"ELECTROMYOGRAPHIC ASSESSMENT OF SPINAL ACCESSORY NERVE FOLLOWING NERVE SPARING NECK DISSECTIONS"

By

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Dissertation submitted to

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of the requirements for the degree of
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under the guidance of

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Date

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List of abbreviations(in alphabetical order)

1	**AAO-HNS**	**American Academy Of Otolaryngology Head and Neck Surgery**
2	**AJCC**	**American Joint Committee on Cancer**
3	**BOT**	**Base of Tongue**
4	**EJV**	**External Jugular Vein**
5	**EMG**	**Electromyography**
6	**FND**	**Functional Neck Dissection**
7	**IJV**	**Internal Jugular Vein**
8	**MRND**	**Modified Radical Neck Dissection**
9	**MUP**	**Motor Unit Potential**
10	**MUO**	**Metastasis of Unknown Origin**
11	**NMJ**	**Neuromuscular Junction**
12	**Pap Ca**	**Papillary Carcinoma Thyroid**
13	**PF**	**Pyriform fossa**
14	**RMT**	**Retromolar Trigone**
15	**RND**	**Radical Neck Dissection**
16	**SAN**	**Spinal Accessory Nerve**
17	**SCM**	**Sternocleidomastoid muscle**
18	**SND**	**Selective Neck Dissection**
19	**SOHND**	**Supraomohyoid Neck Dissection**
20	**TNM**	**Tumor Node Metastasis**
21	**UICC**	**International Union Against Cancer**
22	**UT**	**Upper Trapezius**

ABSTRACT

Background and objectives

Head and Neck cancers are very common in India. The gold standard for treatment of neck metastasis in head and neck cancers has been neck dissection. One of the drawbacks of radical neck dissection is post operative shoulder dysfunction which is due to removal of spinal accessory nerve. To keep postoperative shoulder morbidity to a minimum, nerve sparing neck dissections are preferred. However inspite of saving accessory nerve in neck dissections, few patients develop shoulder dysfunction. This has been attributed to nerve stretching and devascularisation during surgery. Our objective was to evaluate preoperative and postoperative changes in electromyogram related to accessory nerve with reference to nerve sparing neck dissections-MRND, FND and SOHND.

Materials and Methods

A prospective study was done on 50 patients (51 shoulders) with histopathologically proven head and neck cancers with N_0 or N_1 neck. Patients were assessed preoperatively and postoperatively at 3 weeks and 3 months by needle electromyography and muscle strength tests of upper trapezius. All patients underwent nerve sparing neck dissections-MRND or FND or SOHND.

Results and interpretation

At 3 weeks postoperatively, 11 shoulders (39.3%) in FND group and 4 shoulders (33.3%) in MRND group showed severely abnormal EMG, while in SOHND group only 2 shoulders (18.2%) shoulders showed severely abnormal EMG. All patients

who underwent nerve sparing neck dissections showed improvement in at least one category on the second electromyogram at 3 months. This could be attributed to neuropraxia or transient devascularisation of the accessory nerve. In our study, 22 patients after nerve sparing neck dissections (15 FND, 5MRND, 2 SOHND) did not show any improvement in their muscle strength in late postoperative period while their EMG showed improvement. This could be due to adhesive capsulitis. In our study, 11 patients in FND group showed severely abnormal EMG finding, but they did not have as great a degree of shoulder dysfunction as would be expected. This could be due to factors like preoperative condition of other synergistic shoulder girdle muscles, post operative exercises etc.

Conclusion

SAN injuries are common in all types of nerve sparing neck dissections, the incidence of which is less in SOHND. This injury is due to nerve stretching resulting in neuropraxia which tend to improve with time. To conclude, in patients in whom it is oncologically sound, nerve sparing neck dissections offers significant benefit in terms of shoulder function.

Key Words: Spinal accessory nerve, electromyography, supraomohyoid neck dissection

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INTRODUCTION

Head and neck cancers are very common in India and we get a significant number of patients in our hospital. Head and neck cancers in India constitute 40% of all malignancies as compared to 2-4% in western countries[1]. The oral cavity is the predominant location in head and neck region for primary malignant tumors. Most of the head and neck cancers require neck dissection. Head and neck cancers are aggressive and necessitate early treatment. Sometimes even when successful in treating the cancer, substantial morbidity may persist as a result of disease, treatment or both. Therefore the present day head and neck surgeon has the responsibility of eliminating the malignancy, avoiding or limiting morbidity by preserving function, cosmetic appearance and rehabilitating any handicap.

A critical prognostic factor in head and neck cancers is spread of disease to regional lymph nodes and the presence or absence of even microscopic extra capsular spread[2,3]. The gold standard for regional disease control has been neck dissection[4]. As described by Crile in 1906, Radical neck dissection (RND) required complete removal of lymph nodes from levels I to V, along with the sternocleidomastoid (SCM) muscle, internal jugular vein (IJV) and spinal accessory nerve (SAN)[5].

By sacrificing the SAN, patients suffered from the "Eleventh Nerve Syndrome" or "Shoulder syndrome" (which was first described by Ewing and Martin in 1952) as a result of denervation of trapezius muscle. The classic symptoms include the following: drooping of the involved shoulder, limited forward shoulder flexion, limited (active) lateral abduction of the shoulder, a constant dull ache, a sensation of stiffness or soreness in the involved side, aberrant scapular rotation and abnormal electromyographic activity[6]. Typically no radiologic abnormalities are associated with this syndrome[7,8]. Earlier efforts to treat this problem basically involved rehabilitation of the functionally impaired extremity, the results of which were not very encouraging[9,10].

Modifications to the RND gained more approval as numerous studies showed that a more conservative approach sparing the SAN could still control disease and significantly decrease the morbidity in appropriately selected patients[11-15].

The most conservative approach is the selective neck dissection (SND), which preserves the SAN, SCM and the IJV and resects only those nodal levels most likely to be involved with tumor, based on location of the primary tumor[16-20]. However this is used only in N_0 neck and its use in N_1 neck is still under evaluation.

Several reports have reviewed postoperative sequelae after neck dissection, the most significant of which is the impairment of shoulder function. After neck dissection , 70% of patients reported some form of shoulder dysfunction[21]. Various studies have been carried out all over the world on how to reduce shoulder morbidity. Various types of neck dissection have been tried for the purpose. However inspite of nerve sparing in neck dissection few patients develop shoulder morbidity .The reason for this may be that the procedure can still cause some injury to the spinal accessory nerve as a result of traction during the clearance of level II b lymph nodes (supraspinal accessory nodes), skeletonization and devascularisation of SAN (believed to be responsible for its segmental demyelinization and consequent neuropraxia) during clearance of posterior triangle of neck or attributed to inadvertent transection of the nerve or, more frequently, of its fine branch directed to the upper trapezius in the posterior triangle of the neck.[22,23]

Most of the patients in our hospital who undergo neck dissection are manual labourers. It is very important to preserve shoulder function in them. In these patients integrity of spinal accessory nerve is all the more important, as the shoulder dysfunction caused by the damage to the nerve will directly affect the day to day earnings of the patient.

In our study, we plan to compare the pre and post operative spinal accessory nerve functions by electromyography after nerve sparing neck dissections. In this study, we would like to analyse the prognostic factors for spinal accessory nerve integrity and better methods of dissecting spinal accessory nerve.

AIMS OF THE STUDY

1. To assess pre and post operative shoulder function and integrity of spinal accessory nerve following nerve sparing neck dissections in Head and Neck cancers.
2. To compare the extent of damage to spinal accessory nerve in various types of neck dissections.

REVIEW OF LITERATURE

History

In the early 1800s, there was little reference to the treatment of Head and Neck cancers once it had spread to the cervical lymph nodes and it was believed that complete removal of the disease was impossible once the tumor had involved the cervical lymph nodes.

In 1847, Warren described an operation for removal of metastatic lymph nodes from the upper neck. Buten in the year 1900 advocated removal of cervical lymphatics through the kocher incision. It was Dr. George Crile in 1906, who first described a systematic operative procedure for removal of cervical lymphatics and lymph nodes[5].

Handly, in 1907, introduced the permeation theory of metastasis. He concluded that lymphatic metastasis originated by continuous permeation of the lymphatics radiating away from the primary tumor site. This was the basis for the development of in continuity (enbloc) dissection of nodes with primary cancer of head and neck.

Dr Hayes Martin, in 1930, standardised the technique of Radical Neck dissection and reported on 450 cases performed between 1928 and 1950. He developed the "Commando procedure" (composite resection) and favoured in continuity (enbloc) resection of the primary tumor and neck disease. It is till date regarded as the " gold standard" with which all other therapies are compared.

Dr Hayes Martin condemned any partial neck dissection, because lymphatics along the internal jugular vein lie close to the walls of the vein itself and it was unlikely that any procedure short of excision of internal jugular vein, could completely remove the lymphatics in this region.

With sacrifice of the SAN, however, patients suffered from the “Eleventh Nerve Syndrome” or “Shoulder Syndrome”, (which was first described by Ewing and Martin in 1952) as a result of denervation of trapezius muscle. The classic symptoms include the following: drooping of the involved shoulder, limited forward shoulder flexion, limited (active) lateral abduction of the shoulder, a constant dull ache, a sensation of stiffness or soreness in the involved side, aberrant scapular rotation and abnormal electromyographic activity[6].

Earlier efforts to treat this problem basically involved rehabilitation of the functionally impaired extremity. Many procedures to decrease the handicap have been described, which include fixing the root of spine of scapula to the vertebral process of the second and third dorsal vertebrae with fascial slings, then transplanting the levator scapulae to the outer end of the scapular spine[9]. Harris and Dickey described grafting a length of the greater auricular nerve between the proximal and distal stumps of the severed spinal accessory nerve to reinnervate the trapezius[10] .All these methods have a common denominator , they are designed to improve the functionally compromised shoulder.

Dargent, in 1945, was one of the first advocates of preserving the spinal accessory nerve in neck dissection. Dr Hayes Martin felt that the shoulder dysfunction was relatively insignificant because the action was taken over in part by the major and minor rhomboids and the levator scapulae muscles.

A conceptual revolution in the surgical treatment of cervical metastasis from squamous cell carcinoma of the head and neck was set during 1970. Since then the surgical management of cervical metastasis has undergone a process of gradual but steady evolution. This progress resulted from better understanding of the predictable pattern of lymph node metastases[16-19] and appreciation of surgical anatomy of the neck and its fascial compartments.

However, in late 1960s and early 1970s Suarez from Argentina, Ballantyne from North America and Bocca from Italy, began to explore surgical alternatives that would be oncologically sound but preserve important functional and cosmetic anatomical structures in the neck. These variations in the surgical procedures were categorized as Modified Radical Neck Dissection. The conceptual basis of modified radical neck dissection lies in the fact that the whole lymphatic system of the neck lies within fascial compartments, which can be removed without sacrificing the non lymphatic structures.

By 1980s, several concepts that played an important role in the emergence of selective neck dissection had been proposed. Supraomohyoid neck dissection is the most well researched of all selective neck dissections. Selective neck dissections use the oncological level of nodes in the neck and their relative risks of containing metastatic disease depending on the site of primary cancer as a means to define the extent of the lymph node excision.

Supraomohyoid neck dissection involves removal of level I, II and III lymph nodes (submental, submandibular, upper and mid deep cervical lymph node groups) while preserving all three structures namely the spinal accessory nerve, internal jugular vein and sternocleidomastoid muscle[24]. R.M.Byers during 1985 published initial reports on supraomohyoid neck dissection[25]. Similarly Spiro and Shah et al, 1988 and J.J Manni, 1991, have published their results using supraomohyoid neck dissection as an elective or staging procedure in node negative neck in carcinoma oral cavity[11,26].

During treatment of head and neck squamous cell carcinoma, care must be taken to minimize post operative sequelae with a negative impact on the quality of life. Several reports have reviewed post operative sequelae after neck dissection, the most significant of which is the impairment of shoulder function. After neck dissection, 70% of patients reported some form of shoulder dysfunction[21]. Even selective neck dissections, despite preservation of spinal accessory nerve, can lead to some degree of morbidity. The reason for this may be that the procedure can still cause some injury to the spinal accessory nerve as a result of retraction during clearance of level II b lymph nodes and / or ischemia caused as a result of ligation of occipital artery[22,23].

In contrast to a Radical neck dissection, Modified Radical neck dissection and Selective neck dissections can preserve the various functionally important anatomic structures, including spinal accessory nerve, sternocleidomastoid muscle and internal jugular vein, while preserving oncologic safety in selected cases. However, some patients who have undergone SOHND experience postoperative shoulder syndrome, despite preservation of spinal accessory nerve. The reason for this is SOHND can cause some injury to the spinal accessory nerve during removal of the level II b lymph nodes because of the neuropraxia resulting from traction and elevation[22,23].

Surgical anatomy of neck[27,28]

The neck is divided into two triangles, which are known as the anterior and posterior triangles. These triangles are three dimensional in shape and change with the position of the neck.

The posterior triangle is bounded by the anterior border of trapezius muscle, the middle one third of clavicle and by the posterior border of the sternocleidomastoid muscle. It can be divided further by the omohyoid muscle into the occipital triangle above and subclavian triangle below (fig.1a).

The anterior triangle is bounded by anterior border of sternocleidomastoid muscle, the mandible and by the midline of the neck. It may be further divided into submental, submandibular, carotid and muscular triangles (fig.1a).

The submental triangle is a median triangle bounded on each side by the anterior belly of digastric muscle, and the body of hyoid bone forms the base. The apex of the submental triangle is formed by genoid tubercle of mandible. The mylohyoid muscle forms the floor of the triangle. The submental triangle contains two to four small submental lymph nodes and submental veins which join to form the anterior jugular vein.

The submandibular triangle (digastric triangle) is bounded anteroinferiorly by anterior belly of digastric, posteroinferiorly by posterior belly of digastric and stylohyoid muscles and superiorly, by the lower border of body of the mandible and a line joining angle of mandible to the mastoid tip (fig.1a). It extends till the posterior belly of digastric muscle. The roof is formed by skin, superficial fascia containing platysma, marginal mandibular nerve and cervical branch of facial nerve. The mylohyoid muscle forms the floor anteriorly and the hyoglossus posteriorly. The submandibular triangle contains submandibular salivary gland and duct, facial artery, facial vein, submental artery, hypoglossal nerve, lingual nerve, lower part of parotid gland, styloglossus, stylopharyngeus, common facial vein, marginal mandibular nerve and submandibular lymph nodes.

The carotid triangle is bounded superiorly by the posterior belly of digastric muscle and the stylohyoid muscle, anteroinferiorly by superior belly of omohyoid and posteriorly by anterior border of sternocleidomastoid muscle (fig 1a).The roof is formed by skin, superficial fascia and investing layer of deep cervical fascia. The floor is formed by thyrohyoid muscle, hyoglossus, and middle and inferior constrictors of pharynx. The carotid triangle contains common carotid artery, internal carotid artery, external carotid artery with its branches, internal jugular vein, common facial vein, pharyngeal vein, lingual vein, vagus nerve, superior laryngeal nerve, spinal accessory nerve, hypoglossal nerve, ansa cervicalis, sympathetic chain, upper and middle deep cervical lymph nodes (fig1b).

In the posterior triangle, the roof is formed by investing layer of deep cervical fascia, superficial fascia containing platysma, external jugular vein and greater auricular nerve. The floor is formed by prevertebral layer of deep cervical fascia covering the following muscles: semispinalis capitis, splenius capitis, levator scapulae, scaleneus anticus, medius and posterior (fig1b). The contents of posterior triangle include spinal accessory nerve, branches of cervical plexus, brachial plexus, transverse cervical artery and vein, occipital artery, thoracic duct (on left side), supraclavicular nerves, occipital and supraclavicular lymph nodes.

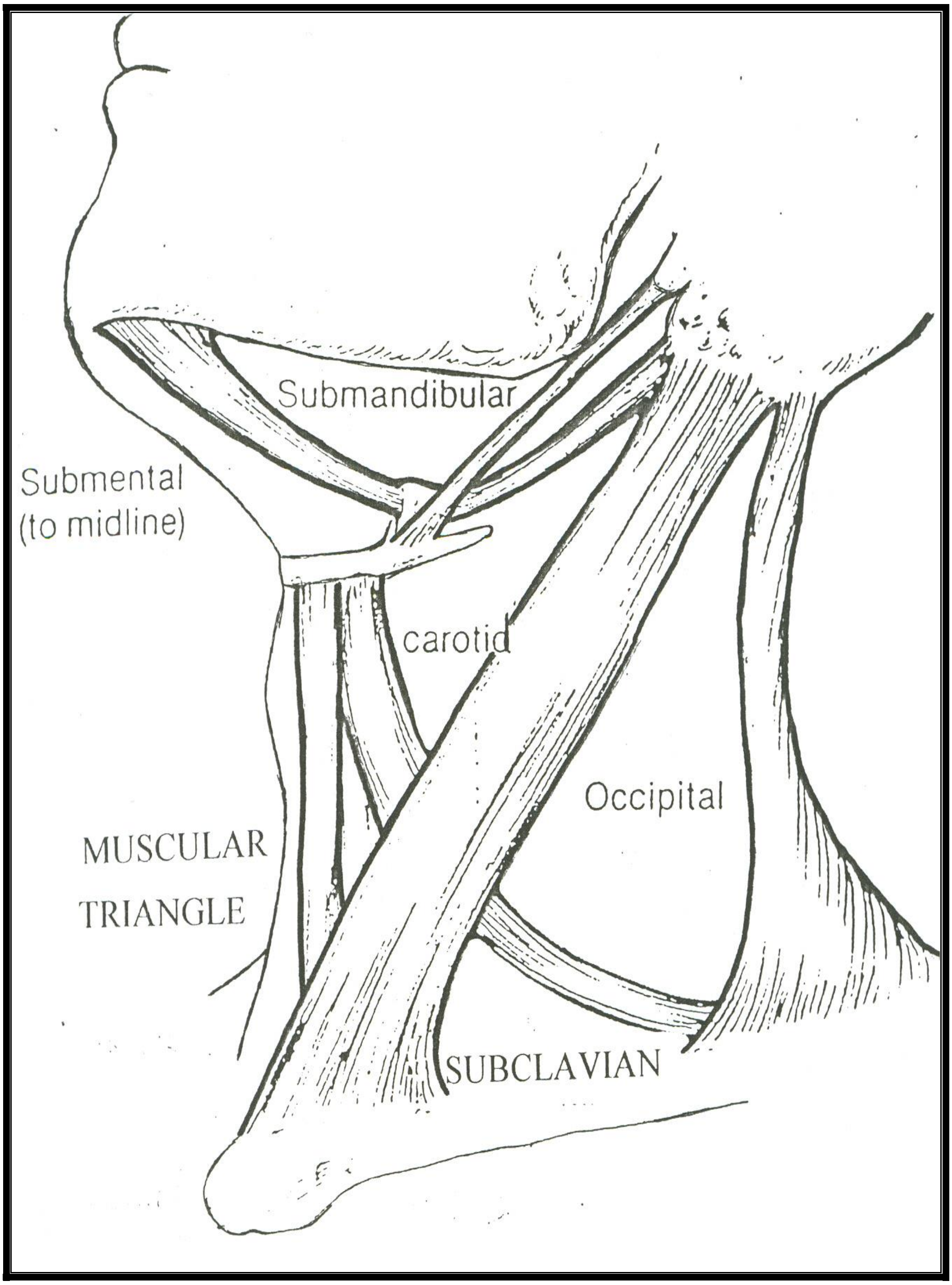


Fig 1 a : Diagram showing Triangles of Neck

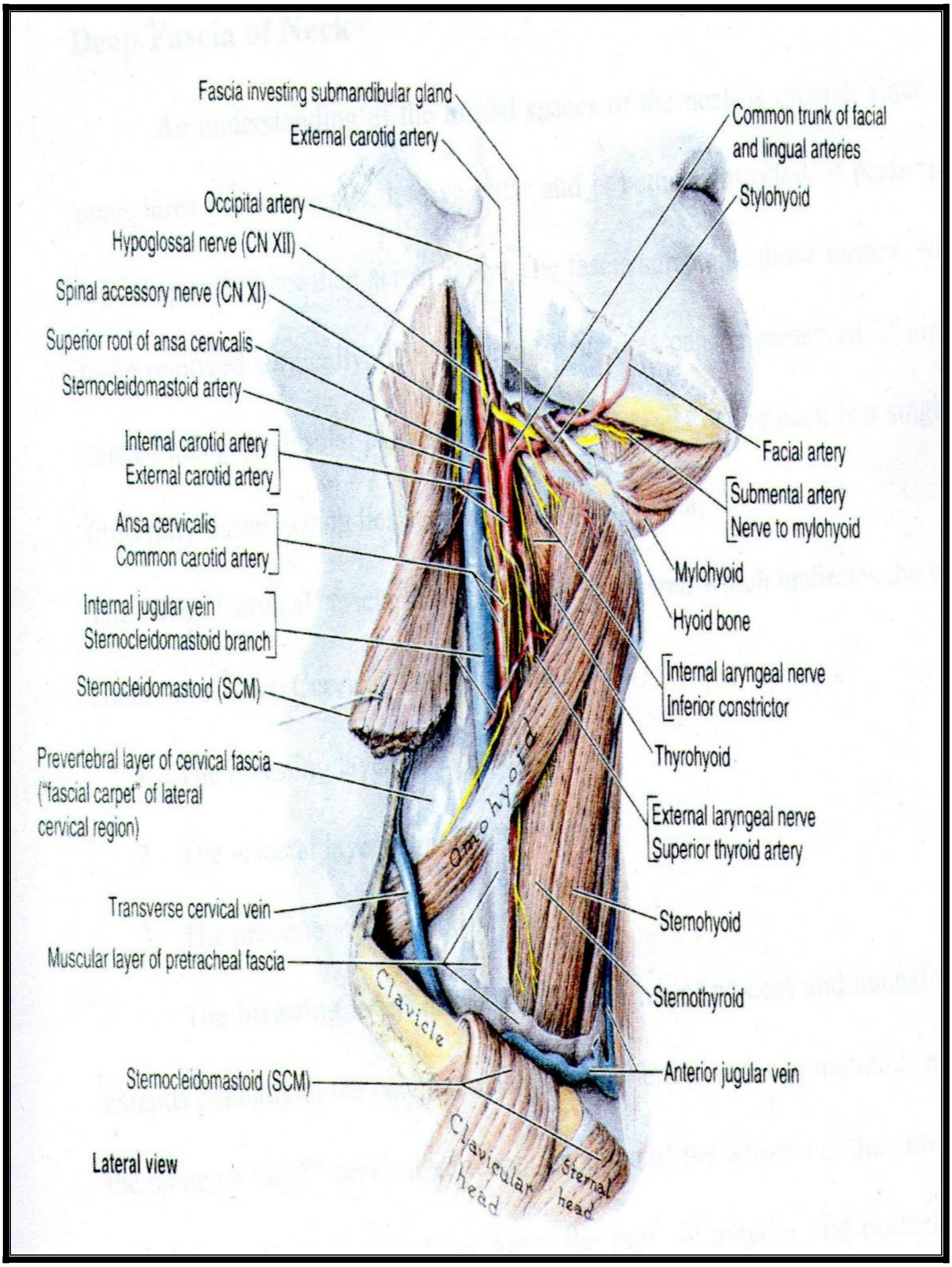


Fig 1 b : Anatomy of the Neck with divided Sternocleidomastoid Muscle showing vital structures

Deep Fascia of Neck[28]

An understanding of the fascial spaces of the neck is crucial, since operative procedures become easier, less vascular and is better controlled, if performed along fascial spaces rather than across them. The fascia surrounds those tissues, which need to be removed surgically. The important structures can be preserved, if dissection is carried along the fascial planes. The superficial fascia of the neck is a single layer of fibro fatty tissue, which lies superficial to the platysma.

The Deep Cervical fascia lies deep to the platysma which encircles the neck like a collar. The Deep Cervical fascia contains (fig.2)

1. The investing layer or outer layer.
2. The visceral layer or middle layer.
3. The prevertebral layer or internal layer.

The investing layer arises from the vertebral process and nuchal ligament. It extends cranially to the occiput, mastoid and inferior border of mandible and below to the spine of the 7th cervical vertebra, the spine of the acromion, the clavicle and the manubrium. The investing layer forms the roof of anterior and posterior triangles. The investing layer of deep cervical fascia splits to surround the trapezius muscle and sternocleidomastoid muscle. The fascia is bilaminar and splits to envelop submandibular glands.

The suprasternal portion is also bilaminar forming a potential space called Suprasternal space of Burns. The fascial extension from the deep surface contributes to the anterolateral portion of carotid sheath.

The visceral or middle or pretracheal layer of fascia surrounds the middle compartment of the neck to include the pharynx, larynx and oesophagus and trachea (fig.2). The fascia allows these structures to move up on each other. This layer envelops the thyroid and parathyroid glands.

The internal layer also called the prevertebral fascia surround the deep muscles of the neck. It provides the floor to the posterior triangle. It covers cervical plexus, phrenic nerve and branchial plexus. It arises from the vertebral spine and nuchal ligament and covers the prevertebral muscles. It extends from the skull base to the transverse process of all cervical vertebrae and continues in to the posterior mediastinum. The carotid sheath is formed by all the three layers of deep cervical fascia (fig.2).

Sternocleidomastoid muscle

The sternocleidomastoid muscle originate from two heads. The sternal head is tendinous and arises from the superolateral part of manubrium sterni. The clavicular head is musculotendinous and arises from medial one third of the superior surface of the clavicle. The two heads blend below the middle of the neck. It gets inserted by a thick tendon into the lateral surface of the mastoid process and by a thick aponeurosis into the lateral half of the superior nuchal line. Part of the muscle is inserted into the skin of the neck. It is supplied by spinal accessory nerve. Branches from the ventral rami of C_2, C_3 are sensory (propriosensitive).

In neck dissection, it is advisable to retain the muscle to provide protection to carotid artery. But long term follow up has shown that after 6 months the muscle gets atrophied as fascia covering the muscle is removed which hampers the blood supply.

Trapezius

The trapezius muscle arises from the medial one third of the superior nuchal line and the occipital protuberance, from ligamentum nuchae, from the spines of the seven cervical and all thoracic vertebrae. The muscular fibres converge as they head laterally towards the shoulder joint. The upper portion of the muscle inserts on the posterior border of the lateral one third of the clavicle. The middle portion inserts on the medial border of the acromion and the upper border of the crest to the spine of the scapula. The lower portion inserts on the tubercle of the crest of the scapular spine.

The nerve supply to the descending part of the trapezius muscle consists of a single fine branch of the spinal accessory nerve, whereas the transverse and ascending parts were innervated by both the spinal accessory nerve and the trapezius branches of cervical plexus[29].The descending part of the trapezius muscle gains its motor innervation from a small branch of the spinal accessory nerve which passes cranial to the main nerve trunk cross the posterior triangle of neck towards the muscle. The trapezius branches of the cervical plexus do not contribute significantly to the muscle's motor innervation except that the spinal accessory nerve does not run through the sternocleidomastoid muscle but dorsal to it[30].

The upper and lower thirds of trapezius rotate the scapula during abduction while the middle third stabilizes the scapula. The role of trapezius in abduction of the arm is significant at and beyond 90^0 abduction.[8,31] To properly test this function the arm should be raised from the side and with the hand in pronation. Supination of the hand and raising the arm by flexion of the shoulder allow action of other muscles such as supraspinatus and deltoid.

The middle third of the trapezius adducts the scapula,i.e, pulls the shoulder and scapula back. This action is assisted by the lower portion of the rhomboid. The upper trapezius elevates the shoulder and also maintains its normal position at rest. It is assisted in this action by the levator scapula and the upper part of the rhomboid. During abduction of the shoulder an important bracing or stabilizing action is performed by the coordinated and opposing contraction of the serratus anterior in a forward direction and the rhomboid and middle third of trapezius in a posterior direction[31.]

Internal jugular vein

It is a direct continuation of the sigmoid sinus. It begins at the jugular foramen and ends behind the sternal end of the clavicle by joining the subclavian vein to form the brachiocephalic vein. The tributaries include

1. Common Facial Vein
2. Lingual vein
3. Pharyngeal Vein
4. Superior thyroid vein
5. Middle thyroid vein
6. Occipital vein

The thoracic duct opens into the angle between the internal jugular vein and subclavian vein on the left side. A controversy still exists regarding the preservation of internal jugular vein due to its close association with the lymph nodes all along its course.

Spinal accessory nerve

The spinal accessory nerve is usually considered to have a bulbar and a spinal portion. The bulbar portion is thought to be a part of vagus nerve as it arises from nucleus ambiguus in the medulla. It exits the brain stem by four or five rootlets .The nerve trunk formed by coalescence of these rootlets runs with the spinal portion of the accessory nerve near the jugular foramen but separates from the spinal portion just inferior to the skull base.

Here it unites with the vagus nerve just proximal to its inferior ganglion. The bulbar portion of the SAN supplies striated muscles of the larynx and pharynx and is therefore, a special visceral efferent.

The motor cell bodies of spinal component of the accessory nerve reside in the ventral horns of the first five or six segments of the spinal cord. On emerging from the cord, the fibres of the SAN turns cephalad between the dorsal and ventral roots of the cervical spinal nerves proximate to the ligament denticulatum. The nerve thus formed is more closely related spatially to the dorsal roots than to the ventral roots and lies between the ligamentum denticulatum and the dorsal roots. The nerve enters the cranial cavity through the foramen magnum and penetrates the dura over the jugular bulb. In the jugular foramen it is joined by the bulbar accessory nerve but quickly separates from the latter after exiting the base of skull. At first the SAN lies between the internal carotid artery and internal jugular vein. It then turns obliquely laterally, usually passing lateral to the internal jugular vein. Occasionally it courses medial to the internal jugular vein[31]. The SAN can be found medial as well as lateral to the internal jugular vein, depending on how far cranial in the neck it is identified. The crossing between these two important structures can happen fully dorsally or ventrally to the internal jugular vein[32].

It pierces the deep surface of the sternocleidomastoid muscle and is often joined at this point by a branch of the ventral ramus of C_2. It emerges into the posterior triangle just below the junction of the upper and middle one third of the sternocleidomastoid muscle. It traverses the posterior triangle and if often joined by branches of C_3 and C_4 or by branches derived from a plexus formed by C_3 and C_4. It passes beneath the anterior border of the trapezius at approximately the junction of middle and lower third of this muscle. It continues inferiorly from the deep surface of this muscle to suppy the muscle. A subtrapezial plexus is thus formed on the underside of the trapezius muscle by the SAN and branches of the ventral rami of C_2, C_3,C_4, and possibly C_5[31].

Methods of identification of spinal accessory nerve during neck dissection

1. 1 cm above the Erb's point (the emergence of Greater auricular nerve at the posterior border of sternocleidomastoid.)[28] at a deeper plane (Bocca method).
2. Dissect up the anterior border of trapezius in the posterior triangle until the nerve is encountered (dividing the sternomastoid into upper one third and lower two third (Ballantyne method).
3. Draw a line from Erb's point to the thyroid notch. The SAN nerve will exit the posterior border of sternocleidomastoid muscle within 2 cm above this line and enter the anterior border of the trapezius muscle within 2 cm below it [33] .

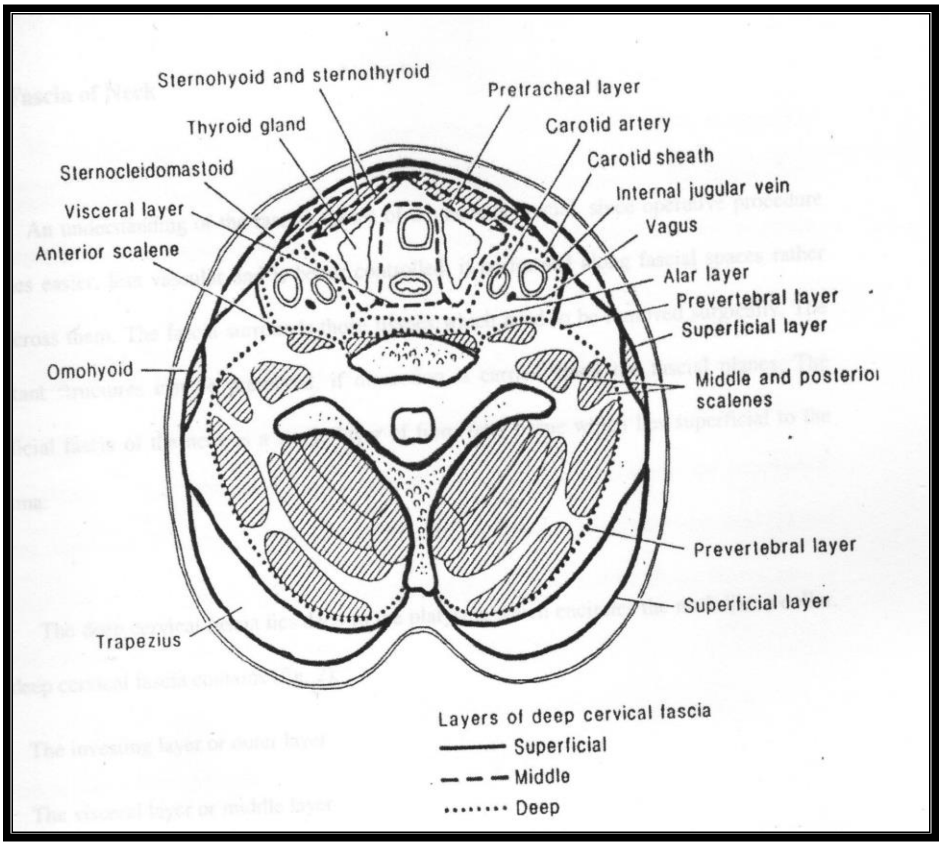


Fig 2: Deep fascia of the neck

Anatomy of cervical lymphatic system[28]

The lymphatic drainage of the head and neck is conventionally divided into three systems

1. Waldeyer's Internal ring
2. Waldeyer's External ring (Superficial system)
3. Deep lymphatic system

Waldeyer's Internal Ring

The Waldeyer's internal ring is a circular collection of lymphoid tissue (MALT) aggregates within the pharynx, which play an important role in early immunologic development. This was first described by Waldeyer who was professor of anatomy in Berlin (1884) (fig.3).

The ring includes the adenoid, the tubal tonsil, palatine tonsil, lingual tonsil and aggregates of lymphoid tissue on the lateral and posterior pharyngeal wall.

Waldeyer's External ring

The external ring includes occipital nodes, post auricular nodes, parotid nodes, buccal or facial nodes, submandibular and submental nodes (fig3).

This superficial system receives drainage from the skin and underlying tissues of the scalp, eyelids, face, waldeyer's internal ring, nasal sinuses and oral cavity.

Deep Lymphatic system

The deep cervical nodes consist of upper, middle and lower deep nodes, junctional nodes, nuchal nodes and upper mediastinal nodes. The deeper fascial structures of the head and neck are drained by deep system (fig4).

The passage of lymph follows a sequential pattern from superficial to deep and from upper to lower parts of the neck. This lower confluent forms a jugular trunk, which on right side ends, at the junction of the jugular vein and the brachiocephalic vein. Whereas on the left side the trunk will join the thoracic duct.

Sloan Kettering Memorial Cancer Centre (1981) devised a classification of neck nodes based on the metastatic spread of tumors originating from the head and neck. They have classified nodes in to 5 levels (fig5). Som (1987) described level VI and level VII lymph node groups.

Level I: Submental and Submandibular Groups[28,34]

The submental lymph nodes (level I a) refers to the nodes lying within the submental triangle. The Submandibular lymph nodes (level I b) are defined as those contained within the Submandibular triangle (fig6).

Level II: Upper jugular nodes

The level II lymph nodes are located around the upper third of internal jugular vein, extending from the level of carotid bifurcation (surgical land mark) or hyoid bone (clinical land mark) to the skull base. The lateral boundary is the posterior border of the sternocleidomastoid and the medial boundary is the lateral border of the sternohyoid muscle.

Level II can be divided into two subzones according to the relationship of the nodes with the spinal accessory nerve. Thus the lymph nodes located inferior and anterior to the spinal accessory nerve is called level II a and those situated superior and posterior to the nerve are called as level II b (Goepfert modification) (fig 6).

Level III: Mid jugular nodes

Level III nodes are located around the middle third of the internal jugular vein, extending from the carotid bifurcation (surgical land mark) or hyoid bone (clinical land mark) to the omohyoid muscle (surgical land mark) or cricoid cartilage (clinical land mark). The lateral boundary is the posterior border of the sternocleidomastoid and the medial boundary is the lateral border of the sternohyoid muscle.

Level IV : Lower jugular nodes

Level IV nodes are located around the lower third of internal jugular vein, extending from the omohyoid muscle (surgical land mark) or cricoid cartilage (clinical landmark) to the clavicle. The lateral boundary is the posterior border of the sternocleidomastoid and the medial boundary is the lateral border of the sternohyoid muscle.

Level IV can be divided into two subzones: The lymph nodes located beneath sternal head of sternocleidomastoid muscle, called level IV a and those located beneath clavicular head are called level IV b.

Level V: Posterior triangle nodes

The level V encompass all nodes contained within the posterior triangle. Level V nodes are located along the lower half of spinal accessory nerve and the transverse cervical artery.

Level V nodes can be divided into two sub zones. The lymph nodes located above the Inferior belly of omohyoid called as level V a and those situated below the inferior belly of omohyoid are called level V b (fig6).

Level VI: Anterior compartment nodes

This group comprises lymph nodes surrounding the midline visceral structures of the neck extending from the level of hyoid bone superiorly to the suprasternal notch inferiorly or till Innominate vessels. On each side the lateral boundary is medial border of the carotid sheath. This includes prelaryngeal nodes (Delphian lymph nodes), pre tracheal nodes and paratracheal nodes (lymph nodes along the recurrent laryngeal nerve).

Level VII

The lymph nodes situated below the suprasternal notch in the upper anterior mediastinum are called level VII nodes till the arch of aorta.

The committee for Head and Neck surgery and Oncology of the American Academy of Otolaryngology Head and neck surgery (AAO-HNS), did not recommend including additional levels such as level VII for the superior mediastinum[24]. It was believed that the 6 levels currently used encompassed the complete topographic anatomy of the neck. Lymph nodes involving regions not located within this region would be referred to by the name of their specific nodal group.

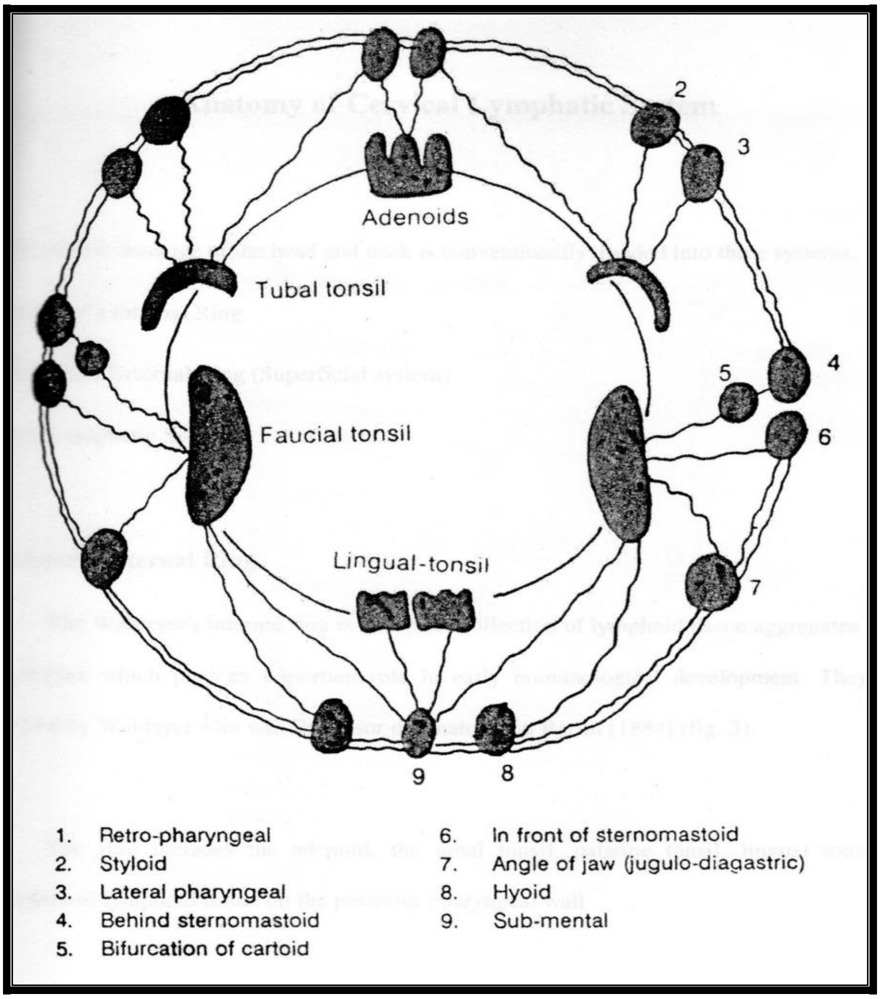


Fig 3 : Waldeyer's Ring

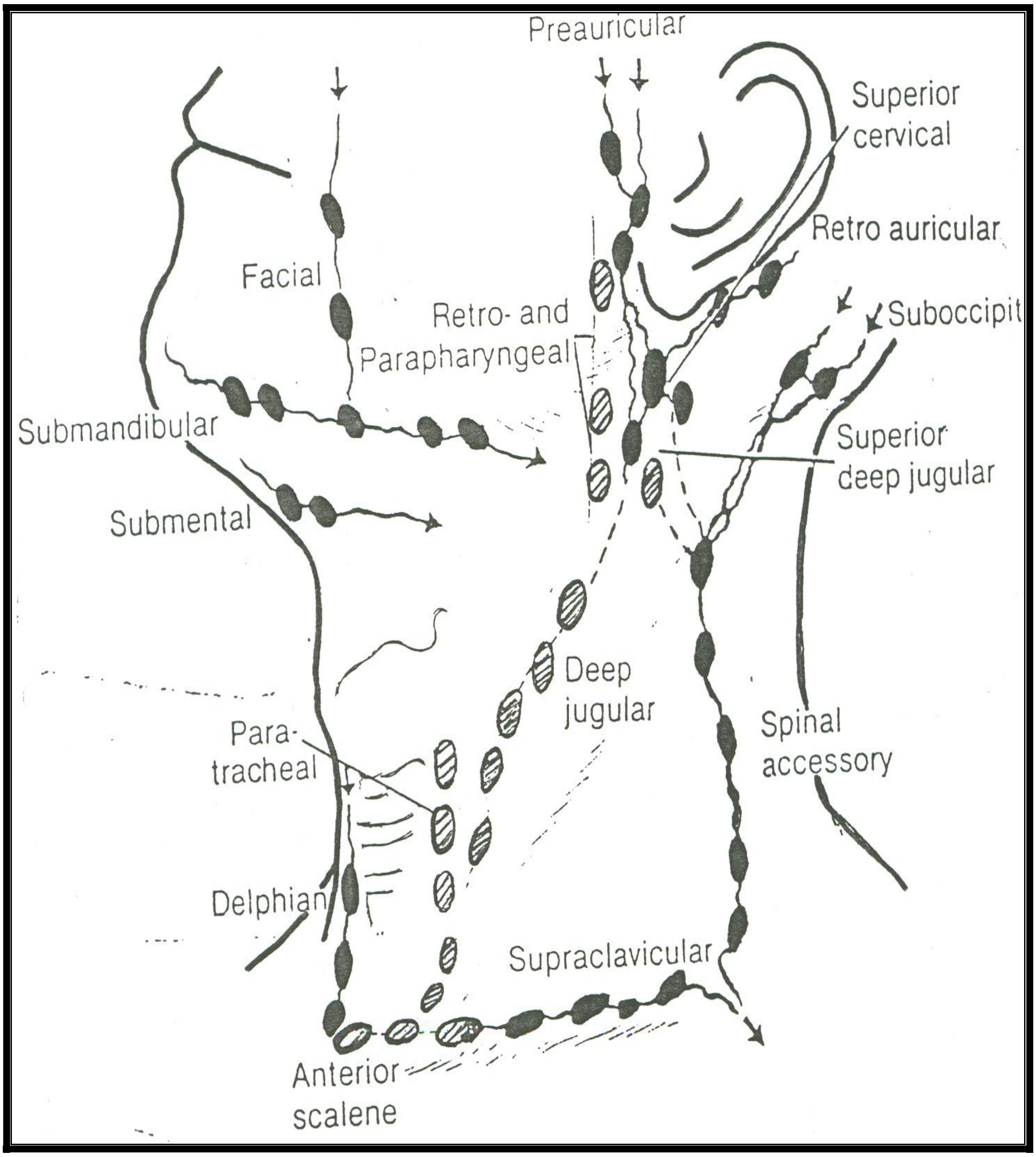


Fig 4 : Deep Lymphatic System

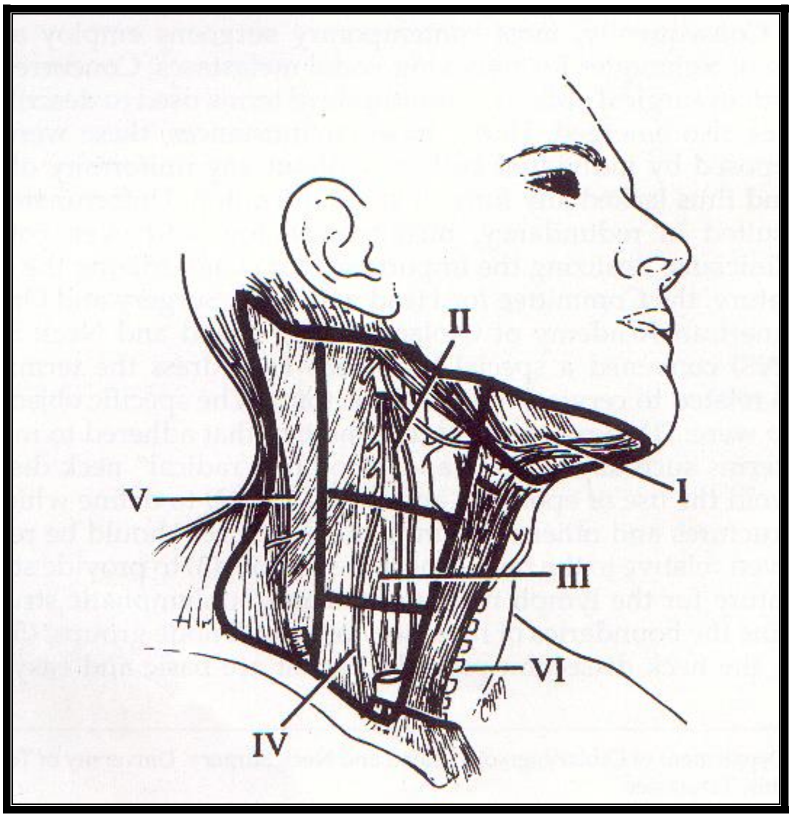


Fig 5 : Levels of Lymph Nodes

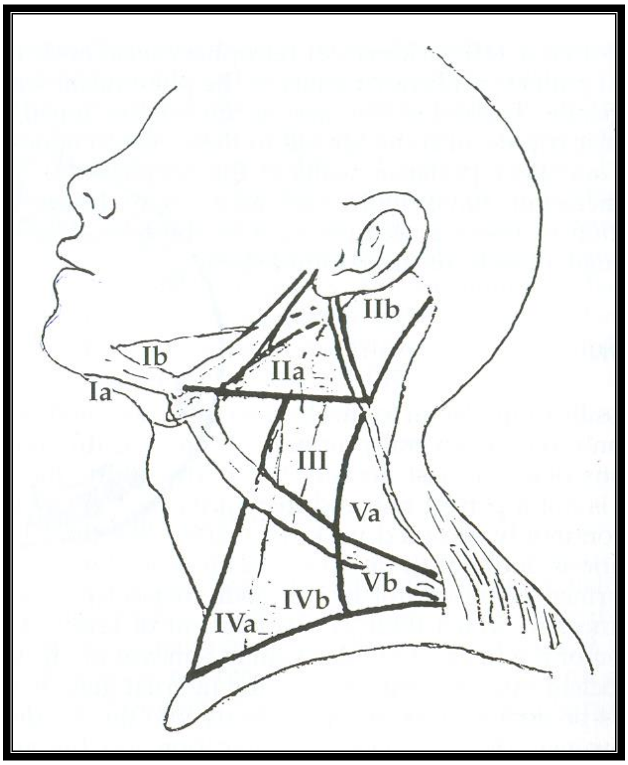


Fig 6 : Sub levels of Lymph Nodes

Clinical staging[35]

Although the presence or absence of cervical metastasis is the single most important factor in determining prognosis of head and neck cancer, the extent of cervical metastasis is also important. Staging of the cervical metastasis is important both for reporting disease and for management and prognosis of patients.

The present TNM classification of regional nodes has evolved from the previous UICC (International union against cancer) and AJCC (American joint committee version 2002). The TNM classification is based mainly upon the size of the node. It does not take into account the position or level of the node.

TNM Classification of regional nodes (fig.7)

N_{x}-Regional lymph nodes cannot be assessed.

N_0-No regional lymph node matastasis (No clinically palpable lymph nodes).

N_1-Metastasis in a single ipsilateral lymph node 3 cm or less in its greatest dimension.

N_{2a}-Metastasis in a single ipsilateral lymph node more than 3 cm but less than 6 cm in its greatest dimension.

N_{2b}- Metastasis in multiple ipsilateral lymph node none more than 6 cm in its greatest dimension.

N_{2c}- Metastasis in bilateral or contralateral lymph nodes none more than 6 cm in its greatest dimension.

N_3- Metastasis in any lymph nodes more than 6 cm in its greatest dimension.

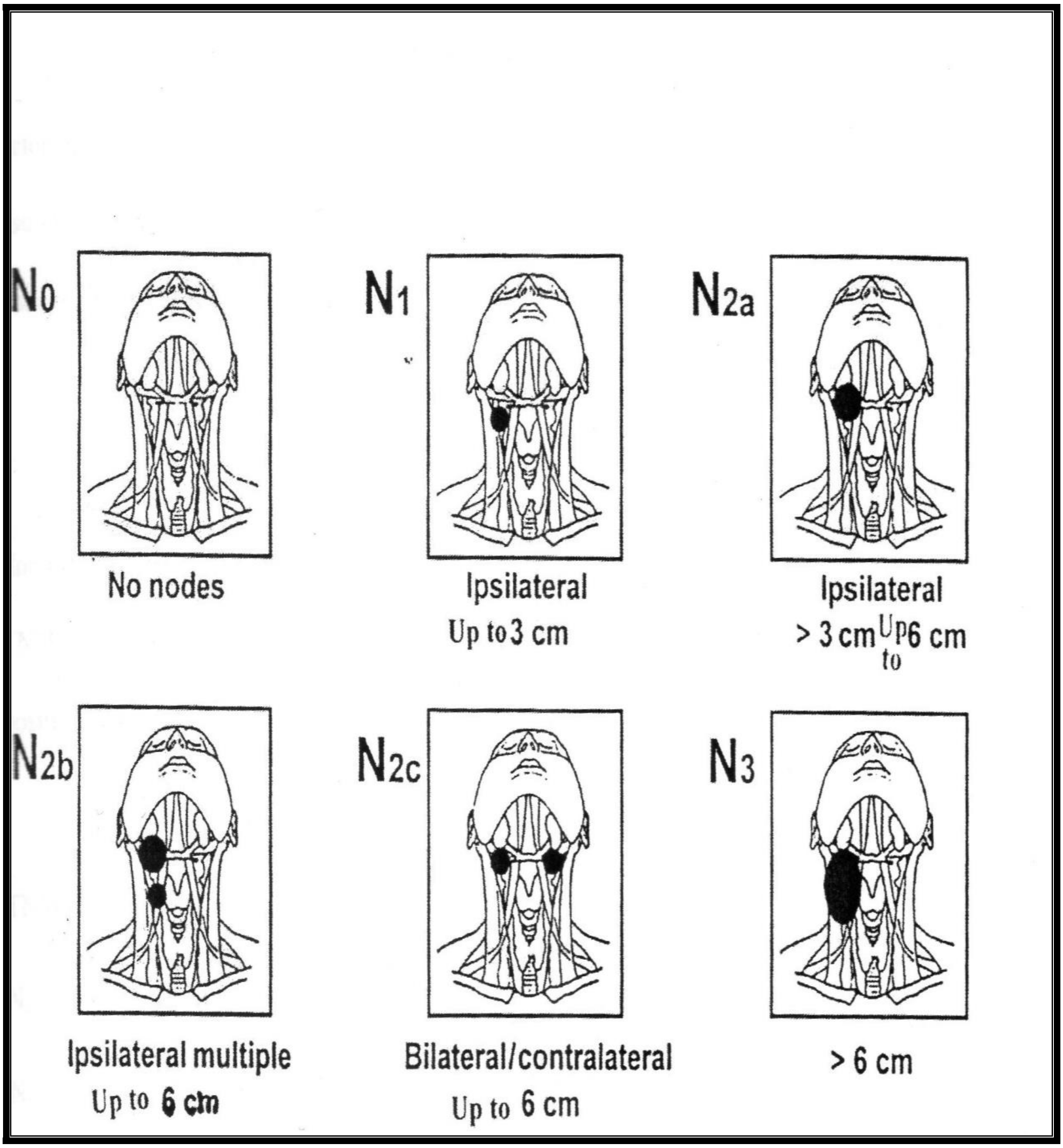


Fig 7 : TNM Classification of Regional Lymph Nodes

NECK DISSECTION CLASSIFICATION[24,36]

American Head and Neck Society and the American Academy of Otolaryngology-Head and Neck surgery proposed revision of neck dissection classification in July 2002. They suggested

1) Radical Neck Dissection
2) Modified Radical Neck Dissection

   Structures preserved should be specifically named

3) Selective Neck Dissection

   Each variation is depicted by SND and the use of parenthesis to denote the levels or sublevels removed.

4) Extended Neck Dissection

The justification to eliminate naming of selective dissections comes from the observation regarding invasive oral tongue cancer. There is evidence indicating Level IV is also at risk. Thus for this subsite within the oral cavity the recommended selective neck dissection will be SND (I-IV).

Radical neck dissection refers to enbloc removal of all ipsilateral cervical lymph node groups extending from inferior border of mandible and line joining angle of mandible to mastoid tip to clavicle, and from the lateral border of sternohyoid muscle, hyoid bone and contralateral anterior belly of digastric muscle anteriorly, to the anterior border of trapezius muscle posteriorly and from investing layer of deep fascia to prevertebral fascia. The spinal accessory nerve, internal jugular vein and sternocleidomastoid muscle are also removed. It doesnot include removal of the suboccipital nodes, periparotid nodes, buccal nodes, retropharyngeal nodes and paratracheal nodes.

Modified Radical Neck dissection refers to the excision of all lymph nodes routinely removed by RND with preservation of one or more non lymphatic structures.

Earlier classification of Modified Radical Neck dissection was as follows

Type I-Only one structure, the spinal accessory nerve is preserved.

Type II-Two structures, the spinal accessory nerve and the internal jugular vein are preserved.

Type III-All three structures, the spinal accessory nerve, internal jugular vein and sternocleidomastoid muscle are preserved. This corresponds to Functional neck dissection.(fig 8)

This has been changed in the present classification of MRND which has no types and names the structures preserved.

Selective neck dissection refers to any type of cervical lymphadenectomy where there is preservation of one or more lymph node groups removed by RND.

Supraomohyoid neck dissection refers to the removal of lymph nodes contained in the submental and submandibular triangles (level I), the upper jugular nodes (level II), and the mid jugular lymph nodes (level III). The posterior limit of the dissection is marked by the cutaneous branches of the cervical plexus and the posterior border of the sternocleidomastoid muscle. Inferior limit is superior belly of omohyoid muscle, where it crosses the internal jugular vein.(fig 9)

Posterolateral neck dissection refers to removal of the suboccipital lymph nodes, retroauricular nodes, level II, level III, level IV and level V.

Lateral neck dissection refers to the removal of the level II, level III and level IV.

Anterior compartment dissection refers to the removal of lymph nodes surrounding the visceral structures of the anterior aspect of the neck.

Extended radical neck dissection refers to removal of one or more additional lymph node groups and / or non lymphatic structures not encompassed by radical neck dissection. The examples of such lymph node groups include the retropharyngeal, superior mediastinal, facial or pre auricular lymph nodes. The examples of non lymphatic structures include the carotid artery, hypoglossal nerve, vagus nerve and the paraspinal vessels.

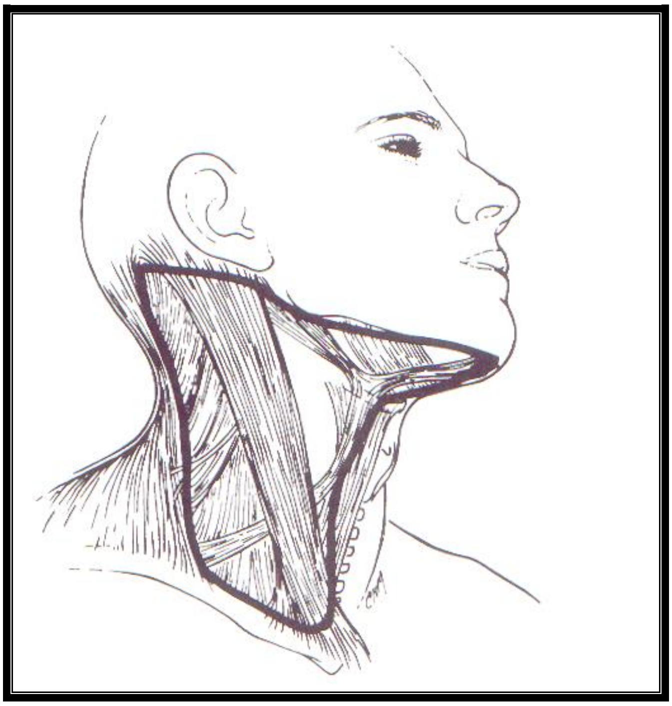


Figure 8: The Extent of Clearance in Functional Neck Dissection

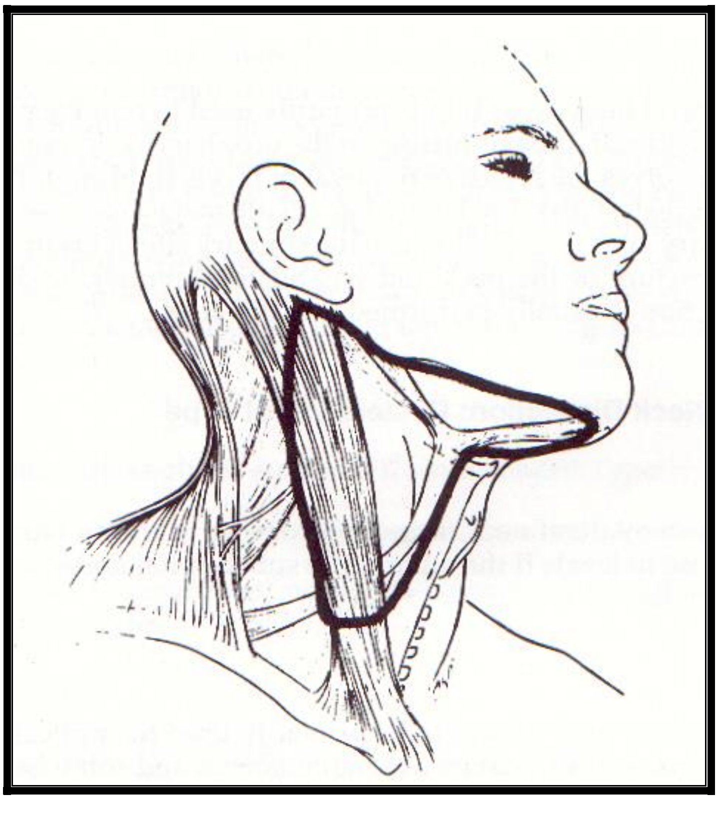


Fig 9 : The Extent of Clearance in Supraomohyoid Neck Dissection

Functional Neck Dissection[24,28,36]

The functional neck dissection consists of enbloc removal of the lymph node bearing tissues on one side of the neck, including lymph node levels I to V, preserving spinal accessory nerve, internal jugular vein and sternocleidomastoid muscle.

The most commonly used incision is Y type Criles incision or Schoebinger's incision with a Lazy 'S' on the vertical limb to reduce scar tissue contracture (fig 10). The incision begins from the mastoid tip curving it to the hyoid bone and then up again to the symphysis menti. The vertical limb /Lazy 'S' shaped incision begins perpendicular to the skin tension lines. The other type of neck incision for neck dissection is shown in the fig.12. The skin incision is taken and the upper flap elevated in subplatysmal plane. The Marginal Mandibular nerve is preserved while elevating the upper flap (fig 13).

The anterior and posterior flaps are elevated and neck is exposed with access to the four corners of consternation. This includes

1. Lower end of internal jugular vein
2. Junction of clavicle with trapezius muscle
3. Upper end of internal jugular vein
4. Submandibular triangle

The investing layer of deep cervical fascia is opened over sternocleidomastoid muscle. The investing layer is reflected medially and the muscle laterally.

Dissection of Lower End of Internal jugular Vein

Chaissaignac's triangle is defined as a triangle between, where the longus colli and Scaleneus anterior attach to the tubercle of C6 (chaissaignac's or carotid tubercle) with the subclavian artery as base. The triangle contains scalene nodes, jugular lymph duct, transverse cervical trunk and vertebral vein. It is here that cervical lymphatics terminate and occult disease may lurk in the scalene nodes. These nodes are removed. Any chylous leak (recognized as milky fluid) should be over sewn with fine silk. Sometimes the leash of lymphatics is found instead of single duct. In such a situation the whole area is over sewn taking large bites with a fine silk. This incites a vigorous inflammatory reaction.

Dissection of Supraclavicular Region

Dissection is started from the bottom end of trapezius muscle behind the omohyoid muscle. The omohyoid muscle is divided and retracted in an upward direction. Transverse cervical artery and vein encountered at omohyoid tendon level medial to the omohyoid muscle, the fascia over the fat lateral to internal jugular vein should be incised and then prevertebral fascia may be exposed by sharp or blunt dissection .Here phrenic nerve is identified as it runs over scaleneus anterior from lateral to medial direction. The prevertebral fascia protects the phrenic nerve and brachial plexus.

The fat in the supraclavicular area should be removed without excessive traction since the subclavian vein can be pulled up. Once the supraclavicular dissection has been completed towards the anterior border of trapezius, the operation continues in an upward direction to dissect the posterior triangle.

Dissection of posterior triangle

The posterior triangle dissection continues till the mastoid tip along the anterior border of trapezius. Spinal accessory nerve runs in the roof of posterior triangle and can be damaged early in the dissection (fig.14).

Everything that is important lies below i.e caudal to the accessory nerve.

The spinal accessory nerve is identified by the following methods

1. Erb's point: Nerve lies 1 cm above the Erb's point i.e the point where the greater auricular nerve winds around the posterior border of sternocleidomastoid (Bocca method).
2. The Spinal accessory nerve exits the lateral border of sternocleidomastoid muscle at the junction of its upper third with the lower two thirds. The nerve has sinusoidal course before arriving at the lower anterior border of trapezius (fig14) (Ballantyne method).
3. The nerve will usually cross the imaginary line drawn laterally from the thyroid notch, as the nerve runs from 1 cm above the Erb's point to the lower posterior corner of the posterior triangle (fig.14).
4. Dissection along the anterior border of trapezius until the nerve is encountered. This is more difficult because the nerve may be confused with branches of cervical plexus.

The spinal accessory nerve is followed through sternocleidomastoid muscle. A tunnel is formed so that the nerve can be followed and dissected free of the muscle upto level II and upto the point where it lies on top of the internal jugular vein.

The supraspinal accessory pad of fat was defined as the node bearing tissue bordered deeply by the fascia overlying the splenius capitis and levator scapulae muscles, anteriorly and inferiorly by a plane at the level of the spinal accessory nerve, superolaterally by the inferior border of the posterior belly of the digastric muscle, superiorly by the skull base, and posterolaterally by the posterior border of sternocleidomastoid muscle, posteriorly by the anterior border of trapezius .

Along with spinal accessory nerve, it is important to preserve the branches to the trapezius from the C_3 and C_4 cervical nerves. These branches of C_3 and C_4 arise deep within the sternocleidomastoid muscle; pass laterally beneath the fascia covering the floor of the posterior triangle to supply trapezius muscle (fig15).In order to preserve the nerves, it is necessary to preserve the fascia on the floor of posterior triangle.

The specimen is mobilized from the mastoid tip. The division of the retromandibular portion of the parotid gland is completed. The hypoglossal nerve is preserved as it runs sharply to cross the external carotid artery.(fig 16)

The branches of cervical plexus are cut distal to the origin for phrenic nerve. Anteriorly lower down, dissection is completed taking the specimen with omohyoid up to the junction with hyoid bone (omohyoid tunnel).

The carotid sheath is opened and dissected from the lower end of internal jugular vein till the upper end of vein (fig 15).

Dissection of Submandibular Fossa

The fibro fatty tissue is dissected from submental triangle. The submandibular gland is dissected, the facial artery and vein ligated and cut. The submandibular gland duct is ligated and cut preserving lingual nerve and hypoglossal nerve (fig 16).

This completes the dissection of four corners of consternation preserving the internal jugular vein, spinal accessory nerve and sternocleidomastoid muscle. Following the antiseptic irrigation of the surgical field, two large drains are placed through the posterior flap and securely tied. Drains should not cross the carotid sheath. Finally a check is made for any chylous leak, any bleeding from the venae nervi hypoglossi comitantes. The wound is closed in layers (fig.17)

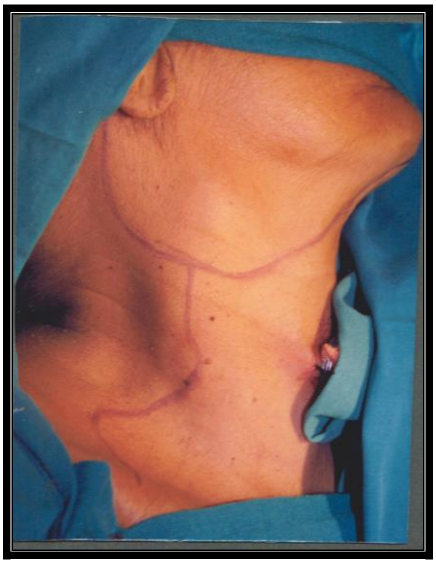


Fig 10: An Incision for Functional Neck Dissection

Fig 11: The same incision deepened till platysma.

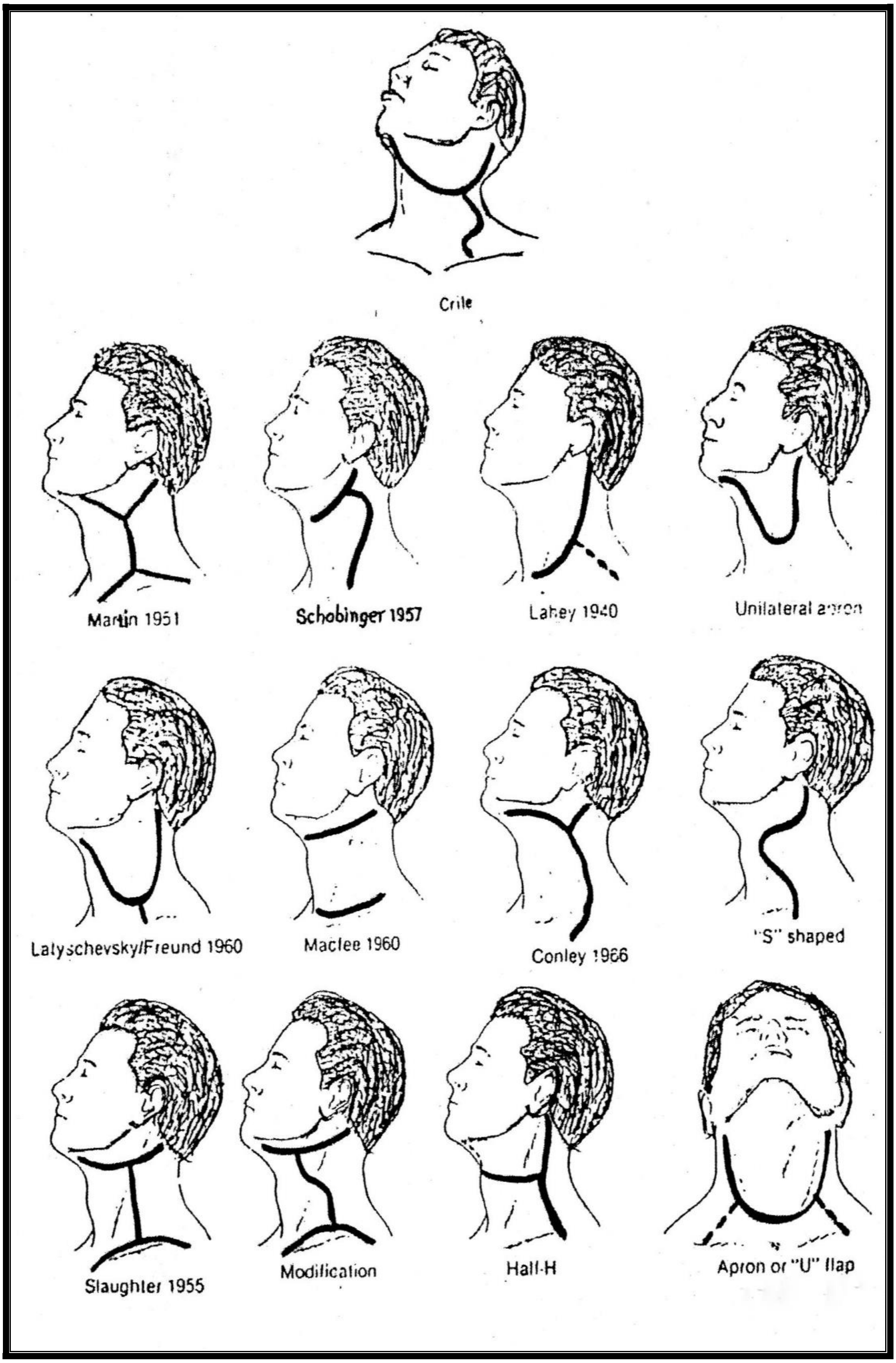


Fig 12: Types of Incisions for Neck Dissection

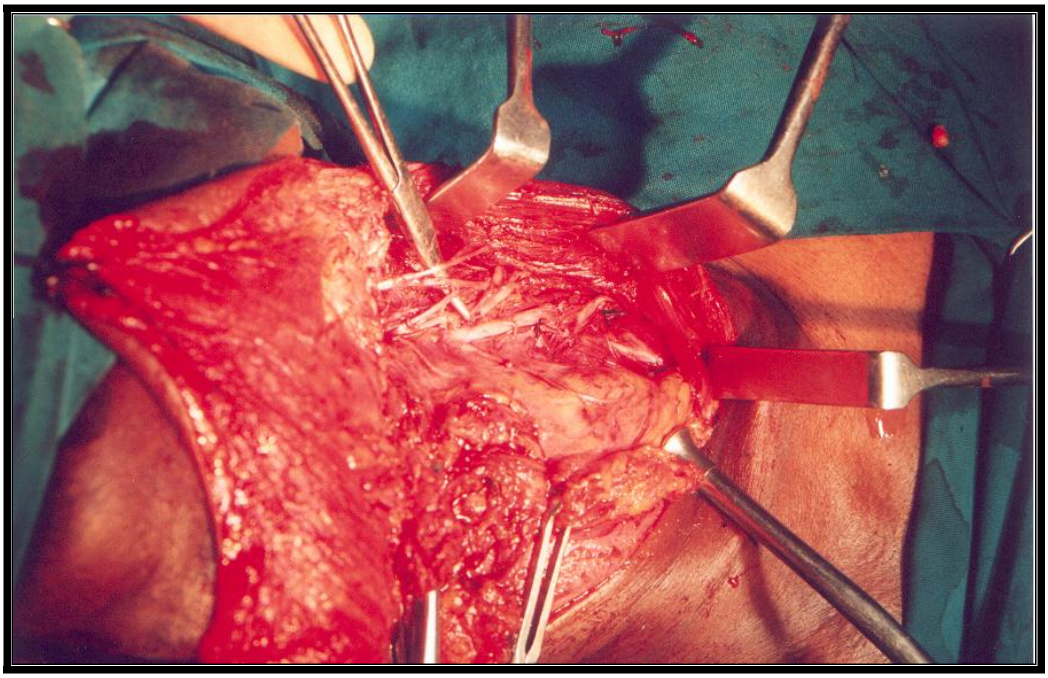


Fig 13: FND showing Marginal mandibular nerve, Cervical plexus, SAN

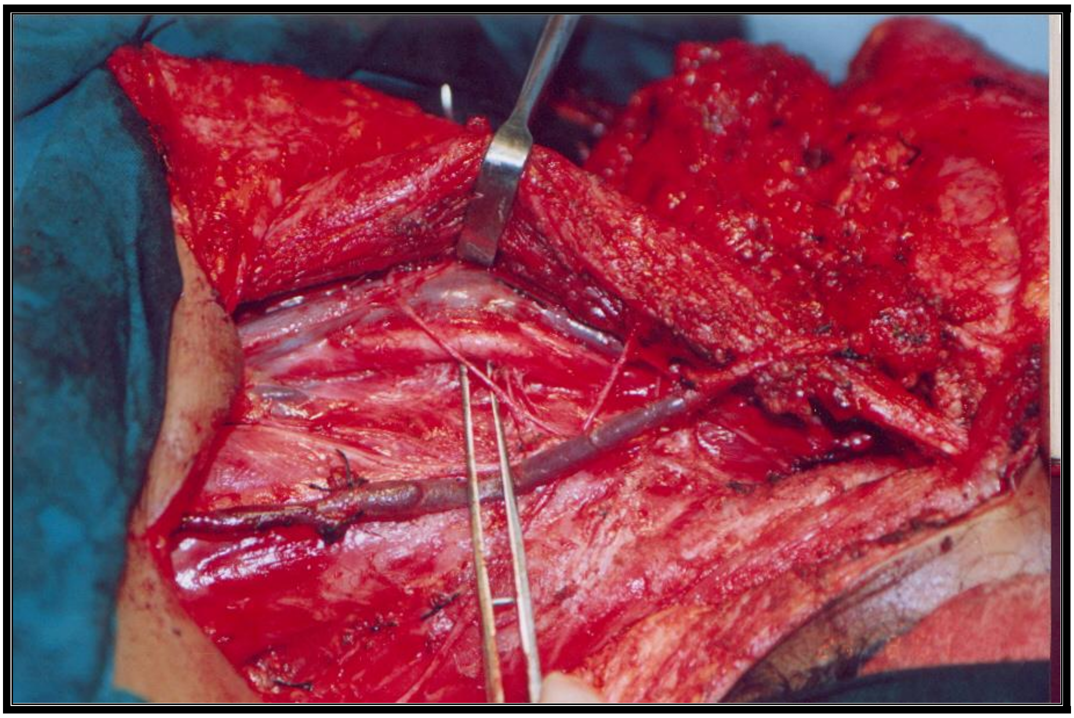


Fig 14: FND showing SAN, EJV

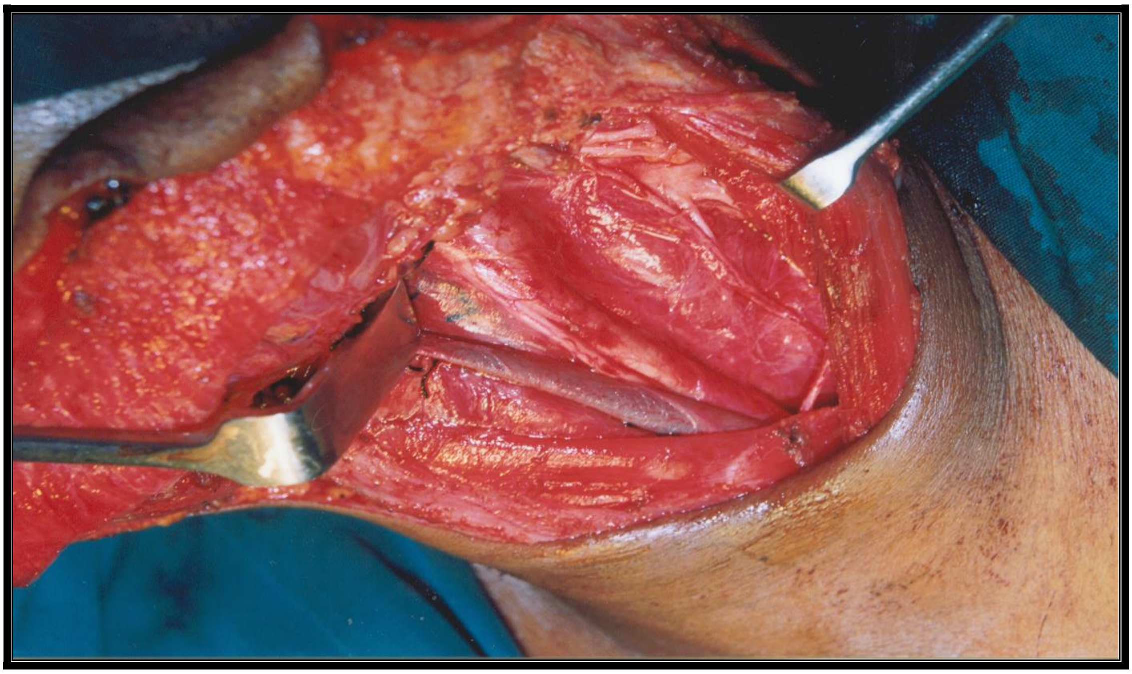


Fig 15: FND showing SAN, Carotid Artery, IJV, Vagus nerve

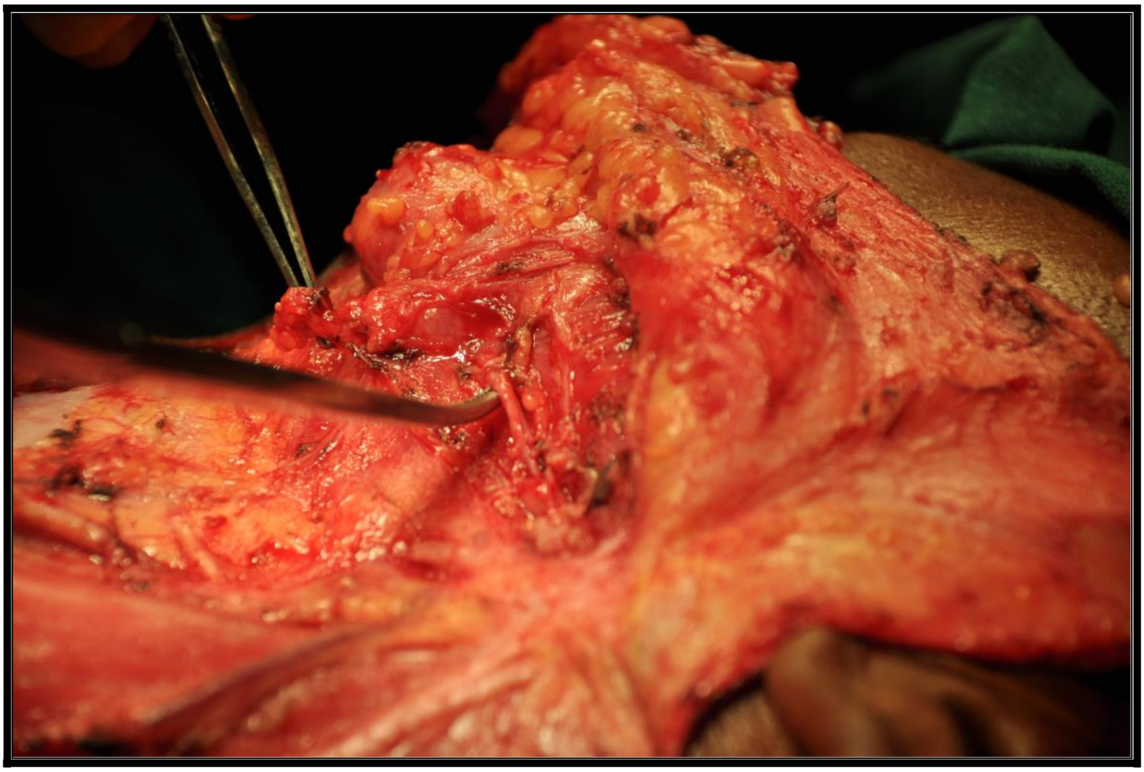


Fig 16: Submandibular fossa dissection

Fig 17 : FND - Skin closure with suction drains in situ

Figs 18 &19: Showing postoperative SAN injury

Fig 18: post operative inability to abduct arms above shoulder level

Fig 19: post operative inability to shrug shoulders

Supraomohyoid neck Dissection[36]

The Supraomohyoid neck Dissection is the most common and best evaluated of all the selective neck dissection procedures. Supraomohyoid neck dissection refers to the removal of lymph nodes contained in the submental and submandibular triangles (level I), the upper jugular nodes (level II), and the mid jugular lymph nodes (level III). The posterior limit of the dissection is marked by the cutaneous branches of the cervical plexus and the posterior border of the sternocleidomastoid muscle. Inferior limit is superior belly of omohyoid muscle, where it crosses the internal jugular vein.

Fig 20: Incision for SOHND

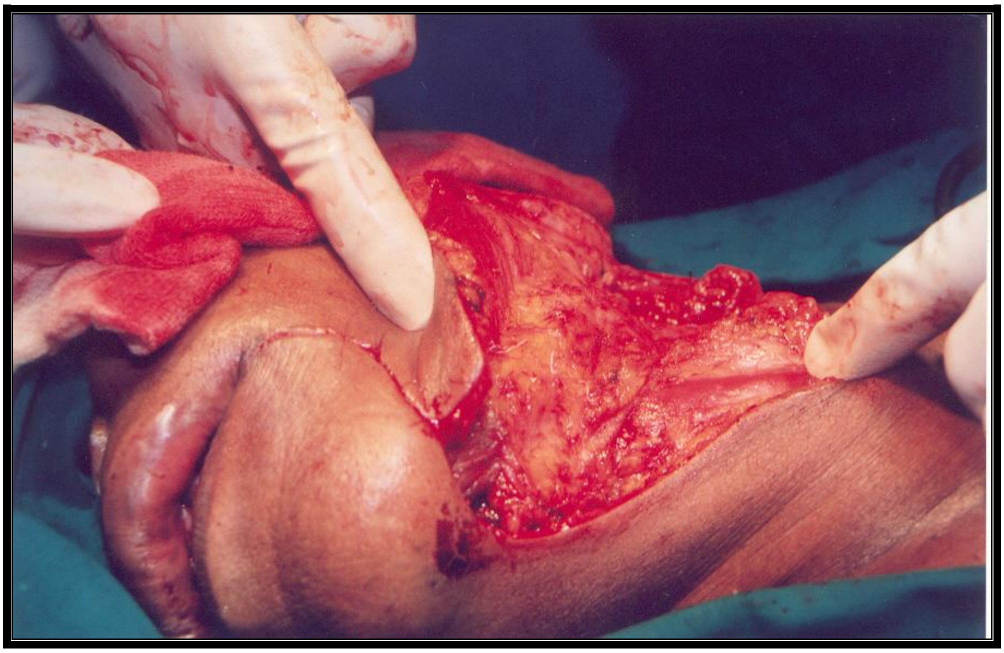


Fig 21: Area of clearance in SOHND

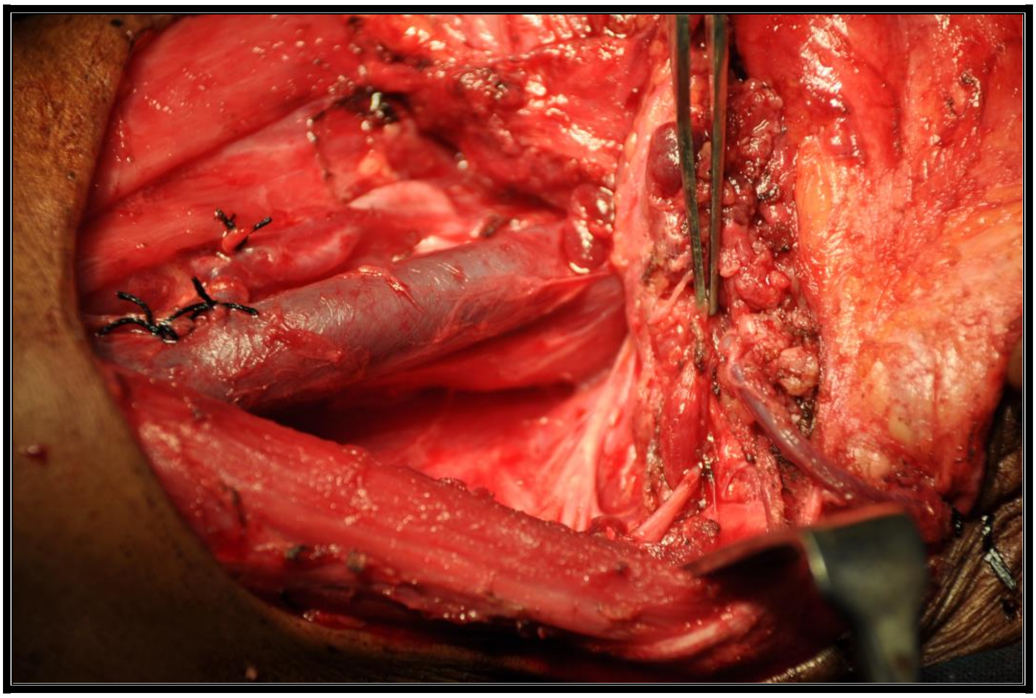


Fig 22: SOHND- Elevated Upper flap showing SAN, Cervical plexus, IJV, Carotid

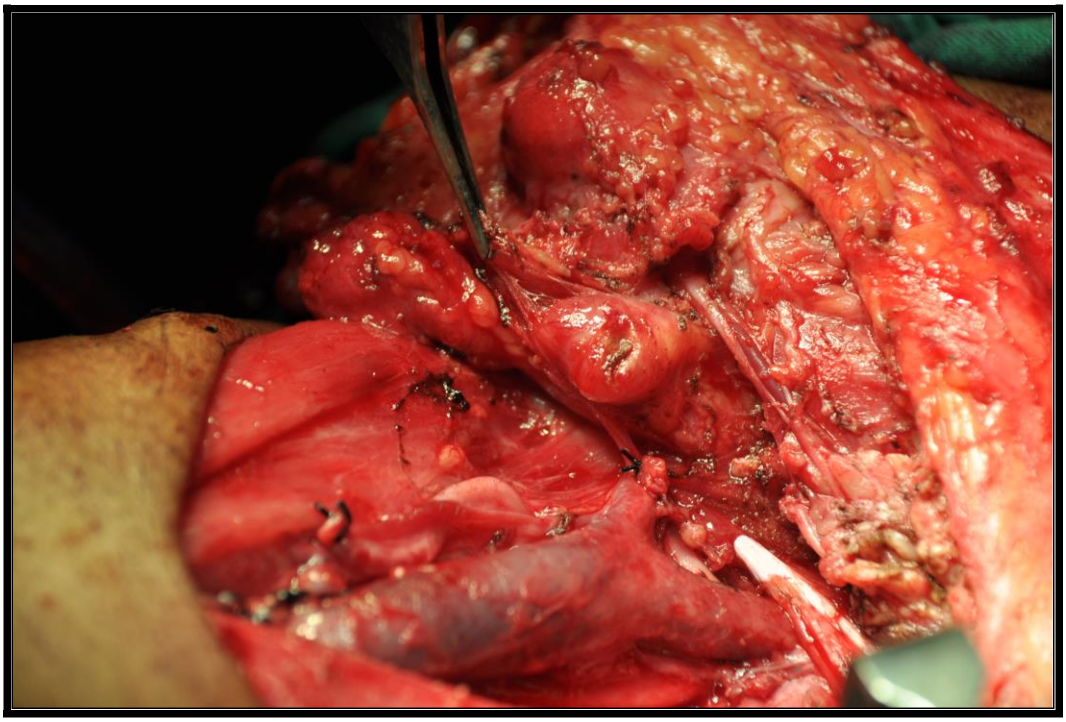


Fig 23a

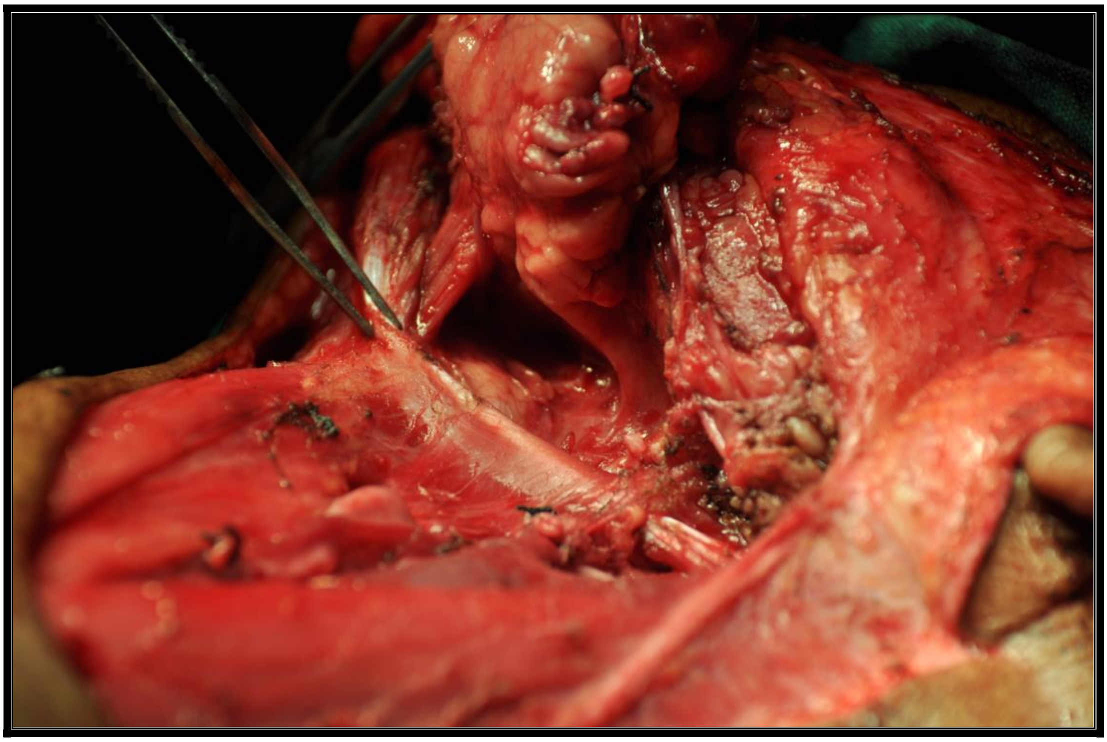


Fig 23b

Fig 23(a,b): Submandibular fossa dissection

Fig 24:SOHND-Skin closure with suction drains in situ

Peripheral nerve injuries[38]

Physical damage to peripheral nerves may result from sudden compression, crush, transection or stretching of a nerve. The mildest form of nerve injury results when a stretch or pressure injury distorts the myelin overlying the nodes of Ranvier and produces focal conduction block. This type of injury with conduction block but without Wallerian degeneration, is referred to as neurapraxia or class I injury. This results in a transient sensation of numbness in an extremity, as occurs after lying or sitting in a certain position. Nerve injury that interrupts the axon's continuity and results in Wallerian degeneration of the nerve distal to the lesion is considered moderate or severe. If the endoneurium is preserved , the lesion is considered moderate and is called axonotmesis or class II injury. If the endoneurium is destroyed the lesion is considered severe and is called neurotmesis.

The various Electro-Diagnostic tests are

1. Electromyography
2. Strength –duration curve
3. Nerve conduction study
4. Electroneuronography

ELECTROMYOGRAPHY[37]

ANATOMY OF MUSCLE

Skeletal or voluntary muscles constitute the principal organ of locomotion. There are more than 600 separate muscles in the human body which constitute 40% of body weight in adults. Each muscle is composed of thousands of muscle fibres, which extend for variable distance along its longitudinal axis. Each muscle fibre is a complex multinucleated cell of variable length ranging between few millimeters and several centimeters. The diameter of muscle fibre ranges between 10 µm and 100 µm. All the nuclei of the muscle are longitudinally oriented and situated beneath the cytoplasmic membrane. The cytoplasm of muscle cells contains myofibrils, various organelles such as mitochondria, ribosomes and endoplasmic reticulum. The myofibrils are composed of longitudinally oriented interdigitating filaments of contractile proteins, which are known as actin and myosin. The individual muscle fibre is enveloped by delicate strands of connective tissue endomysium, which provides support and unity of action. There may be several capillaries and nerve fibres within endomysium for each muscle fibre. Several muscle fibres are enveloped by perimysium into a group of fascicle. Many fascicles together compose a muscle, which is covered by epimysium. The muscle fibres are attached at their ends to tendon fibres, which in turn connect to the periosteum.

Each muscle fibre receives a nerve twig from a motor nerve cell in the anterior horn of spinal cord or brain stem. Groups of muscle fibres innervated by one motor neuron constitute the motor unit. The nerve joins the muscle fibre at a point, which is known as neuromuscular junction. The resting muscle membrane potential is 70-80 mv with intracellular negativity. The spontaneous release of acetylcholine quantum from the nerve ending at the neuromuscular junction results in miniature endplate potential due to localized depolarization. On stimulation a large number of acetylcholine quanta are released . The miniature endplate potential is 4-8 msec in duration and its amplitude depends upon the number of acetylcholine quanta released and sensitivity of acetylcholine receptors.

The action potential is initiated by the endplate potential when it exceeds the threshold .The muscle action potential propogates bidirectionally from the motor endplate at a velocity of 3-5 meters per second. These muscle action potential can be recorded as a monophasic wave in a non conducting medium. Recording in a conducting medium, the current flow generated by the potential is seen as relative positivity when recorded from a distance.

Electromyography refers to recording of action potentials of muscle fibres firing singly or in groups near the needle electrodes in a muscle. The muscle action potential when recorded by a needle appears triphasic as the action potential approaches, crosses and leaves the recording electrode (fig 26). Recording from an area incapable of propagating the impulse therefore results in a large positivity with a low and long negativity.

The distance of recording electrode from the muscle fibres determines the rise time and fall of muscle action potential.

The normal muscle fibres are under neural control. The rate and pattern of firing of the muscle fibres of a motor unit, therefore, depends on the the stimuli approaching through the nerve. The denervated muscle fibres on the other hand have unstable membrane potential and fire spontaneously (without stimulation), individually (single fibre) and regularly.

Types of EMG electrodes

A. Needle Electrode

1.Concentric

2.Monopolar

3.Single fibre

4.Macro

B. Surface electrode

Monopolar needle electrode

Monopolar needle electrode is a solid, 22-30 gauge teflon coated needle with a bare tip of approximately 500 micro meter. The motor unit potentials recorded by monopolar electrode are of high amplitude and longer duration. The monopolar needle electrode has the advantage of being less painful and cheaper .The need for an additional reference surface electrode is the major disadvantage of monopolar needle electrodes.

Recording technique

The equipment setup for EMG recording is as follows

Sweep speed: 5-10ms/div

Amplification: 50 microV/div for studying spontaneous activity and

200 micro V/div for MUPs

Filter setting: 20-10,000Hz

The duration of MUPs should be measured at a gain of 100 microV/div and sweep speed of 5ms/div and low filter at 2-3Hz

Almost every muscle in body can be studied with needle EMG. Patients cooperation is important for proper interpretation of EMG, therefore they should be properly explained about the test. For EMG of each muscle the following steps should be followed

1. select the patient
2. instruct the patient how to contract and relax the muscle
3. Identify the muscle while the patient is contracting and relaxing the muscle
4. Locate the needle insertion point slightly away from the motor point to prevent endplate noice
5. Insert the needle quickly while the muscle is relaxed to minimize the pain.
6. sharp MUPs on minimal contraction confirm that the needle is in proper position. If MUPs are not sharp , needle should be repositioned.

In needle EMG , following three types of activities are studied

1. Insertional activity
2. Spontaneous activity
3. Voluntary activity

Insertional activity

Introduction of the needle into the muscle normally produces a brief burst of electrical activity due to mechanical damage by needle movement. And it lasts slightly exceeding the needle movement (0.5-1.0s).It appears as positive or negative high frequency spikes in a cluster. Increased insertional activity is defined as any activity other than endplate potential lasting more than 300 ms after brief needle movement. Atleast 4-6 brief needle movements are made in four quadrants of each muscle to assess insertional activity. Insertional activity may be increased in denervated muscles and myotonia whereas it is reduced in periodic paralysis during the attack and myopathies when muscle is replaced by connective tissue or fat.

Prolonged insertional activity is sometimes found in normal individuals which is diagnosed by its widespread distribution.

Spontaneous Activity

Once the insertional activity decays after a second or so, in normal individuals there is no spontaneous electrical activity. In the endplate zone, however miniature end plate potentials are spontaneously recorded. On needle recording, endplate potentials appear as monophasic negative waves of less than 100 microV and duration of 1-3ms.The endplate potentials are usually seen with an irregular baseline and are called endplate noise (sea shell sound). In the endplate region, action potentials , which are brief, spike, rapid and irregular with an initial negative deflection are known as endplate spike. These are compared with the sound of sputtering fat in a frying pan. Endplate spikes are due to mechanical activation of nerve terminals by the needle. To avoid the normally occurring spontaneous endplate activities the needle should be introduced slightly away from the muscle endplate , which is usually situated near the center of the muscle belly.

Abnormal spontaneous activities originated from muscle fiber

1.Fibrillations and Positive sharp waves (fig 25)

2.Myotonic discharges

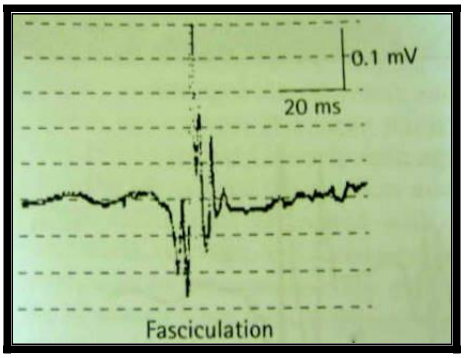
3.Complex repetitive discharges

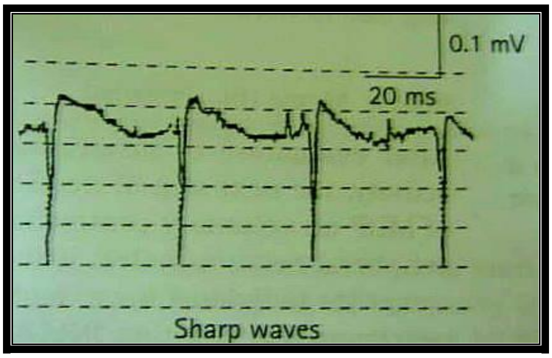
Abnormal spontaneous activities originated from motor neuron or axon

1. Fasciculations (fig 25)
2. Doublets , triplets and multiplets
3. Myokymia
4. Neuromyotonia
5. Cramps

Fibrillations and Positive sharp waves

Fibrillations are spontaneously occurring action potentials from a single muscle fibre. Fibrillation fires regularly at a rate of 0.5-15 Hz with an amplitude of 20-200 microV and duration of 1-5ms. On EMG single fibrillation potential often sound like rain drop on the roof. Positive sharp waves are long duration biphasic potentials with initial sharp positivity followed by a long duration negative phase resulting in a saw tooth appearance. These also appear regularly with an amplitude of 20-200 µV and duration of 10-30ms. It sounds like a dull pop. The positive sharp waves are the action potentials recorded from injured muscle fibres. The denervated muscle fibres develop not only hypersensitivity to acetyl choline but also the number of acetyl choline receptors are increased which leads to depolarization and is responsible for fibrillations and positive sharp waves.





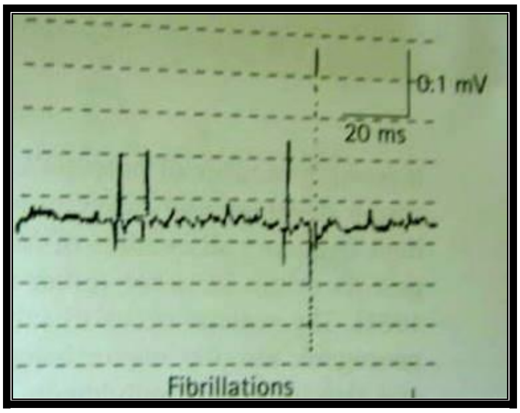


Fig 25 : Fasciculations, Positive sharp Waves, Fibrillations

Normal motor unit potential

Groups of muscle fibres innervated by one motor neuron constitute the motor unit. Normal motor unit potential is formed by the summation of potentials generated by individual muscle fibres innervated by the motor neuron.

After evaluation of insertional and spontaneous activity, the next step of needle EMG is evaluation of MUP on voluntary contraction. The basic unit of peripheral nervous system is the motor unit, which comprises individual lower motor neuron, its axons, neuromuscular junction, and muscle fibres. The number of muscle fibres in a motor neuron varies from 9 in extraocular muscles to 1900 in gastrocnemius. Depolarisation of motor neuron to the threshold results in impulse propogation through axons, which in turn results in excitation of all muscle fibres more or less simultaneously supplied by that motor neuron in normal situation. The slight variability in excitation of muscle fibres is due to the difference in the length of terminal axon and NMJ transmission time.

The recruitment of motor unit following voluntary contraction is determined by size principle. The size of a motor unit is dependent on size of motor neuron, diameter of axon, thickness of myelin, conduction velocity, depolarization threshold and metabolic type of muscle fibre. According to size principle, the motor units are recruited from smallest to largest following voluntary contraction. MUP represents the sum of the muscle action potentials supplied by an anterior horn cell.MUP therefore has a higher amplitude and longer duration than action potential produced by a single muscle fibre.

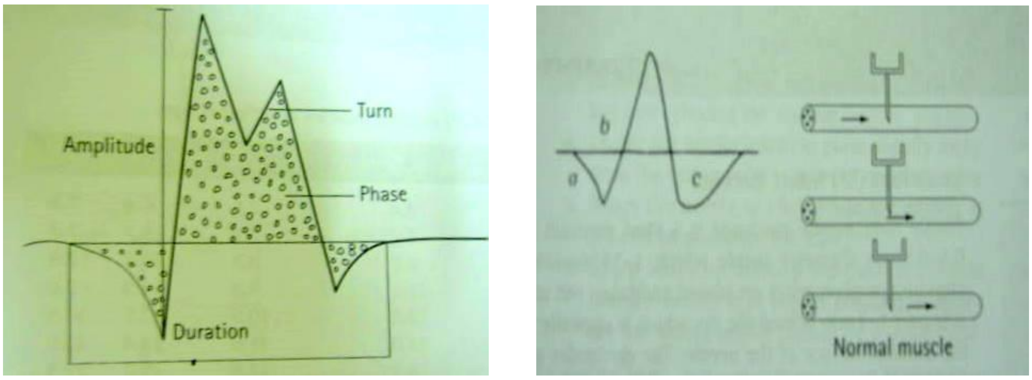


Fig 26: Motor unit potential

Phase of motor unit potential

MUP recorded by a monopolar needle reveals as inverted triphasic potential (positive-negative-positive).The phase is defined as the portion of MUP between departure and return to the baseline i.e number of baseline crossings +1. A MUP with more than four phases is called as polyphasic potential. In normal individuals the polyphasic potential do not exceed 15% of the total MUP population except deltoid in which upto 25% of polyphasia may be present normally. Polyphasic potentials have a high frequency clicking sound on EMG.

Interference pattern

During strong voluntary contraction, normally there is dense pattern of multiple superimposed potentials which is called interference pattern. Less dense pattern may occur with loss of motor units.

Electromyography of trapezius muscle

For lower trapezius EMG, the patient lies in a prone position and arm is extended over the head. The needle is inserted perpendicular to the vertebral column at the level of inferior angle of scapula, 3-4 cm (2 finger breadth) lateral to the spinous process of seventh dorsal vertebra. Elevating the arm from the couch activates the muscle.

For the EMG of the middle portion of trapezius, the patient lies in prone position with arm abducted to 90 degree and elbow flexed over the edge of the couch. The needle is inserted midway between the midpoint of spine of the scapula and vertebra at that level. Elevating the arm from bed activates the middle portion of trapezius muscle. On deep insertion, the needle may lie in rhomboideus minor.

For the EMG of upper trapezius, the patient lies prone and the arm is kept by the side of the body. The needle is inserted at the angle of neck and shoulder. On deep insertion, the needle may lie in levator scapulae. Shrugging the shoulder activates the upper part of the trapezius (fig 28).

Fig 27: RMS EP Mark -II EMG Machine

Fig 28: Electromyography of upper trapezius

MATERIALS AND METHODS

A prospective study of 50 head and neck cancer patients without previous surgical interventions who presented at R. L. Jalappa Hospital and Research Centre, Tamaka, Kolar between Nov 2008 and Dec 2009, was done. They were evaluated preoperatively and staged clinically. All diagnosis were confirmed histopathologically before treatment . The primary tumour was staged according to the 2002 version of classification of American joint committee on cancer.

INCLUSION CRITERIA

1. Histopathologically proven head and neck cancers with N_0 or N_1 neck.

EXCLUSION CRITERIA

1. Patients with advanced neck metastasis [N2,N3].
2. Patients with abnormal electromyography preoperatively.
3. Patients with previous ipsilateral neck surgery.
4. Patients undergoing salvage surgery following radiotherapy failure.
5. Neurological disorders.

Patients presenting with clinically N_0 or N_1 neck were taken up for the study and nerve sparing neck dissections were performed [MRND or FND or SOHND]. Out of 50 cases selected for our study, there were 7 males and 43 female patients in the age group ranging from 19 to 80 years [mean age 50 years].

In 50 patients, 51 neck dissection (11 SOHND, 12 MRND, 28 FND) were performed of which 49 were unilateral and 1 was bilateral. Neck dissection was performed before the excision of primary tumour. SAN was preserved in all cases.

There were three types of neck dissections performed on the patients included in this study. A Modified Radical neck dissection involved resection of all lymphatic contents contained in the anterior and posterior triangles of the neck with preservation of one or more of the following non lymphatic structures- SAN, SCM, IJV. The nerve was dissected from its exit at the skull base to its insertion into the trapezius muscle. The sternocleidomastoid muscle was sacrificed and the internal jugular vein was sometimes preserved. A Functional neck dissection involved resection of all lymphatic contents contained in the anterior and posterior triangles of the neck with preservation of the spinal accessory nerve, sternocleidomastoid muscle and internal jugular vein. The Supraomohyoid neck dissection involved dissection and removal of the lymphatic contents from the submental triangle, submandibular triangle and the upper and middle deep jugular nodes (level I,II,III) with preservation of the spinal accessory nerve, sternocleidomastoid muscle and internal jugular vein. The spinal accessory nerve was dissected only from the jugular foramen to the posterior edge of the sternocleidomastoid muscle.

Thus there were three treatment groups. The Modified Radical neck dissection group consisted of 12 shoulders (12 patients), the Functional neck dissection group consisted of 28 shoulders (27 patients) and the Supraomohyoid neck dissection group consisted of 11 shoulders (11 patients).

The patient underwent evaluation of shoulder function by trapezius muscle strength test and EMG of UT . EMG was done pre operatively, early post operative period (at 3 weeks) and late post operative period (at 3 months).

Muscle strength was evaluated by manually testing shoulder abduction. The findings were scored according to the criteria of **Daniels and Worthingham's SCORE**[39]

5 (Normal) - Muscle strength that could be overcome with strong manual resistance.

4 (Good)- Muscle strength that could be overcome with moderate manual resistance.

3 (Fair) - Muscle strength sufficient to hold a position against a force of gravity.

2 (Poor) - Muscle activity only when the upper limb was supported by the examiner.

1 (Trace) - Only palpable muscle contraction.

0 (Zero) - No palpable evidence of muscle contraction

After an informed written consent electromyographic studies were performed before surgery, during the 3rd week postoperatively and 3rd month post operatively to assess the effects of these procedures on Spinal Accessory nerve and the Trapezius muscle using needle EMG of upper trapezius.(concentric needle electrodes and RMS EP Mark II machine). Recordings were obtained during rest, mild and maximal contraction.

During this procedure the patient sat on a chair with the forearm lying on the thighs and inert. During the trapezius muscle test, the patient kept the head straight up and was asked to look at a hypothetical point 5^0 to 10^0 above the visual horizon. When the subject was completely relaxed electrical silence of both trapezius muscles could be reached[40]. The recording needle was inserted at the angle of neck and shoulder to test upper trapezius.

The electromyograms of the trapezius muscle recorded resting potentials as evidenced by insertional activity, fibrillation potentials - fasciculations and positive sharp waves, as well as active potentials as evidenced by duration, amplitude, phases and recruitment pattern during muscle contraction. Each electromyogram was rated as being normal, slightly abnormal, moderately abnormal or severely abnormal using the classification criteria in table.

Criteria for interpretation of the Electromyogram [14]

Finding	Fibrillation Potentials	Positive Sharp Waves	Amplitude (mv)	Recruitment Pattern
Normal	0	0	>2	Full
Slightly Abnormal	1^+	1^+	1.5-2	Slightly Reduced
Moderately Abnormal	2^+	2^+	1-1.5	Moderately Reduced
Severely Abnormal	$\geq 3^+$	$\geq 3^+$	<1	Severely Reduced

The muscle strength scores and electromyograms were statistically analysed using Paired T test and Independent T test.

RESULTS AND OBSERVATIONS

Sex Distribution

Table 1: Sex distribution

Sex	**No. of Patients**	**%**
Male	7	14
Female	43	86
Total	50	100

Out of the 50 patients included in our study,7 were males (14%)and 43 were females (86%).The sex distribution is shown in pie diagram (Graph 1)

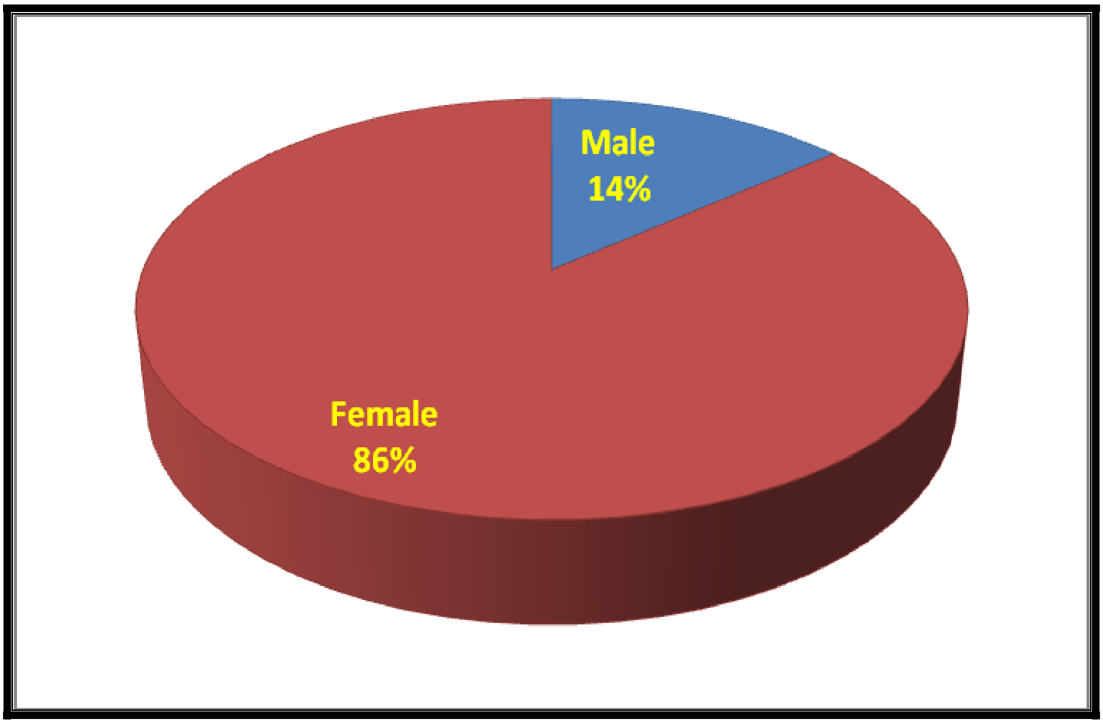
Age Distribution

Table 2 : Age Distribution

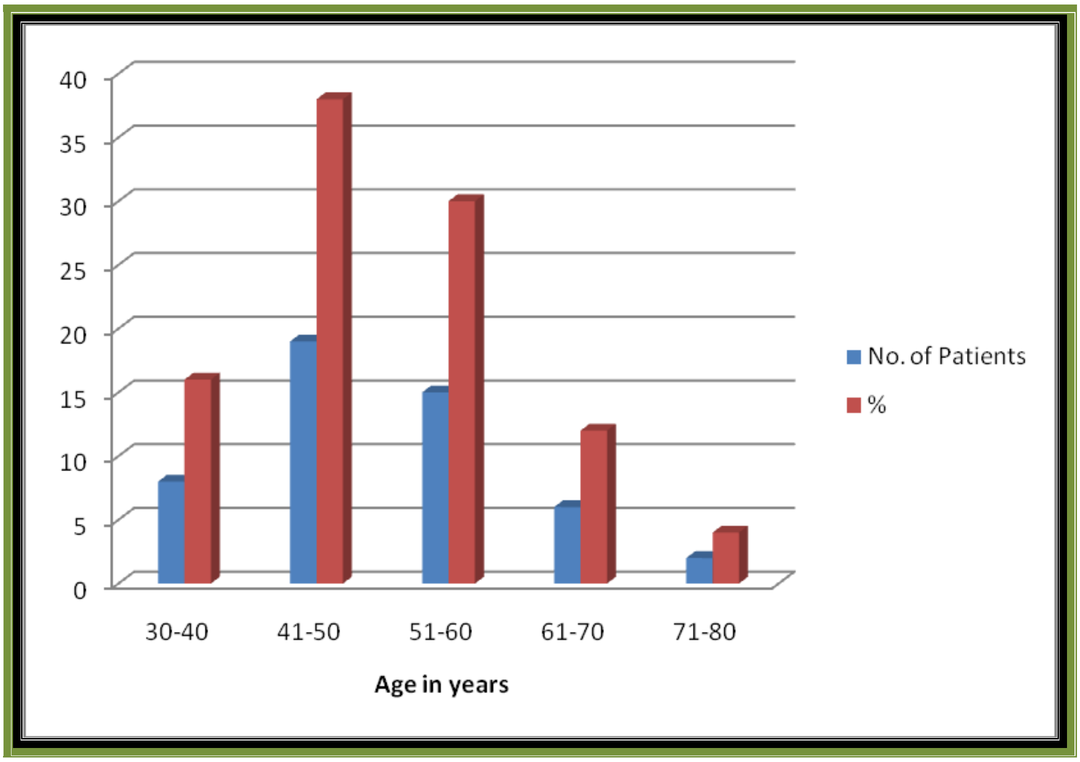
Age in year	**No. of Patients**	**%**
30-40	8	16
41-50	19	38
51-60	15	30
61-70	6	12
71-80	2	4
Total	50	100

The age of the study group patients ranged from 19 to 80 years with a mean age of 50 years . The age distribution is shown in bar diagram (Graph 2).

Graph 1 : Pie Diagram showing Sex Distribution



Graph 2 : Bar Diagram Showing Age Distribution



Site of Primary Tumor

Table 3 : Distribution of Primary Tumour

Site of Primary	No. of Patients	%
Buccal Mucosa	31	62
RMT	1	2
Upper Alveolus	1	2
Lower Alveolus	3	6
Tongue	3	6
Lower lip	1	2
Supra Glottis	1	2
Sub Glottis	1	2
PF	1	2
BOT	1	2
Pap ca Thyroid	5	10
MUO	1	2
Total	50	100

In our study, the majority of primary tumors were Oral cavity tumors (40/50) that is 80%, one Supraglottic laryngeal tumor (2%), one Subglottic laryngeal tumor (2%), one Pyriform fossa tumor (2%), one BOT tumor (2%), 5 Papillary carcinomas of thyroid (10%) and one Metastasis of unknown origin (2%).The distribution of primary tumor is shown in pie diagram (Graph 3).

Among the oral cavity tumors the most commonly involved subsite was Buccal mucosa (31/40) that is 77.5%.

TNM Staging of Primary Tumor

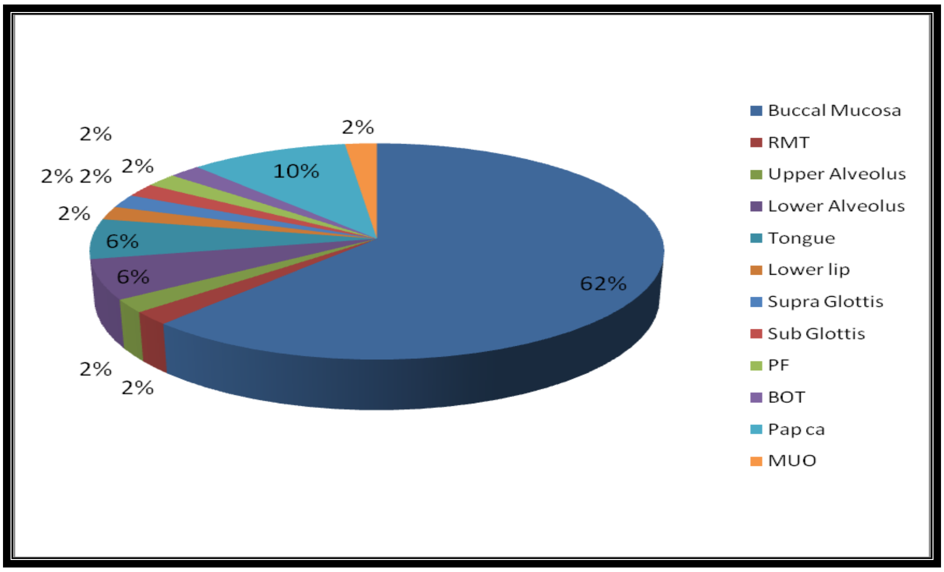
'T' stage of our series

The primary tumor staging included two T_1 lesions (4%), thirteen T_2 lesions (26%), Seventeen T_3 lesions (34%), Seventeen T_4 lesions (34%) and one T_x lesion (2%). Distribution of T stage is shown in Bar diagram (Graph 4).

Table 4: Distribution of 'T' Stage

T stage	**No. Of Patients**	**%**
T_1	2	4
T_2	13	26
T_3	17	34
T_4	17	34
T_x	1	2
Total	50	100

Graph 3 : Pie Diagram showing Distribution of Primary Tumour



Graph 4 : Pie Diagram showing Distribution of 'T' Stage

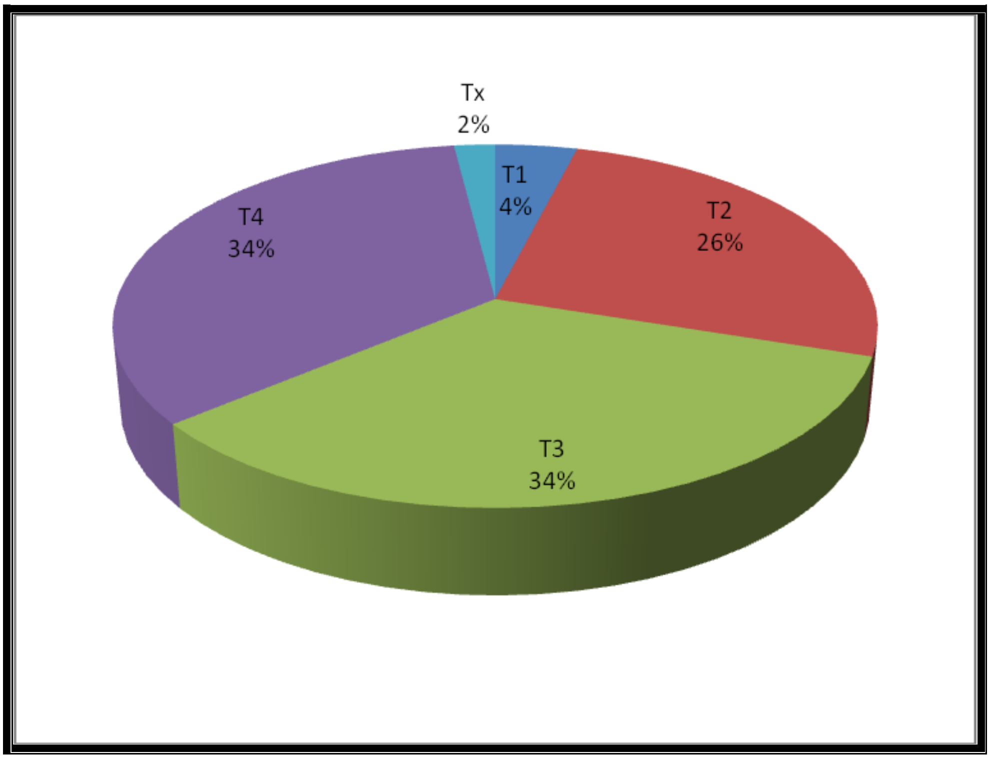
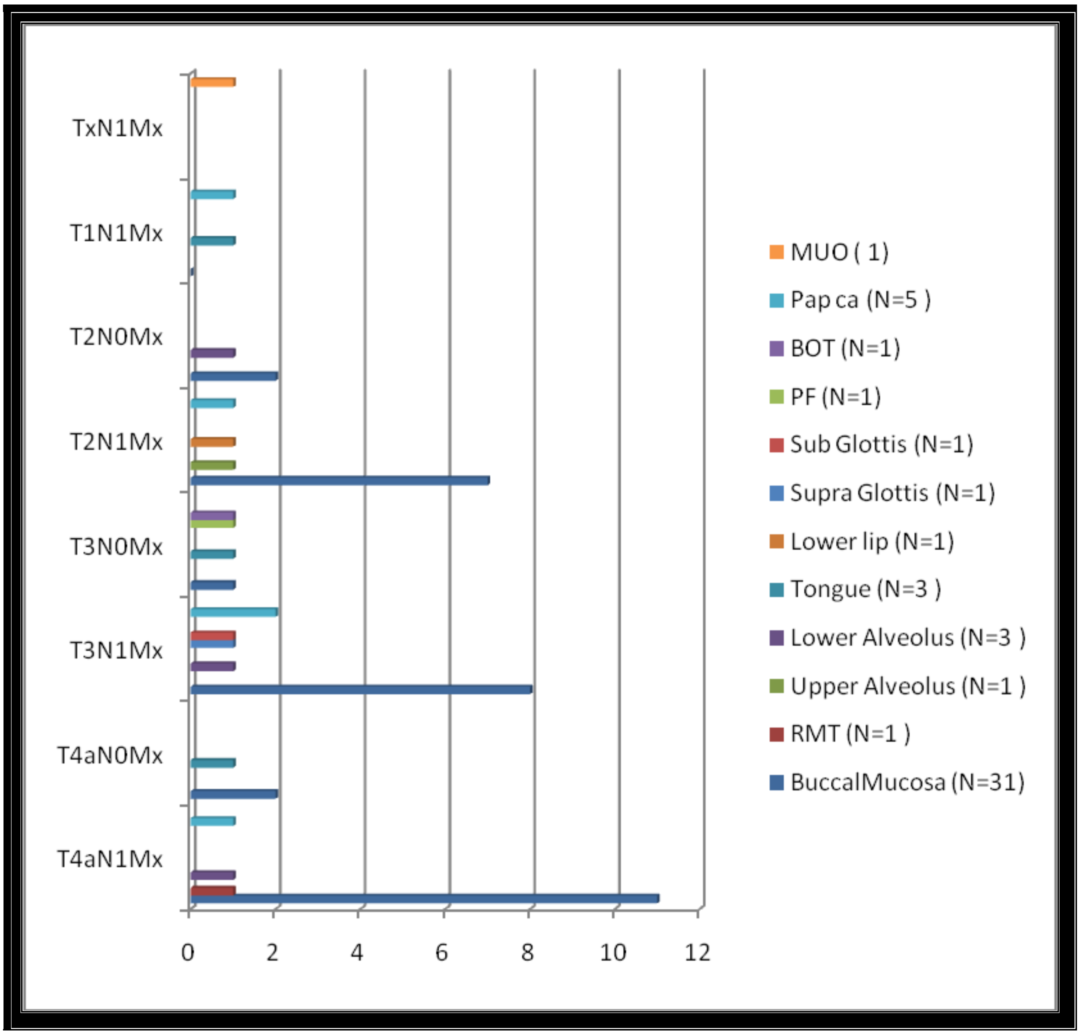


Table 5 :Site of Primary Tumor and TNM Staging of the Primary Tumor

Clinical Staging	Buccal Mucosa (N=31)	RMT (N=1)	Upper Alveolus (N=1)	Lower Alveolus (N=3)	Tongue (N=3)	Lower lip (N=1)	Supra Glottis (N=1)	Sub Glottis (N=1)	PF (N=1)	BOT (N=1)	Pap ca (N=5)	MUO (1)
$T_{4a}N_1M_x$	11	1	-	1	-	-	-	-	-	-	1	-
$T_{4a}N_0M_x$	2	-	-	-	1	-	-	-	-	-	-	-
$T_3N_1M_x$	8	-	-	1	-	-	1	1	-	-	2	-
$T_3N_0M_x$	1	-	-	-	1	-	-	-	1	1	-	-
$T_2N_1M_x$	7	-	1	-	-	1	-	-	-	-	1	-
$T_2N_0M_x$	2	-	-	1	-	-	-	-	-	-	-	-
$T_1N_1M_x$	0	-	-	-	1	-	-	-	-	-	1	-
$T_xN_1M_x$	-	-	-	-	-	-	-	-	-	-	-	1
Total	31	1	1	3	3	1	1	1	1	1	5	1

Distribution of clinical staging of Primary Tumor is shown in Bar diagram (graph 5).

Graph 5 : Bar Diagram Showing TNM Staging of the Primary Tumor



N Stage of our series

Table 6 : Distribution of 'N' Stage

N stages	No. of Patients	%
N_0	10	20
N_1	40	80
Total	50	100

All patients belonged to either N_0 or $N_{1.}$ The majority of our patients were N_1(80%).Only 10 patients (20%) had N_0 neck..

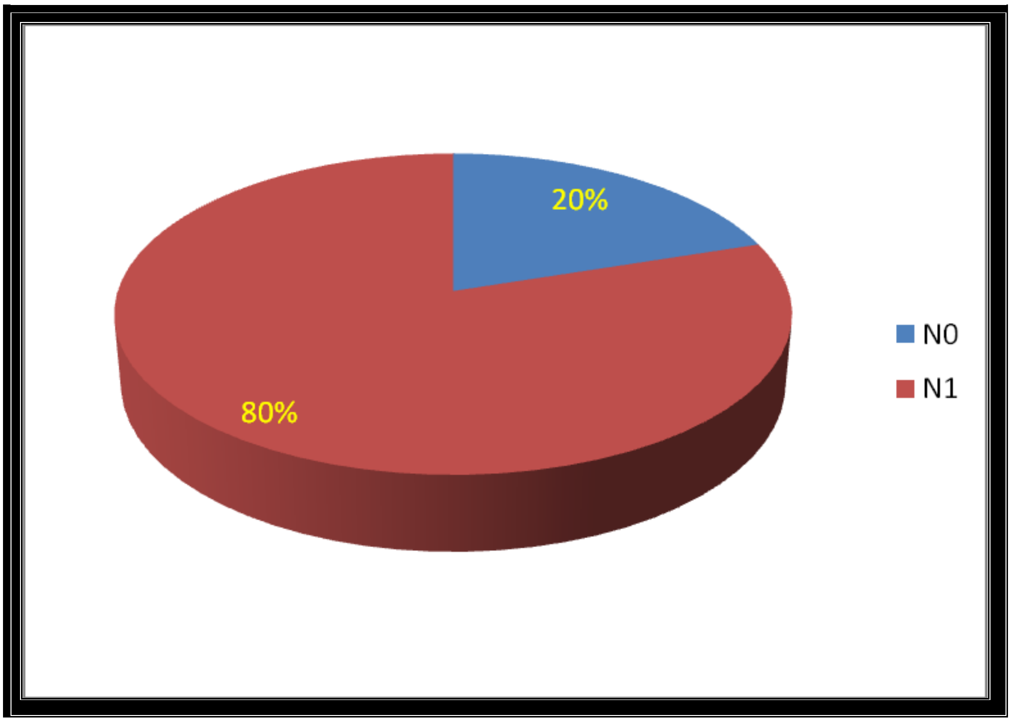
Types of Neck Dissection

Table 7 : Distribution of types of neck dissection

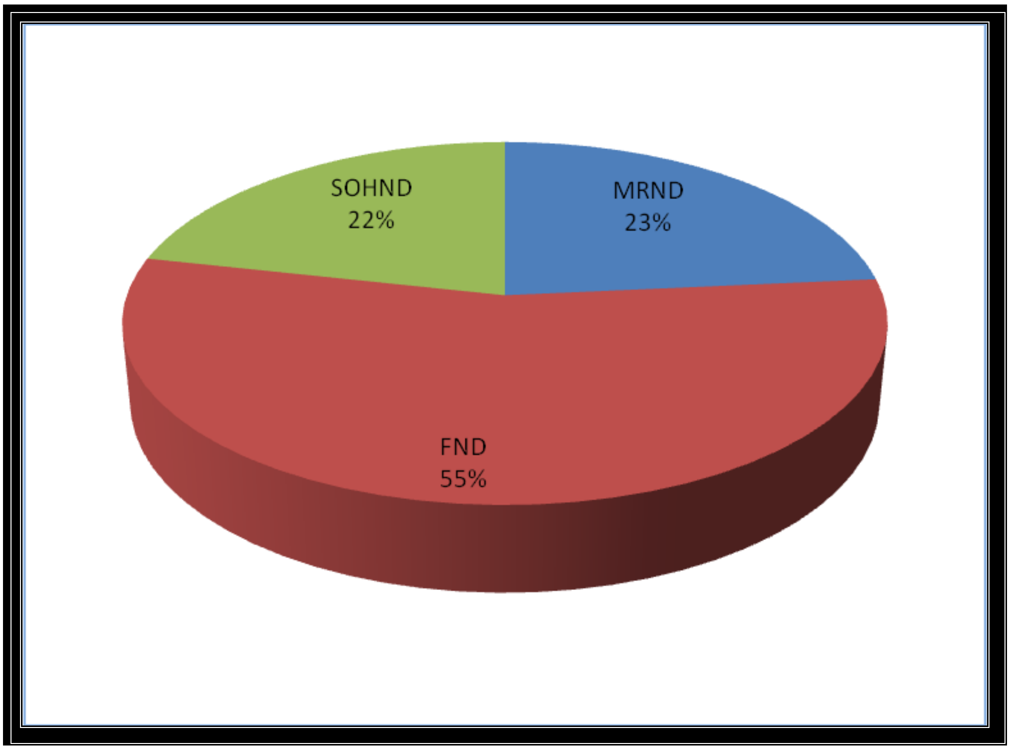
Type of Neck Dissection	No. of Neck Dissections	%
MRND	12	23
FND	28	55
SOHND	11	22
Total	**51**	**100**

Majority of patients, 28 (55%) underwent FND.12 patients (23%) underwent MRND.11 patients (22%) underwent SOHND. Distribution of types of neck dissection is shown in Pie diagram (Graph 7).

Graph 6 : Pie Diagram showing N Stage of our series



Graph 7 :Pie Diagram showing types of neck dissection



Muscle Strength after Neck Dissection

Table 8: Muscle strength after neck dissection(n=51)

Daniels and Worthingham's Score (Denominator 5)	**5(Normal)**	**4(Good)**	**3(Fair)**	**2(poor)**	**1(Trace)**	**0(Zero)**
Pre op	51 (100%)					
Early Post op (3weeks)		16 (31.4%)	34 (66.7%)	1 (2%)		
Late Post op (3 months)	12 (23.5%)	21 (41.2%)	17 (33.3%)	1 (2%)		

In early post operative period (3 weeks), majority of the patients had either Good (score 4) or Fair (score 3) muscle strength. Only one patient had Poor (score 2) muscle strength.

In late post operative period (3 months), 12 patients improved their muscle strength from Good (score 4) or Fair (score 3) to Normal (score 5). One patient who had Poor (score 2) muscle strength in the early post operative period did not show any improvement. The distribution of muscle strength after neck dissection is shown in Bar diagram (Graph 8).

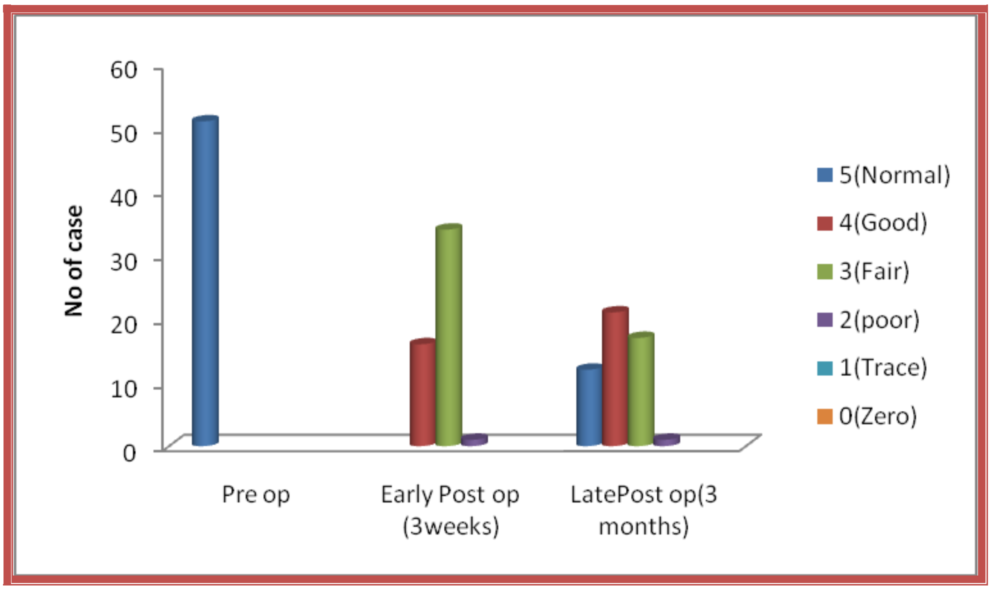
Table 9 : Muscle strength after MRND(n=12)

Daniels and Worthingham's Score (Denominator 5)	5(Normal)	4(Good)	3(Fair)	2(poor)	1(Trace)	0(Zero)
Pre op	12 (100%)					
Early Post op (3weeks)		4 (33.3%)	8 (66.7%)			
Late Post op (3 months)	3 (25%)	3 (25%)	6 (50%)			

In early post operative period (3 weeks), majority of patients had either Good (score 4) or Fair (score 3) muscle strength. None of the patients had Poor (score 2) muscle strength.

In late post operative period (3 months), three patients improved their muscle strength from either Good or Fair to Normal. The distribution of muscle strength after MRND is shown in Bar diagram (Graph 9).

Graph 8 : Bar diagram showing Muscle Strength after Neck Dissection



Graph 9: Bar diagram showing Muscle Strength after MRND

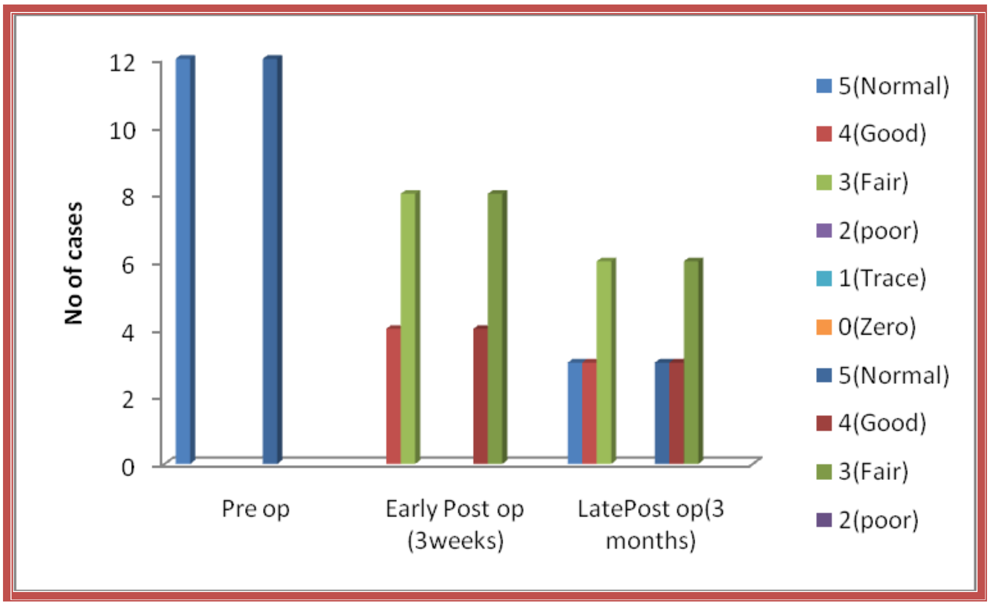


Table 10 : Muscle strength after FND (n=28)

Daniels and Worthingham's Score (Denominator 5)	5(Normal)	4(Good)	3(Fair)	2(Poor)	1(Trace)	0(Zero)
Pre op	28 (100%)					
Early Post op (3weeks)		8 (28.6%)	19 (67.9%)	1 (3.6%)		
Late Post op (3 months)	5 (17.6%)	11 (39.3%)	11 (39.3%)	1 (3.6%)		

In early post operative period majority of the patients had either Good (score 4) or Fair (score 3) muscle strength. One patient had Poor (score 2) muscle strength.

In late post operative period, five patients improved their muscle strength from either Good (score 4) or Fair (score 3) muscle strength to Normal (score 5). One patient who had Poor (score 2) muscle strength in the early post operative period did not show any improvement. The distribution of muscle strength after FND is shown in Bar diagram (Graph 9).

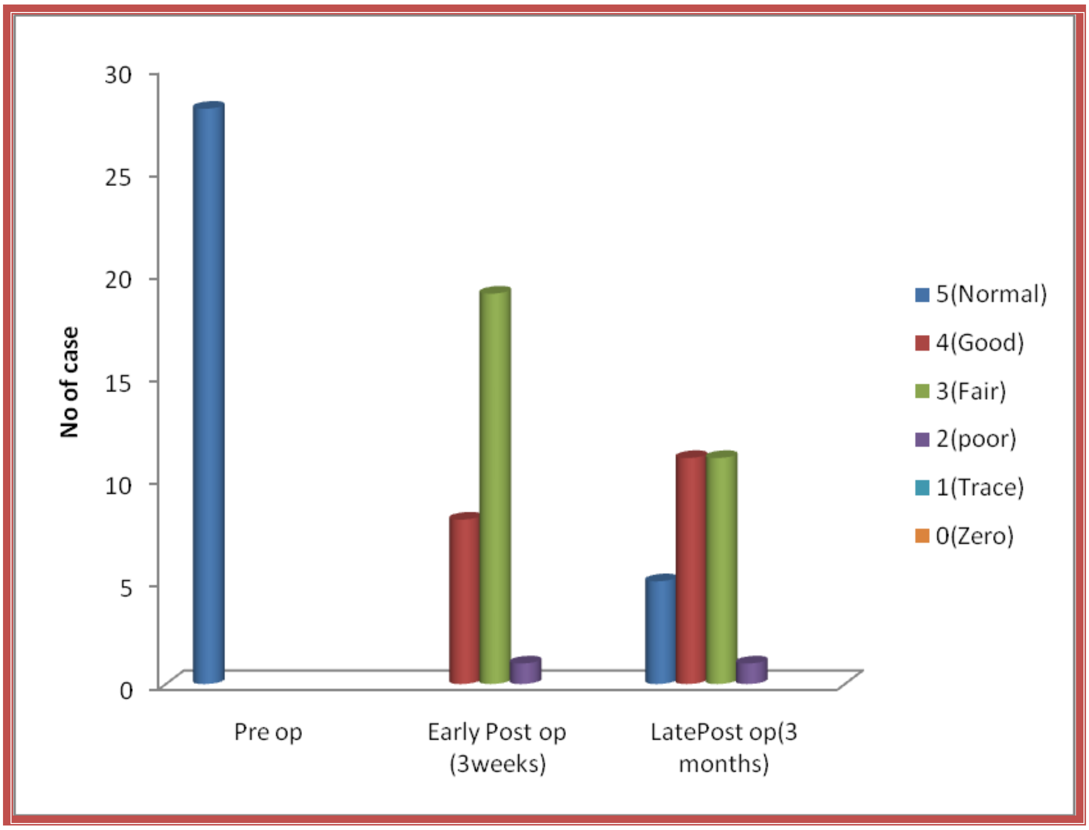
Table 11 : Muscle strength after SOHND (n==11)

Daniels and Worthingham's Score (Denominator 5)	5(Normal)	4(Good)	3(Fair)	2(Poor)	1(Trace)	0(Zero)
Pre op	11 (100%)					
Early Post op (3weeks)		4 (36.4%)	7 (63.6%)			
Late Post op (3 months)	4 (36.4%)	7 (63.6%)				

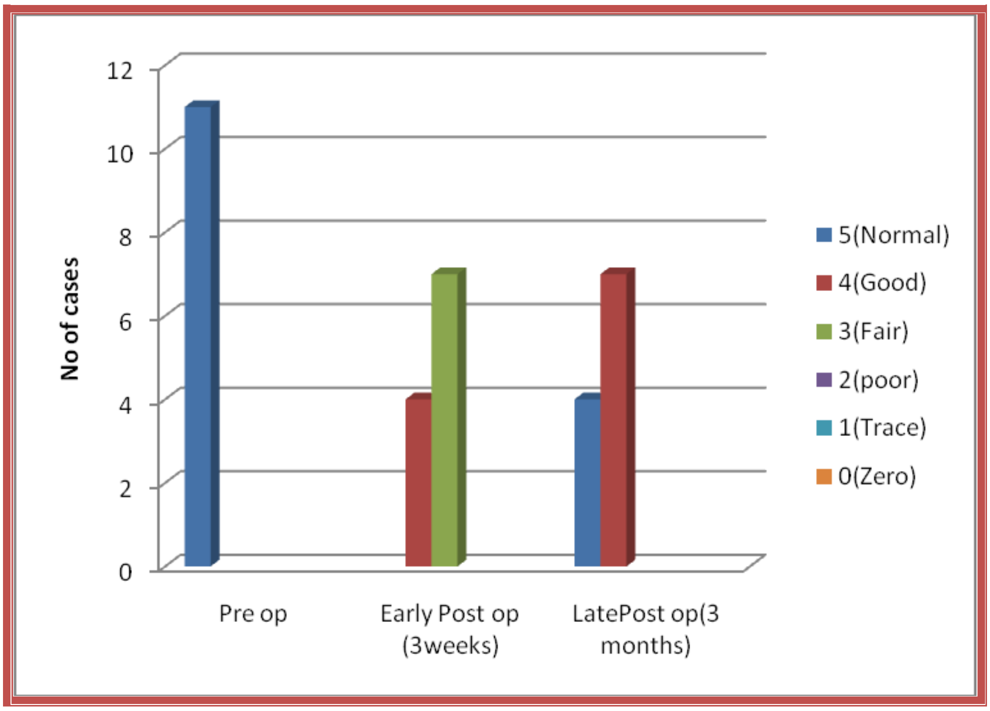
In early post operative period all the patients had either Good (score 4) or Fair (score 3) muscle strength. None of the patients had Poor muscle strength.

In late post operative period, all the patients had either Normal (score 5) or Good (score 4) muscle strength. The distribution of muscle strength after FND is shown in Bar diagram (Graph 11).

Graph 10 :Bar Diagram showing Muscle strength after FND



Graph 11 : Bar Diagram showing Muscle strength after SOHND



Electromyogram After Neck Dissections

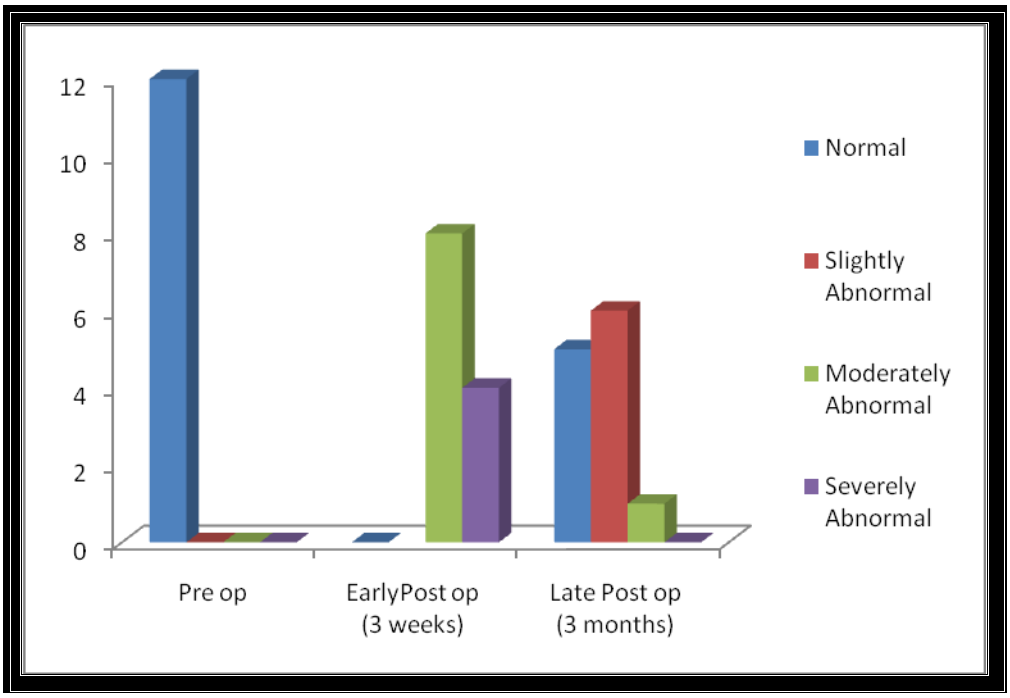
Table 12: Showing Electromyogram after MRND(n=12)

EMG finding	Normal	Slightly Abnormal	Moderately Abnormal	Severely Abnormal
Pre op	12(100%)	_	_	_
EarlyPost op (3 weeks)	_	_	8(66.5%)	4(33.3%)
LatePost op (3 months)	5(41.7%)	6(50%)	1(8.3%)	_

Table 13 : Showing Electromyogram after FND(n=28)

EMG finding	Normal	Slightly Abnormal	Moderately Abnormal	Severely Abnormal
Pre op	28(100%)	_	_	_
EarlyPost op (3 weeks)	_	1(3.6%)	16(57.14%)	11(39.3%)
LatePost op (3 months)	12(42.9%)	11(39.3%)	5(17.9%)	_

Graph 12:**Bar diagram showing Electromyogram after MRND(n=12)**



Graph 13 : **Bar diagram showing Electromyogram after FND(n=28)**

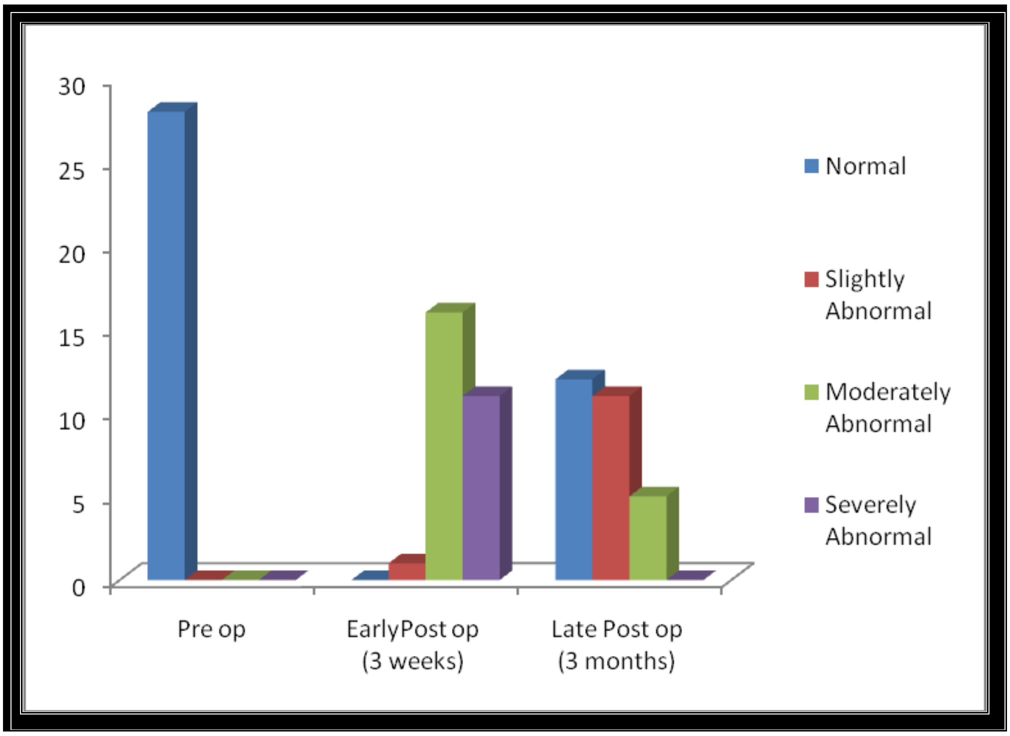
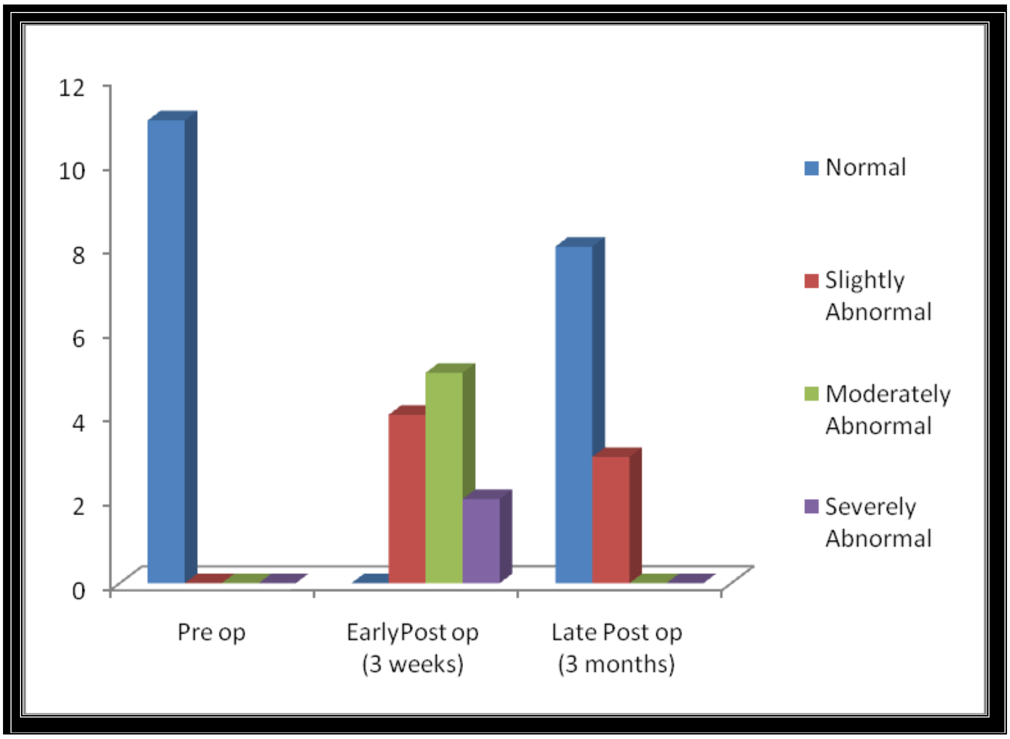


Table 14 : Electromyogram after SOHND(n=11)

EMG finding	Normal	Slightly Abnormal	Moderately Abnormal	Severely Abnormal
Pre op	11(100%)			
EarlyPost op (3 weeks)		4(36.4%)	5(45.5%)	2(18.2%)
Late Post op (3 months)	9 (82%)	2 (18%)	-	-

Graph 14 : Showing Electromyogram after SOHND(n=11)



Of the three groups , those patients who underwent Functional neck dissection showed the most severe disturbance on electromyography at 3 weeks. Of the 28 shoulders (27 patients) in this group,11 had severely abnormal electromyogram (39.3%), 16 had moderately abnormal electromyograms (57.14%) and one had slightly abnormal electromyogram (3.6%). At three months, electromyography showed improvement. 12 patients (42.9%) showed normal electromyogram , 11 patients (39.3%) showed slightly abnormal electromyograms and 5 patients (17.9%) showed moderately abnormal electromyograms.

In the Modified radical neck dissection group, there were 12 shoulders(12 patients). Of these, there were 4 shoulders (33.3%) with severely abnormal electromyogram at 3 weeks post operatively and 8 (66.55%) with moderately abnormal electromyograms. In late post operative period (3 months), one patient (8.3%) showed moderately abnormal electromyograms, 6 (50%) with slightly abnormal electromyograms and 5 (41.7%) showed normal electromyograms.

The supraomohyoid neck dissection group was found to have the least damage to the spinal accessory nerve as demonstrated by post operative electromyogram. Of the 11 shoulders in this group two (18.2%) had severely abnormal electromyograms in the early post operative period (3rd week) , five (45.5%) had moderately abnormal electromyograms and 4 (36.4%) had slightly abnormal electromyograms. On repeat electromyograms at 3 months all showed improvement with nine patients (82%) showing normal electromyograms and 2 patients (18%) showing slightly abnormal electromyograms.

The electromyograms of the supraomohyoid neck dissection group were significantly different from both the modified radical neck dissection group and functional neck dissection group 3 weeks postoperatively ($p<0.05$).The modified radical neck dissection group was not statistically different from the functional neck dissection group on the basis of electromyograms ($p>0.05$).

In MRND group, 4 patients showed improvement from moderately abnormal electromyogram in early post operative period to normal electromyogram in late post operative period . 4 patients showed improvement from severely abnormal electromyogram in early post operative period to either normal or slightly abnormal electromyogram in late post operative period . 3 patients showed improvement from moderately abnormal electromyogram in early post operative period to slightly abnormal electromyogram in late post operative period . One patient who had moderately abnormal electromyogram in early post operative period did not show any improvement in late post operative period. All patients (except one) in the MRND group showed improvement in at least one category on the second electromyogram in late post operative period (3 months).

In FND group, 2 patients showed improvement from severely abnormal electromyogram in early post operative period to normal electromyogram in late post operative period, 4 patients showed improvement from severely abnormal electromyogram in early post operative period to slightly abnormal electromyogram in late post operative period, 5 patients showed improvement from severely abnormal electromyogram in early post operative period to moderately abnormal electromyogram in late post operative period. 9 patients showed improvement from moderately abnormal electromyogram in early post operative period to normal electromyogram in late post operative period . 7 patients showed improvement from moderately abnormal electromyogram in early post operative period to slightly abnormal electromyogram in late post operative period. One patient who had slightly abnormal electromyogram in early post operative period improved to normal electromyogram in late post operative period . Thus, all patients in the FND group showed improvement in at least one category on the second electromyogram in late post operative period (3 months).

In SOHND group, 2 patients showed improvement from severely abnormal electromyogram in early post operative period to normal electromyogram in late post operative period. Out of 5 patients who showed moderately abnormal electromyogram in early post operative period, 3 improved to normal electromyogram and 2 improved to slightly abnormal electromyogram in late post operative period. Out of 4 patients who showed slightly abnormal electromyogram in early post operative period, all improved to normal electromyogram in late post operative period. None of the patients had severe abnormality in electromyogram in late post operative period. Thus, all patients in the SOHND group showed improvement in at least one category on the second electromyogram in late post operative period (3 months).

DISCUSSION

One of the primary goals of modification of Radical Neck Dissection is the preservation of Spinal Accessory Nerve and thereby decreasing the post operative shoulder morbidity. The relationship between the preservation of spinal accessory nerve and post operative shoulder morbidity was investigated by several authors and shoulder function was found to be better in any nerve sparing neck dissection. Although functional superiorty of accessory nerve sparing neck dissection over accessory nerve sacrificing neck dissection is more or less established, there are only very few studies comparing accessory nerve function between various types of accessory nerve sparing neck dissections.

In literature accessory nerve function has been analysed after different types of nerve sparing neck dissections. Leipzig[41] in his study found lesser degree of shoulder dysfunction (30%) when nerve, muscle and vein were preserved during two types of neck dissection-supraomohyoid and functional than those with nerve preservation only– modified radical neck dissection (50%) and radical neck dissection (60%). They concluded that there might be a functional disability associated with any type of neck dissection in which accessory nerve is preserved. This effect was considered to be related to some degree of traction on the nerve.

In our study also, we found that any type of neck dissection can result in some injury to the spinal accessory nerve.

Sobol[14] in his study compared functional results of three types of neck dissections, namely radical neck dissection, modified radical neck dissection and supraomohyoid neck dissection on the basis of electromyography and range of motion assessment of spinal accessory nerve function . Those patients who underwent supraomohyoid neck dissection had significantly better results than patients who underwent either modified radical or radical neck dissection . This difference between supraomohyoid neck dissection and others was attributed to the lack of disturbance of the posterior neck during supraomohyoid neck dissection which results in less damage to the accessory nerve.

In our study also, we found that supraomohyoid neck dissection has significantly better results than modified radical neck dissection. None of the patients who underwent a supraomohyoid neck dissection had a severe or moderate abnormality on their electromyogram approximately three months after surgery. Also there was a significant difference between the supraomohyoid neck dissection group and the modified radical neck dissection group 3 weeks after surgery on the basis of their electromyogram.

Literature shows that the severity of shoulder dysfunction did not correlate closely with the degree of denervation of the trapezius muscle.[7,40,42].In agreement with the literature,11 patients in our FND group showed severely abnormal EMG findings in the trapezius muscle, but they did not have as great a degree of shoulder dysfunction as would be expected. . This may be accounted for by any of several factors, including the pre operative condition of other synergistic shoulder girdle muscles , patients willingness to perform post operative exercises , age , sex and left or right handedness.[41,13]

The difference between the supraomohyoid neck dissection group and both the modified radical neck dissection and functional neck dissection groups can be explained by the difference in extent of dissection in these procedures . Except for its most superior extent, supra spinal accessory region-level IIb , the posterior triangle of the neck is not disturbed by supraomohyoid neck dissection ,which results in less damage to the 11th nerve.

Remmler[15] in his studies reported that nerve sparing neck dissections were followed by a significant but temporary and reversible phase of shoulder dysfunction, where as radical neck dissection was followed by profound and permanent shoulder dysfunction.

Cheng[43] ,in his studies found that selective neck dissections had the least damage to accessory nerve function and the least shoulder disability after neck dissection.

Though there are various studies in literature comparing nerve sparing and nerve sacrificing neck dissection, there is paucity of studies comparing different types of nerve sparing neck dissection with regard to accessory nerve function.

So our study was designed to assess the accessory nerve function after various types of nerve sparing neck dissections-MRND, FND, SOHND. In the present study, we observed functional disturbance of the accessory nerve with all the three types of accessory nerve sparing neck dissections. Relatively more severe nerve damage was found in functional neck dissection patients when compared with modified radical neck dissection patients or supraomohyoid neck dissection patients. This was attributed to varying degrees of traction of the nerve during each procedure. To expose and dissect the lymphatics along the jugular vein, the sternocleidomastoid muscle has to be retracted almost until the end of the operation. This traction is even more accentuated for dissection of supraspinal accessory group of lymph nodes. In contrast, in modified radical neck dissection the nerve is identified and dissected free during the early stages of the procedure and separated from surrounding structures in a better exposed field with less traction achieved by transaction of sternocleidomastoid muscle along the course of spinal accessory nerve.[42]

All patients who underwent nerve sparing neck dissections had some electromyogram abnormality in early post operative period (most severe for FND group) which subsequently improved in late post operative period (3 months). This could be attributed to neuropraxia resulting from traction of nerve or transient devascularisation during surgery.[22,42,45]If the SAN is not cut, this dysfunction may be reversible,[15,43] but it takes a couple of months, and adhesive capsulitis may develop until its fuinction returns to normal[44]. In our study, 22 patient after nerve sparing neck dissections (15 FND, 5 MRND, 2 SOHND) did not show any improvement in their muscle strength in late post operative period while their electromyogram showed improvement. Failure of full recovery from shoulder dysfunction after neck dissection despite electrophysiological improvement was explained by Patten and Hillel[6] as transient limitation of shoulder movement due to adhesive capsulitis secondary to neck dissections. The thickened and contracted joint capsule is strongly attached to the humeral head and sticks to it like a plaster, deserving the term “adhesive capsulitis”.

Table 15 : Comparsion between Literature and our study on EMG abnormality of trapezius muscle after nerve sparing neck dissections

EMG findings	**MRND**			**SOHND**		
	Sobol	**Cheng**	**Our series**	**Sobol**	**Cheng**	**Our series**
Normal	30%	22.2%	41.7%	56%	57.14%	72.7%
Slightly abnormal	4%	33.3%	50%	22%	42.8%	27.3%
Moderately Abnormal	26%	_	8.3%	22%	_	_
Severely abnormal	39%	44.4%	_	_	_	_

CONCLUSION

1. Spinal Accessory Nerve injuries are common in all types of nerve sparing neck dissections done for Head and Neck cancers.

2. The incidence of Spinal Accessory Nerve injury is less in Selective neck dissection (SOHND) where the posterior triangle of neck is not violated.

3. The incidence of Spinal Accessory Nerve injury was found to be more severe in nerve sparing neck dissections where sternocleidomastoid muscle was preserved (FND) compared to those where sternocleidomastoid muscle was sacrificed (MRND) (statistically found to be insignificant).

4. Many nerve injuries improved after a period of time showing that injury was due to either neurapraxia or transient devascularisation of nerve.

5.Some patients who showed significant nerve injury on EMG did not have corresponding handicap clinically which could be attributed to any of the several factors including the pre operative condition of other synergestic shoulder girdle muscles, patients willingness to perform post operative exercises, age, sex and left or right handedness.

6. Accessory Nerve sparing neck dissections definitely preserves shoulder function in a large number of patients who undergo neck dissection and should be advocated in suitable cases.

SUMMARY

The most common morbidity associated with neck dissection is spinal accessory nerve dysfunction and related shoulder disability. Its preservation has been one of the central features of the conservative or modified neck dissection. Various studies have been carried out all over the world on how to reduce shoulder morbidity. Various types of neck dissections have been tried for the purpose. However inspite of nerve sparing in neck dissection, few patients develop shoulder morbidity .The reason for this may be that the procedure can still cause some injury to the spinal accessory nerve as a result of traction during the clearance of level II b lymph nodes (supraspinal accessory nodes), skeletonization and devascularization of SAN (believed to be responsible for its segmental demyelinization and consequent neuropraxia) during clearance of posterior triangle of neck or attributed to inadvertent transection of the nerve or, more frequently, of its fine branch directed to the upper trapezius in the posterior triangle of the neck.

So we took up this study to assess spinal accessory nerve functions in various types of nerve sparing neck dissections. In our study we compared the pre and post operative spinal accessory nerve functions by electromyography of trapezius muscle after nerve sparing neck dissections. We also compared the extent of damage to spinal accessory nerve in various types of neck dissections.

Our series was a prospective study of 50 patients with head and neck cancers having nodal staging of either N_o or $N_{1.}$ who presented at R.L Jalappa Hospital and Research Centre between November 2008 and December 2009. We had 10 patients with N_o necks and the remaining 40 patients had N_1 necks. 51 nerve sparing neck dissections were performed of which 12 were MRND, 28 were FND and 11 were SOHND.

All patients underwent evaluation of shoulder function by trapezius muscle strength test and EMG of UT. EMG was done pre operatively, early post operative period (3 weeks) and late post operative period (3 months).

All patients who underwent nerve sparing neck dissections showed deterioration in muscle strength in the early post operative period (3 weeks) which subsequently improved in late post operative period (3 months).

All patients who underwent nerve sparing neck dissections showed some EMG abnormality in early post operative period (3 weeks). All these patients showed improvement in EMG later on. This could be attributed to neuropraxia resulting from traction of the nerve or transient devascularisation.

In our study, 22 patient after neck dissections did not show any improvement in their muscle strength in late post operative period while their electromyogram showed improvement. This could be due to transient limitation of shoulder movement due to adhesive capsulitis secondary to neck dissections.

11 patients in our FND group showed severely abnormal EMG findings in the trapezius muscle, but they did not have as great a degree of shoulder dysfunction as would be expected. . This may be accounted for by any of several factors, including the pre operative condition of other synergistic shoulder girdle muscles, patients willingness to perform post operative exercises, age, sex and left or right handedness.

In our study it was found that spinal accessory nerve injuries are common in all types of nerve sparing neck dissections, the incidence of which is less in selective neck dissections (SOHND) where the posterior triangle of neck is not violated.

The incidence of spinal accessory nerve injury was found to be more severe in nerve sparing neck dissections where sternocleidomastoid muscle was preserved (FND) compared to those where sternocleidomastoid muscle was sacrificed (MRND). (statistically found to be insignificant).

All types of nerve sparing neck dissections cause some injury to spinal accessory nerve which tend to improve or normalize with time. These findings suggest that, in patients in whom it is oncologically sound, a neck dissection that spares the spinal accessory nerve offers significant benefit in terms of shoulder function.

BIBLIOGRAPHY

1.Williams NS, Bulstrode CJK, Connel PR, editors. Oropharyngeal cancer. In: Bailey & Love's Short Practice of Surgery. 23rd ed. London:Hodder Arnold; 2008. P.734.

2.Mamelle G, Pampurik J, Luboinski B, Lancar R, Lusinchi A, Bosq J. Lymph Node Prognostic Factors in Head and Neck Squamous Cell Carcinomas. Am J Surg 1994; 168: 494-498.

3.Woolgar JA, Rogers SN, Lowe D, Brown JS, Vaughan ED. Cervical lymph node metastasis in oral cancer :the importance of even microscopic extracapsular spread. Oral Oncology 2003; 39: 130-137.

4.Tsuji T, Tanuma A, Onitsuka T, Ebihara M, Iida Y, Kimura A, et al. Electromyographic Findings After Different Selective Neck Dissections. Laryngoscope 2007; 117:319-322.

5.Kuntz AL, Earnest A, Weymuller. Impact of Neck Dissection on Quality of Life. Laryngoscope 1999; 109: 1334-38.

6.Patten C, Hillel AD. The 11th Nerve Syndrome Accessory Nerve or Adhesive Capsulitis. Arch Otolaryngol Head Neck Surg 1993; 119: 215-220.

7.Nahum AM, Mullally W, Marmor L, Angeles L. A Syndrome Resulting from Radical Neck Dissection. Archives of Otolaryngology 1961; 74:82-86.

8.Gordon SL, Graham WP, Black JT, Miller SH. Accessory Nerve Function After Surgical Procedures in the Posterior Triangle. Arch Surg 1977; 112:264-68.

9. Dewar FP, Harris RI. Restoration of function of the shoulder following paralysis of trapezius by fascial sling fixation and transplantation of levator scapulae. Ann Surg 1950; 132: 1111-5.

10.Weisberger EC, Kincaid J, Riteris J. Cable Grafting of the spinal Accessory Nerve After Radical Neck Dissection. Arch Otolaryngol Head Neck Surg 1998;124:377-380.

11.Spiro JD, Spiro RH, Shah JP, Sessions RB, Strong EW. Critical Assessment of Supraomohyoid Neck Dissection. Am J Surg 1988; 156: 286-89.

12.Anderson PE, Shah JP, Cambronero E, Spiro RH. The Role of Comprehensive Neck Dissection With Preservation of the Spinal Accessory Nerve in the clinically Positive Neck. Am J surg 1994; 168:499-502.

13.Short SO, Kaplan JN, Laramore GE, Cummings CW. Shoulder Pain and Function After Neck Dissection With or Without Preservation of the Spinal Accessory Nerve. Am J Surg 1984; 148:478-82.

14.Sobol S, Jensen C, Sawyer W, Costiloe P, Thong N. Objective Comparison of Physical Dysfunction After Neck Dissection. Am J Surg 1985; 150:503-509.

15.Remmler D, Byers R, Scheetz J, Shell B, White G, Zimmerman, et al. A Prospective Study of Shoulder Disability Resulting From Radical And Modified Neck Dissections. Head & Neck Surgery 1986; 8:280-286.

16.Li XM, Wei WI, Guo XF, Yuen PW, Lam LK. Cervical lymph node metastatic patterns of squamous carcinomas in the upper aerodigestive tract. The Journal of Laryngology and Otology 1996; 110: 937-941.

17.Coskun HH, Erisen L, Basut O. Selective neck dissection for clinically N_0 neck in laryngeal cancer:Is dissection of level IIb necessary?. Otolaryngology Head and Neck Surgery 2004; 131: 655-59.

18.Clayman GL, Frank DK. Selective Neck Dissection of Anatomically Appropriate Levels Is as Efficacious as Modified Radical Neck Dissection for Elective treatment of the Clinically Negative neck in Patients With Squamous cell Carcinoma of the Upper Respiratory and Digestive Tracts. Arch Otolaryngol Head Neck Surg 1998; 124: 348-52.

19. Pitman KT, Johnson JT, Myers EN. Effectiveness of selective neck dissection for management of clinically negative neck. Arch Otolaryngol Head Neck Surg 1997;123:917-923.

20.Fisch UP, Sigel ME. Cervical lymphatic system as visualised by lymphography. Ann Otol Rhinol Laryngol 1964; 73: 869-882.

21.Dijkstra PU, Wilgen PCV, Buijs RP, Brendeke W, Goede CJTD, Kerst A, et al. Incidence of Shoulder Pain After Neck Dissection:A Clinical Explorative Study For Risk Factors. Head & Neck 2001; 23:947-953.

22.Cappiello J, Piazza C, Giudice M, Maria GD, Nicolai P. Shoulder Disability After Different Selective Neck Dissections (Levels II-IV Versus Levels II-V):A Comparative Study. Laryngoscope 2005; 115: 259-263.

23.Kraus DH, Rosenberg DB, Davidson BJ, Shaha AR, Spiro RH, Strong EW, et al. Supraspinal Accessory Lymph Node Metastases in Supraomohyoid Neck Dissection. Am J Surg 1996; 172: 646-49.

24.Robbins KT, Clayman G, Levine PA, Medina J, Sessions R, Shaha A, et al. Neck Dissection Classification Update.Arch Otolaryngol Head Neck Surg2002;128:751-58.

25.Byers RM. Modified Neck Dissection A Study of 967 Cases from 1970-1980. Am J Surg 1985; 150: 414-421.

26.Hoogen FJAVD, Manni JJ. Value of the supraomohyoid neck dissection with frozen section analysis as a staging procedure in the clinically negative neck in squamous cell carcinoma of the oral cavity. Eur Arch Otorhinolaryngol 1992; 249: 144-148.

27.Jennings CR. Surgical anatomy of the neck. In: Gleeson M, Browning GG, Burton MJ, Clarke R, Hibbert J, Jones NS, et al, editors. Scott-Brown’s Otorhinolaryngology, Head and Neck Surgery. 7th ed. Great Britain: Hodder Arnold; 2008. p. 1739-53.

28.Watkinson JC, Gaze MN, Wilson JA, editors. Metastatic Neck Disease. In: Stell and Maran's Head and Neck Surgery. 4thed. India: Reed Educational and Professional publishing Ltd; 2000. p. 197-214.

29.Kierner AC, Zelenka I, Burian M. How Do the Cervical Plexus and the Spinal Accessory Nerve Contribute To The Innervation Of The Trapezius Muscle?. Arch Otolaryngol Head Neck Surg 2001; 127:1230-32.

30. Kierner AC, Burian M, Bentzien S ,Gstoettner W. Intraoperative Electromyography for Identification of the Trapezius Muscle Innervation:Clinical Proof of a New Anatomical Concept. Laryngoscope 2002; 112: 1853-56.

31.Weisberger EC. The Efferent Supply Of The Trapezius Muscle:A Neuroanatomic Basis For The Preservation Of Shoulder Function During Neck Dissection. Laryngoscope 1987; 97: 435-445.

32.Kierner AC, Heller S, Burian M. Surgical Anatomy Of the Spinal Accessory Nerve and the Trapezius branches of the Cervical Plexus. Arch Surg 2000; 135: 1428-1431.

33.Becker GD, Angeles L, Parell GJ. Technique of preserving the Spinal Accessory Nerve during Radical Neck Dissection. Laryngoscope 1979; 89: 827-831.

34.Shah JP. Cervical Lymphnodes. In: Head And Neck Surgery. 2nd ed. New-York: Mosby-Wolfe; 1996.p. 355-392.

35.Green FL, Page DL, Fleming ID,editors. Head And Neck Sites. In: The AJCC Cancer Staging Manual. 6th ed. New York: Springer Verlag; 2002.p. 17-31.

36.Robbins KT, Medina JE, Wolfe GT, Levine PA, Sessions RB, Pruet CW. Standardizing Neck Dissection Terminology. Arch Otolaryngol Head Neck Surg 1991; 117: 601-605.

37.Misra UK, Kalitha J. Electromyography. In: Clinical Neurophysiology. 2nd ed. India: Elsevier; 2006.p. 129-144.

38.Fauci AS, Braunwald E, Kasper DL, Hauser SL, Longo DL, Jameson JL, et al, editors. Neurologic Disorders. In: Harrison's Principles of Internal Medicine. 17th ed. New York: McGraw- Hill; 2008.p. 2666.

39.Hislop HJ, Montgomery J. Testing the Muscles of the Upper Extremity. In: Daniels and Worthingham's Muscle Testing Techniques of Manual Examination. 8th ed.India: Elsevier; 2007.p. 69-79.

40.Baiocco F, Bascelli C, Bini A, Canepa A. Spinal Accessory Nerve Function Following Neck Dissection . Ann Otol Rhinol Laryngol 1988; 97: 83-86.

41.Leipzig B, Suen JY, English JL, Barnes J, Hooper M . Functional Evaluation Of The Spinal Accessory Nerve After Neck Dissection . Am J Surg 1983; 146: 526-531.

42.Koybasioglu A , Tokcaer A B, Uslu S S, Ileri F, Beder L, Ozbilen S. Accessory Nerve Function After Modified Radical And Lateral Neck Dissections. Laryngoscope 2000; 110: 73-77.

43.Cheng P T, Hao S P, Lin Y H , Yeh ARM. Objective Comparison Of Shoulder Dysfunction After Three Neck Dissection Techniques. Ann Otol Rhinol Laryngol 2000; 109: 761-766.

44.Salerno G, Cavaliere M, Foglia A, Pellicoro D P, Mottola G, Nardone M, et al. The 11th Nerve Syndrome In Functional Neck Dissection. Laryngoscope 2002; 112: 1299-1307.

45.Selcuk A, Selcuk B, Bahar S, Dere H. Shoulder Function In Various Types Of Neck Dissection.Role Of Spinal Accessory Nerve And Cervical Plexus Preservation. Tumori 2008; 94: 36-39.

PROFORMA

NAME OF THE PATIENT:

AGE: **OCCUPATION:**

ADDRESS: **HOSPITAL NUMBER:**

DATE OF ADMISSION:

HISTORY

History	Yes/No	Since
Pain in the mouth		
Inability to open the mouth		
Ulcer in the mouth		
Change in voice		
Bad smell in the mouth		
Excessive salivation		
Difficulty in swallowing		
Swelling in the neck		
Loss of appetite		
Weight loss		
Generalised weakness		

PAST HISTORY

HTN

DM

PTB

Asthma

Any surgery :Yes No

FAMILY HISTORY

Contributory

Not contributory

PERSONAL HISTORY

Sleep, bowel & bladder habits:

Appetite:

Smoking:

Beedi /cigarette number/day since

Alcohol: Duration

Frequency

Quantity

Areca/betel quid:

Tobacco chewing:

Pan masala:

GENERAL PHYSICAL EXAMINATION

Built	Nourishment
Pallor	Icterus
Cyanosis	Clubbing
Oedema	Weight
Pulse	Blood pressure

LOCAL EXAMINATION

Oral cavity:

Orodental hygiene:

Trismus:

Nicotine stains:

Premalignant lesions:

Primary lesion

Tongue-anterior 2/3

Floor of mouth

Buccal mucosa

Retromolar trigone

Lower alveolus

Upper alveolus

Hard palate

Lips

Others

Side of growth:

Size of growth: 2 cm or <2 cm in greatest dimension

>2 cm but <4 cm in greatest dimension

>4 cm in greatest dimension

Type of growth:

Ulcerative/Proliferative/Ulceroproliferative

IDL:

NOSE EXAMINATION

Anterior Rhinoscopy

Posterior Rhinoscopy

EAR EXAMINATION

NECK NODES: Number:

Level of node: Size:

Consistency: Tenderness:

Mobility: Skin over nodes:

SYSTEMIC EXAMINATION

Cardiovascular system:

Respiratory system:

Per Abdomen:

Central Nervous System:

CLINICAL DIAGNOSIS

INVESTIGATIONS

Hb	Platelet Count
TC	BT
DC	CT
ESR	Blood Grouping & Typing
RBS	

Ultrasonography of neck:

Biopsy: FNAC:

CXR: Ultrasonography of abdomen:

TREATMENT:

Surgery Done:

Date of surgery:

Type of Neck Dissection:

TRAPEZIUS MUSCLE STRENGTH: pre op

post op:3 weeks

:3 months

EMG :

pre op:

Post op: 3 weeks

3 months

KEY TO MASTER CHART

1	A.S.M	Arch saving mandibulectomy
2	Bil	Bilateral
3	BM	Buccal mucosa
4	BOT	Base of Tongue
5	BP	Buccal Pad of Fat
6	DP	Deltopectoral Flap
7	Ext	Extended
8	FND	Functional neck dissection
9	HG	Hemiglossectomy
10	HM	Hemimandibulectomy
11	Lat.Tong	Lateral Tongue
12	Low.al	Lower alveoli
13	Lt	Left
14	M.A	Moderately abnormal
15	MF	Masseter Flap
16	M.M	Marginal mandibulectomy
17	MRND	Modified Radical Neck Dissection
18	MUO	Metastasis of Unknown origin
19	N	Normal

20	ND	Neck Dissection
21	Pap Ca	Papillary carcinoma Thyroid
22	PF	Pyriform fossa
23	PMMC	Pectoralis Major Myocutaneous Flap
24	Rt	Right
25	S.A	Severely Abnormal
26	SG	Skin Graft
27	Sl.A	Slightly Abnormal
28	SOHND	Supraomohyoid Neck Dissection
29	TL	Total Laryngectomy
30	TF	Tongue Flap
31	Up.al	Upper alveoli
32	WE	Wide Excision

MASTER CHART

Sl.NO	NAME	HOSP NO.	AGE	SEX	PRIMARY TUMOUR	TNM STAGING	NECK DISSECTION	DOS	EMG			Muscles Strength			Surgery Done
									Pre OP	Post OP 3 weeks	Post OP 3 months	Pre OP	Post OP 3 weeks	Post OP 3 months	
1	Lakshmamma	620378	46	F	Rt BM	$T_2N_1M_X$	SOHND	05-11-2008	N	Sl.A	N	5	3	4	WE+ND+BP
2	Gangamma	616037	56	F	Lt BM	$T_{4a}N_1M_x$	FND	07-11-2008	N	S.A	Sl.A	5	3	4	WE+HM+ND+PMMC
3	Narayanamma	627936	55	F	Lt BM	$T_3N_0M_x$	SOHND	14-11-2008	N	M.A	Sl.A	5	3	4	WE+ND+PMMC
4	Gulab Jan	617112	38	F	Rt BM	$T_3N_1M_x$	MRND	21-11-2008	N	M.A	N	5	3	4	WE+HM+ND+MF
5	Manimaran	612888	46	M	Supraglottis	$T_3N_1M_x$	BIL FND	28-11-2008	N	M.A	N	5	4	5	TL+BIL ND+primary closure
									N	M.A	N	5	4	5	
6	Chowdamma	605103	70	F	Lt BM	$T_3N_1M_x$	FND	03-12-2008	N	M.A	Sl.A	5	2	2	WE+HM+ND
7	Husen Bee	569356	60	F	Rt BM	$T_3N_1M_x$	FND	10-12-2008	N	M.A	Sl.A	5	3	3	WE+HM+ND+PMMC
8	Narayanamma	572307	60	F	MUO	$T_xN_1M_x$	SOHND	12-12-2008	N	S.A	N	5	4	5	ND
9	Venkatesh	567189	35	M	Pap Ca	$T_2N_1M_x$	FND	19-12-2008	N	S.A	M.A	5	3	3	Total Thyroidectomy +ND
10	Parvathamma	569986	35	F	Rt RMT	$T_{4a}N_1M_x$	FND	26-12-2008	N	S.A	N	5	3	4	WE+HM+ND+PMMC
11	Naramma	577095	75	F	Lt BM	$T_{4a}N_1M_x$	FND	31-12-2008	N	M.A	N	5	4	4	WE+HM+ND+PMMC
12	Krishnamma	577418	55	F	Lt BM	$T_2N_0M_x$	FND	02-01-2009	N	S.A	M.A	5	3	4	WE+HM+ND+PMMC
13	Venkatamma	588464	56	F	Lt BM	$T_{4a}N_1M_x$	FND	09-01-2009	N	S.A	Sl.A	5	3	4	WE+HM+ND+PMMC
14	Anjamma	591305	48	F	Lt Up.al	$T_2N_1M_x$	FND	16-01-2009	N	S.A	M.A	5	3	3	Total Maxillectomy+ND
15	Lakshmamma	607370	60	F	Rt BM	$T_3N_1M_x$	FND	23-01-2009	N	M.A	N	5	3	4	WE+HM+ND+PMMC
16	Jayamma	604747	50	F	Pap Ca	$T_3N_1M_x$	FND	30-01-2009	N	S.A	N	5	4	5	Total Thyroidectomy +ND
17	Basamma	454161	61	F	Rt BM	$T_{4a}N_1M_x$	FND	06-02-2009	N	M.A	Sl.A	5	3	3	WE+HM+ND+DP+SG
18	Muniyamma	437953	60	F	Lt BM	$T_2N_1M_x$	FND	13-02-2009	N	M.A	N	5	4	5	WE+HM+ND+TF
19	Chinnamma	471181	48	F	Lt BM	$T_3N_1M_x$	FND	18-02-2009	N	S.A	Sl.A	5	3	3	WE+HM+ND+DP+SG
20	Nanjamma	508181	50	F	Rt BM	$T_3N_1M_x$	FND	20-02-2009	N	Sl.A	N	5	3	4	WE+HM+ND
21	Jayamma	422449	42	F	Lt BM	$T_{4a}N_1M_x$	FND	27-02-2009	N	M.A	N	5	3	4	WE+HM+ND+PMMC
22	Govindappa	522266	38	F	Rt Lat.Tong	$T_{4a}N_0M_x$	MRND	04-03-2009	N	M.A	N	5	3	4	Ext.HG+ND+PMMC
23	Lakshmamma	516114	60	F	Rt BM	$T_{4a}N_1M_x$	MRND	06-03-2009	N	S.A	N	5	4	4	WE+HM+ND+PMMC

24	Lakshmamma	477092	52	F	Lt PF	$T_3N_0M_x$	MRND	13-03-2009	N	M.A	Sl.A	5	3	3	TL+ ND+primary closure
25	Muniyappa	543146	39	M	BOT	$T_3N_0M_x$	SOHND	20-03-2009	N	M.A	N	5	3	4	WE+Mandibulotomy +ND
26	Vasanthamma	582418	50	F	Lt BM	$T_2N_1M_x$	MRND	25-03-2009	N	S.A	Sl.A	5	3	3	WE+M.M+ND+PMMC
27	Akkayamma	498858	70	F	Lt Low.al	$T_3N_1M_x$	Ext SOHND	27-03-2009	N	S.A	N	5	3	4	WE+A.S.M+ND+TF
28	Ramakka	579067	45	F	Lt BM	$T_{4a}N_1M_x$	MRND	03-04-2009	N	S.A	Sl.A	5	4	5	WE+HM+ND+PMMC
29	Shivaramamma	503374	65	F	Lt BM	$T_{4a}N_0M_x$	SOHND	08-04-2009	N	Sl.A	N	5	4	5	WE+HM+ND+TF
30	Hanumakka	529096	45	F	Rt BM	$T_3N_1M_x$	MRND	10-04-2009	N	M.A	N	5	4	5	WE+ND+PMMC
31	Kalamma	524048	50	F	Lt BM	$T_2N_1M_x$	MRND	17-04-2009	N	S.A	Sl.A	5	3	3	WE+HM+ND+PMMC
32	Parvathamma	536226	65	F	Rt BM	$T_2N_1M_x$	MRND	22-04-2009	N	M.A	N	5	4	5	WE+ND+PMMC
33	Ramalakshmamma	543646	48	F	Rt Lat.Tong	$T_3N_0M_x$	FND	24-04-2009	N	M.A	Sl.A	5	3	3	HG +ND
34	Muniyappa	539057	50	F	Rt BM	$T_{4a}N_1M_x$	MRND	29-04-2009	N	M.A	Sl.A	5	3	3	WE+HM+ND+PMMC
35	Lakshmamma	554740	45	F	Lt Low.al	$T_{4a}N_1M_x$	FND	08-05-2009	N	M.A	N	5	3	4	WE+HM+ND
36	Lakshmamma	557300	39	F	Rt BM	$T_{4a}N_1M_x$	FND	15-05-2009	N	S.A	M.A	5	3	3	WE+HM+ND+PMMC
37	Devegowda	557331	55	M	Subglottis	$T_3N_1M_x$	FND	29-05-2009	N	M.A	Sl.A	5	3	3	TL+ ND+primary closure
38	Bhagyamma	579459	48	F	Lt BM	$T_2N_1M_x$	FND	12-05-2009	N	S.A	Sl.A	5	3	3	WE+ND+TF
39	Yashodamma	587266	45	F	Lt BM	$T_2N_oM_x$	SOHND	26-05-2009	N	M.A	Sl.A	5	4	4	WE+ND+SG
40	Munivenkatappa	580900	65	M	Rt BM	$T_{4a}N_1M_x$	SOHND	12-06-2009	N	Sl.A	N	5	3	4	WE+ND+MF
41	Iliyaz	623539	48	M	Lt.Lat.Tong lateral	$T_1N_1M_x$	FND	26-06-2009	N	M.A	Sl.A	5	4	4	WE+ND
42	Meluramma	588127	60	F	Rt BM	$T_{4a}N_0M_x$	SOHND	03-07-2009	N	M.A	N	5	4	4	WE+HM+ND+TF
43	Samakka	576263	61	F	Pap Ca	$T_{4a}N_1M_x$	MRND	17-07-2009	N	M.A	N	5	3	3	Total Thyroidectomy +ND
44	Mahalakshmi Bhai	573170	41	F	Pap Ca	$T_3N_1M_x$	FND	24-07-2009	N	M.A	Sl.A	5	3	3	Total Thyroidectomy +ND
45	Chowdamma	497636	80	F	Lt BM	$T_{4a}N_1M_x$	MRND	12-08-2009	N	M.A	M.A	5	3	3	WE+HM+ND+PMMC
46	Somappa	524790	41	M	Lt BM	$T_2N_1M_x$	SOHND	21-08-2009	N	M.A	N	5	3	5	WE+M.M+ND
47	Sumangala	557065	19	F	Pap Ca	$T_1N_1M_x$	FND	26-08-2009	N	M.A	M.A	5	4	5	Total Thyroidectomy +ND
48	Sarojamma	542911	50	F	Rt BM	$T_3N_1M_x$	FND	04-09-2009	N	M.A	N	5	4	4	WE+HM+ND+PMMC
49	Chikkamaiah	605599	55	F	Lower Lip	$T_2N_1M_x$	FND	22-09-2009	N	S.A	M.A	5	3	3	WE+ND
50	Venkatamma	520394	55	F	Lt Low.al	$T_2N_0M_x$	SOHND	13-11-2009	N	Sl.A	N	5	3	5	WE+HM+ND