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Medial-to-Lateral Approach in Neck Dissection

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ABSTRACT

This video introduces a medial-to-lateral neck dissection technique in the management of head and neck cancer, emphasizing the importance of the middle layer of the deep cervical fascia as a key surgical landmark. The technique involves systematic dissection from superficial lymphatic tissue (Paddle 1) to deeper structures (Paddles 2 and 3), offering better visualization and preservation of functionally important structures, such as the cervical nerves. This approach enhances surgical precision, minimizes nerve damage, and optimizes lymphatic tissue removal.

1 | Introduction

Neck dissection is a fundamental procedure in the management of head and neck cancers and is performed either prophylactically or therapeutically, depending on the stage of the disease. Traditionally, surgeons have adopted a lateral-to-medial approach, initiating resection away from centrally located tumor sites, such as those in the pharynx and larynx [1, 2]. However, some experienced surgeons occasionally employ a medial-to-lateral approach, which may facilitate more efficient dissection than the conventional lateral-to-medial method. The author (KH) has reported that preserving the cervical nerves (CNs) during neck dissection is beneficial for maintaining cervical sensation and is oncologically safe in many cases [3, 4]. In these cases, the medial-to-lateral approach was used to functionally preserve the CNs. Despite these advantages, a comprehensive step-by-step guide for performing medial-to-lateral neck dissection is lacking. Herein, we address this gap by presenting a medial-to-lateral dissection method through surgical video demonstrations. Emphasis is placed on the middle layer (ML) of the deep cervical fascia, as accurate anatomical understanding and manipulation of the ML are crucial for this approach.

1.1 | Anatomical Overview of the Middle Layer of the Deep Cervical Fascia

The ML of the deep cervical fascia is a critical anatomical structure that serves as a pivotal surgical landmark in medial-to-lateral dissection. It spans from the hyoid bone to the infrahyoid muscles and divides the space between the superficial (SL) and deep (DL) layers of the deep cervical fascia. The ML extends superolaterally over the posterior belly of the digastric muscle (PBDM) and inferolaterally over the omohyoid muscle (OHM). Notably, the ML covers the carotid bulb and adjacent veins (Figure 1).

1.2 | Concept of Lymphatic Paddles

The (adipo-)lymphatic tissue in the neck can be subdivided into three paddles based on their location relative to the ML and the internal jugular vein (IJV) (Figure 1):

Paddle 1: Lymphatic tissue superficial to the ML.

Paddle 2: Lymphatic tissue deep to the ML and medial to the IJV.

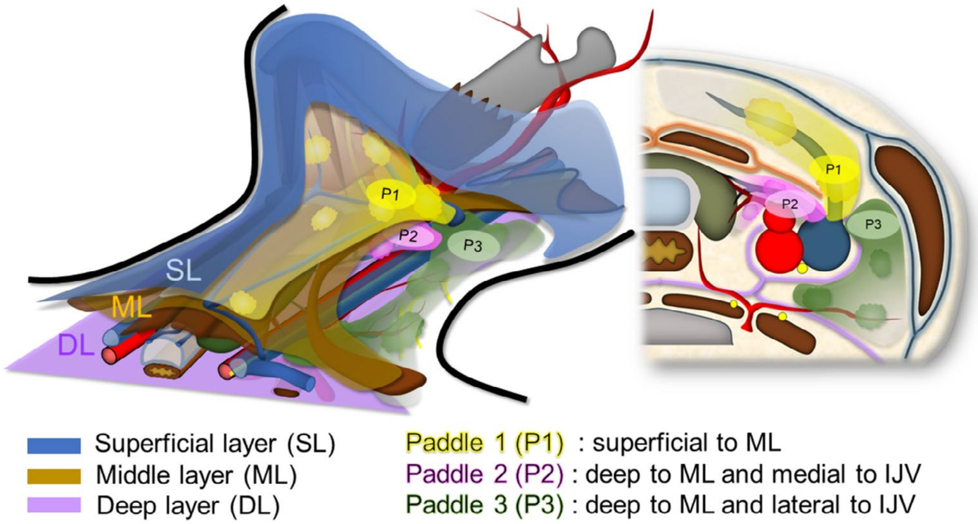

FIGURE 1 | The layers of the deep cervical fascia and the concept of lymphatic "Paddles." [Color figure can be viewed at wileyonlinelibrary.com]

Paddle 3: Lymphatic tissue deep to the ML and lateral to the IJV.

Paddle 1 includes lymphatic tissue associated with the superficial venous system (SVS), such as the submental vein, facial vein, anterior jugular vein, and external jugular vein. It contains Level I and a part of Level II lymph nodes superficial to the ML.

Paddle 2 includes lymphatic tissue in the para-hyoid and para-laryngeal areas, which are associated with the anterior branches of the IJV such as the lingual vein, laryngeal vein and superior thyroid vein. Paddle 2 serves as a conduit connecting the central compartment organs (e.g., the larynx, pharynx, and thyroid gland) to the lymphatic tissue in Paddle 3.

Paddle 3 is closely associated with the IJV and contains most of the Level II to V lymph nodes. Lymphatic flow from the face and oral cavity passes through Paddle 1 to reach Paddle 3, while flow from the pharynx and larynx passes through Paddle 2 to reach Paddle 3 (Video S1).

2 | Operative Procedures

In medial-to-lateral neck dissection, surgeons proceed systematically from Paddle 1 to Paddle 3. After elevating a skin flap, the SL over Paddle 1 is incised, following anatomical landmarks including the anterior belly of the digastric muscle, hyoid bone, lateral edge of the sternohyoid muscle, anterior border of the sternocleidomastoid muscle (SCM), and mandibular bone (Figure 2A).

From the anterior margin of the SCM, dissection advances to the undersurface of the SCM, creating a surgical field for later Paddle 2–3 dissection. The spinal accessory nerve (SAN) is identified at its entry into the SCM, and the bundle of cervical nerves (CNs) is located where they cross the posterior edge of the SCM.

2.1 | Paddle 1 Dissection

Paddle 1 lymphatic tissue includes the submental (Level IA), submandibular (Level IB), and superficial part of Level II lymphatic tissues. Typically, the marginal mandibular branch of the facial nerve is identified where it traverses the submandibular gland, lying immediately deep to the SL of the deep cervical fascia. The key to successful identification is to raise the skin flap precisely over the SL. Once the marginal mandibular branch is preserved, the submental and facial arteries and veins are transected. The submental artery and vein, located in a narrow region bounded by the inferior border of the mandibular bone and the anterior belly of the digastric muscle, penetrate the mylohyoid muscle to communicate with the oral floor. As the submental and facial vessels connect Paddle 1 lymphatic tissue to the oral floor and facial region, respectively, transecting these vessels enhances the mobility of Paddle 1 lymphatic tissue. Following release from the mandibular bone, careful dissection is required to separate Paddle 1 lymphatic tissue from the underlying mylohyoid muscle. As dissection progresses toward the hyoid bone, the fascia overlying the mylohyoid muscle thickens and becomes whitish, extending inferiorly to form the ML. The lingual nerve is identified as it courses behind the superior part of the mylohyoid muscle near the posterior end of the mylohyoid line. Transection of the submandibular ganglion, submandibular duct, and proximal trunk of the facial artery allows for laterally flipping of Paddle 1 including the submandibular gland, exposing the surface of ML. This maneuver facilitates further blunt dissection along the PBDM and the OHM, revealing the lateral extension of the ML. A thin layer of ML between the PBDM and the superior belly of the OHM covers the carotid bulb and anterior branches of the internal jugular vein (IJV), separating superficial Paddle 1 from deep Paddle 2 (Figure 2B,C). Notably, the hypoglossal nerve lies beneath the ML, whereas the lingual nerve runs superficially to the ML in the submandibular region.

2.2 | Paddle 2 and Paddle 3 Dissection

To access the lymphatic tissue within Paddles 2 and 3, incisions are made in the upper, medial, and lower portions of the ML. The upper ML is cut obliquely along the lower edge of the PBDM, while the medial ML is incised longitudinally along the lateral border of the infrahyoid strap muscles. Transecting the upper belly of the OHM at its hyoid bone attachment exposes

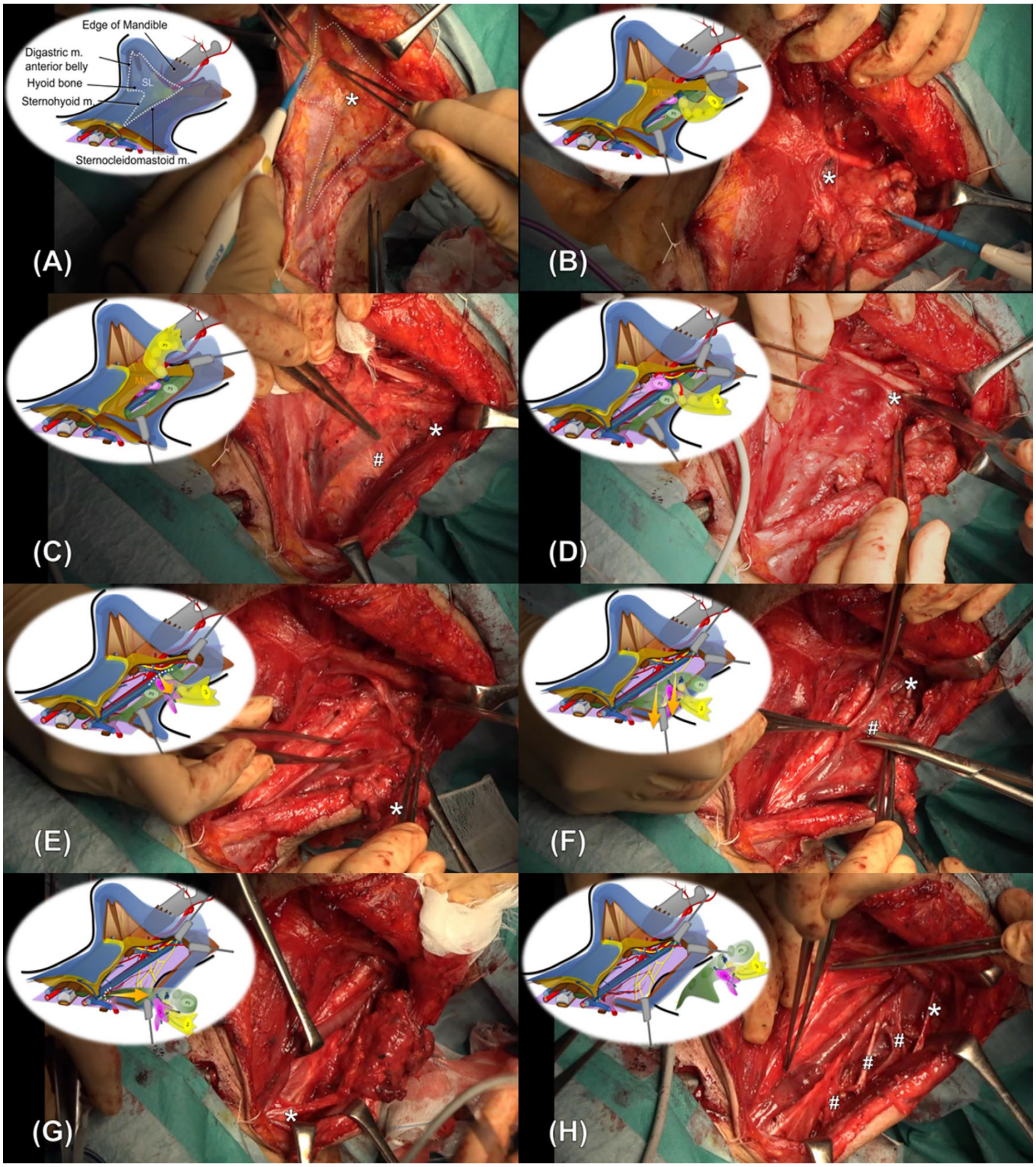

FIGURE 2 | (A) To initiate the dissection of Paddle 1, a superficial layer of the deep cervical fascia is incised along the anterior belly of the digastric muscle, the hyoid bone, the lateral edge of the sternohyoid muscle, and the sternocleidomastoid muscle (*). (B) The middle layer of the deep cervical fascia is revealed by flipping Paddle 1 laterally. The middle layer (*) covers the space between the posterior belly of the digastric muscle and the superior belly of the omohyoid muscle. (C) The surgical field is secured by utilizing two muscle retractors placed along the posterior belly of the digastric muscle and the inferior belly of the omohyoid muscle. Dissection of the undersurface of the sternocleidomastoid muscle creates a good surgical view of the superficial aspect of Paddle 3. *, spinal accessory nerve; #, cervical nerves. (D) The surface of the carotid bulb and external carotid artery is covered with Paddle 2, which is underneath the middle layer of the deep cervical fascia. *, hypoglossal nerve. (E) Paddle 2 has been dissected from the carotid artery to expose the entire length of the internal jugular vein. Dissected Paddle 1(*) has been pulled out from surgical field to maintain optimal visualization. (F) The internal jugular vein is circumferentially dissected from Paddle 3. The deep layer of the deep cervical fascia (#) is subsequently identified posterior to the internal jugular vein. *, spinal accessory nerve. (G) Large lymphatic trunks (*) around the jugular angle are carefully sealed and transected to complete neck dissection. (H) Modified radical neck dissection has been completed without elevating the lateral skin flap over the sternocleidomastoid muscle. *, spinal accessory nerve; #, preserved cervical nerves. [Color figure can be viewed at wileyonlinelibrary.com]

Paddle 2 in the para-hyoid and para-laryngeal areas. The inferior portion of the ML is cut horizontally along the supraclavicular line, and transecting the inferior belly of the OHM enhances mobility of the supraclavicular part of the Paddle 3 lymphatic tissue.

With the PBDM retracted superiorly, dissection of the upper part of Paddle 3 begins, carefully separating it from the upper IJV. The proximal segment of the SAN is identified and preserved. In the lower neck, the lymphatic tissue between the ML and the IJV surface is sparse, with most Level IV lymph nodes positioned lateral to the IJV. The dissection continues around the IJV to release the lowermost part of Paddle 3 (i.e., Level IV) from the IJV.

In Paddle 2, the anterior branches of the IJV (lingual, laryngeal, and superior thyroid veins) are accompanied by small amounts of lymphatic tissue. Depending on the lymphatic channel to be extirpated, lymphatic tissues are selectively removed with or without the accompanying veins (Figure 2D). Dissection of Paddle 2 continues from medial to lateral until the surface of the external carotid artery (ECA) and IJV is fully exposed (Figure 2E).

With the entire length of the IJV in view, Paddle 3 is dissected from the IJV (Figure 2F). The vagus nerve is identified on the back of the carotid sheath. Once the dissection reaches the DL, the IJV and carotid artery are retracted medially to identify the sympathetic trunk running beneath the DL. The fascia connecting the posterior aspect of the carotid sheath to the DL forms the medial wall, which delineates the medial end of the Paddle 3 dissection.

The underside of Paddle 3 is dissected off the DL in a medial-to-lateral manner until the roots of the CNs appear over the middle scalene muscle. These CNs are preserved by dissecting them from their roots to their peripherals. The lateral margin of Paddle 3 is cut from top to bottom, preserving the SAN and CNs. The surface of the anterior scalene muscle can be bluntly dissected along the DL. Observation on the backside of Paddle 3 usually identifies the pulsating transverse cervical artery emerging from the medial edge of the anterior scalene muscle. The transverse cervical artery can be mobilized from Paddle 3 by cutting several ascending branches. After preservation of the transverse cervical artery, the lower margin of Paddle 3 is cut along the supraclavicular line until the dissected tissue is connected only to the jugular angle. Large lymphatic trunks in this area are carefully sealed and transected to complete the neck dissection (Figure 2G,H).

3 | Discussion

In the neck, lymphatic tissue, consisting mostly of invisible lymphatic vessels and numerous lymph nodes, is embedded within the adipose tissue. This enables surgeons to effectively remove lymphatic structures by excising the visible adipose tissue en bloc. Thus, neck dissection can be considered a procedure that targets the comprehensive removal of cervical adipose tissue.

Lymphatic vessels in the neck typically accompany their corresponding veins, suggesting that visible venous pathways can infer the direction of invisible lymphatic flow. In the upper neck, the lymphatic flow direction mirrors that of the SVS, which includes veins such as the submental, facial, anterior, and external jugular veins. Consequently, the lymphatic flow in Paddle 1 is oriented from superior to inferior and from medial to lateral. As Paddle 1 directly receives lymphatic drainage from the anterior head via the SVS, it is often the primary target in neck dissections for oral cancers. The lymphatic flow in Paddle 2 follows a medial-to-lateral trajectory aligned with the branches of the IJV, such as the lingual and superior thyroid veins. Paddle 2 is located beneath the ML and serves as the initial lymphatic drainage site for the pharynx, larynx, and deep parts of the tongue. Therefore, during neck dissection for cancers originating from the pharynx or larynx, meticulous removal of the lymphatic tissue in Paddle 2 surrounding the relevant veins adjacent to the primary tumor is crucial. Paddle 3 is the destination of the lymphatic flow through Paddles 1 and 2. The lymphatic flow direction in Paddle 3 aligns with the downward course of the IJV.

In the medial-to-lateral approach, the dissected tissue can be retracted and maintained outside the surgical field, thereby providing optimal visualization throughout the procedure. Consequently, elevation of the lateral skin flap over the SCM is not necessary, which is effective in preserving cutaneous sensation in the lateral neck.

Performing neck dissections from Paddle 1 to Paddle 3 allows surgeons to target the most common metastatic sites early in the procedure. Observing metastatic lymph nodes in Paddle 1 or 2 intraoperatively enables tailored dissection in Paddle 3, influencing oncologic decisions on the extent of lateral dissection and the preservation or resection of CNs and the DL of the deep cervical fascia.

A key technical advantage of the medial-to-lateral approach is the preservation of the CNs. This dissection technique enables easier identification and preservation of these branching nerves, which is typically more difficult when dissecting in the opposite direction.

The author reported that the preservation of cervical nerve (CN) roots was feasible in 80% of elective neck dissections (114/142 cases) and 31% of therapeutic neck dissections (61/193 cases) [3]. However, previous studies have shown that preserving CN roots does not consistently correlate with the preservation of postoperative cutaneous sensation. Sensory deficits remain common even after CN roots are preserved, particularly when the terminal branches of the CNs are damaged during sub-platysmal dissection [4, 5].

A potential advantage of the medial-to-lateral approach in neck dissection is its ability to preserve the CNs without requiring extensive sub-platysmal dissection of the lateral neck. This approach minimizes the risk of injury to the terminal branches of the CNs, thereby maintaining the integrity of the functional sensory neurocutaneous unit. The author has previously demonstrated that early postoperative sensory outcomes are significantly improved when the medial-to-lateral approach with sub-SCM dissection is employed, compared to the conventional sub-platysmal technique [4]. In the comparative study, early postoperative sensory function was assessed in 54 necks after CN-preserving neck dissection using the medial-to-lateral approach and in 32 necks after CN-preserving conventional neck dissections. The results showed significantly improved early postoperative sensory outcomes with the medial-to-lateral approach (Table 1). Statistical significance was observed in the submandibular, lateral neck, and sub-clavicular regions, underscoring the advantages of the medial-to-lateral approach in reducing early postoperative sensory loss.

While most therapeutic or elective neck dissections can be effectively performed using a medial-to-lateral approach, there are

TABLE 1 | Sensory preservation rates by dissection approach in neck dissection where the cervical nerve roots were preserved [4].

	Medial-to-lateral ($n = 54$)	Conventional ($n = 32$)	p
Ear tab	44 (81.5%)	21 (65.6%)	0.098
Submandibular	15 (27.8%)	3 (9.4%)	0.043
Lateral neck	50 (92.6%)	14 (43.8%)	< 0.001
Sub-clavicular	51 (94.4%)	23 (71.9%)	0.004

Note: p values calculated using χ^2 test.

certain exceptions in which alternative methods may be more appropriate. These exceptions include the following situations:

- Cases in which the primary tumor is resected along with the surrounding cervical adipolymphatic tissue, as observed in locally advanced lingual or lower gingival cancers.
- Necks presenting with significant extracapsular invasion by metastatic nodes that involve critical structures, such as the ECA.

In such cases, a conventional lateral approach or a combination of medial and lateral approaches may be more suitable for ensuring thorough and safe dissection.

4 | Conclusion

The medial-to-lateral approach facilitates the execution of highly precise, patient-specific neck dissection for head and neck cancer. This technique is particularly advantageous in preserving functionally significant anatomical structures such as the CNs and the DL of the deep cervical fascia. A comprehensive understanding of the three-dimensional architecture of cervical lymphatic tissue in relation to the ML of the deep cervical fascia is essential for effective implementation of this approach. By describing a systematic, step-by-step procedure for this method, we aim to enable surgeons to adopt this approach with confidence and safety, thereby expanding their surgical repertoire.

Ethics Statement

The surgical video presented in this manuscript was recorded with the informed consent from the patient. The patient was informed about the potential use of the video for academic and educational purposes, and the possibility of its inclusion in publications. The patient provided written consent for recording and subsequent use of the video.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.