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Transoral endoscopic thyroid surgery in a Korean population

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Abstract

Background Transoral endoscopic thyroidectomy vestibular approach is expected to be a safe alternative to open surgery for certain patients and has been used increasingly by several surgeons around the world for the past 2 years. The purpose of this paper is to review our 2-year experience and describe in detail our preoperative considerations, patient selection, operating room settings, anesthetic considerations, surgical technique, postoperative management, and outcomes.

Methods We reviewed the medical records of 65 consecutive patients who underwent transoral endoscopic thyroidectomy between July 2016 and May 2018 in our hospital.

Results We have performed 65 thyroid surgeries (54 thyroid lobectomies, 1 completion thyroidectomy, and 10 total thyroidectomies) in 64 patients. Postoperative pathology revealed papillary carcinoma in 55 patients (84.6%), follicular carcinoma in two (3.1%), hyalinizing trabecular tumor in one (1.5%), and other benign tumor in seven (10.8%). All surgical margins were negative. Two (3.1%) patients developed transient vocal cord palsy but recovered within 2 months. One (1.5%) patient with vocal cord palsy had not recovered by 3 months after surgery. Five (7.7%) patients who underwent total thyroidectomy developed transient hypocalcemia but recovered within 2 months.

Conclusion Although transoral thyroid surgery is a relatively recent technique requiring further validation, it affords several advantages. Transoral thyroid surgery has not yet been universally accepted, but may be the best choice for thyroid surgery in the future.

Keywords Endoscopy · Minimally invasive surgical procedure · Thyroid · Thyroidectomy · Transoral thyroidectomy · Transoral · TOETVA

The incidence of thyroid cancer in South Korea increased 15-fold between 1993 and 2011, and is currently the most common cancer in females [1]. Most thyroid cancers grow slowly and are seldom life-threatening, but are frequent in the 2nd to 3rd decades of life in young females; a visible hypertrophic scar in the center of the neck after surgery may be disturbing and stressful. Several authors have sought to minimize scarring or to split scars (to aid dispersion), but neck scarring persists. Therefore, efforts have been made to move the incision to an area normally covered with clothing, such as the axilla, breast, or retroauricular region [2]. Approaches commonly used in South Korea include the transaxillary and bilateral axillo-breast (BABA) methods; recently, the retroauricular approach has become popular among head-and-neck surgeons [3–10].

Natural orifice transluminal endoscopic surgery (NOTES) is the latest surgical technique for inserting an endoscope through the mouth, anus, vagina, etc., and for performing surgery with mucosal incision only without skin incision [11]. Recently, a number of researchers have sought to apply NOTES to thyroid surgery and several trials sought to remove the thyroid gland through oral cavity. Transoral thyroid surgery has been performed via two principal routes: the sublingual and vestibular routes, of which the former

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was associated with more complications and tissue damage [12–15]. Recently, a Chinese group reported successful results in 81 cases using a sublingual route of endoscopic insertion, although two cases were changed to open thyroidectomy because of intraoperative CO_2 embolisms [16]. The vestibular route became widely known after Anuwong reported successful results in their first 60 patients: the transoral endoscopic thyroidectomy vestibular approach (TOETVA) has become increasingly recognized as a feasible novel surgical procedure [17]. Several researchers from various countries have reported successful initial results after attempting TOETVA or a similar method [18–25].

TOETVA is expected to be a safe alternative to open surgery for certain patients and has been used increasingly by several surgeons around the world for the past 2 years. The purpose of this paper is to review our 2-year experience (all procedures were performed by the same surgeon); summarize the existing literature; and describe in detail our preoperative considerations, patient selection, operating room settings, anesthetic considerations, surgical technique, postoperative management, and outcomes.

Materials and methods

Indications and contraindications

We reviewed the medical records of 65 consecutive patients who underwent TOETVA between July 2016 and May 2018 in our hospital. All patients were operated on in the same manner, and by the same surgeon (JO Park). The patients were 53 females and 12 males of mean age 42.9 years (range: 19–66 years). Transoral completion surgery was performed after initial transoral thyroid lobectomy in one female. The inclusion criteria were (1) no prior surgical treatment or radiation to the head-and-neck and/or mediastinum (exceptionally, in one case, the permanent pathology revealed a follicular carcinoma after transoral thyroid lobectomy and completion transoral thyroid lobectomy was performed on the 9th postoperative day); (2) provision of consent (the transoral approach was explained to all patients and their families before operation, and written, informed patient consent obtained); (3) no extrathyroidal extension or lymph node metastasis evident on preoperative ultrasonography; and (4) a suspected or confirmed thyroid cancer < 2 cm in diameter on the mid/lower lobe or < 1 cm in diameter on the superior lobe; and (5) a benign tumor < 8 cm in diameter. Our Institutional Review Board approved the study.

Preoperative evaluation

Thorough history-taking included an exploration of why the patient is motivated to try the new surgical approach, any previous keloid issues, and any previous history of head-and-neck surgery, head-and-neck irradiation, or clinical hyperthyroidism. We check if any patient had a protruding chin or prominent Adam's apple (which can cause certain issues during surgery). We also checked oral hygiene status, vocal cord paralysis status, and body fat composition. If an oral abscess or acute inflammation is evident near the lower vestibule, surgery is delayed because of a risk of wound infection. We obtained neck computed tomography (CT) scans to check the location and size of the anterior jugular vein, and if the course of the innominate artery is high. We also checked if the Zuckerkandl tubercle is prominent; this can render identification and preservation of the recurrent laryngeal nerve difficult (Fig. 1).

Setting, instruments, and operating room

A 10-mm-diameter, 30° rigid endoscope is usually used for transoral thyroid surgery. The usual endoscopic instruments included a Babcock forceps, a Johann forceps, a right-angled forceps, a short Maryland forceps, and an ultrasonic device. Three cannulas are used to position the instruments (two 5-mm-diameter cannulas for forceps and one 11-mm-diameter cannula for the endoscope). A Veress needle is used for hydro-dissection and blunt instruments (a vascular tunneller and a Kelly clamp) for creating and widening the working space. Excised specimens are routinely removed using an endoscopic pouch.

Patient positioning

The patient is usually administered general anesthesia via orotracheal intubation and an endotracheal tube is fixed to the right or left corner of the mouth (on the same side as the anesthesia equipment) to prevent it from falling out during surgery. The patient is usually placed in the supine position with a pillow under the back allowing the neck to be slightly extended. The patient's head is fixed to the bed firmly using adhesive plaster so that the head does not turn during surgery (Fig. 2A). The oral cavity and anterior neck are disinfected employing the usual povidone/water solution. Draping is performed so that the upper lip is sufficiently exposed superiorly and the sternal notch inferiorly (Fig. 2B). The surgical team consists of four medical staff: an operator, the first assistant surgeon, the second assistant surgeon, and a scrub nurse (Fig. 2C). The operator usually sits or stands above the patient's head. The operator sits on a chair with an armrest in a stable and comfortable posture. The first assistant surgeon stands on the right or left of the patient (opposite to the side of the lesion; thus on the right side if left thyroid lobectomy is planned) and secures the surgical view by holding the endoscope. The second assistant surgeon stands on the lesion side, and helps the surgeon to

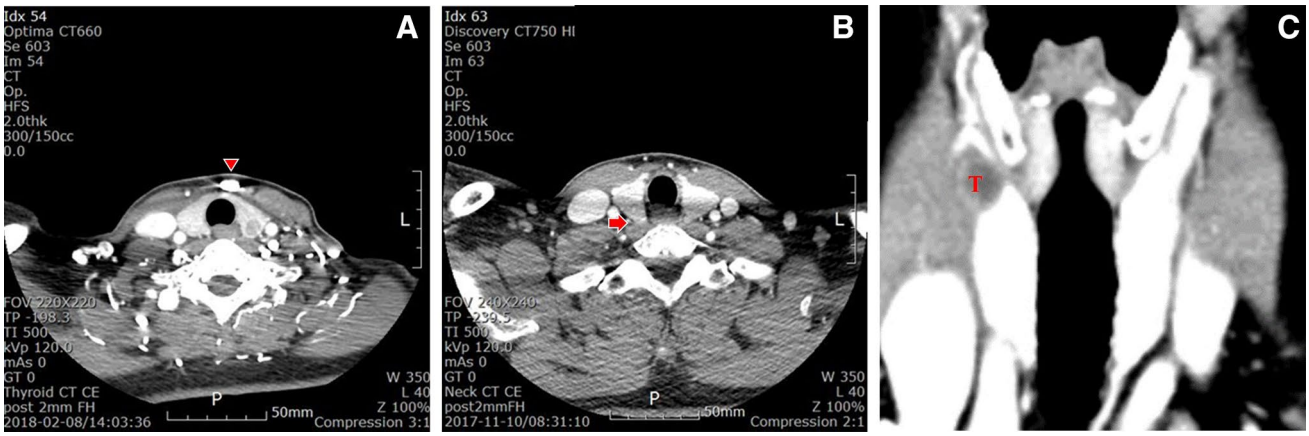

Fig. 1 Preoperative computed tomography (CT) provides useful information allowing safe transoral endoscopic thyroid surgery. **A** A large, centrally located anterior jugular vein is at higher risk of tearing during surgery (arrowhead: anterior jugular vein). **B** A thyroid gland that is developed posteriorly renders it difficult to identify the recurrent laryngeal nerve (arrow: prominent Zuckerkandl's tubercle). **C** A suspicious tumor located on the right superior pole is associated with a higher risk of spillage during the manipulation, which is required to expose the superior thyroid vessels (T, tumor)

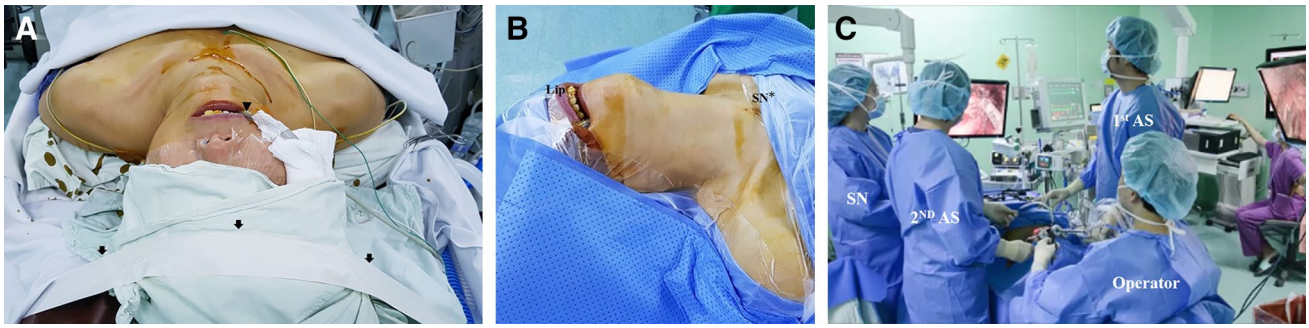

Fig. 2 Positioning and preparation in the operating room. **A** The patient's head is firmly fixed to the bed using adhesive plaster (arrow) and an endotracheal tube (arrowhead) is fixed to the right or left corner of the mouth. **B** The usual draping is performed, so that the upper lip is sufficiently exposed superiorly and the sternal notch inferiorly. **C** The surgical team consists of four medical staff: an operator, the first assistant surgeon, the second assistant surgeon, and a scrub nurse (*AS* assistant surgeon, *SN** sternal notch, *SN* scrub nurse)

open and close the valve of the cannula, to pull the anchoring suture thread securing the working space, and with other procedures.

Creation of the working space

A 2-cm-sized curvilinear incision is made (via a Bovie cautery) in the midline of the vestibule about 1 cm distant from the gingiva and deepened to cut the medial portion of mentalis muscle which is attached to the mandible until the lower margin of the mandible is exposed (Fig. 3A, B). Once the mid-lower border of the mandible is exposed, a Veress needle is used to inject 40–50 mL of normal saline into the subplatysmal plane to hydro-dissect the working space (Fig. 3C). After completing hydro-dissection, the working space in the submental is cautiously widened, in a blind manner, using a blunt instrument such as a Kelly clamp (Fig. 3D). Then, a blunt-tip tissue dissector such as a vascular tunneller is inserted through the incision and advanced in a fan-shaped manner in the subplatysmal plane (Fig. 3E). The shape of the working space is that of a reverse triangle; the boundaries are the sternal notch inferiorly and the anterior borders of both sternocleidomastoid muscles laterally. A 11-mm-diameter cannula is inserted and CO_2 gas insufflated at a pressure of 6 mmHg at a flow rate of 12–15 L/min. A 11-mm-diameter 30° telescope is inserted through the cannula to check that the working space is well-formed. Next, two lateral incisions are made in the vestibule near the second premolar or first molars, and a 5-mm-diameter cannula inserted through each incision (Fig. 3F, G). The mental nerve exits from the mental foramen of the mandible and runs anteriorly, and the mental foramen lies between the first and second premolars; therefore, it is safer to create the incision posteriorly [20]. Peng et al. recently reported

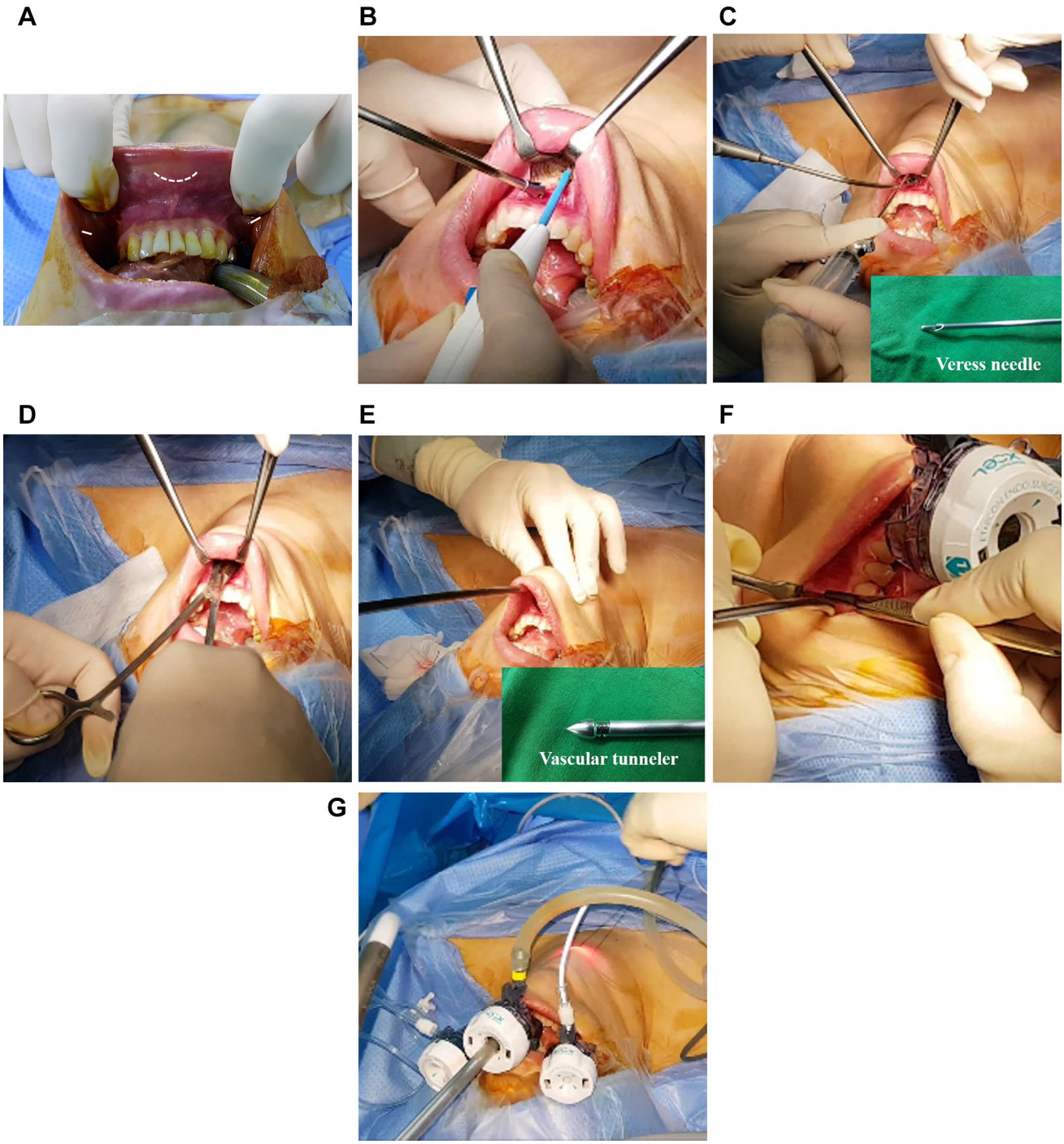

Fig. 3 Creation of the working space. **A** A 2-cm-long curvilinear incision is created in the midline of the vestibule and two 0.5-cm-long incisions in the bilateral vestibules are made near the molar or second premolar teeth. **B** Cutting the medial portion of the mentalis muscle to expose the lower margin of the mandible. **C** Injecting normal saline into the subplatysmal plane to hydro-dissect the working space. **D** Widening the working space using a Kelly clamp. **E** Inserting a vascular tunneller through the incision site and advancing it in a fan-shaped manner in the subplatysmal plane. **F** Lateral incisions created in the vestibules near the second premolars or first molars. **G** An 11-mm trocar placed in the midline vestibule to accommodate the endoscope and two 5-mm trocars are placed in the lateral vestibules to host instruments

a modified technique, creating a large 6-cm incision at the oral vestibule, identifying the bilateral mental nerves, and inserting a 10-mm trocar at the midpoint of the vestibule and two 5-mm trocars lateral or medial to the mental nerve [22]. A short Maryland forceps, L-hook cautery, and an ultrasonic device are positioned through each lateral cannula to widen the working space along the subplatysmal plane to the sternal notch inferiorly, and to both sternocleidomastoid muscles laterally.

Insufflation of carbon dioxide and monitoring of end-tidal carbon dioxide level

Generally, the initial CO_2 pressure do not exceed 6 mmHg, and is held at 3–4 mmHg during surgery to maintain the working space; the flow rate is 12–15 L/min. We work closely with the anesthesiologist to continuously monitor the end-tidal CO_2 level ($ETCO_2$); we ensure that it does not exceed 40 mmHg if at all possible. If the $ETCO_2$ exceeds 40 mmHg during surgery, we lower the gas pressure and continue surgery; if the $ETCO_2$ remains above 40 mmHg, the operation is paused, gas flow stopped, and ventilation started.

Exposure of the thyroid gland and dissection of the upper pole

The median raphe of strap muscle is divided using L-hook cautery or ultrasonic device to expose the thyroid isthmus (Fig. 4A). The strap muscle is detached from the thyroid gland and a percutaneous suture is made using 2–0 black silk from the outside to penetrate the strap muscle before re-exiting via the skin. This procedure is used to retract the strap muscle laterally and expose the thyroid gland during surgery (thus similar to strap muscle retraction using the Army and Navy during open thyroid surgery) (Fig. 4B). Dissection progressed medially and the isthmectomy is completed using an ultrasonic device (Fig. 4C). We then move the device laterally to identify the avascular sternothyroid-laryngeal triangle, and hold and pull the superior pole medially using Babcock or Johann forceps to expose the superior thyroid vessels. Then, the superior thyroid artery and vein are divided using an ultrasonic device (Fig. 4D).

Preservation of the recurrent laryngeal nerve and parathyroid gland

After dividing the middle thyroid vein, the thyroid is retracted medially. With traction of thyroid gland medially, the trachea-esophageal groove and inferior thyroid artery are exposed. Under a magnified telescopic view, all important anatomical structures are identified and preserved including the parathyroid gland, the recurrent laryngeal nerve, and the carotid artery (Fig. 5). After anterior traction of the thyroid, Berry's ligament is dissected from trachea and the unilateral lobe of the thyroid gland completely removed.

Removal of the specimen and closure

The specimen is removed using endoscopic pouches inserted through the midline incision site (Fig. 6). If the thyroid gland or the major nodule is large, or the mandible protrudes, it may be difficult to remove the specimen entirely through the midline incision site. In such cases, it is helpful to lengthen

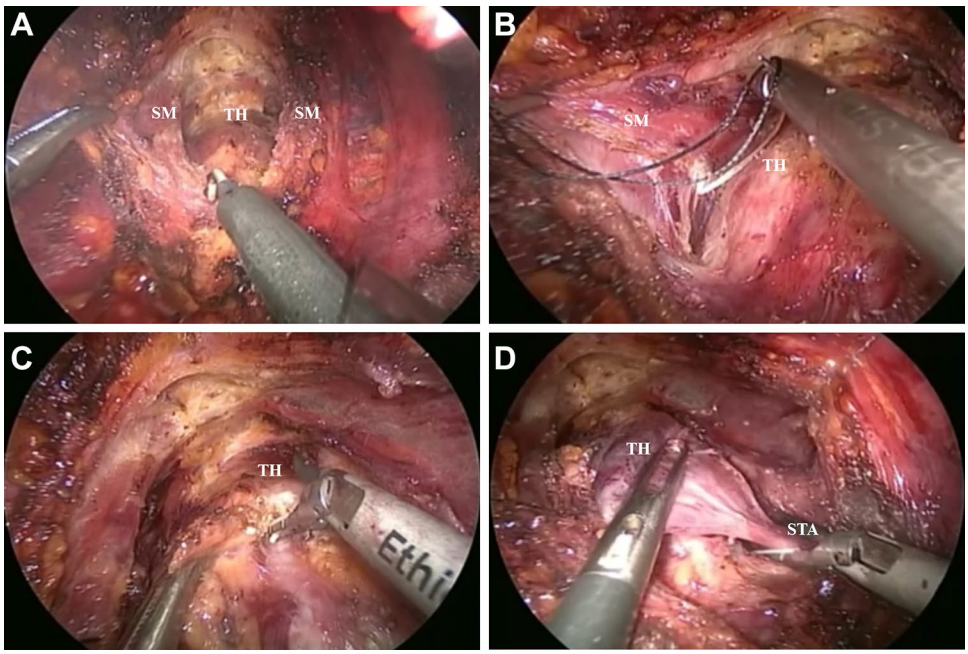

Fig. 4 The surgical field of view during transoral endoscopic total thyroidectomy. **A** The median raphe of the strap muscle is divided via L-hook cautery to expose the thyroid isthmus. **B** A percutaneous suture is created exteriorly using 2–0 black silk to penetrate the strap muscle and pull it out through the skin once more, to expose the thyroid gland. **C** Isthmectomy is performed using an ultrasonic device. **D** The superior thyroid artery and vein are divided using the ultrasonic device (*SM* strap muscle, *TH* thyroid, *STA* superior thyroid artery)

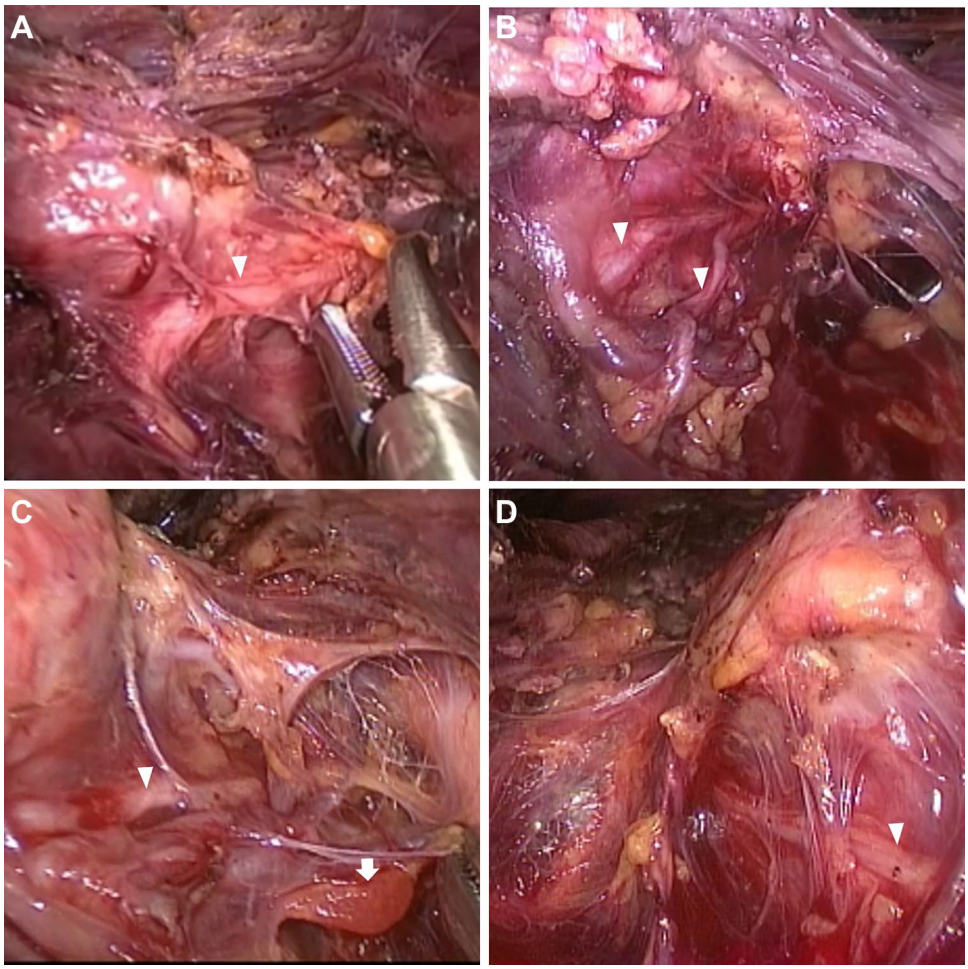

Fig. 5 Preservation of the recurrent laryngeal nerve and parathyroid gland during transoral endoscopic thyroidectomy (arrowhead: recurrent laryngeal nerve; arrow: parathyroid gland). **A** The right recurrent laryngeal nerve. **B** Extralaryngeal branches of the right recurrent laryngeal nerve. **C** The right recurrent laryngeal nerve and the parathyroid gland. **D** The left recurrent laryngeal nerve

the incisions on both sides or to remove the pillow from under the patient's back to place the neck in flexion. If a benign nodule is obvious preoperatively, the specimen can be removed after it is split into several pieces within the endoscopic pouch. Initially, we did not insert drains in patients who underwent lobectomy, but we experienced some cases of seroma. Currently, we insert negative suction drains through a lateral incision in the oral cavity. The strap muscles are re-approximated, and the three incision sites closed using absorbable sutures.

Postoperative care

A pressure dressing is placed around the chin and neck using an elastic bandage and removed 48 h later; the suction drain is routinely removed after a further 24 h. Following surgery, oxygen is supplied through a mask; we monitor oxygen saturation, dyspnea signs, and subcutaneous emphysema. A soft diet is given on the day of operation and a regular diet commences on postoperative day 1 or 2. Intravenous antibiotics are given during the hospital stay and oral antibiotics are prescribed after discharge. Currently, we are gradually reducing the duration of therapy and levels of antibiotics. Oral mucosal suture materials are removed on the first visit to the outpatient clinic.

Results

We have performed 65 thyroid surgeries (54 thyroid lobectomies, 1 completion thyroidectomy, and 10 total thyroidectomies) in 64 patients. The radiological findings, pathological features, operative details, and postoperative progress notes of all patients are summarized in Table 1. The postoperative complications are summarized in Table 2. Two patients developed transient vocal cord palsy but recovered within 2 months. One patient with vocal cord palsy had not recovered by 3 months after surgery, but the voice quality was quite good and we have scheduled 3 more months of follow-up. Five of ten patients (50%) who underwent total thyroidectomy developed transient hypocalcemia but recovered within 2 months. One patient with a 7.5-cm-diameter benign tumor developed transient lower lip sensory loss, but recovered within 1 month. Seven patients developed

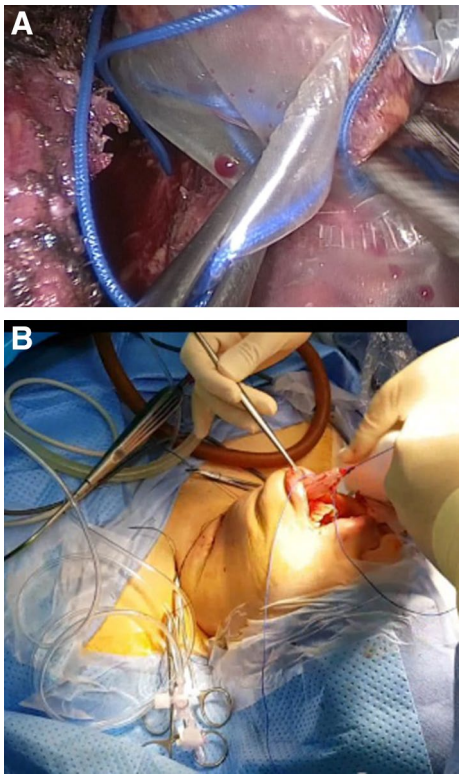

Fig. 6 Removal of the specimen through the midline incision site. **A** Placing the specimen into the endoscopic bag. **B** Removing the endoscopic bag through the midline vestibular incision

subcutaneous emphysema, but the symptoms were mild and recovery spontaneous. Four patients developed seroma, but recovered after aspiration. No patient developed a wound infection or fistula between the oral incision and anterior neck. No visible scar or dimpling was evident on the neck of any patient.

Discussion

Transoral endoscopic thyroid surgery has only recently become popular and no clear evidence-based indications or contraindications have yet been established. Recently, Razavi et al. [26] reviewed relevant articles in the English-language literature. Most authors agree that the most important indication for transoral thyroid surgery is the patient's agreement, but no consensus on the maximum volume of the thyroid gland or major nodule to be removed has appeared. It has been recommended that the thyroid gland should be < 10 cm in diameter, and the major nodule < 6 cm, if a benign or indeterminate condition is suspected, but the major nodule should be < 2 cm if malignancy is suspected. However, we use slightly different indications. In our experience, if the major nodule is large, it is difficult to remove the specimen entirely through oral incision; the specimen must be cut into several pieces. Thus, it seems safer to consider other approaches when treating large indeterminate nodules (Bethesda classes III and IV) if undamaged specimens are required for accurate diagnosis. We perform transoral endoscopic thyroid surgery when benign tumors are 6–8 cm in diameter. However, if malignancy is either suspected or confirmed, the tumor diameter should be < 2 cm. In addition, if a suspect or confirmed malignant tumor is on the superior pole, the tumor diameter should be < 1 cm because the superior pole is poorly visible and a good deal of manipulation is required for visualization and ligation. The prime concern is tumor spillage during manipulation (Fig. 1C). In terms of benign tumors, we have removed nodules up to 8 cm in diameter. Anuwong et al. reported their experience with a 10-cm-diameter benign tumor and commented that 6–8 cm should be considered as the upper limit, especially for surgeons with limited experience [27]. Razavi et al. [26] recommended absolute contraindications as follows: previous head-and-neck surgery/irradiation (including of the mediastinum); an inability to tolerate general anesthesia; acute clinical hyperthyroidism; recurrent laryngeal nerve paralysis; a substernal thyroidal extension; preoperative evidence of lymph node metastasis or extrathyroidal extension; an oral abscess; and failure to meet the indications. Less absolute contraindications were Hashimoto's thyroiditis and obesity. In terms of accessing the central node, it was recommended (in another paper) that this could be performed contemporaneously with transoral total thyroidectomy, either prophylactically if the surgeon routinely performs prophylactic central node dissection or therapeutically if paratracheal lymph node metastasis is newly found during operation [28].

When a beginner commences transoral surgery, it is most important to choose appropriate patients (i.e., those for whom safe and easy removal of the thyroid gland is possible). How might such patients be defined? In general, a right-handed surgeon finds it easier to remove nodules in the right thyroid lobe. Tumors located in the upper lobes of the thyroid may interfere with dissection of the superior pole and, if the tumor is large, it may obstruct the surgical view of the retrothyroidal area. Therefore, a small nodule located in the right middle or lower lobe is the best choice for right-handed beginners. Zuckerkandl's tubercle development, obesity, mandibular development, and a prominent Adam's apple constitute obstacles to transoral surgery. The surgeon may find it difficult to identify and preserve the recurrent laryngeal nerve in patients with prominent Zuckerkandl's tubercles (Table 3).

Patel et al. [26] considered it difficult to check whether the tube is well-fixed by the anesthesiologist during surgery, because the surgeon is located at the patient's head. Also, an oral tube consumes surgical field space and is prone to displacement during surgical manipulations. Anuwong et al.

Table 1 Radiological findings, pathological features, operative details, and postoperative progress notes of patients who underwent transoral, endoscopic thyroid surgery ($n=65$)

Parameter	Number of cases (%)	Other
Mean age (year)(min–max)	42.9 (19–66)	
Gender		
Male	12 (18.4%)	
Female	53 (81.5%)	
Mean tumor size [cm] (min–max)	1.28 (0.3–7.5)	
Preoperative cytopathology		
Malignant (VI)	37 (56.9%)	
Suspicious for malignancy (V)	16 (24.6%)	
Follicular neoplasm (IV)	4 (6.1%)	
Atypia of unknown significance (III)	3 (4.6%)	
Benign (II)	4 (6.1%)	
Follicular carcinoma (after a previous operation)	1 (1.5%)	
Extent (number of cases)		
Total	10 (15.3%)	
Right lobectomy	29 (44.6%)	
Left lobectomy	26 (40.0%)	
Operation time		
Lobectomy	147.5 (100–250)	Excluding 13 patients who underwent total thyroidectomy or combined surgery
Progress notes		
Days to normal diet	1.2 (1–3)	
Hospital stay (days)	4.8 (2–10)	
Stitches out (days)	9.4 (4–16)	Routinely performed at the first visit to the outpatient clinic after surgery
Postoperative pathology		
Papillary carcinoma	55 (84.6%)	
Nodular hyperplasia	4 (6.2%)	
Follicular carcinoma	2 (3.1%)	
Follicular adenoma	3 (4.6%)	
Hyalinizing trabecular tumor	1 (1.5%)	
Margin		
Positive	0 (0%)	
Negative	65 (100%)	

[27] routinely used nasotracheal intubation to deliver general anesthesia. Initially, we used the same approach, but now we employ routine orotracheal intubation; this has never caused any problems [20].

Carbon dioxide gas is injected to maintain the working space during surgery, possibly associated with gas-related complications. Fu et al. reported that 2 of 81 cases were transferred to open thyroidectomy because intraoperative CO_2 embolisms developed [16]. Kim et al. reported one CO_2 embolism developing during flap elevation prior to transoral robotic thyroidectomy; the patient was converted to a retroauricular approach [29]. Wilhelm et al. reported one case of mediastinal emphysema in eight patients (21%); this improved after conservative treatment [12]. Our previous paper describing 18 initial cases reported no gas-related complications [20]. However, we later experienced a case with a CO_2 embolism developing after laceration of the anterior jugular vein during flap elevation, but the vital signs normalized within 1 min of vessel ligation and surgery continued. A low insufflation pressure is essential to prevent gas emboli [27]. We generally set the initial CO_2 pressure to 6 mm Hg, but this is changed to 3–4 mmHg during surgery to maintain the working space. The flow rate is set to 12–15 L/min. Anuwong et al. considered that the flow rate should be set to 15 L/min and the CO_2 pressure should not exceed 6 mmHg, but the flow

Table 2 Postoperative complications after transoral endoscopic thyroid surgery ($n=65$)

Complication	No. of cases (%)
Vocal cord palsy	
Permanent	1 (1.5%)
Transient	2 (3.1%)
Hypocalcemia	
Permanent	0 (0%)
Transient	5 (7.7%)
Sensory loss, mental	
Transient	1 (1.5%)
Permanent	0 (0%)
Facial palsy	
Transient	0 (0%)
Permanent	0 (0%)
Wound infection	0 (0%)
Bleeding	0 (0%)
Subcutaneous emphysema	7 (10.8%)
Seroma	4 (8.5%)

rate could be increased temporally to 20 L/min to create a wider working space when removing a large goiter [30]. We engage closely with the anesthesiologist to monitor the $ETCO_2$ at all times; the value is not to exceed 40 mmHg if possible. CO_2 absorption during extraperitoneal insufflation is higher than during intraperitoneal insufflation [31]. $ETCO_2$ monitoring affords sensitive and noninvasive diagnosis of gas embolisms, which may either raise or lower the $ETCO_2$. Several reports have described increases in the $ETCO_2$ values of patients with CO_2 embolisms. The $ETCO_2$ exhibits small transient increases after large CO_2 boluses, probably attributable to increased blood gas levels. A rapid decrease in the $ETCO_2$ is caused by obstruction of some of the pulmonary vasculature by emboli, expanding the ventilatory dead space [31].

We experienced one case of repeat transoral thyroidectomy performed 9 days after initial transoral thyroid lobectomy, because the pathologist diagnosed a follicular carcinoma. We encountered no problem during repeat surgery. Anuwong et al. [27] recommended that repeat transoral thyroid surgery on the contralateral thyroid gland be performed within 2 weeks or after 6 months of the first surgery.

Table 3 Recommended candidates for beginner surgeons

Patient factors	A middle-aged female without mandibular development and normal body fat composition
Tumor factors	Size: diameter < 1 cm Location: right middle/lower lobe (for a right-handed surgeon)
Glandular factors	Small gland; a small Zuckerkandl's tubercle, without a large pyramidal lobe
Other	No vascular anomaly

Conclusions

Although transoral thyroid surgery is a relatively recent technique requiring further validation, it affords several advantages. The greatest advantage is that the operation can be performed via mucosal incision; no skin incision (which would need dressing and is associated with possible hypertrophic scarring and pigmentation) is required. Compared to other endoscopic approaches, the transoral route is the shortest route to the thyroid gland and as the endoscope is inserted centrally, the approach is optimal when total thyroidectomy is necessary. Transoral thyroid surgery has not yet been universally accepted, but may be the best choice for thyroid surgery in the future.

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Compliance with ethical standards

Disclosures Dr. JO Park, Dr. A Anuwong, Dr. MR Kim, Dr. DI Sun, and Dr. MS Kim have no conflicts of interest or financial ties to disclose.

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