ACTA MÉDICA PORTUGUESA
A Revista Científica da Ordem dos Médicos

The Role of High-Resolution Ultrasound in the Assessment of Surgical Candidates for Transoral Endoscopic Thyroidectomy Via Vestibular Approach (TOETVA)

Papel da Ecografia de Alta Resolução na Avaliação dos Candidatos a Tiroidectomia Endoscópica Trans-Oral por Acesso Vestibular (TOETVA)

Beatriz REBELO✉[1], Ricardo NOGUEIRA[2], Mariana HORTA[1,3]
Acta Med Port 2023 Mar;36(3):212-217 ▪ https://doi.org/10.20344/amp.19038

ABSTRACT

The approach of surgical techniques has evolved significantly over the last decade, with natural orifice surgeries replacing traditional open approaches. In 2016, Angkoon Anuwong, in Thailand, demonstrated it was possible to perform thyroidectomies in a series of patients by a transoral endoscopic approach – transoral endoscopy thyroidectomy vestibular approach (TOETVA) – with similar complication rates when compared to conventional surgeries. This transoral surgery has become a safe alternative with better cosmetic results, compared to conventional open-route procedures, like Kocher cervicotomy. Indeed, it is an option to surgically treat neoplastic and functional thyroid diseases. The technique is performed through a median incision in the oral vestibule, plus two bilateral incisions, followed by the insertion of three trocars, one centrally for a camera, and two laterally for working instruments. Although revolutionary, TOETVA has its technical limitations. Therefore, it is important to precisely define the preoperative eligibility criteria for this type of surgical approach. High-resolution ultrasound is the first imaging modality for the assessment of thyroid nodules, lymph node metastases and surgical field. The aim of this article is to outline the sonographic technique and the role of high-resolution ultrasound in the presurgical evaluation of TOETVA.
Keywords: Endoscopy; Natural Orifice Endoscopic Surgery; Thyroid Neoplasms/surgery; Thyroidectomy

RESUMO

Em muitas técnicas cirúrgicas, o acesso tem evoluído significativamente ao longo da última década, com a substituição das técnicas abertas tradicionais pela utilização dos orifícios naturais. Em 2016, na Tailândia, Angkoon Anuwong demonstrou, numa série de doentes, não só ser possível realizar tiroidectomias por via endoscópica oral, de que é exemplo a *transoral endoscopy thyroidectomy vestibular approach* (TOETVA), como também provou obter, com o mesmo acesso, taxas de complicações comparáveis às da cirurgia convencional. Esta cirurgia transoral tem-se tornado uma alternativa segura e com resultados cosméticos superiores aos procedimentos realizados pela cirurgia aberta, baseada na clássica cervicotomia de Kocher. De facto, é uma opção para o tratamento cirúrgico de doenças neoplásicas e funcionais da tiroide. A TOETVA é realizada através de uma incisão mediana no vestíbulo oral e duas incisões laterais, seguida da inserção de três trocartes, um central, que alberga a óptica e dois laterais para os instrumentos cirúrgicos de trabalho. A TOETVA, apesar de revolucionária, tem as suas limitações técnicas. Assim, é importante definir os critérios de elegibilidade numa avaliação pré-cirúrgica. A ecografia cervical de alta resolução é a modalidade de escolha na avaliação dos nódulos tiroideus, de eventuais metástases ganglionares e do campo cirúrgico. O objetivo deste artigo é descrever a técnica e o papel da ecografia cervical de alta-resolução na avaliação pré-cirúrgica da TOETVA.
Palavras-chave: Cirurgia Endoscópica de Orifício Natural; Endoscopia; Neoplasias da Tiróide/cirurgia; Tiroidectomia

INTRODUCTION

The prevalence of nodular thyroid disease is high in developed nations. In Portugal, the incidence of thyroid neoplasms is estimated at 19 and 4 per 100 000 individuals in women and men, respectively, being the ninth most common cancer, with 1700 new cases every year nationwide.[1] As total or partial thyroidectomies are the standard treatment for nodular thyroid disease, these procedures are common in developed countries. In the last century, thyroidectomies have been performed through a medial cervical incision (Theodor Kocher technique), causing a permanent anterior cervical scar, which is associated with variable degrees of dissatisfaction, body image concerns and religious issues.[2,3]

With the advent of minimally invasive surgery, many surgical approaches have been developed for the treatment of thyroid disease with variable results.[4] Over the past few years, transoral thyroidectomy with endoscopic vestibular approach (TOETVA) has been considered to be a safe alternative to traditional techniques in the management of thyroid nodular disease with easier post-surgical management, less trauma and better cosmetic results.[5-8] This technique is performed through a subplatysmal median incision in the oral vestibule, where the surgical scar is located, plus two bilateral incisions, followed by the insertion of three trocars, one centrally for a camera, and two laterally for working instruments,[9] allowing access to the thyroid gland without any external neck incisions (Fig. 1). Although revolutionary, this approach has its own limitations that are mainly due to the small operative field plus anatomical considerations. Therefore, it is important to precisely define the eligibility criteria

1. Department of Radiology. Instituto Português de Oncologia de Lisboa Francisco Gentil. Lisbon. Portugal.
2. Department of Head and Neck Surgery. Instituto Português de Oncologia de Lisboa Francisco Gentil. Lisbon. Portugal.
3. Institute of Anatomy. Faculty of Medicine. University of Lisbon. Lisbon. Portugal.
✉ **Autor correspondente:** Beatriz Rebelo. beatriz.rebelo@campus.ul.pt
Recebido/*Received*: 03/09/2022 - **Aceite/*Accepted*:** 09/01/2023 - **Publicado/*Published*:** 01/03/2023

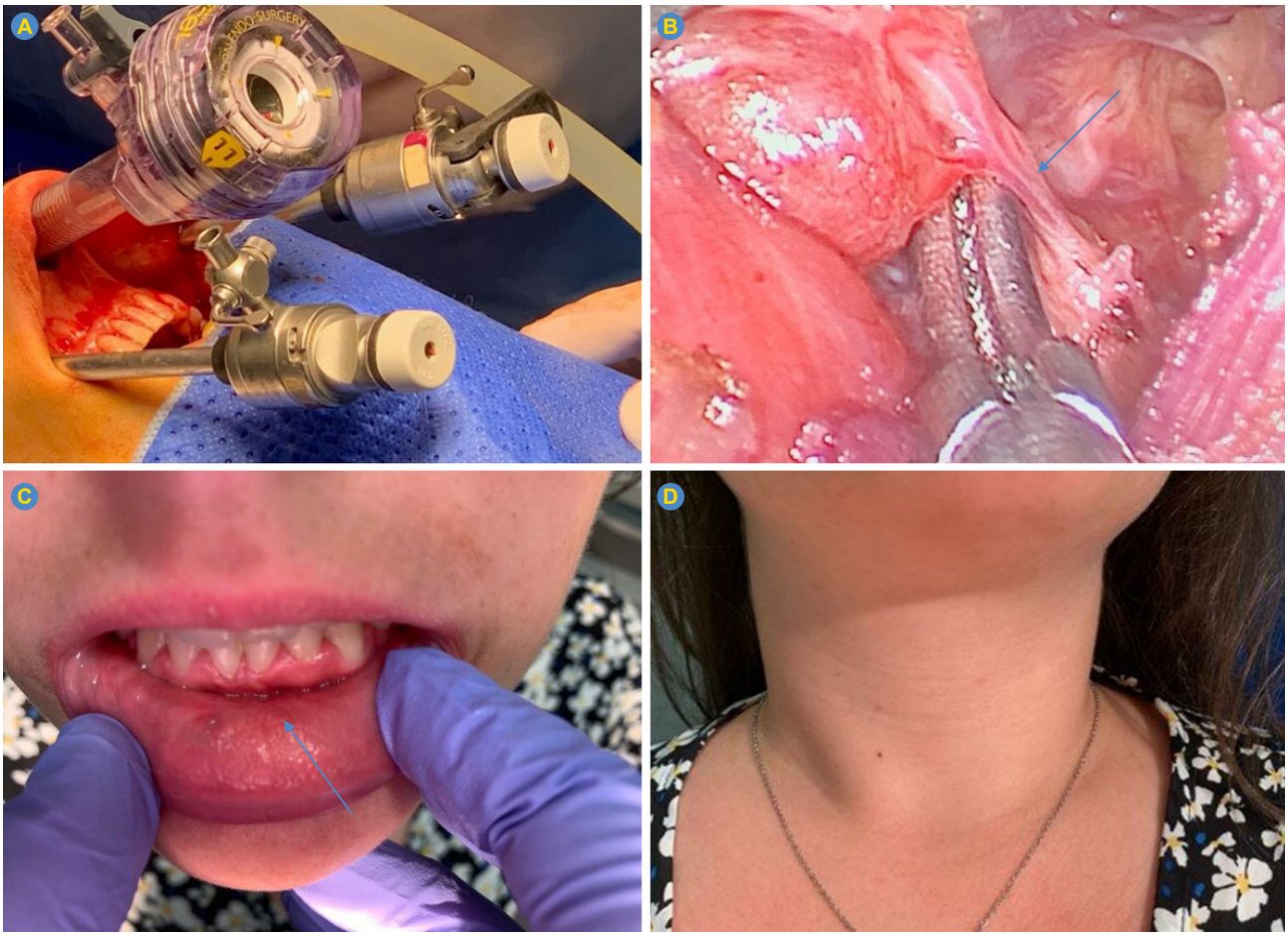

Figure 1 – Surgical TOETVA technique (A, B), showing the positioning of trocars (A), the medial thyroid vein and inferior laryngeal nerve (arrow in B), the surgical scar in the oral vestibule, barely noticeable (C), and the patient's neck, without any scars (D).

for this type of surgical technique (Table 1).

High-resolution ultrasound is the first imaging modality for the assessment of thyroid nodules, lymph node metastases and surgical field. It is an affordable, available, non-invasive, radiation-free, real-time imaging modality, with higher resolution than cross-sectional imaging. The aim of this article is to outline the technique and the role of high-resolution ultrasound in the presurgical evaluation when considering transoral route thyroidectomies, as our institution is a national pioneer in this surgical approach.

The first section of this article outlines the surgical indications for TOETVA and how it is performed in our Institute. The second section covers our technique of high-resolution ultrasound in the presurgical evaluation of these patients, and finally, the third section will focus on specific ultrasonographic criteria that are necessary for this type of surgery.

1. Surgical indications for TOETVA

Thyroid surgery is the primary treatment for thyroid cancer and provides a definitive diagnosis of suspicious thyroid nodules, making it one of the most frequently performed surgeries worldwide. Any novel surgery technique, when applied to thyroid cancer, must be safe.

Understandably, the current indications for TOETVA are conservative, in order to achieve optimal oncological outcomes.

In our institution, we currently perform partial thyroidectomies using the TOETVA technique for thyroid nodules with a cytology result of atypia of undetermined significance/follicular lesion of undetermined significance (corresponding to a Bethesda III classification, according to the Bethesda Classification of Thyroid Nodule Fine Needle Aspirations) and papillary microcarcinomas.[10]

All patients with thyroid cancer should undergo formal screening for nodal metastatic disease. Ultrasound is the most sensitive imaging modality for identifying cervical lymph node metastatic disease. We are not performing this surgical technique in patients with suspected lymph node metastatic disease at the moment. Ultrasound also enables the estimation of thyroid gland volume, nodule size and

Table 1 – Eligibility criteria for the TOETVA approach

Thyroid disease	Nodular disease of Bethesda III or papillary microcarcinoma cytological diagnosis
Thyroid size and distribution	
- Total thyroid volume	< 15 mL, cm^3
- Total thyroid gland diameter (combined transverse diameter)	< 10 cm
- Superior lobe border	Gland/tumours not extending beyond cricoid cartilage superior border
- Inferior lobe border	-
- Isthmus anterior-posterior diameter	Preferably < 1 cm
Node size and location	
- Size	< 3 cm
- Location	Not at the superior pole Not at the retro-thyroid region
- Relation with surrounding structures	Not abutting the course of the recurrent laryngeal nerve
Inflammation	Absence of acute cervical inflammation/infection (i.e., abscess) Absence of sonographic signs of chronic inflammation – oedema, fibrosis, previous cervical radiation therapy Presence of thyroid inflammatory conditions – Hashimoto's thyroiditis, Graves' thyroiditis
Disease extension	Absence of locally advanced disease and cervical lymph node metastases

important anatomical landmarks for surgical planning.

In the setting of thyroid cancer, chronic thyroid inflammation can be associated with prior high-dose radiation exposure. This procedure should not be considered in patients with prior radiation. If signs of chronic inflammation are present (i.e., oedema, fibrotic changes), they should be noted and described, since such cases may be more safely managed with an open approach. Prior neck surgery is currently an exclusion criterion.

2. Technique of high-resolution thyroid ultrasound

The sonographic examination of the thyroid gland and cervical lymph nodes should be performed with a high-frequency linear transducer (7 – 18 MHz) in order to obtain high-resolution images. The preoperative ultrasound protocol of the thyroid gland must include paramedian transverse and longitudinal sweeps obtained with the patient in the supine position. Having the neck and head well positioned is especially important when measuring lobe diameter and volume.[11] If patients cannot sufficiently hyperextend their necks, a small pad may be placed under their shoulders.

First step: thyroid volume and extension

To calculate thyroid volume, right and left lobe volumes should be measured separately. One can start with a paramedian transverse plane of one lobe and find the view where the gland reaches the greatest width (Fig. 2). The maximal transverse and anteroposterior diameter of that lobe should be measured separately, with the depth measurement at a 90-degree angle to the skin surface and the width measurement at 90 degrees to the depth measurement. Afterwards, a longitudinal sweep should be performed, and the greatest longitudinal length should be measured. The ultrasound volume tool should be used to calculate the volume of that lobe. The procedure can be repeated for the other lobe and the sum of both volumes could be calculated. In the median transverse plane, the anterior-posterior diameter of the isthmus should be measured. In the paramedian transverse sweeps, the location of the upper poles of both lobes can be accessed, especially their relation to the upper border of the cricoid cartilage, and of the lower poles and their relation to the mediastinum. Any posterior extension of the thyroid gland into the tracheal-oesophageal grooves should be assessed.

Second step: nodule evaluation

The node that will be surgically removed should be identified and measured on its transverse, anterior-posterior, and longitudinal diameters. The lesion at the superior, medium, or inferior, as well as at the anterior or posterior poles of the gland should be located precisely.[12] The sonographic characteristics of the node according to a risk stratification score should be described (i.e., ACR TIRADS™, EU-TIRADS) and its relation to the thyroid border and the presence of possible extra-thyroid extension should be evaluated.

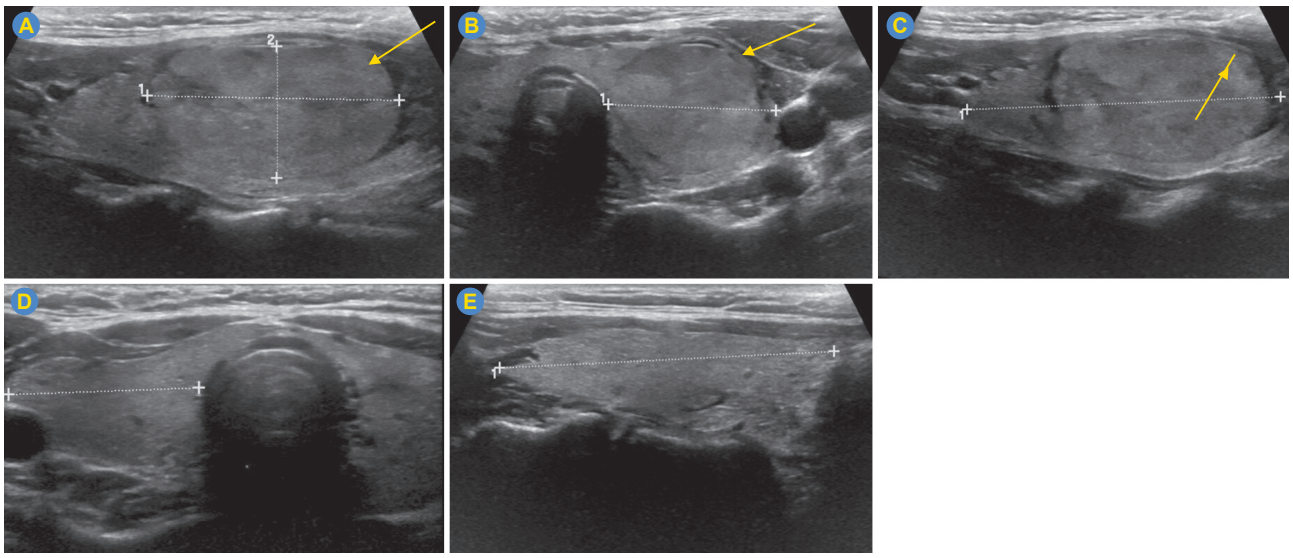

Figure 2 – B-mode ultrasound of the thyroid shows an isoechoic well-defined solid nodule in the left thyroid lobe (arrow), with a fine-needle aspiration result of papillary carcinoma, measuring 3 cm (A). The right and the left lobe diameters are measured in the paramedian transverse and longitudinal planes to determine lobe volume. The total thyroid gland volume was estimated at 12 cc, under 15 cc (B, C, D), making the case suitable for TOETVA approach.

Third step: cervical node evaluation

Start with the evaluation of IA, VI, and VII anatomic lymph node neck levels by performing a median transverse sweep over these cervical lymph node regions. Scan from superior to inferior starting at the submentonian region. When reaching the superior border of the manubrium, the probe should be angled inferiorly in order to access the VII lymph node station. To evaluate IB levels, paramedian transverse sweeps of both sides starting at the anterior belly of the digastric muscles and finishing at the submandibular glands should be performed. In order to access the internal jugular (deep cervical) chain (levels II/III/IV) a paramedian transverse sweep starting at the submandibular gland and finishing at the superior border of the clavicle should be performed. The spinal chain (level V) is accessed with a paramedian transverse sweep between the sternocleidomastoid and the trapezius muscles.

3. Presurgical ultrasound criteria for TOETVA

Thyroid volume, thyroid size, and thyroid tissue extension

In our institution, we use 15 mL of total gland volume and a thyroid gland transverse diameter up to 10 cm (calculated as the sum of the transverse diameter of both lobes) as inclusion criteria,[13-15] excluding the cases exceeding these criteria (Fig. 3). From our own experience so far, more important than the total thyroid volume is the distribution of total thyroid volume in each of the two lobes. If most of the total volume is concentrated in one lobe, even if the total volume is within limits, the case may not be eligible. This criterion is enforced in order to minimize intraoperative bleeding time, as well as to minimize the potential damage of thyroid tissue and of surrounding structures, especially the parathyroids and the laryngeal recurrent nerves.[16] Besides, there is also concern about removing relatively large tissue specimens via small central ports.[17]

The location of the thyroid relative to the laryngeal cartilage is also of interest to the surgical team. A thyroid gland that extends further than the superior border of the cricoid cartilage poses an important surgical challenge, considering the cephalad-to-caudal view afforded by the transoral approach, that can deem the patient not eligible. Successful transoral thyroid surgery also requires transection of the thyroid isthmus, to facilitate medial and anterior thyroid lobe retraction and removal of the surgical specimen. If the thyroid isthmus exceeds 1 cm in anterior-posterior diameter, that step may be more difficult.[16] Thyroid isthmus thickness is not a formal exclusion criterion, but its measurement should be made when scanning the gland.

Node size and location

As discussed previously, the surgical working space is limited. Large-size tumours can obscure laparoscopic vision. Therefore, we include in our criteria nodules under 3 cm in diameter, regardless of node histology. Another limitation of this procedure is the manipulation of the superior pole since these are areas that are particularly difficult to reach. This is explained by the oblique cephalad-to-caudal view and the limited medial/superior instrument angulation, as discussed previously. When approaching the superior

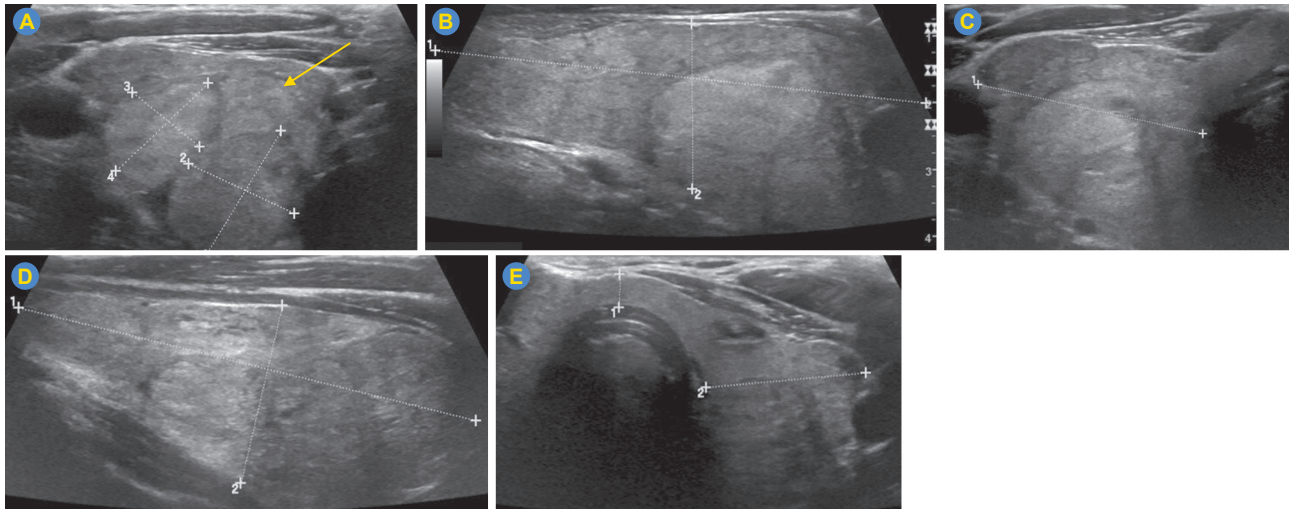

Figure 3 – B-mode ultrasound of the thyroid shows a hypoechoic well-defined solid nodule in the left thyroid lobe (arrow in A), with a fine-needle aspiration result of a follicular lesion of undetermined significance. The right and the left lobe diameters are measured in the paramedian transverse and longitudinal planes to calculate lobe volume, estimated to be 48 cc, exceeding 15 cc, making this case unsuitable for the approach.

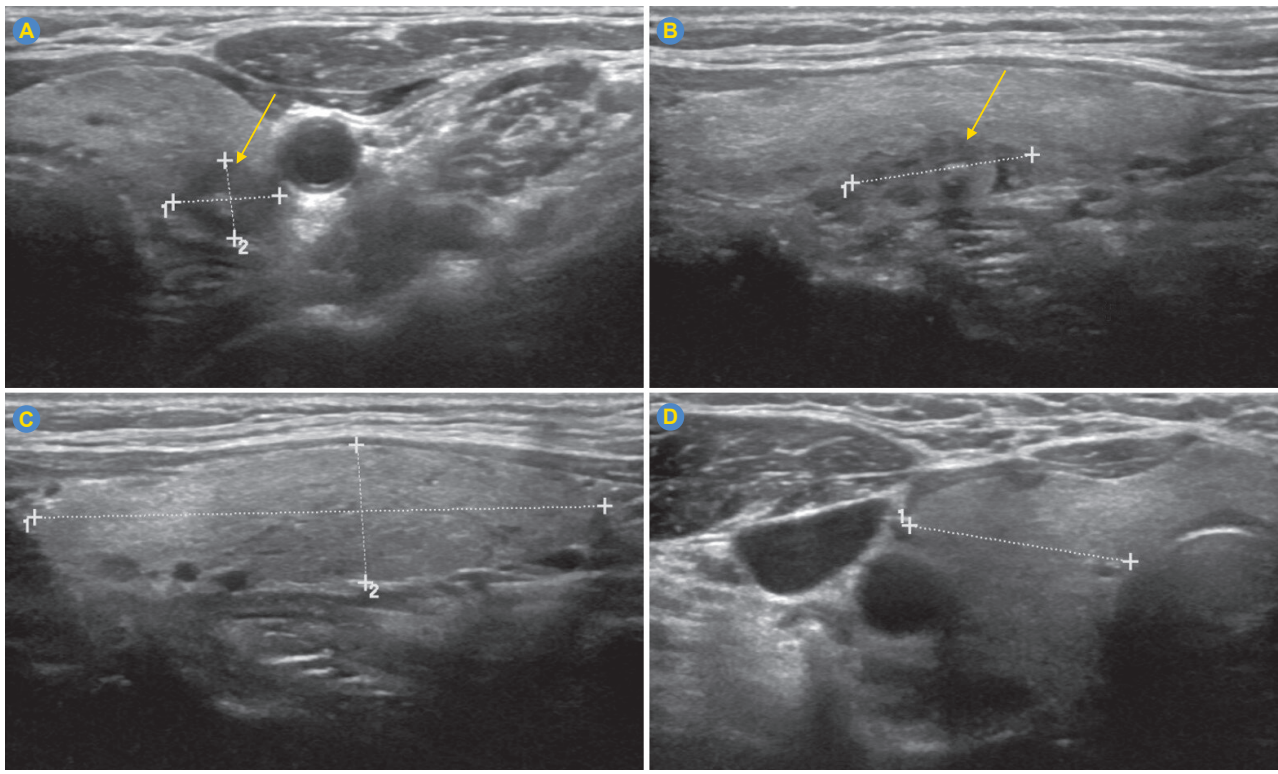

Figure 4 – B-mode ultrasound of the thyroid shows a hypoechoic well-defined solid nodule in the posterior margin of the left thyroid lobe (arrow), with a fine-needle aspiration result of follicular lesion of undetermined significance (A, B). The location of the nodule in the posterior portion of the lobe makes the case unfavorable for the TOETVA approach. The remaining characteristics of the nodule and the gland (C, D) are not impeditive.

pole, the surgeon must apply a skilled technique to avoid leaving the remaining residual thyroid tissue. Moreover, damage to the superior thyroid artery is a concern.[16] Therefore, a node that is located in the superior pole of the thyroid gland might make this procedure inadequate. It is also important to notice if the nodule is in the retro thyroid areas due to the increased risk of recurrent laryngeal nerve damage (Fig. 4). Nodules abutting the expected course of the

recurrent laryngeal nerve should be mentioned, since they may be invading the nerve, which cannot be dealt with this technique.[17]

Thyroid and perithyroiditis

The anatomical distortion that comes with chronic inflammation can be a limitation to an endoscopic procedure since it can affect normal tissue dissection. It can also increase tissue friability, which leads to higher complication rates, particularly higher haemorrhagic risk. Inflammatory thyroid diseases such as Graves' or lymphocytic (Hashimoto's) thyroiditis can increase operative difficulty. Sonographic changes associated with Graves' disease include gland enlargement, parenchymal heterogeneity, and increased vascularity. Hashimoto's thyroiditis can present as an enlarged thyroid gland with a heterogeneous echotexture especially in the initial phase, a gland with hypoechoic micronodules surrounded by echogenic septations and a thyroid with a pseudo nodular pattern. Although focal and mild, fine-needle aspiration can also be a cause of local inflammation. As with any surgery, any ongoing infection such as a cervical abscess is an exclusion criterion.

Cervical and distant metastatic disease

As mentioned above, any preoperative sonographic evaluation of thyroid node malignancy is incomplete unless a cervical nodal metastatic assessment is made. If a lymph node has sonographic findings associated with malignancy (i.e., loss of the fatty hilum, presence of nodal microcalcifications, rounded rather than elongated nodal shape, cystic changes, nodal hyperechogenicity, or lymph node short axis > 8 mm), fine-needle aspiration biopsy of the suspicious lymph node should be performed. If malignancy is confirmed, then cervical lymph node dissection is needed.

For now, central neck dissection is an exclusion criterion for transoral surgery in our institution, considering we are still on the learning curve of this procedure. Findings of extranodal disease extension or local invasion also exclude the patient as a surgical candidate for TOETVA.

AUTHOR CONTRIBUTIONS

All authors contributed equally to this manuscript.

PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the Helsinki Declaration of the World Medical Association updated in 2013.

PATIENT CONSENT

Obtained.

COMPETING INTERESTS

The authors have declared that no competing interests exist.

FUNDING SOURCES

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

REFERENCES

1. World Health Organization. The Global Cancer Observatory. Cancer today. Geneva: WHO. [Cited 2020 Sep 10]. Available from: https://gco.iarc.fr/today/home.
2. Choi Y, Lee JH, Kim YH, Lee YS, Chang HS, Park CS, et al. Impact of postthyroidectomy scar on the quality of life of thyroid cancer patients. Ann Dermatol. 2014;26:693-9.
3. Piccoli M, Mullineris B, Gozzo D, Colli G, Pecchini F, Nigro C, et al. Evolution strategies in transaxillary robotic thyroidectomy: considerations on the first 449 cases performed. J Laparoendosc Adv Surg Tech A. 2019;29:433-40.
4. Lira RB, Ramos AT, Nogueira RM, de Carvalho GB, Russell JO, Tufano RP, et al. Transoral thyroidectomy (TOETVA): complications, surgical time and learning curve. Oral Oncol. 2020;110:104871.
5. Camenzuli C, Schembri Wismayer P, Calleja Agius J. Transoral endoscopic thyroidectomy: a systematic review of the practice so far. JSLS. 2018;22:e2018.00026.
6. Ahn JH, Yi JW. Transoral endoscopic thyroidectomy for thyroid carcinoma: outcomes and surgical completeness in 150 single-surgeon cases [published correction appears in Surg Endosc. 2019 Jun 05]. Surg Endosc. 2020;34:861-7.
7. Jongekkasit I, Jitpratoom P, Sasanakietkul T, Anuwong A. Transoral endoscopic thyroidectomy for thyroid cancer. Endocrinol Metab Clin North Am. 2019;48:165-80.
8. Russell JO, Razavi CR, Al Khadem MG, Lopez M, Saraf S, Prescott JD, et al. Anterior cervical incision-sparing thyroidectomy: comparing retroauricular and transoral approaches. Laryngoscope Investig Otolaryngol. 2018;3:409-14.
9. Dionigi G, Lavazza M, Wu CW, Sun H, Liu X, Tufano RP, et al. Transoral thyroidectomy: why is it needed? Gland Surg. 2017;6:272-6.
10. Alshaikh S, Harb Z, Aljufairi E, Almahari SA. Classification of thyroid fine-needle aspiration cytology into Bethesda categories: an institutional experience and review of the literature. Cytojournal. 2018;15:4.
11. Hopkins CR, Reading CC. Thyroid and parathyroid imaging. Semin Ultrasound CT MR. 1995;16:279-95.
12. Andrioli M, Carzaniga C, Persani L. Standardized ultrasound report for thyroid nodules: the endocrinologist's viewpoint. Eur Thyroid J. 2013;2:37-48.
13. Jitpratoom P, Ketwong K, Sasanakietkul T, Anuwong A. Transoral endoscopic thyroidectomy vestibular approach (TOETVA) for Graves' disease: a comparison of surgical results with open thyroidectomy. Gland Surg. 2016;5:546-52.
14. Dionigi G, Bacuzzi A, Lavazza M, Inversini D, Boni L, Rausei S, et al. Transoral endoscopic thyroidectomy: preliminary experience in Italy. Updates Surg. 2017;69:225-34.
15. Anuwong A. Transoral endoscopic thyroidectomy vestibular approach: a series of the first 60 human cases. World J Surg. 2016;40:491-7.
16. Alkhalili E, Prescott JD. The role of ultrasound in transoral endocrine surgery. In: Russell J, Inabnet III W, Tufano R, editors. Transoral Neck Surgery. Baltimore: Springer; 2020.
17. Udelsman R, Anuwong A, Oprea AD, Rhodes A, Prasad M, Sansone M, et al. Trans-oral vestibular endocrine surgery: a new technique in the United States. Ann Surg. 2016;264:e13-16.