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ORIGINAL ARTICLE

Video-assisted selective lateral neck dissection for papillary thyroid carcinoma

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Abstract
Background The minimally invasive video-assisted thyroidectomy (MIVAT) for thyroid benign nodules and central neck dissection (CND) for papillary thyroid microcarcinoma (PTMC) have been applied, presently, we attempted to perform video-assisted selective lateral neck dissection (VASLND) for papillary thyroid carcinoma (PTC).
Methods Twenty-six consecutive PTC patients with unilateral tumor (size <4.0 cm) and suspected lymph node metastasis at level III, IV, or IIa were included from March 2009 to January 2012.
Results VASLND was successfully performed in all 26 PTC patients. The mean operative time was 46 min (range 26–75 min) on VASLND. No major complications occurred. Average postoperative hospital stay was 3.6 days (range 2–8 days). The mean number of removed nodes was 7.3 (range4–12) in central neck and 8.3 (range 3–21) in lateral compartment. Positive yield amounted to a mean value of 2.6 (range 0–5) and 3 (range 0–6), respectively. No persistent or recurrent disease was observed in any patient during a follow-up period. The cosmetic result was excellent.
Conclusions Our initial experience demonstrates that VASLND is feasible and safe for selected PTCs, with superior appearance and less pain. Nevertheless, larger series and comparative studies with longer follow-up could be necessary to confirm its oncological effectiveness.

Keywords Video-assisted selective lateral neck dissection (VASLND) · Papillary thyroid carcinoma (PTC) · Cosmetic result · Minimal invasiveness

Introduction

In 1996, the first endoscopic neck surgery was initiated for parathyroidectomy by Gagner [1]. Subsequently, this technique was developed rapidly; 3 years later, Miccoli et al. [2] introduced the minimally invasive video-assisted thyroidectomy (MIVAT) for thyroid benign nodules. With the extensive utilization of high-resolution ultrasonography (US) and ultrasound-guided fine needle aspiration cytology (FNAC), small papillary thyroid carcinoma (PTC) had been detected more frequently. In 2002, Miccoli et al. [3] attempted to apply the MIVAT technique to resection of small PTC. In the same year, Bellantone et al. [4] reported the feasibility of video-assisted central neck lymph node dissections in case of PTC. Subsequently, Miccoli et al. [5] tried to develop a minimally invasive video-assisted lateral lymphadenectomy by making a second incision in ipsilateral neck for two small PTC patients. In recent years, MIVAT is much more popular, especially in China and Europe [6, 7]. Furthermore, it has been extended gradually to the treatment of small PTC without lymph node metastasis in lateral neck [3, 8–11]. However, the feasibility of video-assisted lateral neck dissection for thyroid malignancy was rarely reported [12]. Based on our experience on MIVAT and central neck dissection (CND) via an average of 2 cm central neck incision

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[13, 14], we developed a procedure called video-assisted selective lateral neck dissection (VASLND) for PTC with suspicious node metastasis at level III, IV, or IIa [15] through a extended 4–6 cm cervical incision (Fig. 1a). The main aim is to improve the cosmetic result and reduce the operative trauma. In this work, we describe the procedure and evaluate the preliminary results of this new technique, as well as discuss the feasibility and safety of VASLND.

Materials and methods

Patients

Twenty-six consecutive PTC patients (six men and 20 women) with mean age of 43.2 years (range 20–68 years) underwent video-assisted thyroidectomy (VAT), CND plus VASLND from March 2009 to January 2012. Their demographics were summarized in Table 1. Preoperative diagnoses were revealed by US, computed tomography (CT), and ultrasound-guided FNAC examination. The study was carried out with approval of Institutional Ethical Committee, and informed consent was required from each patient preoperatively.

Fig. 1 **a** Photograph of 4- to 6-cm incision after VALNLD, showing the better cosmetic result. **b** Conventional L-shaped incision, often leaving an unsightly scar postoperatively

Table 1 Patients' demographics

Characteristics	No.	%
Gender		
Male	6	23.08
Female	20	76.92
Mean age (years)	43.2	
Min	20	
Max	68	
Mean tumor size (cm)	1.88	
Min	0.6	
Max	3	

The eligibility criteria were as follows: (1) unilateral thyroid tumor size <4.0 cm in the largest diameter; (2) well-differentiated PTC; (3) without extrathyroidal extension, contralateral cancerometastasis and lymph node metastases in level I, IIb or V; (4) no history of previous neck surgery and/or radiation therapy; (5) no evidence of thyroiditis; (6) strong preference for cosmetic result and agreement to undergo this procedure with informed consent. Patient with preoperative invasion of major neurovascular structures, trachea, esophagus, or clinical evidence of distant metastases such as lung, bone, and so on were excluded. In our study, the selected patients were PTC with suspicious lymph node metastasis at ipsilateral level III, IV, or even IIa (Fig. 2a,b). The average maximum diameter of the main tumor was 1.88 cm (range 0.6–3 cm) by US imaging.

Operative technique

The procedure was similar to that technique described in our previous MIVAT literature [13]. Briefly, the patient, under general endotracheal anesthesia, was placed in the supine position, with the neck slightly extended. A 5-mm 30° endoscope was used for vision, the special instrument refered to Harmonic Scalpel (Ethicon Endo-Surgery Inc., Cincinnati, OH, USA), which was very useful for hemostasis. A single 4- to 6-cm-long transversal incision was made in the central neck approximately 2 cm above the sternal notch; the skin was protected by means of a sterile film. After VAT and CND were finished under direct vision or video screen, the VASLND was performed completely via video-assisted approach.

At first, the endoscope was inserted into the operative field through the cervical incision, and its position was adjusted if necessary. It was important to detect the extent of thyroid tumor and identify whether extrathyroidal extension existed. After patients underwent video-assisted unilateral lobectomy (diseased lobe), the resected specimen was sent for intraoperative quick frozen section examination if necessary. If PTC was confirmed, the isthmus and contralateral lobe would be

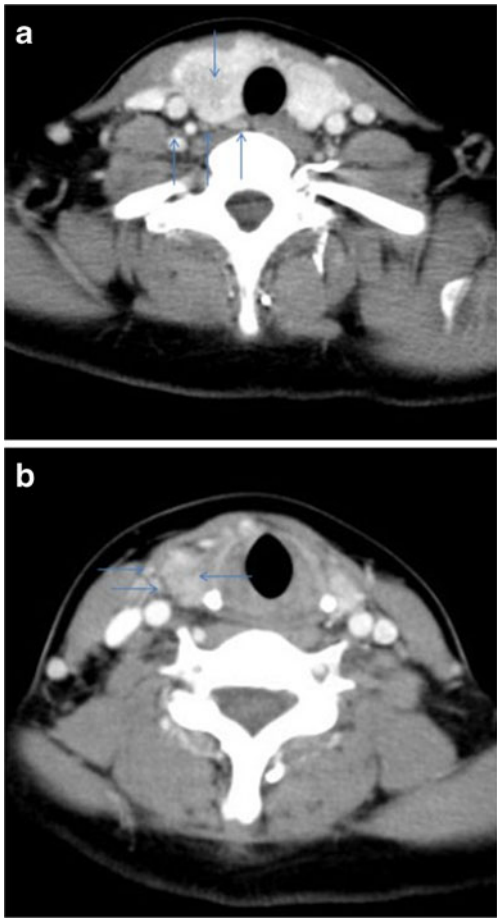

Fig. 2 **a** In a 21-year-old female patient, right PTC with multi-enlarged lymph nodes was shown on CT scan preoperatively. *Down arrow*: thyroid carcinoma, *up arrow*: enlarged lymph node. **b** In a 21-year-old female patient, right PTC with enlarged lymph nodes in lateral neck was shown on CT scan preoperatively. *Right arrow*: enlarged lymph node, *left arrow*: thyroid carcinoma

totally removed. Subsequently, lymph nodes were dissected at level VI.

The second stage, the VASLND was carried out after CND (centrifugal approach). The limits for lateral neck lymphadenectomy in PTC were similar to that described by Uchino et al. [16] except for level Vb. It should comprise the medial border of the sternocleidomastoid muscle (SCM) anteriorly, the carotid sheet medially, the anterior and medium scalenus posteriorly, the anterior border of the trapezius muscle laterally, the posterior belly of the digastric muscle superiorly, and the subclavian vessels inferiorly (levels IIa–III–IV). The operative steps for VASLND were as follows: (1) At the beginning, the medial border of the SCM with fascia was dissected, then, the SCM was pulled apart and oriented laterally in order to expose the omohyoid muscle. After dissecting and sectioning the omohyoid muscle, the strap muscles (sternothyroid and sternohyoid muscles) were oriented medially so as to expose the lateral compartment. (2) Opening the carotid sheet, the common carotid artery (CCA), the internal jugular vein (IJV) and the vagus nerve would be showed clearly. Between the carotid bifurcation cranial and the subclavian vessels inferior, jugulocarotid chain lymph nodes were dissected sequentially (the posterior belly of the digastric muscle and the submaxillary gland could also be exposed under endoscope to dissect level IIa if necessary). The IJV was retracted medially and the SCM laterally, respectively, to identify and dissect the spinal accessory nerve. (3) Thereafter, the lymph nodes together with surrounding fibrofatty tissues were dissected downward until the external jugular vein was identified. The anterior and the medium scalenus muscles as well as the phrenic nerve and the cervical plexus were also exposed (Fig. 3), the endoscope was oriented downward, and dissecting the inferior lymph nodes of lateral neck. (4) Afterward, the lymphatic tissue was retracted medially, the endoscope was oriented laterally to assist in dissecting the lateral lymph nodes. (5) Lastly, the specimen was completely detached en bloc (Fig. 4) to accomplish the VASLND while preserving SCM、IJV and spinal accessory nerves. After the hemostasis was reliably achieved, an aspiration drainage was placed in the operative region and the wound was closed with absorbable suture.

Follow-up evaluation

All the patients were primarily measured by cervical US, serum thyroglobulin (sTg) levels (on and off LT4), radioiodine 131I uptake (RAIU) test at 3- to 6-month intervals postoperatively to evaluate the completeness of surgical resection. Some of them were selected for 131I diagnostic whole-body scans (DxWBS) on the basis of risk factors to assess the oncological effectiveness.

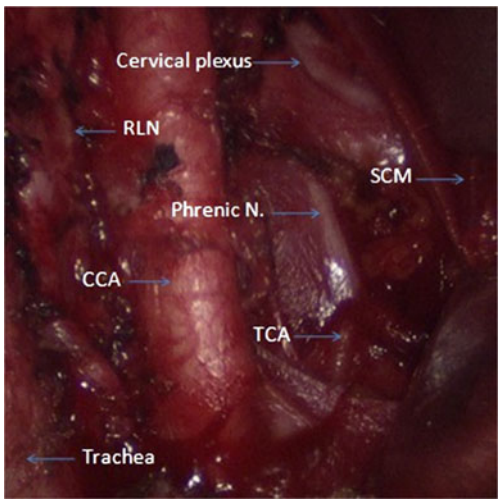

Fig. 3 The operative field during VALNLD. *RLN* recurrent laryngeal nerve, *CCA* common carotid artery, *TCA* transverse cervical artery, *SCM* sternocleidomastoid muscle, *N* nerve

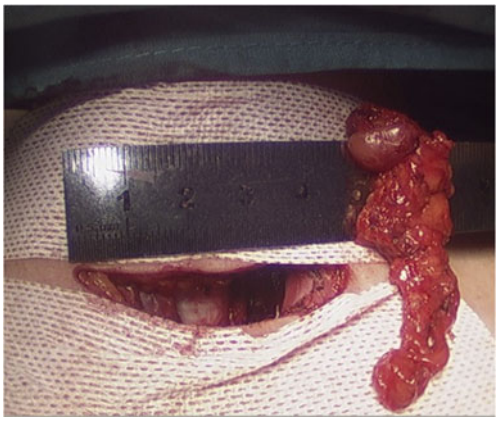

Fig. 4 The operative incision after VALNLD, and detached lymph nodes specimen en bloc in the left levels III–IV

Postoperative cosmetic results were evaluated in all patients by means of a verbal response scale (VRS) [17]. The VRS was defined as follows: 1 = poor, 2 = acceptable, 3 = good, 4 = excellent. All patients were asked to grade their cosmetic appearance of the wound 1 month after surgery.

Results

In this study, all the patients successfully underwent VAT, CND plus VASLND via the single 4- to 6-cm cervical access. The patients' operative outcomes are summarized in Table 2. The mean overall operative time was 137.7 min (range 95–183 min), with mean 46 min (range 26–75 min) spending on VASLND. Postoperative complications included: two cases of transient recurrent laryngeal nerve (RLN) palsy, with complete recovery of nerve function in 1 month postoperatively, showing normal vocal cords motility by laryngoscope examination; four transient hypoparathyroidism, requiring short-term oral calcium and vitamin D administration, who fully recovered within 3 months after surgery, showing normal calcium and parathormone levels. There was no conversion to conventional operation, and no significant blood loss. Postoperative pain was mild. Average postoperative hospital stay was 3.6 days (range 2–8 days). The final pathological diagnoses were all PTCs. Pathologic staging was 17 pT1 and nine pT2 in accordance with the American Joint Committee on Cancer (AJCC) pTNM staging system [18]. All the patients presented lymph node metastases in central level VI or ipsilateral level III, IV, even IIa. The level III was involved most frequently in lateral neck (19 of 26 cases).The mean number of removed lymph nodes was 7.3 (range 4–12) in central neck and 8.3 (range 3–21) in lateral compartment, positive yield was mean 2.6 (range 0–5) and 3 (range 0–6), respectively. Follow-up evaluations, combined with the department of nuclear medicine, were completed for all 26 patients. The follow-up

Table 2 Patients' operative outcomes

characteristics	No (range)	%
Mean operating time (min)	137.7 (95–183)	
Lateral dissection time (min)	46 (26–75)	
Mean lymph node metastases		
Central compartment	2.6 (0–5)	
Lateral compartment	3 (0–6)	
Final histopathology		
PTC	26	
Tumor stage		
pT1	17	65.4
pT2	9	34.6
Complications		
Postoperative bleeding	0	
Wound infection	0	
Seromas or hematoma	0	
Chyle leak	0	
Transient hypoparathyroidism	4	15.38
Transient unilateral RLN palsy	2	7.69
SLN palsy	0	
Postoperative mean stay (days)	3.6 (2–8)	
Lateral node metastases (cases)		
Level III	19	73.08
Level IV	15	57.69
Level IIa	6	23.08
Completeness of the resection		
Remanent on US/CT	0	
Mean sTg off LT4(ng/ml)	6.2	
Mean RAIU (%)	1.9	

PTC papillary thyroid carcinoma, *RLN* recurrent laryngeal nerve, *SLN* superior laryngeal nerve, *US/CT* ultrasonography/computed tomography, *RAIU* radioiodine 131I uptake

period was average 19 months (range 3–36 months). Follow-up data were obtained by outpatient consultations or telephone contact. Suppressive levothyroxine (LT4) treatment was received postoperatively by all the patients. Laryngoscopy was applied preoperatively and 3 days postoperatively in all the cases to examine vocal cord motility, only two cases showed vocal cord hypomotility postoperatively, but both recovered when checked 4 weeks later. US was performed in the neck 3–6 months postoperatively, showing the absent sign of residual thyroid tissue, tumor and lymph node invasion in all the patients. Postoperative sTg level on LT4 was undetectable (<0.1 ng/ml) in most patients, while the average sTg level off LT4 was 6.2 ng/ml (range 0.2–17.8) except for 11 patients (42.3 %) in whom these were undetectable (<0.1 ng/ml). Median RAIU was 1.9 % (range 0.1–8.3 %) at 6 months postoperatively except for absence in two patients, RAIU was <1 % in six of the patients (25.0 %). Eleven patients were selected for DxWBS on the basis of risk factors at 6–12 months

postoperatively, and no locoregional or distant cancerometastasis was revealed. After 3 months, the scars were scarcely visible (Fig. 5), and all patients were satisfied with the cosmetic result.

Discussion

Usually, a long cervical incision (L-shaped, U-shaped, or extended collar) is required to accomplish lateral neck dissection for patients with thyroid malignancy. While the majority of PTC patients are young or middle-aged women for whom the cosmetic result would be of utmost importance. Thus, it is a big challenge to diminish cervical disfigurement resulting from above-mentioned long incision, meanwhile finish effective and safe lymphadenectomy. Recently, MIVAT has been widely adopted by us and other surgical teams for thyroid benign nodules [7, 13, 19]. The tentative endoscopic lateral neck dissection also mainly adopted the cervical approach [5, 12], while the main difficulty was to accomplish an accurate lymphadenectomy at lateral neck compartment [20], i.e., the completeness of the surgical resection. Based on our experience of MIVAT for benign nodules and prophylactic CND for papillary thyroid microcarcinoma (PTMC), we attempted to perform the VASLND via a 4- to 6-cm cervical incision for small (belowT2) PTCs. Our preliminary results have demonstrated that it is a feasible and safe procedure, with an excellent cosmetic outcome and no additional morbidity.

The eligibility criteria we proposed were based on tumor size, capsular invasion, and lymphatic metastasis. Based on the criteria defined by Caron et al. [21], Level I, II and V lymph nodes are resected only when there is evidence of clinical/echographic positive lymph nodes or aggressive local lesion. In other words, levels III and IV often need be dissected because of being involved frequently in metastatic PTC, while level II is resected when extensive lymph nodes involve in level III. Thus, preoperative utilization of high-resolution US and ultrasound-guided FNAC would play an important role. In our all cases, the selected patients were PTCs with suspicious lymph node metastasis at ipsilateral level III, IV, or IIa by US imaging preoperatively, whereas there was no overt lymph node metastasis at level I, IIb or V. Therefore, the central level VI and selective level III, IV, or even IIa lymph node dissection were performed in all cases.

Fig. 5 In a 21-year-old woman, the scar was scarcely visible 3 months after VALNLD

As for the oncologic validity of this procedure, it seems to be comparable to that of conventional surgery if selection criteria are strictly followed. In our study, all the patients were primarily measured by cervical US, sTg levels on and off LT4, and RAIU test at 3- to 6-month intervals postoperatively to evaluate the completeness of surgical resection. Some of them were qualitatively diagnosed by DxWBS to assess the oncological effectiveness. The absent sign of residual thyroid tissue was revealed by US imaging postoperatively in all the patients, RAIU<1 % and undetectable sTg levels also reflected the outcome. The negative result by DxWBS revealed no locoregional or distant cancerometastasis. These lines of evidence demonstrated that it was possible to achieve adequate completeness of VASLND. Furthermore, the incidence of major complications arising from VASLND was seemingly not higher than that from conventional surgery. In our study, there were only two cases of transient RLN palsy; four transient hypoparathyroidism. They all fully recovered during the 3-month follow-up. No chyle leak and other major complications occurred.

In fact, the endoscope is convenient to meticulously explore the operative field, also quite clear to identify even slightly enlarged lymph node; hence, the clearance of lymph node could be better achieved. At the same time, thanks to the magnification of the endoscope, the neck structures were exposed more clearly, which permitted careful dissection and safe preservation of the important structures, such as the central RLN, parathyroid glands, and the lateral vagus nerve, phrenic nerve, spinal accessory nerve, carotid artery, IJV, transverse cervical artery, and thoracic duct (right lymphatic duct) [12]. That could reduce the injury to neurovascular tissue and guarantee a safe surgical resection of lateral neck nodes. In addition, the use of harmonic scalpel has allowed this procedure to be greatly improved. In particular, it significantly reduced the intraoperative blood loss and the operation time. Thus, the better cosmetic result, less surgical trauma or pain, and shorter the postoperative hospital stay and recovery period could be acquired when compared with our traditional surgery. Obviously, a 4- to 6-cm scar is preferable to a conventional longer scar (Fig. 1a,b).

Although the best cosmetic results may be achieved by totally endoscopic techniques via the extracervical approach (such as thoracic-breast, or axilla), their minimal invasiveness is still controversial due to the longer operation time and the wider extracervical tissue dissection [22]. More importantly, with regard to lateral neck dissection via an extracervical approach, there must be a longer learning curve, more demanding techniques, or more specific instruments, even much more expensive robotics. Whereas our procedure not only avoids a long cervical incision and remote extracervical dissection thereby causing less trauma, but also it is convenient to manually palpate the tumor and accomplish bilateral surgery. In addition, the procedure is also convenient to controlling bleeding, and converting to conventional open procedure easily in the case of uncontrolled bleeding or unexpected aggressiveness of the disease. Nevertheless, several limitations still exist in this procedure: level I, IIb and V lymph nodes can be difficult to dissect effectively; it still leaves a small scar in the neck; and harmonic scalpel is expensive.

Finally, we should pay some attention to this procedure. For one thing, we should keep in mind that the safety of patient takes precedence over the cosmetic result. If the dissection of the lateral neck node cannot be as accurate as conventional surgery, conversion to a longer incision is mandatory [4]. Moreover, owing to the small skin incision and working space, the thyroid tumor should be gently manipulated and extracted, thereby preventing thyroid capsule rupture with possible increased risk of the cancer cell seeding in the operative field. In addition, thermal stimulation of the harmonic scalpel may probably impair the function of RLN, the blood supply of parathyroid, or other neck structures. Therefore, it is important to not only avoid blind hemostasis during dissection, but also use the harmonic scalpel or electronic cautery more carefully when dissecting close to nerve (distance <5 mm) [6]. Accordingly, the camera holder should work closely with the surgeon and skillfully adjust the endoscope according to demand. Indeed, to achieve the best results, an appropriate training on VASLND is necessary.

In conclusion, our preliminary experience demonstrates that VASLND is a feasible and safe procedure for selected PTCs, with superior appearance and less trauma. We believe that the indications for VASLND could be further expanded with growing experience. Nevertheless, in order to further validate its oncological effectiveness, larger series and multi-institutional comparative studies with longer follow-up are necessary.

Conflicts of interest The authors declare that they have no conflicts of interest or financial ties to disclose.

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