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CLINICAL REPORT

Awake intubation under sedation using target-controlled infusion of dexmedetomidine: five case reports

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Abstract We used target-controlled infusion (TCI) of dexmedetomidine (DEX) for awake intubation under sedation in 5 patients who had a risk of pulmonary aspiration or difficult airway. Dexmedetomidine level was escalated stepwise until the patients developed tolerance to laryngoscopy. The target DEX concentrations at the time of intubation were 2.10–5.95 ng/ml and were higher than those clinically used for sedation in the intensive care unit (ICU). Chin lift was applied in 1 case, and therefore no assisted ventilation was required and pulse oxygen saturation was maintained at >98% throughout the procedure. Simple pharmacological interventions for blood pressure changes induced by increased target plasma DEX concentrations were needed in 4 cases. However, hemodynamics was stable, and no cardiovascular drug was needed after tracheal intubation. Conditions at laryngoscopy were excellent in all cases, and conditions at tracheal intubation were good except in 1 case. Reflex to intubation was preserved in all cases, and coughing was observed in all cases. The patients had no memory of discomfort and/or intubation. Although further investigations are needed, this method may be useful for awake intubation under sedation.

Keywords Dexmedetomidine · Tracheal intubation · High dose · Target-controlled infusion

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Introduction

Dexmedetomidine is considered useful as an agent for awake intubation under sedation because it exerts almost no effect on respiration [1]. Dexmedetomidine in clinical doses facilitates fiberoptic intubation and neurological assessment immediately after tracheal intubation, and the Ramsay Sedation Scale (RSS) [2] does not increase to more than 3 [3]. We intended to facilitate laryngoscopy and tracheal intubation without causing discomfort and any memory of the event in patients in whom awake intubation under sedation was indicated due to the risk of aspiration or difficult airway. We administered dexmedetomidine (DEX) using a target-controlled infusion (TCI) system, and the target plasma concentration of DEX was escalated until there was no expression of discomfort at laryngoscopy, following which tracheal intubation was performed. Here, we report 5 cases of awake intubation under sedation using high-dose DEX and discuss their management.

Case description

The Research Ethics Committee of Asahikawa Medical College approved and monitored the method of awake intubation under sedation, and we obtained written informed consent from 5 patients in whom awake

Table 1 Patient information

	Case				
	1	2	3	4	5
Age, year/gender	80 s, M	80 s, F	70 s, F	60 s, M	70 s, F
Weight (kg)/height (cm)	57/155	52/148	54/146	63/162	30/155
Diagnosis	Arteriosclerosis obliterans	Thyroid cancer	Phrenic nerve paralysis	Stomach roll cancer	Malnutrition
Surgical procedure	Peripheral vessel bypass grafting	Tumor resection	Diaphragmatic complication	Resection of stomach roll and reconstruction of the jejunum	Cecal fistula plasty
Indication for sedative intubation	After total gastrectomy	Predicted difficult airway	Predicted difficult airway	After esophagectomy	After total gastrectomy

intubation under sedation was indicated due to the risk of pulmonary aspiration or difficult airway (Table 1). No patients received any premedication. In addition to standard monitoring, we monitored blood pressure (BP) invasively via a cannula inserted into the radial artery. We administered oxygen through a face mask at 3 L/min; 6 L/min of oxygen was administered via the mask kept close to the face during laryngoscopy. Dexmedetomidine administration was initiated using the TCI system, targeting a plasma concentration of 0.35 or 0.7 ng/ml. STANPUMP software (available at: http://www.opentci.org/doku.php; accessed 1 March 2010) was used to operate the infusion pump (Graseby 3500, Smiths Medical, UK) with the Dyck parameter setting [4].

The target plasma concentration of DEX was escalated in accordance with the RSS, with an increase of 0.35 or 0.7 ng/ml at an interval of 3–5 min (Fig. 1). Three patients received epidural tubing under sedation prior to attempting tracheal intubation. After an RSS of 3 was attained, 8% lidocaine was gradually sprayed onto the tongue, beginning from the tip to the base, using a laryngoscope. Topical anesthesia was not applied to the trachea in order to preserve the laryngeal reflex. Tracheal intubation (double-lumen tube in case 4) was performed when the patient exhibited no discomfort at laryngoscopy. DEX administration was stopped after intubation in cases 1–3 and 5 and after consequent bronchial fiberscopy in case 4. Propofol (0.5–2 mg/kg) and fentanyl (0–2 μg/kg) were administered for anesthetic induction at the same time. Cardiovascular agents administered, patient condition, and observations made at tracheal intubation [5] are presented in Table 2. During RSS increase, ephedrine was administered for increasing BP to 1 patient because their systolic BP (SBP) had decreased to <80 mmHg, and nicardipine was administered for decreasing BP to 3 patients because the SBP had increased to >160 mmHg. However, there was little cardiovascular response to intubation; the less than 15% hemodynamic change after tracheal intubation in all patients did not necessitate the use of cardiovascular agents after tracheal intubation. No cardiovascular agents were needed after anesthetic induction. The patient condition at intubation was good in 4 cases but poor in 1 case that exhibited vigorous limb movement and persistent coughing for more than 10 s. In case 2, an incomplete airway obstruction was observed, and this was easily rectified by performing a chin lift; the target plasma DEX concentration was 2.1 ng/ml in this case. Further, assisted ventilation was not required, and pulse oxygen saturation was maintained to >98% throughout the process in all patients. The results of blood gas analysis performed in 2 cases were good despite administration of high doses of DEX. The pH, partial pressure of carbon dioxide in arterial blood ($PaCO_2$) (mmHg), and partial pressure of oxygen in arterial blood (PaO_2) (mmHg) were 7.42, 45, and 210, respectively, in case 2 three min after

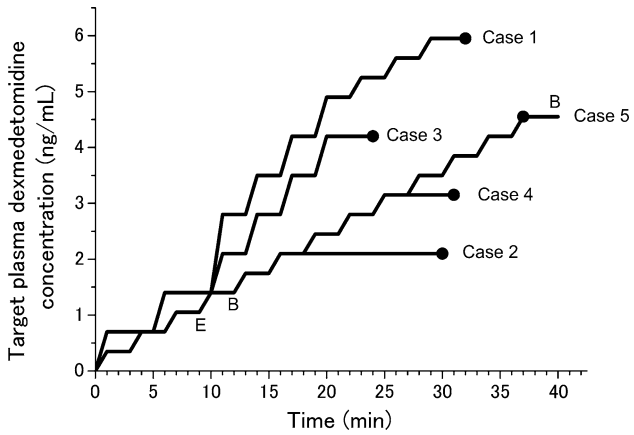

Fig. 1 Target plasma concentration of dexmedetomidine (DEX) and events. Target plasma concentration of DEX (Cp) and the remarkable anesthetic event in each case. The target Cp increased until the patients developed tolerance to laryngoscopy. *E* indicates completion of epidural tubing in cases 3, 4, and 5, when the target Cp was 1.05 ng/ml at 9–10 min after initiating DEX administration. The *closed circles* indicate completion of tracheal intubation. *B* indicates time point of blood gas sampling conducted at a target Cp of 1.4 ng/ml in case 2 and a target Cp of 4.45 ng/ml

Table 2 Cardiovascular agents administered and patient condition at tracheal intubation

	Case				
	1	2	3	4	5
Cardiovascular agent	0.5 mg nicardipine	1 mg nicardipine	5 mg ephedrine	1 mg nicardipine	None
Condition at tracheal intubation	Poor	Good	Good	Good	Good
Laryngoscopy	Excellent	Excellent	Excellent	Excellent	Excellent
Vocal cords					
Position	Good	Good	Good	Good	Good
Movement	Good	Good	Good	Good	Good
Reaction to intubation					
Movement of the extremities	Poor	Good	Good	Good	Good
Coughing	Poor	Good	Good	Good	Good

Intubation conditions [5]: *Excellent* all variables were excellent, *Good* all variables were either excellent or good, *Poor* the presence of one or more variables graded as poor

Laryngoscopy: *Excellent* easy to perform—jaw relaxed, no resistance to the blade during laryngoscopy, *Good* moderately easy to perform—jaw not completely relaxed, slight resistance to the blade, *Poor* difficult to perform—poor jaw relaxation, active resistance by the patient

Position of the vocal cords: *Excellent* abducted, *Good* intermediate, *Poor* closed. Movement of the vocal cords: *Excellent* none, *Good* moving, *Poor* closing

Movement of the extremities in response to intubation: *Excellent* none, *Good* slight, *Poor* vigorous

Coughing: *Excellent* none, *Good* diaphragmatic, *Poor* sustained (>10 s)

Table 3 Whether epidural tubing was performed or not, required time for tracheal intubation, target dexmedetomidine (DEX) concentrations, and amounts administered at intubation

	Case				
	1	2	3	4	5
Epidural tubing	−	−	+	+	+
Required time for tracheal intubation (min)	32	30	25	31	37
Target plasma DEX concentration (ng/ml)	5.95	2.1	4.2	3.15	4.45
Total amount of DEX administered until tracheal intubation (μg)	239	118	193	187	255
Total amount of DEX per kilogram weight until tracheal intubation (μg/kg)	4.2	2.3	3.6	3.0	8.5

targeting a plasma DEX concentration of 1.4 ng/ml, and the respective values were 7.41, 48, and 280 in case 5 three min after intubation at fraction of inspired oxygen (FiO_2) of 66% oxygen. To confirm placement of the double-lumen tracheal tube and replacement of the endotracheal tube in case 4, bronchial fiberscopy was performed, with DEX at the same concentration as that at intubation, without any coughing episodes under regular spontaneous breathing after intubation, during which there was nonpersistent coughing. There was no memory of discomfort at laryngoscopy or of the intubation procedure, as reported during the interview conducted the next day. The time required for intubation was 25–37 min. The target DEX concentrations at intubation were 2.10–5.95 ng/ml, and the amounts of DEX administered were 187–255 μg (2.3–8.5 μg/kg) (Table 3).

Discussion

Awake intubation under sedation using a clinical dose of DEX has 3 advantages: (1) DEX barely affects the respiratory system [1]; (2) it induces conscious sedation that facilitates neurological assessment immediately after intubation [2]; and (3) it causes sialoschesis, thereby providing a good intraoral view for intubation [3, 6]. Since our patients were not at a risk of neurological injury, neurological assessments after intubation were not required. Therefore, we decided to perform awake intubation under sedation after the patients were free from any discomfort at laryngoscopy so the patients would be comfortable at the consequent intubation as well. Hence, high target plasma concentrations of DEX were required.

Ramsay and Luterman reported the usefulness of high-dose DEX for surgery with potential airway management challenges [7]. The required doses to attain an acceptable level of anesthesia during airway surgery were higher than those required for sedation in the intensive care unit (ICU). Our patients also required a high target plasma concentration of DEX to develop tolerance to laryngoscopy. The respiratory condition was stable in all patients, with assisted ventilation not being required in any case and chin lift being required only in case 2 despite administration of high-dose DEX, leading to preservation of saturation of peripheral oxygen (SpO_2) to >98% in all cases. It is believed that a high dose of DEX barely affects the respiratory system, a finding consistent with that reported by Ebert et al. [1]. This method is believed to facilitate intubation without causing discomfort to patients because our patients had no memory of discomfort at laryngoscopy and/or intubation. However, the condition at intubation was poor in case 1, and further studies are required to determine the concentration that would facilitate a good condition at intubation in many patients.

Ebert et al. [1] detailed the effects of increasing the plasma concentration of DEX in humans. It is widely known that such an increase leads to an increase or decrease in BP and a decrease in heart rate (HR). Among our patients, BP increased in 3 patients and decreased in 1, necessitating simple pharmacological interventions. A hemodynamic change warrants strict monitoring of patient hemodynamics and rapid treatment. In contrast, the little cardiovascular response to intubation in all patients did not necessitate the use of cardiovascular agents. The sympatholytic effect of DEX and DEX-induced suppression of catecholamine release in response to a noxious stimulation are believed to cause a decrease in cardiovascular response [1]. Moreover, since the half-life period of DEX is approximately 2.3 h, the effect of DEX on hemodynamics may be prolonged. In our case, hemodynamics remained stable at anesthesia induction. However, attention must be paid to hemodynamics during anesthesia maintenance as well as induction.

We did not aim at an excellent intubation condition, that is, no coughing in response to intubation. Although we desired to reduce the pharyngeal reflex, we must preserve laryngeal reflex to prevent aspiration. Topical anesthesia was applied only up to the base of the tongue and not to the trachea. Pulmonary aspiration did not occur, and the laryngeal reflex was considered preserved because coughing occurred in response to intubation in all patients. We cannot confirm that the above conditions can completely avoid aspiration; nevertheless, we believe that the pharyngeal reflex was preserved.

A limitation of this method was that it was time consuming. We believe that the time required for the procedure increases because the effect-site concentration of DEX cannot be determined. Aantaa [8] reported that sleepiness appeared within 5 min after the intravenous administration of DEX and reached its maximum within 15 min of administration. Although the plasma DEX concentration plateaued rapidly due to the use of the plasma TCI system, the sedative effect of DEX was apparent only after some time. This late sedative effect after changing the target DEX concentration resulted in delayed development of tolerance to laryngoscopy in the patients. Since the DEX concentration required to produce the tolerance is not known, we escalated the concentration in a stepwise manner until the patient exhibited tolerance to laryngoscopy. Eventually, tracheal intubation was also delayed. Moreover, since the required DEX concentration investigated in this study—which proved to be high with a wide range for awake intubation under sedation—was the target and/or predicted plasma concentration and not the effect-site concentration, it is still difficult to decide the optimal dose. To clarify the optimal effect-site concentration of DEX, further studies that estimate the plasma effect-site equilibration rate constant as well as report many experiences with this method are required.

Awake intubation under sedation can be performed without causing discomfort to patients by using high-dose TCI of DEX. This method may be useful for patients with a risk of aspiration or difficult airway. However, further studies are required to validate this method.

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