Review Article

Bilateral Axillo-breast Approach Robotic Thyroid Surgery

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ABSTRACT

Remote access thyroidectomy was initially designed to reduce surgical morbidity and avoid neck scars associated with conventional open thyroid surgery. The bilateral axillo-breast approach (BABA) has become one of the most widely used remote access thyroidectomy techniques worldwide. Since first introduced in 2008, BABA robotic thyroid surgery has undergone advances in surgical techniques and systems, with BABA robotic thyroidectomy (BABA RT) resulting in oncological and surgical outcomes similar to those of conventional open thyroidectomy. Also, BABA RT has been shown to be a feasible and safe method, with excellent surgical and oncological results in comparative study with BABA endoscopic thyroidectomy. Indications for BABA RT have been extended to patients with Graves' disease and lymph node metastasis to the lateral neck compartment. Advances in surgical technology have led to novel feasible and safe techniques enabling the identification of important structures during thyroid surgery, including the parathyroid glands and recurrent laryngeal and external branches of the superior laryngeal nerve. International training programs to share knowledge about and techniques of oncoplasty thyroid surgery have been developed to educate surgeons. Future developments in minimally invasive surgery and robotic surgical systems will lead to a greater use of BABA robotic thyroid surgery for patients with thyroid tumors.

Keywords: Thyroidectomy; Minimally invasive surgical procedures; Robotics;
Robotic surgical procedures; Endoscopic surgical procedures

INTRODUCTION

Since the introduction of robotic thyroid surgery, various robotic thyroidectomy techniques have been utilized to hide neck scars, including anterior chest, transaxillary, postauricular, transoral and the bilateral axillo-breast approach (BABA), with the latter being one of the most frequently used approaches for remote access thyroidectomy worldwide [1]. BABA robotic thyroidectomy (BABA RT) provides a bilaterally symmetric surgical view, similar to that of conventional open thyroidectomy, enabling optimal visualization of critical structures on both sides, including the parathyroid glands, the recurrent and superior laryngeal nerves, and blood vessels supplying the thyroid and parathyroid glands [2]. Moreover, BABA RT has been found to overcome the limitations of initial procedures, enabling wide surgical

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Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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extension and precise operations, resulting in improved clinical outcomes. This review reports up-to-date evidence of the efficacy and safety of BABA RT, as well as describing recent developments and the current status of this method.

A BRIEF HISTORY OF BABA RT

Undesirable anterior cervical scarring occurs frequently after Kocher's transcervical incision in patients undergoing conventional open thyroidectomy, causing patients psychological distress. An endoscopic thyroid and parathyroid surgical procedure was introduced in 1996 to avoid this scarring, with patients first undergoing endoscopic parathyroidectomy in 1997 [3,4]. Subsequent developments in endoscopic thyroid surgery techniques and approaches have expanded its role in various types of thyroid diseases. These approaches include the axillo bilateral breast approach, first developed in 2003 [5], and BABA, first introduced in 2004 [6]. The development of the da Vinci robotic surgical system (Intuitive, Sunnyvale, CA, USA) in 2007 resulted in the introduction of BABA robotic thyroid surgery in 2008 [7]. Subsequent improvements in BABA robotic thyroid surgery have led to its wide use worldwide.

PATIENT SELECTION

Although BABA RT is surgically safe and effective, it is not technically applicable to all patients with thyroid diseases [8]. To date, no definitive guidelines have been established regarding the indications for BABA RT. Initially, this technique was limited to patients with benign thyroid nodules, follicular neoplasms, and papillary thyroid microcarcinomas with low-risk thyroid cancers, defined as tumor size < 1 cm without metastasis to lateral neck compartments or local invasion [7,9]. Recently, however, the surgical indications for BABA RT have expanded to include patients with more complicated benign to advanced thyroid diseases, including those with Graves' disease and thyroid carcinomas with lateral neck node metastasis [10-12]. At present, the indications for BABA RT include age <70 years, low-risk well-differentiated thyroid carcinomas <4 cm in size, clinically suspicious extrathyroidal extension to or invasion of the strap muscle (clinical T3 stage), lymph node (LN) metastasis to the central or lateral neck compartments, and no evidence of distant metastasis or invasion of any other major organ [13,14]. BABA RT is also indicated for benign thyroid nodules < 8 cm in size, as well as in patients with Graves' disease and thyroglossal duct cysts [13,14]. Care is needed, however, in patients with posteriorly located tumors, as there is a risk of recurrent laryngeal nerve (RLN) involvement and damage to the RLN during surgery. Because men have a deeper and wider surgical operative space than women, male gender is an independent factor for predicting the difficulty of BABA RT, emphasizing the need for care when dissecting around the central and lateral neck compartment areas [15]. Although obesity was regarded as predicting the difficulty of BABA robotic surgery, one study reported that obesity, defined as a body mass index (BMI) ≥ 25 kg/m², was not a risk factor for surgical complications or unfavorable outcomes (**Table 1**) [16].

PREOPERATIVE PREPARATION

Following the induction of general anesthesia, the patient was placed in a supine position with hyperextension of the neck. After prepping and draping, anatomical landmarks and

Table 1. Indications for bilateral axillo-breast approach robotic thyroidectomy

Variables	Initial indications (2008)	Current indications (2020)
Age [18]	<50 yr	<70 yr
Obesity (BMI ≥ 25 kg/m ²) [16]	Relatively contraindicated	Applicable (up to 38.8 kg/m ²)
Histopathology [18]	Benign, PTMC	Benign, well-differentiated thyroid carcinoma
Tumor size (benign) [2]	<5 cm	<8 cm
Tumor size (malignant) [11]	<1 cm	<4 cm
Previous neck surgery	Contraindicated	Applicable*
Thyroglossal duct cyst [13]	Contraindicated	Applicable
Graves' disease [12]	Contraindicated	Applicable
Lateral neck lymph node metastasis [10, 39]	Contraindicated	Applicable
Anterior strap muscle invasion [46]	Contraindicated	Applicable

BMI = body mass index; PTMC = papillary thyroid microcarcinoma.

*Personal experience of an expert surgeon from Seoul National University Hospital and College of Medicine, unpublished data.

surgical guide lines were drawn on the operative field. Hydrodissection was performed by injecting a 1:200,000 solution of epinephrine in 0.9% NaCl under the skin flap area to create a surgical working space. Four 8 mm ports were inserted through a bilateral breast circumareolar line and axillary folds. Flap dissection was performed from 2 cm below the clavicle to the thyroid cartilage and beyond the medial border of the sternocleidomastoid muscle laterally. A wide operative working space was created by insufflating carbon dioxide (CO₂) gas at an insufflation pressure of 5–6 mmHg. This pressure was considered sufficient to visualize and maintain the surgical space, while reducing CO₂ toxicity, including pneumomediastinum, respiratory acidosis, and CO₂ embolism, which can be fatal [2,17]. A midline division and lateral dissection were performed using the electrocoagulation device. During the dissection of each thyroid lobe and central compartment LN, care was taken to identify and preserve critical structures, including the parathyroid glands and RLNs. The resected specimen was wrapped and removed in an endoscopic plastic bag through the left axillary port. After meticulous hemostasis, the midline incision was closed with endosuture materials.

COMPARISON BETWEEN BABA ENDOSCOPIC THYROIDECTOMY AND ROBOTIC THYROIDECTOMY

The BABA endoscopic approach has several limitations, including a two-dimensional camera view, its dependence on the proficiency of the camera operator, and non-articulated instrument movement. These limitations make the performance of complicated surgical procedures with endoscopic instruments technically difficult, especially for novice surgeons. These limitations of endoscopic thyroid surgical procedures have been overcome by the introduction of the da Vinci robotic system. This robotic surgical system provides a 15-fold magnified view, a 3-dimensional camera view, and a stable operative view with the robotic arm. Moreover, its multi-articulated endo-wrist technology results in improved ergonomics, enabling surgeons to more easily perform meticulous operative procedures. Unlike endoscopic thyroidectomy, the robotic surgical system provides motion and tremor filtration and an articulated instrument with a superior range of motion. Compared with other types of robotic thyroid surgery, BABA provides the largest operative angles among instruments, resulting in sufficient distance between instruments to prevent interference [7]. These properties of robotic surgical systems have overcome the limitations of endoscopic procedures for thyroid surgery, enabling surgeons to more easily manipulate robotic surgical

Table 2. Comparison between BABA endoscopic thyroidectomy and BABA robotic thyroidectomy

Variables	Endoscopic	Robotic
Visualization	Two-dimensional	Three-dimensional
Camera assistant	Camera instability	Camera stability
Surgical instrument	Non articulated	Articulated
Instrument manipulation	Limited	Seven degrees of freedom, 540 degrees of rotation
Hand tremor	Tremor amplified	Tremor eliminated
Motion scaling	(-)	(+)
Touch sensation	(+)	(-)
Fulcrum effect	(+)	(-)
Microanastomosis of RLN	Difficult	Feasible*
Diameter of ports	Two axillary 5 mm ports, two circumareolar 12 mm ports	All 8 mm ports
Cost (compared with open thyroidectomy)	1.5- to 2-fold higher	3- to 5-fold higher

BABA = bilateral axillo-breast approach; RLN = recurrent laryngeal nerve.

*Personal experience of an expert surgeon from Seoul National University Hospital and College of Medicine, unpublished data.

instruments during meticulous procedures, leading to safe and precise dissection while identifying and saving parathyroid glands and RLNs (**Table 2**) [8].

ONCOLOGICAL OUTCOMES OF BABA RT

Surgical completeness

The surgical completeness of BABA RT was evaluated by assessing various clinical parameters, including thyroglobulin (Tg), anti-thyroglobulin antibody, and stimulated Tg (sTg) concentrations and levels of radioactive iodine (RAI) uptake. sTg concentration is a reliable biochemical marker of the amount of remnant thyroid tissue after total thyroidectomy. A propensity score matching study in patients who underwent BABA RT or conventional total thyroidectomy followed by RAI therapy found that surgical outcomes were equivalent, with 69.1% and 68.6% of these patients, respectively, having Tg concentrations <1.0 ng/mL after the first RAI treatment ($P=0.924$) [18]. Both BABA endoscopic and robotic thyroidectomy showed similar safety and effectiveness in treating various thyroid diseases [19]. Moreover, BABA robotic thyroid surgery may help overcome the drawbacks of manipulating endoscopic instruments in BABA endoscopic thyroid surgery [19,20]. sTg concentration after RAI therapy was significantly lower in patients undergoing BABA robotic than BABA endoscopic thyroidectomy (BABA ET), with 92.7% and 64.6% of these patients, respectively, having sTg concentrations <0.1 ng/mL ($P<0.001$), indicating that the rate of successful treatment after ablation therapy was significantly higher in the BABA robotic than in the BABA ET group [19].

Numbers of retrieved LNs

LN retrieval is a hallmark of favorable oncological control. However, the number of LNs dissected from the central compartment was significantly lower in patients who underwent BABA RT than conventional open thyroidectomy (8.74 ± 5.13 vs. 10.41 ± 6.11 , $P=0.006$) [21], suggesting that BABA RT may be inferior to open thyroidectomy in the number of retrieved central LNs. A more recent study reported that the number of retrieved LNs was comparable in the BABA RT and conventional open thyroidectomy groups (7.53 ± 4.08 vs. 8.23 ± 3.87 , $P=0.087$) [14]. Moreover, the number of retrieved LNs was significantly higher in the BABA RT group than in the BABA ET group (5.3 ± 3.7 vs. 4.4 ± 3.4 , $P=0.003$) [20].

Recurrence and disease-specific survival

Relatively little is known about long-term oncological outcomes after BABA robotic thyroid surgery, such as recurrence and disease survival, due to the natural course of thyroid disease. Studies reporting oncologic outcomes of BABA RT found no recurrences or mortality during follow-up and a recent study reported that the rate of recurrence was significantly lower (0.3% [5/407] vs. 1.4% [10/408], $P<0.001$) and the 5 year recurrence free survival rate significantly higher (99.7% vs. 98.7%, $P<0.001$) in patients who underwent BABA robotic than BABA endoscopic thyroidectomy (0.3% [5/407] vs. 1.4% [10/408], $P<0.001$) [11,18,19].

SURGICAL OUTCOMES OF BABA ROBOTIC THYROID SURGERY

Vocal cord injury

Intraoperative neuromonitoring (IONM) of the RLN has been shown to be useful in identifying and preserving the RLN during BABA RT [22]. A study in 872 patients reported that 14.2% (124/872) experienced transient RLN palsy after BABA RT and 0.2% (2/872) experienced permanent RLN palsy 6 months later [18]. By contrast, another study reported similar rates of transient (11.4% vs. 13.0%, $P=0.656$) and permanent (0.8% vs. 3.3%, $P=0.282$) RLN palsy in patients who underwent BABA robotic and conventional open total thyroidectomy [14]. But laryngeal function recovery times were significantly shorter in the BABA robotic than in the conventional open thyroidectomy group (87 ± 32.4 min vs. 118 ± 49.5 min, $P=0.002$) [14]. Another comparison of surgical outcomes in patients who underwent BABA robotic and endoscopic thyroidectomy found that postoperative transient vocal cord palsy rates were significantly lower in the robotic than in the endoscopic thyroidectomy group (2.3% vs. 5.2%, $P=0.006$) [19].

Hypoparathyroidism

To improve postoperative parathyroid function, novel techniques were introduced to localize and save the parathyroid glands during BABA RT. Near-infrared imaging of indocyanine green (ICG) fluorescence with the Firefly system in the da Vinci robotic surgical system was found to aid in identification of the parathyroid glands during BABA RT, with the rate of incidental parathyroidectomy being significantly lower in the ICG than in the non ICG group (0% vs. 15.9%, $P=0.048$) [23]. In addition, subcapsular saline injection (SCASI) has been shown to be feasible and safe during BABA RT, with the rate of transient hypoparathyroidism being significantly lower in the SCASI than in the non SCASI group (16.1% [5/31] vs. 44% [22/50], $P<0.01$) [24].

During an early study of BABA RT, the rate of transient hypoparathyroidism was 39.1% (341/872), and the rate of permanent hypoparathyroidism 6 months after surgery was 1.5% (13/872) [18]. More recently, however, the rates of transient (31.7% vs. 35.8%, $P=0.438$) and permanent (1.6% vs. 2.8%, $P=0.723$) hypoparathyroidism were found to be similar after BABA RT and conventional open thyroidectomy [14]. Time to recovery of parathyroid function was significantly shorter in the BABA RT group (88 ± 33.1 min vs. 100 ± 16.2 min, $P=0.044$) [14]. Moreover, the rate of permanent hypoparathyroidism was significantly lower in patients who underwent BABA RT than in those who underwent BABA ET (2.3% vs. 5.2%, $P=0.050$) [19].

Operation time

Total operation time is significantly longer for BABA RT than for open thyroidectomy (198.39 ± 137.93 min vs. 123.51 ± 32.63 min, $P < 0.001$), as the former requires skin flap dissection and robot docking time [14]. When compared with BABA ET, the operation times for lobectomy ($P = 0.016$) and total thyroidectomy ($P = 0.031$) were significantly shorter for BABA RT, despite the latter requiring additional procedures for robot docking and exchanging robotic instruments [19]. Due to ergonomic factors, the robotic system may provide better surgical control, even for surgeons with little experience in endoscopic thyroid surgery, thereby shortening operation times.

Estimated blood loss

Mean estimated blood loss volume was similar in patients who underwent BABA RT and conventional open thyroidectomy (31.78 ± 18.93 mL vs. 35.78 ± 22.75 mL, $P = 0.141$) [14].

BMI and surgical outcome

Obesity has been considered a risk factor for unfavorable surgical outcomes, as it increases technical challenges for surgeons. However, a comparison of patients with high (≥ 25 kg/m²) and low (< 25 kg/m²) BMI showed no significant differences in flap dissection time, length of hospital stay, number of retrieved central LNs, and rates of hypoparathyroidism, RLN palsy, and wound complication, indicating that obesity itself does not increase the risk of postoperative complications. BABA RT may therefore provide good cosmetic outcomes for patients with large body habitus [16].

OTHER POSTOPERATIVE OUTCOMES AFTER BABA ROBOTIC THYROID SURGERY

Postoperative pain

To evaluate quality of life and postoperative pain, a randomized control study compared ropivacaine and 0.9% saline instillation into the skin flap after a standard surgical and anesthetic protocol in patients who underwent BABA RT. VAS pain score was found to be significantly lower in the ropivacaine group after adjusting for the effect of time ($F = 6.863$, $P = 0.010$) and analgesic consumption (62.8 ± 47.5 vs. 34.9 ± 34.4 , $P = 0.001$) [25,26].

Sensory change or impairment after BABA RT

Skin flap dissection of the neck and breast area may result in sensory impairment of the anterior chest after BABA thyroid surgery, with time required for the sensory nerves around the skin flap area to recover. This change was found to be temporary, with patients showing significant improvements after 3 months. The anterior chest area is innervated by the supraclavicular nerve (SCN), with preservation of the SCN improving the recovery of sensations in the anterior chest and cervical area during the early period after surgery [27,28].

Cosmetic benefits

Incision scars in the anterior neck region are cosmetically undesirable and may be of significant concern for patients, negatively affecting their health-related quality of life. Cosmesis is important for appearance and social reasons, especially in young women, making the avoidance of neck scars important for all patients, regardless of age and sex, and especially for patients with increased tendency to develop keloid or hypertrophic scars [29]. BABA requires small incisions on both sides of the nipple-areolar and axillar areas, resulting

in better cosmetic satisfaction, avoiding visible anterior neck scarring, and overcoming the postoperative cosmetic concerns after conventional open thyroid surgery [18].

Anterior cervical scarring and contracture of the wound are concerns for many patients, who therefore choose to undergo scarless surgery. The introduction of oncoplastic surgery has enabled the oncologically safe removal of tumors and LNs, as well as improving cosmetic outcomes. BABA RT provides remote access from both the axillar and nipple-areolar areas through 0.8 cm incisions. The cosmetic outcomes following scar healing are excellent, with many patients citing this as the most important reason to choose robotic thyroid surgery [8,18]. A questionnaire study evaluating the cosmetic, physical, and psychological effects of surgical scarring after open or robotic thyroidectomy showed that the mean sum of scarring scores (7.8 ± 2.9 vs. 11.7 ± 3.8 , $P < 0.001$) and the mean degree of psychological distress (4.5 ± 1.8 vs. 5.4 ± 1.9 , $P = 0.002$) were significantly lower in the BABA RT than in the open thyroidectomy group. These results showed the impact of remote access and scarless thyroid surgery and the cosmetic superiority of BABA robotic to open thyroidectomy [30].

Postoperative impact on breast image work up

Because skin flap dissection using a tunneler is limited to the subcutaneous fat tissue layer in patients undergoing BABA robotic thyroid surgery, the flap dissection area is relatively unassociated with fibrotic changes and parenchymal damage to breast tissue. An analysis of 175 breast nodules from patients who underwent BABA RT [31] found that, during follow-up, ultrasonography and mammography could be performed without poor ultrasound window distortion or difficulties. Sixty-five nodules (36.1%) showed changes in BIRADS category from before to after surgery. Six patients who were diagnosed with BIRADS category 4 underwent breast interventions after BABA RT, and all procedures were performed successfully. All the nodules were detected clearly, with structural changes after BABA surgery not affecting the ultrasound window [31].

FEASIBILITY OF BABA RT IN PATIENTS WITH A HISTORY OF BREAST SURGERY

Concerns have arisen about the feasibility of BABA RT in patients who previously underwent breast surgery, including excisional biopsy, breast conserving surgery, modified radical mastectomy, and augmentation with implants. Theoretically, in making a skip flap by injecting epinephrine-saline and using a vascular tunneler, the dissection plane should run through the subcutaneous fat tissue, resulting in no potential risk to the breast parenchyma. A propensity score matched study found no statistically significant differences in postoperative outcomes, including operation time and rates of wound complications, vocal cord palsy, and hypoparathyroidism between patients who had and had not undergone previous breast surgery. These findings indicated that BABA endoscopic and robotic thyroidectomy can be safely performed in patients with a history of breast surgery [32].

USE OF THE DA VINCI XI SYSTEM IN BABA ROBOTIC THYROID SURGERY

The da Vinci S or Si system requires a 12 mm trocar port for insertion of the camera, with insertion of the camera into another port being more difficult due to the large diameter of

the camera. By contrast, the da Vinci Xi system uses 8 mm trocars for all ports, including the camera port and ports for other instrument arms. Thus, changing instruments including the camera among the four instrument port sites is not restricted by the diameter of the trocar port. Moreover, it provides a great advantage for BABA RT, as it easily enables a contralateral symmetrical view of both sides of the thyroid gland, allowing approach for dissections of the central and lateral neck compartments [33]. Although several studies have compared various robotic approaches with thyroid surgery, none to date has provided the details of BABA robotic thyroid surgery. This review describes current evidence and recent advances in BABA robotic thyroid surgery.

IONM SYSTEM IN BABA THYROID SURGERY

In addition to visualization of the RLN and the external branch of superior laryngeal nerve (EBSLN), IONM can aid in identifying these nerves during thyroid surgery [34]. The introduction of a NIM-3.0 neuromonitoring system (Medtronic Xomed, Jacksonville, FL, USA) has improved surgical outcomes, saving the RLN and SLN by assisting in the identification of nerves connected to cautery hook instruments. IONM of the RLN has been shown to be safe and feasible during BABA RT [22].

Furthermore, the EBSLN is important for patient phonation and voice quality. The EBSLN innervates the cricothyroid muscle and its injury impairs the ability to produce high tone voice quality, increases voice fatigue, and has a negative effect on patient quality of life [35]. Advances in IONM techniques during thyroid surgery, including BABA RT, has enhanced its ability to properly identify and preserve the EBSLN. Neuromonitoring of EBSLNs during BABA RT results in the identification of 14 out of 19 (73.7%) EBSLNs by IONM [36]. Of the 19 nerves, four showed neuropathy 1 month after surgery, but all four completely recovered after 3 months. These findings suggested that neuromonitoring of the EBSLNs is useful and feasible to preserve voice quality. A recent randomized control study found that the rate of EBSLN injury during superior pole dissection was significantly lower when the EBSLN was identified by IONM than when it was not identified (0.9% vs. 8.6%, $P=0.010$). Moreover, evaluation using the Voice Impairment Index-5 (VII-5) found that voice changes were significantly lower in the EBSLN identification than in the non-identification group at 1 ($P=0.012$), 3 ($P=0.015$), and 6 ($P=0.02$) months after surgery [37].

BABA ROBOTIC MODIFIED RADICAL NECK DISSECTION

Modified radical neck dissection (MRND) has been shown to be feasible using the BABA robotic method in 15 patients with advanced papillary thyroid cancer and lateral neck node metastasis [38]. Contraindications to BABA robotic surgery included extra-nodal extension and major vessel or nerve invasion by lateral neck node metastases [10]. To secure a larger working space for LN dissection, the sternocleidomastoid muscle was lifted and anchored with 1-0 polydioxanone suture. Of the 15 patients, 14 (93.3%) had sTg levels <2 mg/mL, indicating oncological completeness. This method also showed excellent cosmetic advantages when compared with the long extended cervical incision of conventional open MRND. The mean number of retrieved lateral LNs per patient was 20.7 ± 7.2 , with 5.3 ± 4.4 being metastatic. Postoperative complications, including temporary hypocalcemia (46.7%) and temporary vocal cord palsy (6.7%), were comparable to those of conventional open

MRND. Another study reported successful surgical outcomes of BABA robotic bilateral MRND, which were comparable to those of open bilateral MRND [39].

LEARNING CURVE OF BABA ROBOTIC THYROID SURGERY

Studies assessing the relationship between surgeon experience with BABA robotic thyroid surgery and the surgical outcomes have attempted to determine the number of operations required to achieve the proficiency of more experienced surgeons [40,41]. Similar to other surgical procedures, the operation time and complication rates of BABA procedures were expected to decrease as surgeon experience with robotic thyroid surgery increased.

One study reported that beginning surgeons required 40 BABA robotic thyroid surgery procedures, including lobectomy and central LN dissection, to attain sufficient proficiency to perform these operations safely and effectively [40]. However, a minimum of 75 such operations was required when postoperative surgical complications, including transient hypoparathyroidism, were included as an outcome measure [41]. Cumulative summation analysis showed that the surgeon required 50 operations to attain significant improvements in surgical outcomes [41]. The numbers of operations were similar to those of other types of robotic thyroidectomy, including transoral and transaxillary approaches, which required 25 and 50 patients, respectively [42,43].

EDUCATION AND TRAINING PROGRAM OF BABA ROBOT THYROID SURGERY

Since the BABA method was first developed in our institution, it has been modified and further developed by many endocrine surgeons. Various studies have investigated surgical safety and outcomes of BABA technique. Moreover, the text book *Color Atlas of Thyroid Surgery* (Springer Heidelberg New York Dordrecht London, by Youn et al.), published in 2014, has described the details of thyroid surgery including conventional open and BABA endoscopic and robotic thyroidectomy procedures.

Professional training and a learning curve are required to achieve proficiency in BABA RT. Traditionally, surgeons are trained to perform surgical procedures under the guidance of supervisors in the operating room [44]. This requires considerable time and effort of the experienced surgeons [44]. Moreover, educating surgical trainees on human patients raises ethical concerns. Thus, a surgical training model for BABA RT was developed to educate novice surgeons and reduce their learning curve. This model has been reported to be a more effective learning tool than the da Vinci Skills Simulator [45]. Furthermore, a surgical training protocol using a porcine model for BABA ET has been proposed to educate novice surgeons [45].

The International Society of Oncoplastic Endocrine Surgeons (ISOPES) was established in 2013 to maximize both cosmetic and oncologic outcomes in patients undergoing surgery for endocrine diseases. Since its founding, the ISOPES has shared knowledge, techniques, and experience on oncoplastic endocrine surgery with surgeons worldwide. In particular, a “Proctoship Course,” which is given during the annual international conference of the

ISOPES, provides various professional BABA training programs, including lectures, operating room observations, BABA ET on animals, and robot simulator experience. The ISOPES has also collaborated with the Intuitive surgical company to provide high quality training programs at the Center of Excellence.

CONCLUSION

The most important advantage of BABA robotic thyroid surgery is its excellent cosmetic satisfaction. Although it requires a longer operation time, surgeons require many such operations to overcome the learning curve and higher costs of robotic surgery. When performed by experienced surgeons, BABA robotic thyroid surgery is associated with low rates of complications and high rates of surgical completeness in selected patients. BABA RT is a safe and effective treatment for patients with various thyroid diseases. Improvements in robotic surgical systems and accumulation of surgeon experience may result in the expansion of surgical indications and improved surgical outcomes of BABA robotic thyroid surgery.

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