

Preliminary Experience with Transoral Endoscopic Thyroidectomy and Parathyroidectomy via Vestibular Approach

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ABSTRACT: Recently Natural Orifice Transluminal Endoscopic Surgery (NOTES) has been applied in surgery with a transoral approach. In most cases, surgeries on a thyroid gland are performed through a cut which always leaves a scar afterwards. The approach to the site of surgical interference with no incision has aesthetic advantages. One advantage of transoral endoscopic thyroidectomy is an ability to avoid scars. However, there are many fears of certain negative consequences, such as infection, residual injury of the recurrent laryngeal nerve, and oncologic outcome. During the research, data on 52 patients having undergone thyroidectomy or/and parathyroidectomy via vestibular approach were prospectively studied. The procedure of removing a thyroid gland and parathyroid glands was conducted on the patients. A range of surgeries (including ones for patients with a Body Mass Index (BMI) equal 44) was conducted through remote access incisions. No persistent complications were observed. The average post-surgery Dermatology Life Quality Index constituted 3, which indicates a small influence on a patient's further state of health and quality of life.

KEYWORDS

Scarless surgery; thyroid disease; minimally invasive thyroidectomy; thyroid gland; oral vestibular approach

INTRODUCTION

A transcervical incision is the main surgical approach to a thyroid and parathyroid glands. The effectiveness of this method is obvious, as it offers a surgeon a great exposition and a straight way to the central part of the neck. Despite a meticulous incision closing, a scar of a different intensity degree will inevitably appear, and patients consider it unesthetic.

Increasing frequency of thyroid gland pathologies, young age being average among those who consult doctors, prevalence of women among the ill, and society's attention to appearance encouraged the development of aesthetically more favorable alternative approaches.

Minimally invasive surgery and approaches with the remote access are alternative methods which take into account surgical planes, minimize surgical injuries, and avoid visible scars.

In 1997 more than 20 different thyroidectomy techniques were offered as an alternative for the traditional transcervical incision, but none of them became well known and widespread among the population of western countries [1].

Every method is a surgical compromise between exposure and aesthetics, requiring either a small, but visible, scar, or an extensive tissue dissection with a remote, hidden scar.

Applying these methods for western patients with a higher Body Mass Index (BMI) was problematic in some cases. In order to solve this problem, the authors previously tried using transoral approaches.

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Transoral vestibular approach has been described by many famous surgeons, and modifications of this method received recognition, especially in Asia, where in proceeds developing and placing of incisions proceeds improving [2].

Contrary to other remote access approaches, transoral vestibular approach makes it possible to make limited dissections and leave fully hidden incisions. In this article we are describing our experience of using transoral vestibular approach for thyroidectomy and parathyroidectomy on patients from western countries.

An advantage of this innovative treatment method is an excellent cosmetic result achieved due to the scarless surgery. However, in spite of its advantages, this procedure was considered experimental due to limitations of the previous sublingual approach.

Development of the minimally invasive thyroidectomy

Minimally invasive surgery has been approved for the surgery of the thyroid gland since 1996. For more than two decades numerous approaches of endoscopic thyroidectomy have been suggested, and some of them have become popular nowadays.

The aim of such a means of surgical intervention was to reduce, prevent, or eliminate appearance of scars on a neck, decrease the level of bleeding, and shorten recovery time [3].

A concept of good minimally invasive thyroidectomy technique must include:

1. A small distance from an incision to the thyroid gland, so that the size of the dissection is reduced and so is the risk of surgical injury during the access to the operated area.
2. An excellent cosmetic result with ideally hidden incisions on an inconspicuous body area.
3. A good surgical and anatomical view for the safety of the patient. The view is to be sufficient, so that no vital organs, for example, a carotid artery, an internal jugular vein, or a brachial plexus, are in the operation area.
4. An oncological result, the sample for which was taken in a good state.
5. An affordable price. Exploitation of only common tools with expenses on the surgery affordable for the patient.
6. Simplification of the procedure, which guaranties the opportunity to be learned in the shortest possible period and which can be performed by any surgeon.

Nevertheless, some methods of the thyroidectomy with remote access, such as the BABA or the axillary technique, cannot be considered minimally invasive, since they require dissection of a big flap of an area from an axillary crease or a chest to a thyroid gland.

Later on the skin of the patients there can remain paresthesia for a long time after the surgery, impacting the quality of the patients' lives. Moreover, often there occur surgical complications due to a big distance from the incision to the thyroid gland.

In order to solve the problem and achieve the goal of high-quality minimally invasive thyroidectomy, mentioned above, transoral approach appears to be an appropriate way to perform thyroidectomy, because:

1. The distance between the mouth and the thyroid gland is the shortest among various endoscopic / robot-assisted approaches, which results in a reduction of instrumental collision and surgical complications.
2. Better cosmetic results can be achieved, because the wound will be hidden inside the oral cavity.
3. Surgical visualization—a view from above, from the cranial to caudal. Surgeons can easily adjust to the view, and the anatomy is very clear, it is similar to open operation, but upside-down.
4. No complex tools are needed, and the technique can be taught in the shortest possible period.
5. Complete thyroidectomy or dissection of the central lymph node can be performed without any additional incision.

Classification according to transoral approaches of endoscopic thyroidectomy

1. Sublingual approach

In the framework of the previous researches conducted by Witzel, transoral endoscopic thyroidectomy was carried out on 2 corpses and 10 living pigs using one 10 millimeter incision in the middle of the sublingual area.

Moreover, there were made two incisions of 3.5 mm for two trocars of 3.5 mm outside on the neck which provided triangulation during the surgery. Oscillograph and ultrasonic shears were used during the whole operation. Results of the surgery did not reveal any complications or bleeding in living pigs.

Surgeons were offered another improved method of treatment for parathyroid glands—transoral partial thyroidectomy. The technique presupposed that, contrary to Witzel's technique, a cervicoscope was inserted dorsad and directly in front of the trachea [4].

Experiments were performed on 10 living pigs, 10 human corpses, and on 2 patients with primary hyperparathyroidism. Unfortunately, 1 patient had transient right hypoglossal nerve paralysis.

Moreover, there were conducted experiments in which 85 patients with adenoid tumors of parathyroid glands were offered the above mentioned method as a surgery option, but only 5 patients agreed to participate in the procedure.

Two of three patients demanded to be transferred to the open operation. One of the patients developed transient right hypoglossal nerve paralysis. They concluded that, although it is possible, the patients barely endured the applied method, and complication frequency was high.

Since that moment, application of the described method has been impossible with the equipment available at the moment.

2. Combined sublingual and oral vestibular approach

A combined technique was first presented by Benhidjeb et al. and received the name of transoral video-assisted thyroidectomy (TOVAT). The researchers had conducted their experiments on 5 human corpses.

One trocar with the diameter of 5 mm and two trocars 3 mm in diameter were inserted through the soft palate and the vestibule of the mouth. After the surgery, the corpses were completely prepared for the purpose to study safety and anatomy of the procedure.

Another method was used by Willhelm et al. on 8 real patients. Essentially, that procedure was similar to TOVAT, but the name was changed to endoscopic minimally invasive thyroidectomy (EMIT). The central surgical opening reduced to 10 mm and another opening of 5 mm in diameter were used in the vestibule of the mouth [5].

In 3 cases, transfer to open operation was necessary due to the size of the operated area. Wilhelm et al. later reported a series of conducted two-site EMITs.

However, in 1 case a transient injury of the recurrent laryngeal nerve was detected, in 1 case—a permanent injury of the recurrent laryngeal nerve. Injury of the recurrent laryngeal nerve was discovered in 15 cases. In 6 cases there was infection in the area of the sublingual incision and neck. Transfer to the open operation was necessary in 3 cases.

Sublingual method, including the combination, was criticized, and now its popularity is decreasing due to the difficulty of the method and a high complication rate. Although there are a few works devoted to this method, it is not used in real clinical practice [6].

3. Oral vestibular approach

Oral vestibular approach was first described by Richmon et al. First transoral robot-assisted thyroidectomy (TRAT) with sublingual approach was preformed, and then it was discovered that transfer of a camera to the vestibule of the mouth was better.

In the centre of the vestibule of the mouth, there was made a single incision of 2.5 cm. Only in 1 case, a patient received an injury of the recurrent laryngeal nerve.

All 8 patients experienced paresthesia around the chin which remained for more than 6 months.

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Transoral endoscopic thyroidectomy was performed on 60 patients in one of the conducted researches. All three openings were placed in the vestibule of the mouth. No injuries of the recurrent laryngeal nerve were discovered and only 2 patients developed transient paralysis, which eventually disappeared completely.

Nowadays 500 surgeries using TOETVA were carried out in one hospital. Udelsmal reported a series of 7 cases of TOETVA (2 parathyroidectomies and 5 thyroidectomies) without any complications.

Surgery time was bigger in the TOETVA group. On the contrary, TOETVA was less painful than the open operation. Other parameters did not reveal any significant differences from the safety point of view.

4. Transtracheal approach

Liu et al. presented this technique in 2015 [7]. Complete endoscopic thyroidectomy was performed on 3 pigs and 14 hunting dogs with application of a flexible fiber-optic bronchoscope of 4.2 mm. During the procedure endoscopic biopsy, forceps and laparoscopic curved instruments were used. A scope and instruments were inserted near the orotracheal tube, and then a small incision was made on the front tracheal wall in order to give access to the thyroid gland. In total, 26 thyroidectomies and 8 partial thyroidectomies were carried out. The front tracheal wall was stitched with an endostitch. A result showed absence of morbidity and mortality in 5 days. After that, all the animals were slaughtered. However, that is an experimental procedure conducted only on animals. There has not been any application in surgeries on people.

According to the provided classification, the sublingual approach has never been re-applied, and the transtracheal approach was only used in experiments on animals. The only method applicable for the thyroid gland which is used nowadays is the oral vestibular operation. The number of TOETVA publications has increased recently [8].

5. Surgical technique from TOETVA

In brief, a patient is laid on the back and intubated naso-tracheally. Oral tracheal intubation can also be applied, but it restricts movement of instruments during the surgery.

The neck is placed a little stretched, shoulders are placed on a sack with sand. Prior to the surgery, 30 minutes before an incision, amoxicillin-clavulanic acid is injected.

To insert a laparoscopic trocar in the vestibule area of the mouth there are made 3 incisions. The trocar of 10–15 mm is inserted into the middle and another 2 trocars of 5 mm in diameter are inserted on the side.

Positioning of the side openings since then has been improved and now they are placed closer to the front, immediately below the lower lip. It is done, so that branches of the mental nerves, located a little lower than the area, are not damaged. Afterwards, firstly, they dissect the working area with dilating forceps, and then—under visual control [9].

The median muscle raphe opens exposing the thyroid gland and the trachea. Lateral dissection of the thyroid gland is carried out, and then an outer stitch with 2/0 silk is inserted from the outside of the neck to retract the psoas muscle to the side.

Subsequently, a lobectomy of the thyroid gland via the dissection of the isthmus is performed. Then, they conduct the approach to the superior pole of the thyroid gland in the avascular plane between the cricoids cartilage and the superior pole of the thyroid which is called Johll's area, and which is exposed.

Mobilization of the superior pole is achieved through insertion of grasping forceps into the area and retracting the superior pole upwards. Afterwards, upper vessels of the thyroid are ligated with a harmonic scalpel. Subsequently, the thyroid gland is maximally mobilized to the opposite direction, which is called "medial visceral rotations maneuver" [10].

After the medial rotation, parathyroid gland is revealed. Then it is determined in the insertion site, and tracked down to the bottom, parallel to the trachea, in the tracheoesophageal groove.

As soon as all the important anatomy is determined, lobectomy is completed with the harmonic scalpel. Endobag is inserted and fixed through the opening 10. If the operated object is too big, it is to be cut inside the endobag and under an endoscope [11].

If a complete thyroidectomy is required, contralateral thyroidectomy can be conducted with the help of the same technique. Incisions in the vestibule of the mouth were stitched with absorbable suture 4/0.

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A compressing band was applied onto the chin for 24 hours. Immediately after the surgery, the patient was prescribed a liquid diet, and from the next morning—a soft diet. The patient can be left at hospital for a night and dismissed from there the next day.

However, in Asian cultures it is considered normal for a patient to stay at a hospital for as long as possible. In our experience, 3–4 days of postoperative stay at a hospital is a common phenomenon in Asian countries [12].

6. Surgical approach by Anuwong's method

This surgical approach is based on the method presented by Anuwong. A patient is placed on their back and intubated with an endotracheal tube for monitoring of nerves 6–0. An incision of 1.5 cm is marked by the middle line of the lower lip approximately 1 cm higher than the gingivobuccal sulcus.

Then electrocoagulation and blunt dissection are used to approach the mandibula. When the periosteum is determined, adrenaline 1:500,000 is injected into the neck with a syringe for fat grafting.

They make lateral stab incisions and inject adrenaline solution into a lateral part of the lower lip. Insufflation begins at the pressure of 5–7 mm Hg. The operation continues with endoscopic visualization.

The median raphe of splenius muscles is determined and divided. The thyroid gland isthmus is divided and the trachea serves as a reference point for identification of the recurrent laryngeal nerve. Dissection of the capsule begins around the thyroid gland itself and its superior pole [13].

A nerve stimulator probe is used to stimulate the recurrent laryngeal nerve and to check neurophysiological integrity during and after the procedure. Parathyroid glands are well-seen if they are in the capsule plane. Parathyroid gland adenoma can also be removed by the same method. After the recurrent laryngeal nerve is identified, it is dissected distally, moving laterally and caudally from the port [14].

The thyroid gland is withdrawn from the trachea. If needed, contralateral lobectomy can be performed through the same openings. A sample is extracted through the central incision with a bag fixation.

Homeostasis is achieved and the wound is cleaned. The incisions in the vestibule of the mouth are stitched with stratified dissolvable suture. Dressing anastases are placed across the neck and chin after the patient is extubated. Flexible fiber-optical laryngoscopy is conducted to confirm functioning of vocal folds.

All the patients are dismissed home in 23 hours and prescribed a 5-day course of Augmentin (875 mg twice a day) and Clindamycin (300 mg thrice a day) if the patient is allergic to penicillin. A postoperative goal is to complete the first postoperative observation over all the patients 5–14 days after the surgery, whereupon flexible fiber-optic laryngoscopy is conducted again in order to evaluate functioning of the vocal folds. The patients also filled in the research on Dermatology Life Quality Index on that visit and on each next call, and 6 months later [15].

MATERIALS AND METHODS

Data on 52 patients having undergone thyroidectomy or/and parathyroidectomy via vestibular approach were prospectively studied. The procedure of removing a thyroid gland and parathyroid glands was conducted on the patients. During the research, 15 transoral vestibular operations were analyzed.

RESULTS AND DISCUSSION

It is crucial for innovative surgeries to prove the applied method beneficial for a patient.

In order to ensure safety of patients, clinical data are considered the most important issue provoking concerns against wide use of the method [16].

For transoral endoscopic thyroidectomy, many experiments on animals and corpses were carried out before it was permitted for clinical practice. Transoral approach implies working through the oral cavity, contaminated by many bacteria, and into the sterile neck.

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If infection occurs, it can lead to development of abscesses and generalized infection as well as to compression of respiratory ways. This problem is the main when it comes to performing transoral thyroidectomy.

Clinical data can be sufficient to demonstrate that the sublingual approach may not be appropriate due to many occurring complications.

Literature review did not mention any infection caused by the oral vestibular approach. Thus, a pure oral vestibular approach, especially TOETVA, seems the safest in terms of infection [17].

Injury is another problem which can occur even during endoscopic or open thyroidectomy. Despite the fact that nowadays this indicator is very low due to a more perfect surgical technique, it is better to avoid this problem.

Intraoperative neuromonitoring during TOETVA surgeries was presented and had good results. Nevertheless, the number of patients in these documents was insufficient.

It is necessary to conduct more large-scale researches in order to prove that neuromonitoring can reduce the speed of injury. In case of complete thyroidectomy, the next acute problem is hypoparathyroidism [18].

A normal-sized thyroid gland, not exceeding 3–4 cm, can be removed with sponges, forceps, and the “extrusion and extension” technique which does not cause any rupture of the thyroid gland capsule. Glands of a bigger size cannot be withdrawn without manipulations. In this situation we made two–three incisions of 1 cm in the capsule of the thyroid gland inside the endobag and under the endoscopic view. It is necessary to stay careful so as not to make any incisions on a normal part of the thyroid gland, far from the tumor [19].

Using this technique, one can extrude a sample through 1–1.5 cm incisions. This method works well with benign tumors. However, on any cancer nodule there will be a hidden malignant tumor. Graves-Basedow disease rarely causes cancer, therefore in this case TOETVA is safe to use. In case of postoperative diagnosis of thyroid gland carcinoma TOETVA can be performed on cancer nodules of the size 1–2 cm, since the size of the central incision is constricted to 1–1.5 cm [20].

We are aware of an oncological result of a tumor nodule. Moreover, another advantage of TOETVA is a distinct anatomical view. Dissection of the central lymph node is conducted easily and completely. However, long-term research of oncological outcomes is required to evaluate benefits for the patients with thyroid cancer.

Due to these reasons, we highly recommend this TOETVA surgery is only used for: benign disease of the thyroid gland with nodules of the thyroid sized from small to medium; thyroid cancer with cancer nodules of 1–2 cm, and for Graves-Basedow disease smaller than 10 cm [21].

Below we present the data acquired during the research.

1. Age: 44.8 ± 11.8 age (17–69).
2. Sex: Male 5 (9.6%); Female 47 (90.4%).
3. Thyroid disease (Table 1).

Table 1. Thyroid disease in the patients

Diagnostic	N	%
Single thyroid nodule or cyst	34	65.4
Multinodular goiter	16	30.8
Papillary microcarcinoma	0	0
Graves' disease	1	1.9
Parathyroid tumor	1	1.9

4. Preoperative ultrasound (Table 2).
5. FNA: benign–50/50 (100%), malignant–0/50 (0%).
6. Extend of surgery (Table 3).

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Table 2. Results of the preoperative ultrasound in the patients

TIRADS 2017 (N=50)	n	%
2	1	2.0
3	32	64.0
4	17	34.0
Total	50	100
Not available	1 case of parathyroid tumor; 1 case of Graves' disease	

Table 3. Surgery characteristics

Type of surgery	Extend of surgery		Operative time		Estimate blood loss	
	n	%	Time of operation (min)	Min–Max	Blood loss (ml)	Min–Max
Hemithyroidectomy	40	76.9	91.7±2.6	50–150	30.7±0.9	20–50
Total hyroidectomy	11	21.2	114.4±7.0	90–160	58.3±2.9	45–80
Parathyroidectomy	1	1.9	60		20	
Total	50	100				

7. Converted open and cause: nothing.
8. Operative time, min. (Table 3).
9. Estimate blood loss, ml (Table 3).
10. Tumor size, cm: exclude one case of Graves' disease: 22.9±8.8 (11–45).
11. VAS pain score (Table 4).

Table 4. VAS pain score

	Day 1	Day 3	Day 5
Mean±SD	4.6±1.0	1.6±1.0	0.4±0.3
Min–Max	2–6	0–3	0–1

12. Complication:
 - RLN palsy.
 - Transient: 5/52 (9.6%);
 - no palsy: 47/52 (90.4%);
 - permanent: 0.
 - Hypocalcemia:
 - transient: 6/52 (11.5%);
 - no hypocalcemia: 46/52 (88.5%);
 - permanent: 0.
 - Hematoma:
 - yes: 3/52 (5.8%)
 - no: 49/52 (94.2%).
 - Seroma:
 - yes: 6/52 (11.5%);
 - no: 46/52 (88.5%).
 - Infection:
 - yes: 0/52;
 - no: 52/52 (100%).

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- Mental nerve injury:
 - transient: 3/52 (5.8%);
 - no injury: 49/52 (94.2%);
 - permanent: 0.
- Paresthesia:
 - perioral numbness: 5/52 (9.6%);
 - increased swallowing saliva: 0/52;
 - opening mouth pain: 0/52;
 - neck discomfort: 1/52 (1.9%).
- No paresthesia: 46/52 (88.5%).
- Movement limitation:
 - neck movement limitation: 0/52;
 - swallowing limitation: 0/52;
 - chewing limitation: 1/52 (1.9%);
 - no limitation 51/52 (98.1%).
- 13. Use of drainage:
 - Yes: 0/52.
 - No: 52/52 (100%).
- 14. Thyroid pathology:
 - Nodular goiter: 48/52 (92.3%).
 - Parathyroid adenoma: 1/52 (1.9%).
 - Graves' disease: 1/52 (1.9%).
 - PTC: 2/52 (3.8%).
- 15. Postoperative hospital stay, day: 5.6 ± 0.8 (4–7) days.
- 16. Satisfied:
 - Extremely satisfied: 28/52 (53.8%).
 - Satisfied: 23/52 (44.2%).
 - Average: 1/52 (1.9%).
 - Dissatisfied: 0/52.
 - Extremely Dissatisfied: 0/52.

During the research 15 transoral vestibular operations were analyzed: six of them were associated with cytologically benign nodules of the thyroid, five with unidentified thyroid gland nodules, two with adenomas of the parathyroid gland, one with papillary carcinoma of the thyroid, and one with both thyroid adenoma and an indeterminate thyroid gland nodule [22].

The first case was transferred to the open procedure, but the other 14 were successfully completed without dissection. BMI varied from 19.9 to 44, with an average of 28 and 30.3 [23].

Papillary carcinoma of the thyroid was unifocal and sized 1.3 cm, and the eventual pathology had negative margins. Six (42.9%) out of 14 transoral vestibular operations were carried out with the help of the da Vinci Si robot (Intuitive Surgical, Inc., Sunnyvale, California), and eight (57.1%) were performed using only endoscopic tools. First three samples (21.4%) were separated in a sampling packet to make delivery through the transoral incision easier, while the other were treated and removed as a single block [24].

The average maximum size of the removed thyroid lobes constituted 6.5 cm (range 2.6–6.5). The average surgery time equalled 288.5 min. (range 189–448 min). The first procedure lasted 322 min., the last one—189 min. The average duration of robot-assisted procedures constituted 344 min. (range 287–448 min), while endoscopic procedures required on average 235 min (range 189–343 min). Surgical drainages were used for 3 out of 14 patients (21.4%).

One (7.2%) of fourteen patients was dismissed the same day, and the other 13 (92.8%) were dismissed in 23 hours. Out of 12 completed lobectomies of the thyroid gland there was identified only one case of intrathyroid parathyroid gland. Estimated bleeding was minimal in all the 14 cases.

The recurrent laryngeal nerve was visually identified, stimulated, and formally dissected in 5 cases (35.7%). In five patients (35.7%) with benign nodules the nerve was protected anatomically by leaving a cuff of the normal thyroid on Berry's ligament.

Evaluation was lower in further surveys in all the cases when the questionnaire was introduced more than once. The patients did not experience persistent complications. One (7.1%) robot-assisted procedure was transferred to the endoscopic approach with removal of a thyroid lobe through a transoral incision.

During the post-operative period in one patient (7.1%) there was observed self-limited numbness under the mental nerve, which lasted for less than a month. One patient (7.1%) suffered from temporary paralysis of the left vocal fold, and he underwent injection medialisation until complete functioning of the vocal fold recovered in 3 months after the surgery.

Our index case was transferred to the open approach due to substernal and retroesophageal location, which had not been detected at the preoperative US. That patient was not included into the above presented data [25].

CONCLUSION

We present the biggest series of transoral vestibular approaches to the thyroid and parathyroid glands, including the first practices of transoral robot-assisted thyroidectomy and transoral robot-assisted thyroidectomy in the case of thyroid carcinoma.

Persistent complications were not observed, and the experiments were completed for patients with various BMI. The considered methods are in their infancy, but they boast significant perspectives for patients with benign or indeterminate nodules of the thyroid and well-localized adenomas of the parathyroid gland who strive to avoid a visible skin scar.

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