

Equipment failure of intravenous syringe pump detected by increase in Narcotrend stage

A case report

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Abstract

Rationale: Awareness is the recovery of consciousness during general anesthesia. It occurs when patients under general anesthesia receive inadequate anesthetic medications to maintain unconsciousness during surgery. Equipment failure is a common cause of intraoperative awareness.

Patient concerns: A 16-year-old boy, 85 kg in weight, was admitted to our hospital for thyroglossal cystectomy under general anesthesia. Six minutes after the intubation, we noted that the Narcotrend index indicated a condition of light anesthesia and the patient was observed to be in tears.

Diagnosis: Improper positioning of the syringe fixing clamp on the CP700TCI infusion pump caused equipment failure and light anesthesia.

Interventions: Bolus of 50 mg propofol and 2 mg midazolam were administered manually by syringe, and inhalation of 2% sevoflurane was supplemented. Infusion pump was replaced.

Outcomes: The Narcotrend index of the patient returned to state of deep anesthesia following manual administration of the anesthetic medications. Following the surgery, the patient had an uneventful recovery, and did not present with evidence of awareness.

Lessons: Users of the CP700TCI syringe pump should pay attention to the position of the syringe fixing clamp. Anesthesiologists should check all the equipment according to a defined checklist prior to anesthesia. Narcotrend monitor could help to detect light anesthesia and prevent potential awareness.

Abbreviations: BIS = bispectral index, EEG = electroencephalogram.

Keywords: consciousness monitors, equipment failure, intraoperative awareness, prevention and control

1. Introduction

Awareness is the unintended recovery of consciousness during general anesthesia. It can occur when there is insufficient anesthetic medication to keep patients unconscious during the

operation. Awareness can cause significant distress, with some patients who experience awareness developing posttraumatic stress disorder.^[1] Equipment failure is a common cause of intraoperative awareness.^[2] Intravenous syringe pumps (CP700TCI, SLGO Medical Technology Co, Beijing, China) are widely used in China; to date, no equipment failure has been reported. Electroencephalographic (EEG) brain activity monitoring has the potential to decrease the risk of awareness. Bispectral index (BIS) monitor is the most widely used EEG monitoring system to measure the depth of anesthesia, and its application has been associated with a decrease in incidence of awareness. An increase in the BIS index could indicate a need for interventions to prevent possible awareness.^[3–5] Narcotrend, another type of EEG monitor, is equally effective in measuring the depth of anesthesia,^[6–8] but reports on the use of Narcotrend to prevent awareness are rare. Here, we report a case where improper positioning of a syringe fixing clamp of the infusion pump could have resulted in inadequate delivery of anesthetic medication and ultimately intraoperative awareness. Narcotrend index monitoring enabled real-time detection of the insufficient anesthetic condition due to equipment failure, and helped to prevent possible awareness.

2. Case presentation

A 16-year-old boy, 85 kg in weight, was admitted to our hospital (The First Hospital of Jilin University) for thyroglossal cystectomy under general anesthesia. Preoperative laboratory results, chest X-ray, and electrocardiogram (ECG) were within the

Editor: N/A.

A consent for participation was obtained from the parent.

A consent for publication was obtained from the parent.

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

The authors did not receive any funding for the preparation of this manuscript.

The authors have no conflicts of interest to disclose.

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Medicine (2018) 97:47(e13174)

Received: 9 July 2018 / Accepted: 17 October 2018

<http://dx.doi.org/10.1097/MD.00000000000013174>

normal ranges. The patient fasted for 12 hours prior to the operation.

In the operating room, noninvasive blood pressure, ECG, and oxyhemoglobin saturation (SpO₂) were monitored by the IntelliVue MP50 monitor (Philips Medizin Systeme, Graseby Medical Limited, Watford, U.K.) and Narcotrend index by the Narcotrend Index Monitor (Technik, Bad Bramstedt, Germany). Rapid induction of anesthesia was performed with fentanyl (3 μg/kg), cisatracurium (0.2 mg/kg), and propofol (1.5 mg/kg). One minute after the induction, the Narcotrend index decreased from 99 to 27. After intubation, continuous infusion of 2% propofol (6 mg/kg/h and remifentanyl 0.5 mg/h) was provided using an intravenous syringe pump (CP700TCI, SLGO Medical Technology Co China). Six minutes after the intubation, the Narcotrend index increased from 27 to 84 (Fig. 1). At the same time, the surgical staff observed that the patient was in tears. These observations indicated that the patient was under light anesthesia and might be at risk of developing awareness. The patient was twice provided with a bolus of propofol (10 mg/bolus) through the syringe pump. The infusion rate of propofol was increased to 8 mg/kg/h because we believed that the drug clearance rate in this patient was high. However, the Narcotrend index remained in the 73–85 range. The Narcotrend index did not change even after the patient was administered with additional bolus of propofol. During the trouble-shooting procedure, we noted that the syringe fixing clamp of the infusion pump was not in the proper position. Further examination showed that the spring has been eroded by colloid and became viscid, and in consequence could not push up on the clamp. In effect, the syringe pump was found to be in working condition, but the issue with the syringe fixing clamp resulted in no infusion of propofol (demonstrated in Fig. 2A). This was confirmed by a lack of any change in volume of the propofol in the syringe in spite of multiple efforts at infusion. In light of this finding, the patient was manually administered with a bolus of 50 mg of propofol and 2 mg of midazolam using a

syringe, and supplemented with inhalation of 2% sevoflurane by inhalation. We noted that the Narcotrend index had returned to 23 (a state of deep anesthesia) following the manual administration of anesthetic medications. The syringe pump was replaced, and the surgery was allowed to proceed and lasted for 105 minutes. During the surgery, the Narcotrend Index was maintained within the 22–64 range. The patient had an uneventful recovery, and showed no evidence of awareness immediately after the recovery period or in the 3-day follow-up.

3. Discussion

We report that improper positioning of the syringe fixing clamp component of the infusion pump resulted in insufficient delivery of anesthetic medication, and could have led to intraoperative awareness. We were able to detect the insufficient anesthesia on the basis of Narcotrend index monitoring, leading to the discovery of equipment failure, and more importantly were able to provide proper intervention to prevent potential intraoperative awareness. The intravenous syringe pump (CP700TCI, SLGO Medical Technology Co) is widely used in China, but we have identified 2 apparent defects that need to be addressed. First, the spring located at the end of syringe pump is liable to erosion, causing the syringe fixing clamp to become viscid and unable to bounce up to the correct position. This prevented delivery of the appropriate dose of medication unknowingly to the medical staff. Second, there was no alarm to notify users of issues with the specific syringe pump. We believe that attention should be given to the above-described components of the CP700TCI syringe pump to ensure correct administration of anesthetic medications.

We have now carefully evaluated the different syringe pumps available in our department, and these include the CP700TCI (SLGO Medical Technology Co), the CP3100 (SLGO Medical Technology Co), the JZB-1800C (Jianyuan Medical Technology Co), and the Graseby 3500 (Graseby Medical Limited, UK). We

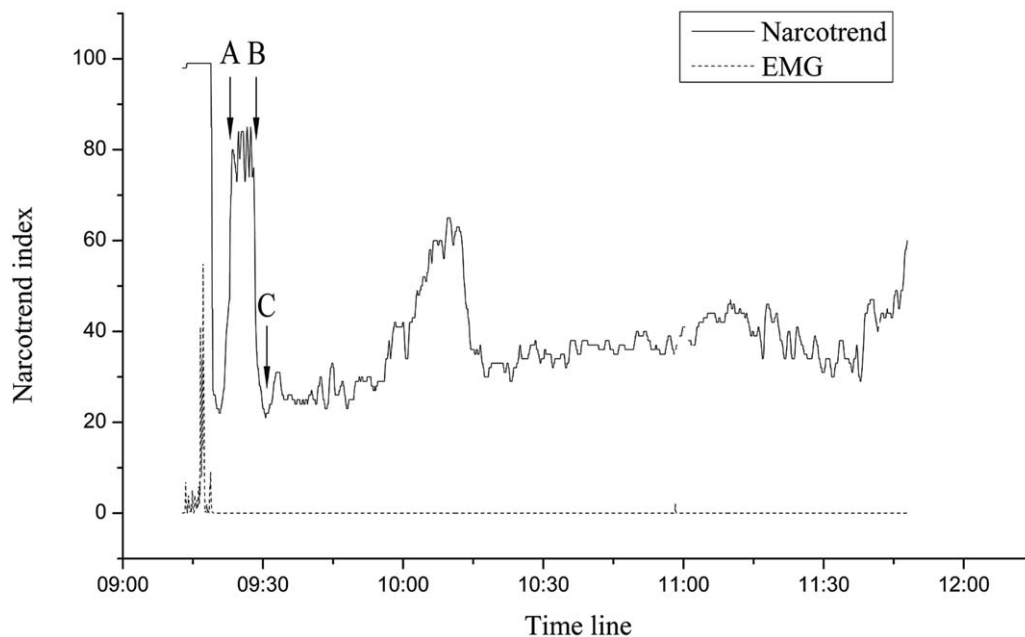


Figure 1. The Narcotrend tracing (black line), and the facial electromyographic activity (EMG) tracing (red line) for the case. At arrow A the rapid increase of Narcotrend index was discovered, and a propofol bolus through intravenous syringe pump was given. At arrow B the incorrect position of the clamp was found, and a propofol bolus was given through manual IV. At arrow C Narcotrend index returned to deep anesthesia after administration of propofol manually.

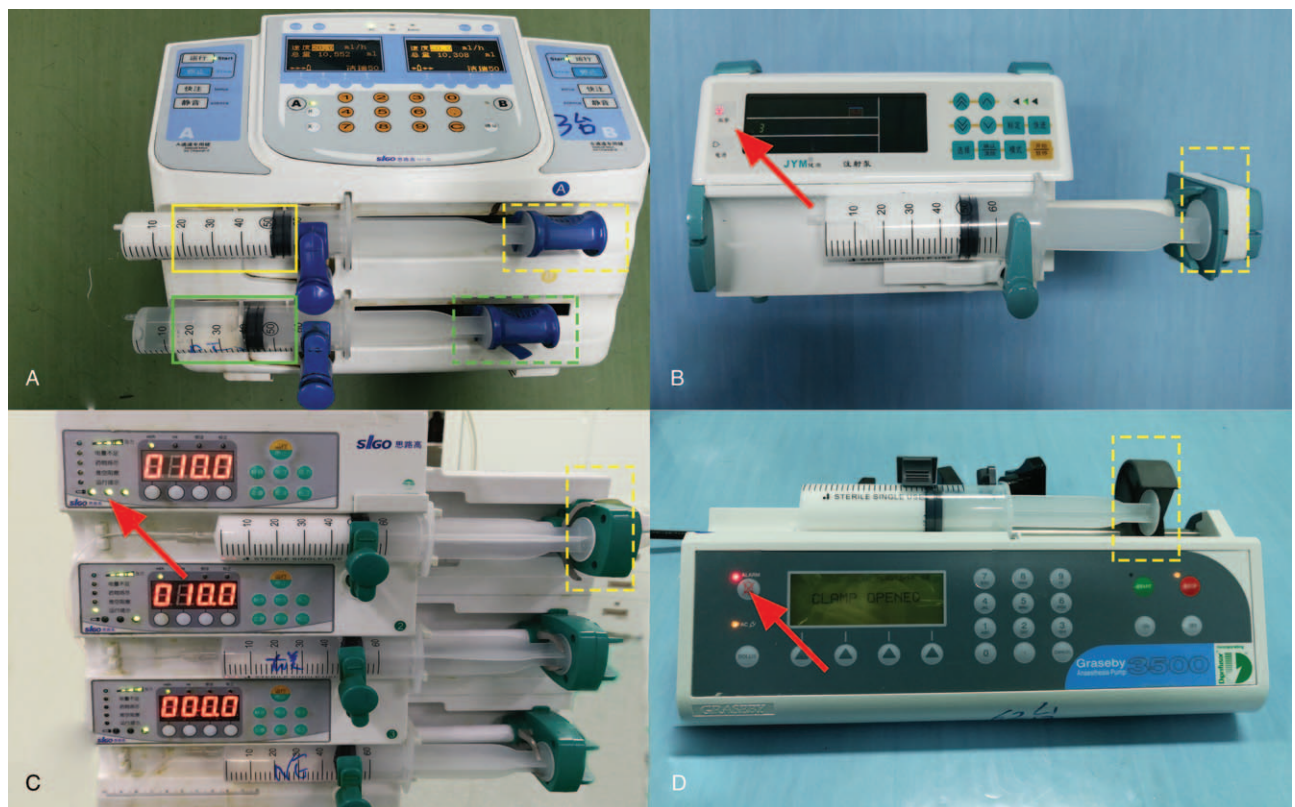


Figure 2. The syringe pumps mentioned in this article. A, The syringe pump (CP700TCI) used in this case. The green rectangle highlights the clamp of the intravenous syringe pump was in right position and the volume of syringe changed after infusion for 30 minutes, while the yellow rectangle highlights the syringe clamp did not bounce back and the volume of syringe did not change without alarming during 30 minutes infusion. B–D, Another 3 types of syringe pumps in our department (CP3100, JZB-1800C, and Graseby 3500). We intentionally put the clamp of the intravenous syringe pump in the wrong position by adhesive tape or manually open the clamp (highlighted by the yellow rectangle in (B–D)), all the 3 types of pumps showed alarms ((highlighted by the red arrows).

intentionally place the syringe fixing clamp at the wrong position by using adhesive tape or manually opening the clamp (shown in Fig. 2B–D) to mimic the condition described above. An alarm was triggered with the CP3100, JZB-188C, and Graseby 3500, but not with the CP700TCI. We concluded that alarm system in the CP700TCI was defective or not properly designed. We are in the process of removing the CP700TCI syringe pump from use in our hospital.

We strongly suggest that a systemic preoperative evaluation for anesthesia machine, vaporizer, leak detection of the respiratory circle, patient's IV line, and intravenous syringe pump be implemented. There is evidence to suggest that a checklist system to monitor equipment could improve the safety of anesthesia.^[9,10] After this experience, we have made further improvements to our preoperative checklist, and emphasized the importance of this procedure to our entire department.

It has been reported that BIS index monitoring can help to prevent awareness during general anesthesia.^[4] Narcotrend (Monitor Technik, Bad Bramstedt, Germany) is another EEG device for the assessment of the depth of anesthesia, and has been commercially available in Europe since 2000 and recently received US Food and Drug Administration approval.^[6] However, reports on the use Narcotrend monitoring to help prevent awareness are limited. While the BIS index is more widely accepted by anesthesiologists, Narcotrend monitoring does have advantages. First, the cost of the sensors in the Narcotrend (£0.14 per sensor) is lower than those of the BIS system (£14.50 per sensor).^[11] Second, there is a good correlation between

Narcotrend and BIS index.^[12] Lastly, in this report the Narcotrend index played a major role in identifying a risk of awareness due to an issue with the syringe pump.

In conclusion, we report a case of light anesthesia caused by failure of the CP700TCI infusion pump. Users of this specific syringe pump should pay attention to potential issues with the syringe fixing clamp and alarm system. Anesthesiologists should perform thorough evaluation of equipment using a well-defined checklist before anesthesia. Finally, we strongly advocate the application of Narcotrend monitor during anesthesia to detect signs of light anesthesia in order to prevent the occurrence of awareness.

Author contributions

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