



Review Article

The role of surgeon-performed ultrasound in transoral endoscopic thyroidectomy vestibular approach (TOETVA)

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Abstract Transoral Endoscopic Thyroidectomy Vestibular Approach (TOETVA) is a recently described surgical technique where the thyroid and central neck can be accessed without a cutaneous incision. To date nearly 700 cases have been described within the English literature demonstrating the feasibility, safety, and efficacy of the technique. As more institutions begin to adopt the surgical approach, it is important that surgeons pay close attention to appropriate patient selection and surgical optimization to prevent experience-related complications. A valuable tool to facilitate these considerations is the utilization of surgeon-performed ultrasonography (US). While the merits of surgeon-performed US are well-documented within head & neck endocrine surgery as a whole, its value may be of even greater importance when implementing a novel surgical technique such as TOETVA. Here we highlight and summarize the role of surgeon-performed US within head & neck endocrine surgery, focusing on how it may influence patient selection and surgical planning with TOETVA.

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Introduction

Transoral endoscopic thyroidectomy vestibular approach (TOETVA) is the only remote-access thyroidectomy technique that allows access to the central neck without a cutaneous scar. As such, it has grown in popularity since its initial clinical description in 2016 by Anuwong.¹ To date, nearly 700 cases have been described within the literature successfully utilizing the technique.^{1–14} As more surgeons and institutions adopt the approach, it is important to establish a framework for implementation that ensures patient safety.¹⁵ Considerations include: strong administrative support, case observation and cadaveric dissection, appropriate patient selection, and awareness of the expected learning curve.¹⁶ Additionally, surgeon-specific characteristics such as a high-volume of yearly open thyroidectomy and central neck cases, contribute to an in depth understanding of central neck anatomy and facilitate successful adoption of TOETVA.

Although cytopathology, index nodule size and thyroid lobe size contribute greatly to predicting a patient's candidacy for TOETVA, the interplay between the index nodule/thyroid lobe and the surrounding anatomy is also vital. Similarly, nodule characteristics regarding composition and elasticity may also play a role in projecting case complexity and ultimately determining patient candidacy. While a working relationship with radiologists is valuable, it is our belief that the feedback loop of a surgeon performing both US and surgery allows the surgeon to most accurately synthesize US observations into intraoperative findings - predicting which cases will be challenging. Consequently, surgeon performed ultrasonography (US) plays a fundamental role in identifying patients who may be successfully managed via TOETVA. Here we describe the importance of surgeon performed US and its role in patient selection and operative planning with TOETVA, highlighting specific anatomic features to be identified on preoperative evaluation.

Importance of surgeon performed ultrasound in head & neck endocrine surgery

US is a powerful tool in the head & neck endocrine surgeon's armamentarium, and is an extension of the physical exam of the neck. It is a low-cost, noninvasive imaging modality that has a vital role in disease detection/diagnosis, treatment, and surveillance of the central neck. Surgeon performed US can provide significant value to both the patient and the healthcare system as a whole, as the surgeon can characterize lesions, evaluate lymph nodes, and perform fine needle aspiration biopsy (FNAB) all during a single visit.¹⁷

As US is a user-dependent dynamic exam, reliance on still images or radiology reports may be inadequate, or at the very least, a missed opportunity for surgical planning. This is particularly relevant when considering that high-resolution US has been previously shown to alter the surgical plan in up to 40% of patients with thyroid cancer.¹⁸ Moreover, with the implementation of the 2015 American Thyroid Association (ATA) guidelines, surgeon performed US has proven to be an important adjunct in determining

extent of surgery for low and intermediate-risk differentiated thyroid cancers 1–4 cm in size.¹⁹ Factors such as extrathyroidal extension (ETE) and nodal metastasis, which can lead to incomplete initial surgical resections, can be apparent on US. In fact, Kuo et al²⁰ demonstrated that ETE, the most common reason for interval completion thyroidectomy in the above cases, can be ruled out with a negative predictive value of 100% with surgeon performed US by high-volume endocrine surgeons. Similarly, pathologic nodes that may not be palpable on physical exam are easily apparent with US, however, these may be overlooked by an US technician, particularly if located in the lateral neck.²¹ As such, we advocate for surgeon-performed US in a ubiquitous fashion throughout head & neck endocrine surgery, and not only for select cases such as those considered for TOETVA.

Determining TOETVA candidacy via dynamic US evaluation

Although the selection criterion for TOETVA are relatively broad, there remain anatomic considerations regarding size and location of the pathology in question.²² As such, preoperative US evaluation is necessary for all potential candidates. Evaluation should begin in the usual fashion with identification and characterization of the index nodule(s) in regards to size, shape, composition, and elasticity. Similarly, the remainder of the thyroid gland should be evaluated with documentation of maximum dimension and volume of each individual lobe.^{10,22,23}

Recommended selection criterion includes the following: index nodule size ≤ 6 cm in largest dimension if cytopathology is benign or indeterminate or ≤ 2 cm if cytopathology is suspicious or DTC. In either case, the thyroid lobe should not be greater than 10 cm in largest dimension. While these numbers are discrete, the candidacy of individual patients will fall on a continuum that includes other considerations such as oromaxillofacial contour (mandibular/thyroid cartilage prominence, Dedo classification,²⁴ neck length) and proximity of the nodule to vital anatomic structures, which will be detailed below. Such additional factors comprise relative indications and contraindications that enrich surgeon and patient understanding and may encourage or discourage proceeding with TOETVA. Radiographic examination should then move to evaluation for substernal extension, ETE (if applicable) and for nodal disease in the central and lateral neck, which are all currently relative exclusion criteria. Although central neck dissection is feasible via the transoral endoscopic approach, we currently do not routinely offer TOETVA to patients with evidence of preoperative central neck nodal disease.²³ Likewise, substernal extension may increase case complexity and we do not routinely offer this approach to most of these patients.

Our experience has led us to suggest other areas of focus for US, such as the heterogeneity and thickness of the thyroid isthmus and prominence of delphian node/pyramidal lobe. As TOETVA begins at midline with a medial to lateral dissection, the pyramidal lobe and delphian nodes should be removed when present. US can help surgeons avoid the unfortunate circumstance of leaving remnant

tissue in this area. Likewise, because the isthmus is divided early in the procedure, predicting the thickness and location of the isthmus (if there is deviation from midline) can allow the surgeon to anticipate if additional surgical instruments may be necessary (Fig. 1). For example, in cases with a large isthmus, the authors have found that advanced bipolar may offer hemostatic advantages over other energy devices, such as those ultrasonic in nature. Similarly, when the thyroid is very heterogeneous, suggesting chronic thyroiditis, hemostasis can be problematic and advanced bipolar devices may be preferred or at least be available on demand intraoperatively.

Although all of the aforementioned criterion may be theoretically ascertained through review of a radiologist's US report and images, the interplay between the pathology and surrounding anatomy cannot. The value of this dynamic information in surgical planning should not be underestimated, especially when one is utilizing a novel surgical approach with a concomitant need for additional patient counseling to set expectations. In addition to the above described criterion, we recommend detailed US review of the following: the relationship between the index nodule and expected recurrent laryngeal nerve (RLN) course, superior-most extent of the superior poles, evidence of prominent or bridging anterior jugular veins, relative location of the innominate artery, presence of a retroesophageal subclavian artery, and the compressibility/composition of the index nodule.

Dynamic US findings & patient candidacy

Appreciation of the location of the index nodule with the expected course of the RLN/Berry's ligament is of great value when offering patients TOETVA, as it elucidates candidacy as well as expected case complexity. This is particularly relevant in a surgeon's initial TOETVA

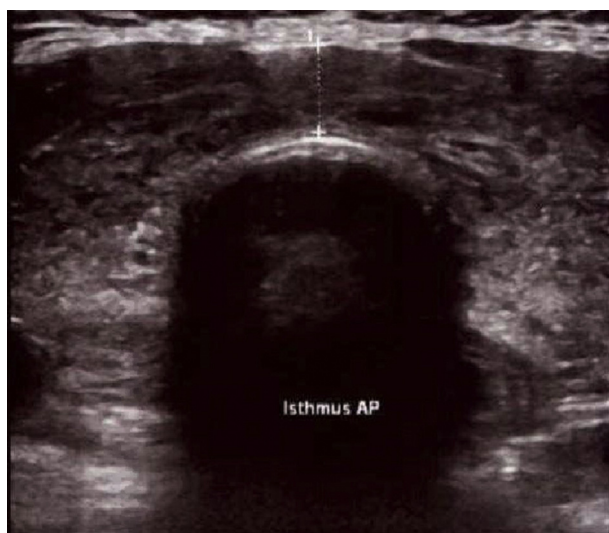


Figure 1 Ultrasonographic evaluation of the neck demonstrating identification of the thyroid isthmus and documentation of its thickness for the purposes of TOETVA surgical planning.

experience. As patient safety is paramount, authors have recommended specific criterion for surgeons' initial cases, such as benign unilateral disease with the index nodule located away from Berry's ligament.¹⁵ (Fig. 2) This allows a small cuff of thyroid tissue to be left if necessary.^{15,16}

In a similar manner, understanding the degree of cranial extent of the superior poles and any pathology within these poles also guides candidacy in one's initial surgical experience. Significant cranial extension can make release of the superior pole more challenging, while also theoretically increasing the risk of injury to the external branch of the superior laryngeal nerve.

Finally, noting the compressibility of the nodule gives guidance as to the ease or difficulty with which the specimen can be manipulated or extracted. A large firm nodule can make manipulation of the specimen quite difficult, hindering effective dissection. Moreover, it may also lead to thyroidal maceration and surface bleeding from multiple attempts to grasp the gland. Given the endoscopic access, this bleeding can inhibit visualization and potentially lead to conversion to the open approach. Likewise, very large nodules that are also spherical as opposed to ovoid, may be more challenging to deliver via the central vestibular incision. As such, alternative approaches to remove the specimen, such as transaxillary extraction, may need to be considered in these circumstances.

Surgical planning & identifying potential intraoperative pitfalls

In addition to identifying factors that influence patient candidacy, surgeon-performed US significantly aids in surgical planning and identification of potential case or positioning-specific pitfalls. Accordingly, our group routinely performs intraoperative US with the patient in the operative position prior to port placement. We find this especially valuable for parathyroidectomy cases and cases

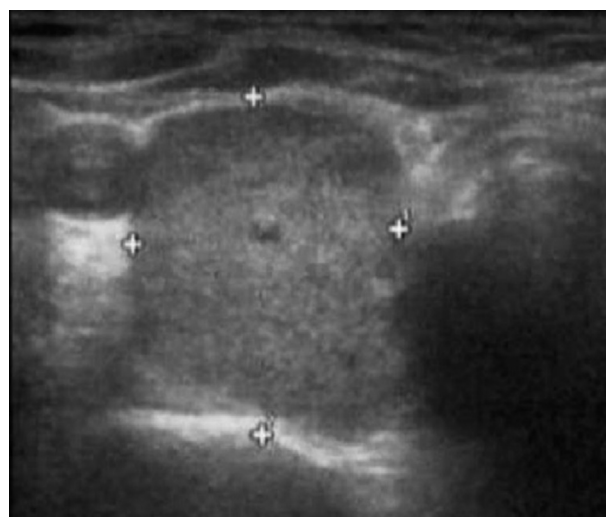


Figure 2 Ultrasonographic demonstration of a solid right lower pole thyroid nodule with smooth borders that was benign on fine needle aspiration. This nodule was amenable to management with TOETVA.

of malignancy, where intraoperative positioning may lead to US findings that differ from the initial outpatient examination. Consequently, we have encountered cases where we have determined the patient to longer be an appropriate transoral candidate and have completed the operation via the standard transcervical technique. This US is therefore done in adjunct to the standard preoperative US evaluation, and also highlights the importance of a detailed informed consent, which should always include the potential for transcervical conversion or primary transcervical surgery.

Identification and documentation of prominent vasculature, including bridging anterior jugular veins, is important for development of a suitable operative strategy. While, such vessels can be managed with relative ease via the open approach, transection of an anterior jugular vein can be more challenging to address via TOETVA. This is especially true if the proximal end retracts superiorly where endoscopic visualization and instrumentation are more difficult. Furthermore, if the distal transected end of the vein is not identified and ligated, the lack of bleeding caused by tamponade from the insufflation pressure can be problematic. This presents, at worst, a risk for CO₂ embolism, and at best a risk for interval bleeding after insufflation has been discontinued.²⁵

The location of other major vascular structures should also be carefully delineated. The caudal extent of dissection is routinely the sternal notch; however, surgeons may adapt the inferior extent of dissection should sonographic findings suggest vascular abnormalities such as a relatively cranial extent of the innominate artery. Similarly, the location of the right subclavian artery should be noted. If it is found to be retroesophageal, the possibility of a non-recurrent right RLN should be carefully investigated both with consideration of preoperative computed tomography or other axial imaging, as well as with intraoperative stimulation of the vagus nerve. If the laryngeal nerve is indeed non-recurrent, this will lead to modifications in the operative technique.

Conclusions

TOETVA is a procedure that can be safely performed in a select patient population with appropriate understanding of central neck anatomy and its potential variants. Surgeon-performed US is invaluable in identifying these characteristics and developing appropriate management strategies, regardless of the operative approach to the thyroid. It is especially valuable to determine relative contraindications and intraoperative pitfalls that can be addressed both in preoperative conversation with patients and the surgical team, as well as with instrumentation or approach modifications. The additional information gained from surgeon-performed US can help prevent complications by optimizing the surgical candidate and operative plan.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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