J Anesth (2008) 22:443–445
DOI 10.1007/s00540-008-0655-x

Journal of
Anesthesia

Total intravenous anesthesia without muscle relaxant in a patient with amyotrophic lateral sclerosis

Dongchul Lee, Kyung Cheon Lee, Ji Young Kim, Yeon Soo Park, and Young Jin Chang

Department of Anesthesia and Pain Medicine, Gachon University of Medicine and Science, Gil Medical Center, 1198 Guwol-dong, Namdong-gu, Incheon 405-760, South Korea

Abstract
A 63-year-old woman with amyotrophic lateral sclerosis (ALS) was scheduled for open reduction and internal fixation of the right tibia. Total intravenous anesthesia using propofol and remifentanil without muscle relaxant was selected as the anesthetic method, in order to avoid the possible occurrence of ventilatory depression due to abnormal responses to muscle relaxants and exacerbation of the motor neuron disease. After standard and neuromuscular monitoring devices were applied, anesthesia was induced and maintained with target controlled infusion of propofol and remifentanil in the range of 2.5–5.0 $\mu g \cdot ml^{-1}$ and 2.5–5.0 $ng \cdot ml^{-1}$, respectively. To avoid delayed neuromuscular recovery, we did not use any muscle relaxant at all. Intubation was successful and there were no remarkable events during anesthesia, except for three brief hypotensive events; there was no exacerbation of ALS itself during or after the anesthesia. She was discharged on postoperative day 3, without any discomfort.

Key words Amyotrophic lateral sclerosis · Total intravenous anesthesia

Introduction

Amyotrophic lateral sclerosis (ALS) is a disease characterized by the progressive degeneration of the lower motor neurons, the motor nuclei of the brain stem, and the descending pathway of the upper motor neurons; there is currently no effective treatment for this disorder [1]. As the disease progresses, atrophy and weakness involve most of the skeletal muscles, including those of the tongue, pharynx, larynx, and chest. Impairment of respiration, altered response to muscle relaxants, and predisposition to aspiration affect safe anesthetic management. General anesthesia may cause ventilatory depression due to abnormal responses to muscle relaxants [1]. Regional anesthesia, such as spinal and epidural anesthesia, is also relatively contraindicated in patients with a motor neuron disease such as ALS, for fear of exacerbating the disease [1,2]. In general, intravenous anesthetics, including propofol and opioids, are believed not to seriously affect neuromuscular function compared with volatile anesthetics [3].

We report a patient with ALS in whom total intravenous anesthesia (TIVA) without muscle relaxant was successfully used for open reduction and internal fixation of the right tibia.

Case report

A 63-year-old female patient scheduled for the repair of a fracture of the right tibia was admitted via the emergency room. Her body weight was 65 kg and height was 155 cm. She had been taking antihypertensive and antidiabetic agents for 7 years and 10 years, respectively. About 6 years before the present admission, she had had intraabdominal surgery for a stomach tumor and removal of gallstones, separately. Then, at another hospital about 6 months before the present admission, she was diagnosed with ALS, due to progressive dysarthria, swallowing difficulty and, finally, motor weakness.

Preoperative evaluation revealed muscle weakness and atrophy. She demonstrated slurred speech and inability to move by herself. Her laboratory findings were all within normal limits, except for decreased forced expiratory volume in 1s (FEV_1) of 1.04 l (54% of predicted value) and forced vital capacity (FVC) of 1.43 l (54% of predicted value) and positive serology for the venereal disease research laboratory (VDRL) test. FEV_1/FVC was 73%. Her blood pressure remained within the normal range. Fasting blood sugar was

Address correspondence to: Y. J. Chang
Received: March 29, 2008 / Accepted: June 9, 2008

maintained between 150 and 250 mg·dl^{-1}. Her American Society of Anesthesiologists (ASA) physical status was found to be 3.

No preanesthetic medication was prescribed. In the operating room, we applied standard and neuromuscular monitoring devices (TOF GUARD; Biometer, Copenhagen, Denmark). After a baseline train-of-four (TOF) ratio was taken in the left wrist, the patient was anesthetized. At that time, the TOF ratio was about 120% at 40 mA. The TOF ratios were then continuously monitored until the end of anesthesia. To block injection pain, 30 mg lidocaine was injected intravenously. After setting the effect-site drug concentrations as 3.0 ng·ml^{-1} for remifentanil and 3.0 μg·ml^{-1} for propofol, we started anesthetic infusion. After the patient had lost consciousness, she was ventillated manually for about 1.5 min with 100% oxygen. To block a hypertensive response to airway manipulation, we set the effect-site concentration of remifentanil as 5.5 ng·ml^{-1} and that of propofol as 5.0 μg·ml^{-1}. After 30 s, we intubated the patient's trachea, using an endotracheal tube (internal diameter [ID], 7 mm). At that time, the patient could not make any movement or bucking; the vocal cords were not moving and were fixed laterally.

Anesthesia was maintained at an effect-site concentration of 2.5–5.0 ng·ml^{-1} for remifentanil and 2.5–5.0 μg·ml^{-1} for propofol, with 100% oxygen, according to the patient's vital signs. The patient was mechanically ventilated with a tidal volume of 10 ml·kg^{-1} and 12 breaths·min^{-1}. Three hypotensive events occurred, and we treated these immediately by using 100 μg phenylephrine and 5 mg ephedrine according to the situation. At these times of these hypotensive events, the blood pressure was 80/50 mmHg, 70/40 mmHg, and 80/50 mmHg, respectively. Then the blood pressure was maintained at 90/50 mmHg–130/70 mmHg until the surgery was over. The entire surgery was finished without any significant sequelae, and total anesthesia time was 150 min. Total fluid intake during surgery was 400 ml. The TOF ratio was kept within 100%–120% during surgery. After confirming the patient's consciousness and motor power (knee bending), tracheal extubation was performed immediately after thorough oral secretion suctioning. The patient was kept in the postanesthesia care unit (PACU) for about 30 min until she reached the discharge criteria. She breathed well spontaneously without any discomfort. Arterial blood gas analysis (ABGA) was not performed in the PACU or in the general ward because she had not complained of any respiratory symptoms or signs. Oxygen saturation was kept between 98% and 99% in room air. On postoperative day 3, the patient was discharged without any serious complications, although she had experienced a slight nauseous sensation during postoperative days 2–3, which had required no rescue drugs. No exacerbations of neurologic signs or symptoms were noted. There was no worsening of the motor weakness or dysarthria.

Discussion

Amyotrophic lateral sclerosis (ALS) is a degenerative disease of the motor ganglia in the anterior horn of the spinal cord and spinal pyramidal tracts. Patients with bulbar muscle involvement develop a slurring of speech that leads to aphasia, associated with impaired swallowing, cough, and airway protection. Atrophy and weakness of the respiratory muscles eventually lead to respiratory failure and death [4].

In choosing an anesthesia method for an ALS patient, anesthesiologists should consider which anesthesia method will be least harmful, in terms of the nature of the patient's disease's and its progression. If the surgery is confined to the extremities, regional anesthesia using local anesthetics can be selected. However, anesthesiologists should remember that local anesthetics can result in neurologic insult, although dilute local anesthetics may be used to reduce their neurotoxic effect. If the surgery involves body parts that are not suitable for regional anesthesia, anesthesiologists must consider general anesthesia. In ALS patients, neurons are believed to be vulnerable to muscle relaxants. The response to muscle relaxants, either depolarizing or nondepolarizing, is also altered in ALS patients. Thus, patients with ALS require special care throughout the perioperative period. Irrespective of the type of muscle disease present, titration of the dose of muscle relaxant should always be done using a nerve stimulator [5,6]. Judicious use of nondepolarizing muscle relaxants would seem preferable [7]. There are some reports of successfully managed general anesthesia in ALS patients. The study of Kim et al. [4] indicates that a low dose of rocuronium appears feasible and safe in an ALS patient.

If a surgery requires general anesthesia but does not need intense muscle relaxation, one can select TIVA without a muscle relaxant to be used in conjunction with general inhalational anesthesia. In general, propofol is believed not to have a great influence on neuromuscular function compared with volatile anesthetics. Opioids such as fentanyl or alfentanil are also thought to be safe in patients with motor neuron disease [3]. The clearance of propofol (2,6-diisopropylphenol) exceeds hepatic blood flow, implying the existence of extrahepatic metabolism. This exceptionally high clearance rate probably contributes to the relatively rapid recovery after a continuous infusion [8]. The unique ester structure of remifentanil, an ultrashort-acting opioid with a terminal elimination half-life of less than 10 min, makes

it susceptible to rapid ester hydrolysis by nonspecific esterases in blood (red cells) and tissue. Biotransformation is so rapid and so complete that the duration of a remifentanil infusion has little effect on wake-up time. Its context-sensitive half-time is approximately 3 min, regardless of the duration of infusion [9].

In our patient, we could have selected spinal or epidural anesthesia instead of TIVA. However, we selected TIVA because there was still controversy about the possible exacerbation by local anesthetics of the motor neuron disease in ALS patients. Thus, we used TIVA instead of regional or general inhalational anesthesia. During the infusion of propofol and remifentanil, the TOF ratio remained at a slightly lower value than the preoperative ratio. But we believe that this was not significant. TOF monitoring may be unreliable in patients with lower motor neuron disease, because the degree of muscle impairment is different in each muscle group [10, 11].

In a previous report, epidural anesthesia appear red to be useful and safe for patients with ALS undergoing lower-abdominal or lower-extremity surgery [12]. However, careful postoperative management is important, because, in ALS patients, mild pulmonary dysfunction may occur without hypoxemia or any clinical symptoms, regardless of the anesthesia method used [13]. We regret that we did not measure ABGA and carry out a pulmonary function test postoperatively. Although our patient had no respiratory symptoms, if we had checked these parameters, we may have obtained more accurate information about her condition.

In summary, we have reported the use of TIVA, performed without a muscle relaxant, in a patient with ALS. If anesthesiologists do not want to use muscle relaxants or local anesthetics for fear of disease exacerbation in ALS patients, they can employ TIVA instead of regional or general inhalational anesthesia, even in those patients in whom regional anesthesia could be performed. However, careful postoperative monitoring of pulmonary function is strongly recommended.

References

1. Vandem LD, Dripps RD. Exacerbation of preexisting neurologic disease after spinal anesthesia. N Engl J Med. 1956;255:843–9.
2. Nicolas F, Sollet JP, Mathe JF. Aggravation following anaesthesia in a case of unknown lateral amyotrophic sclerosis (author's translation). Anesth Analg. 1979;36:235–8.
3. Naguib M, Lien CA. Pharmacology of muscle relaxants and their antagonists. In: Miller RD, editor. Anesthesia. 6th ed. Philadelphia: Elsevier Churchill Livingstone; 2005. p. 515–6.
4. Kim TK, Kwon JE, Kim YL. General anesthesia in a patient with amyotrophic lateral sclerosis. Korean J Anesthesiol. 2007;51:S18–9.
5. Diefenbach C, Buzello W. Muscle relaxation in patients with neuromuscular diseases. Anaesthesist. 1994;43:283–8.
6. Mashio H, Ito Y, Yanagita Y, Fujisawa E, Hada K, Goda Y, Kawahigashi H. Anesthetic management of a patient with amyotrophic lateral sclerosis (in Japanese with English abstract). Masui (Jpn J Anesthesiol). 2000;49:191–4.
7. Rosenbaum KJ, Neigh JL, Strobel GE. Sensitivity to nondepolarizing muscle relaxants in amyotrophic lateral sclerosis: report of two cases. Anesthesiology. 1971;35:638–41.
8. Morgan GE, Mikhail MS, Murray MJ. Nonvolatile anesthetic agents. In: Morgan GE, editor. Clinical anesthesiology. 4th ed. New York: Lange Medical Books/McGraw-Hill; 2006. p. 200–1.
9. Morgan GE, Mikhail MS, Murray MJ. Nonvolatile anesthetic agents. In: Morgan GE, editor. Clinical anesthesiology. 4th ed. New York: Lange Medical Books/McGraw-Hill; 2006. p. 194.
10. Stucke AG, Stuth EA. Use of rapacuronium in a child with spinal muscular atrophy. Paediatr Anaesth. 2001;11:725–8.
11. Ali HH, Savarese JJ. Monitoring of neuromuscular function. Anesthesiology 1976;45:216–49.
12. Kochi T, Oka T, Mizuguchi T. Epidural anesthesia for patients with amyotrophic lateral sclerosis. Anesth Analg. 1989;68:410–2.
13. Hara K, Sakura S, Saito Y, Maeda M, Kosaka Y. Epidural anesthesia and pulmonary function in a patient with amyotrophic lateral sclerosis. Anesth Analg. 1996;83:878–9.