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Anesthesia for Transoral Endoscopic Parathyroidectomy by Vestibular Approach (TOEPVA)

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Abstract

Background: After thyroid diseases, hyperparathyroidism is one of the most common endocrine surgical diseases. The increasing diagnosis of thyroid pathologies in early stages and a societal emphasis on physical appearances, especially in young women, have led to the development of new surgical techniques alternative to conventional transcervical incision consistently. Here, we describe our anesthesia experience for parathyroidectomy with Transoral Endoscopic Parathyroidectomy by Vestibular Approach (TOEPVA). Patients who undergo TOEPVA at our institution between November 2018 and April 2019 were reviewed. Demographic data and hemodynamic parameters were reported.

Results: Seven patients were operated successfully by this technique, none of which required conversion to conventional open surgery. Two patients required atropine and one patient required ephedrine during insufflation.

Conclusion: After induction of anesthesia with propofol, remifentanil, and rocuronium and anesthesia managed by desflurane co-administered with continuous infusion of remifentanil provide feasible and safe anesthesia for TOEPVA. However, especially during hydrodissection and insufflation, a close cooperation between surgeon and anesthetist has a great value to improve patient management.

Keywords: General anesthesia, Transoral endoscopic parathyroidectomy, Vestibular approach, Anesthesia management, Inhalation anesthesia

Background

After thyroid diseases, hyperparathyroidism is one of the most common endocrine surgical diseases (Bhargav et al., 2019). It occurs either from a disorder within the parathyroid glands (primary hyperparathyroidism) or disorder outside the parathyroid glands (secondary or tertiary hyperparathyroidism) (Sasanakietkul et al., 2016). In recent years, since described by Kocher in the late 1980s, treatment of hyperparathyroidism was the surgical removal of 4 parathyroid glands with transcervical incision (Sasanakietkul et al., 2016; Russell et al., 2017; Guerrero et al., 2007). After the realization that a single adenoma is the cause of hyperparathyroidism in most of the patients (80–85%), surgical management was changed significantly (Sasanakietkul et al., 2016). With preoperative imaging tools (ultrasound and technetium-99m sestamibi scintigraphy) for localization of the adenoma and intraoperative parathyroid hormone level measurements for confirmation, surgical excision of the offending parathyroid adenoma is still accepted as the main treatment of primary hyperparathyroidism (Bhargav et al., 2019; Sasanakietkul et al., 2016; Sasanakietkul & Carling, 2017).

The increasing diagnosis of thyroid pathologies in early stages and a societal emphasis on physical appearances, especially in young women, have led to the development of new surgical techniques alternative to conventional transcervical incision consistently (Russell et al., 2017;

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Razavi et al., 2018). Over the last two decades, so many techniques such as open minimally invasive parathyroidectomies (OMIP), minimally invasive video-assisted parathyroidectomy (MIVAP), pure endoscopic minimally invasive parathyroidectomy (EMIP), and recently transoral endoscopic parathyroidectomy vestibular approach (TOEPVA) have been developed (Russell et al., 2017; Gagner & Rubino, 2004).

Here, we describe our anesthesia experience for parathyroidectomy with Transoral Endoscopic Parathyroidectomy by Vestibular Approach (TOEPVA). According to our knowledge, this is the first report that explains anesthesia management in TOEPVA.

Methods

Seven patients undergo TOEPVA at our institution between November 2018 and April 2019. All patients were diagnosed with primary hyperparathyroidism due to a solitary parathyroid adenoma and were managed by the same anesthetist and by the same experienced surgeon on minimally invasive and endocrine surgery. Demographic data, drugs used for anesthesia management (induction, maintenance, and extubation), hemodynamic parameters, end-tidal carbon dioxide and pulse-oximeter values, additional agents used preoperatively in anesthesia management, and preoperative and peroperative measurements of PTH levels were recorded prospectively and evaluated retrospectively.

Preoperative setting

After the informed consent of the patients was approved for anesthesia, all patients received preoperative anesthesia evaluation, including laboratory tests and imaging studies (chest radiography, focused ultrasound for parathyroid adenoma mapping). Also, preoperative PTH levels were obtained to compare intraoperative rapid parathormone levels. All patients received amoxicillin-clavulanic acid (1.2 g) 30 min before the incision as antibiotic prophylaxis.

Anesthesia management

After routine monitorization (non-invasive blood pressure, electrocardiogram, end-tidal carbon dioxide, and pulse-oximeter), anesthesia was induced with propofol (2 mg/kg), remifentanil infusion (0.01–0.5 mcg/kg/min), and rocuronium (0.6mg/kg) and was administered to facilitate the tracheal intubation. Airway patency was achieved by nasal intubation with an inner diameter of 6.5 mm spiral endotracheal tube in six patients and with an inner diameter of 6.0 mm spiral endotracheal tube in one patient. The eyes were carefully closed to keep them closed peroperatively and to prevent contact with the solution (chlorhexidine and povidone-iodine) used to clean the vestibular area. Dexametazone (8 mg) and H_2 blocker (50 mg) were applied to all cases after anesthesia induction as routine clinical practice. Anesthesia was maintained with desflurane 5 to 6% concentration in a gas mixture consisting of 45% oxygen in the air. All patients were ventilated on volume control ventilation mode with 5–7 mL/kg tidal volume, and respiratory rate was modified to keep the end-tidal carbon dioxide within the normal values (35–45 mmHg) perioperatively. Also, pulse-oximeter values were changed between 96 and 100% in all patients perioperatively. The neuromuscular blocker dose was repeated every 30 min routinely and also administered as a rescue bolus dose if the view of the surgical field was worsened. After removal of parathyroid adenoma, which was verified by histopathological examination and by blood PTH level decrease, we administered tramadol 0.3 mg/kg intravenously for postoperative analgesia. At the end of the operation, sugammadex (2–4 mg/kg) was administered to reverse the neuromuscular block. All patients were transferred to the post-anesthesia care unit (PACU) at the end of the operation and to their ward 1 h after PACU stay, uneventfully.

Surgical management

All patients were operated by the same principles of TOEPVA which was described by Anuwong (Anuwong, 2016). In detail, the patient is placed in a supine position with a slight neck extension. After a proper surgical preparation, a 10–11-mm transverse incision is made at the center of the oral vestibule just below the vermilion border. Once the periosteum is approached and identified by electrocautery and blunt dissection through the central incision, the neck area is injected with 20 to 40 mL diluted epinephrine (0.5 mg epinephrine in 500 mL saline) by a Veress needle. About 2.5 cm distance from this central incision, two additional 5-mm vertical incisions are made on both sides, above and as lateral as possible to the canine teeth to avoid mental nerve injury. These lateral trocar sides are also prepared by injection with the same diluted epinephrine solution of 5 to 10 mL. Then, one central 10–11-mm and two lateral 5-mm trocars are inserted, and CO_2 insufflation began at a maximum pressure of 6 mmHg with a flow rate of 6 L/min to create an air pocket to perform parathyroidectomy with ordinary laparoscopic instruments.

Results

The patients' characteristics and preoperative, operative, and postoperative details are shown in Table 1. Two patients (case 1 (heart rate 43/min) and case 5 (heart rate 41/min)) required atropine (0.5 mg), and one patient (case 2) (blood pressure 60/40 mmHg) required ephedrine (10 mg) administration during insufflation, while all patients require a lower dose of remifentanil infusion during drapping and preparation for surgery after

Table 1 Demographic data and preoperative and operative details

Case no.	Gender	Co-morbidity	Localization of parathyroid adenoma	Atropin (mg)	Ephedrine (mg)	Preoperative PTH level (pg/mL)	Intraoperative PTH level after removal of parathyroid adenoma (pg/mL)
1	Female	No	Left inferior	0.5	–	133.84	12.75
2	Female	HT, DM, CML	Left inferior	–	10	113.10	34.80
3	Female	HT	Right inferior	–	–	183.40	34.30
4	Female	No	Left superior	–	–	137.35	29.20
5	Female	No	Left inferior	0.5	–	190.00	30.40
6	Female	No	Left superior	–	–	127.76	19.80
7	Female	No	Left inferior	–	–	166.00	25.20

BMI body mass index, *PreOHS* preoperative hospital stay, *POHS* postoperative hospital stay, *CML* chronic myeloid leukemia, *HT* hypertension, *DM* diabetes mellitus, *HPT* hyperplastic parathyroid tissue

induction of anesthesia, requiring higher doses remifentanil during hydrodissection. Except for insufflation and hydrodissection phases of surgery, patients' hemodynamic parameters (blood pressure, heart rate) were stable (changed ±20% from baseline) during the operation time. End-tidal carbon dioxide levels of all cases were within normal limits perioperatively. Changes in the mean arterial pressure and heart rate in cases by the operation time are shown in Figs. 1 and 2, respectively. No conversion to conventional open surgery was necessary. In all patients, intraoperative parathyroid hormone level decrease was confirmed by laboratory test. None of the patients complained of any complication postoperatively as pneumomediastinum and/or pneumothorax or recurrent laryngeal nerve injury or surgical emphysema or sign of carotid decompression. All patients' visual analog scale scores were <4 in 24 h postoperatively. None of them required any additional analgesic.

Discussion

Anuwong (Anuwong, 2016) introduced transoral endoscopic surgery using conventional laparoscopic instruments via the oral vestibule, through the premandibular space with CO_2 insufflation. First, they used this approach in thyroidectomy patients (transoral endoscopic thyroidectomy by vestibular approach (TOETVA)). They reported that TOETVA is safe and feasible, resulting in no visible scar thus an ideal method for cosmetic results. In 2016, Sasanakietkul et al. (Sasanakietkul et al., 2016) adapted Anuwong's technique, which he introduced for TOETVA, to parathyroid surgery (primary hyperparatyrisidism or renal hyperparatyrisidism) using the inferior lip (Transoral Endoscopic Parathyroidectomy by Vestibular Approach (TOEPVA)). They reported excellent cosmetic outcomes with feasible and safe surgical options.

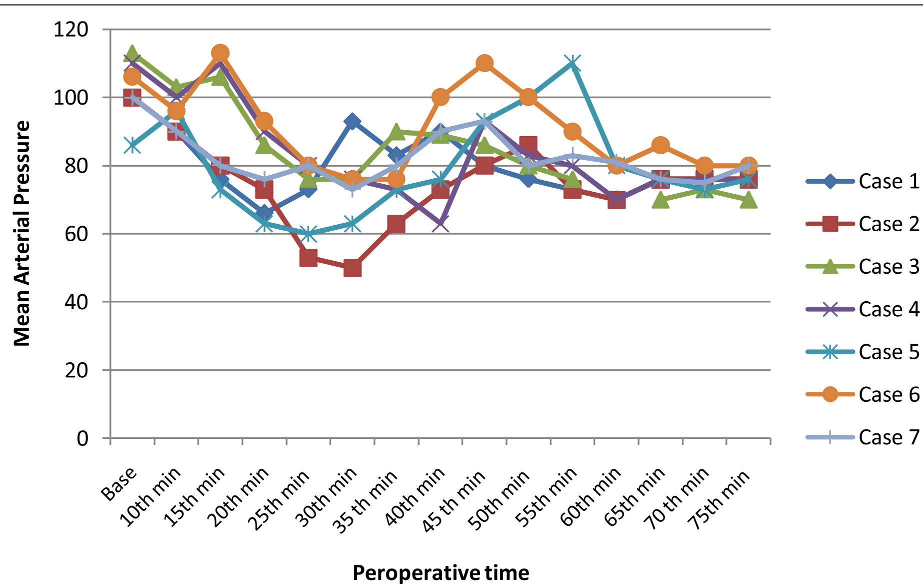

Fig. 1 Changes in mean arterial pressure in cases by the operation time

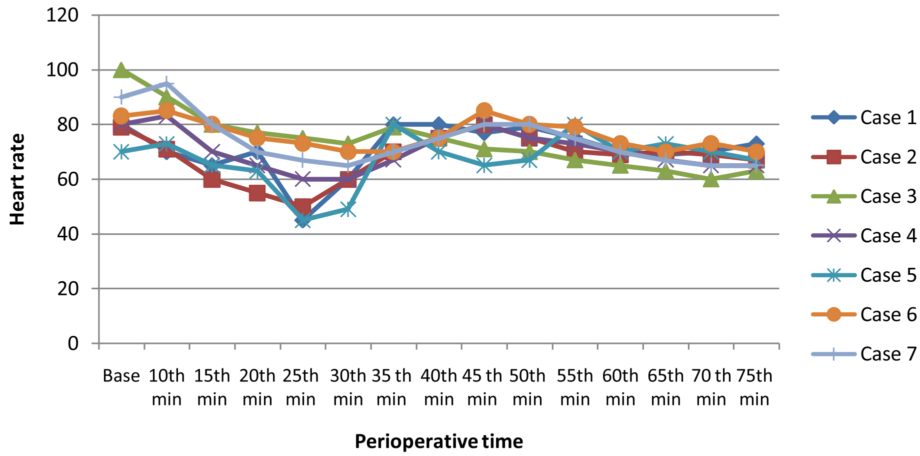

Fig. 2 Changes in heart rate in cases by the operation time

While advances in surgical technique have been continued in parathyroid surgery, we have not been able to find recommendations regarding the anesthesia management of these cases in the literature. Up to date, there is no report is published about how we can manage these patients under general anesthesia. Therefore, we want to share our anesthesia management in TOEPVA in the literature.

Transoral surgery can be considered as having three important stages in terms of anesthesia management: (1) hydrodissection, (2) insufflations, and (3) surgical phase. While the hydrodissection phase may cause an increase in sympathetic activity by diluted epinephrine solution used for hydrodissection, neck insufflations by carbon dioxide may cause sudden suppression of sympathetic activity. During the surgical phase, due to the surgical technique applied, absolute immobility of the case is very necessary for the anesthetist and surgeon to avoid serious events. The most important complications in the surgical phase are pneumomediastinum and/or pneumothorax and recurrent laryngeal nerve injury which requires close monitoring of capnography and follow-up of respiration, respectively (Bacuzzi et al., 2018).

For the best management of all the phases that mentioned above, we preferred balanced anesthesia (inhalation anesthesia with opioid) in our anesthesia management in TOEPVA. We preferred desflurane as inhalation anesthetic remientanil as opioid, and rocuronium bromide as neuromuscular blocker. All patients were reversed by sugammadex and extubated at the end of the surgery. So, in this article, we want to explain why we preferred these agents in our anesthesia management in TOEPVA.

Desflurane is a relatively new volatile anesthetic that has low blood-gas solubility resulting in rapid uptake and elimination (Wulf et al., 1998). Its muscle-gas partition coefficient is lower than other volatile anesthetics (Maidatsi et al., 2004). The enhancement of the neuromuscular blocking effects of muscle relaxants (both benzylisoquinoline and aminosteroid) by volatile anesthetics is well known (Maidatsi et al., 2004; Bock et al., 2000; Lee et al., 2016), and this phenomenon is called "potentiation" (Wulf et al., 1998). Rocuronium bromide is a monoquaternary, aminosteroid, non-depolarising muscle relaxant with rapid onset and intermediate duration of action (Wulf et al., 1998; Lee et al., 2016). Sugammadex is a modified ɣ-cylodextrin developed for reversal of neuromuscular blockade induced by aminosteroid neuromuscular blocking agents, particularly rocuronium by formatting a complex with rocuronium (encapsulation). Previous meta-analysis results reported that sugammadex is superior to neostigmine, as it reverses neuromuscular block faster and more reliable and accelerates postoperative discharge of patients after general anesthesia (Carron et al., 2016; Carron et al., 2017).

Wulf and colleagues (Wulf et al., 1998) reported that neuromuscular blocking effect of rocuronium to be enhanced by sevoflurane and desflurane, compared with total intravenous anesthesia (TIVA) (propofol/fentanil). Bock et al. (Bock et al., 2000) showed that there was a marked interaction between neuromuscular blocking effects of rocuronium and isoflurane, desflurane, and sevoflurane, compared with propofol. Maidatsi et al. (Maidatsi et al., 2004) reported that desflurane anesthesia significantly prolongs the duration of action of rocuronium, compared to sevoflurane or propofol anesthesia in anesthesia maintenance regimens. Although in vitro studies propofol has been reported to potentiate the effects of neuromuscular blockers; there is no report to date that propofol can clinically potentiate the effects of neuromuscular blockers clinically (Lee et al., 2016).

While neuromuscular blockade should be intense peroperatively because of the nature of the surgery, maintenance of the airway patency must be supplied at the end of the surgery. So, we preferred rocuronium as a neuromuscular agent, which has a specific and reliable reversal agent to manage airway patency uneventfully after extubation, and desflurane as an inhalation agent, which enhances the neuromuscular block effect of rocuronium peroperatively.

It is important to measure the intraoperative PTH level to verify the removal of pathological parathyroid adenoma. PTH has a short half-time and rapid metabolic clearance rate and has a rapid assay. But on the other hand, PTH level was influenced by many factors including stress, stress hormones (such as catecholamines, cortisol, and inulin), general anesthesia and endotracheal intubation (the most stress-baring procedure), calcium, magnesium, vitamin D, anesthetic agents (propofol), and laparoscopic surgeries (elevated blood CO_2 may change blood pH and cause a shift of ionized calcium) (Carron et al., 2017; Cinamon et al., 2017). Also, previous studies reported that propofol influences PTH level; Kivela et al.'s 2011 results suggest that there is no need to avoid propofol during parathyroid surgery as previously suggested (Cinamon et al., 2017). Whether propofol affects the PTH level or not is still a debate, so we prefer inhalation anesthesia and desflurane as an inhalation anesthetic. We preferred propofol only during induction to prevent hemodynamic alternations to stress response and to suppress upper airway reflexes for nasal intubation. But Bacuzzi et al. (Bacuzzi et al., 2018) suggest total intravenous anesthesia (bolus dose of propofol (2 mg/kg) followed by infusion (0.2–0.5 γ/kg/min) of remifentanil) for transoral approaches.

Opioids have an important influence on upper airway events, purposeful movements during surgery, and recovery time (Kowark et al., 2018), the requirements for propofol or volatile anesthetics (Kowark et al., 2018; Nooh et al., 2013). Remifentanil has rapid onset, short duration of action (Kowark et al., 2018; Nooh et al., 2013; Ryu et al., 2018), great intraoperative analgesia (Nooh et al., 2013; Ryu et al., 2018; Grundmann et al., 2001), quick recovery time (Nooh et al., 2013; Ryu et al., 2018; Grundmann et al., 2001), and excellent controllability (Kowark et al., 2018) and is metabolized by non-specific esterase so elimination is independent from the liver and renal (Kowark et al., 2018; Nooh et al., 2013). But over-administered opioid analgesics during surgery delay recovery from anesthesia and cause opioid-related side effects (Nooh et al., 2013; Ryu et al., 2018).

Ryu et al. (Ryu et al., 2018) compared intraoperative remifentanil requirements during equi-minimum alveolar concentration (MAC) anesthesia of 1 MAC sevoflurane and desflurane anesthesia via surgical pleth index-guided remifentanil administration. They reported that intraoperative remifentanil consumption was significantly lower in the desflurane group than in the sevoflurane group. Kowark and colleagues (Kowark et al., 2018) have shown that in the presence of a continuous infusion of remifentanil, desflurane is significantly superior to sevoflurane and propofol in terms of emergence from anesthesia. Fukunaga et al. (Fukunaga et al., 2003) and Nooh et al. (Nooh et al., 2013) showed the same results. Remifentanil provides effective suppression of cardiovascular responses to surgical stimulation and promotes hemodynamic stability and improves recovery profiles.

We preferred remifentanil infusion as an opioid analgesic to manage sempatic activity changes during hydrodissection and insufflation phases of anesthesia in our anesthesia management because of its best pharmacokinetics and pharmacodynamics properties. And also, we believe that we lower intraoperative remifentanil consumption, avoid over administered opioid side effects, and better emergence from anesthesia as Kowark et al. reported, by combining remifentanil with desflurane.

Some concerns exist regarding the safety of neck insufflations by carbon dioxide, and since then, severe hypercapnia, acidosis, massive subcutaneous emphysema, and tachycardia were observed (Rubino et al., 2000; Bellantone et al., 2001). Bellantone et al. reported that carbon dioxide neck insufflations are safe ≤10 mmHg but the use of insufflation pressures higher than >15 mmHg should be avoided to prevent metabolic and hemodynamic complications (Bellantone et al., 2001). Rubino et al. (Rubino et al., 2000) reported that carbon dioxide neck insufflation up to 10 mmHg does not alter intracranial pressure and is recommended for clinical application in endoscopic neck surgery. The important issues during neck insufflation are insufflation pressure and the rate of insufflation. The head and neck region is dense in terms of the vessel and nerve packs. Carbon dioxide neck insufflations may cause negative hemodynamic effects by compressing these packs. We must take care (atropine, ephedrine, adrenaline, large vessel, close communication with surgeon for urgent desufflation, etc.) during the insufflation phase of surgery.

On the other hand, PTH itself causes alterations in vasodilatory properties of the endothelium by hypercalcemia which leads to short QT intervals, prolongation of PR and QRS intervals, and myocardial depression (Brown et al., 2017). Therefore, we should follow ECG changes and hemodynamic parameters more closely during anesthesia induction, hydrodissection, and insufflation.

We do not prefer N_2O in laparoscopic surgeries in our clinical practice. In addition, N_2O increases postoperative nausea and vomiting (Bacuzzi et al., 2018; Grundmann et al., 2001) which is a drug side effect that we do not want to encounter in patients with TOEPVA and to meet with any infection postoperatively.

Conclusion

This is the first study which describes the anesthetic management for TOEPVA in the literature. After induction of anesthesia with propofol, remifentanil, and rocuronium, anesthesia management by desflurane co-administered with continuous infusion of remifentanil provides feasible and safe anesthesia for TOEPVA. However, especially during hydrodissection and insufflation, a close cooperation between surgeon and anesthetist has a great value to improve patient management. Further studies are needed on anesthesia management for TOEPVA in clinical practice.

Abbreviations

TOEPVA: Transoral Endoscopic Parathyroidectomy by Vestibular Approach; CO_2: Carbon dioxide

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None

Authors' contributions

FY and KB reviewed the available literature. FY and KB prepared the primary article. FY and KB reviewed, edited, and approved the manuscript. The authors have read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Regional Ethical Committee of the University of Health Sciences Izmir Bozyaka Training and Research Hospital Ethical Committee (Protocol No: 2021/68). The written informed consent was obtained from all patients.

Consent for publication

Written permission/consent of the patient for the purpose of publication in an educational medical journal was obtained from the patients.

Competing interests

The authors declare that they have no competing interests.

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