

# Robotic-assisted modified radical neck dissection using a bilateral axillo-breast approach (robotic BABA MRND) for papillary thyroid carcinoma with lateral lymph node metastasis

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Received: 25 February 2017 / Accepted: 8 October 2017 / Published online: 3 November 2017  
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## Abstract

**Background** Although safe in patients with papillary thyroid carcinoma (PTC), robotic thyroidectomy using a bilateral axillo-breast approach (BABA) has not been frequently performed in patients with advanced PTC. This study describes surgical outcomes in patients with PTC and lymph node metastasis (LNM) in lateral neck compartment who underwent robotic-assisted modified radical neck dissection with BABA (robotic BABA MRND).

**Methods** The medical records of patients with PTC and lateral LNM who underwent robotic BABA MRND from March 2010 to July 2016 were retrospectively reviewed.

**Results** Fifteen patients, 14 women and 1 man, of mean age  $37.1 \pm 9.3$  years, were enrolled. Mean operation time was  $272.7 \pm 33.8$  min. A mean  $20.7 \pm 7.2$  lymph nodes were retrieved from the lateral neck compartment, with a mean  $5.3 \pm 4.4$  lymph nodes being metastatic. The rates of transient and permanent hypocalcemia were 46.7 and 0%,

respectively, and the rates of transient and permanent vocal cord palsy were 6.7 and 0%, respectively. Fourteen patients (93.3%) had stimulated thyroglobulin concentrations below 2 ng/mL after the first treatment with radioactive iodine.

**Conclusions** Robotic BABA MRND could be safely performed and may be a good surgical option in selected patients with PTC and lateral LNM.

**Keywords** Bilateral axillo-breast approach · Modified radical neck dissection · Papillary thyroid carcinoma · Thyroid carcinoma · Lymph node metastasis

Robotic thyroidectomy using a bilateral axillo-breast approach (BABA RT), first introduced in 2008, is a popular method of thyroid surgery [1, 2]. BABA RT combines the da Vinci robot surgical system with the BABA surgical method, requiring four small incisions at the circumareolar and skin creases of the axilla [3]. Its advantages include an operative approach similar to that of conventional thyroidectomy, while not leaving scars on the neck [4, 5]. BABA RT has shown oncological safety and surgical completeness with cosmetic advantages in patients with papillary thyroid carcinoma (PTC) [6, 7]. To date, however, BABA RT has seldom been performed in PTC patients with extensive neck lymph node metastasis (LNM).

BABA RT is safe in patients with advanced stage thyroid disease [7]. Moreover, robot-assisted modified radical neck dissection (MRND) was shown to be feasible and safe in patients with PTC and lateral LNM [8], resulting in the performance of RT in selected patients with PTC and lateral LNM [9]. Although robot-assisted BABA MRND (robotic BABA MRND) was found to be as successful as open MRND, few PTC patients to date have been surgically

**Electronic supplementary material** The online version of this article (doi:10.1007/s00464-017-5927-9) contains supplementary material, which is available to authorized users.

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treated by this method [10]. Therefore, there is not much evidence for MRND and procedures are not standardized.

In the present study, we review cases of robotic BABA MRND and report the indications, operation procedures, and surgical outcomes of the patients who underwent robotic BABA MRND with PTC and lateral LNM at a single institution.

## Materials and methods

### Patients

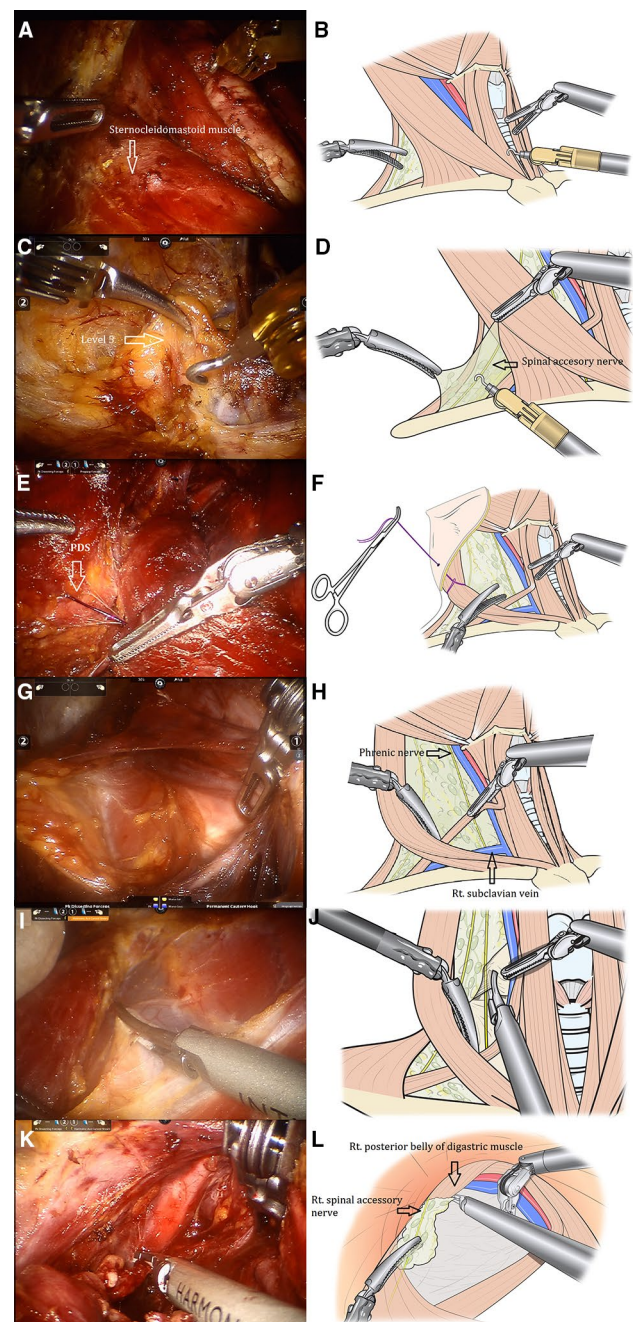
The medical records of patients with PTC and lateral LNM who underwent robotic BABA MRND at Seoul National University Hospital from March 2010 to July 2016 were retrospectively reviewed. Lateral LNM was confirmed pre-operatively in all patients by fine needle aspiration with wash out thyroglobulin (Tg) test. Patients who had an extra-nodal extension, and vessel invasion and/or vagus nerve invasion of lateral neck node were contraindication of robotic BABA MRND. This study was approved by the Institutional Review Board of Seoul National University Hospital (H-1609-109-794).

### Procedures of making a flap and performing BABA RT

The patient was placed in supine position with neck extension [11]. After aseptic draping, a dilute epinephrine solution (1:200,000) was injected into the subcutaneous layer of the anterior chest to lift the skin and subcutaneous layer, a procedure called hydro dissection. Incisions were made in the skin at the circumareolar and axilla, followed by dissection of the subcutaneous area with a vascular tunneler. The da Vinci robot was docked through an inserted trocar. BABA RT with bilateral central lymph node (LN) dissection was performed prior to robotic BABA MRND.

### Procedures of robotic BABA MRND

The surgical procedure for robotic BABA MRND is shown in Fig. 1. After BABA total thyroidectomy, the robotic instrument was docked at the location of lateral LNM. PK dissecting forceps were docked in the ipsilateral axillary trocar, and Prograsp forceps were docked in the contralateral axillary trocar (Fig. 1A, B). The sternocleidomastoid (SCM) muscle was separated from the sternohyoid and sternothyroid muscles using a permanent cautery hook. The sternohyoid and sternothyroid muscles were retracted in the medial direction using Prograsp forceps, and the SCM muscle was retracted laterally using PK dissecting forceps. The medial border of the lateral LN (right level III) was dissected from the internal jugular vein and the lateral border of right level



**Fig. 1** The procedure of robotic-assisted modified radical neck dissection with a bilateral axillo-breast approach (robotic BABA MRND). Fine needle aspiration of 37-year-old woman indicated papillary thyroid carcinoma in the right thyroid nodule and metastatic papillary thyroid carcinoma in right level III. **A** and **B** preparing for robotic BABA MRND. **C** and **D** Dissection of lymph node in level V while preserving the spinal accessory nerve. **E** and **F** Pull the sternocleidomastoid (SCM) muscle by polydioxanone (PDS) suture. **G** and **H** Dissection of level IV was started from the junction between the internal jugular and right subclavian vein while preserving the phrenic nerve **I** and **J** Dissection of level III **K** and **L** Dissection of level II up to right posterior belly of digastric muscle

III was dissected from the SCM muscle using a harmonic scalpel or permanent cautery hook. Prograsp forceps were carefully passed through the SCM muscle from level IV to level V. The entire lateral border of the SCM muscle was dissected with a permanent cautery hook while lifting the SCM muscle with Prograsp forceps.

Level V LNs were dissected with medial traction of Prograsp forceps, while preserving the brachial plexus and spinal accessory nerve with a permanent cautery hook (Fig. 1C, D). Both robotic instruments were utilized for tenting and detailed observation of level V, followed by two laparoscopic clippings of level V. A 1-0 polydioxanone (PDS) suture was passed through the left areola trocar, and sutures anchored by the PDS were used by the assistant to pull the SCM muscle (Fig. 1E, F). Lifting of the SCM muscle ensures a sufficient workspace for LN dissection, which proceeded from level IV to level II.

To dissect level IV, the omohyoid muscle was lifted with PK dissecting forceps. The bottom of level IV and the junction between the internal jugular and right subclavian veins could be clearly observed with proper motions of the PK dissecting forceps and the Prograsp forceps (Fig. 1G, H). To dissect level IV in an upward direction, the omohyoid muscle was pulled down by the Prograsp forceps. Careful dissection of level IV was required to prepare the phrenic nerve, with level IV dissection followed by continuous dissection of the medial borders of level III (Fig. 1I, J) and level II, the latter while preserving the right spinal accessory nerve. The right posterior belly of the digastric muscle was exposed in level II (Fig. 1K, L). Clipped level V LNs were moved to level IV through the bottom of the SCM. The lateral borders of levels III and II were dissected continuously. LNs from level IV to level II were carefully dissected while preserving the phrenic nerve. Dissected LNs were removed with lap bags, and sutures anchored by the PDS were released and removed through the areolar trocar. Midline closure with Vicryl sutures was used for midline closure, followed by placement of a Jackson-Pratt drain.

### Postoperative management and outpatient follow-up

Patients who underwent robotic BABA MRND started food intake 6 h after surgery. The amount of drainage fluid was regularly checked during each patient's hospital stay, and the drain was removed on the morning the patient was discharged, usually on postoperative day 3. The final pathology report was available 2 weeks after surgery. All patients were encouraged to undergo radioactive iodine (RAI) treatment, based on published guidelines for radioactive treatment of differentiated thyroid cancer [12]. RAI dose was based on pathologic aggressiveness. Whole body scintigraphy (WBS) and serum stimulated thyroglobulin (sTg) tests were performed to check remnant thyroid tissue or detect distant

metastases after RAI treatment. Tumor recurrence was monitored regularly by ultrasonography and by measuring sTg concentrations.

## Results

The 15 patients identified included 14 women (93.3%) and one man (6.7%), of mean age  $37.1 \pm 9.3$  years and mean body mass index  $22.1 \pm 3.3$  kg/m<sup>2</sup> (Table 1). Ten (66.7%) and five (33.3%) patients had main tumors on the right and left sides, respectively, with a mean tumor size of  $1.0 \pm 0.6$  cm. Eight (53.3%) and seven (46.7%) patients had right and left sided MRNDs, respectively, whereas five (33.3%), two (13.3%), and eight (53.3%) patients were classified as having T1, T2, and T3 tumors, respectively. Four patients (26.7%) had bilateral tumors.

Surgical outcomes are shown in Table 2. The mean operation time was  $272.7 \pm 33.8$  min. The mean numbers of central retrieved and central metastatic LNs were  $8.1 \pm 6.8$  and  $2.9 \pm 4.2$ , respectively, and the mean numbers of lateral retrieved and lateral metastatic LNs were  $20.7 \pm 7.2$  and  $5.3 \pm 4.4$ , respectively. Mean postoperative hospital stay was  $3.1 \pm 0.4$  days, and the mean total amount of drainage was

**Table 1** Clinicopathological characteristics of patients with papillary thyroid carcinoma and lateral lymph node metastasis

	Robotic BABA MRND (n = 15)
Mean age (years)	37.1 ± 9.3
Gender	
Male	1 (6.7%)
Female	14 (93.3%)
Body mass index (kg/m <sup>2</sup> )	22.1 ± 3.3
Main tumor location	
Right	10 (66.7%)
Left	5 (33.3%)
Median tumor size (cm)	1.0 ± 0.6
T classification	
T1	5 (33.3%)
T2	2 (13.3%)
T3	8 (53.3%)
T4	0 (0%)
Bilaterality	4 (26.7%)
MRND site	
Right	8 (53.3%)
Left	7 (46.7%)

Results are reported as mean ± standard deviation or number (%), as appropriate

Robotic BABA MRND, robotic-assisted modified radical neck dissection with a bilateral axillo-breast approach; MRND, modified radical neck dissection

**Table 2** Surgical outcomes of patients with papillary thyroid carcinoma and lateral lymph node metastasis who underwent robotic-assisted modified radical neck dissection with bilateral axillo-breast approach

	Robotic BABA MRND ( <i>n</i> = 15)
Operation time (minutes)	272.7 ± 33.8
Number of central lymph nodes	
Metastatic lymph nodes ( <i>n</i> )	2.9 ± 4.2
Total retrieved lymph nodes ( <i>n</i> )	8.1 ± 6.8
Number of lateral lymph nodes	
Metastatic lymph nodes ( <i>n</i> )	5.3 ± 4.4
Total retrieved lymph nodes ( <i>n</i> )	20.7 ± 7.2
Postoperative hospital stay (days)	3.1 ± 0.4
Total amount of drainage (mL)	348.8 ± 163.7
Mean follow-up period (months)	18.7 ± 19.1
Median stimulated Tg at first radioactive iodine (ng/mL)	0.8 (range 0.1–36.5)
Percentage of stimulated Tg < 1 ng/mL ( <i>n</i> )	8 (53.3%)
Percentage of stimulated Tg < 2 ng/mL ( <i>n</i> )	14 (93.3%)

*Robotic BABA MRND* robotic-assisted modified radical neck dissection with a bilateral axillo-breast approach, *Tg* thyroglobulin

Results are reported as mean ± standard deviation, number (%), or median (range) as appropriate

**Table 3** Surgical complications in patients with papillary thyroid carcinoma and lateral lymph node metastasis who underwent bilateral axillo-breast approach robotic thyroidectomy with modified radical neck dissection

	Robotic BABA MRND ( <i>n</i> = 15)
Transient/permanent hypocalcemia ( <i>n</i> )	7 (46.7%)/0 (0.0%)
Temporary/permanent vocal cord palsy ( <i>n</i> )	1 (6.7%)/0 (0.0%)
Postoperative bleeding ( <i>n</i> )	0 (0%)
Chyle leakage ( <i>n</i> )	0 (0%)
Horner's syndrome ( <i>n</i> )	1 (6.7%)
Wound infection ( <i>n</i> )	0 (0%)

Robotic BABA MRND, robotic-assisted modified radical neck dissection with a bilateral axillo-breast approach

Results are reported as number (%)

348.8 ± 163.7 mL. Mean follow-up period was 18.7 ± 19.1 months. The median sTg concentration after the first RAI treatment was 0.8 ng/mL (range 0.1–36.5 ng/mL), with 8 (53.3%) and 14 (93.3%) of these patients having stimulated Tg concentrations below 1 ng/mL and below 2 ng/mL, respectively.

Table 3 shows surgical outcomes after robotic BABA MRND. The rates of transient and permanent hypocalcemia were 46.7 and 0%, respectively, and the rates of transient and permanent vocal cord palsy were 6.7 and 0%, respectively.

There were no reports of chyle leakage, postoperative bleeding, and wound infection. One patient experienced Horner's syndrome, with the symptoms spontaneously regressing.

## Discussion

To date, the surgical outcomes of robotic BABA MRND in patients with PTC and lateral LNM have been unclear. This study reports our initial experience and surgical outcomes of robotic BABA MRND in 15 patients with PTC and lateral LNM.

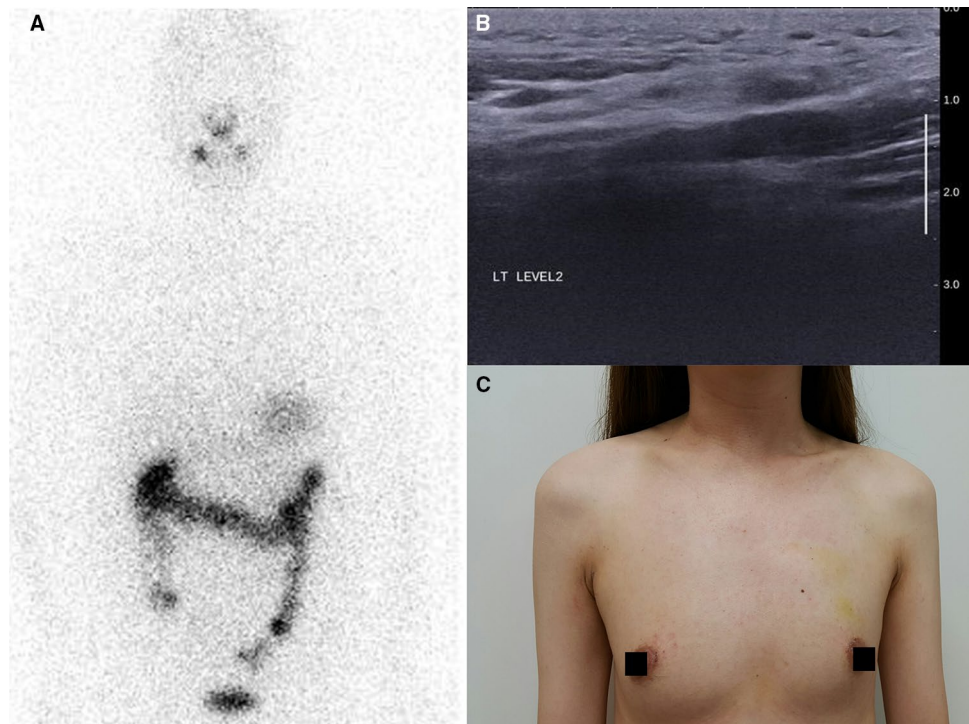
The main advantage of BABA RT is the ability of the surgeon to see the operation field symmetrically, as in open surgery [13]. This advantage was equally applicable to robotic BABA MRND. Most surgeons stand at the right side of the patient during open MRND and look upward. The operative view during robotic BABA MRND is identical because the camera is inserted through the right areola of the patient. The similarities between open surgery and BABA MRND enable the surgeon to more easily adapt to the latter [11, 14].

As in open MRND, the first surgical procedure during lateral neck dissection in robotic BABA MRND is dissection of structures adjacent to the SCM muscle and exposure of LNs, thereby widening the surgical field. Compared with open MRND, in which the adjacent area is exposed by a large incision and an army navy retractor, enabling dissection of the sides of the SCM muscle, BABA MRND uses different instruments, including PK dissecting forceps and Prograsp forceps [10]. The movements of both these instruments are precise and sufficient for traction and counter-traction of the SCM muscle. The endowrist function of these instruments and the magnification by the camera enable the performance of complex tasks in lateral compartment areas [15]. In addition, the PDS is used to lift and anchor the dissected SCM muscle [10], securing a larger workspace. This surgical technique has the advantage of causing little or no injury to the skin, with operative visibility similar to that of open MRND.

The surgical procedure and the extent of the dissected area of robotic BABA MRND are similar to those of open MRND. Dissection of the lateral LN is easier when starting from level V, because the level V space is narrow, whereas the space between levels II and IV is relatively wide. The location of LNs was identified by clipping level V twice with laparoscopic clippers, which transferred level V LNs to level IV through the SCM muscle. During LNM dissection from level IV to level II, MRND can be performed safely, while preserving the SCM muscle, spinal accessory nerve, internal jugular vein, phrenic nerve, vagus nerve, and transverse cervical artery. The dissected LNs are removed using the lap bag after surgery and separated based on clipping sites.

Following robotic BABA MRND, patients underwent RAI and were monitored by measuring their concentrations

**Fig. 2** Oncological and cosmetic results of robotic BABA MRND. A 29-year-old woman underwent robotic BABA MRND for papillary thyroid carcinoma with lymph node metastasis in lateral neck compartment. The patient underwent ultrasonography and whole body scintigraphy after 2 cycle of radioactive iodine treatments. **A** Whole body scintigraphy, **B** ultrasonography of lateral neck compartments, **C** cosmetic results 2 weeks after operation



of sTg. sTg is a good indicator of remnant thyroid tissues, thereby confirming the completeness of surgery [16]. A low sTg concentration indicates complete thyroid removal and oncological safety. A study of 1026 PTC patients who underwent BABA RT showed that the mean sTg level was 0.4 ng/mL, with 65.1% of these patients having sTg concentrations below 1 ng/mL [3]. In this study of patients with PTC and LNM, we found that 53.3 and 93.3% of patients had sTg concentrations below 1 and 2 ng/mL, respectively. These findings show that the oncological completeness of robotic BABA MRND in selected patients was acceptable (Fig. 2A, B). Furthermore, the cosmetic result of robotic BABA MRND was excellent (Fig. 2C).

The rates of temporary hypocalcemia and temporary vocal cord palsy in the present study were 46.7 and 6.7%, respectively. This rate of temporary hypocalcemia was in the range reported for open MRND (1.6–50%) [17], and this rate of temporary vocal cord palsy was no higher than that of RT (up to 20%) [16]. One patient experienced post-operative Horner's syndrome, with symptoms improving 6 months after surgery without treatment or intervention. Brachial plexus injuries, which were reported in studies of RT using a transaxillary approach, were not observed in the present study [18–20].

This study had several limitations, including its retrospective design, which may be associated with selection bias. Second, the number of included patients was small, which may have increased the incidence of complications. Prospective, large-scale observational studies are needed

to determine the prevalence of complications, such as temporary hypocalcemia, temporary vocal cord palsy, and Horner's syndrome, in patients undergoing BABA MRND for PTC and lateral LNM.

In conclusion, this study showed that the surgical procedures for robotic BABA MRND are similar to those for open MRND, with an acceptable complication rate, in selected patients with PTC and lateral LNM. Robotic BABA MRND may be safe and effective and an excellent surgical option in selected PTC patients with lateral LNM.

**Acknowledgements** This research was supported by the Basic Science Research Program through the National Research Foundation of Korea (NRF), funded by the Ministry of Science, ICT & Future Planning, Republic of Korea (Grant Number: 2015R1C1A1A01055464).

#### Compliance with ethical standards

**Disclosures** Hyeong Won Yu, Young Jun Chai, Su-jin Kim, June Young Choi, and Kyu Eun Lee have no conflicts of interest or financial ties to disclose.

#### References

- Lang BH-H, Wong CKH, Tsang JS, Wong KP, Wan KY (2014) A systematic review and meta-analysis comparing surgically-related complications between robotic-assisted thyroidectomy and conventional open thyroidectomy. *Ann Surg Oncol* 21:850–861. doi: [10.1245/s10434-013-3406-7](https://doi.org/10.1245/s10434-013-3406-7)

2. Lee KE, Koo DH, Kim SJ, Lee J, Park KS, Oh SK, Youn YK (2010) Outcomes of 109 patients with papillary thyroid carcinoma who underwent robotic total thyroidectomy with central node dissection via the bilateral axillo-breast approach. *Surgery* 148:1207–1213. doi: [10.1016/j.surg.2010.09.018](https://doi.org/10.1016/j.surg.2010.09.018)
3. 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* 27:2955–2962. doi: [10.1007/s00464-013-2863-1](https://doi.org/10.1007/s00464-013-2863-1)
4. Lee KE, Choi JY, Youn Y-K (2011) Bilateral axillo-breast approach robotic thyroidectomy. *Surg Laparosc Endosc Percutan Tech* 21:230–236. doi: [10.1097/SLE.0b013e31822d0455](https://doi.org/10.1097/SLE.0b013e31822d0455)
5. 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 Other Interv Tech* 26:948–955. doi: [10.1007/s00464-011-1973-x](https://doi.org/10.1007/s00464-011-1973-x)
6. Lee KE, Koo DH, Im HJ, Park SK, Choi JY, Paeng JC, Chung JK, Oh SK, Youn YK (2011) Surgical completeness of bilateral axillo-breast approach robotic thyroidectomy: comparison with conventional open thyroidectomy after propensity score matching. *Surgery* 150:1266–1274. doi: [10.1016/j.surg.2011.09.015](https://doi.org/10.1016/j.surg.2011.09.015)
7. Chai YJ, Suh H, Woo J-W, Yu HW, Song R-Y, Kwon H, Lee KE (2016) Surgical safety and oncological completeness of robotic thyroidectomy for thyroid carcinoma larger than 2 cm. *Surg Endosc*. doi: [10.1007/s00464-016-5097-1](https://doi.org/10.1007/s00464-016-5097-1)
8. Kang SW, Lee SH, Ryu HR, Lee KY, Jeong JJ, Nam KH, Chung WY, Park CS (2010) Initial experience with robot-assisted modified radical neck dissection for the management of thyroid carcinoma with lateral neck node metastasis. *Surgery* 148:1214–1221. doi: [10.1016/j.surg.2010.09.016](https://doi.org/10.1016/j.surg.2010.09.016)
9. Lee J, Kwon IS, Bae EH, Chung WY (2013) Comparative analysis of oncological outcomes and quality of life after robotic versus conventional open thyroidectomy with modified radical neck dissection in patients with papillary thyroid carcinoma and lateral neck node metastases. *J Clin Endocrinol Metab* 98:2701–2708. doi: [10.1210/jc.2013-1583](https://doi.org/10.1210/jc.2013-1583)
10. Seup Kim B, Kang KH, Park SJ (2015) Robotic modified radical neck dissection by bilateral axillary breast approach for papillary thyroid carcinoma with lateral neck metastasis. *Head & Neck* 37(1):37–45
11. Kim S, Eun Lee K, Pyo Myong J, Ra Kwon M, Youn Y-K (2011) Recovery of sensation in the anterior chest area after bilateral axillo-breast approach endoscopic/robotic thyroidectomy. *Surg Laparosc Endosc Percutan Tech* 21:366–371. doi: [10.1097/SLE.0b013e31822dd24f](https://doi.org/10.1097/SLE.0b013e31822dd24f)
12. Luster M, Clarke SE, Dietlein M, Lassmann M, Lind P, Oyen WJG, Tennvall J, Bombardieri E (2008) Guidelines for radioiodine therapy of differentiated thyroid cancer. *Eur J Nucl Med Mol Imaging* 35:1941–1959. doi: [10.1007/s00259-008-0883-1](https://doi.org/10.1007/s00259-008-0883-1)
13. Bae DS, Suh BJ, Park JK, Koo DH (2016) Technical, oncological, and functional safety of bilateral axillo-breast approach (BABA) robotic total thyroidectomy. *Surg Laparosc Endosc Percutan Tech* 26:253–258
14. Lee S (2015) Robotic thyroidectomy : pros and cons of various surgical approaches. *Korean J Endocr Surg* 1703:73–78
15. Lee KE, Rao J, Youn Y-K (2009) Endoscopic thyroidectomy with the da Vinci robot system using the bilateral axillary breast approach (BABA) technique: our initial experience. *Surg Laparosc Endosc Percutan Tech* 19:e71–e75. doi: [10.1097/SLE.0b013e3181a4ccae](https://doi.org/10.1097/SLE.0b013e3181a4ccae)
16. Chai YJ, Lee KE, Youn Y (2014) Can robotic thyroidectomy be performed safely in thyroid carcinoma patients ? *Endocrinol Metab* 29:226–232. doi: [10.3803/EnM.2014.29.3.226](https://doi.org/10.3803/EnM.2014.29.3.226)
17. Reeve T, Thompson NW (2000) Complications of thyroid surgery: how to avoid them, how to manage them, and observations on their possible effect on the whole patient. *World J Surg* 24:971–975. doi: [10.1007/s002680010160](https://doi.org/10.1007/s002680010160)
18. Landry CS, Grubbs EG, Stephen Morris G, Turner NS, Christopher Holsinger F, Lee JE, Perrier ND (2011) Robot assisted transaxillary surgery (RATS) for the removal of thyroid and parathyroid glands. *Surgery* 149:549–555. doi: [10.1016/j.surg.2010.08.014](https://doi.org/10.1016/j.surg.2010.08.014)
19. Konia MR, Reiner M, Apostolido I (2013) Acute persistent brachial plexopathy after robot-assisted transaxillary right thyroid lobe resection. *J Clin Anesth* 25:166–169. doi: [10.1016/S0924-977X\(10\)70869-5](https://doi.org/10.1016/S0924-977X(10)70869-5)
20. Kang SW, Lee SC, Lee SH, Lee KY, Jeong JJ, Lee YS, Nam KH, Chang HS, Chung WY, Park CS (2009) Robotic thyroid surgery using a gasless, transaxillary approach and the da Vinci S system: the operative outcomes of 338 consecutive patients. *Surgery* 146:1048–1055. doi: [10.1016/j.surg.2009.09.007](https://doi.org/10.1016/j.surg.2009.09.007)