Received: 2 May 2017 | Revised: 20 September 2017 | Accepted: 25 October 2017

DOI: 10.1002/hed.25034

ORIGINAL ARTICLE

WILEY

Comparative analysis of two robotic thyroidectomy procedures: Transoral versus bilateral axillo-breast approach

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Funding information
This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (Ministry of Science, ICT and Future Planning, NRF-2016R1E1A1A01942072).

Abstract

Background: The surgical outcomes of a single surgeon's initial cases of transoral robotic thyroidectomy (TORT) were compared with the surgeon's initial cases of a bilateral axillo-breast approach (BABA) robotic thyroidectomy.

Methods: The medical reports were retrospectively reviewed. The BABA robotic thyroidectomies were performed between 2008 and 2009, and TORTs were performed between 2012 and 2016.

Results: Each group comprised 50 patients. Operative time for total thyroidectomy was shorter, the pain scores were lower, and hospital stays were shorter in the TORT group than in the BABA robotic thyroidectomy group. There were no significant differences between groups in either vocal cord palsy or hypoparathyroidism rates. There were 9 cases of mental nerve injury in the first 12 cases of TORT, but none subsequently.

Conclusion: The TORT procedure could be performed safely and showed comparable outcomes with BABA robotic thyroidectomy in selected patients. Therefore, TORT may be an alternative approach for patients who prefer a scar-free thyroidectomy.

KEYWORDS
robotic, thyroid carcinoma, thyroidectomy, thyroid nodule, transoral

This study was conducted at the Department of Surgery, Korea University College of Medicine Thyroid Center, Korea University Hospital, Korea University College of Medicine, Seoul, Korea.

1 | INTRODUCTION

Various remote-access thyroidectomy procedures have been developed to avoid scarring of the neck during thyroid surgery.[1–3] Initially, an endoscopic approach was used; however, since the last decade, robotic surgery has become the preferred approach, as robotic systems offer better operative views and allow for multiarticulated movement. Each approach has its advantages and disadvantages, and a particular approach may be more beneficial depending on patient criteria. However, most surgeons adopt a single approach because of the limited number of patients and the learning curves involved.

One of the most widely practiced of these remote-access approaches is the bilateral axillo-breast approach (BABA). The BABA robotic thyroidectomy technique uses two 8-mm axillary incisions and two 12-mm circumareolar incisions. The surgeon uses one of the circumareolar incisions as a camera port.[4] Since BABA robotic thyroidectomy was first performed in 2008, many such interventions have been undertaken and robust evidence has been accumulated.[5–7] An advantage of BABA robotic thyroidectomy is that the approach provides a similar operative view to a conventional open thyroidectomy, and facilitates total thyroidectomy.[8] On the other hand, BABA robotic thyroidectomy requires extensive flap dissection on the anterior chest and is difficult to perform in male patients.[9]

Among the other approaches, the transoral approach has recently become popular,[10–13] and robotic systems have also been adapted accordingly.[14,15] Transoral robotic thyroidectomy (TORT) uses 3 ports on the lower lip and an additional right axillary port. The major advantages of TORT are that the area of flap dissection is relatively small compared with other remote-access approaches, and wounds on the lip disappear over time leaving only a small hidden scar in the armpit region. However, the surgical safety of TORT has not yet been reported.

Interestingly, in our institution, a single surgeon has experience with both BABA robotic thyroidectomy and TORT procedures. The surgeon performed BABA robotic thyroidectomy as a remote-access surgery exclusively in the earlier period, and adopted the TORT procedure later. Under this unique circumstance, we could compare the outcomes of BABA robotic thyroidectomy and TORT performed by a single surgeon.

2 | MATERIALS AND METHODS

2.1 | Patients

This study was approved by the Institutional Review Board of Korea University Hospital (No. ED14085). The BABA robotic thyroidectomy was performed exclusively as a remote-access robotic thyroidectomy until TORT was adopted in 2012, and both BABA robotic thyroidectomy and TORT have been used since, according to patient preference. All the operations were performed by a single surgeon (H.Y.K.). The BABA robotic thyroidectomy group comprised the surgeon's initial 50 BABA robotic thyroidectomy cases, and the TORT group comprised the surgeon's initial 50 TORT cases. The BABA robotic thyroidectomy was performed between 2008 and 2009, and TORT was performed between 2012 and 2016. The indications for BABA robotic thyroidectomy and TORT were the same: benign thyroid nodule or papillary thyroid carcinoma (PTC), smaller than 4 cm, and without extensive lymph node metastasis on preoperative ultrasound. Prophylactic ipsilateral lymph node dissection was routinely performed when either preoperative fine-needle aspiration cytology on the primary tumor was classified as Bethesda category VI, or when the intraoperative frozen section of the resected thyroid nodule suggested papillary thyroid carcinoma (PTC).

2.2 | Preoperative preparation

Preoperative preparation included prophylactic antibiotics and preoperative indirect laryngoscopic vocal cord evaluation, as for conventional thyroidectomy. The BABA robotic thyroidectomy approach included an additional preoperative breast mammography or ultrasound examination in female patients, as this approach requires subcutaneous tunneling on the anterior chest. The patients who underwent TORT were referred to a dentist for dental calculus scaling to optimize oral hygiene 1 week before surgery.

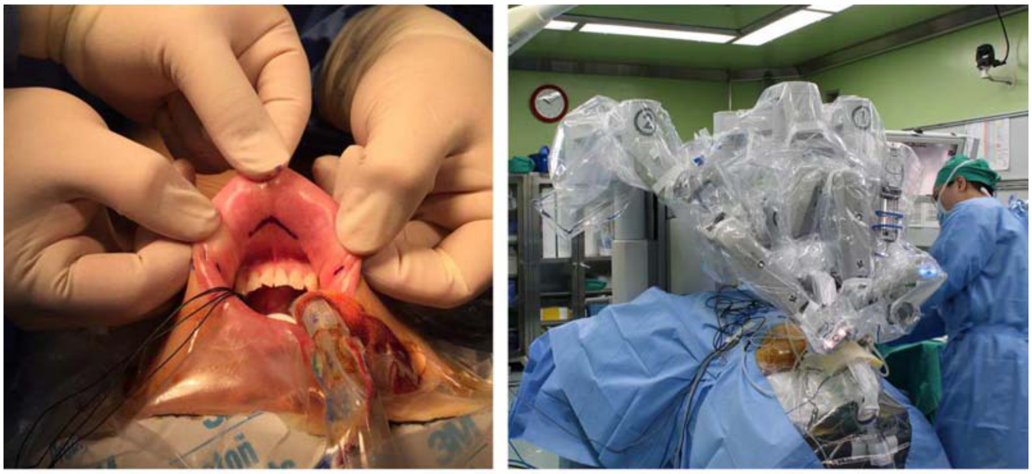
2.3 | Operative procedures for the bilateral axillo-breast approach robotic thyroidectomy

The BABA robotic thyroidectomy techniques have been previously described in detail.[9] In brief, the patient was placed in a supine position with slight neck extension. After drawing an outline for the flap dissection, diluted epinephrine (1:200 000) was injected in the subplatysmal space of the flap area. Two 12-mm superomedial circumareolar incisions and two 8-mm axillary skin incisions were then made. After creating the flap using a vascular tunneler, trocars were inserted through the 4 incisions. CO_2 gas was insufflated at 6 to 9 mm Hg to create a working space. Thyroidectomy was performed similarly as an open thyroidectomy, after the robotic instruments were docked.

2.4 | Operative procedures for transoral robotic thyroidectomy

2.4.1 | Incision and flap formation

The patient was transorally intubated and the endotracheal tube was fixed to either side of the mouth, and then the



(A) (B)

FIGURE 1 A, Location of incisions in transoral robotic thyroidectomy. B, Patient position for robotic docking in transoral robotic thyroidectomy [Color figure can be viewed at wileyonlinelibrary.com]

patient was placed in the lithotomy position. After draping, the oral cavity was irrigated with chlorhexidine and povidone-iodine solutions. The middle incision was made, 2 cm in length, with an inverted U shape at the end of the lower lip frenulum, and lateral incisions were made, 5 mm in length, 1 cm medial to either mouth angle (Figure 1A). We entered and widened the subplatysmal space using a vascular tunneler through the midline incision after injecting diluted epinephrine (1:200 000) at the chin and the lower neck. Then a 12-mm trocar for the camera and two 5-mm trocars were inserted into the patient. We used an ultrasonic energy device and suction-irrigator through the lateral ports to create adequate working space in the subplatysmal space. The upper, lower, and lateral flap margins were the thyroid cartilage, sternal notch, and medial border of the sternocleidomastoid muscle, respectively. Subsequently, we made an 8-mm incision along the axillary fold and a trocar was inserted. The axillary port was made on the right side for countertraction and to be used later for drain insertion.

2.4.2 | Thyroidectomy procedure

The robot was docked in the midline (Figure 1B). Throughout the thyroidectomy procedure, we used Harmonic ACE + (Ethicon Endo-Surgery, Cincinnati, OH) through the right lateral port and 2 bipolar forceps through the left lateral and axillary ports. First, the isthmus was divided at the midline, and the sternothyroid muscle was dissected from the thyroid gland. While reflecting the thyroid gland with the instrument through the axillary port, the superior pole and ligated superior thyroidal vessels were lifted, saving the superior parathyroid gland. The thyroid gland was then reflected in a contralateral anterior direction, and the recurrent laryngeal nerve (RLN) was identified at its entry point (Figure 2A). Lobectomy was completed from a cephalad to caudal direction preserving the RLN and the lower parathyroid gland (Figure 2B). The specimen was removed in a plastic bag through the axillary port, and a drain was inserted.

2.4.3 | Closure and postoperative management

The midline of the strap muscles and oral mucosa were closed with an absorbable suture. A compressive dressing was applied around the chin for 24 hours. Patients started water intake 4 hours after the operation and a soft blended diet on the first postoperative day. The drain was removed on the third postoperative day. Acetaminophen (650 mg) and analgesic injections (intramuscular ketorolac 30 mg) were prescribed upon patient request.

2.5 | Postoperative follow-up

Patients attended the outpatient clinic and intraoral stitches were removed in the second week after discharge. Follow-up examinations, including thyroid function tests and wound inspection, were subsequently performed at 1 and 3 months, then every 6 months thereafter. Levothyroxine was prescribed to the patients with carcinoma for thyroid-stimulating hormone suppression.

2.6 | Outcome evaluation

Postoperative pain was scored using a visual analog scale (VAS) ranging from 0 (no pain) to 10 (worst pain). A routine indirect laryngoscopic examination was performed preoperatively and postoperatively. Cases of RLN palsy were defined as transient when vocal cord movement recovered within 6 months. Hypoparathyroidism was defined as the parathyroid hormone (normal range > 8 pg/mL) and calcium levels

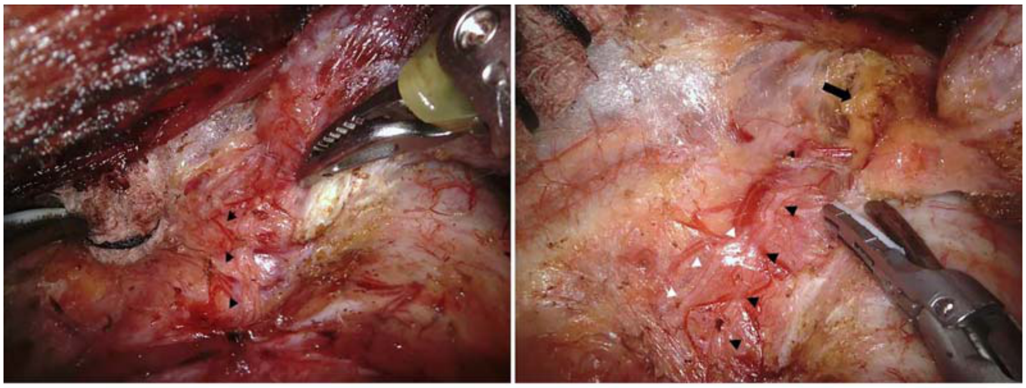


FIGURE 2 A, Identification of recurrent laryngeal nerve (black arrowheads). B, Completion of thyroidectomy preserving recurrent laryngeal nerve (black arrowheads) and left lower parathyroid gland (black arrow).
Posterior branch of the recurrent laryngeal nerve was marked with white arrow heads [Color figure can be viewed at wileyonlinelibrary.com]

below the normal range, with ongoing requirement for oral calcium supplements. Permanent hypoparathyroidism was defined as hypoparathyroidism lasting >1 year after surgery.

2.7 | Statistical analysis

Results were analyzed using SPSS version 20 (SPSS, Chicago, IL). Continuous variables were expressed as the mean with the SD, and categorical variables as the number with the percentage. The groups were compared using the Mann-Whitney *U* test, Fisher's exact, or chi-square test according to sample size. Differences were considered significant when $P \leq .05$.

3 | RESULTS

In total, 50 patients from each group were compared (Table 1). There were no significant differences between the BABA robotic thyroidectomy and TORT groups in the mean age (41.2 ± 9.4 vs 39.5 ± 10.4 years; $P = .373$), sex distribution (women 46 vs men 47), body mass index (22.8 ± 2.6 vs 23.1 ± 4.7 kg/m^2; $P = .725$), or tumor size (1.1 ± 0.8 vs 1.0 ± 0.6 cm; $P = .481$). Total thyroidectomy was more frequently performed in the BABA robotic thyroidectomy group (74.0% vs 12.0%; $P < .001$).

The operative outcomes and postoperative complications are shown in Table 2. The operative time for total thyroidectomy

TABLE 1 Patient characteristics

Variables	BABA robotic thyroidectomy (n = 50)	TORT (n = 50)	*P* value
Age, mean ± SD, years	41.2 ± 9.4	39.5 ± 10.4	.373
Sex			
Male	4 (8.0%)	3 (6.0%)	1.000
Female	46 (92.0%)	47 (94.0%)	
Body mass index, mean ± SD, kg/m^2	22.8 ± 2.6	23.1 ± 4.7	.725
Tumor size, mean ± SD, cm	1.1 ± 0.8	1.0 ± 0.6	.481
Extent of surgery			
Total thyroidectomy	37 (74.0%)	6 (12.0%)	< .001
Bilateral subtotal thyroidectomy	1 (2.0%)	1 (2.0%)	
Lobectomy	12 (24.0%)	43 (86.0%)	
Pathologic diagnosis			
Benign nodule	13 (26.0%)	1 (2.0%)	< .001
Follicular thyroid carcinoma	1 (2.0%)	0 (0%)	
PTC	36 (72.0%)	49 (98.0%)	

Abbreviations: BABA robotic thyroidectomy, bilateral axillo-breast approach robotic thyroidectomy; PTC, papillary thyroid carcinoma; TORT, transoral robotic thyroidectomy.

TABLE 2 Surgical outcomes of transoral robotic thyroidectomy

Variables	BABA robotic thyroidectomy (n = 50)	TORT (n = 50)	*P* value	
Operative time for total thyroidectomy, minutes	301.1 ± 35.7	259.2 ± 10.7	.043	
Operative time for lobectomy, minutes	234.8 ± 36.2	211.6 ± 34.8	.180	
Pain score (VAS)[a]				
Day 0	4.6 ± 1.2	3.9 ± 0.8	.001	
Day 1	3.2 ± 0.8	2.8 ± 0.8	.013	
Day 2	2.6 ± 0.8	2.3 ± 0.8	.071	
Day 3	2.1 ± 0.9	2.0 ± 0.7	.532	
No. of analgesic injections	2.2 ± 1.4	0.8 ± 1.1	< .001	
Hospital stay, days	3.9 ± 1.2	3.4 ± 0.8	.011	
No. of retrieved central lymph nodes in patients with PTC	4.0 ± 2.7	4.5 ± 3.2	.502	
No. of cases of vocal cord palsy				
Transient	2 (4.0%)	0 (0%)	1.000	AQ3
Permanent	0 (0%)	0 (0%)	N.A.	
No. of cases of hypoparathyroidism[b]				
Transient	4/37 (10.8%)	0/6 (0%)	1.000	AQ4
Permanent	0/37 (0%)	0/6 (0%)	N.A.	
No. of infections	0 (0%)	0 (0%)	N.A.	

Abbreviations: BABA robotic thyroidectomy, bilateral axillo-breast approach robotic thyroidectomy; N.A., not applicable; PTC, papillary thyroid carcinoma; TORT, transoral robotic thyroidectomy; VAS, visual analog scale.

Values are presented as mean ± SD or number (%).

[a]VAS ranges from 0 (no pain) to 10 (worst pain).

[b]Denominator is the number of the patients who underwent total thyroidectomy.

was significantly longer in the BABA robotic thyroidectomy group than in the TORT group (301.1 ± 35.7 vs 259.2 ± 10.7 minutes; $P = .043$). For lobectomy, the operative time was similar between the groups (234.8 ± 36.2 vs 211.6 ± 34.8 minutes; $P = .180$). The mean postoperative pain scores on operative day 0 and 1 were significantly lower in the TORT group than in the BABA robotic thyroidectomy group. The mean number of analgesic injections required was lower in the TORT group than in the BABA robotic thyroidectomy group (0.8 ± 1.1 vs 2.2 ± 1.4; $P < .001$). Hospital stay was shorter in the TORT group than in the BABA robotic thyroidectomy group (3.4 ± 0.8 vs 3.9 ± 1.2 days; $P = .011$). The number of retrieved central lymph nodes in the patients with PTC was similar in the 2 groups.

Two patients (4.0%) in the BABA robotic thyroidectomy group had transient vocal cord palsy, whereas there was no transient or permanent vocal cord palsy in the TORT group. Of the 37 patients who underwent total thyroidectomy in the BABA robotic thyroidectomy group, 4 (10.8%) had transient hypoparathyroidism, and none developed permanent hypoparathyroidism. There was no transient or permanent hypoparathyroidism in the 6 patients who underwent total thyroidectomy in the TORT group. No patient in either group developed surgical site infection.

Of the first 12 cases of TORT, 9 patients had postoperative paresthesia in the lower lip, which is indicative of mental nerve injury. Paresthesia was transient in 6 patients and permanent in 3 patients. No further paresthesia was reported after the initial 12 cases. Regarding minor complications of TORT, there was 1 case of lip commissure tearing, 1 case of chin flap perforation, and 2 cases of bruising over the zygoma. There was no anatomic recurrence or mortality during the median follow-up period of 84.5 months for the BABA robotic thyroidectomy patients and 6.2 months for the TORT patients.

4 | DISCUSSION

This study showed that the initial surgical outcomes for TORT were comparable with those for BABA robotic thyroidectomy. The TORT group had better outcomes for operative time, postoperative pain, and hospital stay compared to the BABA robotic thyroidectomy group.

The TORT procedure is superior to the other remote-access approaches in terms of invasiveness. Unlike other remote-access approaches, TORT does not require flap dissection on any areas of the body except the anterior neck, and the area of flap dissection is similar to that of an open thyroidectomy. In addition, TORT is truly scar-free, except for a single small subcentimeter incision in the axillary area. This led to several surgeons trying the transoral approach in animal models,[16] cadavers,[17,18] and humans.[19] However, it was prevented from becoming popular because of the possibility of mental nerve injury, which leads to significant numbness on the chin and lower lip.[14,20] We also encountered this complication initially. In the initial 12 cases, the midline incision was placed in the gingival-buccal sulcus at the central incisors, and the lateral incisions at the first molar.[15] We suspect the lateral incisions were too close to the mental foramen, which caused stretching of the root of the mental nerve. However, we have not had any mental nerve injury since the 13th case, after which we adjusted the midline incision to the tip of the frenulum, and the lateral incisions to 1-cm medial to the mouth angle. Likewise, a recent study reported no mental nerve injury in 60 transoral thyroidectomies, which used incisions similar to our adjusted incisions.[21]

Each remote-access surgery has its own approach-related complications. For example, the transaxillary approach can cause brachial plexus injury and axillary skin flap perforation,[22] and with BABA robotic thyroidectomy, it can cause sensory change on the chest for several months after the operation.[23] The TORT procedure has unique minor complications besides mental nerve injury, including lip commissure tearing, chin flap perforation, and bruising over the zygoma. Most of these complications occurred during the initial learning period and rarely thereafter, as we came to better understand the range of motion of the robotic arms. To prevent these complications, we now carefully monitor the robotic arm movements to avoid exerting excessive force on the patient.

There were no surgical site or deep space infections in either the BABA robotic thyroidectomy or TORT groups. In the TORT group, we initially used intravenous antibiotics for 3 days after the operation because of concern about infection. However, as we had no infection for the first 30 cases, we began to use only a single dose of preoperative intravenous antibiotics, as in open thyroid surgery. In fact, no significant infection has been reported in the literature, except for a single patient who had an infection at the vestibular incision site 4 weeks after surgery, requiring an incision.[19] Further studies with larger numbers of patients are necessary to determine the true incidence of infection related to the transoral approach.

The TORT procedure had a shorter operative time than the BABA robotic thyroidectomy for total thyroidectomy. This may be because the flap dissection area in BABA robotic thyroidectomy is much wider than in TORT. However, a more probable reason is that the experience gained in BABA robotic thyroidectomy may have reduced the operative time for TORT. The operator has performed >300 cases of BABA robotic thyroidectomy, and the 2 approaches have similarities in the flap dissection method and operative view. Unlike transaxillary or face-lift surgery, the surgeon should perform a blind flap dissection using the tunneler after a diluted epinephrine injection in both the BABA robotic thyroidectomy and TORT approaches. This dissection method requires experience because entering the subplatysmal layer properly is often difficult, and penetrating the strap muscle leads to significant bleeding and an extended operative time. In this regard, we assume that such trial and error in flap dissection was more frequent in BABA robotic thyroidectomy than in TORT, contributing to the difference in operative time between the 2 approaches. In addition, the 2 approaches both offer a midline view, therefore, surgeons who have experience in BABA robotic thyroidectomy may feel comfortable undertaking TORT. Furthermore, BABA robotic thyroidectomy and TORT both have similarities in manipulation, such as retracting the thyroid gland, tracing the RLN, using the energy-based device, and closure of strap muscles. Similarly, the docking time in TORT might have been shorter than in BABA robotic thyroidectomy, as docking time tends to decrease once the surgical staff in the operating room builds up experience.

The main limitation of this study is that we compared 2 surgical methods that were performed at different times, and, therefore, the experience of the surgeon and surgical staff was not matched. In addition, the numbers of patients enrolled were insufficient and follow-up was not sufficiently long enough to evaluate oncologic outcomes. Surgical outcomes of TORT should be evaluated with a larger number of patients and a longer follow-up in the future.

In conclusion, TORT could be performed safely and showed comparable outcomes to BABA robotic thyroidectomy in selected patients. The TORT procedure may be a suitable alternative for patients undergoing a thyroidectomy who prefer a scar-free surgery.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest or financial ties to disclose with the contents of this article.

FUNDING INFORMATION

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (Ministry of Science, ICT and Future Planning, NRF-2016R1E1A1A01942072).

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How to cite this article: Chai YJ, Kim HY, Kim HK, et al. Comparative analysis of two robotic thyroidectomy procedures: Transoral versus bilateral axillo-breast approach. *Head & Neck*. 2017;00:1–7. https://doi.org/10.1002/hed.25034