J Endocrinol Invest (2017) 40:1259–1263
DOI 10.1007/s40618-017-0676-0

OPINION

Transoral thyroidectomy: advantages and limitations

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Received: 8 April 2017 / Accepted: 10 April 2017 / Published online: 21 April 2017

Abstract In this opinion paper of the *Journal of Endocrinological Investigation*, leading experts in the field report on their current clinical experience with a novel approach for thyroid gland surgery, namely, "transoral thyroidectomy" (TOT). This feasible and novel surgical procedure does not require visible incisions and is, therefore, a truly scarless surgery. Patients meeting the following criteria can be considered as candidates for TOT: (a) an ultrasonographically (US) estimated thyroid diameter ≤10 cm; (b) US-estimated gland volume ≤45 mL; (c) nodule size ≤50 mm; (d) presence of a benign tumor such as a thyroid cyst or a single- or multi-nodular goiter; (e) Bethesda 3 and/or 4 category and (f) papillary microcarcinoma without the evidence of metastasis. The procedure is conducted via a three-port technique at the oral vestibule using a 10-mm port for the 30° endoscope and two additional 5-mm ports for the dissecting and coagulating instruments. TOT is performed using conventional endoscopic instruments and is probably the best scarless approach to the thyroid because of the short distance between the thyroid and the incisions placed intra-orally that do not result in any cutaneous scar and upon following the surgical planes. Experts in TOT organized a working group of general, endocrine, head and neck ENT surgeons and endocrinologist to develop the standards for practicing this emerging technique.

Keywords Thyroid · Thyroidectomy · Mini-invasive thyroidectomy · Transoral thyroidectomy

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Endoscopic thyroid surgery is developing into a common procedure at high-volume endocrine surgery centers [1–10], representing almost 90% of all thyroidectomies performed at some centers [8–10]. Endoscopic thyroid surgical procedures have led to an improvement in the postoperative quality of life; for example, cervical minimally invasive mini-incision and video-assisted techniques ameliorate the postoperative course and extracervical access allows excellent cosmesis [7–14].

Improved cosmetic outcomes have been a direct and logical derivative of the technical advances offered by minimally invasive and endoscopic approaches [7–14]. Upon gaining experience in the procedure, surgeons focus and emphasize on the cosmetic outcomes of endoscopic procedures [7–14]. The prevalence of thyroid disorders is significantly higher in women than in men. Moreover, women, especially working women, have an increased societal focus on appearance and cosmetic outcomes [15]. When esthetically pleasing endoscopic thyroidectomy can be performed without compromising surgical goals and patient safety, cosmesis should be a

factor in the presurgical planning and discussion with the patients.

Approximately 20 different endoscopic thyroid approaches, including some variations, have been published till date [7–14]. This diversity in surgical endoscopic approaches may imply that either the ideal technique and best instruments have not been developed yet or endoscopic thyroidectomy is merely in a "transition state" between open surgery and truly noninvasive surgery, i.e., surgery through a natural orifice such as the mouth, without an incision [16, 17]. Neither endoscopic approaches show characteristics that are superior to the other. Furthermore, large, prospective randomized trials to compare the outcomes of different endoscopic procedures or demonstrate a high level of evidence and grade of recommendation are missing [16, 17].

Natural orifice transluminal endoscopic surgery (NOTES) is a surgical technique whereby "scarless" surgery can be performed using an endoscope introduced through a natural orifice such as the mouth, urethra, or anus. Surgery is completed via internal incisions in the stomach, vagina, bladder, or colon, thereby avoiding external visible incisions and scars [16–18].

Since 2008, scarless endoscopic thyroid surgery has been proposed and applied with NOTES in the form of endoscopic transoral thyroidectomy (TOT) via the sublingual or transtracheal approaches [19–25]. However, these techniques cause severe tissue damage, have high complication rates, and increase conversion rates to open surgery and surgical difficulties because of limited movement during surgery, and were, therefore, abandoned [19–25].

Between 2013 and 2015, Anuwong et al. successfully introduced a new NOTES procedure for a truly scarless thyroid surgery via a vestibular approach [26–34]. They first presented a standardized technique in porcine and cadaver models [26–34]. Using these models, they improved the procedure and surgical view, validated its safety, and introduced it for human subjects using common endoscopic or robotic instruments [26–34]. The procedure is carried out under general anesthesia via a three-port technique at the oral vestibule, involving one 10-mm port for the 30° endoscope and two additional 5-mm ports for the dissecting and coagulating instruments [26–34]. TOT is performed endoscopically or robotically using conventional endoscopic instruments. Postoperatively, dressing is not required and the patient is only prescribed oral antibiotics and mouthwash 3 times per day for 5 days. Patients are mobilized from the bed 4 h after the operation and placed on an oral diet in the evening of the same day. All patients can take a shower and male patients could even shave the same evening. Patients can also sunbathe the following weekend [26–34].

The TOT surgery is currently performed at multiple institutions and is being embraced by several universities globally [26–34]. It was proposed, introduced, and applied in different countries like Thailand, South Korea, India, China, Singapore, Taiwan, USA, Mexico, Japan, Hongkong, Philippines, Indonesia, Ecuador, and Italy with currently about 1000 procedures performed worlwide. It seems possible that TOT might represent the newest frontier in minimally invasive surgery [34].

Patients have to meet the following precise, but wide inclusion criteria to be considered candidates for TOT: (a) an ultrasonographically (US) estimated thyroid gland diameter ≤10 cm; (b) US-estimated thyroid volume ≤45 ml; (c) US-estimated main nodule size ≤50 mm; (d) presence of a benign tumor such as a thyroid cyst or a uni- or multinodular goiter; (e) follicular neoplasm; or (f) papillary microcarcinoma of the thyroid without evidence of metastasis [26–34]. Patients are excluded if they (a) are unfit for surgery; (b) cannot tolerate general anesthesia; (c) have undergone previous radiation therapy in the area of the head, neck, and/or upper mediastinum; (d) had previous neck surgery; (e) have recurrent goiter; (f) have a thyroid volume >45 ml; (g) have a dominant nodule size >50 mm; or (h) show evidence of lymph node or distant metastases, (i) tracheal/esophageal invasion, (l) recurrent laryngeal nerve palsy, (m) biochemical of hyperthyroidism, or (n) oral abscesses [26–34].

Not-preferred candidates for the transoral approach are patients with poorly differentiated or undifferentiated

Table 1 Advantages and limitations of transoral thyroidectomy (TOT)

Advantages
Optimal cosmetic result: truly cutaneous scar-free surgery
The concept of natural orifice transluminal endoscopic surgery (NOTES)
Extensive inclusion criteria
Real minimally invasive surgery (MIS): avoids distant surgical access, minimize surgical trauma and excessive tissue dissection, easy access to subplatysma space and respects anatomical planes
Median central approach: achieve bilateral revelation of the thyroid gland and of the central compartment
Both conventional endoscopic and robotic techniques have been described
Reliable postoperative course
Technique is reproducible in many centers
Possible central neck dissection
Limitations
Non preferred candidates: patients with poorly differentiated or undifferentiated cancer, differentiated thyroid cancer with posterior extrathyroidal extension and/or N1b, huge goiter and Graves' disease.
'Clean' surgery to 'clean contaminated' surgery
Mental nerve injury
CO_2 leakage
Collision of instruments
Unable to perform 4-port transoral operation

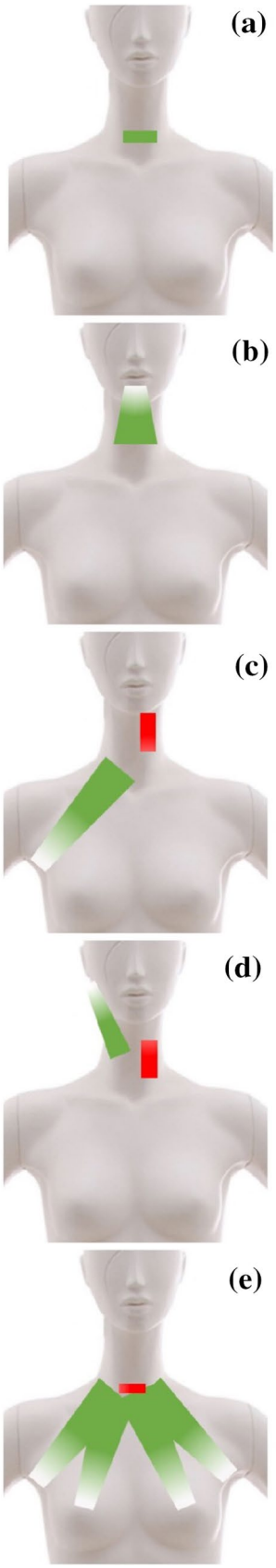

Fig. 2 Limits of endoscopic thyroid approaches. Minimally invasive video assisted thyroidectomy (MIVAT) (**a**) and transoral thyroidectomy (TOT) (**b**) present a direct and limited dissection and for anatomical planes. Axillary (**c**), retroauricular (**d**) and breast (**e**) approaches are not truly "minimally invasive" as more flap dissection and longer operative time are required. Bilateral axillo-breast approach (BABA) has a limited access to central neck compartment (**e**). Axillary (**c**) and retroauricular (**d**) present limited evaluation of contralateral and/or pyramidal lobe

cancer, posterior extrathyroidal extension and/or N1b differentiated thyroid cancer, large goiter and Graves' disease.

This new approach has certain uncharacteristic features (Table 1). First, it is a minimally invasive endoscopic thyroid surgery. Extracervical procedures that are completely endoscopic may be not minimally invasive as the surgical dissection area is larger (trocars are away from the neck, and this requires a vast exploration area) [16–18]. Extracervical endoscopic procedures have various advantages and disadvantages, though none of them completely avoids a cutaneous scar or scars in the neck and chest regions. Furthermore, some of these approaches are often associated with more postoperative pain, given the additional tissue dissection and retraction necessary to access the gland from a distant cutaneous entry site. TOT is a minimally invasive procedure because the approach is near the thyroid gland and only minimal dissection is required [26–34]. Moreover, the approach route to the anterior neck is shorter than that from the axilla, breast, or retroauricular regions [26–34].

Traditional open surgery involves a low transverse cervical incision, at least 4 cm long, that results in a visible scar. In contrast to conventional and endoscopic thyroidectomy, TOT leaves no visible cutaneous scar [26–34]. Therefore, it

Fig. 1 Transoral thyroidectomy: cosmetic outcome on Day 2 post operation

does not entail any physical or physiological complication related to scars such as keloid, hypertrophic scar, contracture formation, or dehiscence [26–34] (Fig. 1). Moreover, given the predominance of thyroid surgery in women, often accompanied by a benign histology, an effort should be made to minimize surgical invasiveness and improve cosmesis. Young women and men frequently raise cosmetic concerns and requests, and these appear to be important factors that influence the choice of surgery in patients.

The transoral approach follows surgical planes while minimizing surgical trauma, avoiding distant surgical access, excessive tissue dissection, and scars. The approach offers a remote access that makes surgery virtually scarless; moreover, the dissection area between the oral cavity and neck only minimally adds to the standard surgical bed (Fig. 2).

The TOT surgery is performed via a central-median approach that enables bilateral exposure of the thyroid and avoids additional incisions [26–34]. The transoral approach offers superb visibility of the central compartment of the neck down to the level of the innominate artery below the sternal notch. In contrast to other endoscopic and robotic-assisted approaches that have a lateral entry point, the transoral approach provides a midline exposure and equivalent access to both the right and left thyroid lobes and central compartments. This is a considerable advantage over the transaxillary technique, in which approaching the contralateral thyroid lobe or paratracheal nodal basin may be quite challenging (Fig. 2). Some authors believe that the view offered by the transoral approach is more similar to that offered by the traditional open approach and might diminish the surgeon's learning curve because this approach is well known to experienced thyroid surgeons [26–34]. It also provides a more familiar perspective for identifying the recurrent laryngeal nerve and excellent exposure, thereby allowing complete central neck dissection [26–34].

Although robotic-assisted neck surgery is an established technique now, it is not performed on a large scale so far because of its high costs. Thus, this technology is currently available only to a limited patient population. Given the economic reality of most countries, the alternative use of TOT seems a more feasible option, as it can be performed with or without robotic assistance, requiring only conventional endoscopic instruments.

In conclusion, this is an opinion report of our ongoing experience with TOT. We will continue to apply this technique with caution in selected patients. TOT should be performed only in specialized centers for endocrine and endoscopic surgery. There are some major areas of research needed for TOT. These areas included continuous auditing and creation of dedicated endoscopic surgical tools.

TOT would be enhanced to the ideal procedure with specific instrumental and technical advances, for example to degree the collision of instruments, the inability to perform 4-port transoral operation, CO_2 leakage owing to weak and friable mucosa in human and the development of a reliable extraction technique for specimen. Current and future research should focus on refining and developing dedicated surgical instruments.

However, this novel approach seems to raise the necessary investments in future research and demand a complete examination and verification. Experts in TOT organized a working group of general, endocrine, head and neck ENT surgeons and endocrinologist to develop the standards for practicing this developing technique. This interdisciplinary group is needed to make these measurements and offer patients with appropriate information. TOT is associated with changes, specific potential complications are likely to occur as mental nerve injury and infection. Identifying specific contributors to postoperative morbidity following TOT will allow for significant improvement in the care of these patients. To detect possible problems early, outcome databases are being established.

Author contributions (I) Conception and design: Gianlorenzo Dionigi, Hoon Yub Kim, Angkoon Anuwong; (II) Administrative support: Gianlorenzo Dionigi, Ralph P. Tufano, Angkoon Anuwong; (IV) Collection and assembly of data: Gianlorenzo Dionigi, Hoon Yub Kim, Ralph P. Tufano; (V) Data analysis and interpretation: Gianlorenzo Dionigi, Hoon Yub Kim, Ralph P. Tufano, Angkoon Anuwong; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

Compliance with ethical standards

Conflict of interest The authors have no conflict of interest to disclosure, and no other funding or financial relationship with the surgical industry.

Ethical approval The study was approved by the institutional ethics committee of Department of Medicine and Surgery, University of Insubria.

Informed consent All patients were provided the particular details for their surgeries and informed consent obtained from each patient.

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