1 Introduction to Head and Neck Surgery

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1.1 Introduction

Head and neck surgery is crucial as it involves a complex head and neck region, which harbours multiple delicate anatomic structures. Many of the human vital functions such as breathing, speech, mastication, swallowing, hearing, and vision are carried out by the structures and organs that are located in the head and neck region (Fig. 1.1). Importantly, numerous major neurovascular structures, namely the cranial nerves, jugular vein, and carotid artery, are residing in this critical region in which any injury to these structures may lead to serious complications. For instance, cranial nerve palsy like facial nerve palsy will lead to facial asymmetry that can cause social embarrassment and is associated with drooling and incomplete closure of the eye that affect a patient's aesthetics. Jugular vein and carotid artery (Fig. 1.2) injury will lead to inevitable blood loss and risk of hypovolaemic shock. Hypoglossal nerve palsy will interfere with swallowing, speech, and so forth. All of these complications are avoidable if the practicing surgeons and the managing team have a sound anatomic knowledge of the head and neck regions, adequate clinical skills and practice, and a good teamwork during management of clinical cases.

To illustrate further, nasal cavity and paranasal sinuses (PNS) (Fig. 1.1) are critical anatomic regions in the facial and head region. They are responsible for multiple functions, for instance humidification of the inspired air, immune protection, mucociliary clearance, and facilitation of smell. An excellent knowledge of delicate vascular supply and innervation at the nasal cavity and PNS area will dictate safe surgical and endoscopic procedures necessary to treat related diseases and tumours in this region. Maxillary sinus is commonly affected by carcinoma, which sometimes necessitates maxillectomy. Different types of maxillectomy entail different segments of maxilla resection and lead to significant surgical and post-surgical sequelae. This again highlights the necessity of in-depth knowledge of anatomy of each subsite region of the head and neck region.

At the end of the other spectrum, oral cavity carcinoma such as tongue carcinoma has a different surgical management approach. The tongue has a rich lymphatic drainage to the neck nodes. This lymph node drainage area is also greatly different for a different part of the tongue. Tip of tongue drains to submental nodes, lateral tongue drains to ipsilateral jugular nodes, and base of tongue drains to both ipsilateral and contralateral deep cervical nodes. Thus, hemiglossectomy for tongue carcinoma (T1 and T2 lesion) should

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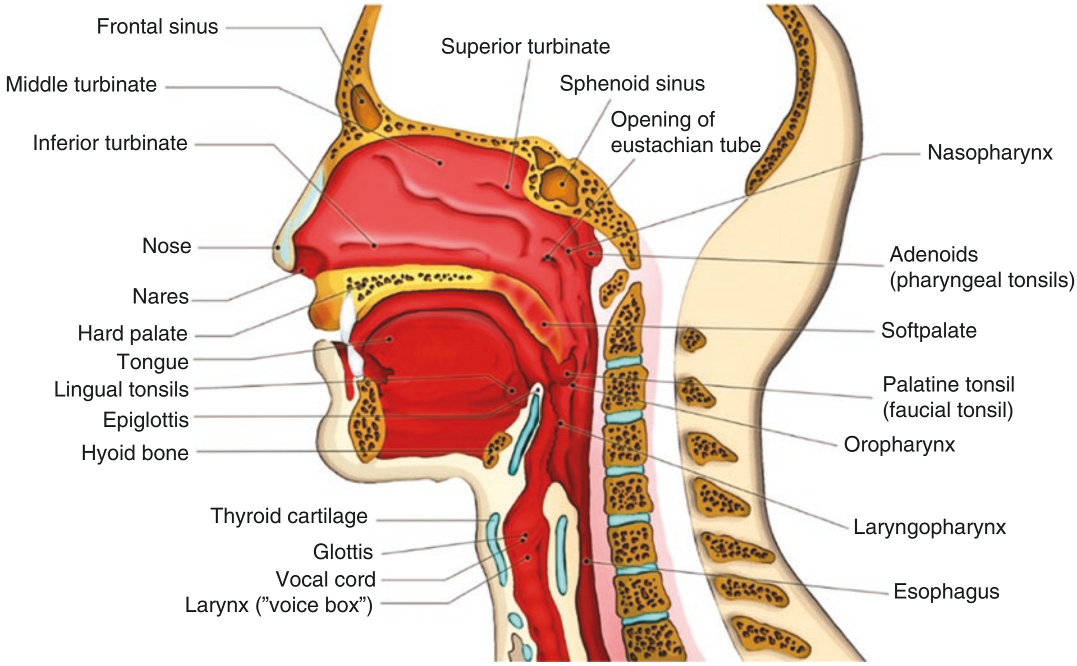

Fig. 1.1 Neck anatomy comprises vital soft-tissue structures and cartilaginous structures

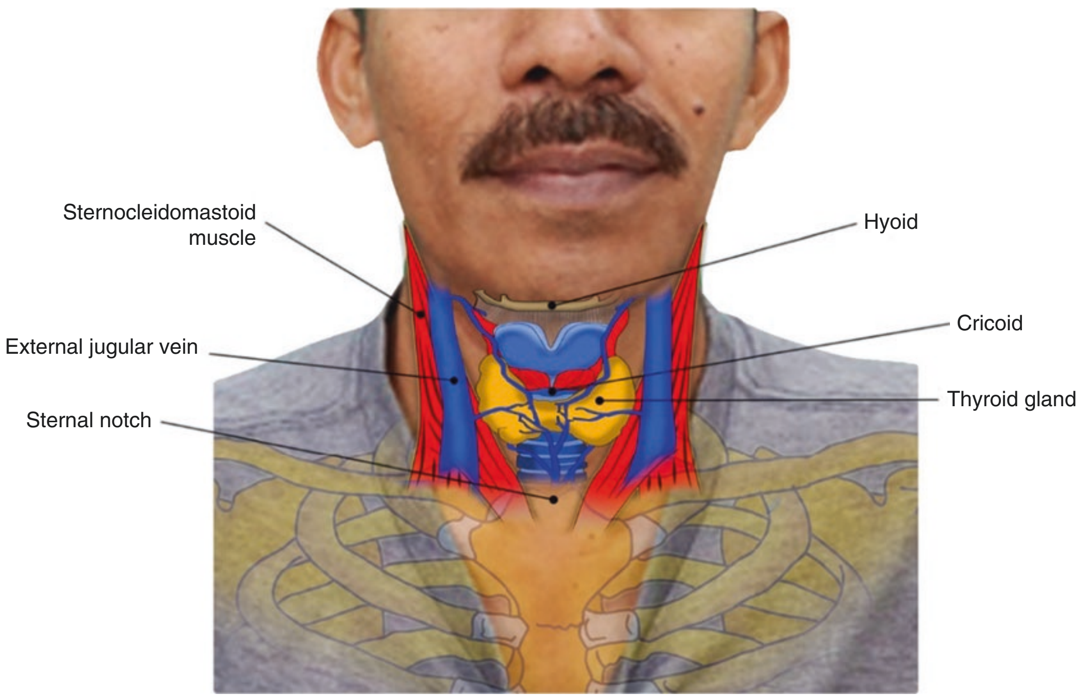

Fig. 1.2 Structures like sternocleidomastoid, jugular vein, hyoid bone, and cricoid cartilage are important landmarks at the neck

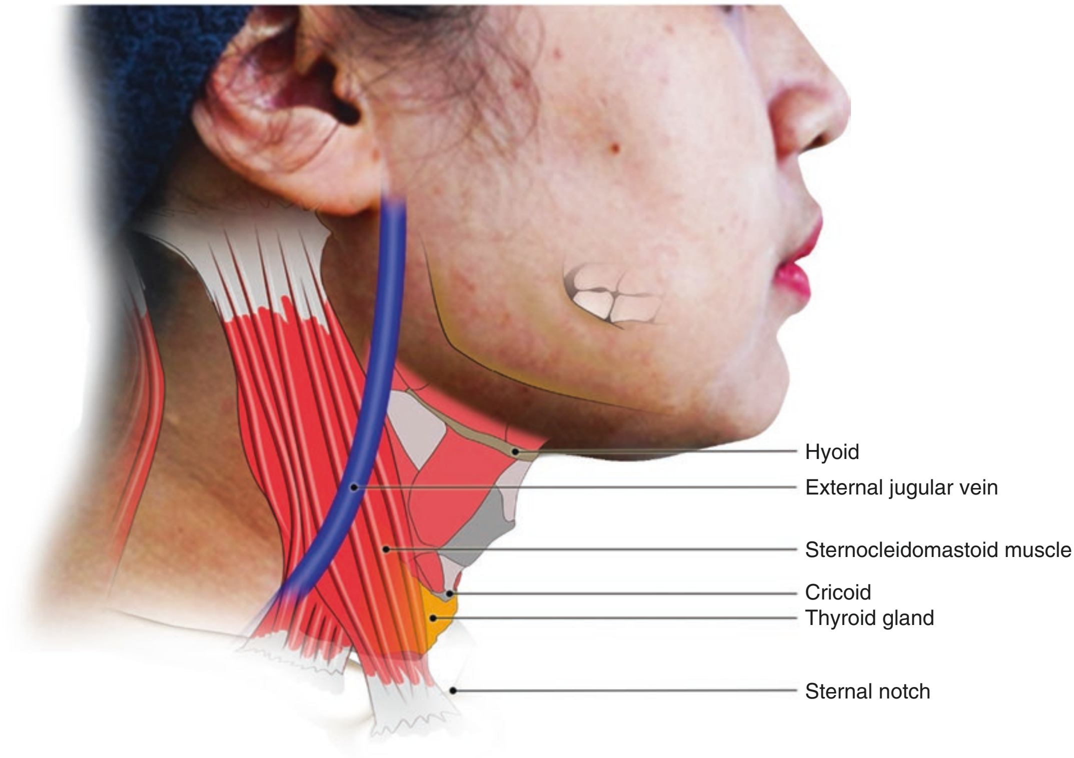

Fig. 1.3 The relationship of soft-tissue structures such as external jugular vein (EJV) to sternocleidomastoid muscle (SCM), or carotid sheath deep to SCM, is vital for deciding the surgical approach to the neck

always be accompanied by ipsilateral neck dissection of level I, II, III, and sometimes IV. If the tumour reaches the midline or the tumour originates from the tongue base, bilateral neck dissection should be performed. In neck dissection, relation of sternocleidomastoid muscle (Fig. 1.3) to vascular and adjacent structures is critical to be considered to facilitate a safe surgery.

1.2 Head and Neck Anatomy

Head and neck anatomy is a critical region as it encompasses highly vascularized areas with the involvement of multiple organs and structures required for vital human functioning. Such structures include oral cavity, nasal cavity and paranasal sinuses, pharynx, larynx and trachea, thyroid glands, salivary glands, cranial nerves, and eyes and orbits. The practicing surgeons, especially the junior trainees in the related field such as ORL, OMF, dental, and plastic reconstructive and oncologists, are required to have an optimal understanding of this critical head and neck region. This is crucial for the clinicians to accurately communicate findings and generate meaningful differential diagnoses, so that a better treatment plan can be incorporated.

The head and facial complex region is further subdivided into anterior or superior face, midfacial, and inferior facial regions. This complex structure of the midface presents a greater challenge to the clinician evaluating the outcomes of facial aesthetic. Numerous factors need to be considered when addressing the surgical approach for the head and neck region. The diversity and changes in the soft tissue of the midface region will alter the surgical techniques. The variable thickness of soft tissue and presence of multiple structures, such as the orbit, nose, and upper lip, each with variable anatomy, need to be considered when planning the surgical steps. The

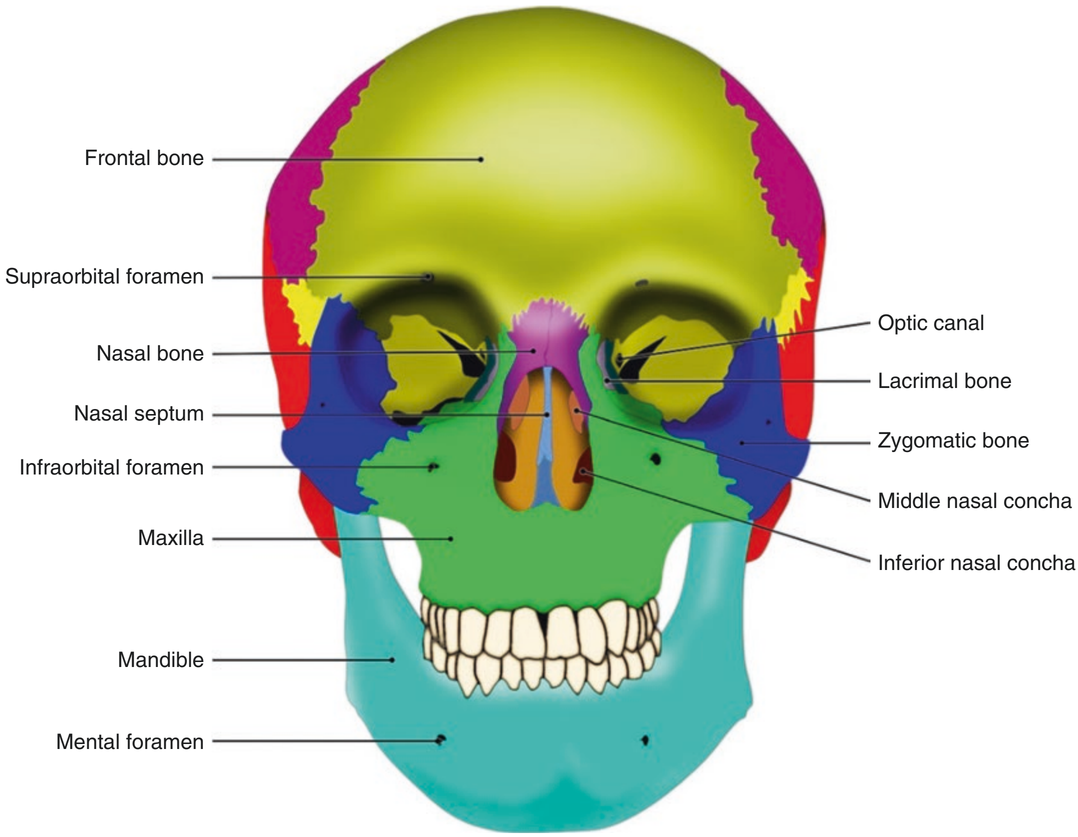

Fig. 1.4 The bony structures like maxilla, mandible, and temporal bones house many critical organs and tissues

effect of the musculature of facial structures may alter its dynamics and function [1].

The skull and the facial bones have their own critical features in humans (Fig. 1.4). Among these, the pillars of the maxilla, enlarged jaw, and robust orbits are the protective buttress of the face [2]. The paranasal sinuses are significant as they contain air that gives some weight support as the head houses muscular structures, which are heavy. Within the head and its structural regions, multiple vessels and nerves are vital as they supply these structures. Most of the surgical procedure involves or interrupts with the vascular supply; thus, surgeons need to be fully familiar with these vessels, its distribution, and their relation to the adjacent organ. In addition, dentofacial deformities, as well as malocclusion and consequent functional deficit, can cause disharmony of the facial form. Major and complex surgeries like total maxillectomy will cause significant impairment to the facial appearance. The treatment goals vary depending on the stage of the tumour and the wishes of each patient. In addition to achieving better oncological outcomes, the surgery should also aim to improve facial aesthetics. This can be achieved with multiple soft-tissue constructions. This is the cosmesis goal that clinicians need to consider when performing any surgery in the head and neck region [1].

The neck and its deeper structures are equally important in the head and neck surgical oncology arena. This begins with surface anatomy inspection for apparent surgical scar (Fig. 1.5). This will give clue to the possibility of difficult dissection due to the presence of scarring and fibrotic tissue. In order to perform neck dissection, the detailed knowledge of the deeper tissue planes, vasculatures, nerves, and lymphatic drainage is a prerequisite. Otherwise, the risk of

Fig. 1.5 Surface anatomy of head and neck structures and presence of surgical scars are important assessments during the outpatient clinic review: (**a**) The outline of SCM, lower border mandible, level Ia, Ib, II, III, IV, thyroid cartilage, cricoid cartilage sternal notch should be identified during inspection and palpation (**b**) A surgical scar, post modified Blair skin incision for parotidectomy (arrow)

bleeding, cranial nerve neuropathies, and chylous leaks can be very severe and life-threatening. Sternomastoid muscle is useful as a flap in selected head and neck malignancy surgery. This includes parotidectomy, temporal bone tumour dissection, and neck dissection. The segmental arterial supply of the sternomastoid makes it suitable for superiorly or inferiorly based flap. The spinal accessory nerves enter the sternomastoid at its superior third part and should be identified and preserved during harvesting the muscle for the rotational flap or during neck dissection. This illustrates how detailed anatomy of a structure is critical in ensuring a safe and effective surgery.

Importantly, the carotid sheath and last four cranial nerves are located deep in the neck. These structures will be encountered in the majority of head and neck cancer surgeries such as submandibulectomy, selective neck dissection, excision of vagal schwannomas, and thyroid surgery. Injury to these structures will result in significant morbidity to the patients. Occasionally, the internal jugular vein has many small branches that need to be identified during the dissection and clipped or ligated to avoid unnecessary bleeding during neck dissection. The carotid artery branches are sometimes used for donor vessels for flap reconstruction and should be properly identified and dissected.

1.3 Role of Imaging Complementing the Anatomical Details Necessary for a Surgical Mapping

In order to know the detailed anatomy and extent of the tumour, imaging has significant roles in delineating the extent of tumoural and pathology details in relation to adjacent structures' involvement. Even a simple neck X-ray (Fig. 1.6) can provide many critical information about the disease and for surgical mapping. The other conventional imaging modalities are ultrasound, CT scan, MRI, and PET scan. Other newly developed imaging tools have been used in select institutes and centres around the world, in order to enhance the disease and tumour detection and staging for a better management plan. This ensures an optimal treatment outcome for the majority of patients (Fig. 1.7).

Ultrasound is the mainstay of imaging modality in thyroid and salivary gland tumour, especially in small- to moderate-size tumours. In large and extensive tumours, CT scan is required in order to assess the extent of tumour and adjacent tumour involvement. For instance, in the suspected case of a submandibular malignancy, assessment of neck nodes and mandible involvement is important (Figs. 1.8 and 1.9).

This is critical for a decision whether to perform a submandibulectomy with or without neck dissection or marginal mandibulectomy. In case of nasopharyngeal carcinoma, CT scan allows assessment of the nasopharynx area and pterygoid muscle involvement (Fig. 1.10). In parotid gland and thyroid gland malignancy, CT scan gives additional information on margins of the tumour, neck node metastases, or airway patency (Fig. 1.11). A CT scan also allows accurate assessment of the parapharyngeal space mass or collection (Fig. 1.12). MRI, on the other hand, is used to assess the soft-tissue involvement, for instance in the oral cavity carcinoma, i.e. tongue carcinoma, where the inferior extension or depth of infiltration is one of the criteria for current TNM staging, the 8th edition.

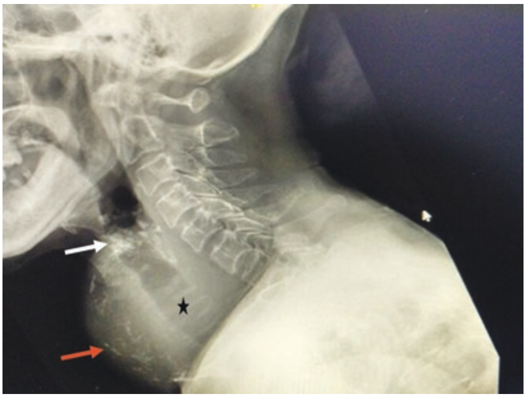

Fig. 1.6 Head and neck imaging such as a neck X-ray complementing the clinical examination findings. This is necessary for a complete assessment of the head and neck disease. This lateral neck X-ray shows a huge thyroid mass (red arrow) with evident calcification (white arrow) and the shadow of trachea (star)

Other types of imaging mode depend on the tissues and organs that need to be assessed (Table 1.1). For instance, the cone beam computed tomography is suggested as the 3D imaging modality for maxillofacial region imaging due to much reduced costs, lower radiation levels compared to multi-slice computed tomography, high bone and teeth resolution, and ability to obtain the entire set of traditional orthodontic images in just a single exposure [3].

The neck is a critical region that bridges the head with the rest of the body. It houses the cervical oesophagus, trachea, thyroid gland, and parathyroid glands. In addition, a dense network of

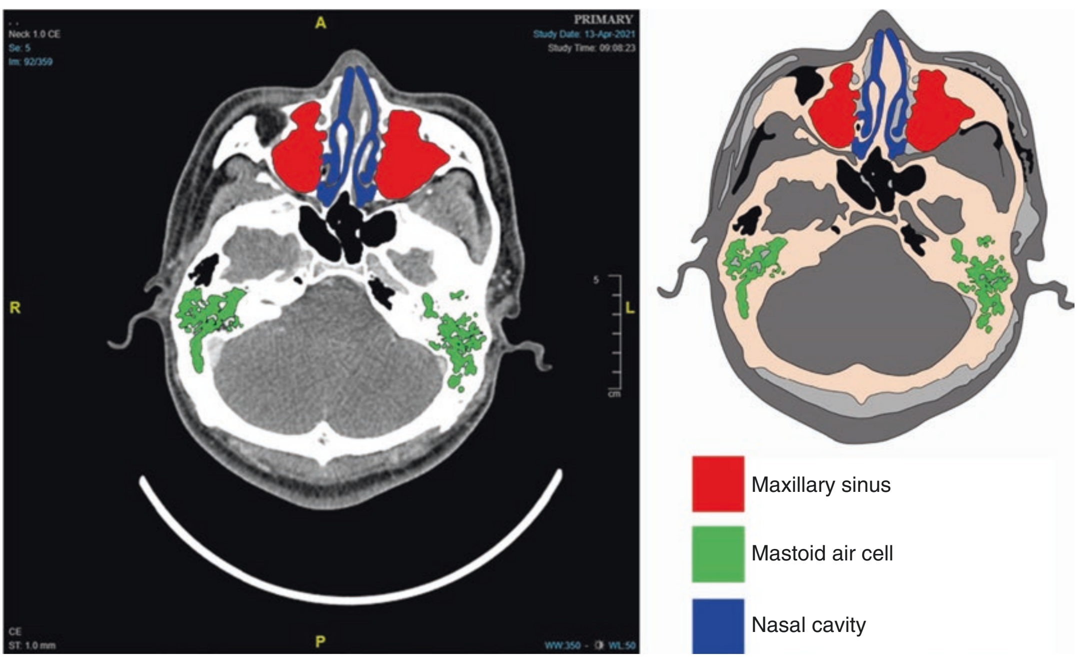

Fig. 1.7 The nasal cavity, sinuses, and temporal bones with mastoid air cell present a small part of the anatomy of the head and skull region but have tremendous implication in head and neck diseases and tumours management

lymphatic channels and nerves are located in the neck (Fig. 1.13). These lymphatics are critical as many of the head and neck diseases and tumours will spread through these lymphatic channels.

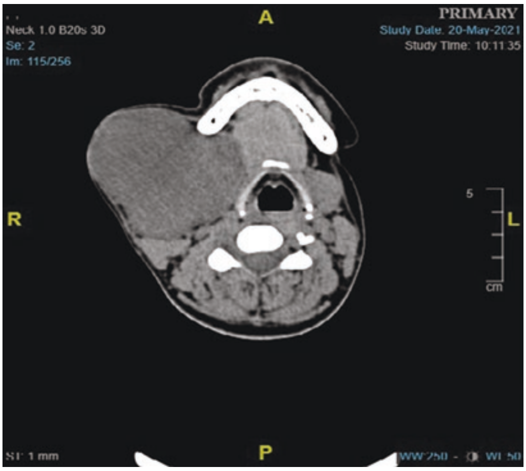

Fig. 1.8 Relationship of submandibular gland mass to adjacent structures like mandible, airway, and vertebra is critical when assessing the compression effect or infiltration by the tumour, benign or malignant

The malignant tumour will eventually cause neck node enlargement due to this lymphatic spread. Importantly, different levels of neck nodes indicate different sites of primary tumours (Table 1.2). Other important structures include deep spaces of the neck such as parapharyngeal space, retropharyngeal space, and carotid space that are involved in the pathologies like tumour spread and abscess formation.

Conventionally, the neck is divided into two major triangles: anterior and posterior triangles. These are further divided into smaller additional triangles, which include submental, submandibular, and carotid triangles.

1. The anterior triangle is bounded inferiorly by the sternal notch and clavicle, laterally by the sternocleidomastoid, and medially by the trachea, thyroid, and cricoid cartilages.
2. The posterior triangle is bounded posteriorly by the anterior border of trapezius muscle, anteriorly by the posterior border of the sternocleidomastoid muscle, and inferiorly by the clavicle [4].

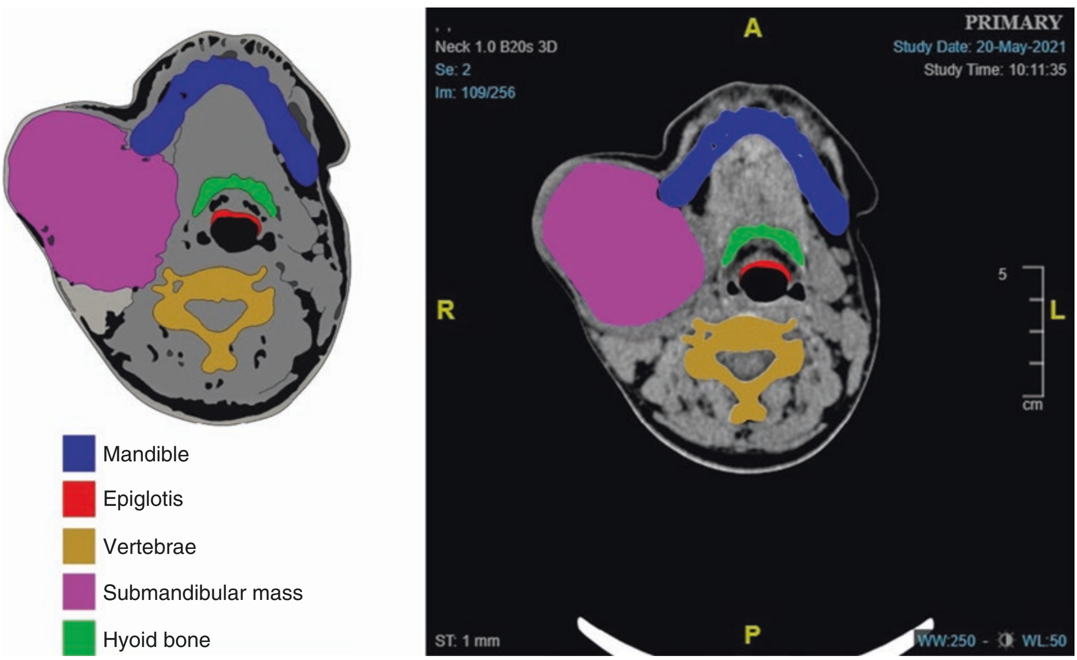

Fig. 1.9 Identification of vital structures in relation to the submandibular gland mass like mandible, epiglottis (and airway), and prevertebral area is critical when assessing the infiltration by the malignant tumour for designing a proper surgical approach

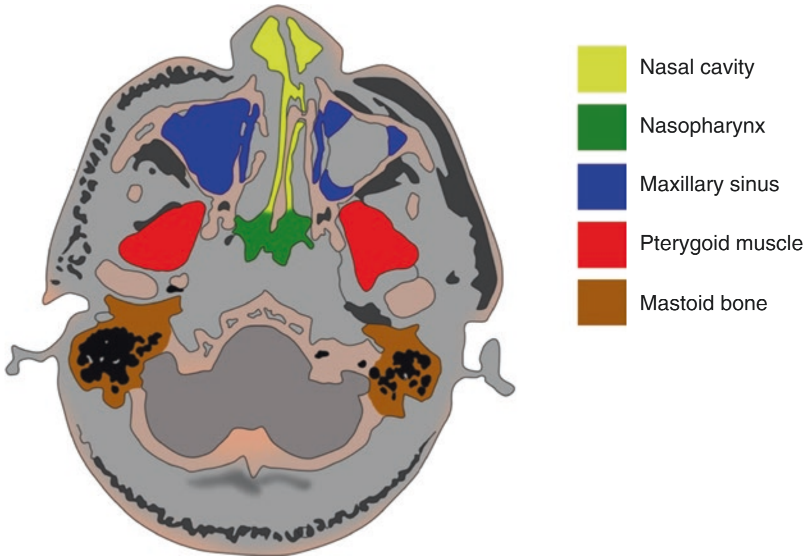

Fig. 1.10 Nasopharynx is a midline anatomic region and is surrounded by maxillary sinus and nasal cavity anteriorly, pterygoid muscle, pterygoid plates laterally, prevertebral space posteriorly, and skull base superiorly

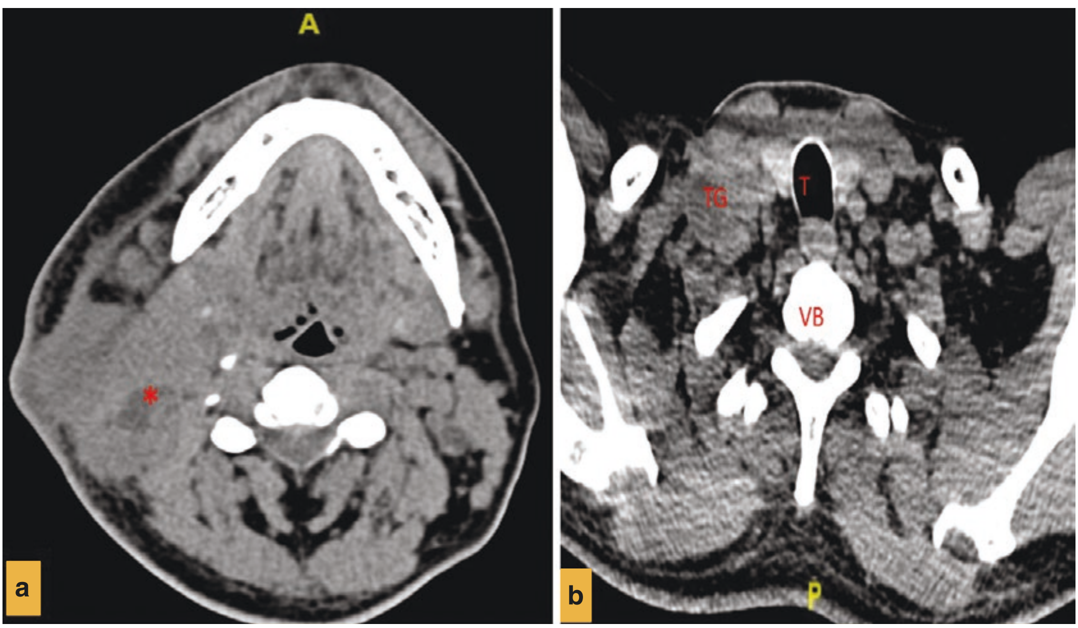

Fig. 1.11 CT scan of neck showing a heterogenous parotid tumour (asterisk), which could represent malignancy (**a**). Right thyroid gland (TG) is cystic and enlarged and can cause compression of the trachea (T) and airway (**b**). (**a**) Parotid gland mass with possibility of skin and subcutaneous infiltration. (**b**) Outline of normal structures; trachea (T), thyroid glands (TG), and vertebra (VB)

Apart from the lymphatic drainage, the arterial and venous supply of the neck is also crucial. These structures are commonly addressed in any surgery because of bleeding or as a part of vascular supply to the flap. The flap plays a significant role in head and neck reconstruction in the treatment of head and neck malignancy. The viability of flap depends on sufficient vascular supply.

The external carotid arteries have eight major branches. These branches supply critical organs and structures in the head, neck, and face region. The terminal branches of the external carotid

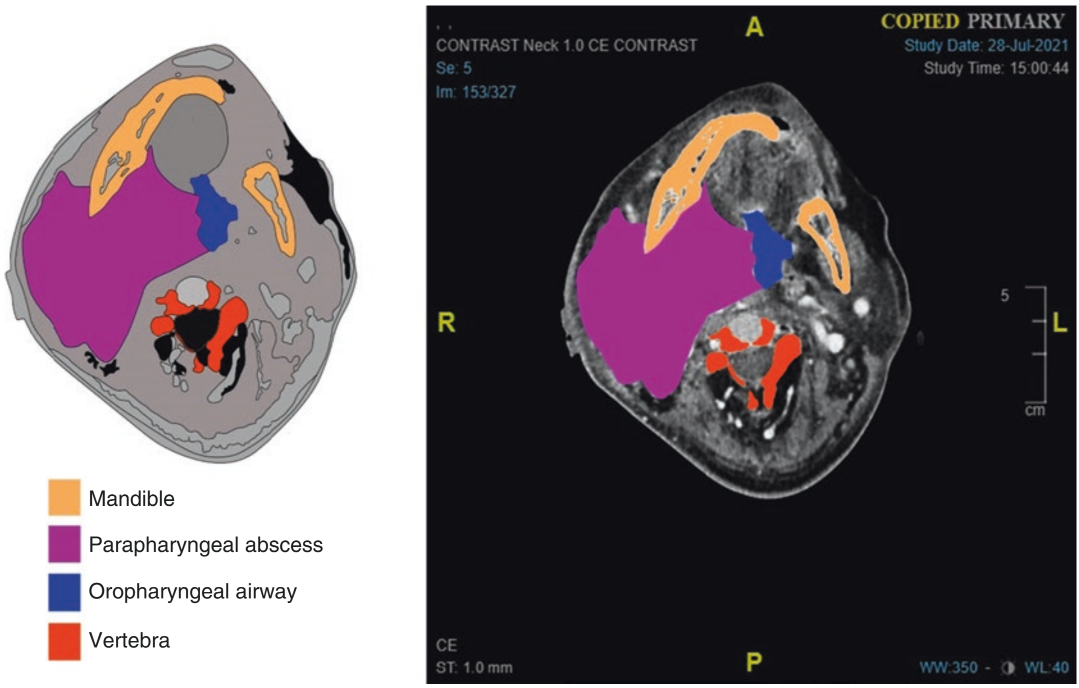

Fig. 1.12 Deep spaces of the neck can be complicated with abscess such as parapharyngeal abscess

Table 1.1 Imaging modalities and their indications in head and neck disease assessment

	Imaging modality	Application
1.	Ultrasound	• Assessment of thyroid mass: solid vs. cystic, vascularity, calcification, TIRADS classification • Assessment of salivary glands: parotid lobes, intraparotid nodes, capsular invasion
2.	Ultrasound Doppler	• Suspicion of vascular neck mass
3.	CT scan	• Assessment of malignant neck mass; adjacent tissue infiltration, mandible erosion, carotid sheath compression, airway obstructions, neck node metastases • Distant metastases
4.	MRI	• Soft-tissue tumour delineation • DOI of tongue tumour • Facial nerve infiltration
5.	PET scan	• Follow-up of head and neck cancer cases • Suspicious distant metastases • Suspicious local recurrence • TRO residual tumour
6	PET-CT scan fusion	• Better mapping of tumour size and location • Recurrent tumour

artery are the maxillary artery and superficial temporal artery. The maxillary artery is further divided into three parts with many small branches (Fig. 1.14). These branches of maxillary artery supply many structures in the head such as the muscles of mastication, teeth and the underlying gingivae, dura mater, calvaria, tympanic membrane, jaw, and external acoustic meatus of the ear. The superficial temporal artery supplies the scalp around the temporal region [5].

Apart from neck triangles, the level of neck nodes is equivocally important as many of the head and neck malignancies will require treatment of the neck. This treatment of the neck is critical in order to prevent recurrent tumour in the neck. Most of the times, treatment of the neck will be performed in the form of neck dissection, which should be performed in the most oncologically safe manner (Fig. 1.15).

The neck dissection surgery will require a thorough understanding of the anatomy of structures of head and neck along with their lymphatic drainage. Most of the lymphatic drainage will be to neck node levels I–IV. These neck node levels I–IV are further divided into a and b and contain

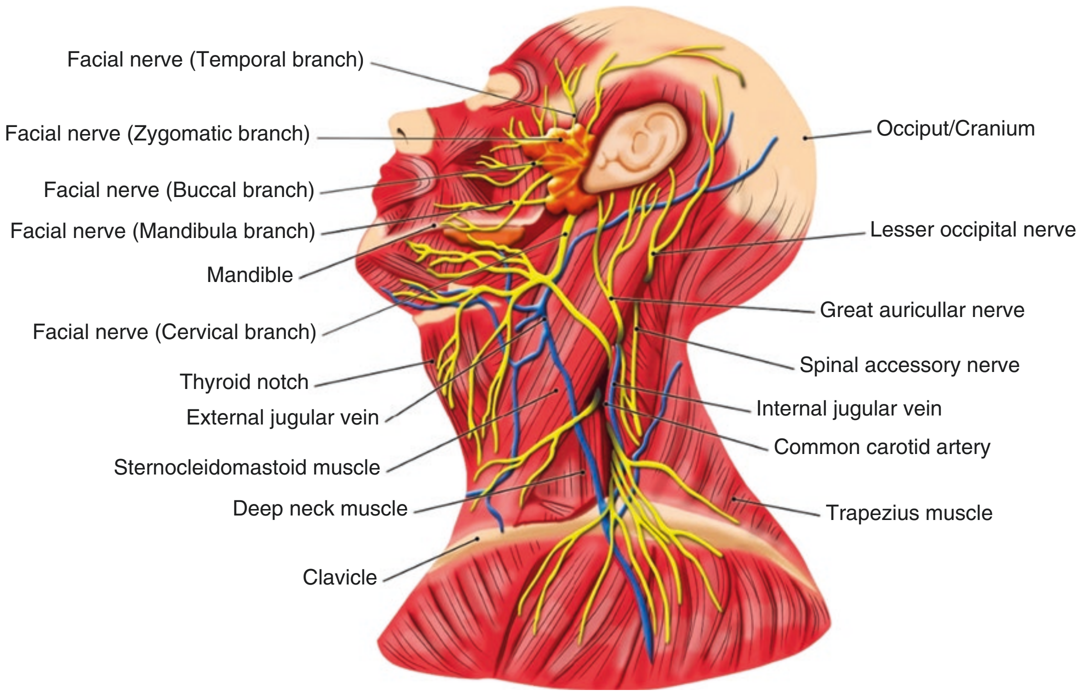

Fig. 1.13 Neck anatomy is a complex network of soft tissues like vessels, nerves, and muscles

Table 1.2 Neck node levels and their primary drainage area

	Neck node levels	Primary site drainage
1.	Level I Level Ia (submental) Level 1b (submandibular)	Anterior lips Tip of tongue Oral cavity Palate Buccal mucosa
2.	Level II	Oral cavity Larynx (supraglottic and subglottic) Pharynx
3.	Level III	Oral cavity Larynx (supraglottic and subglottic) Pharynx
4.	Level IV	Oral cavity Larynx (supraglottic and subglottic) Pharynx
5.	Level V	Thyroid glands Nasopharynx Laryngopharynx
6.	Level VI	Thyroid glands

multiple neurovascular structures together with the neck nodes (Fig. 1.16). The sound knowledge of detailed anatomy of this region will prevent complications of bleeding and nerve paralysis, which sometimes are difficult to manage. These include the boundaries of each neck node level and all their content (Table 1.3).

For instance, the oral cavity is mostly drained to levels I–III of the neck nodes. This entails the nodes at submental and submandibular triangle plus nodes that are located on the superior third of the IJV. The oral cavity has seven subsites, namely lip, alveolus, floor of mouth, buccal mucosa, tongue, palate, and retromolar trigone. Each of these subsites may have predilection of nodes to either level. Lip is commonly drained to levels I and II principally, while retromolar trigone may drain to levels III and IV.

Importantly, also in violated neck due to previous surgery or radiation, the normal lymphatic drainage is distorted, and the drainage may go to other neck node levels. The oral cavity is prone to ‘skip metastases’ to level IV neck nodes. Thus, in the majority of cases, selective supraomohyoid neck dissection levels I–III or anterolateral neck dissection levels I–IV should be performed for tongue carcinoma or other oral cavity carcinoma.

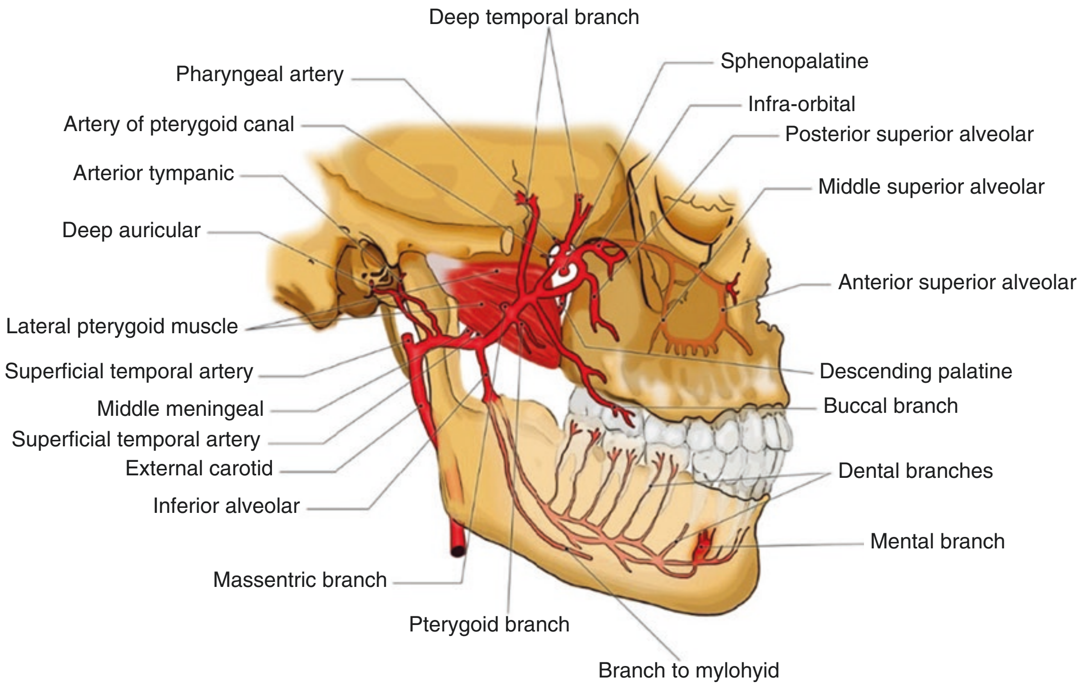

Fig. 1.14 The branches of external carotid artery include maxillary artery, which is further divided into three parts. The branches from these three parts supply important anatomic regions of the head and neck

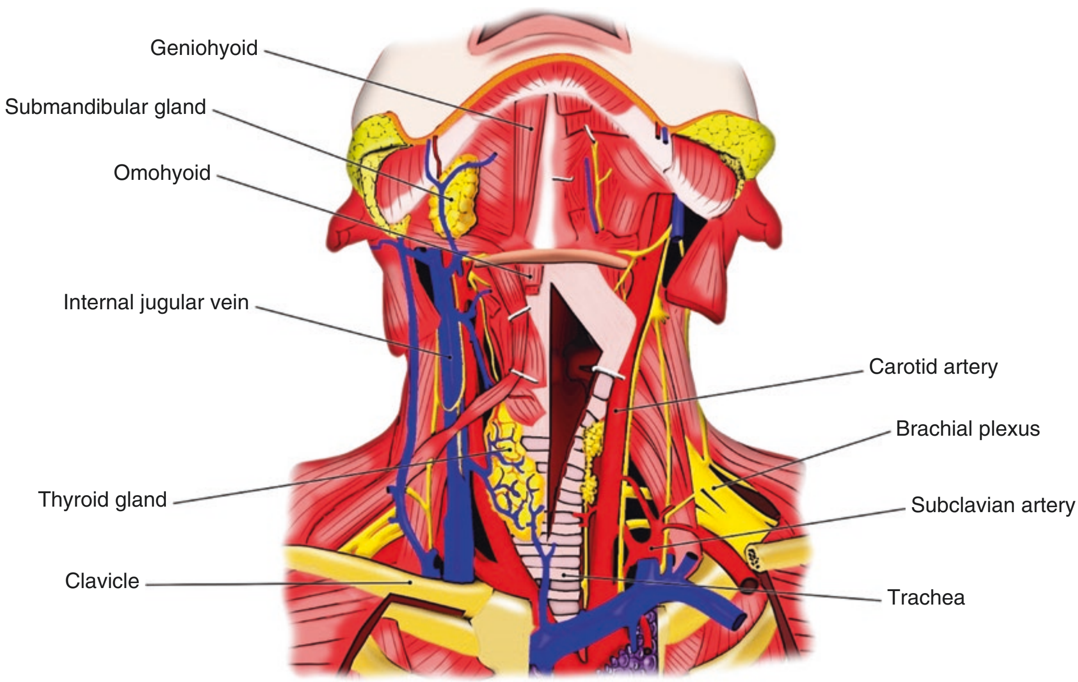

Fig. 1.15 Neck and its anatomy are critical for a safe surgery like neck dissection

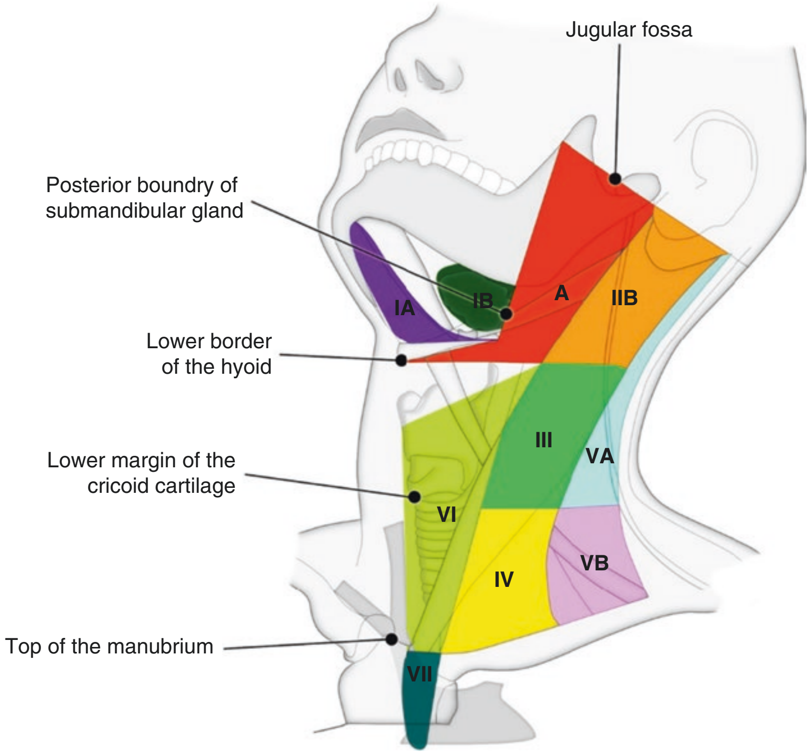

Fig. 1.16 Neck node levels (I–VI) and their detailed anatomy are critical for the conduct of a safe surgery like neck dissection

Table 1.3 Neck node levels and their boundaries and contents

	Level and triangles	Boundaries	Contents
1.	Level IA (submental triangle)	Between medial margins of anterior belly digastric	Submental nodes
	Level IB (submandibular triangle)	Mandible and symphysis menti Digastric muscle	Submandibular gland Submandibular nodes Lingual nerve, hypoglossal nerve
2.	Level IIA	IJV SCM	Upper jugular nodes
	Level IIB	Carotid artery Scalene muscle	
3.	Level III	Caudal edge of hyoid bone Caudal border of cricoid cartilage	Middle jugular nodes
4.	Level IV	From caudal border of cricoid to clavicle	Lower jugular nodes
5.	Level VA Level VB	Skull base to cricoid cartilage Cricoid cartilage till clavicle	Spinal accessory nerves Transverse cervical artery Brachial plexus
6.	Level VI	Hyoid Carotid artery Manubrium	Paratracheal nodes Pretracheal nodes

The lymph nodes in the retropharyngeal space are split into medial and lateral compartments. The medial compartment, at the level of the atlantoaxial junction, lies directly behind the nasopharynx. The lateral compartment lies between the longus capitis muscle and the carotid sheath, and slightly anterior to it. The retropharyngeal nodes are not palpable, and it is the deepest group of lymph nodes in the neck. The identification of retropharyngeal node disease can only be made by CT scan or MRI [6].

For differential diagnosis, prediction of disease spread, and surgical management, an accurate comprehension of the arrangement and anatomic details of the cervical fascia and its associated compartments is crucial [7]. Ultrasound-guided fine needle aspiration cytology (FNAC) is the commonest procedure to investigate the neck mass. It is non-invasive and easy and has a high reliability in expert hands. As far as surgery is concerned, the decision on surgical margin is very important especially if the tumour is malignant [8]. An ample surgical margin will lessen the risk of recurrence. In case of benign parotid tumour for example, wider surgical margin is critical because of the pseudopods of the tumour, which if transected result in tumour spillage and can result in recurrence.

1.4 Anatomical Landmark of Head and Neck Region

Apart from surgical skill, the anatomical knowledge is also one of the basic tenets of surgery. Variations in anatomy are well known among physicians, radiologists, anatomists, and surgeons. This impacts their daily clinical routines such as decision-making of selected cases that were planned for surgery. Surgeons from different fields such as oral and maxillofacial surgery, otorhinolaryngology, vascular, plastic, orthopaedic, and general surgery frequently operate in the head and neck region [9]. They should be familiarized with the head and neck anatomy. Anatomical and surgical landmark is crucial in order to orientate the surgeon about the important structures that are being addressed during specific surgery. It provides tremendous information and useful guidance intraoperatively so that the surgery can be performed safely and effectively, without any sequelae and morbidities.

Sound knowledge of critical anatomical structures and its related relationship with the surrounding tissues and structures will give clues to the specific type of necessary resection of the tumours. Most of the tumours, especially advanced tumour, will show invasion and infiltration to the surrounding tissues. Some tissues can be resected without immediate complications; however, some of the other structures and tissues can cause significant complications if they are resected. This is apparent if resection involves scarification of major neurovascular structures.

Fig. 1.17 Facial nerve trunk identification during the parotidectomy. It divides into two main branches within the substance of superficial lobes of the parotid gland. The superficial lobe of parotid gland has been removed in the photograph. The facial nerve stimulator with blue handle is used to locate the nerve and also assess its functionality

For instance, in the parotid gland surgery, the operation will be intricately involved with the identification and preservation of the facial nerves and its five important terminal branches (Fig. 1.17). The knowledge on the anatomical landmark to identify the facial nerve trunk is critical as it will assist the surgeon to quickly identify the nerves and save the operation time. The dissection can be performed continuously without interruption, and the surgeon will be able to avoid bleeding from injury to the vessels.

Generally speaking, the cervical region is regarded as similar to the stratified structure, which includes layers of skin, subcutaneous tissue, platysma, muscles and neurovascular structures. Nevertheless, the findings of anatomical and surgical studies have shown that subplatysmal structures, such as digastric structures, mylohyoid muscle, hyoid muscle, subplatysmal muscle fat, and bilateral salivary submandibular glands, influence the dissection techniques and outcomes of surgery [10].

1.4.1 Thyroid and Parathyroid Glands

Injury to the recurrent laryngeal nerve, superior laryngeal nerve, or glands of the parathyroid may have profound lifelong consequences for the patient. A surgeon must have a thorough understanding of the anatomy of the thyroid and parathyroid glands and be able to apply this information to perform a safe and effective operation in order to minimize the morbidity of the operation [11]. A safe thyroidectomy starts with a correct design of skin incision (Fig. 1.18). Subsequently, a proper subplatysmal skin flap should be raised meticulously (Fig. 1.19). This is to avoid flap necrosis and to promote good healing of the wound later.

Fig. 1.18 The thyroid surgery is critical as skin incision has to be designed properly in order to have an excellent scar post-operatively

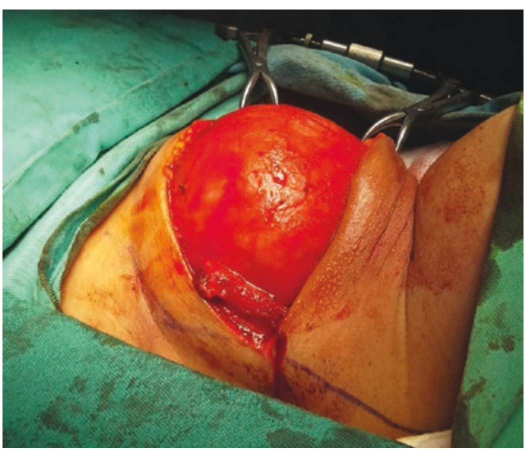

Fig. 1.19 The skin flap has to be raised in correct plane to facilitate easy and uncomplicated dissection. The subplatysmal flap is elevated before exposing the strap muscle and SCM

The preservation of RLN is critical in thyroidectomy (Fig. 1.20), as it controls the vocal cord mobility and influence the voice outcomes postoperatively. As the RLN rises, it develops an intimate relationship with the ITA in the TE groove. Several studies have attempted to define the relationship between the RLN and the ITA. The nerves can typically pass superficially or deeply, or between branches of the ITA. The ability of the surgeon to rely solely on the ITA as a landmark to identify the nerve is limited by this variable branching pattern (of the nerve and arterial system). The only constant is the ITA's intimate relationship with the RLN; most researchers recommend identifying the nerve before ligating the artery to avoid accidental nerve injury [12].

The Zuckerkandl tubercle is a poorly known and variable thyroid gland anatomical feature that is rare. It is the extension of the thyroid gland lobes laterally. This tubercle is regarded as a constant landmark for recurrent laryngeal nerve and also for the identification of superior parathyroid glands [13]. It occurs for embryological reasons, and during thyroid surgery, it can be a reliable anatomical landmark for identifying the recurrent laryngeal nerve. It should be included in the Nomina Anatomica as described by Zuckerkandl as the 'processus posterior glandulae thyroideae' [14].

Another critical structure that needs to be identified and preserved during thyroid surgery is the external laryngeal nerve (ELN). The ELN supplies the cricothyroid muscle, which tenses

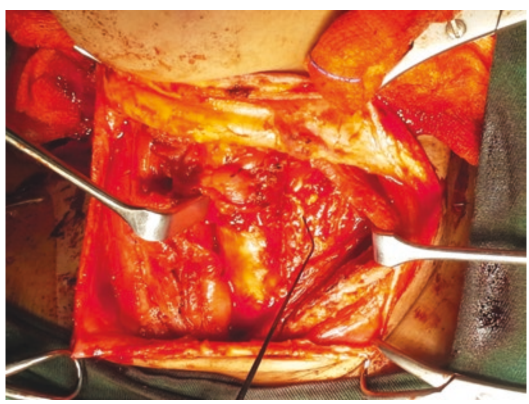

Fig. 1.20 The identification and preservation of RLN (under the black probe needle) are vital in thyroid surgery. This ensures normal voice post-operatively

the vocal cord and is useful in professional voice users such as singers and teachers. Thus, injury of the ELN during thyroid surgery causes significant morbidities. In particular, surgeons should be mindful that other types of surgery can also increase the morbidity to the ELN, including a variety of neck procedures such as parathyroidectomy, carotid endarterectomy, and anterior cervical spine procedures [15].

In the anatomical course of the ELN, there are large variations, making the intraoperative identification of the nerve difficult. This is compounded if surgical exposure of the thyroid gland area is limited. The nerve also sometimes can be very small and can only be visualized and assessed better using magnifying loupes or microscopes. Many authors consider the topographical relationship of the ELN to the superior thyroid artery and the upper pole of the thyroid gland to be the key point for identifying the nerve during neck surgery [15]. In fact, a classification system by Cernea provides information on the distance between external laryngeal nerve and upper pole thyroid (Fig. 1.21).

Fig. 1.21 The identification and preservation of RLN are aided by the usage of nerve stimulator. The nerve probe with a blunt-pointed end is used for stimulating the nerve

1.5 Surgical Landmarks of Selected Head and Neck Surgery

Surgical landmarks during the surgery can be a little bit different from the anatomical landmarks. It is well known that there is a variation of the anatomy of any given structures and organs within the human body. The anatomical landmarks are normally described based on the majority of the known anatomical details that are most of the time based on the cadaveric dissection specimen. However, there is variation in the organs and structures in the location, size, branching pattern, colour, and so forth. The variation especially is significant between the adult and paediatric patients.

These variations are mainly related to subcutaneous tissue, calibre of the nerve, number of branches and pattern of the branches of artery or vein, size and shape of the organs, location and consistency of organs, and so forth. All these variations need to be considered during the surgery. More experienced surgeons normally will be able to anticipate the anatomical details of the structures and organs and their variation, as they have been operating on many cases [16].

For instance, the facial nerve in a paediatric patient is located more superficially in contrast to an adult. Critically, the colour of facial nerve is very different to the colour of the facial nerve in an adult patient, which is usually white or pearly white. In paediatrics, the colour of the facial nerve is similar to the tissues, with more of tan or brownish in appearance. Thus, the use of intraoperative nerve stimulation is extremely helpful for the operating surgeon to locate the facial nerve in a paediatric patient. Injury to facial nerve can lead to major dreadful complications of the facial paralysis with facial asymmetry for life.

The SMAS layer is continuous with the platysma muscle inferiorly and the temporoparietal fascia and galea aponeurotica superiorly. In the face, the SMAS lies between the subcutaneous adipose tissue and the underlying parotidomasseteric fascia within which lies the facial nerves. The thickest SMAS is found in the lateral face overlying the parotid gland [17]. Sub-SMAS methods of dissection may allow both the improvement of aesthetic change and enhanced longevity.

Surgeons depend on the use of anatomical landmarks for identifying various structures. Good landmarks are those which are easy to identify and easy to palpate and remain in a relatively constant position throughout the procedure, thus allowing for a safe and fast identification of anatomical structures. Bony structures are ideal than soft-tissue or cartilaginous landmarks because of their rigid and reliable anatomical location. For identification of the facial nerve during parotid surgery, a number of reference points have been used. These include the TP, stylomastoid foramen, TMS, PBDM, stylomastoid artery, retromandibular vein, transverse process of the atlas, styloid process, angle of the mandible, junction of the bony and cartilaginous EAM, and peripheral branches of the facial nerve. There seems to be little agreement over the most reliable and appropriate landmark [18].

The paired jugular veins and the carotid arteries form the major vasculature of the head and neck region. There is anatomical variation of these two structures between individuals. There is evidence to suggest that the right IJV is slightly larger and thicker in dimension compared with the left [9]. In almost any extensive surgery of the neck, proficient knowledge of the neck anatomy is essential to prevent accidental injury to these vessels and their branches, for instance, during a selective or modified neck dissection. Reasonable speed and safety are of fundamental importance in identifying and preserving important anatomical structures during any head and neck surgery. Importantly, for example, particular attention must be paid to the refined identification of the spinal accessory nerve (SAN) at level V during modified radical neck dissection [19].

1.5.1 Transverse Process of the First Cervical Vertebra

The useful surgical landmark at upper cervical region is the transverse process of the first cervical vertebra. This can be easily palpated anterior and inferior to mastoid process deep in the upper cervical region, level IIb. It has intimate relationship with IJV, SAN, and internal carotid artery [19]. The SAN is superficially located as it runs through the neck's posterior triangle or level V neck. In order to avoid injury to this nerve, the skin flap raised over this region must be kept relatively thin and the contraction of the trapezius should be constantly observed during the dissection. In this area, there are two significant anatomical landmarks that can be used to locate the SAN: firstly, Erb's point, and secondly, the distance between the trapezius muscle entering the nerve and the clavicle [20]. This is of importance because any inadvertent injury to the SAN during surgical procedures is a cause of significant morbidity with medicolegal repercussions. SAN injury may be avoided by safely identifying it in lymph node levels II and V. Numerous methods are proposed that utilize the SAN's relationship to structures such as the transverse process of C1, perforating veins draining the sternocleidomastoid (SCM), SCM branch of the occipital artery, and superior SCM tendon [21].

Additionally, hyoid bone is an important surgical landmark for neck procedures. The hyoid bone is located just beneath the mandible in the anterior midline. The anterolateral aspect of the hyoid bone may be present with a radiolucent gap or radiodense line [6]. When planning the operation of a neck lift, the surgeon has to make several decisions regarding whether to perform it in isolation or in combination with a facelift. It is critical to consider the use of an anterior (submental) or posterior (lateral) surgical approach and the subplatysmal layer. If the space of the subplatysmal is explored, the digastric muscle can be identified. Important neurovascular structures in the neck are located deep to the posterior belly of digastric muscle. Platysma muscle on its own is an important muscle. Midline plication, partial or complete horizontal transection, and most recent lateral skin displacement are platysma-modifying techniques [17].

1.5.2 Parapharyngeal and Retropharyngeal Space

Parapharyngeal space (PPS) is a deep space of the neck and harbours numerous critical structures, namely the deep lobe of parotid glands,

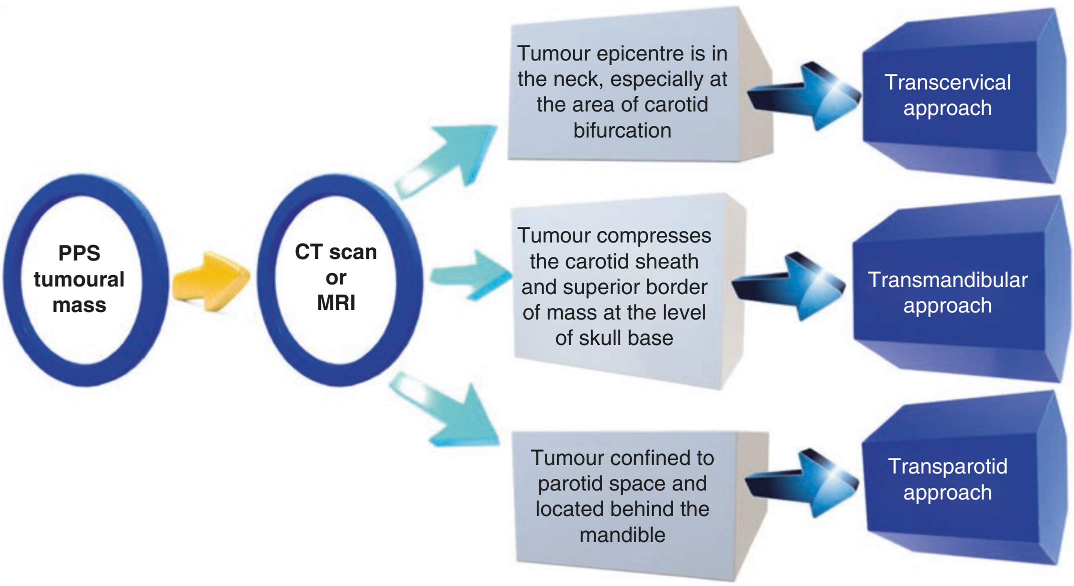

Fig. 1.22 Selection of surgical approach for a parapharyngeal space tumour depends on the tumour characteristic

cranial nerves, carotid sheath, and nodes. This deep space of the neck is significant as the surgical access to this region is technically challenging. In this region, the majority of pathology includes tumours of the salivary gland in the pre-styloid compartment and neurogenic tumours in the post-styloid of PPS. Pleomorphic adenoma is the most common salivary gland tumour, while schwannomas are the most prevalent neurogenic lesion in this area [22]. The other rare tumours include soft-tissue tumours, vascular tumours, and malignant tumours like acinic cell carcinoma of parotid glands. The retropharyngeal space (RPS) extends from the skull base to the upper mediastinum. Diseases are rare in this space but can lead to significant morbidity and mortality if not adequately managed.

In the assessment of the RPS and PPS, cross-sectional imaging plays an important role. Lesions arising within these spaces are difficult to evaluate on clinical examination due to their deep location within the neck [23]. Thus, imaging modality such as CT scan, MRI, or PET scan is very valuable in providing extra important findings and details characteristic of the mass that will help with the management of the patient. This can be highly crucial in deciding the details of surgical approaches for the mass extirpation, the pre-planned involvement of other expertise, and so forth.

The main surgical approach for addressing the PPS includes transoral, transmandibular, transparotid, and transcervical [24]. The choices of best approaches will depend on the location and size of the tumours (Fig. 1.22). Several PPS surgical approaches are available for use in addressing the pathology in this anatomic region. This includes the upper PPS, which can be exposed via a transnasal approach, though with limited working volume. The middle PPS can be exposed by transoral approaches, minimizing the neurovascular structures crossed. The entire PPS can be exposed only by transcervical and skull base approaches, crossing several neurovascular structures [25] (Fig. 1.23).

In order to improve treatment outcomes, the current trend in PPS tumour surgery is to develop minimally invasive approaches that enable tumour resection without the need for mandibulotomy or approaches to the lateral skull base. This can be achieved by considering a well-defined surgical route such as the transcervical, transnasal, or transvestibular, especially in a small and limited PPS tumour. Therefore, in view of the wide and heterogeneous choice of techniques that are available, careful surgical plan-

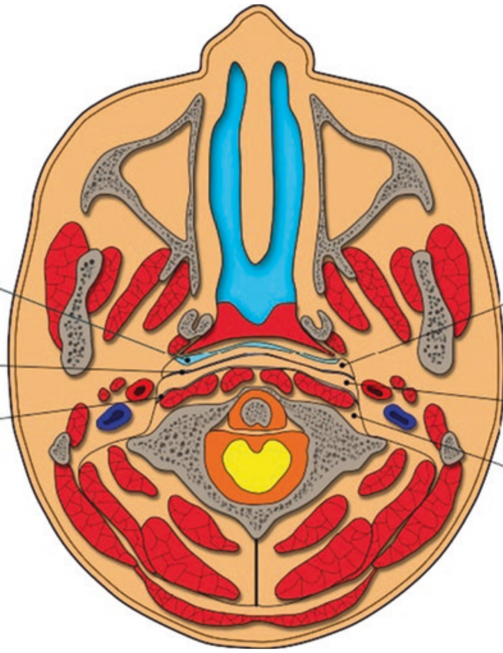

Fig. 1.23 Deep neck space of the head and neck region contains many structures and has many functional significances. Among these critical structures is this fascia layers and spaces, which is an easy route of spread of disease and tumour in this deep neck space, as it is a very thin layer. Importantly, communication exists between these deep neck spaces

ning is mandatory in order to tailor the surgical treatment according to the patient and tumour characteristics [26].

1.5.3 Sentinel Lymph Node Biopsy

Sentinel lymph node biopsy is an integral management component of oral cancers, and currently multiple studies are investigating its roles in other head and neck tumours like salivary gland tumour, thyroid tumour, and sinonasal carcinoma. The concept of sentinel lymph node biopsy is similar with super-selective neck dissection. This applies to a focal removal of at-risk or involved nodes only. Morbidity can be significantly reduced; hence, patient quality of life will be much improved. Some of the procedures have also been performed using a robotic system. At this juncture, as the robotic system has revolutionized most of the surgical approaches, the scars and aesthetic complication can be minimized, provided that the practising surgeon is well versed with the robotic system and its instrumentation.

Transoral robotic surgery has become significant in head and neck cancer treatment such as for oral, tongue base, and oropharyngeal cancers. For tongue base tumour, this approach is an efficient approach, as miniprobes and gadgets can be manipulated under direct visualization. The robotic endoscope will allow the control over the neurovascular structures in order to minimize complications. Transoral robotic surgery (TORS), which offers patients with newly diagnosed oropharyngeal carcinoma a novel option to the standard of care with RT and may provide better functional results, is now being used for the majority of early OPSCC patients in the United States [27].

1.6 Dissection Procedure

The plane of neck structures is vital in determining the bloodless, safe, and effective surgery. Most of the time, neck surgery will be initiated with the subplatysmal flap. Some vessels like EJV, which runs over the sternomastoid muscle, can be easily seen once the flap is raised. Inadvertent injury to EJV and feeding veins can jeopardize the surgical bed and further compromises safer dissection or deeper structures like sternocleidomastoid muscle and the carotid sheath underneath. The sternocleidomastoid muscle is innervated by spinal accessory nerves, which run and enter the sternomastoid muscle at its superior one-third, and further anteriorly this SAN is closely related to IJV and carotid artery and its branches.

Following the IJV on a correct plane is essential, especially in case of neck dissection where the recurrent tumour can occur along this IJV. Multiple fascia layers envelope the IJV, where the lymphatic networks are located. Thus, dissection needs to include this layer together with the dissection specimen, so that the risk of recurrent neck tumour can be reduced. In some patients, the IJV can have multiple branches, which necessitate ligation with small clips. Otherwise, the dissection can freely continue through this plane.

1.6.1 Pearls and Pitfalls of Dissection Techniques

The pearls and pitfalls of dissection technique are depicted in the table as below:

Types of surgery	Pearls	Pitfalls
1. Oral cavity surgery	Need to get ample surgical margins due to overstretched tongue musculature during palpation and dissection Depth of invasion (DOI) is critical to be considered during glossectomy. DOI has been incorporated in the current eighth edition of TNM staging system In advanced tumour, floor of mouth needs to be resected together with glossectomy. FOM needs to be reconstructed with either SSG or STSG, in order to prevent tethering of neotongue to FOM during healing, which impairs speech and mastication	Total glossectomy mandates total laryngectomy, which further impacts the patient's functioning Choices of reconstruction post-resection are multiple and depend on the defect coverage characteristics
2. Oropharyngeal surgery	Combined mandible and oral surgery (commando) is required in T3 tumour and higher De-escalation treatment for HPV-positive patients has improved prognosis with this therapy Surgical tissue specimen should be assessed for HPV positivity/status, as it dictates the prognosis and treatment	Metastasis neck disease may present with cystic neck mass, mimicking brachial cyst Mandibulectomy is necessary in T3 tumour and higher Risk of osteoradionecrosis of mandible especially in patients with comorbidities
3. Nasal, paranasal sinus, and nasopharyngeal surgery	Maxillectomy is necessary in maxillary sinus carcinoma Robotic nasopharyngectomy Endoscopic nasopharyngectomy is indicated for a small recurrent tumour EBV status has been included in the current 8th edition of TNM staging system	Neck metastases in sinonasal malignancy imply distant metastases Retropharyngeal node involvement is challenging to address for NPC patients
4. Salivary gland surgery (a) Parotidectomy (b) Submandibulectomy	Facial nerve monitoring is a prerequisite during parotidectomy Marginal mandibular nerve needed to be identified during submandibulectomy Surgical loupes enhance the facial nerve dissection	Excessive stimulation with the nerve and traction causes temporary facial nerve paralysis Local anaesthesia interferes with the nerve identifications since the LA agent infiltrates the nerve and causes paresis

Types of surgery	Pearls	Pitfalls
5. Thyroid gland surgery	The identification of recurrent laryngeal nerve is aided with the uses of surgical loupes and nerve stimulator, to know the landmarks and meticulous dissection Parathyroid gland can be identified and reimplanted to reduce the morbidity of the surgery Use of ultrasonic device facilitates faster and bloodless surgery	External laryngeal nerve identification is challenging RLN palsy causes hoarseness, which impairs the functionality of professional voice users Central compartment neck dissection poses risks of RLN palsy and hypocalcaemia
6. Neck dissections	Knowing the anatomy and surgical landmarks of neck will facilitate easy dissection Use of ligaclips, surgical loupes, and ultrasonic device will save the operative time	Multiple complications arise from MRND and RND, which are difficult to manage such as frozen shoulder syndrome and chylous leak
7. Parapharyngeal spaces	Wide exposure and dissection of neck along the digastric to midline will facilitate access to parapharyngeal space without the need for mandibulotomy	Difficult access, which occasionally necessitates mandibulotomy for access

1.6.2 Dissection Guide

Multiple factors are a prerequisite for determining the success of dissection during any given specific surgeries. These factors include patient's factors, tumour factors, instrument factors, and staff's factors (Table 1.4).

The skill and experience of operative surgeons determine the success of a surgery. Meticulous dissection, adequate assistant, well-functioning instruments, and great teamwork with anaesthetists will ensure the success of any surgery.

Table 1.4 Determining factors for the success of a surgery

	Factors which influence the success of the dissection
Patient factors	Patient's consent Patient's financial status Patient's insight of the disease Patient's positioning Patient's blood parameter Patient's medication
Tumour factors	Complete evaluation of tumour Histology and grade of tumour Recurrent tumour
Instruments and facility factors	Adequate instruments Sharp instruments Spacious OT space Correct patient's positioning
Staffs and personnel factors	Proactive communication among surgeons, nurses, and paramedics

1.7 Optimal Setting for Head and Neck Cancer Surgery

The proper setting of instruments and monitor in the theatre is vital, as it facilitate a safe and effective surgery. For instance, the correct placement and usage of facial nerve stimulator in the operative theatre will ensure the success of a parotid gland surgery, as the facial nerve can be identified and preserved efficiently during the dissection. The useful anatomical landmarks for the facial nerve identification during the parotid surgery include the following:

1. Facial nerves run between the superficial lobe of parotid glands and the deep lobe of parotid glands. It gives off five peripheral branches within the substance of the parotid glands.
2. The facial nerve trunk lies 1 cm inferior to the tragal pointer and medial to the posterior belly of digastric muscle.
3. The facial nerve lies 4–5 mm to the tympanomastoid suture.

1.8 Availability of Necessary Instrument and Supportive Staffs

Instruments and facility play a significant role in determining the success of any surgeries. Knowledge details of the instruments that are available at the centre and correct handling of the

Fig. 1.24 Instruments for a surgical procedure should be prepared early. The OT nurses should be well informed if there is any extra equipment required for specific surgery

Fig. 1.25 The instruments and staffs should be well prepared. The monitor, OT patient table, and anaesthetic machine should be placed at an optimal position. This allows the surgery to proceed as planned without any unnecessary interruptions

equipment will ease the surgery and reduce the operation time (Figs. 1.24 and 1.25). This in turn will lessen at-risk complications including anaesthesia-related complications. The availability of committed supportive staffs is also essential in maximizing the success of a surgery

Fig. 1.26 Instruments like energy device and its monitor, a trolley, OT patient table, and anaesthetic machine should be placed at an ideal position. This facilitates efficient surgery with less unwanted complications

Fig. 1.27 The anaesthetist, scrubbing nurse, OT assistant, and medical officer should have a proactive role and communication. This ensures that the surgery will proceed with best outcomes

(Figs. 1.26 and 1.27). At this juncture, refinement and advancement in surgical techniques and instrumentations have led to the performance of multiple surgical procedures that are effective and optimal. Less time and minimal complications from the surgery translate into a safer procedure. This will improve the patient's treatment outcomes and overall quality of life. For instance, with the advancement of current imaging tools, surgical instrumentation, and minimal-access surgical procedures, the management of frontal sinus pathology has improved. Depending on the surgeon's expertise and experience, frontal sinus lesions can be treated in a variety of ways, ranging from totally endoscopic to fully open. This will also depend on the detailed characteristics of the tumours. Smaller tumours are accessible via an endoscopic approach, and minimal morbidity is expected from experienced surgeons.

At present, many surgical instruments have evolved in order to be used conveniently by the practising surgeons. The cost of some of these instruments has also been reduced, as more choices of brands and types are available in the market. Newly developed technology gadgets, such as the ultrasonic devices, multi-angle endoscopes, 3D imprinting, digital nerve monitoring, and robotic systems, have escalated the management of head and neck diseases and tumour management [28]. For instance, 3D printing in reconstructive surgery has become critical in mapping the relevant structures that are involved during tumour resection, which need to be addressed during the surgical procedures. Three-dimensional printing offers a great appeal as customized materials can be invented and occasionally applied into the tissues with less reactions and morbidity [29]. For instance, three-dimensional printing offers an intuitive solution in otological, rhinological, or laryngological anatomy for preoperative design and surgical education [29]. This 3D printing is also routinely used in the OMF practice and surgery.

1.9 Conclusion

Head and neck surgery requires meticulous dissection so as to avoid complications and surgery-related morbidities. This is critical to ensure a complete resection especially of a malignant tumour in order to prevent future recurrences. Complications from unsafe surgery can be occasionally fatal and impair patient's quality of life. Importantly, recurrent diseases are more difficult to manage. It is a prerequisite for a surgeon to possess sound anatomical knowledge and be well versed with surgical landmarks in order to effectively perform a head and neck surgery. Additionally, knowledge of instruments, committed supportive staffs, and experience in handling complicated cases will ensure better surgical outcomes for patients.

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