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Transoral thyroidectomy and parathyroidectomy – A North American series of robotic and endoscopic transoral approaches to the central neck

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ABSTRACT

Objective: Most thyroid surgery in North America is completed via a cervical incision, which leaves a permanent scar. Approaches without cutaneous incisions offer aesthetic advantages. This series represents the largest series of transoral vestibular approaches to the central neck in North America, and the first published reports of robotic transoral vestibular thyroidectomy for thyroid carcinoma.
Materials and methods: Data was prospectively collected for patients that underwent transoral vestibular approach thyroidectomy and/or parathyroidectomy between April 2016 and February 2017.
Results: Fifteen patients underwent the procedure for removal of the thyroid (n = 12), parathyroid (n = 2) or both thyroid and parathyroid glands (n = 1). The first case was converted to an open procedure. Fourteen were completed through these remote access incisions, including patients with a body mass index as high as 44. There were no permanent complications. The postoperative median Dermatology Life Quality Index score was 3, which indicates a small effect on quality of life.
Conclusion: The transoral vestibular approach to the central neck is a promising technique for patients who desire to optimize aesthetics.

Introduction

Since its description by Kocher in the late 1880's, the transcervical incision has constituted the primary surgical approach to the thyroid and parathyroid glands [1]. The utility of this incision design is clear, as it provides the surgeon with excellent exposure and a direct route to the central neck. Despite meticulous closure of the incision, a scar of variable prominence is inevitable and patients can find it disagreeable [2–4].

The increasing incidence of thyroid pathology, the young average age at presentation, a female predominance, and a societal emphasis on physical appearances have provided impetus to develop aesthetically favorable alternative approaches [5,6]. Minimally invasive surgery and remote access approaches are alternative methods that respect surgical planes, minimize surgical trauma and avoid visible scarring [7,8]. Since 1997, over 20 different thyroidectomy techniques have been proposed as alternatives to the conventional transcervical incision, but none has gained prominence or been widely adopted in a Western population [8,9]. Each represents surgical compromise between exposure and aesthetics, necessitating either a small but visible scar [10] or extensive tissue dissection with a remote, hidden scar [11–18]. Application of these techniques to Western patients with a higher body mass index (BMI) has also been difficult in some cases [5].

To address these concerns, authors have previously attempted transoral approaches [7]. A transoral vestibular approach avoiding the floor of mouth was described by Richmon et al. [19], and modifications of this technique have gained favor particularly in Asia, where it continues to evolve with refinement of incision placement [20,21]. When contrasted with other remote access approaches, the transoral vestibular approach offers the potential for limited dissection and a completely hidden incision. Here, we describe our experience using the transoral vestibular approach for thyroidectomy and parathyroidectomy in a Western population. To our knowledge, this single institution series represents the largest

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patient cohort reported in the Western Hemisphere, and the first to report robotic assistance. It is also the first to report robotic assistance via a transoral approach for a known thyroid carcinoma.

Materials and methods

Study population

All cases were performed at the Johns Hopkins Hospital between April 2016 and February 2016 by the Head and Neck Endocrine Surgery team, and data was collected prospectively. Patients were offered a transoral vestibular approach if they had a history of hypertrophic scarring or were otherwise motivated to avoid a cervical incision, did not have a known history of thyroiditis or external beam radiation, and had a thyroid nodule that was smaller than 6 centimeters (cm) on preoperative ultrasound. Informed consent was obtained from all patients, including a review of the novel nature of this procedure and the associated risks. Patients were offered robotic or endoscopic transoral vestibular approaches as per robot availability, with no set criteria being established to differentiate between the two groups. The procedure was approved by the operating room privileging committee as well as risk management. Johns Hopkins Institutional Review Board approval was obtained to review the collected data.

Surgical technique

The surgical approach is based on the technique described by Anuwong [20]. The patient is positioned supine and intubated with a 6-0 nerve monitoring endotracheal tube (Medtronic, etc). A 1.5 centimeter (cm) incision is marked out in the midline of the lower lip at approximately 1 cm above the gingivobuccal sulcus (Fig. 1A). Electrocautery and blunt dissection are then used to approach the mandible. Once the periosteum is identified, the neck is injected with 1:500,000 epinephrine using a fat injection syringe. Next, a dilator is used to develop the submental and subplatysmal plane bluntly in the midline. Lateral stab incisions are made and injected with the epinephrine solution at the lateral aspect of the lower lip (Fig. 1C). The endoscopic ports are brought into the field and insufflation begins at a pressure of 5–7 mmHg (Fig. 1D).

The subplatysmal pocket is developed with endoscopic instrumentation to the level of the sternum and laterally to the sternocleidomastoid muscles. When utilized, the robot is docked and used for the remainder of the surgery; otherwise, the surgery proceeds with endoscopic visualization. The median raphe of the strap muscles is identified and divided. The thyroid isthmus is divided and the trachea serves as a landmark for identification of the RLN. A capsular dissection begins around the thyroid itself and the superior pole is taken down with the Harmonic scalpel. The nerve stimulator probe is used to stimulate the RLN and to test neurophysiologic integrity during and after the procedure. The parathyroid glands are readily appreciated if they are in the capsular plane. A parathyroid adenoma may also be removed in a similar fashion.

The RLN is dissected distally after identification as it proceeds laterally and caudally from the point of insertion. The thyroid is delivered off of the trachea. The contralateral lobectomy can be completed via the same incisions if necessary [20]. The specimen is retrieved via the central incision using an endocatch bag (Fig. 2A). Hemostasis is achieved and the wound is irrigated. The oral vestibule incisions are closed with layered absorbable sutures. A compression dressing is placed across the neck and chin after the patient has been extubated. Flexible fiberoptic laryngoscopy is completed to confirm vocal fold function.

Postoperative care

All patients are discharged home within 23 h with a 5-day course of Augmentin (875 mg twice daily), and clindamycin (300 mg three times daily) is substituted if allergic to penicillin. It is our practice to complete the first postoperative follow up for all patients 5–14 days from surgery (Fig. 3), at which time a flexible fiberoptic laryngoscopy is again performed to evaluate vocal fold function. Patients also completed the Dermatology Life Quality Index (DLQI) survey at this visit, at each subsequent visit, and again at 6 months [22]. The DLQI survey has 10 questions with each containing a score of 0–3; a maximum possible score of 30 indicates dermatologic issues resulting in severely impaired quality of life. In our series, the first and the last DLQI from each patient were used to calculate the mean and median.

Results

A total of 15 transoral vestibular approaches were attempted between April 2016 and February 2016: Six of these cases were for cytologically benign thyroid nodules, five were for indeterminate thyroid nodules, two were for parathyroid adenomas, one was for papillary thyroid carcinoma, and one was for both a parathyroid adenoma and an indeterminate behavior thyroid nodule. The first case was converted to an open procedure, but all of the subsequent 14 cases were successfully completed without a cervical incision. The characteristics of all patients who completed the transoral vestibular approach are summarized in Table 1. The BMI ranged from 19.9 to 44, with a median of 28 and a mean of 30.3. The papillary thyroid carcinoma was unifocal with a size of 1.3 cm, and final pathology demonstrated negative margins.

Of the 14 transoral vestibular surgeries, six (42.9%) were performed using the da Vinci Si robot (Intuitive Surgical, Inc, Sunnyvale, CA) and eight (57.1%) were performed with endoscopic instrumentation alone (Table 2). The first three specimens (21.4%) were divided within the specimen bag to facilitate delivery via the transoral incision, while the remainder were removed en bloc. The median maximal dimension of the removed thyroid lobes was 6.5 cm (range 2.6–6.5 cm). The median operative time was 288.5 min (range 189–448 min). The first procedure took 322 min, while the last took 189 min. Robotic procedures had a median duration of 344 min (range 287–448 min), while endoscopic procedures required a median of 235 min (range 189–343 min). Surgical drains were used in 3 of 14 patients (21.4%). One (7.2%) of the fourteen patients was discharged on the same day, while the remaining 13 (92.8%) were discharged within 23 h. Only one intrathyroidal parathyroid was identified in the 12 thyroid lobectomies completed. Estimated blood loss was minimal in all 14 cases. The recurrent laryngeal nerve was visually identified, stimulated and formally dissected in 5 cases (35.7%). Five patients (35.7%) with benign nodules had the nerve protected anatomically by leaving a cuff of normal thyroid at Berry's ligament.

Table 3 shows the DLQI scores for 14 patients. The median and mean DLQI scores were 3 and 3.9 (out of a possible 30), respectively, corresponding to minimal effect. The score was lower on subsequent administrations of the survey in all cases in which the questionnaire was administered more than once.

No patients had permanent complications. One (7.1%) robotic procedure was converted to an endoscopic approach, with the thyroid lobe removed via the transoral incision. Post-operatively, one patient (7.1%) had self-limiting numbness over the mental nerve lasting for less than 1 month. One (7.1%) patient had a temporary left vocal fold palsy and underwent injection medialization before regaining full vocal fold function within 3 months of surgery. Our

Fig. 1. a) A 1.5 cm incision is marked out in the midline at approximately the distal aspect of the buccal frenulum. b) The incision is infiltrated with lidocaine and epinephrine before making a 1 cm incision with a scalpel. c) Stab incisions are next made at the lateral aspect of the lower lip and infiltrated as above. d) The ports are placed.

Fig. 2. a) One of the thyroid lobes retrieved using a trans oral approach. b) Patient neck immediately at end of transoral thyroid lobectomy.

index case was converted to an open approach due to a substernal and retroesophageal location that was not recognized on preoperative ultrasound. This patient was not included in the data listed above.

Discussion

This is the largest North American series of transoral vestibular approaches to the central neck, and the first report of robot assisted thyroidectomy. Furthermore, it is the first report of a North American series to use the transoral vestibular approach for a known papillary thyroid carcinoma. Finally, this series is the first to report objective quality of life data documenting the minimal impact of the vestibular incisions on quality of life. This approach is unique in that it completely avoids a cervical incision. It can be safely completed on obese populations without permanent complications. It has multiple advantages over other remote-access approaches to the thyroid including less tissue

Fig. 3. a) Demonstrates a postoperative mucosal incision site 9 days after surgery. b) Demonstrates a neck 1 month postoperatively.

Table 1
Summary of patient characteristic of pathology and size of the thyroid nodules.

Case no.	Gender	Age (years)	BMI	Laterality	Pre-operative cytology	Pre-operative size of specimen on Imaging (cm)	Pre-operative nodule size
1	Female	53	44	Left	Adenomatoid nodule	5.3 × 2.3 × 3.2	3.5
2	Female	17	36	Left	AUS	5.3 × 2.5 × 3	3.6
3	Female	32	23	Left	AUS	5 × 1.9 × 2.2	3.4
4	Female	65	26	Left	AUS	4.6 × 2.7 × 1.9	2.8
5	Female	58	30	Left	Parathyroid (presumed)	2.5 × 2.6 × 3.5	3.5
6	Female	60	25	Right	Parathyroid (presumed)	0.1 × 0.8 × 0.6	0.8
7	Female	52	40	Left	Hurthle cell neoplasm	6.3 × 2.6 × 3	3.8
8	Female	17	20	Left	Adenomatoid nodule	5.4 × 2.2 × 2.6	4.3
9	Female	24	23	Right	AUS	5.2 × 2 × 2.7	4.2
10	Female	49	39	Left	Adenomatoid nodule	5.6 × 1.3 x1.4	1.9
11	Female	37	26	Right	SFN	6.8 × 1.9 × 2.5	1.7
12	Female	46	32	Left	Adenomatoid nodule	5.6 × 3.3 × 2.9	4.1
13	Female	32	38	Right	PTC	6.1 × 1.4 × 2.3	1.5
14	Female	44	22	Right	Adenomatoid nodule	5.3 × 2 × 2.8	4

AUS = Atypia of Undetermined Significance.
BMI = Body Mass Index.
NA = Not Available.

Table 2
Summary of intraoperative events and postoperative complications .

Case	Method	Surgery	Total operative time (min)	Specimen divided	Specimen size (cm)	Final pathology	Inadvertent removal of parathyroid	Complications
1	Robotic	Lobectomy	322	Yes	6.5 × 4 × 1.8	Benign	No	None
2	Robotic	Lobectomy	287	Yes	6.5 × 3.2 × 2	Benign	No	None
3	Robotic	Lobectomy	377	Yes	5 × 3 × 1.5	Benign	No	Temporary lip numbness
4	Robotic	Lobectomy, parathyroidectomy	290	No	4.6 × 2.6 × 1.2	Benign	No	None
5	Endoscopic	Parathyroidectomy	336	No	3.5 × 2.5 × 1	Parathyroid	No	None
6	Endoscopic	Parathyroidectomy	232	No	1.5 × 0.8 × 0.3	Parathyroid	No	None
7	Endoscopic	Lobectomy	343	No	4.5 × 2.7 × 1	Benign	No	Temporary vocal fold palsy
8	Endoscopic	Lobectomy	238	No	4.2 × 2.5 × 1.8	Benign	No	None
9	Endoscopic	Lobectomy	208	No	5.3 × 3.2 × 1.9	Benign	No	None
10	Endoscopic	Lobectomy	282	No	5.1 × 2.1 × 1	Benign	Yes: Intrathyroidal	None
11	Endoscopic	Lobectomy	213	No	0.8 × 2.6 × 1.5	Benign	No	None
12	Robotic	Lobectomy	448	No	4.4 × 2.9 × 2.0	Benign	No	None
13	Robotic	Lobectomy	366	No	5.1 × 3 × 2.1	1.3 cm PTC	No	None
14	Endoscopic	Lobectomy	189	No	5.2 × 3.1 × 1.1	Benign	No	None

PTC = Papillary Thyroid Cancer.

dissection, midline access to both central neck compartments, and the ability to offer safe same-day discharge with minimal discomfort.

The evolution of the present technique began with a sublingual transoral endoscopic thyroid surgery on pigs and human cadavers [23–30]. Early reports noted a conversion rate of 38% and permanent recurrent laryngeal nerve injury in 13% in a cohort of 8 patients [31]. Modifications led to a vestibular incision [19,32,33], and Anuwong reported excellent outcomes in a series of 60 patients [20], as did Yang et al. [21]. Of the 14 cases in our series, one (7.1%) each developed symptomatic temporary RLN and temporary lip weakness. Patients had complete resolution of

Table 3
Dermatology life quality index scores.

Case no.	DLQI 1	Effect	Days postop	DLQI 2	Effect	Days postop
1	3	Small	20	NA	NA	NA
2	1	None	30	0	None	171
3	3	Small	19	NA	NA	NA
4	14	Very large	12	4	Small	98
5	7	Moderate	15	0	None	89
6	10	Moderate	13	NA	NA	NA
7	1	None	81	0	None	126
8	18	Very large	5	3	Small	26
9	3	Small	13	NA	NA	NA
10	6	Moderate	17	NA	NA	NA
11	4	Small	7	0	None	49
12	17	Very large	8	NA	NA	NA
13	5	Small	12	NA	NA	NA
14	0	None	10	NA	NA	NA

DLQI = Dermatology of Life Quality Index.
NA = Not Available.

these problems within 3 months (RLN) and 1 month (lip) of surgery. Other remote access approaches have been associated with serious complications [13,34,35]. All of those approaches also require cutaneous incisions.

Quality of life studies have demonstrated that a cervical incision can have negative consequences. Choi et al. used the DLQI to investigate the impact of thyroid scars on the quality of life and found the mean score to be 9.02, similar to that of patients who suffer from chronic skin disease such as psoriasis, vitiligo and severe atopic dermatitis. Furthermore, they found that quality of life was not associated with the severity of the scar, but rather with the presence of the scar itself [4]. Using the same instrument, the DLQI median score of 3 for a transoral vestibular approach in this series was much better than traditional cervical incisions. We expect that scores will continue to improve for each patient as time passes, as the surveys were administered very early in the postoperative period for most patients.

Appropriate patient selection is critical to the success of the transoral vestibular approach. Patients may have a history of keloid or hypertrophic scar formation and/or be strongly motivated to avoid a cervical incision [5]. Patients should be screened for contraindications that affect patient positioning and intraoperative dissection during this procedure, such as cervical spine disease, previous surgery, thyroiditis or irradiation of the neck. We recommend initiating this procedure in patients with smaller benign or suspicious nodules (<6 cm). This approach does not appear to be limited by body habitus, as the approach was completed successfully for patients with a BMI as high as 44. Previous attempts to apply novel remote access approaches in a Western population with a higher BMI have had complications that served to quell early enthusiasm [5].

As with any novel surgical technique, the importance of the surgical informed consent process cannot be overstated [36]. Patients should undergo preoperative imaging, including axial imaging if there are concerns for substernal extension, and diagnostic tissue sampling. In our first attempted transoral approach, the preoperative ultrasound underestimated the size of the thyroid nodule. To avoid this problem, we now perform a surgeon-directed ultrasound preoperatively on all patients and perform additional axial imaging when there is concern for substernal extent.

In this series the operative time is noted to be substantially longer than that required to complete a standard open lobectomy or parathyroidectomy (unpublished data specific to the authors). As with any novel surgical technique there is a learning curve. We did note a trend towards shorter operative times with successive cases, highlighted by the fact that the first case took 322 min while the last took 189 min. Other authors have demonstrated that a learning curve exists for remote-access thyroidectomy, requiring between 20 and 50 cases [14,21,37]. In a series of 60 patients using a transoral endoscopic technique to the thyroid gland, comparable surgical times are reported to the standard open transcervical approach [20]. Transoral thyroid surgery may best be provided by high volume thyroid surgeons who are well situated to develop and perfect these techniques. It is notable, however, that despite the prolonged operative times during the initial learning curve, there were no permanent complications.

There are numerous advantages to the transoral vestibular approach. First, the natural orifice incisions are completely inconspicuous. Second, the approach allows excellent visualization of the bilateral recurrent laryngeal nerves (RLN) near their insertion into the larynx. Third, the distal identification of the RLN at its insertion is familiar to most experienced endocrine surgeons, and provides a favorable angle of dissection along the plane of the nerve. Fourth, the additional soft tissue dissection needed to approach the thyroid through this approach is relatively limited, which may lend itself to application in patients with a higher BMI. Finally, critical structures such as the esophagus and carotid arteries do not need to be exposed in the field of dissection.

We used a combination of both endoscopic and robotic techniques. The endoscopic approach affords the surgeon tactile feedback, provides quicker and more fluid switching of instruments, and avoids the time required to dock the robot. In contrast, the robot provides wristed instrumentation, additional arms, and a high-resolution, three dimensional view. These robotic advantages may be best utilized for smaller tumors or malignancies. The da Vinci robot is not FDA approved for head and neck surgery, and this must be disclosed to the patient as an off-label application. A surgeon's choice between endoscopic and robotic techniques is ultimately determined by factors including skill set, access to facilities, equipment, and cost.

With any surgery in the central neck, the ability to protect the recurrent laryngeal nerve is paramount. In this series, we demonstrate that the RLN can be safely identified and even dissected via this approach. We also demonstrate that, in some cases of benign nodules, the gland can be safely freed from the trachea near the midline after freeing lateral attachments and rotating the lobe medially. In cases where more thorough identification of the nerve is required, this can be completed as demonstrated repeatedly in this series.

The 2015 ATA guidelines on management of thyroid nodules suggest that a diagnostic lobectomy for cytologically indeterminate nodules 4 cm or smaller in the appropriate clinical context may be sufficient therapeutic treatment if these nodules are ultimately proven to be differentiated thyroid cancer on final

pathology [38]. This may serve to favor a transoral approach for some patients with differentiated thyroid cancer and cytologically indeterminate nodules [39]. The current healthcare environment in the United States encourages value-added care, such that any increased cost must provide an objective benefit to patients and healthcare systems. It remains to be determined if this approach can be delivered in a cost-neutral fashion with a similar efficiency and safety profile to that of the traditional approach. The cost and reimbursement model for transoral thyroidectomies remains to be defined in the United States.

Conclusions

We present the largest reported series of transoral vestibular approaches to the thyroid and parathyroid glands in North America, including the first reports of robotic assisted transoral thyroidectomy, and first reports of transoral robotic thyroidectomy for thyroid carcinoma. There were no permanent complications, and cases were completed on patients with a BMI as high as 44. This technique remains in its infancy but holds great promise for patients with benign or indeterminate thyroid nodules and well localized parathyroid adenomas who strive to avoid a visible cutaneous scar.

Conflict of interest disclosures

Ralph P. Tufano – Medtronic consultant.
No other relevant conflict of interest disclosures exist.

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