Review Article

Sedation for Percutaneous Endoscopic Lumbar Discectomy

Menekse Oksar

Department of Anesthesiology and Reanimation, Mustafa Kemal University Faculty of Medicine, 31100 Hatay, Turkey

Correspondence should be addressed to Menekse Oksar; menekseoksar@gmail.com

Received 20 February 2016; Accepted 29 August 2016

Academic Editor: Serra Sencer

Copyright © 2016 Menekse Oksar. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Although anesthetic requirements for minimally invasive neurosurgical techniques have been described in detail and applied successfully since the early 2000s, most of the literature on this subject has dealt with cranial cases that were operated on in the supine or sitting positions. However, spinal surgery has also used minimally invasive techniques that were performed in prone position for more than 30 years to date. Although procedures in both these neurosurgical techniques require the patient to be awake for a certain period of time, the main surgical difference with minimally invasive spinal surgery is that the patients are in the prone position, which may result in increased requirement of airway management because of deep sedation. In addition, although minimally invasive spinal surgery progresses slowly and different techniques are used with no agreement on the terminology used to describe these techniques thus far, the anesthetist needs to understand the surgical and anesthetic requirements for each type of intervention in order to take necessary precautions. This paper reviews the literature on this topic and discusses the anesthetic necessities for percutaneous endoscopic laser surgery.

1. Introduction

Endoscopic procedures became widely accepted in the 1990s and substantially contributed to advances in minimally invasive neurosurgery (MIN) in the 2000s [1]. Several percutaneous endoscopic procedures for lumbar disc herniation have been developed since minimally invasive discectomy (MID) was first introduced [1–9]. The central approach for MID shifted toward the posterolateral discectomy approach because of its several advantages, including the fact that it is a more direct approach, prevents nerve injury, and preserves spinal stability [10].

The standard surgical approach for lumbar disc herniation is either open discectomy (OD) or microdiscectomy (MD) [11]. Alternative surgical techniques are available, including MID. The percutaneous endoscopic approach has some advantages over open procedures, such as the preservation of healthy tissue, shorter hospital stays, less blood loss and postoperative pain, and faster patient recovery. However, previous randomized clinical trials on laser discectomy have not provided conclusive evidence on its efficacy because of the small sample sizes [12].

MIN has mostly been used for cranial cases and is performed under sedation [13,14]. However, optimal sedative and/or sedation protocols for neurosurgical anesthesia have not yet been described [15]. Moreover, there is a lack of knowledge about the optimal position of the patient and their airway management during percutaneous endoscopic laser discectomy (PELD), which are mainly different from MIN procedures in terms of anesthesia. Thus, a comprehensive description of the requirements for MID, particularly for PELD, in terms of sedation/sedoanalgesia and airway management, is required to avoid adverse outcomes and complications during the procedure.

2. Evolution of Percutaneous Endoscopic Discectomy Technique and Effectiveness

PELD has potential advantages over standard surgical procedures for lumbar OD or MD. Percutaneous endoscopy for lumbar discectomy was first described by Kambin and Schaffer in 1973 and percutaneous nucleotomy by Hijikata in 1975, which was referred to as percutaneous discectomy [16,17], and PELD has been evolving since then because of the need for further development of the technique and equipment. Percutaneous discectomy is a minimally invasive technique that requires a small skin incision and is performed under local anesthesia with or without sedation/sedoanalgesia. However,
it is difficult to remove the herniated nucleus pulposus from the channel without an endoscope. Kambin et al. used a posterolateral arthroscopic decompression technique in patients with lateral recess stenosis and reported satisfactory results in 31 of 38 patients (success rate, 82%) [3]. Yeung established the current spinal endoscopic technique in the 1990s, which led to the widespread use of percutaneous discectomy in the 2000s [1].

In addition, Ahn et al. reported the effectiveness of PELD for recurrent disc herniation in selected cases [10], and a systematic review by Rasouli et al. on studies conducted from 1946 to 2013 to compare the pros and cons of MD versus MD/OD revealed contradictory evidence on MID in terms of its potential advantages over MD/OD [11]. Furthermore, in a systematic review of surgical interventions for lumbar disc prolapse, Gibson and Waddell reported that the results of laser discectomy were unclear because only three small randomized clinical trials had been conducted [12]. They also reported that no randomized clinical trials had been conducted on coblation therapy or transforaminal endoscopic discectomy. On the other hand, a multicenter, randomized, protocol [23]. Keifer et al. reported the timeline of conduction anesthesia with an asleep-awake-asleep technique for awake craniotomy that required brain mapping under propofol and remifentanil infusion; this technique allowed satisfactory anesthetic conditions in most of the patients and a wakeup time of 9 min [24]. The authors also reported that frequent respiratory complications decreased over the course of the study as the anesthetist gained experience about the study protocol [23]. Berkenstadt et al. monitored hemodynamic and respiratory status while administering propofol and remifentanil infusion during awake craniotomy and found that overall respiratory complications decreased over the course of the study as the anesthetist gained experience about the study protocol [23]. Keifer et al. reported the timeline of conduction anesthesia with an asleep-awake-asleep technique for awake craniotomy that required brain mapping under propofol and remifentanil infusion; this technique allowed satisfactory anesthetic conditions in most of the patients and a wakeup time of 9 min [24]. The authors also reported that frequent respiratory depression [i.e., PaCO$_2$ = 50 (36–69) mmHg, minimum respiratory rate = 0 (0–3) breaths/min, and lowest peripheral capillary oxygen saturation (SpO$_2$) = 95% (92–98)] and short hypertensive episodes [maximum value = 150 (139–175) mmHg] were observed during the painful procedures. However, there are important differences between percutaneous endoscopic discectomy and MIN for cranial cases. Deep sedation in the prone position is required during the former, and thus proper management of sedation depth is necessary.

4. Sedation Depth during Percutaneous Endoscopic Discectomy

Besides considering the absolute indications of the sedatives and medications affecting sedation depth, monitoring of sedation can be helpful for the management of PELD cases. The bispectral index score (BIS) can be used to monitor anesthetic depth and is an electroencephalography- (EEG-) derived parameter for the intraoperative monitoring of anesthetic depth [25]; BIS correlates with the level of sedation and loss of consciousness during the administration of propofol, midazolam, isoflurane, or alfentanil [26]. In BIS monitoring of computer-controlled infusion of propofol and remifentanil for awake craniotomy cases, Hans et al. adjusted the target drug concentrations according to the patient’s responses to the painful stimuli and to the need for functional/speech testing [27]. They concluded that BIS correlated better with the level of sedation/patient responsiveness than the predicted effect-site concentrations of propofol. Schmidt et al. compared Narcotrend (NT), BIS, and EEG in terms of their ability to monitor the depth of consciousness in different states, from immediately after induction until extubation, in laminectomy cases under propofol and remifentanil combination and infusion technique, Sarang et al. developed an anesthetic technique for awake craniotomy cases, successfully protecting patient safety with adequate acceptability. This technique was a true asleep-awake-asleep technique in which a laryngeal mask airway was used, and remifentanil was administered to produce respiratory depression to control ventilation to a desirable partial pressure of arterial carbon dioxide (PaCO$_2$) during the period of being asleep [22]. Moreover, during awake craniotomy, Yamamoto et al. reported successful anesthesia using noninvasive mechanical ventilation (NIMV) with bilevel positive airway pressure in a patient. Proportional assist ventilation was administered to another patient via a nasal mask during tumor resection, with NIMV being discontinued during cortical mapping [21].
anesthesia. The authors found that, for a standardized regimen of propofol and remifentanil, only NT and BIS could accurately distinguish among all the investigated states; remifentanil infusion of 0.3 μg/kg/min during propofol infusion had no statistically significant effects on any of the EEG variables during the 10 min observation period [28]. Sebel et al. examined the correlation between BIS and patients’ responses in skin incision study and found that BIS clearly depends on the anesthetic technique and correlates best with the effects of hypnotic-based anesthetic agents. In contrast, opioid-based techniques reduced patients’ movements with little effect on EEG confounding the use of BIS for an adequate anesthetic effect [29]. The simultaneous use of different monitoring tools that collect data from different mechanisms may be better than using one tool alone for achieving safe sedation that is not deeper than necessary for the specific surgical intervention. Kasuya et al. investigated the correlations between the BIS value and the Observer’s Assessment of Alertness/Sedation (OAA/S) score during separate infusion of propofol and dexmedetomidine in volunteers and found that BIS values were lower for dexmedetomidine at comparable OAA/S scores. They concluded that both scales provide different and complementary data for clinicians and thus suggested that clinicians using dexmedetomidine should use both scales to evaluate a patient’s response to sedation [30].

5. Suggestions for Handling PELD Cases

The anesthesia technique for MID is chosen depending on the specific procedure, with consideration of whether or not it is an endoscopic intervention. Local anesthesia with conscious sedation is an option in percutaneous endoscopic discectomy procedures, which differ from percutaneous lumbar disc decompression procedures in that the latter are typically performed under local anesthesia. Percutaneous endoscopic discectomy also differs from the standard OD or MD in that the patient can warn the surgeon if the instrumentation impinges on the nerve root during the procedure. However, patients may require extra sedatives or analgesics because of the surgical conditions.

BIS is not affected by noxious stimuli under adequate analgesia; thus, sedation maintenance can be achieved by the concomitant use of analgesics during painful procedures. Appropriate analgesic doses and timing are important for adequately maintaining sedation depth and keeping it within the safe range of sedation levels/scores. Thus, for safe sedation, it is important not to exceed the sedation targets, and different sedation evaluation tools should be used simultaneously rather than one tool alone. In case of respiratory depression, equipment for ventilatory support should be readily available throughout the procedure. Furthermore, conversion from local to general anesthesia should always be an option in prone-positioned patients, which requires complete abandonment of the surgical procedure, followed by endotracheal intubation and repositioning of the patient. Although minimally invasive spinal surgery techniques are continually evolving, anesthetic requirements can be concluded as using sedatives with absolute indications, achieving a safe sedation depth using proper monitoring tools to avoid oversedation, and proper airway management in the prone position.

Ethical Approval

This study is in compliance with ethical standards.

Competing Interests

The author declares that there are no competing interests regarding the publication of this manuscript.

References

[1] A. T. Yeung, “The evolution of percutaneous spinal endoscopy and discectomy: state of the art,” Mount Sinai Journal of Medicine, vol. 67, no. 4, pp. 327–332, 2000.
[2] F. U. Hermantin, T. Peters, L. Quartararo, and P. Kambin, “A prospective, randomized study comparing the results of open discectomy with those of video-assisted arthroscopic microdiscectomy,” The Journal of Bone & Joint Surgery—American Volume, vol. 81, no. 7, pp. 958–965, 1999.
[3] P. Kambin, K. Casey, E. O’Brien, and L. Zhou, “Transforaminal arthroscopic decompression of lateral recess stenosis,” Journal of Neurosurgery, vol. 84, no. 3, pp. 462–467, 1996.
[4] M. T. N. Knight, D. R. Ellison, A. Goswami, and V. F. Hillier, “Review of safety in endoscopic laser foraminoplasty for the management of back pain,” Journal of Clinical Laser Medicine and Surgery, vol. 19, no. 3, pp. 147–157, 2001.
[5] M. T. N. Knight, A. Goswami, J. T. Patko, and N. Buxton, “Endoscopic foraminoplasty: a prospective study on 250 consecutive patients with independent evaluation,” Journal of Clinical Laser Medicine and Surgery, vol. 19, no. 2, pp. 73–81, 2001.
[6] M. T. N. Knight, A. Vajda, G. V. Jakab, and S. Awan, “Endoscopic laser foraminoplasty on the lumbar spine—early experience,” Minimally Invasive Neurosurgery, vol. 41, no. 1, pp. 5–9, 1998.
[7] S. M. Lew, T. F. Mehaliak, and K. L. Fagone, “Transforaminal percutaneous endoscopic discectomy in the treatment of foraminal lumbar disc herniation,” Journal of Neurosurgery, vol. 94, no. 2, pp. 216–220, 2001.
[8] H. M. Mayer and M. Brock, “Percutaneous endoscopic lumbar discectomy (PELD),” Neuro Surgical Review, vol. 16, no. 2, pp. 115–120, 1993.
[9] A. T. Yeung and P. M. Tsoi, “Posterolateral endoscopic excision for lumbar disc herniation: surgical technique, outcome, and complications in 307 consecutive cases,” Spine, vol. 27, no. 7, pp. 722–731, 2002.
[10] Y. Ahn, S.-H. Lee, W.-M. Park, H.-Y. Lee, S.-W. Shin, and H.-Y. Kang, “Percutaneous endoscopic lumbar discectomy for recurrent disc herniation: surgical technique, outcome, and prognostic factors of 43 consecutive cases,” Spine, vol. 29, no. 16, pp. E326–E332, 2004.
[11] M. R. Rasouli, V. Rahimi-Movaghar, F. Shokraneh, M. Moradi-Lakeh, and R. Chou, “Minimally invasive discectomy versus microdiscectomy/open discectomy for symptomatic lumbar disc herniation,” The Cochrane Database of Systematic Reviews, vol. 9, Article ID CD001332, 2014.
[12] J. N. Gibson and G. Waddell, “Surgical interventions for lumbar disc prolapse,” Cochrane Database of Systematic Reviews, vol. 2, Article ID CD001350, 2007.
[13] N. Fàbregas and R. A. Craen, “Anaesthesia for minimally invasive neurosurgery,” Best Practice and Research: Clinical Anaesthesiology, vol. 16, no. 1, pp. 81–93, 2002.

[14] S. P. Ambesh and R. Kumar, “Neuroendoscopic procedures: anesthetic considerations for a growing trend: a review,” Journal of Neurosurgical Anesthesiology, vol. 12, no. 3, pp. 262–270, 2000.

[15] S. Himmelseher and E. Pfenninger, “Anaesthetic management of neurosurgical patients,” Current Opinion in Anaesthesiology, vol. 14, no. 5, pp. 483–490, 2001.

[16] P. Kambin and J. L. Schaffer, “Percutaneous lumbar discectomy. Review of 100 patients and current practice,” Clinical Orthopaedics and Related Research, vol. 238, pp. 24–34, 1989.

[17] S. Hijiikata, “Percutaneous nucleotomy. A new concept technique and 12 years’ experience,” Clinical Orthopaedics and Related Research, no. 238, pp. 9–23, 1989.

[18] P. A. Brouwer, R. Brand, M. E. Van Den Akker-Van Marle et al., “Percutaneous laser disc decompression versus conventional microdiscectomy in sciatica: a randomized controlled trial,” Spine Journal, vol. 15, no. 5, pp. 500–503, 2006.

[19] K. Gerlach, T. Uhlig, M. Huppe et al., “Remifentanil-propofol versus sufentanil-propofol anaesthesia for supratentorial craniotomy: a randomized trial,” European Journal of Anaesthesiology, vol. 20, no. 10, pp. 813–820, 2003.

[20] F. Yamamoto, R. Kato, J. Sato, and T. Nishino, “Anaesthesia for awake craniotomy with non-invasive positive pressure ventilation,” British Journal of Anaesthesia, vol. 90, no. 3, pp. 382–385, 2003.

[21] A. Sarang and J. Dinsmore, “Anaesthesia for awake craniotomy—evolution of a technique that facilitates awake neurological testing,” British Journal of Anaesthesia, vol. 90, no. 2, pp. 161–165, 2003.

[22] H. Berkenstadt, A. Perel, M. Hadani, I. Unofrievich, and Z. Ram, “Monitored anaesthesia care using remifentanil and propofol for awake craniotomy,” Journal of Neurosurgical Anesthesiology, vol. 13, no. 3, pp. 246–249, 2001.

[23] J. C. Keifer, D. Detchev, K. Little, D. S. Warner, A. H. Friedman, and C. O. Borel, “A retrospective analysis of a remifentanil/propofol general anesthetic for craniotomy before awake functional brain mapping,” Anesthesia and Analgesia, vol. 101, no. 2, pp. 502–508, 2005.

[24] J. C. Sigl and N. G. Chamoun, “An introduction to bispectral analysis for the electroencephalogram,” Journal of Clinical Monitoring, vol. 10, no. 6, pp. 392–404, 1994.

[25] P. S. Glass, M. Bloom, L. Kearse, C. Rosow, P. Sebel, and P. Manberg, “Bispectral analysis measures sedation and memory effects of propofol, midazolam, isoflurane, and alfentanil in healthy volunteers,” Anesthesiology, vol. 86, no. 4, pp. 836–847, 1997.

[26] P. Hans, V. Bonhomme, J. D. Born, A. Maertens De Noordhoudt, J. F. Brichant, and P. Y. Dewandre, “Target-controlled infusion of propofol and remifentanil combined with bispectral index monitoring for awake craniotomy,” Anaesthesia, vol. 55, no. 3, pp. 255–259, 2000.

[27] G. N. Schmidt, P. Bischoff, T. Standl, G. Lankenau, M. Hilbert, and J. Schulte Am Esch, “Comparative evaluation of narcotrend, bispectral index, and classical electroencephalographic variables during induction, maintenance, and emergence of a propofol/remifentanil anaesthesia,” Anesthesia and Analgesia, vol. 98, no. 5, pp. 1346–1353, 2004.