Initial experience with robot-assisted modified radical neck dissection for the management of thyroid carcinoma with lateral neck node metastasis

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Background. *Since the introduction of endoscopic techniques in thyroid surgery, several trials of endoscopic lateral neck dissection have been conducted with the aim of avoiding a long cervical scar, but these endoscopic procedures require more effort than open surgery, mainly because of the relatively nonsophisticated instruments used. However, the recent introduction of surgical robotic systems has simplified the operations and increased the precision of endoscopic techniques. We have described our initial experience with robot-assisted modified radical neck dissection (MRND) in thyroid cancer using the da Vinci S system.*

Methods. *From October 2007 to October 2009, 33 patients with thyroid cancer with lateral neck lymph node (LN) metastases underwent robot-assisted thyroidectomy and additional robotic MRND using a gasless, transaxillary approach. Clinicopathologic data were analyzed retrospectively.*

Results. *Mean patient age was 37 ± 9 years and the gender ratio (male to female) was 7:26. The mean operating time was 281 ± 41 minutes and mean postoperative hospital stay was 5.4 ± 1.6 days. The mean tumor size was 1.1 ± 0.5 cm and 20 cases (61%) had papillary thyroid microcarcinoma. The mean number of retrieved LNs was 6.1 ± 4.4 in the central neck compartment and 27.7 ± 11.0 in the lateral compartment. No serious postoperative complications, such as Horner's syndrome or major nerve injury, occurred.*

Conclusion. *Robot-assisted MRND is technically feasible, safe, and produces excellent cosmetic results. Based on our initial experience, robot-assisted MRND should be viewed as an acceptable alternative method in patients with low-risk, well-differentiated thyroid cancer with lateral neck node metastasis. (Surgery 2010;148:1214-21.)*

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IMPROVING ECONOMIC STATUS in South Korea has generated much interest in lifestyle and health, and these interests have led to the initiations of many health-screening programs. As a result, the detection of thyroid neoplasms has increased notably, because the neck is readily accessed by ultrasound imaging devices. In particular, the incidence of thyroid cancer in women has markedly increased, and thyroid cancer in young women is now the most prevalent cancer in Korean women.[1] Papillary thyroid carcinoma (PTC) is the most common type of thyroid malignancy, usually exhibits mild biological behavior, and has a favorable prognosis.[2,3] Recently, various types of minimally invasive operative techniques have been introduced to treat PTC, given its favorable prognosis and the importance of esthetics to female patients.[4-6] However, PTC is likely to metastasize to cervical lymph nodes (LN), which reflects its tendency toward locoregional recurrence.[7,8] Although, the introduction of high-resolution ultrasonography has resulted in an overwhelming improvement in the detection of early PTC, locally advanced PTC with lateral neck node metastasis is still encountered, and requires more aggressive operative intervention, which often produces poor cosmetic results. Minimally invasive neck dissection techniques have been attempted to avoid long cervical scars in PTC,[6,9] but the purely endoscopic methods

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used are technically limited when procedures are complex. However, the incorporation of surgical robotic systems into the operative management of PTC has enabled surgeons to overcome some of these technical difficulties.[10-12] We have recently published reports on robotic thyroid surgery for PTC using a gasless, transaxillary approach.[10,11] Herein, we have described the operative technique of robot-assisted total thyroidectomy and modified radical neck dissection (MRND) in papillary thyroid cancer using a gasless, transaxillary approach, and provide details of short-term operative outcomes.

PATIENTS AND METHODS

Patients. From October 2007 to October 2009, 995 patients with a preoperative diagnosis of well-differentiated thyroid carcinoma underwent robot-assisted thyroidectomy using a gasless, transaxillary approach, as previously described.[10,11] Of these, 33 patients underwent additional robotic MRND for lateral neck LN metastasis. Details of clinical characteristics, operating times, postoperative hospital stays, complications, and pathologic characteristics were obtained from our institutional database.

The inclusion criteria were (1) well-differentiated thyroid carcinoma with clinical lateral neck LN metastasis (cases with 1 or 2 minimal metastatic LNs on the lateral neck), (2) tumor ≤4 cm, and (3) minimal invasion to the anterior thyroid capsule and strap muscle. The exclusion criteria were (1) definite tumor invasion to an adjacent organ (recurrent laryngeal nerve [RLN], esophagus, or trachea) and (2) multilevel LN metastases of the lateral neck or perinodal infiltration at a metastatic LN. Bilateral total thyroidectomy with prophylactic ipsilateral central compartment node dissection was performed in all cases.

All patients with clinically palpable lateral neck nodes or a lateral LN with a suspicious ultrasound appearance by preoperative staging ultrasonography underwent fine-needle aspiration biopsy. The presence of lateral neck node metastasis was predicted preoperatively based on histologic examinations of ultrasonography-guided fine-needle aspiration biopsy or based on thyroglobulin (Tg) levels in fine-needle aspiration biopsy wash out fluid (FNA-Tg >10 ng/mL, >mean + 2SD of FNA-Tg measured in node negative patients, or greater than serum-Tg) from lateral neck LNs.[13]

At our institution, we follow general approaches to lateral neck node dissection for PTC (MRND type III, sparing sternocleidomastoid muscle (SCM), spinal accessory nerve, and the internal jugular vein [IJV]; Fig 1). In terms of dissection extent, the submental, submandibular, parotid, and retroauricular nodes are rarely dissected in PTC,[14] and level IIB and VA LNs are not routinely dissected.[15,16] However, if an enlarged or suspicious node is encountered by palpation or on preoperative ultrasonography at the I or IIB levels or among VA LNs, these compartments are included in the en bloc dissection.

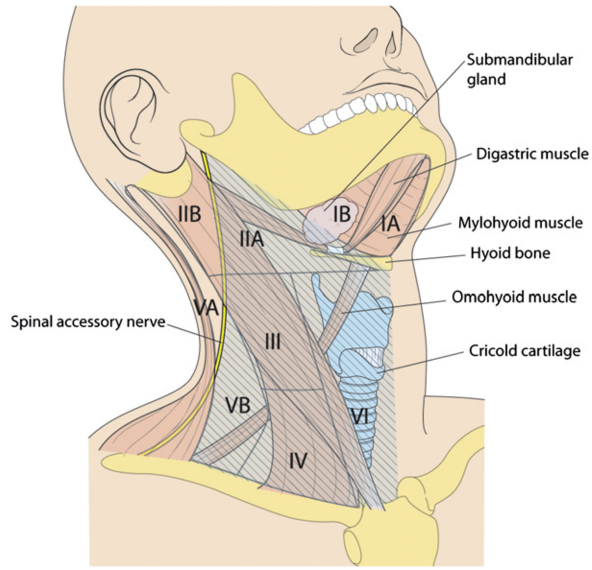

Fig 1. The anatomic landmarks used to divide the lateral and central LN compartments into levels I–VI. The area with a deviant crease line is where LN dissection is made during MRND.

The mean ± standard deviation follow-up period was 14 ± 5 months (range, 7–28).

Operative methods. *Operative setup and instrumentation*: With the patient in the supine positions and under general anesthesia, the neck is extended slightly by inserting a soft pillow under the shoulder and the face is turned away from the lesion. The lesion side arm is then stretched laterally and abducted by about 80 degrees from the body (to optimally expose the axillar and lateral neck; Fig 2, *A*). A 7- to 8-cm vertical skin incision is then made in the axilla, and a subcutaneous skin flap from the axilla to the midline of the anterior neck is dissected over the anterior surface of the pectoralis major muscle and clavicle by electrical cautery under direct vision (Fig 2, *B*).

After exposing the clavicle, subplatysmal flap dissection proceeds to the midline of the anterior neck medially, to the upper point where the external jugular vein and great auricular nerve cross the lateral border of the SCM superiorly and to the trapezius muscle posteriorly. During flap dissection in the posterior neck area, the spinal

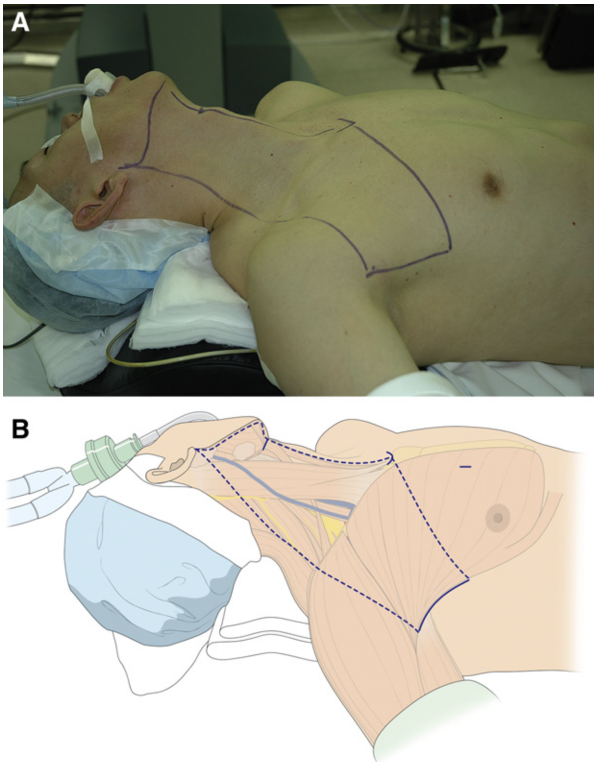

Fig 2. (*A*), Patient position. (*B*), Actual extent of flap dissection from the axilla to the anterior neck. (Margined by the *dotted line*; *unbroken line* is the skin incision line).

accessory nerve is identified and exposed along its course. After subplatysmal flap dissection, the posterior branch (clavicular head) of the SCM is transected at the level of the clavicle-attached point (to achieve complete exposure of the junction area between the IJV and the subclavian vein). Soft tissue and LNs are detached from the posterior surface of the SCM. The proximal external jugular vein is then clipped and divided at the crossing point of the SCM lateral border, and soft tissue detachment from the posterior surface of the SCM is continued lateral to medial until the IJV and common carotid artery are exposed. The dissection is approached through the avascular space between the carotid sheath and strap muscles, and the thyroid gland exposed. To expose the level II area, the dissection is progressed along the reverse side of the SCM until the submandibular gland and posterior belly of the digastric muscle are exposed superiorly (Fig 3). After flap dissection, the patient's head is returned to the neutral position. A spatula-shaped external retractor (Chung's retractor) is then used to create a working space (the retractor's blade has suction holes that can used to remove smoke and fumes). The external retractor is then inserted through the axillary skin incision and located between the anterior surface of the thyroid and strap muscles. The retractor is then used to raise and tent the skin flap at the anterior chest wall, the SCM, and the strap muscles to create a working space (Fig 4, *A*). A second skin incision (0.8 cm long) is then made on the medial side of the anterior chest wall to allow the 4th robotic arm to be inserted (2 cm superiorly and 6–8 cm medially from the nipple).

The robotic column is placed on the lateral side of the patient contralateral to the main lesion, and the operative table is positioned slightly obliquely with respect to the direction of the robotic column to allow direct alignment between the axis of the robotic camera arm and the operative approach (from the axilla to the anterior neck, which is usually also the direction of retractor blade insertion).

Four robotic arms are used during the operation. Three arms are inserted through the axillary incision: a 30-degree dual channel endoscope (Intuitive, Inc., Sunnyvale, CA) is placed on the central camera arm through a 12-mm trocar; a Harmonic curved shears (Intuitive, Inc.,) is placed on the right arm of the scope through an 8-mm trocar, and a 5-mm Maryland dissector (Intuitive, Inc.,) is placed on the left side arm of the scope. A ProGrasp forceps (Intuitive, Inc.,) is placed on the 4th arm and inserted through the 8-mm anterior chest trocar.

Proper introduction angles are important to prevent collisions between robotic arms. In particular, the camera arm should be placed in the center of the axillary skin incision. This arm is inserted to face upward (the external 3rd joint should be placed in the lowest portion [floor] of the incision entrance, and the camera tip should be directed upward). The Harmonic curved shear (ultrasonic coagulator shears) and the 5-mm Maryland dissector arms should be inserted in the opposite manner to the camera arm (to face downward). Finally, the external 3 joints of the robotic arms should form an inverted triangle.

Total thyroidectomy with central compartment LN dissection: We previously described in detail the procedures we use for robotic total thyroidectomy with central compartment node dissection.[10,11] Briefly, under endoscopic guidance, the upper pole of the thyroid is drawn downward and medially using a ProGrasp forceps, and the superior thyroid vessels are then identified and individually ligated close to the thyroid gland using Harmonic curved shears to avoid injuring the external branch of the superior laryngeal nerve. The upper pole of the thyroid is then detached from the

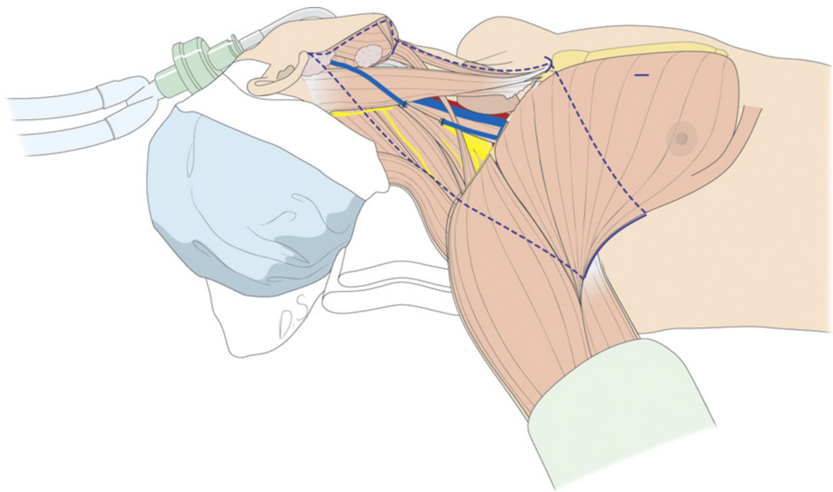

Fig 3. After subplatysmal flap dissection.

cricopharyngeal and cricothyroid muscles until the superior parathyroid gland is exposed. The thyroid gland is then pulled superiorly and medially using the ProGrasp forceps to expose the lateroinferior portion of the thyroid. The lateral side of the central compartment LN dissection is started from the common carotid artery and continued to the inferior thyroid artery superiorly and the substernal notch inferiorly. After exposing the common carotid and inferior thyroidal arteries, soft tissues and LNs in the pretracheal area are detached from cervical thymic tissues and dissected to the substernal notch until the anterior surface of the trachea is exposed. The perithyroidal fascia is then carefully divided to identify the inferior thyroid artery and the RLN in their usual anatomic relationship. The inferior thyroid artery is then divided close to the thyroid gland using the Harmonic curved shears, and the whole cervical course of the RLN is traced. If the superior parathyroid gland is not identified during dissection of the upper pole, it is identified during RLN tracing and left intact. In the Berry ligament area, the thyroid gland is detached meticulously from the trachea to avoid direct or indirect thermal injury of the RLN. Contralateral thyroidectomy is performed in the same order as described for the opposite site with medial traction of the thyroid. Contralateral thyroidectomy usually proceeds with subcapsular dissection to preserve the parathyroid glands and the RLN. In cases with a prominent trachea and a deeply located contralateral thyroid, the surgical table can be tilted by 10–15 degrees to provide optimal exposure of the contralateral tracheoesophageal groove. The resected specimen is then extracted through an axillary skin incision.

MRND procedure: After thyroidectomy, lateral neck dissection is started from the level III/IV area. The IJV is hauled medially using the ProGrasp forceps, and soft tissues and LNs are pulled laterally using a Maryland dissector and detached from the anterior surface of the IJV to the posterior aspect of IJV until the common carotid artery and vagus nerve are identified. Smooth, sweeping, lateral movements of a Harmonic curved shears can establish a proper plane and allow vascular structures to be differentiated from specimen tissues. The dissection of the IJV is progressed upward from level IV to the upper level III area. During this procedure, the superior belly of the omohyoid muscle is cut at the thyroid cartilage level. Packets of LNs are then drawn superiorly using the ProGrasp forceps, and the LNs are meticulously detached from the junction of the IJV and subclavian vein. Difficulty may be experienced reaching this point with a nonarticulated Harmonic curved shears owing to obstruction by the clavicle. In such cases, increasing the height of the external 3rd joint of the robotic arm equipped with the Harmonic curved shears and increasing its introduction angle is likely to resolve these problems and allow the target point to be reached. In general, the transverse cervical artery (a branch of the thyrocervical trunk) courses laterally across the anterior scalene muscle, anterior to the phrenic nerve. Using this anatomic landmark, the phrenic nerve and transverse cervical artery can be preserved without injury or ligation. Further dissection is followed along the subclavian

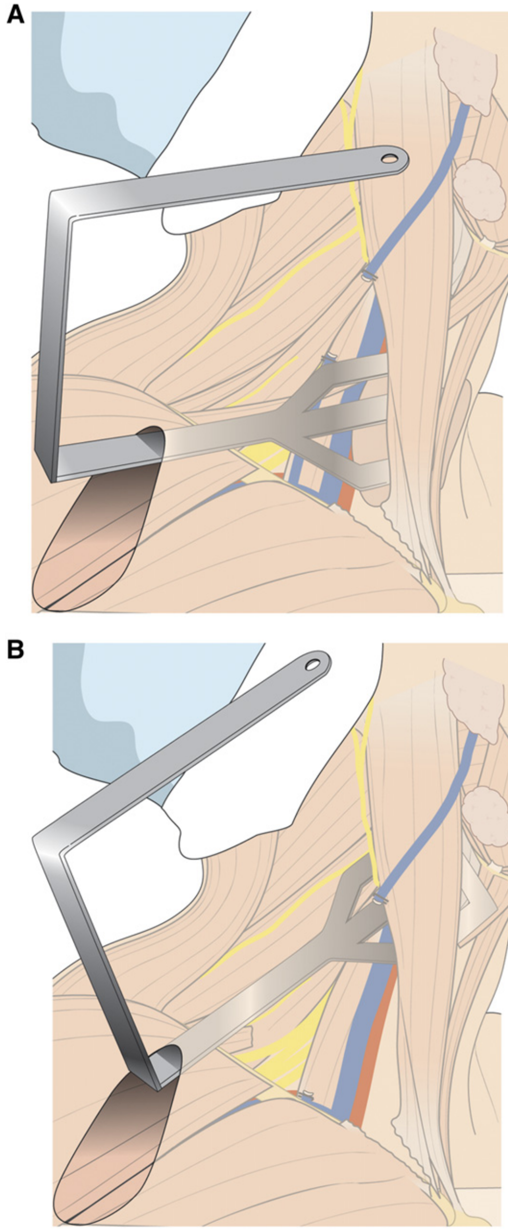

Fig 4. External retractor insertion. (*A*), Initial position of retractor for thyroidectomy and neck dissection of levels III, IV, and VB. (*B*), Repositioned external retractor for level II dissection.

vein laterally. The inferior belly of omohyoid muscle is cut where it meets the trapezius muscle. The distal external jugular vein (which can join the IJV or the subclavian vein) is then clipped and divided at its connection with the subclavian vein. Level VB dissection in the posterior neck area proceeds along the spinal accessory nerve in the superomedial direction, and is followed by level IV dissection, while preserving the brachial nerve plexus, the phrenic nerve, and the thoracic duct.

Table I. Clinical characteristics of the patients

Age (year)	37.2 ± 9.2 (range 22–59)
Gender ratio (male:female)	1:3.71 (7:26)
Operation time (min)	280.8 ± 40.6 (range 186–357)
Post operative hospital stay (day)	5.4 ± 1.6 days (range 3–11)
Operation type (n = 33)	Bilateral total thyroidectomy with ipsilateral CCND*
MRND† side	Left: 14, Right: 19

*Central compartment neck dissection.
†Modified radical neck dissection.

The dissection proceeds by making turns at levels VB, IV, and III, and then by proceeding upward to the level IIA area. The individual nerves of the cervical plexus are sensory nerves, and when encountered during dissection they are sacrificed to ensure complete node dissection, while preserving the phrenic nerve and ansa cervicalis.

After dissection of the level III area, the external retractor and robotic axis are repositioned to allow better exposure of the level II area. The external retractor is then reinserted through the axillary incision and directed toward the submandibular gland (Fig 4, *B*). The operating table should also be repositioned more obliquely with respect to the direction of the robotic column to allow the same alignment between the axis of the robotic camera arm and the direction of retractor blade insertion.

Drawing the specimen tissue inferolaterally, soft tissues and LNs are detached from the lateral border of the sternohyoid muscle, the submandibular gland, and the anterior surfaces of the carotid artery and the IJV. Level IIA dissection is advanced until the posterior belly of the digastric muscle is exposed superiorly. After removing the specimen, fibrin glue is sprayed around the area of the thoracic duct and minor lymphatics, and a 3-mm closed suction drain is inserted just under the axillary skin incision. Wounds are closed cosmetically. The incision scar in the axilla is completely covered when the arm is in its neutral position.

RESULTS

We reviewed 33 cases for the present study. The mean patient age was 37 ± 9 years, and the cohort was composed of 26 females and 7 males. Fourteen patients underwent left side MRND and 19 right side MRND. No case was converted to a conventional open operation. The mean total operating time was 281 ± 41 minutes and mean postoperative hospital stay was 5.4 ± 1.6 days (Table I).

Table II. Pathologic characteristics of the patients

Tumor size (cm)	1.09 ± 0.52 cm (range 0.5–2.5)
Retrieved lymph node (N) per patient	33.0 ± 11.6 (range 16–63)
Central compartment	6.1 ± 4.4 (range 1–22)
Lateral compartment	27.7 ± 11.0 (range 12–58)
Level IIA/III/IV/VB	7.31/7.45/8.17/6.34
Multiplicity (N)	
Yes	16 (48.5%)
No	17 (51.5%)
Bilaterality (N)	
Yes	7 (21.2%)
No	26 (78.8%)
Tumor size (cm)	1.09 ± 0.52 cm (range 0.5–2.5)
TNM stage (N)	
T1/T2/T3/T4a	8(24.2%)/1(3%)/22(66.7%)/2(6%)
Stage I/IVa	25(75.8%)/8(24.2%)

Mean tumor diameter was 1.1 ± 0.5 cm. All patients were confirmed to have PTC. Twenty (60.6%) patients had papillary thyroid microcarcinoma (PTMC, tumor ≤1 cm). Multiple or bilateral thyroid gland lesions were observed in 16 (49%) and 7 (21%) cases, respectively. The mean number of LNs retrieved per patient was 6.1 ± 4.4 from the central compartment and 27.7 ± 11.0 from the lateral neck compartment. We retrieved a mean number of 7.3 ± 3.1 LN from level IIA, 7.5 ± 4.4 LN from level III, 8.2 ± 5.8 LN from level IV, and 6.3 ± 4.5 LN from level V. For these nodes, the mean number of metastatic LNs was 3.6 ± 2.9 (range, 0–11) in the central compartment and 4.5 ± 4.1 (range, 1–21) in the lateral neck compartment. The cohort included 8 patients (24.2%) with stage T1, 1 (3%) with stage T2, 22 (66.7%) with stage T3, and 2 (6%) with stage T4a disease. For stage T3 patients, most tumors were <2 cm, but they invaded the thyroid capsule. Two stage T4a patients showed RLN invasion and underwent a Maryland dissector shaving procedure. All patients had stage N1b disease, and no patient had distant metastasis. There were 25 patients (76%) had stage I disease and 8 (24%) with stage IVA disease (Table II).

Postoperative complications included 17 patients (52%) with transient hypocalcemia, 2 (6%) with transient hoarseness, 4 (12%) with seroma, and 3 (9%) with a minor chyle leak (Table III). However, no serious postoperative complications, such as, Horner's syndrome or major nerve injury (vagus, spinal accessory, phrenic, brachial plexus, hypoglossal, recurrent laryngeal, or marginal mandibular branch of the facial nerve) were encountered. Transient hypocalcemia resolved within 2 months. Permanent hypocalcemia was not encountered in any patient, and no patient required reoperation owing to postoperative bleeding. The 2 cases of transient hoarseness resolved and were normal by postoperative laryngoscopy at 2–3 months. Three cases of minor chyle leak occurred and all responded to conservative management within a few days.

Table III. Postoperative complications

Complication	*Patients (N)*
Transient hypocalcemia	17 (51.5%)
Transient hoarseness	2 (6.0%)
Permanent RLN injury	0 (0%)
Seroma	4 (12.1%)
Hematoma	0 (0%)
Horner syndrome	0 (0%)
Chyle leak (minor)	3 (9.1)

Of the 33 patients, 22 underwent RAI therapy (with 150 mCi) at 1–3 months postoperatively and a ^{131}I whole body scan 2 days after RAI therapy (11 patients had not undergone RAI therapy at the time of writing owing to a shortage of RAI treatment facilities), but no patient was found to have abnormal RAI uptake. Serum Tg levels (with suppressed thyroid-stimulating hormone) were checked at 4 months postoperatively. Serum Tg levels in 22 patients (66.7%) were <1 ng/mL and in the remaining 11 (33.3%) were 5.4 ± 3.5 ng/mL (range, 1.2–9.6). All patients underwent neck ultrasonography at 10 and 18 months postoperatively to check for local recurrence; no recurrence was found.

DISCUSSION

During the early 20th century, Crile[17] described a systematic operative approach to en bloc neck dissection for head and neck cancers, and subsequently, Martin et al[18] extensively expanded the concept of radical neck dissection. Many authors have attempted to modify, standardize, or establish the extent of neck dissection for head and neck cancers. Recently, selective neck dissection (the removal of LN compartments at highest risk of metastasis, based on primary lesion location) has been adopted worldwide for head and neck cancers, although this depends on the biology of the primary cancer and the metastatic pattern.[19]

The optimal management of PTC remains the subject of considerable debate. Nevertheless, the most important initial consideration is complete operative resection of the thyroid and involved LNs. Radioactive iodine treatment can be administered later for remnant thyroid tissue ablation and thyroid-stimulating hormone suppression therapy can be added according to risk.[14] The extent of operative intervention for PTC can be classified using the 2 LN-bearing compartments to which PTC usually metastasizes, namely, the central and lateral compartments. Routine prophylactic lateral neck dissection in patients with PTC is controversial because lateral neck areas may be treatable at reoperation. However, therapeutic lateral neck dissection in PTC patients with clinically determined lateral neck node metastasis is always necessary.[20,21] In terms of the operative treatment of PTC with lateral neck metastasis, bilateral total thyroidectomy with MRND (selective neck dissection of levels II–V) is most commonly used.[14] At our institution, we usually perform selective neck dissection (levels IIA, III, IV, and VB) for MRND. LN metastasis to level I is extremely rare in PTC,[16] and level IIB or level VA metastasis from PTC is unusual without multiple level IIA or level IV and VB metastases, respectively.[15,16]

Although the extent of MRND for PTC has decreased because of efforts made to reduce postoperative morbidity (based on documented frequencies of LN metastases), a long incision scar and muscle deformities in the neck area are unavoidable. In particular, in patients with early thyroid cancer and limited metastasis to 1 or 2 lateral neck LNs, conventional open MRND using a long anterior neck incision is of great concern to patients, especially young women, and this poses problems for surgeons.

Various types of endoscopic thyroid surgeries have been described to date,[4-6,9] and several reports have been issued on the safety of endoscopic thyroidectomy in patients with early thyroid cancers.[4-6,9] Furthermore, to overcome abject cosmetic results, several endoscopic lateral neck dissection trials have been conducted using remote skin incisions.[6,9] However, the instruments used to conduct these minimally invasive endoscopic techniques (a 2-dimensional flat monitor, and rigid, straight endoscopic instruments with no tactile sense) have definite limitations in these small, narrow working spaces.[10-12] In particular, for complex and difficult procedures like lateral neck dissection, it is difficult to perform endoscopic surgery in keeping with the principles of oncologic safety.

The adoption of robotic technology in surgery has been popularized by the increased dexterity of the instrumentation used.[22,23] In particular, in the head and neck, the da Vinci robotic system allows some of the technical pitfalls and limitations of endoscopic thyroid surgery to be overcome.[10-12,24] Furthermore, precise and complex endoscopic procedures can now be accomplished using advances in robotic technology, such as a steady camera platform, a 3-D magnified view, 7 degrees of freedom, scaled and tremor-filtered movement, and a multi-articulated endowrist.[10-12,22-24] Accordingly, the meticulous and precise motions of modern robotic instruments have introduced new levels of technical safety and feasibility to robotic thyroidectomy.[10-12,24] At our institution, robotic thyroid surgery using a gasless, transaxillary approach has been performed in >950 thyroid cancer patients, and this experience led to attempts to use robotic instruments for endoscopic MRND. We have also performed pure endoscopic MRND using conventional endoscopic instruments,[6] but we found that it took more time and effort to perform accurate compartment-oriented dissection than conventional open surgery. On the other hand, by using the da Vinci robotic system, the surgeon can manipulate the 3-arm system simultaneously (1 for traction, 1 for countertraction, and 1 for dissection). Furthermore, the scaled, tremor-free motion facility enables precise and meticulous dissection around major vessels and nerves. The articulated instruments also enable straightforward deep and corner dissection (eg, where the IJV joins the subclavian vein or in the uppermost region of level II) in regions inaccessible to rigid or straight instruments. The transaxillary approach uses a route from the armpit to the anterior neck region, which crosses over the anterior chest, clavicle, and lateral neck, and thus, slightly wider flap dissection (usually into the level V and II areas) during robotic thyroid surgery offers a comprehensive operative view and working space for lateral neck dissection.

In the present study, short-term operative outcomes were satisfactory and no serious perioperative or postoperative complications occurred. The 3 cases of chyle leakage were caused by injured minor lymphatics in the right side, and all responded satisfactorily to conservative management within 5 days (a fat-free diet and external gauze compression around the right lower neck area). We believe that these minor lymphatic injuries were probably caused by careless dissection with a Harmonic curved shears in the lower level IV area. The mean numbers of retrieved LNs per patient and postoperative serum Tg levels were also acceptable. The 11 patients with a serum Tg of >1 ng/mL were among the first cases treated, and we believe that either some thyroid tissue was missed in these patients (at the Berry ligament area of the contralateral thyroid gland) or metastatic LNs were present at the IIB or VA levels. However, the extent of lateral neck LN dissection, including that of clinically suspicious LNs, performed by robot-assisted MRND was identical to that of conventional open MRND. In fact, serum Tg levels in these 11 patients are not unduly high. Nevertheless, all will be closely followed after high-dose RAI therapy (150 mCi) on thyroid-stimulating hormone suppression.

In conclusion, this study demonstrates the technical feasibility and safety of robotic approaches to lateral neck dissection. Robot-assisted thyroidectomy and MRND using the transaxillary approach was found to allow the precise manipulation of robotic instruments and complete compartment-oriented dissection without injuring major vessels or nerves or compromising surgical oncologic principles.

Our initial experiences indicate that robot-assisted MRND is an acceptable alternative operative method in patients with low-risk, well-differentiated thyroid cancer with lateral neck metastasis.

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