Original Article

# Flexible single port access in transoral endoscopic thyroidectomy vestibular approach

**Michael de Cillia[1]^, Christian Obrist[1], Christof Mittermair[1]^, Elias Karakas[2], Helmut Weiss[1]**

[1]Department of Surgery, Saint John of God (SJOG) Hospital, Salzburg, Austria; [2]Department of General-, Visceral-, Endocrine Surgery, Hospital Maria Hilf, Alexianer GmbH, Krefeld, Germany

*Contributions:* (I) Conception and design: H Weiss, E Karakas, M de Cillia; (II) Administrative support: C Mittermair, C Obrist; (III) Provision of study materials or patients: M de Cillia, C Obrist; (IV) Collection and assembly of data: M de Cillia, C Mittermair; (V) Data analysis and interpretation: H Weiss, E Karakas, M de Cillia; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

*Correspondence to:* Prim. Prof. hc Univ. Doz. Dr. Helmut Weiss, MSc, FEBS or Dr. Michael de Cillia. Department of Surgery, Saint John of God Hospital, Kajetanerplatz 1, 5020 Salzburg, Austria. Email: helmut.weiss@bbsalz.at or michael.decillia@bbsalz.at.

**Background:** Transoral endoscopic thyroidectomy vestibular approach (TOETVA) is regarded the only no-scar technique which combines minimized surgical trauma with all advantages of endoscopy such as enhanced view, fluorescent parathyroid imaging (FPI) and optimum cosmesis. Addressing TOETVA specific local risk profiles like mental nerve injury, the potential of skin lesions or difficult specimen retrieval we modified the three trocar based TOETVA towards a soft single port platform.

**Methods:** Single port-TOETVA (SP-TOETVA) was established and retrospectively analysed in five patients using a soft handmade single port housing multiple trocar valves. Standard laparoscopic instruments, one articulating instrument and a vessel-sealing device were utilized. $CO_2$ insufflation was maintained at 6–8 mmHg.

**Results:** In all patients SP-TOETVA was completed successfully. Hemigland and total thyroid volumes ranged from 5–40 and 55 mL, respectively. Neither additional trocars nor conversion to open was required. Operation time yielded 102–214 min. Neuromonitoring and FPI were applied. The soft wound protection foil served for convenient specimen harvest. No intra- or postoperative complication occurred. In particular, no functional impairment on mental nerve was seen.

**Conclusions:** SP-TOETVA with the soft and flexible handmade single port system is feasible and ensures wound protection. It allows for easy instrument application and benefits of minimally invasive surgery without the specific risk of lateral vestibular incisions.

**Keywords:** Transoral endoscopic thyroidectomy; single port; transoral endoscopic thyroidectomy vestibular approach (TOETVA)

Submitted Nov 30, 2021. Accepted for publication Apr 02, 2022.
doi: 10.21037/gs-21-818
**View this article at:** https://dx.doi.org/10.21037/gs-21-818

## Introduction

Development of minimal invasive parathyroid and thyroid surgery has come a long way since the first endoscopic parathyroidectomy performed by Gagner in 1996 (1) and the first video-assisted endoscopic thyroidectomy performed by Hüscher in 1997 (2) were published. Various techniques evolved with either the goal of smaller cervical incisions as demonstrated by Miccoli, the minimally invasive video-assisted thyroidectomy (MIVAT) technique (3), or extracervical approaches without a visible scar in the

^ ORCID: Michael de Cillia, 0000-0002-5240-8919; Christof Mittermair, 0000-0002-1928-1231.

**Figure 1** Operation room setup.

neck. The breast approach by Ohgami *et al.* (4), the endoscopic neck surgery by the axillary approach by Ikeda *et al.* (5) or endoscopic axillo-bilateral-breast approach (ABBA) reported by Shimazu *et al.* (6) have been criticized as not being minimally invasive (7) as they require even more dissection than open surgery (6,8). A special branch in minimal invasive surgery (MIS) is focusing on procedures performed via natural orifices (NOTES-Natural Orifice Translumenal Endoscopic Surgery) (9) to prevent any complication and scarring on the body surface. Various working groups in Europe and later also in Asia developed techniques that followed the thyroid on its way of descent through the floor of the mouth (10-12) or the oral cavity (13,14). This approach seemed especially attractive when facing patients with tendency of hypertrophic scars or the utmost individual desire of an intact integrity of the neck and chest.

The advantages of MIS such as less postoperative pain, shorter hospital stay, less scarring, enhanced view, fluorescent parathyroid imaging (FPI) techniques and faster recovery times are well known (15-19). However, the need of triangulation in MIS when adjusted to transoral thyroid surgery comes into conflict with human anatomy resulting in a method specific complication, namely mental nerve injury, especially with the use of two lateral trocars in the vestibulum oris (20). In addition, extensive manipulation via the lateral trocars is reported to provoke oral commissure tears. The first case report was published previously by Park *et al.* (21) utilizing a commercially available, bulky stiff single port system that requires a wide approach and shows limitations in instrument delivery and degrees of freedom. As a highly specialized center in single-port minimally invasive surgery, with an experience of more than 6,000 advanced single port laparoscopic procedures, we implemented a novel flexible handmade glove for the first time in thyroid single port transoral endoscopic surgery (SP-TOETVA). We present the following article in accordance with the STROBE reporting checklist (available at https://gs.amegroups.com/article/view/10.21037/gs-21-818/rc).

## Methods

In October 2021, we established SP-TOETVA at the Saint John of God Hospital in Salzburg, Austria. Single port approach was approved by the local ethical committee (Ethikkommission-Land Salzburg: 415EP/73/25-2011; 13-07-2011). All consecutive patients eligible for this method were motivated to avoid an anterior cervical scar and signed informed consent prior to operation. We aimed to follow the inclusion and exclusion criteria predefined for classic TOETVA (14). The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Preoperative investigation followed standard protocols, including laboratory thyroid function test, ultrasound of the thyroid gland and neck as well as scintigraphy and fine needle aspiration in doubt of dignity. The dissection steps are already well described and standardized in various publications (13,15,20,22). Therefore, we focused on the technical aspects, port positioning and details of the novel SP-TOETVA technique.

### *Patient positioning and operation room setup*

Procedures were performed under general anaesthesia and oral intubation. Patients were placed in supine position. The neck was firmly extended. According to the strategy published by the Endoscopic Thyroid and Parathyroid Surgery Study Group (23), a single shot antibiotic intravenous injection (3 g of ampicillin/sulbactam) was administered 30 minutes before mucosal incision. A gauze was used as a plug to protect the pharynx from liquid or blood accumulation. Oral cavity and skin were cleaned using Octenisept® (Schülke & Mayr GmbH, Germany). The patient was draped exposing the operation field from the upper lip down to the sternal notch. The surgeon was sited at the head of the patient, flanked by the camera assistant and a second assistant. Laparoscopic monitors were placed lower to the patient's feet. The scrub nurse stood on the patient's right side, the anaesthesiologist on the left (*Figure 1*).

A horizontal 15 mm median mucosal incision inside the lower lip served as the only approach. The 15 mm

**Figure 2** Hydrodissection of the subplatysmal space (this image is published with the patient's consent).

**Figure 3** Handmade single port system.

incision will be enlarged to 18 mm with respect to the tissue elasticity, which is appropriate for either one 10 mm trocar (inner diameter) or the 5 mm camera and two 5 mm working instruments. Therefore, the length of the incision does not directly depend to patients gender, race or anatomy.

Blunt dissection was used to divide the mentalis muscle and subcutaneous tissue downwards to the chin. Slight bleeding of the mentalis muscle and the lip was easily controlled by adrenalin soaked gauze and compression.

A Veress needle was inserted to access and expand the subplatysmal space by hydrodissection (2 mg L-adrenalin 1:10,000 in 250 mL saline) down to the sternal notch (*Figure 2*).

A blunt tissue dissector was passed through the same incision to enlarge the working field downwards and to either side. Then the handmade glove port was installed. $CO_2$ insufflation was initiated with AirSeal® (ConMed, US) low flow (5 L/min) and held at 6–8 mmHg to avoid subcutaneous emphysema. We never used cautery in the lips region in any of our patients in order to prevent burning. Specific heat protection, other than air exchange via the AirSeal®, is not considered mandatory in this approach.

### *Inserting the handmade single port system*

The handmade glove port comprises a soft double ring foil (DACH Medical Group, Austria) and a regular surgical glove. Conventional trocars were inserted in the fingers (*Figure 3*) and fixed with Leukostrip®S (Smith & Nephew GmbH, Austria).

The port is put together after introducing the inner ring of the foil underneath the level of the chin without further fixation (*Figure 4A-4C*).

### *Assembling the handmade glove port*

A 30° 10 mm camera is inserted through the 12 mm AirSeal® trocar to allow straight top down vision. The 5 mm trocar on the left was used to advance an articulating blunt tissue clamp and the 5 mm trocar on the right for variable dissection devices. An additional 5 mm trocar served to pass the long neuromonitoring probe (Medos Austria Medizintechnik OG, Austria).

### *Exposure of the surgical field*

First the subplatysmal space was further enlarged using the monopolar hook or vessel sealer to clearly identify the midline and infrahyoid muscle group. A median stay-suture (Prolene® 3.0, Johnson & Johnson, USA) was passed through the skin from outside at the level of the thyroid cartilage to dynamically widen the space when needed (*Figure 5*). The linea alba of the infrahyoid muscle group was then divided. Once the thyroid capsule could be identified, the sternohyoid muscle and sternothyroid muscle were swiped away and a second stay-suture was placed through the skin and the infrahyoid muscle on demand to gain additional lateral traction.

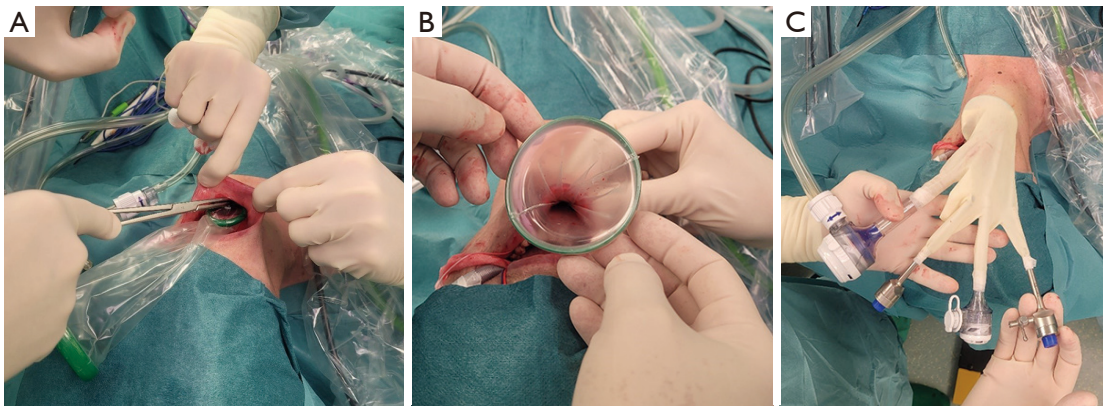


**Figure 4** Mounting the handmade single port system. (A) Inserting the wound protector foil; (B) rolling up the outer ring before connecting the glove; (C) connecting the glove port.

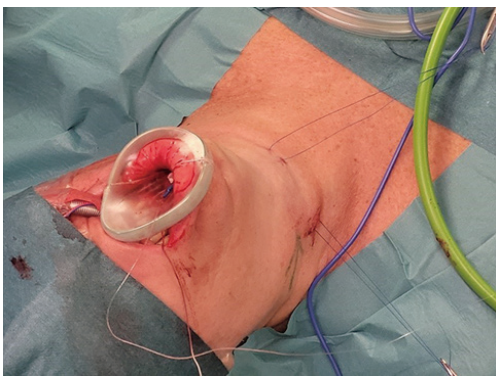

**Figure 5** Stay sutures (ventral and lateral) for dynamic traction in a SP-TOETVA right hemithyroidectomy procedure (this image is published with the patient's consent). SP-TOETVA, single port-transoral endoscopic thyroidectomy vestibular approach.

### *Thyroid dissection*

Dissection of the isthmus and the superior thyroid vessels was achieved with an energy sealing and cutting device (Ligasure®, Medtronic, IRL). Intravenous indocyanine green (ICG) (0.1 mg/kg) negative staining was used to identify parathyroid glands and their supporting blood vessels (*Figure 6*).

Further dissection was taken down to the mid thyroid vein and the posterior processus of the thyroid gland. At this point the lobe was luxated contra-laterally and the tracheoesophageal groove could be identified. Recurrent laryngeal nerve (RLN) function was controlled with indirect (via the vagal nerve) and direct stimulation.

The inferior vessels were sealed and cut and the lobe was carefully dissected from the trachea. Lymph node sampling was carried out in one patient due to an enlarged nodule in the central compartment (benign histopathological result).

Images with key steps of the operation and insight view of the handmade port can be seen in *Figures 7,8*.

### *Specimen removal*

A tear proof endobag (Espiner, DACH Medical, Austria) was inserted under direct vision through the additional 5 mm trocar and the specimen was secured in the bag. Insufflation was stopped, the glove port was disconnected from the wound protector and the specimen could be removed following this guide rail (*Figure 9*). The wound protector allowed for a smooth retrieval as well as wound protection. Transoral specimen harvest is limited to the anatomic fulcrum of the chin. Alternatively, a retroauricular removal was performed in three patients for specimen exceeding 4 cm in diameter or due to highly rigid and fibrotic specimen tissue.

### *Haemostasis and wound closure*

Thereafter the glove port is reconnected to ensure haemostasis under high pressure ventilation (30 mmHg). Since the platysma stays intact in this procedure, we did not adapt the linea alba. Ultimately the foil was removed. The wound was closed with running sutures of the mentalis muscle and mucous membrane (Vicryl® rapid 4.0, Johnson & Johnson, USA) (*Figure 10*).

The retroauricular incision in three patients was closed with a running intracutaneous suture (Monocryl® 3.0,

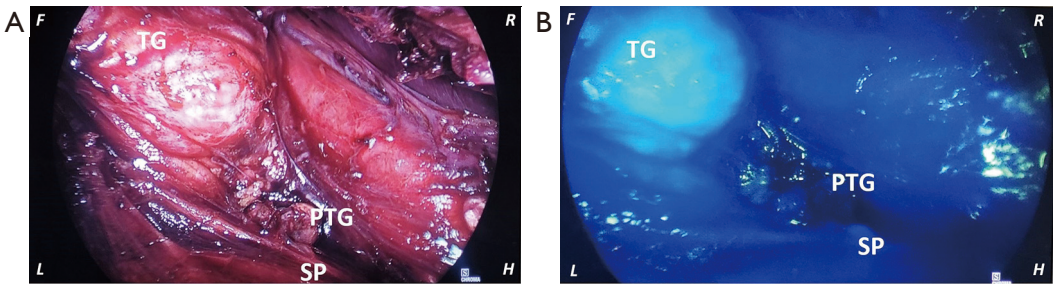


**Figure 6** Intraoperative use of indocyanine green to facilitate identification of parathyroid glands. (A) Normal view and (B) contrast view using ICG negative staining for parathyroid gland identification. ICG, indocyanine green; TG, thyroid gland; SP, supporting blood vessel of PTG; F, feet; H, head; L, left; R, right; PTG, parathyroid gland.

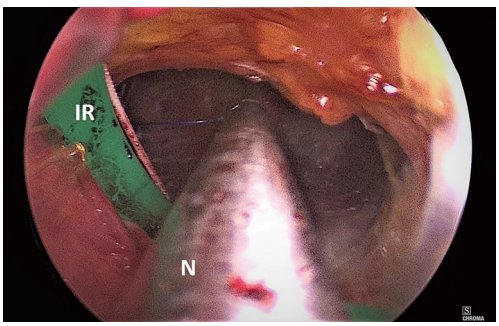


**Figure 7** Inside view of the handmade port when passing a laparoscopic needle holder. IR, inner ring of wound protector; N, laparoscopic needle holder.

Johnson & Johnson, USA).

### *Postoperative regime*

Patients were held on liquid diet on first postoperative day. On second day they started with solid food and teeth brushing. No antibiotics were administrated. Postoperative pain was assessed using the average visual analog pain scale (VAS) until discharge. Baseline analgesic therapy included non steroidal anti-inflammatory drugs and further pain killers on demand. Neck circumference was daily correlated to preoperative values as well as evaluation of mental nerve function using the finger touch test on lips and chin of the patient. Parathyroid hormone (PTH) levels were controlled once after 72 hours to exclude Hypoparathyroidism. Vocal cord function was examined by an ear-nose-throat (ENT) consultant using flexible or rigid laryngoscopes.

All retrieved data was collected in an Excel file (Microsoft Excel, Microsoft, Redmond, Washington, USA) and analysed therein. Results are given as mean, the range is displayed in round brackets.

## Results

Patient demographics and operative details are listed in *Table 1*, whereas pre- and postoperative laboratory results are given in *Table 2*. Generally, patients with symptomatic or progressive nodules were treated, whereas the largest nodule was 4.5 cm in diameter. One patient presented with a visible prominent solitary "cold" nodule with no tracer uptake in scintigraphy. All other patients had no conspicuous uptake in scintigraphy. Hypertrophic scarring after breast reduction surgery was evident in one patient. All procedures were carried out without additional trocars in the vestibulum oris. However, in three patients an additional retroauricular access (SP-TOVARA) was used to extract the thyroid specimen within the retrieval bag because of a rigid 4.5 cm nodule in one patient, a 3.6 cm nodule in a hemigland specimen of 40 mL in another patient and a highly rigid and fibrotic transformed gland in the third patient. Division of the isthmus was performed at the beginning of thyroidectomy to remove the right side and left side separately. Operation time yielded 102 to 214 minutes, respectively. Blood loss was neglectable in either patient and no signs of infection occurred postoperatively. One patient developed a small bruise on the chin which lead to temporary dysesthesia on the center of the chin but resolved spontaneously without intervention. Length of stay yielded three to five days in all patients. No mental nerve palsy, RLN injury or hypoparathyroidism occurred.

The data of postoperative pain were documented using the VAS and given in *Table 3*. Histopathological workup yielded benign nodules in all cases.

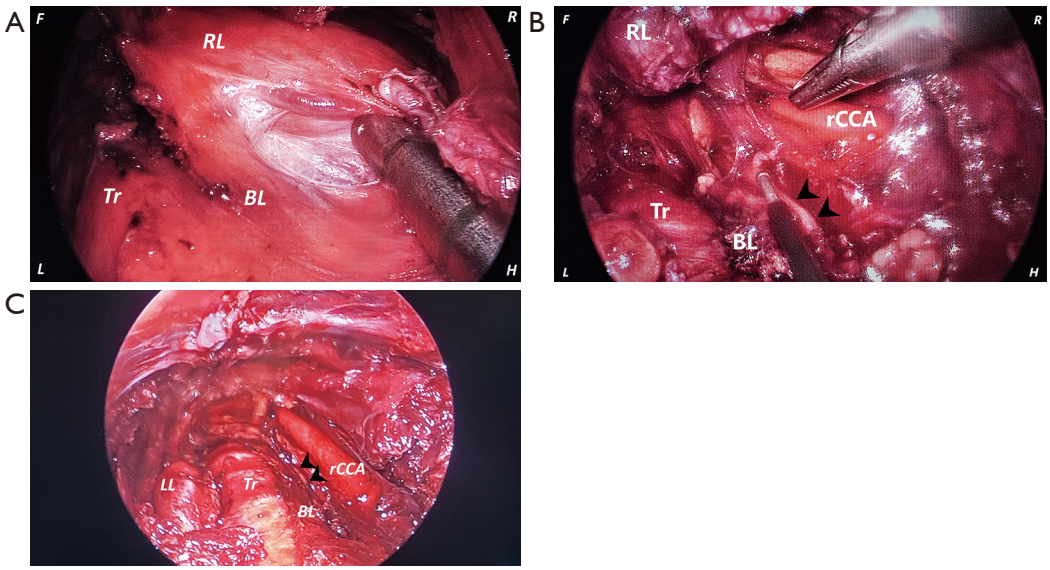


**Figure 8** Illustration of operative key steps. (A) Exposing the ligament of Berry; (B) identification of right recurrent laryngeal nerve (black arrow heads) after dissecting the ligament of Berry; (C) top down anatomic overview after right hemithyroidectomy in SP-TOETVA technique with exposed right recurrent laryngeal nerve (black arrow heads). SP-TOETVA, single port-transoral endoscopic thyroidectomy vestibular approach; RL, right lobe of thyroid gland; BL, Berry ligament; Tr, trachea; rCCA, right common carotid artery; LL, left lobe of thyroid gland.

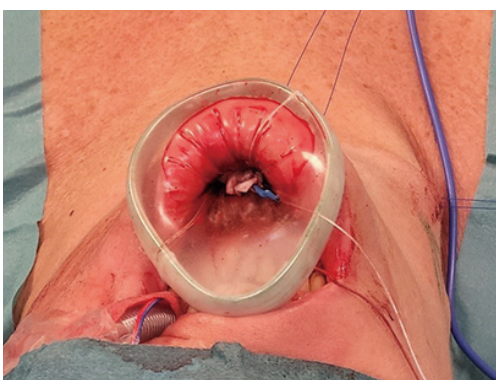

**Figure 9** Guided harvest of the specimen entrapped in the retrieval bag and delivered through the sleeve of the foil (this image is published with the patient's consent).

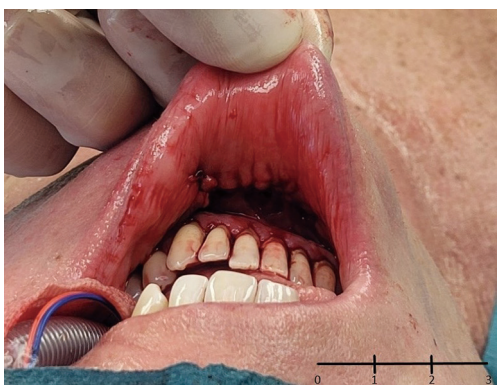

**Figure 10** Sutured single median oral vestibule access. Black scale is divided into centimeters (this image is published with the patient's consent).

## Discussion

Herein we introduce a novel single port technique which is not in need of additional lateral trocars and may therefore help in overcoming the downsides of classic TOETVA.

The transoral endoscopic vestibular approach for thyroidectomy is an attractive new technique in the evolution of minimal invasive thyroid surgery (24). TOETVA meets the criteria of minimally access trauma as it does not need extensive flap mobilization and has been demonstrated to be safe even when compared to open thyroidectomy (15). One drawback of this technique is the potential risk of mental nerve palsy which results in lower lip and chin numbness which can be permanent in up to 2% (25). Particularly positioning the lateral trocars with the intention to achieve better triangulation is worrying (13,26). Modification of lateral port placement more lateral

**Table 1** Patient demographics and operative parameters

| Parameters | Patient 1 | Patient 2 | Patient 3 | Patient 4 | Patient 5 |
|---|---|---|---|---|---|
| Gender | Female | Female | Female | Female | Male |
| Age, years | 51 | 90 | 61 | 65 | 58 |
| BMI (kg/m$^2$) | 32.2 | 20.9 | 28.3 | 30.5 | 24.8 |
| Smoker | No | No | Yes | No | Yes |
| Levothyroxine-natrium (µg) daily | 50 | 50 | 100 | 0 | 0 |
| Type of goiter | Solitary right nodule | Solitary left nodule | Solitary right nodule | Multinodular goiter | Multinodular goiter |
| Scintigraphy | Decreased uptake (cold) | No conspicuous uptake | No conspicuous uptake | No conspicuous uptake | No conspicuous uptake |
| Size of nodule (cm) | 1.8 | 4.5 | 2.5 | 3.6 (largest on left side) | 1.7 |
| Hemithyroid gland volume (mL) | 18 | 35 | 5 | Left 40, right 15 | Left 20, right 20 |
| SP-TOETVA procedure | Right hemithyroidectomy | Left hemithyroidectomy | Right hemithyroidectomy | Thyroidectomy | Thyroidectomy |
| Specimen retrieval | Transoral | Retroauricular | Transoral | Retroauricular | Retroauricular |
| Operation time (min) | 131 | 115 | 102 | 204 | 214 |
| Additional trocars | 0 | 0 | 0 | 0 | 0 |
| Hospital stay after surgery (days) | 4 | 5 | 3 | 4 | 4 |
| Histopathological workup | Benign | Benign | Benign | Benign | Benign |

BMI, body mass index; SP-TOETVA, single port-transoral endoscopic thyroidectomy vestibular approach.

**Table 2** Pre- and postoperative laboratory parameters

| Parameters (normal values) | Preoperative | 48 h postoperative | 72 h postoperative |
|---|---|---|---|
| Leukocytes (4–10 GIGA/L) | 8.9 (6.9–13.8) | 8.6 (5.8–12.4) | – |
| CRP (0.0–0.5 mg/dL) | 0.3 (0.1–0.6) | 6.5 (3.8–10.7) | – |
| $Ca^{++}$ (2.1–2.55 mmol/L) | 2.36 (2.27–2.48) | 2.13 (2.05–2.23) | – |
| TSH (0.34–4.94 µlU/mL) | 1.49 (0.43–2.37) | 2.52 (0.17–8.28) | – |
| PTH (15–65 pg/mL) | – | – | 28 (19.0–38.0) |

Data are presented as mean (range). CRP, C-reactive protein; $Ca^{++}$, calcium; TSH, thyroid-stimulating hormone; PTH, parathyroid hormone.

in the region of the oral commissure helped to minimalize mental nerve injury but may increase the risk of vascular complications such as lacerating the inferior labial artery or facial artery (20).

Additionally, extensive manipulations of rigid trocars may foster lacerations at the corner of the mouth. However, in a recent report of the first single port transoral thyroidectomy, using a multiport platform, Park *et al.* customized complete upper and lower tooth protectors to avoid teeth injury by a rigid port system (21). In addition with the evolution of advanced single port laparoscopy flexible platforms reveal better degrees of freedom in instrument manipulation,

**Table 3** Postoperative pain

| POD | VAS |
|---|---|
| 1 | 3 [1–6] |
| 2 | 2 [0–4] |
| 3 | 2 [0–4] |
| 4 | 0 [0–1] |

Data are presented as mean [range]. VAS, visual analogue scale; POD, postoperative day.

provide wound protection and are capable to deliver up to five instruments, e.g., in case of intraoperative ultrasound or simultaneous neuromonitoring. Using a single access may be demanding which could reflect the longer operation times compared to those reported in classic TOETVA in the literature (15). However, accurate comparison of procedural time to other approaches for thyroid resection might be possible after larger series.

Robotic assisted surgery might enhance dexterity when compared to standard TOETVA but requires rigid trocars, extended operative time, a longer learning curve and occasionally an axillary incision for the fourth arm of the robot. With the new da Vinci® single-port robotic system additional cutaneous incisions are no longer necessary, as Park *et al*. reported in their study on two human cadavers (27), but customize a large trocar device. As a consequence, the first robotic single port transoral thyroidectomy series utilizing this very robust and stiff trocar system showed high postoperative sensitivity disorders at the chin and lower lip (28). Yang *et al.* reported that there is also a potential risk of injuring the mental nerves with the median incision when leaving the trapezoid shaped safety zone due to larger incisions (29) that are currently mandatory in robotic single port surgery.

Since the facial, oral and mental region is a highly sensitive field and present in nearly everyday life situation it should not be compromised by utilizing a technique with a high risk of facial injury in order to prevent cervical scarring. To meet the flexible requirements of the transoral access without enlarging the median incision of a conventional 10 mm trocar, we developed the SP-TOETVA and transposed a cost effective handmade single port system from the abdominal to the cervical level. An incision suitable for three 5 mm instruments requires the length of 1.8 cm, at least, which is comparable with the incision of a 10 mm trocar (inner diameter). Therefore, we are able to entirely prevent any trauma lateral to the incision. This is one of our key arguments to advocate this access. However, specimen retrieval might lacerate this incision. Removal of the inner ring of the handmade port might help for easier specimen harvest. A limitation of this new technique might be the inability of specimen retrieval of nodules larger than 4 cm in minimum diameter throughout the system. We recommend to take advantage of an alternative retrieval site, such as the retroauricular region at the hair line to fulfill both safe organ harvest and an operation with invisible scars recently described as the combined transoral and retroauricular approach (TOVARA) (30). If cost effectiveness is relevant and further risk minimizing of subcutaneous emphysema is wanted, the implementation of a gasless anterior neck skin lifting method as reported in the Trans-oral Video-Assisted Neck Surgery (TOVANS) by Nakajo *et al.* (31) might be an option. However, gasless surgery is probably at higher risk for inappropriate exposure of the surgical field and higher trauma at the skin of the neck.

The technique presented herein was carried out by surgeons experienced in endocrine and single port surgery, after cadaver training and clinical observation. Another surgeon, experienced in multiport TOETVA, served as a proctor for further safety. This new method has the potential to be offered to a substantial number of patients with uni- and bilateral pathologies of the thyroid and parathyroid glands. In addition to careful patient selection, surgeon proficiency in single port skills and standard procedures of the central neck, including thyroidectomy, parathyroidectomy, and central neck dissection in case of necessary conversion from TOETVA to an open approach is of utmost importance for procedural safety.

We want to emphasize that any implementation of premature SP-TOETVA might increase morbidity.

Several limitations of this study have to be addressed: First, this series represents an early experience with this method and further application may slightly adapt the results. Second, the relatively small number of patients does not yet allow for a generalized conclusion. Third, the noncomparative study design impedes reliable comparison with the standard TOETVA method and further comparative studies shall address this circumstance.

## Conclusions

The reported data suggest that the novel technique of SP-TOETVA, performed with the soft handmade single port platform, achieves all the requirements that are necessary for minimally invasive, scarless endoscopic surgery

with additional protection from mental nerve palsy and complicated specimen retrieval documented in multiport TOETVA.

## Acknowledgments

*Funding:* None.

## Footnote

*Reporting Checklist:* The authors have completed the STROBE reporting checklist. Available at https://gs.amegroups.com/article/view/10.21037/gs-21-818/rc

*Data Sharing Statement:* Available at https://gs.amegroups.com/article/view/10.21037/gs-21-818/dss

*Peer Review File:* Available at https://gs.amegroups.com/article/view/10.21037/gs-21-818/prf

*Conflicts of Interest:* All authors have completed the ICMJE uniform disclosure form (available at https://gs.amegroups.com/article/view/10.21037/gs-21-818/coif). The authors have no conflicts of interest to declare.

*Ethical Statement:* The authors are accountable for all aspects of the work in ensuring that questions related to accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Single port approach was approved by the local ethical committee (Ethikkommission-Land Salzburg: 415EP/73/25-2011; 13-07-2011). Informed consent was obtained from all subjects involved in the study.



## References

1. Gagner M. Endoscopic subtotal parathyroidectomy in patients with primary hyperparathyroidism. Br J Surg 1996;83:875.
2. Hüscher CS, Chiodini S, Napolitano C, et al. Endoscopic right thyroid lobectomy. Surg Endosc 1997;11:877.
3. Miccoli P, Berti P, Raffaelli M, et al. Minimally invasive video-assisted thyroidectomy. Am J Surg 2001;181:567-70.
4. Ohgami M, Ishii S, Arisawa Y, et al. Scarless endoscopic thyroidectomy: breast approach for better cosmesis. Surg Laparosc Endosc Percutan Tech 2000;10:1-4.
5. Ikeda Y, Takami H, Sasaki Y, et al. Endoscopic neck surgery by the axillary approach. J Am Coll Surg 2000;191:336-40.
6. Shimazu K, Shiba E, Tamaki Y, et al. Endoscopic thyroid surgery through the axillo-bilateral-breast approach. Surg Laparosc Endosc Percutan Tech 2003;13:196-201.
7. Henry JF. Minimally invasive thyroid and parathyroid surgery is not a question of length of the incision. Langenbecks Arch Surg 2008;393:621-6.
8. Ikeda Y, Takami H, Sasaki Y, et al. Clinical benefits in endoscopic thyroidectomy by the axillary approach. J Am Coll Surg 2003;196:189-95.
9. Kavic MS. Natural orifice translumenal endoscopic surgery: "NOTES". JSLS 2006;10:133-4.
10. Karakas E, Steinfeldt T, Gockel A, et al. Transoral thyroid and parathyroid surgery. Surg Endosc 2010;24:1261-7.
11. Benhidjeb T, Wilhelm T, Harlaar J, et al. Natural orifice surgery on thyroid gland: totally transoral video-assisted thyroidectomy (TOVAT): report of first experimental results of a new surgical method. Surg Endosc 2009;23:1119-20.
12. Witzel K, von Rahden BH, Kaminski C, et al. Transoral access for endoscopic thyroid resection. Surg Endosc 2008;22:1871-5.
13. Anuwong A, Sasanakietkul T, Jitpratoom P, et al. Transoral endoscopic thyroidectomy vestibular approach (TOETVA): indications, techniques and results. Surg Endosc 2018;32:456-65.
14. Karakas E, Anuwong A, Ketwong K, et al. Transoral thyroid and parathyroid surgery : Implementation and evaluation of the transoral endoscopic technique via the vestibular approach (TOETVA). Chirurg 2018;89:537-44.
15. Anuwong A, Ketwong K, Jitpratoom P, et al. Safety and Outcomes of the Transoral Endoscopic Thyroidectomy Vestibular Approach. JAMA Surg 2018;153:21-7.
16. Mohiuddin K, Swanson SJ. Maximizing the benefit of minimally invasive surgery. J Surg Oncol 2013;108:315-9.
17. Keus F, de Jong JA, Gooszen HG, et al. Laparoscopic versus open cholecystectomy for patients with

symptomatic cholecystolithiasis. Cochrane Database Syst Rev 2006;(4):CD006231.
18. Kulkarni N, Arulampalam T. Laparoscopic surgery reduces the incidence of surgical site infections compared to the open approach for colorectal procedures: a meta-analysis. Tech Coloproctol 2020;24:1017-24.
19. Bullen NL, Massey LH, Antoniou SA, et al. Open versus laparoscopic mesh repair of primary unilateral uncomplicated inguinal hernia: a systematic review with meta-analysis and trial sequential analysis. Hernia 2019;23:461-72.
20. Celik S, Makay O, Yoruk MD, et al. A surgical and anatomo-histological study on Transoral Endoscopic Thyroidectomy Vestibular Approach (TOETVA). Surg Endosc 2020;34:1088-102.
21. Park JH, Bilegsaikhan SE, Suh YJ. A Novel Technique for Performing Transoral Endoscopic Thyroidectomy Vestibular Approach (TOETVA): A Single-port Platform. Surg Laparosc Endosc Percutan Tech 2020;30:e4-7.
22. Dionigi G, Lavazza M, Bacuzzi A, et al. Transoral Endoscopic Thyroidectomy Vestibular Approach (TOETVA): From A to Z. Surg Technol Int 2017;30:103-12.
23. Karakas E, Klein G, Michlmayr L, et al. Transoral thyroid surgery vestibular approach: is there an increased risk of surgical site infections? Updates Surg 2022;74:303-8.
24. Anuwong A. Transoral Endoscopic Thyroidectomy Vestibular Approach: A Series of the First 60 Human Cases. World J Surg 2016;40:491-7.
25. Fernandez-Ranvier G, Meknat A, Guevara D, et al. Transoral Endoscopic Thyroidectomy Vestibular Approach: A Single-institution Experience of the First 50 Cases. Surg Innov 2020;27:439-44.
26. Tae K. Complications of Transoral Thyroidectomy: Overview and Update. Clin Exp Otorhinolaryngol 2021;14:169-78.
27. Park D, Shaear M, Chen YH, et al. Transoral robotic thyroidectomy on two human cadavers using the Intuitive da Vinci single port robotic surgical system and CO2 insufflation: Preclinical feasibility study. Head Neck 2019;41:4229-33.
28. Park YM, Kim DH, Moon YM, et al. Gasless transoral robotic thyroidectomy using the DaVinci SP system: Feasibility, safety, and operative technique. Oral Oncol 2019;95:136-42.
29. Yang HM, Shin KJ, Min J, et al. Anatomical study of gasless transoral thyroidectomy and clinical application. Surg Endosc 2020;34:3414-23.
30. Schopf S, Karakas E, Klein G, et al. First extracervical (remote-access) thyroid lobectomy for large specimen without a visible scar via a transoral vestibular and retroauricular approach (TOVARA). Endocr Abstr 2018;56:P1068.
31. Nakajo A, Arima H, Hirata M, et al. Trans-Oral Video-Assisted Neck Surgery (TOVANS). A new transoral technique of endoscopic thyroidectomy with gasless premandible approach. Surg Endosc 2013;27:1105-10.

**Cite this article as:** de Cillia M, Obrist C, Mittermair C, Karakas E, Weiss H. Flexible single port access in transoral endoscopic thyroidectomy vestibular approach. Gland Surg 2022;11(5):778-787. doi: 10.21037/gs-21-818