631 ms) was 10% with a difference between the maximal (694 ms) and the minimal perioperative value (584 ms) of 16%. Recovery from anaesthesia was uneventful and postoperative pain control was achieved by i.v. piritramid. Despite severe QTc-prolongation during the entire perioperative period (Fig. 1), the patient remained free from cardiac arrhythmia such as T-wave alternans, short–long–short RR intervals, R on T phenomena, or TdP. The patient was discharged from the post-anaesthesia recovery unit fully awake, free from pain, and without any signs of cardiovascular compromise.

Monitoring of the QT interval during the entire perioperative treatment of patients with LQTS has been recommended. However, despite these requirements, neither the feasibility of