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Review

Robotic thyroidectomy : Evolution and Outcomes

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Recently robotic thyroidectomy has gained its popularity for the treatment of differentiated thyroid cancer and benign thyroid tumors. It has been developed to overcome the drawbacks of conventional open trans-cervical thyroidectomy, which is an apparent neck wound that is visible unless concealed with clothes. Robotic thyroidectomy provides surgeons with three-dimensional magnified view and multi-articulated robotic arms that can stabilize hand tremors. It also has advantages over conventional trans-cervical thyroidectomy that include recovery of voice symptoms and acoustic parameters along with superior cosmetic outcomes. Robotic thyroidectomy results in equivalent surgical outcomes including oncologic safety and complications compared with conventional thyroidectomy. Various approaches including transaxillary, postauricular facelift, and breast-axillary approaches have been developed for robotic thyroidectomy. Recently, the indication of robotic surgery has been extended to neck dissection of the lateral compartment. Herein we summarize the indication, procedures, and efficacy of robotic thyroidectomy, and also introduce our experience with robotic thyroidectomy.

Key words: robotic thyroidectomy, endoscopic thyroidectomy, thyroid carcinoma, robot, outcomes

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INTRODUCTION

The incidence of thyroid cancer has been increasing rapidly in Korea during the last two decades, due to the development of screening modality including ultrasonography, and the increase in health related screening [1]. Well-differentiated thyroid cancers, including papillary and follicular carcinoma, are associated with a good disease-specific prognosis with less cancer-related morbidity compared with other head and neck cancers [2,3]. Thyroid cancer tends to be more common in young female patients, who have much more interest in the postoperative cosmetic results [4]. Therefore, neck scarring became one of major concerns in thyroid surgery. To decrease the apparent scar in the neck area, various remote access thyroidectomies using remote site incisions have been developed. With the development of video system and endoscopy, endoscopic thyroidectomy using CO2 insufflations was first reported in 1997 by cervical approach [5]. Minimally invasive video-assisted thyroidectomy (MIVAT) using a small neck incision (2-3 cm) has been widely performed mainly from Italy since 1999 [6]. To avoid a neck incision, endoscopic thyroidectomy utilizing transaxillary, breast, or anterior chest approach has been developed since 2000[7,8]. The development of the da Vinci Surgical System (Intuitive Surgical, Sunnyvale, CA) and its approval by US Food and Drug Administration in 2000 for laparoscopic operations [9,10], has led to the development of robotic thyroidectomy since 2007 to overcome the disadvantages of endoscopic thyroidectomy [11-13]. In our institution, we have been performing endoscopic thyroidectomy via transaxillary approach without CO2 gas insufflation since 2005, and initiated robotic thyroidectomy in 2008 [14,15].

CLASSIFICATION OF ROBOTIC THYROIDECTOMY

Table 1. Classification of remote access thyroidectomy

Anterior chest approach
Breast approach (with CO2 gas insufflations)
Breast approach with parasternal port
Axillo-Bilateral Breast Approach (ABBA)
Bilateral Axillo-Breast Approach (BABA)
Axillary approach
Axillary approach with CO2 gas insufflations
Gasless transaxillary with anterior chest port
Gasless unilateral axillo-breast (GUAB) or axillary (GUA) approach
Axillo-breast approach with CO2 gas insufflations
Postauricular Facelift approach
Trans-oral approach

Remote access thyroidectomy can be classified according to the site of incision such as transaxillary, breast, anterior chest, postauricular facelift, and transoral approach (Table 1). Also there are various modifications and combinations of those approaches.

1. Transaxillary approach

First, the axillary approach with CO_2 gas insufflation was developed by Ikeda et al. [16]. Transaxillary approach gained popularity by a gasless method modified by Chung et al. [17]. The methods were modified as a gasless unilateral axillary approach (GUA) or a gasless unilateral axillo-breast approach (GUAB) by Tae et al. [14]. Transaxillary approach is the most widely used approach for robotic thyroidectomy to date, due to good exposure and excellent surgical view of the thyroid gland and lateral neck level III, IV, and V. Also, total thyroidectomy and bilateral central neck dissection is possible with a unilateral approach, since the contralateral thyroid lobe and recurrent laryngeal nerve can be identified by an experienced robotic surgeon. Its disadvantage is sensory disturbance and pain in the anterior chest area [18].

Indications for transaxillary robotic thyroidectomy include benign thyroid nodules less than 5 cm, differentiated thyroid carcinoma less than 4 cm in diameter regardless of minimal extrathyroidal extension, and small metastatic lymph nodes in the central and lateral compartment [19,20]. Exclusion criteria for this approach includes gross extrathyroidal extension, multiple or large metastatic lymph nodes in the central or lateral compartment, patients with a history of neck surgery or irradiation, and distant metastasis [14].

We briefly summarize the procedures for GUAB and GUA. Patients are in a supine position, the neck is slightly extended, and the arm on the side of incision is raised upwards to expose the axillary area. Then a 5 or 6 cm vertical main incision is made in the mid-axillary line. The skin flap is extended to the neck area, and a working space is made between the clavicular and sternal head of the sternocleidomastoid (SCM) muscle. After exposure of the thyroid gland, the sternal head of the SCM and the strap muscles are retracted upwards with the external retractor (Meditech Inframed, Seoul, Korea). A mini-incision 5mm-in length is made in the circum-areolar margin in the GUAB approach (Fig 1A, B), or in the lower axillary area inferior to the main incision in the GUA approach (Fig 2A, B), respectively. In the GUAB approach, a 30-degree endoscope is placed in the center of the main incision, and Maryland dissector and Harmonic scalpel are placed on either sides

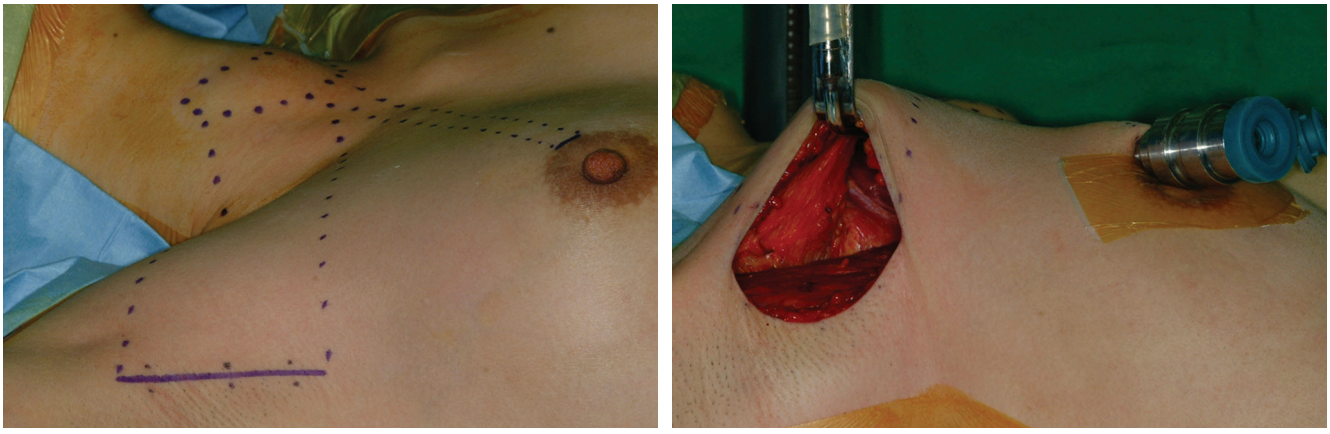

Fig. 1. Gasless unilateral axillo-breast approach (right side approach). (A) Incisions consist of a main vertical axillary incision and a minor incision in the circum-areolar margin. (B) After flap dissection, a retractor is inserted in the main axillary space, and a trocar for Prograsp forceps is inserted in the minor incision site.

of the main incision port, and Prograsp forceps is inserted through the circum-areolar incision [19]. In GUA approach, three robotic arms (1 endoscope and 2 robotic instruments) are inserted through the main axillary port, and a Harmonic scalpel is inserted through the mini-incision in the right-side approach. Thyroid lobectomy is initiated on the lesion side in an inferior to superior direction. In cases of central neck dissection, the ipsilateral paratracheal, pretracheal, and prelaryngeal lymph nodes are resected en-bloc with the thyroid lobe. For experienced robotic surgeons, contralateral lobectomy and the contralateral paratracheal lymph node dissection are possible from the same position without further skin incision.

2. Facelift approach

Robotic facelift thyroidectomy was described by Terris et al. since 2011 [21-23]. The incision is placed along the postauricular crease and extended to the occipital hairline. The facelift approach is familiar to the head and neck surgeons, which is widely used in parotidectomy, submandibular gland, and branchial cleft cyst excision [24-26]. This approach allows smaller dissection area and shorter distance from the incision site to the thyroid gland compared with the transaxillary approach [20]. The advantage of this approach is that the scar is concealed beneath the auricle and hair, particularly in female patients. Also, this approach allows a more rapid learning curve for the robotic surgeon compared to the transaxillary approach [27]. The disadvantages of this approach are narrow working space and technical difficulty to approach the contralateral thyroid lobe [28]. Another disadvantage of this approach is the transient decrease of sensation in the auricle area innervated by the great auricular nerve, or the possibility of transient paralysis of the marginal branch of facial nerve [20,27]. Usually 3 robotic arms including endoscopic camera, Harmonic scalpel, and Maryland dissectors can be used in facelift thyroidectomy. However, in the transaxillary approach, surgeons can use up to 4 robotic arms.

Indication for postauricular facelift robotic thyroidectomy is similar to transaxillary thyroidectomy [20]. However, the transaxillary approach is preferred for total thyroidectomy over the facelift approach due to the limitation of the surgical view of the contralateral thyroid lobe and the contralateral recurrent laryngeal nerve via facelift approach.

In facelift thyroidectomy, the incision is placed in the postauricular crease, extending posteriorly to the hairline and then is continued inferiorly along the hairline [22]. The skin flap is elevated medially in the plane of subplatysmal layer, and the omohyoid muscle and sternothyroid muscle are dissected, and the muscles are retracted anteriorly. Then the thyroid gland is identified, and the external retractor is applied. The working space is widened by the retraction of the SCM by an assistant or self-retractor [20]. The direction of the surgical view is from superior to the inferior. After dissection of the thyroid gland, central neck dissection can be performed.

3. Bilateral Axillo-Breast Approach (BABA)

Robotic BABA thyroidectomy is a modification of axillo-bilateral-breast approach (ABBA) used in endoscopic thyroidectomy by Shimazu et al. [29]. BABA approach requires four incision sites, two in the areola, and two incisions in each axillary area. The advantage of this approach is the similar surgical view with the conventional trans-cervical

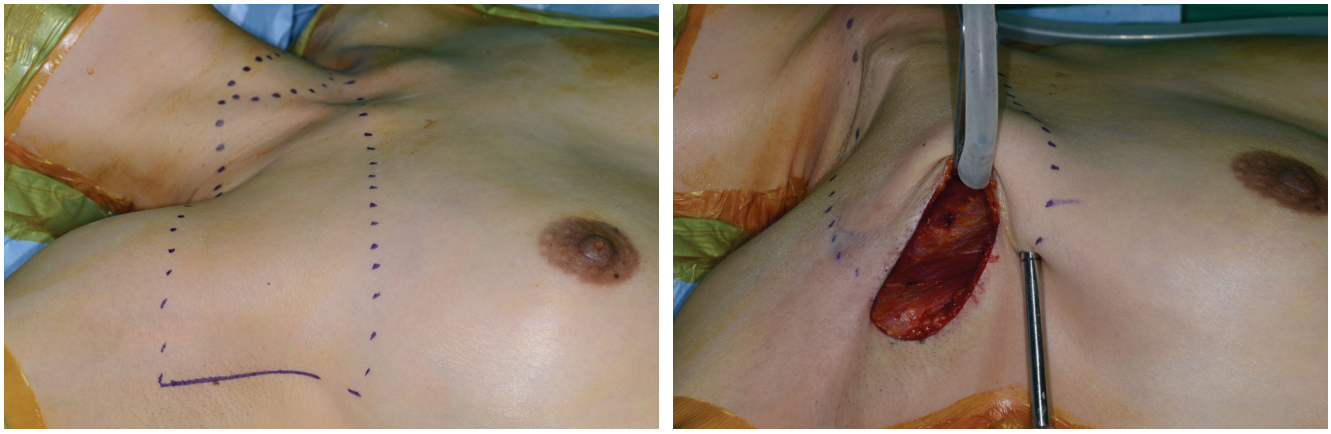

Fig. 2. Gasless unilateral axillary approach (right side approach). (A) A main vertical incision is made in the axillary fossa, and a minor incision is made inferior to the main incision. (B) After the flap is dissected, the retractor is inserted in the main axillary incision, and a trocar for Harmonic curved shears is inserted in the accessory incision site.

thyroidectomy, viewing the thyroid gland from the anterior portion and from the midline. The disadvantage of this approach is a wide dissection area and the use of CO2 gas insufflation [28].

SURGICAL OUTCOMES OF ROBOTIC THYROIDECTOMY

1. Operative time

The operative time of robotic thyroidectomy is significantly longer than that of conventional thyroidectomy due to the longer flap dissection time and additional time for robot docking [13,30,31]. The difference of operative time between the two approaches is about 30 minutes in cases of total thyroidectomy [30]. The learning curve duration for robotic thyroidectomy is 40-50 cases, due to the complexity of flap dissection and the manipulation of robotic instruments [32]. However, the authors expect that the total operative time of robotic thyroidectomy will decrease with the accumulation of experience in robotic procedure. Actually, the time for docking and console decreased significantly after 20 cases of robotic thyroidectomy in our institution [14]. Lee et al. reported that the operative time of transaxillary robotic thyroidectomy is mean 30 minutes shorter than endoscopic thyroidectomy [33]. However, there is no difference of operative time between transaxillary approach and facelift approach robotic thyroidectomy [20].

2. Safety & complications

In our institution, there was less transient hypopar athyroidism among total thyroidectomy cases performed by robotic surgery compared with trans-cervical thyroidectomy (30.1% vs. 46.8%, p=0.017) [30]. We attribute the difference to 3-dimensional and magnified surgical view provided by the robotic system, resulting in good preservation of vessels supplying the parathyroid glands. However, the rates of permanent hypoparathyroidism, hematoma, and recurrent laryngeal nerve paralysis are similar between robotic and open thyroidectomy [34]. Seroma is more encountered in robotic surgery than open, although it is easily controlled with repeated aspiration in outpatient clinic [30]. Transient brachial plexus has been reported in transaxillary approach robotic thyroidectomy, but we have not experienced any cases in our institution [28,35,36]. The risk can be reduced with proper arm and shoulder positioning [37].

3. Oncologic outcomes for thyroid cancer

Oncologic outcome including disease-specific survival and recurrence rate are not significantly different between transaxillary robotic and conventional thyroidectomy [30]. In the comparison of propensity score matched groups, the recurrence rates were 0.5% and 1.1% in the robotic and conventional groups, respectively after a mean follow-up of 43.6 months (p=0.375). Indicators of surgical completeness in thyroid cancer including thyroid stimulating hormone-stimulated thyroglobulin levels and uptake in whole body iodine scan, reached the level similar to conventional open thyroidectomy after about 40 cases of experience with transaxillary total robotic thyroidectomy in our institution [34].

4. Quality of life and functional outcomes

Health-related quality of life after robotic thyroidectomy in thyroid cancer patients including physical, psychological, social, and spiritual well-being are similar to those of patients who underwent conventional thyroidectomy [38]. Cosmetic excellence is the most important reason patients and surgeons choose robotic surgery. Veritably, cosmetic outcome is superior in robotic thyroidectomy compared with conventional surgery in both short-term and long-term follow-up period [39].

Robotic thyroidectomy shows better voice recovery after surgery, and also superior results in acoustic parameters regarding voice pitch compared with conventional surgery [40]. Postoperative swallowing function and sensory change in the neck area are comparable in open and robotic thyroidectomy [41]. However, sensory disturbance in the anterior chest area is more severe and requires longer period in the robotic group compared with open group [18]. This can be reduced by minimizing the dissection of anterior chest during flap elevation. In the early postoperative period, robotic thyroidectomy shows higher scores for pain in the anterior chest and lower scores in the neck area [4,14]. However, these differences diminished within 1 to 3 months. Another study showed no difference of subjective visual analogue scale scores for postoperative pain, and the doses of analgesics administered postoperatively, between the robotic and open groups [42].

ROBOTIC LATERAL NECK DISSECTION

Thyroid cancer with lateral compartment lymph node metastasis is treated with thyroidectomy and lateral neck dissection. Robotic lateral neck dissection for thyroid cancer can be performed by experienced robotic surgeons using both transaxillary and facelift approaches [17,43-45]. To date, robotic lateral neck dissection lacks

long-term follow-up study, thus oncologic safety needs further evaluation. Robotic lateral neck dissection can be more easily performed by ultrasound-guided charcoal tattooing for metastatic lymph nodes prior to surgery [46].

FUTURE DIRECTION AND INNOVATIONS

Innovative technology has been developed for robotic surgery rapidly in the last decade. For instance, flexible robotic systems will allow for smaller dissection areas and faster operations. Medrobotics Flex system (Medrobotics Corp., Raynham, MA, USA) provides flexible endoscope and flexible instruments, and allows good visualization and access in narrow surgical spaces [47]. Also, the single port da Vinci robot for transoral robotic surgery (TORS) has been developed by Intuitive surgical. This system uses a 24 mm port with a single rigid arm that deploys two flexible instruments and a flexible endoscope. Real time near-infrared intraoperative imaging can be applied to robotic thyroid surgery in the future, and can provide useful information on tumors and vasculature [48]. Also, various robotic surgery simulators have been developed, and will provide beginners in robotic surgery with valuable training [49].

CONCLUSION

In summary, robotic thyroidectomy has proven to be effective and safe for the treatment of thyroid tumors. It has advantages of excellent cosmetic outcomes, and will evolve in the future with the advance of robotic technology.

CONFLICT OF INTEREST

The authors have no financial conflicts of interest.

REFERENCES

1. Han MA, Choi KS, Lee HY, Kim Y, Jun JK, Park EC. Current status of thyroid cancer screening in Korea: results from a nationwide interview survey. Asian Pac J Cancer Prev 2011;12:1657-63.
2. Palme CE, Waseem Z, Raza SN, Eski S, Walfish P, Freeman JL. Management and outcome of recurrent well-differentiated thyroid carcinoma. Arch Otolaryngol Head Neck Surg 2004;130:819-24.
3. Al-Sarraf M. Treatment of locally advanced head and neck cancer: historical and critical review. Cancer Control 2002;9:387-99.
4. 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.
5. Huscher CS, Chiodini S, Napolitano C, Recher A. Endoscopic right thyroid lobectomy. Surg Endosc 1997;11:877.
6. Miccoli P, Berti P, Conte M, Bendinelli C, Marcocci C. Minimally invasive surgery for thyroid small nodules: preliminary report. J Endocrinol Invest 1999;22:849-51.
7. Duncan TD, Rashid Q, Speights F, Ejeh I. Endoscopic transaxillary approach to the thyroid gland: our early experience. Surg Endosc 2007;21:2166-71.
8. Choe JH, Kim SW, Chung KW, Park KS, Han W, Noh DY, et al. Endoscopic thyroidectomy using a new bilateral axillo-breast approach. World J Surg 2007;31:601-6.
9. Sun GH, Peress L, Pynnonen MA. Systematic review and meta-analysis of robotic vs conventional thyroidectomy approaches for thyroid disease. Otolaryngol Head Neck Surg 2014;150:520-32.
10. Goh HK, Ng YH, Teo DT. Minimally invasive surgery for head and neck cancer. Lancet Oncol 2010;11:281-6.
11. Lobe TE, Wright SK, Irish MS. Novel uses of surgical robotics in head and neck surgery. J Laparoendosc Adv Surg Tech A 2005;15:647-52.
12. Tanna N, Joshi AS, Glade RS, Zalkind D, Sadeghi N. Da Vinci robot-assisted endocrine surgery: novel applications in otolaryngology. Otolaryngol Head Neck Surg 2006;135:633-5.
13. Kang SW, Jeong JJ, Yun JS, Sung TY, Lee SC, Lee YS, et al. Robot-assisted endoscopic surgery for thyroid cancer: experience with the first 100 patients. Surg Endosc 2009;23:2399-406.
14. Tae K, Ji YB, Jeong JH, Lee SH, Jeong MA, Park CW. Robotic thyroidectomy by a gasless unilateral axillo-breast or axillary approach: our early experiences. Surg Endosc 2011;25:221-8.
15. Tae K, Ji YB, Cho SH, Kim KR, Kim DW, Kim DS. Initial experience with a gasless unilateral axillo-breast or axillary approach endoscopic thyroidectomy for papillary thyroid microcarcinoma: comparison with conventional open thyroidectomy. Surg Laparosc Endosc Percutan Tech 2011;21:162-9.
16. Ikeda Y, Takami H, Sasaki Y, Kan S, Niimi M. Endoscopic resection of thyroid tumors by the axillary approach. J Cardiovasc Surg (Torino) 2000;41:791-2.
17. Lee J, Chung WY. Robotic thyroidectomy and neck dissection: past, present, and future. Cancer J 2013;19:151-61.
18. Song CM, Ji YB, Bang HS, Park CW, Kim H, Tae K. Long-term sensory disturbance and discomfort after robotic thyroidectomy. World J Surg 2014;38:1743-8.
19. Song CM, Cho YH, Ji YB, Jeong JH, Kim DS, Tae K. Comparison of a gasless unilateral axillo-breast and axillary approach in robotic thyroidectomy. Surg Endosc 2013;27:3769-75.
20. Sung ES, Ji YB, Song CM, Yun BR, Chung WS, Tae K. Robotic

Thyroidectomy: Comparison of a Postauricular Facelift Approach with a Gasless Unilateral Axillary Approach. Otolaryngol Head Neck Surg 2016;154:997-1004.
21. Singer MC, Seybt MW, Terris DJ. Robotic facelift thyroidectomy: I. Preclinical simulation and morphometric assessment. Laryngoscope 2011;121:1631-5.
22. Terris DJ, Singer MC, Seybt MW. Robotic facelift thyroidectomy: II. Clinical feasibility and safety. Laryngoscope 2011;121:1636-41.
23. Terris DJ, Singer MC, Seybt MW. Robotic facelift thyroidectomy: patient selection and technical considerations. Surg Laparosc Endosc Percutan Tech 2011;21:237-42.
24. Song CM, Jung YH, Sung MW, Kim KH. Endoscopic resection of the submandibular gland via a hairline incision: a new surgical approach. Laryngoscope 2010;120:970-4.
25. Grover N, D'Souza A. Facelift approach for parotidectomy: an evolving aesthetic technique. Otolaryngol Head Neck Surg 2013;148:548-56.
26. Song CM, Ji YB, Kim KR, Tae K. Robot-assisted excision of branchial cleft cysts using a postauricular facelift approach. Auris Nasus Larynx 2015;42:424-7.
27. Terris DJ, Singer MC. Qualitative and quantitative differences between 2 robotic thyroidectomy techniques. Otolaryngol Head Neck Surg 2012;147:20-5.
28. Berber E, Bernet V, Fahey TJ, 3rd, Kebebew E, Shaha A, Stack BC, Jr., et al. American Thyroid Association Statement on Remote-Access Thyroid Surgery. Thyroid 2016;26:331-7.
29. Shimazu K, Shiba E, Tamaki Y, Takiguchi S, Taniguchi E, Ohashi S, et al. Endoscopic thyroid surgery through the axillo-bilateral-breast approach. Surg Laparosc Endosc Percutan Tech 2003;13:196-201.
30. Tae K, Song CM, Ji YB, Sung ES, Jeong JH, Kim DS. Oncologic outcomes of robotic thyroidectomy: 5-year experience with propensity score matching. Surg Endosc 2016.
31. Lee J, Nah KY, Kim RM, Ahn YH, Soh EY, Chung WY. Differences in postoperative outcomes, function, and cosmesis: open versus robotic thyroidectomy. Surg Endosc 2010;24:3186-94.
32. Lee J, Yun JH, Nam KH, Soh EY, Chung WY. The learning curve for robotic thyroidectomy: a multicenter study. Ann Surg Oncol 2011;18:226-32.
33. Lee J, Lee JH, Nah KY, Soh EY, Chung WY. Comparison of endoscopic and robotic thyroidectomy. Ann Surg Oncol 2011;18:1439-46.
34. Tae K, Song CM, Ji YB, Kim KR, Kim JY, Choi YY. Comparison of surgical completeness between robotic total thyroidectomy versus open thyroidectomy. Laryngoscope 2014;124:1042-7.
35. Jackson NR, Yao L, Tufano RP, Kandil EH. Safety of robotic thyroidectomy approaches: meta-analysis and systematic review. Head Neck 2014;36:137-43.
36. Landry CS, Grubbs EG, Morris GS, Turner NS, Holsinger FC, Lee JE, et al. Robot assisted transaxillary surgery (RATS) for the removal of thyroid and parathyroid glands. Surgery 2011;149:549-55.
37. Kuppersmith RB, Holsinger FC. Robotic thyroid surgery: an initial experience with North American patients. Laryngoscope 2011;121:521-6.
38. Song CM, Ji YB, Bang HS, Park CW, Kim DS, Tae K. Quality of life after robotic thyroidectomy by a gasless unilateral axillary approach. Ann Surg Oncol 2014;21:4188-94.
39. Ji YB, Song CM, Bang HS, Lee SH, Park YS, Tae K. Long-term cosmetic outcomes after robotic/endoscopic thyroidectomy by a gasless unilateral axillo-breast or axillary approach. J Laparoendosc Adv Surg Tech A 2014;24:248-53.
40. Song CM, Yun BR, Ji YB, Sung ES, Kim KR, Tae K. Long-Term Voice Outcomes After Robotic Thyroidectomy. World J Surg 2016;40:110-6.
41. Tae K, Kim KY, Yun BR, Ji YB, Park CW, Kim DS, et al. Functional voice and swallowing outcomes after robotic thyroidectomy by a gasless unilateral axillo-breast approach: comparison with open thyroidectomy. Surg Endosc 2012;26:1871-7.
42. Song CM, Ji YB, Bang HS, Kim KR, Kim H, Tae K. Postoperative Pain After Robotic Thyroidectomy by a Gasless Unilateral Axillo-Breast or Axillary Approach. Surg Laparosc Endosc Percutan Tech 2015;25:478-82.
43. Kang SW, Lee SH, Ryu HR, Lee KY, Jeong JJ, Nam KH, et al. Initial experience with robot-assisted modified radical neck dissection for the management of thyroid carcinoma with lateral neck node metastasis. Surgery 2010;148:1214-21.
44. Kim WS, Koh YW, Byeon HK, Park YM, Chung HJ, Kim ES, et al. Robot-assisted neck dissection via a transaxillary and retroauricular approach versus a conventional transcervical approach in papillary thyroid cancer with cervical lymph node metastases. J Laparoendosc Adv Surg Tech A 2014;24:367-72.
45. Song CM, Ji YB, Sung ES, Kim DS, Koo HR, Tae K. Comparison of Robotic versus Conventional Selective Neck Dissection and Total Thyroidectomy for Papillary Thyroid Carcinoma. Otolaryngol Head Neck Surg 2016;154:1005-13.
46. Song CM, Park JS, Park W, Ji YB, Cho SH, Tae K. Feasibility of Charcoal Tattooing for Localization of Metastatic Lymph Nodes in Robotic Selective Neck Dissection for Papillary Thyroid Carcinoma. Ann Surg Oncol 2015;22 Suppl 3:S669-75.
47. Mandapathil M, Greene B, Wilhelm T. Transoral surgery using a novel single-port flexible endoscope system. Eur Arch Otorhinolaryngol 2015;272:2451-6.
48. Herz D, DaJusta D, Ching C, McLeod D. Segmental arterial mapping during pediatric robot-assisted laparoscopic heminephrectomy: A descriptive series. J Pediatr Urol 2016;12:266 e1-6.
49. Abboudi H, Khan MS, Aboumarzouk O, Guru KA, Challacombe B, Dasgupta P, et al. Current status of validation for robotic surgery simulators - a systematic review. BJU Int 2013;111:194-205.