Review Article

Preoperative, intraoperative and postoperative anesthetic prospective for thyroid surgery: what's new

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Abstract: The aim of this review is to analyze what's new on anesthetic prospective to perioperative management for thyroid surgery. For recent decades intraoperative neuromonitoring (IONM) during thyroid and parathyroid surgery has obtained more and more popularity. New modality of anesthetic technique was also developed to incorporate into surgical teamwork. For example, the precise position of EMG tube and optimal use of neuromuscular blocking agents (NMBAs) play key roles in successful IONM system. Special focus is paid to following issues: (I) preoperative airway evaluation and pre-op preparation; (II) anesthetic managements including advanced intubation tools, NMBAs and sugammadex; and (III) post-op adverse events such as pain and postoperative nausea vomiting.

Keywords: Thyroid surgery; anesthesia; intraoperative neuromonitoring (IONM)

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Introduction

Traditional roles of anesthesia to thyroidectomy include preoperative assessment of thyroid function, anticipated difficult airway, adequate surgical relaxation and postoperative urgent airway complications (hematoma, bilateral vocal palsy) (1,2). In past decades, intraoperative neuromonitoring (IONM) has been widely accepted as adjunct technique to identify the target nerves, to detect variation, to elucidate nerve injury mechanism and to assess real-time nerve function during thyroid surgery (3-9). Therefore, special considerations should be taken into anesthetic management to ensure anesthesia-related factors to successful IONM system. For example, malposition of electromyography (EMG) tube and improper use of neuromuscular blocking agent (NMBA) might be the common causes of monitor dysfunction. Worldwide standard IONM protocol or international guideline has been published to make neural monitor as a precise and certain system for thyroid surgery (10). This review is intended to analyze what's new on anesthetic prospective to improve the quality of care and to reduce perioperative adverse events.

Preoperative evaluation

Upper airway evaluation (including denture)

Tracheal intubation is the key technique of general anesthesia. However, this technique was associated with various complications such as tissue trauma particularly when difficult intubation occurred. In the literatures, thyroid surgery is considered as a risk factor for difficult intubation due to large goiter or cancer. The reported incidence of difficult intubation in thyroid surgery ranged from 5.3% to 24.6% which was higher than general population (11-13). A detailed upper airway assessment is a necessary part of preoperative evaluation. In our medical center at Taiwan, an online electronic system of preoperative evaluation was designed to ensure complete upper airway and dental assessment (*Figure 1*). The online preoperative evaluation system could not progress without fulfilling airway and dental requested parameters. A detailed and careful preoperative assessment of upper airway might predict difficult intubation and alert potential dental injury to anesthesiologists. Kuo *et al.* reported that anesthesia-related dental trauma was significantly reduced after a quality improvement program based on routine dental diagram and difficult airway parameters of every patient undergoing elective surgery (14).

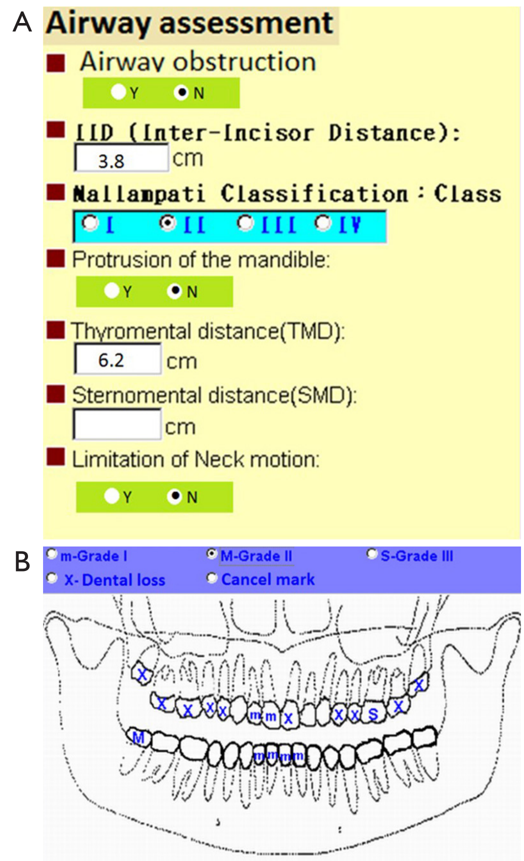

Figure 1 A sample of airway and dental assessment of electronic preoperative evaluation system. (A) Routine airway document to screen possible difficult intubation; (B) standardized electronic dental chart to record dental loss or teeth mobility (m = mild, M = moderate, S = severe).

Preoperative preparation following enhanced recovery after surgery (ERAS) protocols

ERAS protocols or the perioperative surgical home (PSH) has become an important issue of care coordination to improve medical outcome. In recent years, anesthesiologists play a key role in those perioperative care coordination (15,16). ERAS protocols consist of multimodal perioperative managements developed to reduce complications and length of stay after surgery by maintenance of preoperative organ function and reduction of postoperative stress response (17). The shortening of preoperative fasting has proposed to replace fasting patient from the midnight without increase in aspiration risk (18). Preoperative solid food up to 6 hours and clear fluids or clear carbohydrate drinks up to 2 hours were allowed to attenuate insulin resistance, protein loss, muscle wasting, hunger, thirst and anxiety (19-22). Preadmission counseling, antibiotic prophylaxis, no premedication and thromboprophylaxis were also recommended as preoperative preparation for major surgery in ERAS protocols (23).

Anesthetic management

Advanced airway devices and EMG tube positioning

As mentioned previously, the incidence of difficult intubation may be higher in thyroid surgery when conventional intubation tool "laryngoscope" was used. During thyroid surgery with neuromonitoring setting, the success of airway management demands not only correct tracheal intubation but also proper position of EMG tube (24,25). Accurate positioning of the EMG endotracheal tube is the key step for the precise neuromonitoring. Kim *et al.* used a porcine model to demonstrate that artificial endotracheal tube rotation and depth changes induced significant EMG amplitude change with relatively stable EMG latency (26). In a retrospective review of ten patients with EMG tube malposition, similar EMG outcomes (decrease in EMG amplitudes but not latency) were found during tube rotation or vertical displacement (27). Cherng *et al.* showed tube rotation caused by the right or left side

Figure 2 The Trachway intubating stylet loaded with an EMG endotracheal tube. The rigid stylet was lengthened up to 34 cm fit for the EMG tube. EMG, electromyography.

mouth corner fixations in a manikin study; therefore, middle fixation of EMG tube between incisors was recommended for IONM setup (28).

In recent decades, many novel airway devices have been designed to improve success rate of tracheal intubation and reduce intubation difficulty (29-31). There are two major system of advanced airway device: (I) video-assisted laryngoscope with a changeable blade such as the GlideScope, the Airway Scope (AWS; Pentax) and UESCOPE. (II) Intubating stylet with a rigid fiberscope for direct visualization such as Trachway Video Intubating stylet (Trachway), and the Bonfils fiberscope. When an EMG tube placement is requested for neuromonitoring, the GlideScope not only allows direct visualization of glottis but also enables proper surface electrode positioning to the vocal cords during tube placement (32,33). The EMG tube could be placed via the Trachway (*Figure 2*) and further rechecked position under fiberscopic visualization after successful tracheal intubation.

NMBA and sugammadex

In anesthetic perspective, NMBAs (muscle relaxants) is generally considered as gold standard for surgical relaxation and tracheal intubation with less airway complications (34,35). In neuromonitoring era, the liberal use of NMBA might diminish derived EMG signals to various degrees and confuse interpretation of IONM results (36-40). A series of porcine models and clinical trials have proceeded to investigate suitable non-depolarizing NMBA and optimal dose feasible to IONM during thyroid surgery.

There are five strategies of neuromuscular blockade management for IONM as followings: (I) no NMBA use for entire perioperative period. It is possible to perform tracheal intubation without muscle relaxant with experienced hands (41). However, it was not suggested as a routine practice due to higher risk of airway injury (34,35). (II) Depolarizing NMBA (succinylcholine). Succinyl choline at 2 to 2.5 mg per kilogram is an ideal choice with respect to rapid onset and short duration of muscular relaxation (10). Many anesthesiologists avoid succinyl choline because of its side effects, such as cardiac dysrhythmia, hyperkalemia, and malignant hyperthermia (42,43). (III) Single induction dose of non-depolarizing NMBA. For example, rocuronium and atracurium at 0.5 mg/kg was adequate for tracheal intubation and allowed spontaneous recovery of neuromuscular transmission and positive EMG signals gradually (44). (IV) Single reduced dose of rocuronium. One of widely accepted regimen was one effective dose of rocuronium (0.3 mg/kg) for anesthesia induction. It was recommended as an optimal dose for IONM during thyroid surgery for providing high EMG amplitude at early stage of operation and satisfactory intubating conditions (36). (V) Two effective dose of rocuronium with subsequent sugammadex. Rocuronium 0.6 mg/kg at anesthesia induction yields excellent intubating condition. Sugammadex acts as a selective relaxant binding agent for rapid neuromuscular blockade reversal induced by steroidal NMBA (i.e., rocuronium, *vecuronium)* (45,46). Sugammadex 2 mg/kg at skin incision rapidly restores neuromuscular function suppressed by rocuronium. The regimen seems to meet both anesthesia (intubation) and surgery (monitoring) demands. The drawback is the high cost of sugammadex which restricts its use in most countries currently (47).

Post-operative adverse events

Pain-multimodal analgesia

Postoperative pain control by multimodal analgesia using more than one analgesic modality is mandatory to enhanced recovery. Undermanaged postoperative pain delays recovery and discharge after surgery (48). Parenteral opioids are effective analgesic regimen but are associated with adverse effects such as respiratory depression, postoperative nausea and vomiting (PONV), pruritus, urinary retention, and ileus. Postoperative recovery and hospital stay may prolong if those unwanted side effects occur (49). Advancements in multimodal analgesic techniques are aimed to achieve more effective pain control and less opioid-related side effects (50).

Available systemic analgesia except opioids includes followings: non-steroidal anti-inflammatory drugs (NSAID) and cyclooxygenase-2 (COX-2) inhibitor (parecoxib), acetaminophen (oral or intravenous), alpha 2 agonists (clonidine or dexmedetomidine),intravenous lidocaine infusion, anticonvulsants (gabapentin and pregabalin), glucocorticoids (e.g., dexamethasone), beta-blockers (e.g., esmolol), N-methyl-D-aspartate (NMDA) receptor antagonists (ketamine) (51). Parecoxib, the only intravenous COX-2 inhibitor, has been reported to reduce opioid consumption in major surgery (total knee replacement) (52) and to provide comparable analgesic effect as opioids in minor surgery (laryngeal microsurgery) (53). Furthermore, fewer opioid-related adverse events and faster functional recovery could be expected.

PONV

It has been reported that PONV may prolong the recovery, delay discharge from hospital and reduce patient satisfaction (54). PONV affects 25–30% of overall surgical population (54,55) and the incidence becomes as high as 63–84% in patients undergoing thyroid surgery (56-58). The etiology of PONV is complex and can be classified into patient, anesthetic and surgical factors. The incidence might be predicted by following risk factors: a history of motion sickness or PONV, female patients, non-smokers, postoperative opioids use and emetogenic surgery (59,60). A multimodal approach to PONV prophylaxis by more than two interventions is suggested in adults with high risk (>2 risk factors) (54,61).

Prophylaxis and treatment interventions included propofol anesthesia, propofol low dose infusion, traditional antiemetics (droperidol, dimenhydrinate, scopolamine, metoclopramide), non-traditional antiemetics (propofol and dexamethasone), and serotonin receptor antagonist (ondansetron) and non-pharmacologic approach such as acupuncture (61,62). If prophylaxis fails and PONV is present, a multimodal approach is recommended by using antiemetic from different class than prophylactic drug. Alternatively, propofol anesthesia alone or combined with inhaled anesthetics can be beneficial in patients with susceptibility to PONV. Chen *et al.* reported a relative low PONV incidence (3.8–4.2%) with propofol target-controlled infusion in patients undergoing laparoscopic cholecystectomy (63).

Conclusions

There have been many efforts paid to optimize anesthetic care for thyroid surgery, particularly with specific perioperative management to facilitate IONM protocols. Perioperative managements proposed to enhance recovery after surgery may be beneficial to thyroid surgery but it requires further evidence. Airway management should be prepared for any possible airway difficulty and proper position of the endotracheal tube. IONM has become a mature adjuvant for a possible event of any nerve injuries and palsies. A well communication between surgeons and anesthesiologists will avoid potential obstacles and interferences to neuromonitoring setup. Adequate prophylaxis and treatment of pain and PONV are of major concern during postoperative care. Currently, anesthesiologists not merely serve as an isolated guardian to keep patient safety but also as a part of teamwork to enhance better medical outcomes.

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Footnote

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