Surg Endosc
DOI 10.1007/s00464-017-5724-5

Transoral robotic thyroidectomy: lessons learned from an initial consecutive series of 24 patients

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Received: 3 December 2016 / Accepted: 13 July 2017

Abstract

Background Transoral thyroid surgery is an ideal method for minimally invasive thyroidectomy, as there is less flap dissection during the procedure and no postoperative scars. Nonetheless, technical obstacles have precluded the wide dissemination of this procedure. We present the surgical procedures and outcomes of transoral robotic thyroidectomy (TORT).

Methods From September 2012 to June 2016, we performed TORT at Korea University Hospital. We used three intraoral ports and a single axillary port for the system's four robotic arms. The surgical outcomes were retrospectively reviewed.

Results Twenty-four female patients (mean age 39.6 ± 11.6 years; mean tumor size 1.0 ± 1.3 cm) underwent unilateral thyroid lobectomies with or without ipsilateral central neck dissection. Twenty patients had papillary thyroid carcinomas (PTC), three had benign nodules, and one had a follicular thyroid carcinoma. The mean surgical time was 232 ± 41 min; the mean hospital stay was 3.3 ± 0.8 days. The number of retrieved central lymph nodes in the PTC patients was 4.7 ± 3.2. There were no reports of transient or permanent vocal cord palsy, recurrence, or mortality during the median follow-up period of 16.8 months. Paresthesia of the lower lip and the chin due to mental nerve injury was observed in nine of the first 12 patients (six transient, three permanent), but no further reports of paresthesia were recorded after patient 12, when the locations of the intraoral incisions were modified.

Conclusions TORT is feasible and safe for selected patients after technical refinements, and can be a potential alternative approach for scarless thyroid surgery.

Keywords Transoral robotic thyroidectomy · Transoral thyroidectomy · Robotic thyroidectomy · Thyroid carcinoma

Conventional thyroid surgery involves a transverse neck incision that results in a scar that is often conspicuous. Various surgical procedures of endoscopic thyroidectomy have since been developed and performed worldwide to avoid this undesirable cosmetic outcome, including the transaxillary approach, bilateral axillo-breast approach, and facelift approach [1–3]. However, these remote-access approaches require extensive tissue dissection and result in significant scarring in other areas of the body; thus, these approaches are considered to be more invasive scar-transferring approaches. However, the transoral approach is considered truly scarless, as the oral mucosal incisions heal completely in 2–3 weeks and vanish in several months.

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Published online: 19 July 2017

The first study to evaluate the feasibility of the transoral approach used a porcine model [4]. During the procedure, which involved a surgical approach through the floor of the mouth, the authors demonstrated feasibility by resecting the thyroid gland without the risk of a recurrent laryngeal nerve (RLN) injury. Subsequently, reports of the utility of transoral thyroidectomy in human patients were published in 2011 and 2013 [5, 6]. However, the surgical outcomes of the two studies were not satisfactory when compared to the open conventional thyroidectomy. For example, in the first study, the incidences of transient and permanent RLN palsy were 25 and 13%, respectively [5]. In the second study, all patients reported chin numbness for a period of more than 6 months after surgery [6]. However, a recent study reported promising results using the endoscopic transoral approach, in which no instances of permanent hoarseness, mental nerve injury, or infection were reported among the 60 enrolled patients [7].

A robotic system has recently been adapted to facilitate transoral thyroidectomy; our initial experiences with transoral robotic thyroidectomy (TORT) in human patients were described in 2015 [8]. We have since modified and refined the surgical procedure, with demonstrable advantages. In this study, we present the surgical procedure and outcomes of TORT using the da Vinci Si Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA, USA).

Materials and methods

Patients

This study was approved by the Institutional Review Board of Korea University Hospital (IRB No. ED14085). From September 2012 to June 2016, eligible patients were enrolled to undergo TORT at Korea University Hospital. All surgeries were performed by a single surgeon (H.Y.K.). A diagnostic finding of a thyroid nodule measuring less than 4 cm on preoperative ultrasound was an indication for lobectomy by TORT. Patients with suspected lateral neck metastasis or extensive central lymph node (CLN) metastasis were not candidates for TORT. Eligible patients were extensively counseled on the various approaches to the thyroid used in our institution, including transcervical, bilateral axillo-breast, and transoral. The relative advantages and disadvantages of each technique were discussed in detail. Those patients who elected to undergo TORT were enrolled in this study.

Preoperative preparation

At least 1 week prior to surgery, patients were evaluated by a dentist who scaled the teeth and gingiva of all dental calculus to optimize oral hygiene. Patients were admitted to the ward the day before surgery as is customary in our institution, and they underwent preoperative indirect laryngoscopic examination for evaluation of vocal cord movement. Prophylactic antibiotics (cefazedone, 1 g) were administered intravenously 30–60 min before the incision.

Operative procedures

Patient positioning and draping

The patient was transorally intubated with an endotracheal electromyogram tube (Medtronic, Dublin, Ireland) after induction of anesthesia, and the tube was fixed to either side of the mouth. The patient was placed in the lithotomy position. Draping was performed to expose the upper chest, both axillae, and the lower lip, and povidone-iodine solution was painted on the exposed areas as shown in Fig. 1A. Subsequently, we irrigated the oral cavity with chlorhexidine and povidone-iodine solution.

Incision and flap formation

After injecting 10 mL of dilute epinephrine-saline solution (1:200,000) into the lower lip down to the tip of the chin with a spinal tapping needle, an inverted U-shaped incision 2 cm in length was made over the end of the frenulum of the lower lip (Fig. 1B). The space was then widened by muscle dissection with electrocautery and blunt curved mosquito clamps. Once the space was extended to the tip of the chin, 30–50 mL of epinephrine-saline solution was injected into the subplatysmal space down to the lower neck using a Veress needle. We subsequently created a wide subplatysmal space bluntly passing the vascular tunneller (8 mm diameter), and inserted a 12 mm bariatric trocar through the lip incision for the camera port. Lateral oral mucosal incisions 5 mm in length were made 1 cm medial to both lateral labial commissures. After injection of 10 mL of epinephrine-saline solution, 5 mm short robot trocars were inserted through the incisions (Fig. 1C). The robotic camera, ultrasonic energy device (Harmonic ACE+, Ethicon Endo-Surgery, Inc., Cincinnati, OH, USA), and endoscopic suction irrigators were inserted into the midline, right lateral, and left lateral ports, respectively, and the subplatysmal flap was elevated. The upper, lower, and lateral margins of the flap were the thyroid cartilage, sternal notch, and medial aspect of the sternocleidomastoid muscle, respectively. Subsequently, an 8 mm bariatric trocar was inserted through an incision made along the patient's right axillary fold into the subplatysmal working space for counter traction during the operation and for later drain insertion.

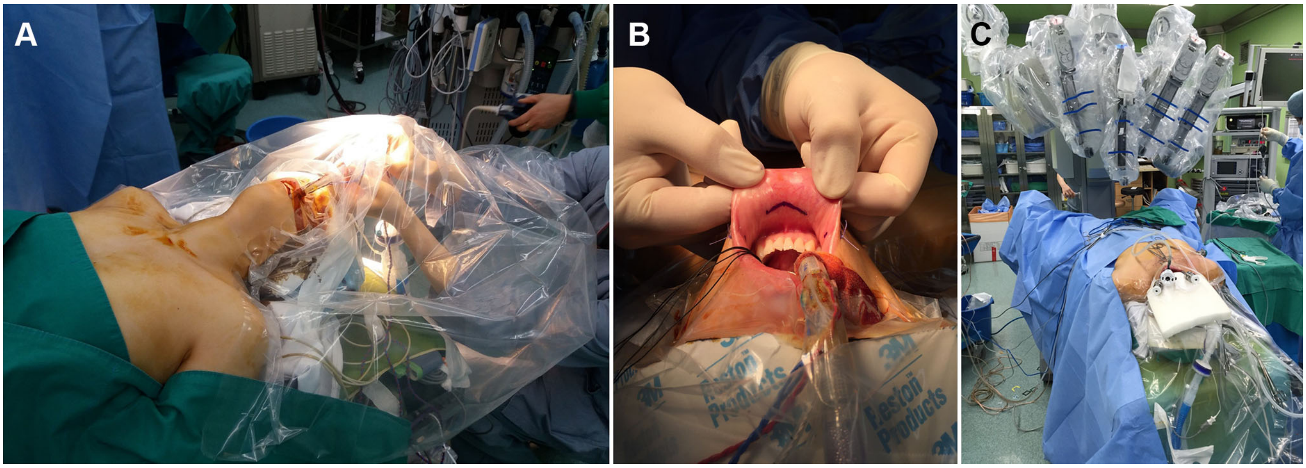

Fig. 1 The procedure of a transoral robotic thyroidectomy. Draping (**A**), incision (**B**), and trocar positions (**C**)

Robot docking and thyroidectomy procedures

The robot was docked on the midline between the patient's legs. The midline raphe of the strap muscles was divided from the thyroid cartilage notch to the sternal notch. The isthmus was first divided at the midline, and the posterior surface of the isthmus was detached from the trachea to the ligament of Berry (Fig. 2A). The sternothyroid muscle was then dissected from the thyroid gland and reflected with the fourth arm. The superior pole was lifted, and the superior thyroidal vessels were divided individually with harmonic shears (Fig. 2B). The superior parathyroid was then identified and dissected downward, with caution. The thyroid gland was reflected in a contralateral anterior direction, and the ligament of Berry was dissected to identify the RLN at its entry point (Fig. 2C). Intraoperative nerve monitoring was routinely used to confirm the location and integrity of the RLN. The robotic monopolar hook coagulator was used as the nerve stimulator by connecting the stimulator cable to the nerve stimulator. The lobectomy was completed in a cephalad to caudal direction, with the identification and preservation of the lower parathyroid gland. A frozen biopsy was routinely performed. A prophylactic ipsilateral central neck dissection was performed when either preoperative fine needle aspiration (FNA) cytologic examination or intraoperative frozen biopsy suggested malignancy.

Specimen retrieval and closure

The resected specimen was placed in an endoplastic bag inserted through the transoral midline port or the axillary port and removed extracorporeally. After meticulous hemostasis, a Jackson Pratt drain was inserted through the axillary port and the midline raphe of the strap muscles was closed using an absorbable suture. The oral mucosa was closed with interrupted absorbable sutures. A compressive dressing was applied around the patient's chin and submandibular area for 24 h.

Postoperative management

Intravenous antibiotics used for preoperative prophylaxis were maintained for an additional 3 days after surgery, and oral antibiotics were maintained for an additional 4 days.

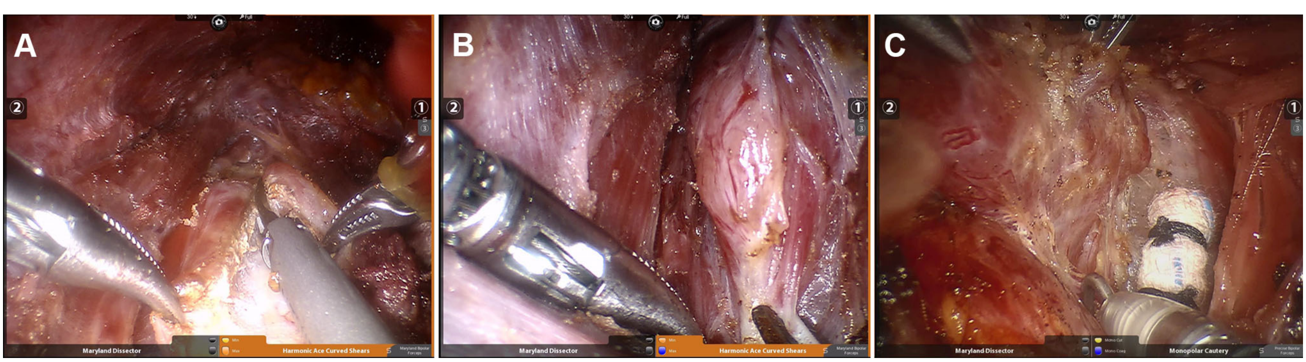

Fig. 2 The procedure of a transoral robotic thyroidectomy. Isthmus division (**A**), ligation of the superior thyroidal vessels of the left thyroid gland (**B**), and identification of the right recurrent laryngeal nerve (**C**)

Patients were permitted to sip water 4 h after surgery. They were placed on a soft bland diet on the first postoperative day and a normal regular diet on the second day. The Jackson Pratt drain was removed on the third postoperative day.

Patient follow-up

The patients visited the outpatient clinic during the second week after discharge for removal of the intraoral stitches and an indirect laryngoscopic examination. Follow-up examinations, including a thyroid function test and a wound inspection, were subsequently performed during the first and third months after surgery, and every 6 months thereafter. Levothyroxine was prescribed to the patients with carcinomas to suppress thyroid stimulating hormone.

Statistical analysis

Results were analyzed using SPSS Statistics for Window Version 20.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as the mean ± standard deviation, and the groups were compared using the Mann–Whitney *U* test. Categorical variables were compared using the Fisher's exact test. *P* values <0.05 were considered significant.

Results

Patient characteristics

A total of 24 female patients were enrolled in this study; patient demographics and clinicopathological characteristics are listed in Table 1. The mean patient age was 39.6 ± 11.6 years. The mean body mass index (BMI) was 22.4 ± 2.6 kg/m^2, and the mean tumor size was 1.0 ± 1.3 cm. There were 19 patients with preoperative suspicious histology on FNA, four with atypia of unknown significance, and one with a follicular neoplasm. On frozen and/or final pathology, three patients were diagnosed with benign nodules, one patient was diagnosed with a follicular thyroid carcinoma, and 20 patients were diagnosed with papillary thyroid carcinomas (PTC). Lymph node metastases were present in two patients.

Surgical outcomes

Table 2 shows the surgical outcomes of TORT. The mean operative time was 232 ± 41 min. The mean hospital stay was 3.3 ± 0.8 days. The number of retrieved CLNs in the PTC patients was 4.7 ± 3.2. There was no evidence of transient or permanent vocal cord palsy. Paresthesia of the lower lip and the chin was observed in nine patients. It was transient in six patients, resolving within 6 months, and permanent in three patients. Bruising over the zygomatic regions, which resolved within a few weeks, was present in two patients. One patient experienced a perforation of the chin skin; another experienced tearing of the oral commissure. There were no conversions to open or endoscopic surgery, postoperative bleeding, tracheal injury, or chyle leakage.

Table 1 Patient characteristics

Variables	Value ($n = 24$)
Age (mean ± SD) (years)	39.6 ± 11.6
Gender	
Male	0 (%)
Female	24 (100%)
Body mass index (mean ± SD) (kg/m^2)	22.4 ± 2.6
Tumor size (mean ± SD) (cm)	1.0 ± 1.3
Preoperative FNA diagnosis	
Atypia of unknown significance	4 (16.7%)
Follicular neoplasm	1 (4.2%)
Suspicious malignancy	19 (79.2%)
Pathologic diagnosis	
Benign nodule	3 (12.5%)
Follicular thyroid carcinoma	1 (4.2%)
Papillary thyroid carcinoma	20 (83.3%)
Nodal stage in cancer patients	
N0	22 (91.7%)
N1a	2 (8.3%)

FNA fine needle aspiration

Learning curve in transoral robotic thyroidectomy

The initial 12 cases were categorized as "period A" and the subsequent 12 cases as "period B"; the surgical outcomes of the two periods were compared (Table 2). There were no significant differences in patient characteristics such as age and BMI. Significant differences were also not evident in the surgical outcomes, including operative time, number of retrieved CLNs in PTC patients, and the length of hospital stay. When surgical complications were considered, mental nerve injuries were observed in patients only in period A (period A, 9/12 vs. period B, 0/12; $P < 0.001$). However, minor complications such as bruising in the zygomatic region, chin flap perforation, or oral commissure tearing were present only in period B patients. Figure 3 shows the surgical time according to the case number. A decrease in operative time was not observed. There was no recurrence or mortality during the median follow-up of 46.3 months for period A or 7.9 months for period B.

Table 2 Surgical outcomes of transoral robotic thyroidectomy and comparison during period A (initial 12 cases) and period B (latter 12 cases)

Variables	Total ($n = 24$)	Period A ($n = 12$)	Period B ($n = 12$)	P value*
Age, years	39.6 ± 11.6	38.3 ± 11.0	41.0 ± 12.5	0.684
Body mass index (kg/m^2)	22.4 ± 2.6	22.0 ± 3.0	22.7 ± 2.1	0.684
Operation time (min)	232 ± 41	234 ± 54	230 ± 24	0.100
Hospital stay (days)	3.3 ± 0.8	3.2 ± 0.4	3.5 ± 1.0	0.640
No. of retrieved CLN in PTC patients	4.7 ± 3.2	5.0 ± 3.2	4.5 ± 3.6	0.370
Vocal cord palsy				
Transient	0 (0)	0 (0)	0 (0	n.a
Permanent	0 (0)	0 (0)	0 (0)	
Mental nerve injury		9 (75.0)	0 (0)	<0.001
Transient/permanent†		6/3	0/0	
Bruise over zygomatic region	2 (8.3)	0 (0)	2 (16.7)	0.478
Perforation of chin flap	1 (4.2)	0 (0)	1 (8.3)	1.000
Tearing of commissure of lips	1 (4.2)	0 (0)	1 (8.3)	1.000
Median follow-up (range) (months)	24.2 (6, 52)	46.3 (39, 52)	7.9 (6, 9)	

Data are expressed as the mean ± SD or n (%)

CLN central lymph node, *PTC* papillary thyroid carcinoma

* Period A versus period B

† Sensory of the lower lip recovered but paresthesia of the chin persisted

Discussion

Since the development of endoscopic parathyroid surgery 20 years ago [9], various remote-access approaches for thyroid surgery have been developed to avoid visible neck scarring. A few large case-series have reported the feasibility and safety of endoscopic thyroidectomy [10, 11]. With the recent introduction of robotic technology, there has been increasing enthusiasm for robotic thyroid surgery despite the high costs [12, 13]. Some advantages of robotic over endoscopic instrumentation include a magnified three-dimensional operative view that allows for a more precise and safe surgical procedure with less fatigue. Furthermore, the wristed instrumentation allows a range of motion and dexterity not possible with laparoscopic instruments. Consequently, robotic thyroidectomy has replaced endoscopic thyroidectomy and has gradually become the procedure of choice for remote-access thyroid surgery.

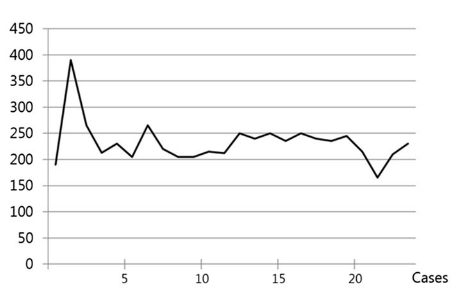

Fig. 3 Operative time in minutes according to the case number

Robotic thyroidectomy has primarily been performed through axillary, breast, or facelift incisions. While these approaches enable excellent access to the ipsilateral neck, contralateral neck surgery presents challenges. Furthermore, these approaches require increased tissue dissection and flap elevation, and introduce new operative risks that are incompatible with minimally invasive surgery. A much more direct approach, which is truly scarless, involves a transoral route that has recently been developed and modified [7]. This approach has been successfully utilized with endoscopic instrumentation. To leverage the technical advantages mentioned above, we introduced the robotic system for transoral thyroidectomy [14–16] and reported the first instance of TORT in a case-series of four patients [8]. This is the first report to detail the efficacy of TORT in a large number of consecutive cases.

The primary advantage of transoral thyroidectomy is cosmetic, as the intraoral scars are hidden and completely heal in 2–3 weeks. Other approaches have resulted in the appearance of small scars on the neck, or have merely transferred scars to other parts of the neck. In addition, the transoral thyroidectomy does not require extensive flap dissection. The extent of transoral thyroidectomy dissection is similar to that of conventional open thyroidectomy, which extends from the sternal notch to the thyroid cartilage level. It is also much smaller than the remote-access approaches mentioned above. The small dissection area of the transoral thyroidectomy may result in slight sensory loss or postoperative pain related to the flap dissection; however, this might be less significant compared to other remote-access approaches [17–20]. The potential benefits of a small dissection area should be evaluated in a prospective setting.

A unique and serious complication of the transoral thyroidectomy is mental nerve injury. The mental nerve is a sensory nerve that innervates the skin of the lower lip and chin; injury may result in transient or permanent paresthesia in this area. We considered the incidence of mental nerve injury to be an obstacle during our initial experiences with this procedure [8]. In the initial 12 cases, we made the midline incision in the gingival-buccal sulcus of the central incisors and the lateral incisions at the first molars (Fig. 4A) [8]; mental nerve injury was common using this approach. However, we were able to avoid this complication by relocating the incision sites. We moved the midline incision to the end of the frenulum of the lower lip and the lateral incisions to 1 cm medial to both lateral labial commissures. (Fig 4B) No further mental nerve injury was reported after this change was made. The mental nerve emerges from the mental foramen in the mandible and branches into upper and lower branches. The mental foramen is generally located below the canine root, and the mental nerve runs medially after branching. Therefore, the nerve is less likely to be injured when the ports are placed more laterally and more distal to the canine root. We moved the port insertion sites accordingly and therefore avoided nerve injury.

We observed minor surgical complications such as bruising of the zygomatic region and tearing of the oral commissure. Consequently, we fixed sponges to the zygomatic bones to prevent bruising and carefully monitored the robotic arm movements to prevent the application of excessive force. As a precautionary note, bedside assistant surgeons should always be aware of the range of motion of the robotic arms to avoid physical trauma and should provide frequent feedback to the console surgeon.

The current primary limitation of TORT is the extended surgical time, which results in increased anesthesia time and cost. The initial application of this procedure was cautious; we limited the extent of surgery to a thyroid lobectomy to avoid serious complications related to the total thyroidectomy, such as bilateral vocal cord palsy or permanent hypoparathyroidism. However, we have learned from the initial experience that there is no difference between left and right lobectomies concerning the identification of the recurrent laryngeal nerve or preservation of the parathyroid glands. As our experience accumulates, we anticipate safe performance of total thyroidectomies using TORT.

During the study period, the patients received intravenous antibiotics during their hospital stays even though no infection occurred at the surgical site or in the deep space. In fact, the only reported infection of this kind was a patient who contracted an infection at the vestibular incision site 4 weeks after surgery; the patient required re-incision [5]. Further studies involving a large number of patients are necessary to reveal the incidence of infection associated with the transoral approach. Lastly, the follow-up period in this study was too short to evaluate the long-term oncologic outcomes of TORT. Further studies involving longer follow-up are necessary.

We reported the surgical outcomes of TORT in the largest series of patients to date. TORT may be an ideal approach for patients with surgical thyroid disease pursuing favorable cosmetic outcomes. Although our initial experiences involved a higher rate of mental nerve injury, the results after refinement and technical modification are very

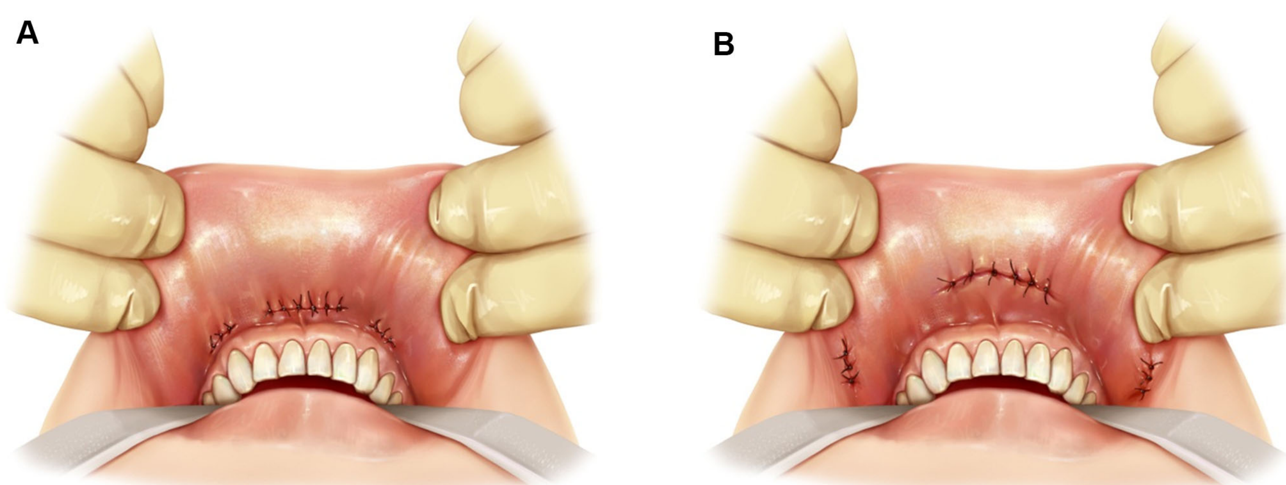

Fig. 4 Port placements in the initial 12 cases (**A**) and final 12 cases (**B**)

encouraging. Despite the current limitations of TORT, which include a long operative time and the continued risk of mental nerve injury, we believe that with a better understanding of the mental nerve anatomy and continuing technical refinements, TORT can be performed safely. Therefore, TORT holds great promise as the ideal scarless surgical approach to the thyroid, and further study is warranted.

Acknowledgements We would like to thank Hong Kyu Kim for preparing the figures, and Ji Young Won and Woong Hyun Lee for the illustration.

Funding This work was supported by a National Research Foundation of Korea (NRF) Grant funded by the Korean government (Ministry of Science, ICT & Future Planning, NRF-2016R1E1A1A01942072).

Compliance with ethical standards

Disclosures Drs. Hoon Yub Kim, Young Jun Chai, Gianlorenzo Dionigi, Angkoon Anuwong, and Jeremy D. Richmon have no conflicts of interest or financial ties to disclose.

References

1. Yoon JH, Park CH, Chung WY (2006) Gasless endoscopic thyroidectomy via an axillary approach: experience of 30 cases. Surg Laparosc Endosc Percutan Tech 16(4):226–231
2. Choe JH, Kim SW, Chung KW, Park KS, Han W, Noh DY, Oh SK, Youn YK (2007) Endoscopic thyroidectomy using a new bilateral axillo-breast approach. World J Surg 31(3):601–606
3. Terris DJ, Singer MC, Seybt MW (2011) Robotic facelift thyroidectomy: patient selection and technical considerations. Surg Laparosc Endosc Percutan Tech 21(4):237–242
4. Witzel K, von Rahden BH, Kaminski C, Stein HJ (2008) Transoral access for endoscopic thyroid resection. Surg Endosc 22(8):1871–1875
5. Wilhelm T, Metzig A (2011) Endoscopic minimally invasive thyroidectomy (eMIT): a prospective proof-of-concept study in humans. World J Surg 35(3):543–551
6. Nakajo A, Arima H, Hirata M, Mizoguchi T, Kijima Y, Mori S, Ishigami S, Ueno S, Yoshinaka H, Natsugoe S (2013) Trans-oral video-assisted neck surgery (TOVANS). A new transoral technique of endoscopic thyroidectomy with gasless premandible approach. Surg Endosc 27(4):1105–1110
7. Anuwong A (2016) Transoral endoscopic thyroidectomy vestibular approach: a series of the first 60 human cases. World J Surg 40(3):491–497
8. Lee HY, You JY, Woo SU, Son GS, Lee JB, Bae JW, Kim HY (2015) Transoral periosteal thyroidectomy: cadaver to human. Surg Endosc 29(4):898–904
9. Gagner M (1996) Endoscopic subtotal parathyroidectomy in patients with primary hyperparathyroidism. Br J Surg 83(6):875
10. Kang SW, Jeong JJ, Yun JS, Sung TY, Lee SC, Lee YS, Nam KH, Chang HS, Chung WY, Park CS (2009) Gasless endoscopic thyroidectomy using trans-axillary approach; surgical outcome of 581 patients. Endocr J 56(3):361–369
11. Choi JY, Lee KE, Chung KW, Kim SW, Choe JH, Koo DH, Kim SJ, Lee J, Chung YS, Oh SK, Youn YK (2012) Endoscopic thyroidectomy via bilateral axillo-breast approach (BABA): review of 512 cases in a single institute. Surg Endosc 26(4):948–955
12. Lee KE, Kim E, Koo DH, Choi JY, Kim KH, Youn YK (2013) Robotic thyroidectomy by bilateral axillo-breast approach: review of 1026 cases and surgical completeness. Surg Endosc 27(8):2955–2962
13. Ban EJ, Yoo JY, Kim WW, Son HY, Park S, Lee SH, Lee CR, Kang SW, Jeong JJ, Nam KH, Chung WY, Park CS (2014) Surgical complications after robotic thyroidectomy for thyroid carcinoma: a single center experience with 3000 patients. Surg Endosc 28(9):2555–2563
14. Richmon JD, Pattani KM, Benhidjeb T, Tufano RP (2011) Transoral robotic-assisted thyroidectomy: a preclinical feasibility study in 2 cadavers. Head Neck 33(3):330–333
15. Richmon JD, Holsinger FC, Kandil E, Moore MW, Garcia JA, Tufano RP (2011) Transoral robotic-assisted thyroidectomy with central neck dissection: preclinical cadaver feasibility study and proposed surgical technique. J Robot Surg 5(4):279–282
16. Lee HY, Richmon JD, Walvekar RR, Holsinger C, Kim HY (2015) Robotic transoral periosteal thyroidectomy (TOPOT): experience in two cadavers. J Laparoendosc Adv Surg Tech A 25(2):139–142
17. Kim SJ, Lee KE, Myong JP, Koo DH, Lee J, Youn YK (2013) Prospective study of sensation in anterior chest areas before and after a bilateral axillo-breast approach for endoscopic/robotic thyroid surgery. World J Surg 37(5):1147–1153
18. Chai YJ, Song J, Kang J, Woo JW, Song RY, Kwon H, Kim SJ, Choi JY, Lee KE (2016) A comparative study of postoperative pain for open thyroidectomy versus bilateral axillo-breast approach robotic thyroidectomy using a self-reporting application for iPad. Ann Surg Treat Res 90(5):239–245
19. Hong JY, Kim WO, Chung WY, Yun JS, Kil HK (2010) Paracetamol reduces postoperative pain and rescue analgesic demand after robot-assisted endoscopic thyroidectomy by the transaxillary approach. World J Surg 34(3):521–526
20. Song CM, Ji YB, Bang HS, Park CW, Kim H, Tae K (2014) Long-term sensory disturbance and discomfort after robotic thyroidectomy. World J Surg 38(7):1743–1748