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Technical nuances and step- by - step approach of Robotic Assisted Breast Axillo Insufflation Neck Dissection (RABIND) - A novel technique from tertiary cancer centre

Surender Kumar Dabas
Manipal Hospital
Sukirti Tiwari
sukirti.t@gmail.com
Manipal Hospital
Reetesh Ranjan
Manipal Hospital
Himanshu Shukla
Manipal Hospital
Bikas Gurung
Manipal Hospital
Nandini Menon
Royal Marsden Hospital
Bharat B Bassan
Manipal Hospital
Daksh Goel
Manipal Hospital

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Abstract

Minimally invasive surgery in head and neck oncology has significantly advanced the approach to neck dissection, offering improved cosmetic and functional outcomes. We introduce a novel technique termed **Robotic-Assisted Breast Axillo-Insufflation Neck Dissection (RABIND)**. This article provides a comprehensive and detailed description of the technique, along with a step-by-step procedural approach to facilitate its ease and reproducibility in clinical practice.

Our experience includes over 150 cases performed using this method, during which continuous refinements and technical modifications were implemented to optimize surgical efficiency and outcomes. RABIND has better functional and oncological outcome when compared to the conventional neck dissection.

Introduction

Cervical nodal metastasis is the single most independent prognosticator of oral squamous cell carcinoma. Presence of cervical nodal metastasis reduces the overall survival rates by 50% and subsequently reduces more if extranodal extension is noted. The management of neck in Oral SCC is one of the most debatable topic.[1] Over the years, significant advances in neck dissection have occurred with respect to the type of incision, lymph node levels addressed, and extent and type of neck dissection. The evolution of this procedure began with the introduction of radical neck dissection in 1905 and has progressed through successive refinements in surgical technique to the development of robotic neck dissection in the early 2000s. This evolution represents a paradigm shift in the management of the neck, from conventional radical surgery towards minimally invasive and robotic approaches.

Minimally invasive surgery has gained widespread acceptance in abdominal and urological procedures. Its application in head and neck surgery was subsequently expanded with the introduction of transoral robotic surgery (TORS) in 2006 by Drs. Weinstein, O'Malley, and their colleagues.[2] This was followed by the development of various robotic approaches for thyroidectomy and neck dissection, with the aim of achieving adequate oncological clearance while minimizing visible surgical morbidity.

Robotic neck dissection was first described by Kang et al. in 2010[3] and subsequently by Kim et al. in 2012[4], using different surgical approaches. Initially, transaxillary and retroauricular approaches were utilized for the removal of cervical lymph nodes. Subsequently, several techniques combining different approaches have been described to facilitate adequate clearance of various nodal levels while improving surgical access and cosmesis.

In this article, we describe our technique of robotic neck dissection in details and shared our insights about this technique. We have named this technique as Robotic Assisted Breast Axillo Insufflation neck dissection(RABIND). We highlight the key technical steps and practical considerations that may facilitate a better understanding and reproducibility of the procedure.

For ease of understanding, we have divided the procedure into manual flap elevation, Robot docking and working space creation in chest and neck region and lastly lymph node clearance from different levels depending upon the primary pathology.

Patient Positioning

The patient was positioned supine with the neck maintained in a neutral position, avoiding cervical extension. The preferred positioning was the “praying mantis” position, in which the upper extremities are placed alongside the head with the elbows flexed. This position facilitates adequate surgical exposure while maintaining neutral cervical alignment.

Following positioning, the relevant anatomical landmarks in the cervical and pectoral regions were identified and marked. In the cervical region, the superior boundary was defined by the inferior border of the mandible, with the sternocleidomastoid muscles identified bilaterally. The inferior boundary was marked at the sternal notch in the midline, while the postero - lateral boundary was delineated by the external jugular veins.

In the pectoral region, the clavicles, anterior axillary lines, and bilateral nipple–areolar complexes were identified and marked.

Port Placement and Flap Elevation

A four-port configuration was used, comprising three robotic instrument ports and one port for a 0° or 30° endoscopic camera. Manual flap elevation was initiated preferentially on the side of the neck dissection. The port placement described below corresponds to a **left-sided neck dissection**.(Fig. 1)

The first port was positioned approximately 1 cm posterior to the left anterior axillary line through a 1.5-2 cm skin incision. This incision was used for initial manual elevation of the chest flap, extending medially toward the second port and superiorly toward the ipsilateral clavicle. During this initial dissection, the posterior border of the pectoralis major muscle was identified. The pectoral fascia was subsequently used as a consistent anatomical landmark and guiding plane for flap elevation. The flap was elevated in the plane between the subcutaneous tissue and the fascia overlying the pectoralis major muscle, thereby maintaining the dissection superficial to the pectoral fascia.

Once adequate working space had been created, the second port was positioned at the 11 o’clock position to the left nipple–areolar complex (NAC). Following placement of the first two ports, the DA Vinci Xi robot was docked. Under endoscopic visualization, the monopolar scissors were introduced through the robotic instrument arm and used to continue elevation of the pectoral flap within the previously established plane overlying the pectoralis major fascia.

The third port was marked at the 1 o’clock position relative to the contralateral NAC. After adequate working space had been created, the third port was inserted **under direct endoscopic vision**. A Maryland

bipolar forceps was then introduced through the third port and used to provide countertraction, facilitating further dissection and creation of the working space required for placement of the fourth port. The fourth port was positioned at the contralateral anterior axillary line. Following insertion, fenestrated bipolar forceps were introduced through the fourth port.

The robotic chest flap was subsequently elevated in the same anatomical plane established during the initial manual dissection, immediately superficial to the pectoralis major fascia. The assistant surgeon plays a critical role during port placement by directing the console surgeon toward the appropriate trajectory and assisting in optimization of the working space for subsequent port insertion.

Particular caution was exercised during flap elevation across the midline, where paraseptal perforating vessels may be encountered. These vessels were identified and managed carefully to minimize the risk of vascular injury and preserve flap viability. (Fig. 2)

The **da Vinci Xi robotic surgical system** permits the use of both conventional and bariatric-length trocars. In patients with a broad chest, including males with a wide thoracic circumference and females with a larger breast volume, bariatric trocars were preferentially used for ports 3 and 4 to facilitate adequate reach and instrument maneuverability within the working space.

Modification of Port Placement in Broad-Chested Male Patients

In male patients with a broad chest and a prominent thyroid cartilage, a slight modification of the standard port configuration may be required. In such cases, the port normally positioned in relation to the nipple–areolar complex is shifted superiorly along the same longitudinal axis. The skin incision is placed approximately three fingerbreadths superior to the standard position.(Fig. 1B)

This modification provides improved instrument accessibility during clearance of level IIb lymph nodes and reduces the tendency of the instruments to glide over the prominent thyroid cartilage. The superior displacement of the port thereby facilitates a more favorable trajectory toward the upper cervical surgical field while maintaining adequate instrument maneuverability.

Robotic flap elevation in neck

Following completion of the initial chest flap elevation, dissection is continued superiorly into the cervical region to establish the working space. The sternal notch is identified in the midline, and the platysma is identified laterally. A subplatysmal plane is then developed and extended superiorly and laterally under direct endoscopic visualization.

The principal anatomical landmarks encountered during cervical flap elevation include the anterior jugular veins, bilateral sternocleidomastoid (SCM) muscles, external jugular veins laterally, and the inferior border of the mandible superiorly. Fenestrated bipolar and Maryland bipolar forceps are used to

provide controlled traction and countertraction, facilitating precise development of the subplatysmal plane.

Particular attention is required during flap elevation in the submental region, where the presence of natural skin folds increases the risk of inadvertent buttonholing. This risk may be further accentuated by maintaining the neck in a neutral position, as cervical extension is deliberately avoided throughout the procedure. The posterior extent of flap elevation is defined by identification of the external jugular vein and greater auricular nerve. Branches of the superficial cervical plexus and other relevant cutaneous sensory nerves are identified and preserved whenever feasible to minimize postoperative sensory disturbance.

Orientation of Instrumentation

The configuration of the robotic instruments is adjusted according to the side of the neck dissection to optimize instrument triangulation and facilitate dissection.

For a **left-sided neck dissection**, the endoscopic camera is positioned through the third port (R3). The Fenestrated bipolar forceps and Maryland bipolar forceps are positioned on either side of the camera through the first port (R1) and fourth port (R4) respectively. The monopolar scissors are introduced through the second port (R2), adjacent to the fenestrated bipolar forceps.

For a **right-sided neck dissection**, the instrument configuration is modified such that both bipolar instruments—the Maryland bipolar forceps and fenestrated bipolar forceps—are positioned to the left of the endoscopic camera, while the monopolar scissors are positioned to the right.

Endoscopic Camera Selection

A 0° endoscopic camera is used during initial creation of the working space in both the pectoral and cervical regions. Following completion of flap elevation the 0° camera is exchanged for a 30° endoscopic camera. The angled field of view provided by the 30° camera facilitates visualization of the cervical nodal compartments and improves access to anatomically concealed areas during lymph node dissection.

Clearance of Levels II–V

Once adequate cervical flap elevation has been achieved, the 30° endoscopic camera is introduced. The SCM muscle is identified and delineated along its anterior and posterior borders, creating a working tunnel between these boundaries. The SCM is retracted superiorly using the fenestrated bipolar forceps, thereby exposing levels II–V within a continuous operative field.

The inferior belly of the omohyoid muscle is identified, and dissection of the fibrofatty tissue lateral to the muscle is initiated. The dissection is continued lateral to the internal jugular vein (IJV), with

systematic clearance of the associated lymphatic and fibrofatty tissue. Inferiorly, dissection proceeds until the transverse cervical vessels are identified and adequately exposed. During level IV dissection, particular care is taken to identify and preserve the thoracic duct which minimize the risk of postoperative chyle leak.

During clearance of level III, the cervical plexus is identified and preserved. In level II, meticulous identification of the spinal accessory nerve (SAN) is essential. The vascular supply to the SAN is preserved whenever feasible to optimize postoperative shoulder function and facilitate rehabilitation. The SAN serves as the principal anatomical landmark separating level II into levels IIA and IIB, and both compartments are systematically cleared.

Dissection is subsequently continued medially along the IJV, with removal of the intervening fibrofatty and lymphatic tissue, including the jugulodigastric nodal basin. Throughout the dissection, the major neurovascular structures are identified and preserved while ensuring adequate oncological clearance. (Fig. 3A-H)

Clearance of Levels Ia and Ib

Level Ia is cleared by removal of the fibrofatty and lymphatic tissue within the submental triangle, bounded by the anterior bellies of the bilateral digastric muscles.

Level Ib clearance is performed by dissecting the submandibular gland and associated lymphatic tissue within the submandibular triangle, bounded by the anterior and posterior bellies of the digastric muscle. Particular attention is directed toward identification and preservation of the marginal mandibular branch of the facial nerve. The facial vessels are identified and preserved in continuity whenever oncologically appropriate. (Fig. 3I-L)

Hemostasis, Specimen Retrieval, and Closure

Following completion of the cervical lymphadenectomy, meticulous hemostasis is achieved and confirmed under endoscopic visualization. The cervical lymphadenectomy specimen is retrieved in toto using a specimen retrieval bag through port 1.

A cervical drain is subsequently placed under endoscopic guidance through the fourth port (R4), while a chest drain is placed through port 1(R1). The robotic system is then undocked. The port sites and incisions are closed in layers using 3 – 0 polyglactin (Vicryl) for the deeper tissues and 4 – 0 poliglecaprone (Monocryl) for skin closure.

Discussion

The incidence of occult cervical lymph node metastasis in head and neck squamous cell carcinoma is approximately 13%. D'Cruz et al. demonstrated that elective neck dissection confers a significant survival benefit in clinically node-negative oral cavity cancers, particularly in patients with a depth of invasion (DOI) of ≥ 3 mm. Cervical lymphatic metastasis remains an important determinant of recurrence and survival, underscoring the importance of adequate management of the clinically N0 neck.[5]

The surgical management of the neck has evolved considerably from conventional radical neck dissection to functional neck dissection and minimally invasive approaches. The oncological principle of neck dissection remains complete clearance of the lymph-bearing fibrofatty tissue within the defined nodal levels while preserving non-lymphatic structures, including the spinal accessory nerve (SAN), internal jugular vein (IJV), and sternocleidomastoid (SCM) muscle, when oncologically feasible. Robotic-assisted neck dissection has emerged as an alternative approach that aims to achieve adequate oncological clearance while avoiding a visible cervical scar.

Several remote-access approaches to robotic neck dissection have been described. The retroauricular or modified facelift approach provides a concealed incision but has certain limitations, including restricted access to the contralateral neck, potential risk of marginal mandibular nerve injury, and increased operative time.[6] Similarly, the transaxillary approach requires extensive subcutaneous tunnelling to establish access to the neck and may be associated with an increased risk of injury to the brachial plexus.[4]

Our technique offers several potential advantages over these approaches. The access provides a relatively symmetrical and direct working corridor to either side of the neck while completely avoiding a cervical skin incision. This facilitates bilateral procedures through a similar access route and may improve ergonomics during nodal clearance. The use of a robotic platform also provides enhanced three-dimensional visualization and improved instrument articulation within the confined surgical field.[7]

We routinely utilise both 0° and 30° robotic cameras according to the operative step. The 0° camera provides a more intuitive and panoramic view during elevation of the cervical and pectoral flaps, facilitating development of the working space. The 30° camera is particularly useful during dissection of anatomically deeper and more angulated regions, including levels IB, IV, and V, where an angled view facilitates visualization around critical structures and improves the line of sight during nodal clearance.

An important technical consideration in our approach is the positioning of the neck. We avoid excessive neck extension to minimise gliding of the robotic arms over the thyroid cartilage, particularly during clearance of levels I and II. Maintaining the neck in a neutral or minimally extended position provides greater stability of the operative field and facilitates controlled robotic instrument movement during nodal dissection.

Taken together, these technical modifications allow adequate exposure and systematic clearance of the cervical nodal basins while maintaining the principal advantages of a remote-access robotic approach,

namely avoidance of a visible neck scar and preservation of non-lymphatic structures. Further comparative studies with conventional and other remote-access approaches are required to establish the reproducibility, operative efficiency, oncological adequacy, and functional outcomes of this technique.

Carbon dioxide (CO_2) insufflation is an integral component of this technique and is considered a safe method for maintaining an adequate working space. In our experience, CO_2 is insufflated at a flow rate of 8–12 L/min, with the insufflation pressure maintained between 8 and 12 mmHg. End-tidal CO_2 ($EtCO_2$) is routinely monitored to detect systemic CO_2 absorption and potential hypercapnia. Although uncommon, gas-related complications can occur. In our series, we encountered one episode of suspected CO_2-related air embolism following injury to the external jugular vein, manifested by electrocardiographic changes and a fall in oxygen saturation. The procedure was promptly converted to an open neck dissection. To our knowledge, this represents the only such event encountered in our experience with this technique.[7]

Preservation of the superficial cutaneous nerves, including the greater auricular nerve, helps in better sensory function. Maintaining these sensory nerves may contribute to improved postoperative sensory function over the neck and upper chest. Transient postoperative paresthesia involving the chest and neck is observed in some patients; however, sensory function generally recovers within approximately 6 weeks in the majority of cases.

Nodal yield, defined as the total number of lymph nodes retrieved during neck dissection, is an important surrogate measure of the adequacy of cervical lymphadenectomy.[9] We have performed more than 150 robotic neck dissections using the RABIND approach. For the purpose of assessing nodal yield, patients were categorised into two groups: selective neck dissection (SND; levels I–IV) and modified neck dissection (MND; levels I–V).

The mean nodal yield was 24.36 lymph nodes in the SND (I–IV) group and 31.16 lymph nodes in the MND (I–V) group. Ebrahimi et al.[9] suggested that retrieval of at least 18 lymph nodes represents an adequate nodal yield for neck dissection. The nodal yields observed in our series exceed this proposed threshold in both groups, suggesting that robotic neck dissection using the RABIND approach can achieve an adequate nodal clearance. However, nodal yield alone should be interpreted as a surrogate measure of oncological adequacy and should ideally be evaluated alongside margin status, lymph-node density, extranodal extension, regional control, disease-free survival, and overall survival.

Complications associated with robotic neck dissection can be broadly classified into perioperative and postoperative complications. Perioperative complications include skin burns, buttonholing during flap elevation, injury to nerves or major vessels, CO_2-related complications including gas embolism, and the need for conversion to open surgery. Careful flap elevation, appropriate insufflation parameters, meticulous identification of critical neurovascular structures, and continuous cardiopulmonary monitoring are essential to minimise these risks.

Postoperative complications may include haemorrhage, flap necrosis or flap failure, chyle leak, marginal mandibular nerve injury, shoulder dysfunction, and phrenic nerve injury. We have not encountered any case of chyle leak and phrenic nerve injury in our patients. Though we have noticed that sensory changes in neck and chest region are present which improves with time and it may require upto 3–6 months to recover in certain cases. RABIND provides superior functional outcomes in terms of better neck and shoulder movement and lack of drooping of shoulder. Ji et al reported reduced edema and postoperative sensory loss in robotic neck dissection group compared to the conventional neck dissection .[10]

Limitations

Despite its potential advantages, robotic neck dissection has certain limitations. These include prolonged operative time, increased financial burden, requirement for specialised equipment and infrastructure, and a steep learning curve. The remote-access nature of the procedure also requires familiarity with altered surgical anatomy and instrument orientation compared with conventional open neck dissection.

Despite these limitations, our experience suggests that robotic neck dissection using the RABIND approach provides adequate exposure and nodal clearance while avoiding a visible cervical scar and facilitating preservation of important non-lymphatic structures. The observed nodal yields are comparable with open neck dissection and support the oncological feasibility of this technique. However, prospective comparative studies with conventional open neck dissection and other remote-access techniques are warranted to establish its long-term oncological efficacy, functional outcomes, complication profile, and cost-effectiveness.

Abbreviations

Robotic
assisted breast axillo insufflation neck dissection-RABIND
Transoral Robotic Surgery
TORS
Nipple Aerolar Complex
NAC
Spinal accessory nerve
SAN
Sternocleidomastoid muscle
SCM
Selective neck dissection
SND
Modified neck dissection
MND

Internal jugular vein
IJV

Declarations

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Conflict of interest :

No potential conflict of interest relevant to this article exist.

compliance with ethical standards:

Written and informed consent has been taken from the patient for the procedure and all procedures have been done ethically. No human or animals were used for research in the study.

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Figures



Figure 1

A. Marking of Port Positioning for left neck dissection ; R1 1.5-2cm incision marked posterior to the anterior axillary line, R2 is the 8mm incision over the 11’O clock position to left NAC, R3 is the 8mm incision over the 1’O clock position to right NAC, R4 is the 8mm incision over the contralateral anterior axillary line.

B. Modification done for board chested male patients for avoiding glide over the prominent thyroid cartilage and better accessibility to level IIb.

C. Manual flap elevation for R1 and R2 whereas robotic space creation for R3 and R4.

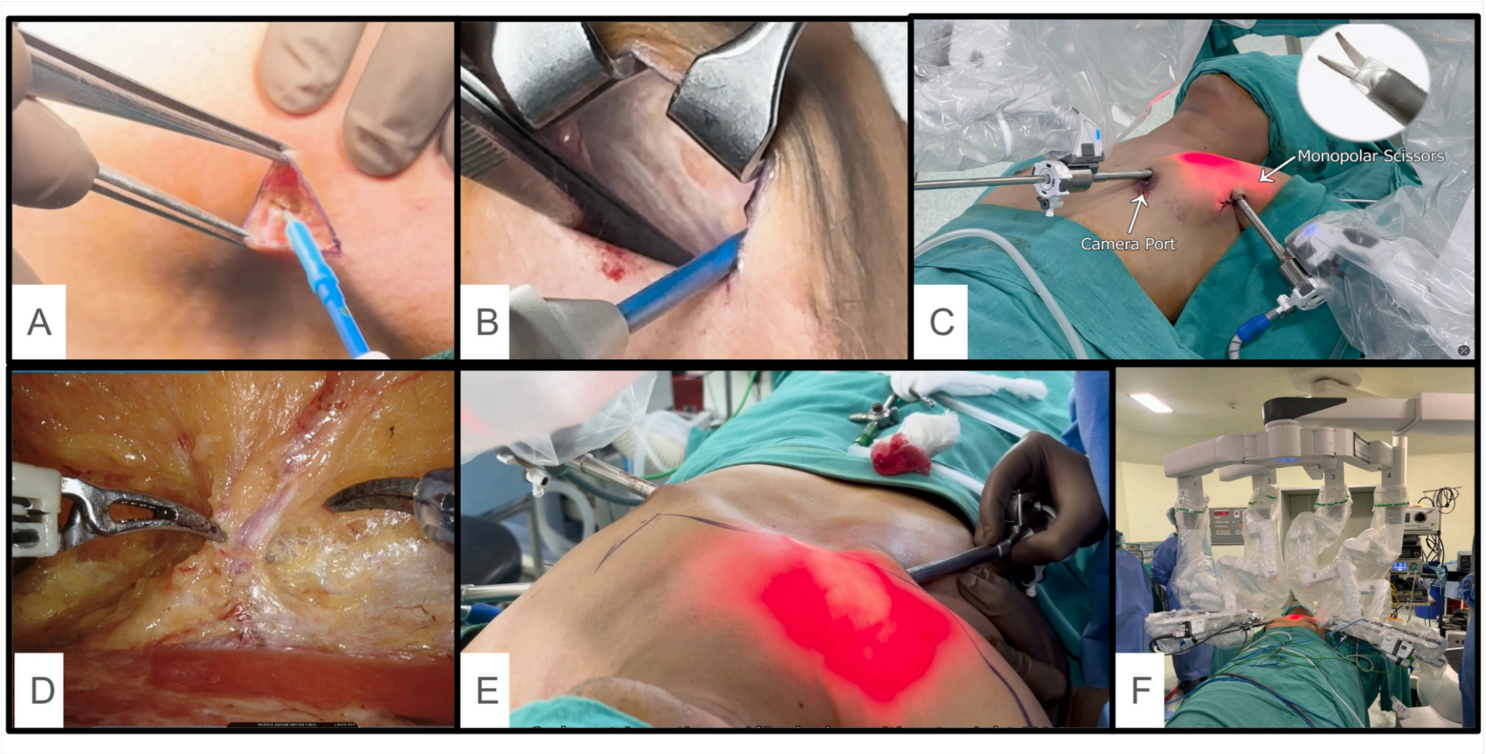


Figure 2

A. Manual flap elevation from the anterior axillary line, B. Flap elevation above the fascia of Pectoralis Major Muscle, C. Port 1 and 2 fixed, CO2 sufflation done and Robot Docking completed with Zero degree endoscopic camera in Port 2 and Monopolar Scissor in Port 1, D. Parasternal perforator encountered during robotic chest flap elevation, E. Port 3 Insertion after adequate space creation, F. Port 4 fixed and Robot docking completed

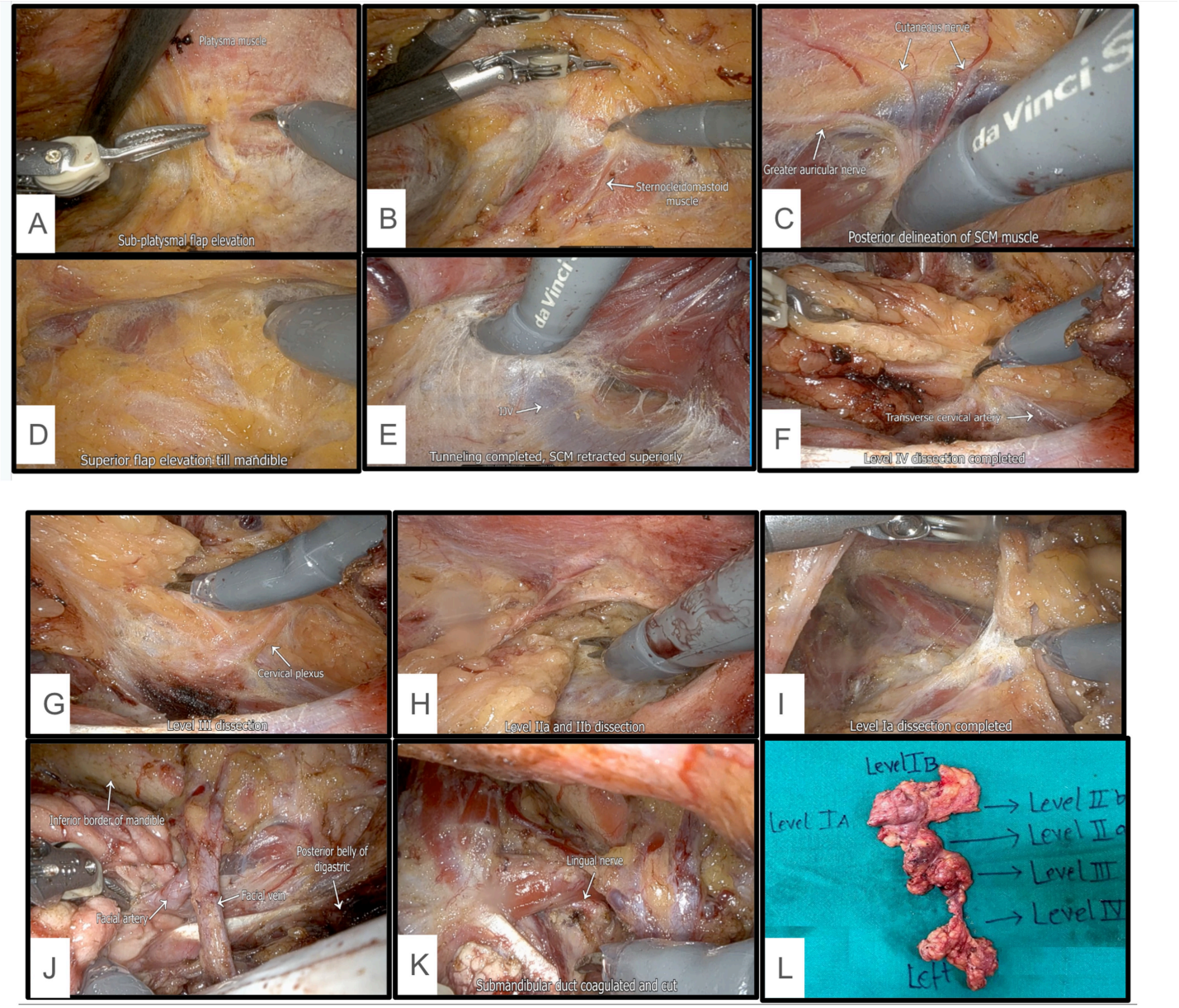


Figure 3

A. Subplatysmal Neck flap elevation , B. Identifying Sternocleidomastoid muscle bilaterally, C. Identifying Greater auricular nerve , cutaneous nerve , External jugular vein which limits the posterior extent of flap elevation, D. Exposing mandible will limit the superior extent of flap elevation, E. Delineation of SCM muscle anteriorly and posteriorly creating the tunnel for elevation of SCM, F. Identifying omohyoid muscle, internal jugular vein medially and transverse cervical vessels for adequate clearance of level IV, G. Level III lymph node clearance preserving the cervical plexus, H. Identifying the Spinal Accessory nerve and clearance from level IIa and IIb completed, I. Clearanace from level Ia by exposing bilateral anterior belly of digastric muscle, J. Level Ib clearance by meticulous identification of marginal mandibular nerve, facial vessels are preserved in toto, K. anatomy at submandibular region after clearance of level Ib, L. specimen retrieved.



Figure 4

A. 6 months Postoperative picture showing no scar in neck

B. Postoperative pic showing intact marginal mandibular nerve.