Robotic Thyroidectomy: Pros and Cons of Various Surgical Approaches

Sohee Lee
Department of Surgery, The Catholic University of Korea College of Medicine, Seoul, Korea

Robotic thyroidectomy has been a good option in the treatment of benign and early stage differentiated thyroid cancers, with several functional benefits. In the last few years, many surgeons have established their own robotic thyroidectomy techniques, and published many reports on the feasibility, safety and benefits of their robotic procedures. Although there are many different surgical techniques, robotic thyroidectomy can be classified according to the different means of remote access to the thyroid gland. Each method has advantages and disadvantages, and surgeons have modified each procedure in an effort to eliminate its shortcomings. With the remarkable innovation of robotic instruments and patient selection based on the appropriate indications, robotic thyroidectomy may usher a paradigm shift for thyroid surgery in the near future.

Key Words: Robotic Thyroidectomy, Pros, Cons

INTRODUCTION

Over the past century, a conventional open thyroidectomy has been approved as a standard procedure for the surgical removal of thyroid disease with excellent surgical view and low morbidity.(1) However, its conspicuous neck scar reduces the postoperative quality of life, and many efforts have been made to achieve a scarless thyroidectomy.(2,3) After Gagner first described endoscopic neck surgery in 1996, many surgeons have developed diverse extra-cervical endoscopic approaches to remove neck scars.(2-4)

With the adoption of surgical robotic technology, extra-cervical thyroidectomy has proven to be a good alternative to the traditional procedure, with myriad functional benefits for treatment of benign and early stage differentiated thyroid cancers.(5-11) Many surgeons have established their own robotic thyroidectomy techniques, and they have demonstrated feasibility, safety, and functional benefits by comparing these new techniques with the conventional open method.(5-23)

Each method has its own advantage, however, each also has shortcomings. This article reviews the various robotic thyroidectomy procedure, describes their pros and cons, and offers methods to remedy their weaknesses.

ROBOTIC THYROIDECTOMY

The thyroid glands are located in a relatively limited space, surrounded by the trachea, esophagus, and major blood vessels including the common carotid artery (CCA) and internal jugular vein (IJV).(24) The surgical principle of the robotic thyroidectomy is the same as that of the conventional open thyroidectomy. However, the head and neck area has no natural body cavity. Therefore, the extra-cervical robotic thyroidectomy must involve artificial tunneling toward the thyroid glands.(2,3,24-26) Many types of robotic thyroidectomy have been reported,
and they can be classified into four major maneuvers, according to the access route to the thyroid glands: the trans-axillary approach (TAA), the bilateral axillo-breast approach (BABA), the retroauricular approach (RAT) and the trans-oral approach.(2,3,5,7,25-27)

A sufficient working space is most important factor for successful robotic thyroidectomy.(3,24) Maintenance of the working space can be classified under two major ways. The first way is continuous carbon dioxide (CO2) gas insufflation method, which is used in the bilateral axillo-breast approach and the trans-oral approach.(2,5,25,27) This method has a number of advantages, including a smaller incision, a shorter learning curve in making the working space by blunt dissection, and no needs for extra-devices to maintain the working space.(5,25,27) The second method is by placing a self-retaining external retractor after creating the working space under direct vision. This method is used in the transaxillary approach and the retroauricular approach.(7,26) This method has the merits of a stable working space with clean view and no CO2 gas-related complications, such as hypercapnia, subcutaneous emphysema, and air embolisms.(7,26)

VARIOUS APPROACHES: THE ADVANTAGES, DISADVANTAGES, AND MODIFICATIONS THAT REDUCE SHORTCOMINGS

1. Trans-axillary approach robotic thyroidectomy

The gasless TAA approach to robotic thyroidectomy was first introduced by Kang et al. in 2007.(7) The patient is placed the supine position with the neck extended.(7,22) The lesion side arm is raised and fixed to achieve the shortest distance between the axilla and thyroid glands.(7,22) A 5~6 cm incision is made along the lateral border of the pectoralis major muscle, a subplatysmal skin flap is prepared from the axilla to the anterior neck.(7,22) The dissection is performed through the avascular space between the two SCM muscle branches and beneath the strap muscles.(7,22) The external retractor is placed to maintain the working space, and then the thyroidectomy proceeds.(7,22) Since July 2009, Chung and colleagues have performed transaxillary, single-incision, robotic thyroidectomies.(16) Four robotic arms, including a telescope, are introduced via a single axillary incision and all are controlled by the operator at the robotic console.(16) In case of total thyroidectomy, the dissection of the opposite lobe of the thyroid is performed via unilateral axillary incision.(7,16,22) Additionally, a modified radical neck dissection can be performed successfully through this single axillary incision.(12,13,28) In this case, the patient’s lesion-side arm is abducted 80° from the body to expose the axilla and lateral neck.(12,13,28) During flap dissection, the spinal accessory nerve is identified at the anterior border of trapezius muscle and preserved.(12,13,28) The subplatysmal flap is prepared to the boundary of the neck dissection, including the submandibular gland and the posterior belly of the digastic muscle.(12,13,28)

1) Pros

(1) In TAA robotic thyroidectomy, the strap muscle is lifted by an external retractor. Therefore, the surgeon can make the best use of the three robotic instruments for the traction, countertraction, and dissection, and can obtain the optimal dissection plane.(7,22)

(2) The lateral aspect of the thyroid gland is fully exposed from its superior pole to the lower central node at the sternal notch. This enables the surgeon to identify the anatomic structures easily, including the ipsilateral superior/inferior parathyroid gland and the recurrent laryngeal nerve. It also allows the surgeon to complete the central node dissection as effective as the conventional open method.(7,22,29)

(3) The unilateral transaxillary approach does not involve the medial area to SCM muscle. This preservation of anterior neck results in several functional benefits, including fewer sensory changes in the anterior neck area, reduced swallowing discomfort, and reduced voice change compared with other robotic methods.(12,14,19,21,29)

(4) During mRND, the lateral approach and preservation of the directly visible spinal accessory nerve enables complete level Vb dissection.(13,28)

2) Cons and modifications to improve shortcomings

(1) In the unilateral TAA, removal of the contra-lateral lobe and CCND can be challenging. To remedy this shortcoming, the surgeon can make a sufficient working
space and tilt the operating table 10 to 15 degrees up to achieve better exposure of the contralateral tracheoesophageal groove.\(^{16,22}\)

(2) Brachial plexus paralysis is a very rare, but troublesome, procedure-related complication of the TAA. The patient’s arm is raised naturally within the range of motion of the shoulder and should not be hyperextended. A modified arm position with elbow flexion or monitoring of ulnar and median nerve function using Somatosensory Evoked Potentials (SSEPs) can be helpful to avoid this complication.\(^{23,30}\)

(3) The robotic arms that are docked at the single axillary incision can cause inter-instrumental collision. Modification of the robotic docking position can decrease this interference by placing the 3rd joint of each robotic arm in different planes.\(^{16}\)

(4) Dead spaces case such as the highly located pyramidal lobe, a thyroglossal duct cyst, or a metastatic lymph node in the deep cervical area (levels VI and IV) are difficult to access by the TAA due to an anatomical barrier and limitation of robotic instruments. The repositioning of remote center of robotic arms and modification of the docking positions can reduce these dead spaces.\(^{13,28}\)

2. Bilateral axillo-breast approach robotic thyroidectomy

BABA robotic thyroidectomy was first reported by Lee et al. in 2008.\(^{5}\) The patient is placed in the supine position with the neck extended and both arms mildly abducted.\(^{5,10,31,32}\) A diluted epinephrine (1:200,000) solution is injected under the subcutaneous space in both breast and platysma muscles in the neck.\(^{5,10,31,32}\) This hydro-dissection helps with the blunt dissection and reduces bleeding.\(^{5,10,31,32}\) Bilateral axillary and circumareolar incisions are made, and the flaps are bluntly dissected with a vascular tunneler.\(^{5,10,31,32}\) After blunt dissection, 8- to 12-mm ports are inserted and the working space is maintained with CO\(_2\) insufflation at 5~6 mmHg.\(^{5,10,31,32}\) The subplatysmal flap is extended from the thyroid cartilage superiorly to 2 cm below the bilateral clavicle inferiorly and laterally from just beyond the medial border of the SCM muscle.\(^{5,10,31,32}\) The telescope is inserted through the right breast and the energy device is inserted through left breast.\(^{5,10,31,32}\) The graspers (Prograsp forceps and Maryland forceps, Intuitive surgical Inc., Sunnyvale, CA) are inserted through both axillary ports.\(^{5,10,31,32}\) The thyroidectomy procedure is executed with separation of the linea alba between the strap muscles and proceeds similarly to the conventional open method.\(^{5,10,31,32}\) In cases with lateral neck node metastasis, a modified radical neck dissection can be performed with same bilateral axillo-breast incision by pulling the SCM muscle with anchoring sutures.\(^{31}\)

1) Pros

(1) The thyroidectomy procedure begins with the separation of the midline of the strap muscle and the anatomy is more familiar to surgeons than that with other robotic methods.\(^{5}\)

(2) The bilateral approach enables a complete removal of thyroid gland with preservation of both recurrent laryngeal nerves, similar to conventional open thyroidectomy. Furthermore, bilateral mRND can be performed without additional incisions.\(^{5,31}\)

(3) Highly located pyramidal lobe and/or combined thyroglossal duct cyst are easily accessible by this approach compared with TAA or RAT.\(^{5}\)

(4) The four robotic arms introduced through a separated skin incision, reduces the chance of instrumental collision compared with other robotic methods.\(^{5}\)

2) Cons and modifications to improve shortcomings

(1) The dissection area is wider than other robotic methods; however, the surgical field of the thyroidectomy is smaller than TAA or RAT. Further, the working space is not easily expandable in a male patient or a female patient with highly-tensile or small breasts.\(^{33}\)

(2) One robotic arm is used for muscle traction during the procedure, and only two robotic arms are used for active dissection. To circumvent this issue, the surgeon may fix of muscles externally with suture materials to free the robotic arm from muscle traction, allowing the use of three robotic arms during active dissection.\(^{31}\)

(3) Anatomical dead spaces are formed in lower cervical level VI and IV area which are blocked by sternum and clavicles. To overcome this issue, a modified breast position with elastic bandages and the reverse-Trendelenburg
position enable the surgeon to raise the trocar pivot point
and to complete low central neck dissection without a
blind spot. (32)

(4) In mRND cases, some anatomical dead space,
including high level IIb and/or Va are difficult to access.

3. Retroauricular approach robotic thyroidectomy

With the application of the facelift incision used in
parotidectomy to the robotic thyroid surgery, Terris et al
reported the facelift robotic thyroidectomy in 2011. (26)
This procedure is also called the retroauricular approach.
(26,30) At first, the retroauricular robotic thyroidectomy
was actually hybrid technique of the retroauricular and
transaxillary approaches in cases of total thyroidec-
tomy. (8,30,34,35) However, as experience accumulated,
Byeon et al reported a single retroauricular approach for
robotic total thyroidectomy with mRND. (8,30,34,35) The
patient is placed the supine position with the head rotated
to the side contralateral of the approach and an skin
incision is made just posterior to the earlobe, extending
into the postauricular crease and crossing over to the
occipital hairline. (26,30,36,37) Subplatysmal skin flap is
made above the SCM muscle, preserving the greater
auricular nerve and external jugular vein, and proceeds to
the midline until the thyroid gland is exposed. (26,30,36,37)
A self-retaining external retractor is placed to maintain the
working space, and the dissection of the total thyroid gland
proceeds in the cranial to caudal direction. (26,30,36,37) In
modified radical neck dissection cases, the upper neck is
dissected under gross vision, and robot-assisted neck
dissection in executed combined with robotic total thyroi-
dectomy through a single retroauricular incision. (34,35)

1) Pros

(1) RAT boats easier patient positioning and shorter
distance to the thyroid gland compared with TAA. (26,30)

(2) The flap dissection that conducted while establishing
the working space is less demanding in obese patient than
that of with TAA. (26,30)

(3) The retroauricular approach is superior for neck
dissection cases to levels I and II and retropharyngeal node.
Additionally, the deep cervical level IV is more accessible by
this method due to its cranial to caudal approach. (34,35)

2) Cons and modifications to improve shortcomings

(1) The retroauricular approach is less familiar than
other approaches, and the injury to the greater auricular
nerve can cause transient hypesthesia. The greater
auricular nerve can be preserved by careful dissection of
the external jugular vein along the SCM muscle anteriorly
and inferiorly. The operating table is placed in reverse
Trendelenberg position and rotated away from the surgeon
to allow better visualization of the anteromedial border of
the SCM to the clavicle. (26,30,36,37)

(2) Contralateral thyroid removal is difficult due to the
unilateral approach. Furthermore, three robotic arms,
including a telescope, are introduced via retroauricular
incision, and only two robotic arms are available for active
dissection because of the increased risk of instrumental
collision within the single incision. Therefore, the patient-
side assistant has a key role in the operation and aids the
surgeon with long-suction tips to maintain optimal surgical
view by manipulating the dissected specimen. (26,34,35)

4. Trans-oral approach robotic thyroidectomy

The trans-oral approach robotic thyroidectomy is based
on the natural orifice transluminal endoscopic surgery
(NOTES). (25,27) The patient is placed in the supine position
and neck is extended with nasal intubation. (25,27) The
thyroid gland is accessed through the submental and
subplatysmal spaces via an incision at the mouth. (25,27)
The working space is made by blunt dissection and
maintained with CO₂ insufflation. (25,27) The thyroidec-
tomy procedure begins with separation of cervical linea
alba and proceeds in the superior to inferior direction.
(25,27) After removal of thyroid gland, the gingival-buccal
incision fade from sight within 2 weeks. (25,27)

1) Pros

(1) The main concept of the trans-oral approach is
NOTES, which leaves no visible scar. (25,27)

(2) The distance from the incision to the thyroid gland is
the shortest among the robotic methods, therefore the
minimal dissection is required. (25,27)

(3) The bilateral approach enables a complete removal
of both lobess. (25,27)
2) Cons and modifications to improve shortcomings

(1) Evidence about feasibility and safety of this procedure is weak because most papers are cadaveric or with only a few case reports. Therefore, a large-scale study is needed.(25,27)

(2) The approach via the floor of mouth is less familiar and the working space is relatively small.(25,27)

(3) Even though there were no reported postoperative infections, there is a possibility of infection from the normal flora of oral cavity.(25,27)

(4) Mental nerve injuries including tearing or stretching injuries can cause sensory changes around chin and lower lip. To avoid mental nerve injury, two lateral incisions are made at the first molar gingival-buccal sulcus. Currently, the bulky robotic instrument causes transient paresthesia; however, continued instrumental improvements may solve this problem in near future.(25)

(5) The previous trans-oral method introduced the scope through the lingual frenulum, the floor of the mouth, but this approach caused collisions with the nose and maxilla.(25,27) In the modified trans-oral robotic thyroidectomy (robotic transoral peristeal thyroidectomy, TOPO), the ports are inserted through the periosteal gingival-buccal incision and placed anterior to the mandible.(25,27) This approach reduces the rate of collision, but can cause cosmetic deformity of the mentum.(25,27)

(6) Only two robotic arms are used, and one should retract the strap muscle during dissection. External fixation of strap muscles with suture materials make the robotic arm free from muscle traction and enable better dissection.(25,27)

CONCLUSION

Each robotic thyroidectomy method has its pros and cons, and surgeons have modified their procedures to overcome various shortcomings. Choosing the most suitable method according to the patient status with appropriate indication and remarkable innovations in robotic instruments may lead a paradigm shift in thyroid surgery in the near future, and that may maximize the patient’s quality of life after thyroidectomy.

REFERENCES

15. Tae K, Ji YB, Cho SH, Lee SH, Kim DS, Kim TW. Early surgical
outcomes of robotic thyroidectomy by a gasless unilateral axillo-breast or axillary approach for papillary thyroid carcinoma: 2 years’ experience. Head Neck 2012;34:617-25.


