

Original Article

Anesthetic strategy for percutaneous endoscopic gastrostomy in amyotrophic lateral sclerosis patients

Shengqun Liu, Zhe Liu, Jingliang Zhang, Zhanwen Li, Zhenhua Hu, Wuchen Yang, Suzhen Zhao

Department of Anesthesiology, Henan Provincial People's Hospital, Zhengzhou University, Zhengzhou 450003, Henan, P. R. China

Received October 16, 2016; Accepted November 23, 2016; Epub February 15, 2017; Published February 28, 2017

Abstract: Amyotrophic Lateral Sclerosis (ALS) is a kind of severe and lethal motor neuron disease, its clinical symptom including dysphasia, choking, cough, acataposis and different levels of limb-muscle and mastication weakness, which increase the difficulty and danger of anesthetic strategy for Percutaneous Endoscopic Gastrostomy (PEG) in ALS patients. In order to develop a better anesthesia procedure for PEG in ALS patients in this research, nine ASA II-III ALS patients were enrolled. Midazolam (1-2 mg), sufentanil (3-5 μ g), propofol (1.5-2 mg/kg) and etomidate (0.2-0.3 mg/kg) were intravenously applied for anesthesia induction. The operation would be performed after the patients lost their consciousness and eyelash reflex, and could not respond to verbal command. The PEG tube placements were performed via the pull-through technique under anesthesia with endoscopic mask for oxygen inhalation and local anesthesia (2% lidocaine) at the site. Propofol (20-50 mg) was further applied as required. A special endoscopic mask for gastroscopy was used for oxygen inhalation. Blood pressure (BP), heart rate (HR), oxyhemoglobin saturation (SpO_2), dosage of anesthetics, surgery duration, recovery duration and relative complications were recorded. From the results, we get that all patients successfully received PEG with well anesthesia. No cough, agitation or drastic fluctuations in BP, HR or SpO_2 was observed during the procedures of all patients. No anesthesia-related complications were observed within 24 hours after PEG placement. One patient was transferred to ICU for breathing support due to the deteriorated condition or anesthesia. Therefore, with the help of small doses of midazolam, sufentanil, etomidate, propofol, and breathing support with a special endoscopic mask for gastroscopy, PEG can be safely and effectively performed in ALS patients.

Keywords: Motor neuron disease, amyotrophic lateral sclerosis, ALS, endoscopic mask, enteral nutrition, gastrostomy, percutaneous endoscopic gastrostomy

Introduction

Amyotrophic lateral sclerosis (ALS) is a rare, uniformly fatal, degenerative neurological disease caused by loss of upper and lower motor neurons. Due to lack of curative therapies for ALS, management is directed at preventing and palliating complications associated with advanced disease [1]. Muscle weakness in these patients leads to decreased swallowing and respiratory function, thus increasing the risk of malnutrition, aspiration, and pneumonia. ALS patients have poor swallowing functions, dietary difficulties, therefore the use of percutaneous endoscopic gastrostomy (PEG) tubes has become standard in the care of patients with ALS [2]. However, during the percutaneous endoscopic gastrostomy (PEG) operation, Anesthesia is an extremely challenging

and controversial issue. The general anesthesia of ALS patients includes continuous epidural anesthesia, intravenous anesthesia. And taking endotracheal intubation on the basis of sedative and analgesic, is relatively appropriate, while, try to avoid using muscle relaxant [3, 4]. More studies reported that the ALS patients after continuous epidural anesthesia have the probability of suffering nerve injury [5, 6]. The study of Nishino [7] showed that general anesthesia can inhibit swallowing reflex, add the upper respiratory tract obstruction of the ALS patients. Therefore, a new anesthesia for percutaneous endoscopic gastrostomy (PEG) operation of ALS patients is in a highly need. Herein, we reported a new and effective anesthesia procedures of nine ALS patients undergoing PEG.

Methods

Patients

Clinical symptoms of ALS including dysphasia, choking, cough, acatoposis and different levels of limb-muscle and mastication weakness appeared in these patients. Amyotrophic lateral sclerosis function rank scale (ALS FRS) was adopted, the scale is on the basic of ALS severity scale (ALSSS) and unified Parkinson disease rating scale (UPDRS). Then more movement function scores were added. Its indicators including four balls-respiratory function, two upper limb function (with utensils and clothing), two lower extremities function index (walking and climbing), etc. This scale is simple, easy to operate, as well as widely used, and its sensitivity, reliability and stability have been widely confirmed, besides, its existing assessment scale comparability and other correlation are high. In this study, the Nine ASA II-III ALS patients, aged 35-75 years, weighing 47-62 kg, hospitalized at our institution between January 2013 and January 2016, were enrolled. Two patients could walk slowly while the remaining seven only could sit or lie. Two patients had dyspnea and required respiratory support by using a noninvasive ventilator. Two patients were suffered with hypertension. All patients were scheduled to perform PEG.

Preoperative evaluation

In terms of the ALS patients with clinical diseases such as dysphagia, cough reflex reduction and respiratory motion decreased, before the surgery, they need special treatments and optimization, such as fasting, breathing exercise etc., in order to increase the success rate of surgery and postoperative survival rate. Patients suffering with aspiration pneumonia would take elective surgery. They were treated with pneumonia. Who were with the Gastric retention, should firstly take gastric bowel catharsis. Patients with respiratory function is insufficient, to avoid intraoperative hypoxia, should take breathing training and performed elective surgery.

ASA II-III

No abnormalities was observed in liver, kidney, coagulation function and ECG. SpO₂ was 90-97% without oxygen inhalation. Two patients required noninvasive ventilator, of which one

had severe pulmonary infection. Mild anemia was observed in three of these patients.

Anesthesia methods

Intravenous general anesthesia combined with local anesthesia without tracheal intubation was employed.

Anesthesia process

None medicines were taken before procedures. Venous channel was established while the patients entering the preparation Room. Sodium, potassium, magnesium, calcium and glucose injection (Hengrui Pharmaceuticals) (10 ml/kg) were applied for 30 minutes before continuous monitored of ECG, BP, HR and SpO₂. For anesthesia induction, midazolam (1-2 mg) and sufentanil (3-5 µg) were administered about 2 minutes before propofol (1.5-2 mg/kg) and etomidate (0.2-0.3 mg/kg) applied. Surgery was performed after patients lost consciousness and eyelash reflex, and did not respond to verbal command. Propofol (20-50 mg) was further supplied according to the patients' condition during the anesthesia maintenance. Oxygen was inhaled (1-3 L/min) via a special endoscopic mask (Tuoren Medical Device Co Ltd) for gastroscopy as a substitute for nasal cannula. The mask was fixed around the mouth and nose of patients with four-tailed bandages and connected to the thread pipe of anesthesia machine (DragerFabius, Dellger Medical Device Co Ltd). Autonomous respiration was retained as far as possible. When the patients suffered from apnea or a desaturation of 90%, noninvasive ventilation was performed with the endoscopic mask and the anesthesia machine bag. Non-invasive ventilator was used for the patients who received the same support before surgery. SpO₂ was maintained at 85-98%. The patients were strictly monitored and not transferred back to the ward until their vital signs were stable.

Surgical procedure

Gastroscope was inserted via endoscopic mask, mouth, throat and esophagus to the stomach. The fistula was located under the guidance of gastroscopy. After local anesthesia with 2% lidocaine, an incision of about 1 cm was made in different layers of the abdominal wall and fistula was applied, then feeding tube was inserted and fixed well.

Anesthesiology of ALS

Table 1. Patient demographics

	N (%)
Male	3 (33%)
Female	6 (67%)
Age (x±s, years)	55.11±12.89
Weight (x±s, kg)	53.56±5.68
ASA physical status II	5 (44%)
ASA physical status III	4 (56%)
Dyspnea	2 (22%)
Hypotension	2 (22%)
Pain score	1.01±0.31
Patient satisfaction scores	91.71±2.11

Table 2. Vital signs before and after anesthesia (mean ± standard deviation, n = 9)

	T1	T2	T3
NIBP	100.89±19.05	98.74±23.58	96.55±21.47
HR	76.78±8.94	75.32±10.82	72.58±9.24
SpO ₂	94.44±2.55	97.56±1.87	94.63±2.92

Table 3. Dosage of anesthetics, time of surgery and recovery (mean ± standard deviation, n = 9)

Sufentanil (µg)	4.11±0.78
Midazolam (mg)	1.67±0.5
Etomidate (mg)	8.89±1.45
Propofol (mg)	227.78±52.63
Time of surgery (min)	32.78±8.12
Time of recovery (min)	14.22±6.36
Transfusion volume (ml)	385.58±114.87

Table 4. Anesthesia satisfaction

Group	N (%)	Preoperative anxiety
Satisfied	7 (78%)	3 (42%)
General	2 (22%)	2 (100%)
Unsatisfy	0	0

Observed and recorded items

The primary objectives were to detect the incidences of oxygen desaturation and oxygen saturation trend. Oxygen desaturation was defined as an oxygen saturation of 90% for more than 10 s. In the event of oxygen desaturation, oxygen delivery was increased from 4 to 10 litre min⁻¹, and then airway assistance manoeuvres (endoscopic mask, manual ventilation) were performed and recorded. At the same time, in

order to take the strength of local anesthesia into consideration, add patients' satisfaction and follow-up of pain. Numerical rating scale (NRS) is used to record the pain after PEG surgery. Patient satisfaction questionnaire is used as a tool to reflect the satisfaction of service, all of these are recorded, as shown in **Table 4**.

Vital signs were continuous monitored during surgery. BP, HR and SpO₂ were recorded after patients entered the operation room (T1), 10 minutes after surgery beginning (T2), and recovery (T3). Hypertension (systolic blood pressure >150 mmHg), hypotension (systolic blood pressures <90 mmHg), bradycardia (heart rate <50), tachycardia (heart rate >90) were observed and recorded.

Anesthesia effects, dosage of used anesthetics, duration of operation, length of surgery and recovery were recorded.

Anesthesia-related complications (such as nausea, vomiting, hypoxemia (SpO₂ <90%), hypertension (systolic blood pressure >150 mmHg), hypotension (systolic blood pressures <90 mmHg), bradycardia (heart rate <50 beats min⁻¹), tachycardia (heart rate >90 beats min⁻¹) were observed and recorded.

In order to determine the analgesic benefit of the study, as a criteria, at some point during the PEG procedure they had to report a pain score <5 on an 11-point numerical rating scale (NRS), where 0 = no pain, and 10 = worst possible pain, see **Table 5**.

In reference to the satisfaction self-rating scale of relevant literature [8-10], its full mark is 100 points, and the higher score, the better the satisfaction of anaesthesia.

Statistical analysis

Quantitative data were expressed as mean ± standard deviation. Differences between different times were compared via "t" test. P-value less than 0.05 was considered statistically significant. SPSS statistics 17.0 (SPSS, Chicago, IL, USA) was used for all statistical analysis.

Results

Patient demographics

Records of all 9 ALS patients who underwent PEG from 2013 to January, 2016 were identi-

Anesthesiology of ALS

Table 5. Patient anesthesia scores and pain level

Patient anesthesia score				Patient pain level				
Excellent	Fine	Bad	effective percent age	ClassA	ClassB	ClassC	ClassD	Effective percent age
5	4	0	100%	6	3	0	0	92%

fied. ASA physical status and other demographics are listed in **Table 1**.

Anesthesia effect

All patients successfully received PEG with well anesthesia. No cough, agitation or drastic fluctuation in BP, BR and SpO₂ were observed during surgery in any patient. Anesthesia was smooth in all patients. Vital signs are listed in **Table 2**.

Dosage of anesthetics and duration of surgery and recovery

Dosage of anesthetics and duration of surgery and recovery are listed in **Table 3**.

Adverse events

No anesthesia-related complications (such as nausea, vomiting, hypoxemia (SpO₂ <90%), hypertension (systolic blood pressure >150 mmHg), hypotension (systolic blood pressures <90 mmHg), bradycardia (heart rate <50 beats min⁻¹), tachycardia (heart rate >90 beats min⁻¹) were observed in eight patients during the 24-hour post-operation follow-up and they were discharged after 2-5 days. One patient (74-years-old) was sick, bedridden, and unable to eat and he needed non-invasive ventilator support before surgery. The patient suffered from severe pulmonary infection. During pre-operation examination, obvious bilateral moist crackles in the lung and slight pleural effusion were observed via auscultation and chest X-ray, respectively. This patient recovered spontaneous respiration after surgery and could breathe autonomously with noninvasive ventilator.

A Patient, male, 61 years old, the main symptoms was his voice was not clear, had swallowing choking cough for two years, and dietary difficult for one year. Diagnosis: amyotrophic lateral sclerosis (amyotrophic lateral sclerosis, ALS). Physical examination: conscious, without apparent difficulty breathing, severe dysarthria, cannot move the tongue, gag reflex (-), the contralateral trapezius muscle strength level 0,

sternocleidomastoid muscle strength level 3, right and left upper level 4 upper level 5, the left leg level 3, right leg level 5. On both sides of limbs of tendon reflex (-), pathological disease (+), tongue muscle atrophy, liver and kidney functions, blood electrolyte was Normal. Nasal oxygen absorption and peripheral SpO₂ were 5 L/min and 92% respectively. In the process of percutaneous endoscopic gastrostomy (PEG), because of the unfriendly patient cooperation, we chose intravenous anesthesia. After patients were into the operating room, monitor BP, ECG, SpO₂, open peripheral vein and left lateral position, intravenous use of Penicillin Hydrochloride Injection of 0.3 mg, Midazolam of 1 mg, and ketamine of 20 mg one by one. Wait for patients with eyelash reflex disappears, insert enterogastroscope. During the operative with ketamine intermittent intravenous anesthesia, the total dosage of 50 mg, between operation period maintained the SpO₂ at 92%~95%, BP 105~138/56~82 mmHg, H R 73~92 times/min. The operation was completed within 25 min. About 10 min after operation, patient would wake up, and be returned to the ward. Postoperative follow-up of patients is normal, and discharge 1 week after.

Discussion

Amyotrophic lateral sclerosis (ALS) is a relentlessly progressive paralyzing disease, one of the types of motor neuron diseases (MND) [11], pathological changes of upper and lower motor neuron are involved. Major clinical manifestations are a series of symptoms, which caused by motor nerve function impairment [12]. There was increased utilization of percutaneous endoscopic gastrostomy (PEG) in ALS patients for dysphagia. Decreasing choking, cough, respiratory motions and all mentioned important factors were taken in concern when chose the way of anesthesia. Case reports of ALS in the literature are related to the combined spinal epidural or epidural anesthesia, or general anesthesia management with or without using non-depolarizing neuromuscular blocking agents. General anesthesia management is

predominate in above, via or without endotracheal intubation. PEG tube insertion in patients without ALS often adopt the former way, considering most of PEG patients are advanced age and poor health [13], cause poor tolerance to anesthesia and surgery, as a matter of fact, general anesthesia with endotracheal intubation could contribute to or aggravate respiratory failure in patients with PEG, prolonged or lasting mechanical ventilation time, even the main cause of postoperative death [14, 15]. But there was no report on the anesthesia method of PEG operation in ALS patient, in our report, we used a special mask to replace nasal base on the general population way as intravenous general anesthesia combined with local anesthesia and without tracheal intubation.

In terms of anesthetics, there are no abnormalities in liver and kidney function of ALS patients, so most narcotics are feasible. As for combination, therapy can reduce the use of a single drug and increase the effectiveness. General anesthesia was induced by combination of four anesthetics drugs, such as Sufentanil, Midazolam, Etomidate, and propofol. All of these anesthetics drugs have been successfully applied in ALS patients before. Propofol has the advantages of fast onset, dissipate of anesthesia for induction and maintenance, rapid recovery and can make the patient quickly reach a deeper level of sedation [16, 17].

We connected a special endoscopic mask for gastroscopy to the anesthesia machine for ventilation, and autonomous respiration was retained as far as possible. If patients suffered from apnea or desaturation of 90%, noninvasive ventilation was performed with the endoscopic mask and the anesthesia machine bag. With this paradigm, SpO₂ of patients was well maintained and patients quickly recovered with high quality, except for one patient who was sick before surgery. The special endoscopic mask for gastroscopy is designed to provide breathing support for anesthetized patients during gastroscopy-examination [18-20], which combines the function of gastroscopy passage, oxygen supply and ventilation. If respiratory depression occurs, timely breathing support can be provided without interfering with gastroscopy-examination. Some strategy was adopted to maintain autonomous respiration

and employed general anesthesia under endoscopic mask-assisted breathing.

From the results we can see that all patients were maintained under safe and effective anesthesia, emerged from general anesthesia smoothly, 2 of them suffered from transitional expiratory dyspnea, we paid close attention to blood oxygen saturation, took assisted ventilation, and the indicators were back to normal soon. It was suspected that from diaphragm paralysis, 2 of patients suffered from brief hypotension event, and hypotensive activity of propofol, special treatments were not taken, and blood pressure returned to normal soon. Although 56% of the patients had anxiety during the anesthesia, postoperative analgesia met their expectation of 78% patients.

All in all, with the help of small doses of midazolam, sufentanil, etomidate, propofol, and breathing support with a special endoscopic mask for gastroscopy, PEG can be safely and effectively performed in ALS patients. For surgery in ALS patients that may result in large lesions, efforts are needed to explore the procedures for anesthetization, vital signs monitoring and respiratory control.

Acknowledgements

The authors are grateful to the staffs at the Center of Endoscopy, Henan Province People's Hospital for their assistant to this project. This work is supported by a Bio-Medical research grant (Grant #201303140) from Health and Family Planning Commission of Henan province.

Disclosure of conflict of interest

None.

Address correspondences to: Jingliang Zhang, Department of Anesthesiology, Henan Provincial People's Hospital, Zhengzhou University, # 7 Wei Wu Road, Zhengzhou 450003, Henan, P. R. China. Tel: +86 (371) 6589 7579; Fax: +86 (371) 6596 4376; E-mail: zhangjinglianganes@163.com

References

- [1] Miller RG, Jackson CE, Kasarskis EJ, England JD, Forshe D, Johnston W, Kalra S, Katz JS, Mitsumoto H, Rosenfeld J, Shoosmith C, Strong MJ and Woolley SC. Practice parameter up-

Anesthesiology of ALS

- date: the care of the patient with amyotrophic lateral sclerosis: multidisciplinary care, symptom management, and cognitive/behavioral impairment (an evidence-based review): report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology* 2009; 73: 1227-1233.
- [2] Seitzer F, Kahrass H, Neitzke G and Strech D. The full spectrum of ethical issues in the care of patients with ALS: a systematic qualitative review. *J Neurol* 2016; 263: 201-209.
- [3] Wang YL, Cao F, Geng S. Progress of research on amyotrophic lateral sclerosis. *Practical Journal of Medicine & Pharmacy* 2004; 21: 165-167.
- [4] Park Y, Park J, Kim Y, Baek H and Kim SH. Association between nutritional status and disease severity using the amyotrophic lateral sclerosis (ALS) functional rating scale in ALS patients. *Nutrition* 2015; 31: 1362-1367.
- [5] Wang B, Xu RS. Progress of research on pathogenic genes for amyotrophic lateralsclerosis. *Chinese Journal of Gerontology* 2011; 31: 1694-1698.
- [6] Iwanaga S, Kitamura T, Ogawa M and Yamada Y. [Anesthetic management of laparotomy for a patient with amyotrophic lateral sclerosis: a case report]. *Masui* 2008; 57: 987-989.
- [7] Umegaki H and Tagami N. [Anesthetic management of an ALS patient with remifentanyl]. *Masui* 2008; 57: 1139-1142.
- [8] Martínez E, Román MD, López-Escobar M, Torres Luis. Degree of satisfaction and complications with obstetric epidural analgesia. *Revista De La Sociedad Española Del Dolor* 2003; 10: 349-356.
- [9] Stocki D, Matot I, Einav S, Eventov-Friedman S, Ginosar Y and Weiniger CF. A randomized controlled trial of the efficacy and respiratory effects of patient-controlled intravenous remifentanyl analgesia and patient-controlled epidural analgesia in laboring women. *Anesth Analg* 2014; 118: 589-597.
- [10] Rosen DR, Siddique T, Patterson D, Figlewicz DA, Sapp P, Hentati A, Donaldson D, Goto J, O'Regan JP, Deng HX and et al. Mutations in Cu/Zn superoxide dismutase gene are associated with familial amyotrophic lateral sclerosis. *Nature* 1993; 362: 59-62.
- [11] Vance C, Rogelj B, Hortobagyi T, De Vos KJ, Nishimura AL, Sreedharan J, Hu X, Smith B, Ruddy D, Wright P, Ganesalingam J, Williams KL, Tripathi V, Al-Saraj S, Al-Chalabi A, Leigh PN, Blair IP, Nicholson G, de Belleruche J, Gallo JM, Miller CC and Shaw CE. Mutations in FUS, an RNA processing protein, cause familial amyotrophic lateral sclerosis type 6. *Science* 2009; 323: 1208-1211.
- [12] Cai X, Zhang P, Lu S, Zhang Z, Yu A, Liu D and Wu S. Effects of Intraoperative dexmedetomidine on postoperative pain in highly nicotine-dependent patients after thoracic surgery: a prospective, randomized, controlled trial. *Medicine (Baltimore)* 2016; 95: e3814.
- [13] Pattamanuch N, Novak I, Loizides A, Montalvo A, Thompson J, Rivas Y and Pan D. Single-center experience with 1-step low-profile percutaneous endoscopic gastrostomy in children. *J Pediatr Gastroenterol Nutr* 2014; 58: 616-620.
- [14] Hare A, Chatwin M, Hind M, Polkey M, Jordan S, Simonds A. Percutaneous gastrostomy (PEG) insertion under general anaesthesia (GA) in ventilator-dependent patients with neuromuscular disease (NMD). *European Respiratory Journal* 2013.
- [15] Vorasubin N, Vira D, Jamal N and Chhetri DK. Airway management and endoscopic treatment of subglottic and tracheal stenosis: the laryngeal mask airway technique. *Ann Otol Rhinol Laryngol* 2014; 123: 293-298.
- [16] Machin KL and Caulkett NA. Evaluation of isoflurane and propofol anesthesia for intraabdominal transmitter placement in nesting female canvasback ducks. *J Wildl Dis* 2000; 36: 324-334.
- [17] Kottenberg E, Musiolik J, Thielmann M, Jakob H, Peters J and Heusch G. Interference of propofol with signal transducer and activator of transcription 5 activation and cardioprotection by remote ischemic preconditioning during coronary artery bypass grafting. *J Thorac Cardiovasc Surg* 2014; 147: 376-382.
- [18] Kelsaka E, Karakaya D and Zengin EC. Use of sugammadex in a patient with amyotrophic lateral sclerosis. *Med Princ Pract* 2013; 22: 304-306.
- [19] Yuanchang X, Chen H, Hua X and Yuanzhang X. Application of endoscopic facial mask in painless fiberoptic bronchial endoscopy. *Academic Journal of Second Military Medical University* 2006; 27: 1156-1157.
- [20] Zhuang XL, Zeng YM, Cheng BL. *Modern anesthesiology*. 3rd Edition. Beijing: People's Medical Press; 2008. pp. 585.