ORIGINAL ARTICLE

Establishing the robotic surgery procedure and techniques for head and neck tumors: a single surgeon's experience of 945 cases

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Abstract

We suggested operative techniques and indications of robotic neck surgery. To determine operative techniques and the indications for robotic neck surgery, we analyzed treatment outcomes of patients who received robotic neck surgery. Between May 2010 and July 2018, a total of 945 patients with various neck diseases visited Severance Hospital and underwent robotic neck surgery. A variety of approaches, including the retroauricular approach (RA), modified facelift approach (MFLA), transaxillary approach (TA), and transaxillary retroauricular approach (TARA), was used to remove various tumors in the neck. A total of 235 patients underwent a robotic neck dissection (elective or therapeutic) in the treatment of head and neck cancer with metastatic cervical lymph nodes. Five hundred-seventeen patients underwent robotic thyroidectomy or parathyroidectomy for thyroid or parathyroid disease, respectively. The remaining 193 patients underwent robotic neck surgery in the treatment of other neck diseases. Various neck lesions were successfully excised using RA or MFLA (including salivary gland tumors, thyroid tumors, vascular tumors, neurogenic tumors, lipomas, lymphangiomas, venous malformations, dermoid cysts, and others). Robotic neck surgery is a feasible and safe technique for the resection of various head and neck tumors. This method could be particularly useful in young patients with thyroid tumors, salivary gland tumors, and vascular tumors, among others, because it does not leave a visible scar on the face or neck. The superior visualization and articulate robotic arm that moves freely at various angles allows surgeons to perform delicate and precise surgeries.

Keywords Robotic neck surgery · Head and neck tumor · Operative technique · Surgical procedure

Abbreviations

TORS   Transoral robotic surgery
TARA   Transaxillary retroauricular approach
TA   Transaxillary approach
RA   Retroauricular approach
MFLA   Modified facelift approach

Background

In 2000, the US Food and Drug Administration (FDA) approved the use of the DaVinci surgical system (Intuitive Surgical, Sunnyvale, CA, USA) for some laparoscopic procedures. Since then, the DaVinci system has been applied to urologic, thoracic, and head and neck surgery. In the field of head and neck surgery, pioneers have performed robotic head and neck surgery through transoral approach or remote access ports, such as transaxillary, and retroauricular approaches, to resect thyroid tumors, salivary gland tumors, and other neck diseases. [1–5] As transoral robotic surgery (TORS) was performed through the oral cavity without external incision, patients showed rapid functional recovery with low morbidity. In robotic neck surgeries through the remote access ports, it does not require a transverse skin incision on the anterior neck and patients are satisfied with cosmetic results because of avoiding visible scar on the neck. The robotic surgical system provides superior visualization of the surgical site and fine manipulation of the tissue, as the robotic arm can move freely at various angles within a narrow space of robotic head and neck surgery. This arm enables surgeons to perform complicated and sophisticated procedures that previously were not possible using conventional endoscopic techniques. Since our institution installed the DaVinci system in 2008, we have established various robotic operative techniques for the surgical removal of head and neck diseases, including thyroid tumors, neurogenic

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tumors, and vascular tumors. In particular, we were the first to perform robotic neck dissections through remote access port in patients with head and neck squamous-cell carcinomas and reported this technique to be safe and useful in previous studies. [3–5] So far, our senior author (K.Y.W) has performed 1000 cases of robotic head and neck surgeries between May 2010 and July 2018, and analyzed our experiences to define our operative techniques, and the surgical indications of robotic head and neck surgery.

Methods

Patients

Between May 2010 and July 2018, 945 patients underwent robotic neck surgery at Severance Hospital. Their records were retrospectively analyzed. This study was approved by the Institutional Review Board of Yonsei University. (4-2018-1227). Various remote access approaches, including the retroauricular approach (RA), modified facelift approach (MFLA), transaxillary approach (TA), and transaxillary retroauricular approach (TARA), were used to remove tumors in the neck. A total of 235 patients underwent a robotic neck dissection (elective or therapeutic neck dissection) in the treatment of head and neck cancer with metastatic cervical lymph nodes. (Table 1) The mean age of these patients was 52.9 years, with 161 men and 74 women. Five hundred-seventeen patients underwent robotic thyroidectomy or parathyroidectomy due to thyroid or parathyroid disease, respectively (Table 2). The average age of this group was 39.2 years, 114 men and 403 women. The remaining 193 patients underwent robotic neck surgery in the treatment of other neck diseases (excluding the thyroid glands) (Table 3). The average age of these patients was 37.7 years, with 76 men and 116 women.

Surgical approaches

In RA robotic neck surgery, the technique proceeded as follows. After a 6-cm skin incision was made along the hairline behind the ear, the skin flap was elevated along the subplatysmal plane using the external jugular vein and greater auricular nerve as anatomic landmarks. The skin flap was lifted along the parotidomasseteric fascia covering the parotid up to the zygomatic arch superiorly and down to the clavicle inferiorly. A self-retaining retractor was positioned to expose the working space. The surgery was performed by inserting two or three instrument arms and one endoscopic arm through this field. To minimize the collision between the robotic arms, appropriate distances and angles of each arm must be set. During MFLA, the retroauricular incision was extended to the preauricular

Table 1 Information of patients who received robotic neck dissection [elective ($n=193$) or therapeutic ($n=42$)]

Variables	No. of patients (%)
Mean age, years (range)	53.2 (13–42)
Gender	
Male	161 (68.5)
Female	74 (31.5)
Primary lesion	
Oral cavity	64 (27.2)
Oropharynx	75 (31.9)
Hypopharynx	17 (7.2)
Larynx	16 (6.8)
Nose and nasopharynx	6 (2.5)
CUP	3 (1.3)
Skin	8 (3.4)
Salivary gland	36 (15.3)
Neck	10 (4.3)
Pathology	
Malignancy	225 (95.7)
Benign disease	10 (4.3)
Surgical approach	
RA or mFLI	226 (96.2)
TA or TARA	9 (3.8)
T classification[a]	
0	34
1	86
2	74
3	15
4	6
N classification	
0	114
1	32
2	64
3	5
Mean operation time, min	462.5 (52–1498)
Mean blood loss, cc	149.1 (10–1500)
Hospital stay, days	15.3 (5–62)
Perioperative complication	
Hematoma/hemorrhage	2
Chyle leakage	5
Seroma	2
Skin flap ischemia	2
Mean removed LNs	31 (1–88)

CUP cervical lymph node metastasis of unknown primary site, *RA* retroauricular approach, *mFLI* modified facelift incision, *TA* transaxillary approach, *TARA* transaxillary and retroauricular approach, *LN* lymph node

[a]Only 215 patients with squamous cell carcinoma of upper aerodigestive tract were included in T and N classification

Table 2 Baseline information of patients who underwent robotic thyroidectomy or parathyroidectomy (with or without robotic neck dissection)

Variables	No. of patients (%)
Mean age, years (range)	39.17 (9–73)
Gender	
Male	114 (22.1)
Female	403 (77.9)
Pathology	
PTC	453 (87.6)
Follicular carcinoma	7 (1.4)
MTC	4 (0.8)
Metastatic carcinoma	5 (1)
Malignant lymphoma	1 (0.1)
Benign disease	40 (7.7)
Parathyroid lesion	7 (0.1)
Surgical approach	
TA	202 (39.1)
TARA	20 (3.9)
MFLA	2 (0.2)
RA	293 (56.7)
Mean operation time, min	142.5 (54.9–249.6)
Mean blood loss, cc	27.3 (10–60)
Hospital stay, days	7.0 (4–8)
Perioperative complication	
Permanent vocal cord palsy	4
Permanent hypoparathyroidism	1
Seroma	26
Hematoma/hemorrhage	3
Skin flap ischemia	3

PTC papillary thyroid carcinoma, *MTC* medullary thyroid carcinoma, *TA* transaxillary approach, *TARA* transaxillary and retroauricular approach, *TO* transoral approach, *RA* retroauricular approach

area along the auricular cartilage. After lifting this skin flap, there was a wider working space in this procedure than there is during RA (Fig. 1).

Below, we describe the techniques used during the TA robotic neck surgery. A 6-cm skin incision was made along the anterior axillary line. The fascia covering the pectoralis major muscle was identified. The tissue was then dissected in the inferior-superior direction over the clavicle. Next, we identified the sternocleidomastoid muscle and the external jugular vein. These structures were used as anatomical landmarks. The flap was lifted up to the lower margin of the mandible. This elevated skin flap was maintained using a self-retractor to secure the working space. Next, three robotic arms were inserted through the entrance of the working space. In cases of TARA (TA combined with RA), the surgeon could approach the upper and lower neck bi-directionally through either the TA or RA. This TARA technique allowed surgeons to have a convenient approach

to all parts of the neck. However, it is the most invasive approach among those described here.

Robotic system

From 2010 to 2013, all robotic neck surgeries were performed only using the Si system. Two robotic arms were equipped with 5-mm Maryland forceps, Harmonic curved shears, and 12-mm endoscopic camera arm. After the introduction of the Xi system in 2013, many robotic neck surgeries begun to proceed using this system. Since 2015, most robotic surgeries have been performed using the Xi system, and the Si system is now rarely used. Xi system has the advantage of using three robotic arms compared to the previous Si system. The 8-mm sized Maryland forceps, monopolar curved scissors, and fenestrated bipolar forceps can be mounted on each robotic arm. In addition, the flexible EndoWrist vessels sealer with Erbe system can be used, which offers the advantage of more flexible movement and secure hemostatic ability compared to using a rigid Harmonic curved shear. The three-dimensional endoscope of the Xi system is also equipped with an auto-focusing system, which is advantageous for securing a better vision of the surgical field.

Operative techniques

The operative techniques of robotic neck dissection have already been reported in prior papers from our group. Therefore, we did not describe this procedure in detail here [6, 7].

Robot-assisted Sistrunk operation

RA can easily create a working space around the anterior neck of the hyoid level where the thyroglossal duct cyst is located. One endoscopic arm and two robotic arms were inserted through the RA working space. The midline of the strap muscle was confirmed first. The cystic lesion located beneath it was then identified and dissected from the surrounding fibro-fatty tissue. Next, the right side of the hyoid bone was skeletonized. The surgical assistant cut the hyoid bone using a bone cutter. The contralateral hyoid bone was skeletonized, and this bone was also cut using the same method. Finally, the thyroglossal duct cyst, including the fibrous stalk leading to the tongue base, could be removed (Fig. 2).

Robotic parotidectomy

After creating the retroauricular incision, the flap was lifted along the parotidomasseteric fascia. A self-retained retractor was inserted to secure the working space. First, the parotid gland and the anterior border of the sternocleidomastoid

Table 3 Baseline information of patients who underwent robotic neck surgery for the removal of head and neck diseases

	Salivary gland (n=90)	Schwannoma (n=21)	TGDC (n=23)	Zenker's diverticulum (n=3)	Second BCC (n=18)	Thoracic outlet SD (n=4)	Other (n=34)
Mean age, years	40.1	38.4	37.7	44	33.6	49	38.4
Gender							
Male	37	9	7	1	8	0	15
Female	53	12	16	2	10	4	19
Surgical approach							
RA	57	18	23	3	18	4	34
MFLI	33	1	0	0	0	0	0
TA	0	2	0	0	0	0	0
Pathology							
Malignant	10	0	1	0	0	0	1
Benign	80	21	22	3	18	4	33
Mean operation time, min	183.8	211.3	175.2	267.6	133	285.8	190.7
Mean blood loss, cc	13.5	50.5	4.2	26.6	4.4	25	10.9
Hospital stay, days	7.1	7.8	6.3	8	6	7.8	6.9

Dz disease, *TGDC* thyroglossal duct cyst, *BCC* brachial cleft cyst, *SD* syndrome, *RA* retroauricular approach, *MFLA* modified facelift approach, *TA* transaxillary approach, *Op* operation

Fig. 1 Retroauricular approaches for robotic neck surgery. **a** Skin design. **b** Working space of retroauricular approach. **c** Self-retaining system for maintain elevate skin flap

muscle were separated. The posterior belly of the digastric muscle was identified in the lower edge of the parotid tissue. Dissection was performed along the preauricular incision. The tragal pointer was located along the contour of the auricular cartilage. We used the previously identified posterior belly and tragal pointer as anatomical landmarks to identify the main trunk of the facial nerve. In most cases, the main trunk of the facial nerve was identified 1 cm above the site where the posterior belly was inserted onto the digastric ridge. The parotid tissue was dissected along the facial nerve using the tunnel technique, with the scissor mounted on the right arm and the Maryland dissector on the left arm. The

Fig. 2 Robotic Sistrunk operation. **a** Preoperative CT scan and surgical specimen. **b** The midline of the strap muscle was confirmed first. The cystic lesion located beneath it was then identified and dissected from the surrounding fibro-fatty tissue. **c** The right side of the hyoid bone was skeletonized. The surgical assistant cut the hyoid bone using a bone cutter. **d** The contralateral hyoid bone was skeletonized, and this bone was also cut using the same method
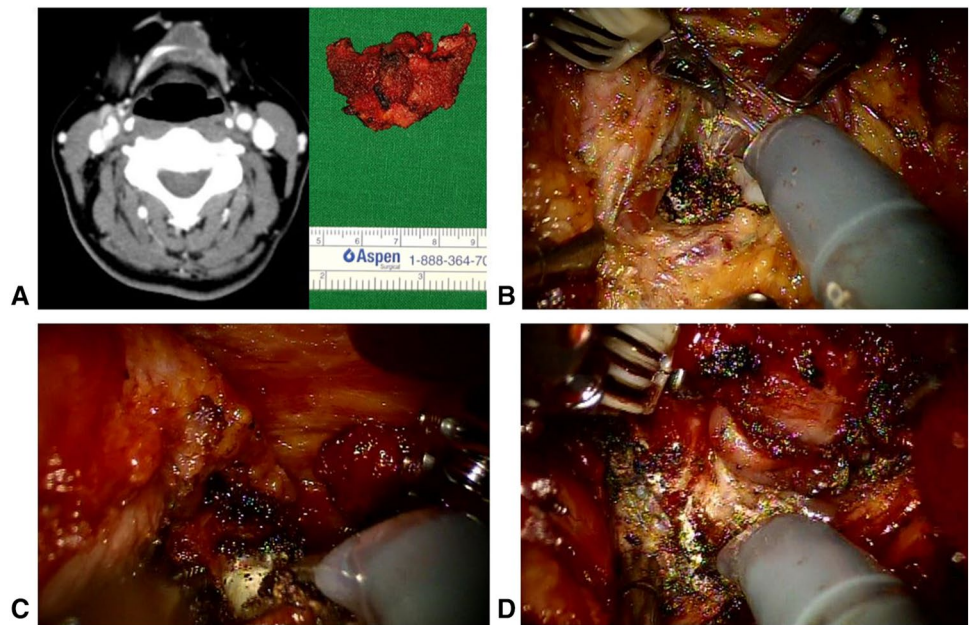
appropriate resection range was determined based on the location and extent of the tumor. (Fig. 3) Unlike traditional skin incisions for open parotidectomy, only retroauricular incision can be used to remove tumors located in all areas of the parotid gland, without preauricular incision. In addition, even when neck dissection is required, robotic neck dissection can be performed only through a retroauricular incision without an extended cervical incision, thereby reducing morbidity in patients.

Robotic schwannoma resection

Both the RA and TA approaches allow for easy access to the parapharyngeal or carotid spaces, where schwannomas are typically located. After the working space is maintained with a self-retractor, the deep cervical fascia along the anterior border of the sternocleidomastoid muscle is resected. This technique allows for identification of the posterior belly of the digastric muscle. After identifying the internal jugular

Fig. 3 Robotic parotidectomy. **a** Preoperative CT scan and surgical specimen **b** First, the parotid gland and the anterior border of the sternocleidomastoid muscle were separated. The posterior belly of the digastric muscle was identified in the lower edge of the parotid tissue. **c** The main trunk of the facial nerve was identified 1 centimeter above the site where the posterior belly was inserted onto the digastric ridge. **d** The parotid tissue was dissected along the facial nerve using the tunnel technique, with the scissor mounted on the right arm and the Maryland dissector on the left arm
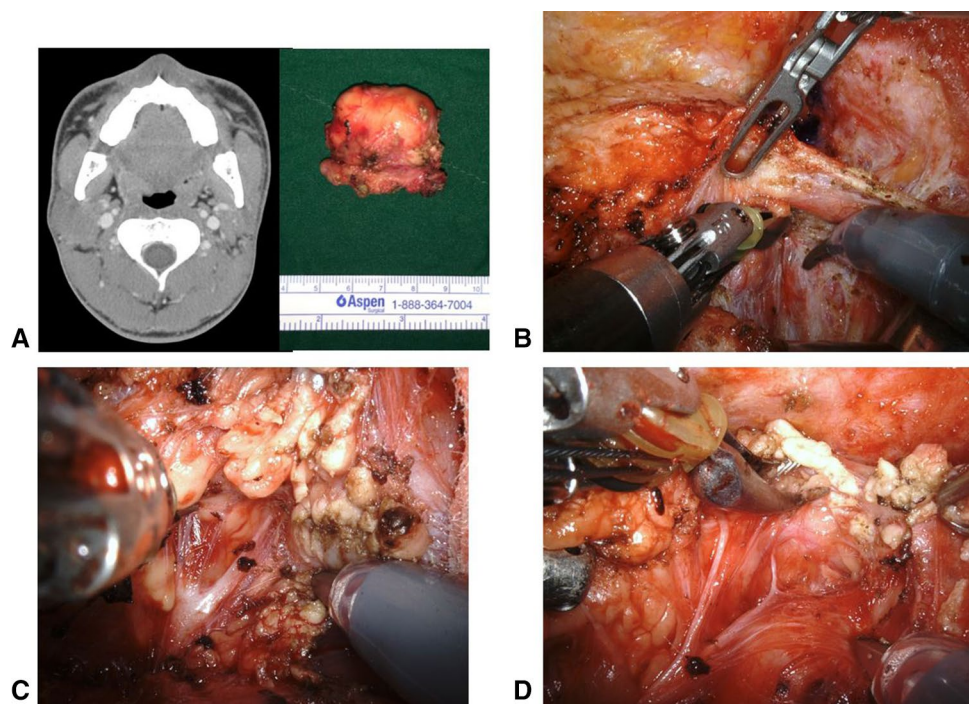
vein and carotid artery, the location of the schwannoma originating from the vagal schwannoma or sympathetic nerve in the carotid sheath was confirmed. The schwannoma could then be enucleated from the capsule using three robotic arms under a tenfold magnified view of surgical site, thereby attempting to preserve the postoperative nerve function (Fig. 4).

Robotic resection of paraganglioma

As described above, after making the working space through RA, dissection along the anterior border of the SCM allowed for easy access to the carotid space. Carotid body tumors could be easily identified around the bifurcation of the carotid artery. Scissors and Maryland dissection were then mounted on the left and right robotic arms, respectively. The tumor was dissected from the carotid artery. Monopolar cautery using the Erbe system was helpful to minimize intraoperative hemorrhage (Fig. 5).

Results

Among 945 patients who participated in this study, 235 patients underwent robotic neck dissection. Among these patients, 227 underwent unilateral robotic neck dissection, and eight underwent bilateral robotic neck dissection. The average number of resected lymph nodes after the robotic neck dissection was 31. Extracapsular nodal spread was reported in 68 patients on postoperative pathologic examination. Of the 235 patients, 225 patients underwent robotic

neck dissection for the removal of metastatic cervical lymph nodes in patients with malignant tumors. The remaining ten patients underwent robotic neck dissections for other diseases, such as TB lymphadenopathy or Kimura disease. Of the 225 patients who were diagnosed with a malignant tumor and underwent robotic neck dissection, 135 (60%) received adjuvant treatment after surgery (including radiotherapy in eight patients, concurrent chemoradiotherapy in 92, and chemotherapy in five). During the follow-up period, recurrence occurred in 23 patients (10.2%) (local recurrence in five, regional recurrence in eight, and distant metastasis in ten). Eighteen patients died during the study period. Ten of these patients (4.4%) died of their disease. The remaining eight patients died due to other underlying diseases (Table 4).

Of the 510 patients who underwent robotic thyroidectomy, 261 received robotic hemithyroidectomy, 167 received robotic total thyroidectomy, 69 received robotic total thyroidectomy with robotic neck dissection, and 11 received robotic neck dissection alone. The remaining two patients underwent other robotic neck surgery. A total of 286 patients underwent robotic surgery through RA, two through MFLA, 202 through TA, and the remaining 20 through TARA. Twelve patients had vocal cord paralysis after surgery, although one patient already had vocal cord paralysis preoperatively. Of the 12 patients with vocal fold paralysis, two recovered spontaneously. Postoperatively, papillary carcinoma was diagnosed in 453 patients, follicular carcinoma in seven patients, medullary carcinoma in four, metastatic cancer in five, malignant lymphoma in one, and other benign diseases in 40 patients. The mean

Fig. 4 Robotic resection of a schwannoma. **a** Preoperative CT scan and surgical specimen. **b** After the working space is maintained with a selfretractor, the deep cervical fascia along the anterior border of the sternocleidomastoid muscle is resected. **c** After identifying the internal jugular vein and carotid artery, the location of the schwannoma originating from the vagal schwannoma or sympathetic nerve in the carotid sheath was confirmed. **d** The schwannoma could then be enucleated from the capsule using three robotic arms under a 10-fold magnified view of surgical site
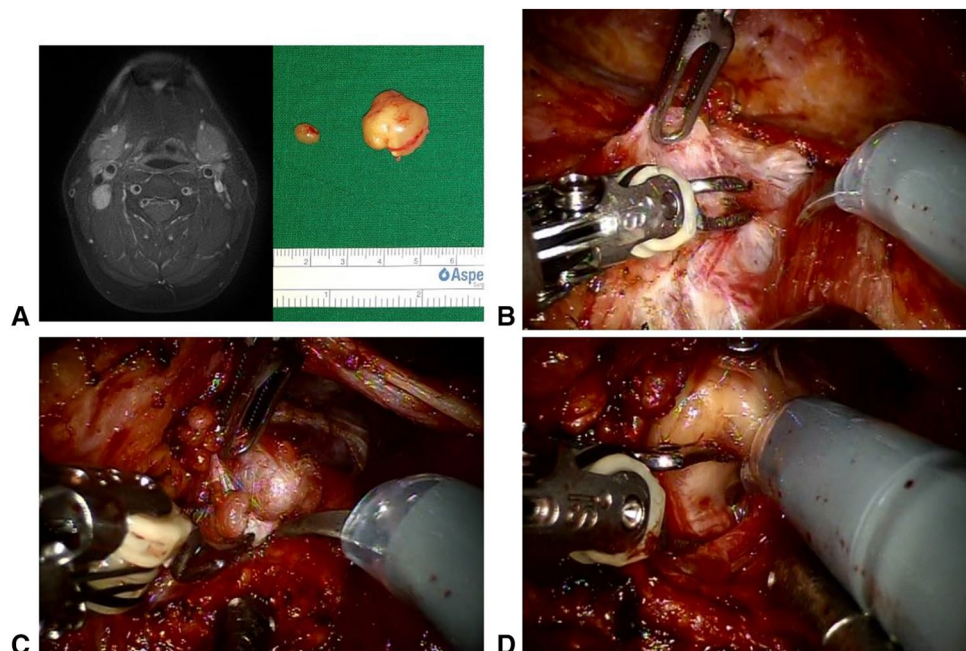
Fig. 5 Robotic resection of a paraganglioma. **a** Preoperative CT scan and surgical specimen. **b** Carotid body tumors could be easily identified around the bifurcation of the carotid artery. **c-d** Scissors and Maryland dissection were then mounted on the left and right robotic arms, respectively. The tumor was dissected from the carotid artery
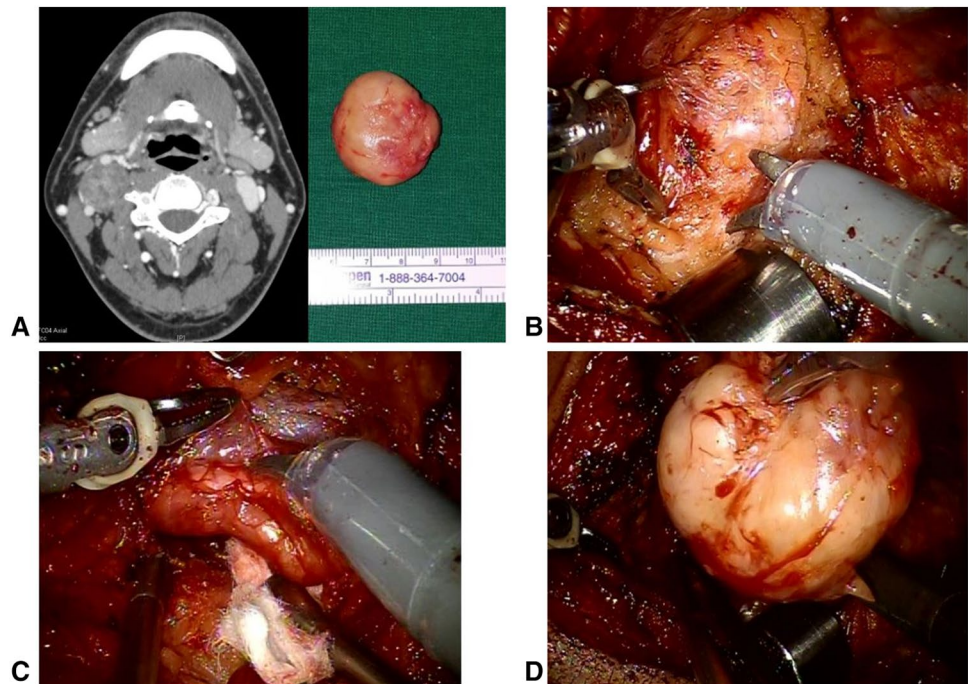

Table 4 Treatment outcomes of patients ($n = 225$) with malignant tumors who underwent robotic neck dissections

Recurrence	
Local	5
Regional	8
Distant metastasis	10
Disease status	
NED	174
LWD	11
DOD	11
DOID	7
Follow-up loss	4

NED no evidence of disease, *LWD* alive with disease, *DOD* died of disease, *DOID* died of intercurrent disease

Note: Mean follow-up period of the patients was 45.3 months (range 19–69)

follow-up period of the patients who received robotic thyroidectomy was 60.5 months (range 14–123). During the follow-up period, recurrence occurred in twelve patients (2.6%). (lymph node recurrence in 11 patients and contralateral lobe recurrence in one patient) In this study, seven patients underwent robotic surgery for parathyroid disease. Four patients were diagnosed with parathyroid adenomas, and three were diagnosed with parathyroid cysts. All of the patients underwent robotic neck surgery through the RA,

during which the recurrent laryngeal nerve was identified and preserved intraoperatively in all patients. Therefore, none of these patients developed vocal fold paralysis postoperatively. The mean operative time was 64 min and the mean hospital stay was 7 days (Table 5).

Of 193 patients who underwent robotic neck surgery for the removal of neck diseases other than thyroid tumors, 90 patients had salivary gland disease. Fifty-seven patients underwent robotic surgery through RA, while the remaining 33 patients underwent robotic surgery via MFLA. Fifty-six patients underwent robotic submandibular gland resection and 34 patients underwent robotic parotidectomy. Of these, 80 patients underwent robotic surgery for benign salivary glands, while the remaining ten had malignant salivary tumors. The mean operative time was 183.8 min. The mean blood loss was 13.5 mm, and the mean hospital stay was 7.1 days (Table 3).

Of the 193 patients with other neck diseases, 21 patients underwent robotic neck surgery to remove schwannomas in the neck. The mean age of these patients was 38.4 years, with nine men and 11 women. Eighteen patients removed the tumor through RA, one underwent robotic neck surgery through MFLA, and the other two underwent TA. There were 15 cases of vagal schwannomas. One of these patients had vocal fold paralysis preoperatively (and postoperatively), while four patients developed vocal fold paralysis after surgery. Four patients had sympathetic nerve schwannomas and underwent robotic schwannoma excision through RA. In all of these patients, Horner

Table 5 Pathologic findings and perioperative data of patients with well-differentiated carcinoma of the thyroid gland ($n = 464$)

Variables	No. of patients (%)
Tumor size, mm	
≤ 10	144 (31.0)
> 10 and ≤ 20	21 (4.5)
> 20 and ≤ 40	159 (34.4)
> 40	131 (28.2)
N/A	9 (1.9)
ETE	
Yes	206 (44.4)
No	258 (55.6)
Multifocality	
Yes	97 (20.9)
No	367 (79.1)
T classification	
0	9 (1.9)
1	270 (58.2)
2	16 (3.4)
3	168 (36.2)
4	1 (0.2)
N classification	
0	283 (61)
1	181 (39)
Postoperative VC palsy	
Yes	12 (2.6)
No	452 (97.4)
Hospital stay, days	7.0
Mean blood loss, cc	25.6

ETE extrathyroidal extension, *VC* vocal cord

syndrome occurred after robotic tumor removal. There was one case of hypoglossal nerve schwannoma, and one case of glossopharyngeal nerve schwannoma. The average operative time was 211.3 min. The mean blood loss was 50.5 cc, and the mean hospital stay was 7.8 days.

Twenty-three patients underwent a robot-assisted Sistrunk operation for the removal of a thyroglossal duct cyst. Of the remaining patients, three underwent removal of a Zenker's diverticulum of the cervical esophagus via RA. None of these patients experienced esophageal-cutaneous fistulas due to the leakage of the surgical site. Eighteen patients underwent robotic mass excision through RA for the removal of a second branchial cleft cyst. There were no significant cranial nerve deficits postoperatively, and no disease recurrence. Four patients were diagnosed with thoracic outlet syndrome and underwent robot-assisted scalene muscle resection through the RA to perform decompression of the brachial plexus. One patient received robotic neck surgery through the RA in the resection of a paraganglioma. There

were no serious complications, including cranial nerve palsy. There were no serious bleeding events or need for blood transfusion. The remaining thirty-three patients underwent successful resections of various neck lesions via the RA or MFLA approaches [lipoma ($n = 4$), lymphangioma ($n = 4$), venous malformation ($n = 3$), dermoid cyst ($n = 3$), Castleman disease ($n = 1$), laryngocele ($n = 1$), fibromatosis ($n = 1$), others ($n = 8$)] (Table 6).

Changing trends in the surgical approaches in robotic neck surgery

In the early stages of this study (2010 ~ 2012), TA was most commonly used to perform robot neck surgery. However, since TA involves a bottom-to-top approach, it makes it difficult to access the upper neck (level I or II). Therefore, we decided to combine the TA and RA approaches for such surgeries (TARA). However, the dissection range of TARA is the broadest and the most invasive compared to other surgical approaches. To minimized the extent of dissection and patient's morbidity, its frequency of use gradually decreased, and was no longer used after 2013. In contrast, the frequency of use of RA and MFLA gradually increased during this time (Fig. 6).

Discussion

Minimally invasive surgery has been widely adopted and performed in various fields because it reduces postoperative morbidity and improves patients' quality of life after surgery. Prior studies have described the use of video-assisted or endoscopic surgeries using the rigid endoscope and long surgical instruments. [8] However, because endoscopic surgery should be performed under two-dimensional operative fields of view using rigid and long instruments, collisions between the operator and the assistant are unavoidable. It takes a lot of effort and experience to master the endoscopic procedure technique. Therefore, the recent trend of minimally invasive surgery has shifted toward robotic surgery using DaVinci systems. Since the surgical robot was first introduced in 1985, robotic systems have provided surgeons superior visualization of the filed and dexterity of the robotic arms. These characteristics allow surgeons to perform more sophisticated and less invasive surgeries compared to conventional open surgeries or endoscopic surgeries. [9] Robotic surgery also provides advantages such as tremor filtration and motion scaling based on the advanced robotics technology. Therefore, it is possible to perform more precise surgery compared to that of endoscopic techniques. Furthermore, robotic surgery requires little effort and time to get accustomed to the surgical technique given the user-friendly eco-system of the surgical robot.

Table 6 Indications and surgical approaches of robotic neck surgery for the removal of head and neck diseases

Site	Operation	Possible surgical approach
Thyroid	Hemithyroidectomy	RA, TA
	Total thyroidectomy	RA, TA
	Total thyroidectomy with modified radical neck dissection	RA, TA, TARA
Salivary gland	Submandibular gland resection	RA
	Parotidectomy	RA or MFLA
Anterior neck	TGDC	RA (Sistrunk operation)
	Dermoid cyst	RA
Lateral neck	Second branchial cleft cyst	RA
	Hemangioma	RA
	Lymphangioma	RA
	Lipoma	RA
	Laryngocele	RA
	Venous malformation	RA
	Castleman disease	RA
	Fibromatosis	RA
Parapharyngeal space	Schwannoma (nerve-preserving enucleation)	RA or TA
	Paraganglioma	RA
Cervical esophagus	Zenker's diverticulum	RA
Other	Thoracic outlet syndrome (or brachial plexus decompression)	RA

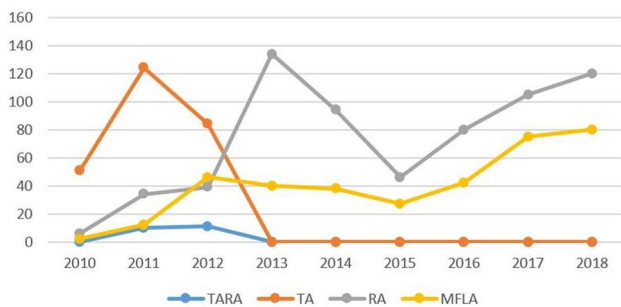*RA* retroauricular approach, *MFLA* modified facelift approach, *TA* transaxillary approach

Fig. 6 Changing trends in the surgical approaches in robotic surgery

At our institution, we are attempting to improve the limit of traditional head and neck surgeries using two main principles. First, the transverse skin incision or U-shaped incision, which is commonly used for conventional neck surgery, usually leaves a scar on the face or neck. This result can be displeasing for patients with regard to their quality of life due to facial disfigurement. To overcome this problem, we developed various remote access ports, such as TA and RA, to excise various benign thyroid/neck tumors using endoscopic equipment or surgical robots. As our experience with these procedures increased, we confirmed that RA produces much more satisfactory cosmetic outcomes and is also less invasive than TA. Therefore, TA is now rarely used at our

institution and most robotic neck surgeries are now performed through RA or MFLA approaches.

Since the DaVinci surgical system was installed at our institution, we have performed various neck surgeries using it through remote access ports including TA, TARA, RA, and MFLA. [7, 10, 11] The indications for robotic neck surgery have gradually expanded as experience with robotic neck surgery also grows. Currently, robotic neck surgery is being applied to treat almost all diseases in the neck. Its feasibility has already been demonstrated in previous reports. Our robotic operative techniques have also been adopted and performed at several institutions around the world. [12–14] Because robotic neck surgery is performed through a remote access port, it does not produce a visible scar on the face or neck. This means that patients tend to be very satisfied with their postoperative cosmetic results. Therefore, the demand for the procedure is very high, especially in younger patients with head and neck tumors. In addition, unlike the transverse skin incision that is used in general head and neck surgery; superficial dermal lymphatics are preserved after robotic surgery. Therefore, there is less extensive lymphatic edema after robotic neck dissection through the TA or RA approaches than there is after conventional neck dissection.

Recently, almost all neck tumors at our institution have been resected through robotic surgery using the DaVinci robot system and RA or MFLA approaches. We have used this technique to remove various neoplasms, such as neurogenic tumors, paragangliomas, vascular tumors, branchial

cleft cysts, and lipomas in the neck. In addition to the excellent cosmetic results that we have described, the robotic system also enables more precise surgery than do conventional or endoscopic approaches. Furthermore, robotic surgery minimizes bleeding, allows for complete tumor tissue removal and preserves the surrounding normal tissue better than do conventional or endoscopic surgeries based on 3-dimensional magnified visualization of surgical site. In this study, the length of hospital stay was a bit longer compared to non-robotic conventional surgery. In robotic neck surgery, the extent of dissection is more extensive than that in conventional non-robotic surgery, which may increase the amount of drainage and affect hospital stay. However, the relatively long hospitalization period might also be influenced by other factors, such as the national insurance system. Since the public insurance system of South Korea covers much of the medical cost, many patients tend to be admitted until their surgical wound is completely healed. Although multi-institutional prospective study is required to confirm our results, we have assured that these techniques offer similar cure rates and complication rates in select patients.

Conclusion

Robotic neck surgery is a feasible and safe technique for the resection of various head and neck tumors. The superior visualization and articulate robotic arms allow surgeons to perform delicate and precise surgeries.

Compliance with ethical standards

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