2 Principle of Head and Neck Surgery and the Importance of Anatomical Characteristics

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2.1 Introduction

Head and neck surgery consists of surgical procedures, which involve many critical anatomic regions of the facial, head, and neck regions. These anatomic regions are responsible for most of the human vital functioning like breathing, olfaction, speech, mastication, swallowing, facial expression, hearing, and vision. In-depth knowledge of the surgical landmarks of specific surgery in combination with imaging findings will provide a crucial information for a surgical mapping. This ensures a safe surgery, where the inadvertent injury to critical structures can be minimized or avoided. Hence, surgery-related morbidities can be reduced to this subset of patients and their treatment outcomes and quality of life can be improved.

The head and neck region is the most exposed area of the human body. Importantly, this anatomic region is prone to infection, trauma, and tumour formation. These pathologies are very debilitating and can significantly interfere with humans' critical functions. The tumour, either benign or malignant, adversely affects patient prognosis and survival. Depending on the anatomic region of tumour formation, different sites involved present with different clinical manifestations. For instance, patients who had nasal polyps will present with a complaint of nasal blockage and rhinorrhoea, whereas patients with nasoangiofibroma will present with recurrent episodes of epistaxis that may necessitate ward admission. A nasopharyngeal carcinoma patient will present with neck node enlargement. Details of anatomic involvement by specific pathologies at these regions contribute to these different clinical presentations. This includes neural and vascular structure compression or erosion, pattern of the lymphatic drainage, and other adjacent structures' involvement.

Salivary gland's surgery can lead to significant morbidities in the patient. Thus, a meticulous examination and assessment of any parotid swelling are crucial. For instance, on inspection, parotid gland is visible just anterior to the tragus (Fig. 2.1). Anatomically, the parotid gland has delicate relationship with critical structures such as facial nerve, retromandibular vein, and maxillary artery. Surgery to parotid glands can be divided into two main types, the superficial parotidectomy and total parotidectomy. In superficial parotidectomy, the facial nerve needs to be identified and preserved during the dissection of the superficial lobe of the parotid glands (Fig. 2.2). The retromandibular vein needs to be ligated and secure, as it is located very close to the facial nerve. In a few instances, the retromandibular

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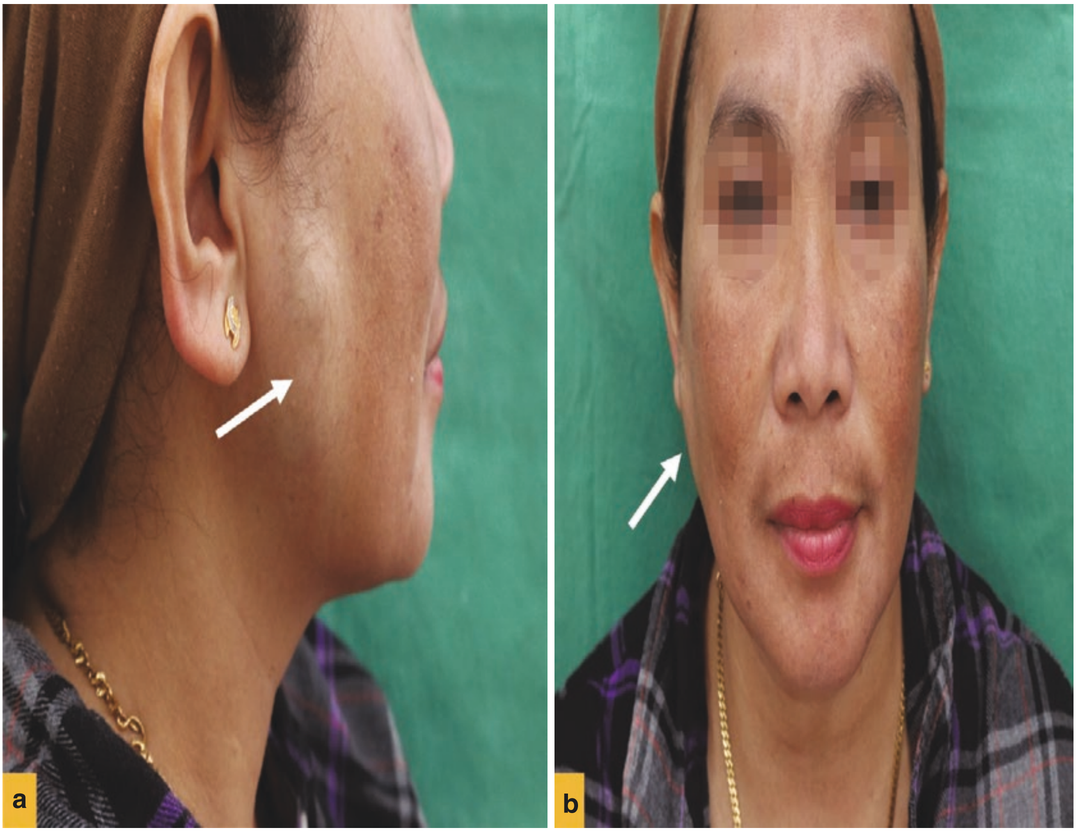

Fig. 2.1 Parotid gland enlargement (arrow) mostly located superficial to the facial nerve trunk and its branches. (**a**) Lateral view of neck inspection. (**b**) Anterior view of facial and neck inspection

Fig. 2.2 Intraoperative figures showed facial nerve and its branches (star). Left sternocleidomastoid muscle is visualized laterally (arrow)

vein is located below or medial to the facial nerves. The maxillary artery (Fig. 2.3) can be palpated during dissection at the medial side of the superficial lobe so as to avoid inadvertent injury and unwanted bleeding. However, this rarely occurs.

Submandibular gland surgery is slightly different compared to parotid surgery as the submandibular area contains different neurovascular structures. Submandibular area is equal to level Ib neck node. It contains multiple critical structures including marginal mandibular nerves, facial artery and vein, lingual nerve, and hypoglossal nerve (Fig. 2.4). All of these neurovascular structures need to be identified and addressed accordingly in order to avoid the complications that may arise from the submandibular gland's surgery. These, for instance, can be uncontrolled

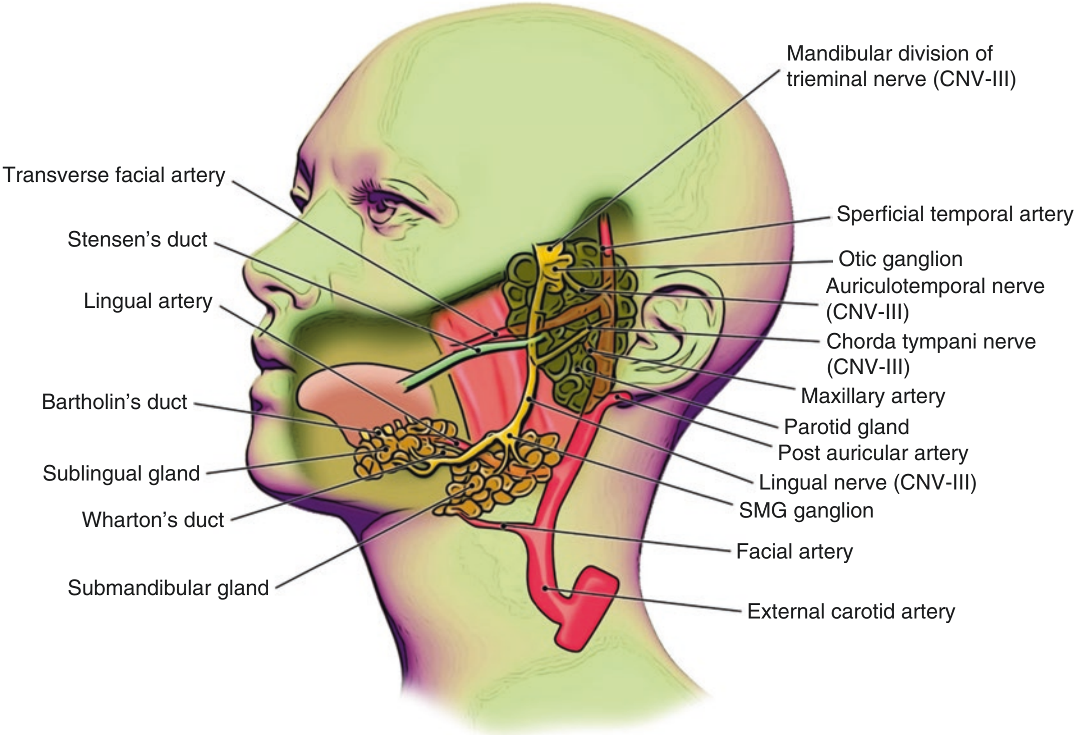

Fig. 2.3 Parotid glands and facial nerve and its branches and relation to adjacent critical structures such as carotid artery, maxillary artery, Stensen's duct, and submandibular gland

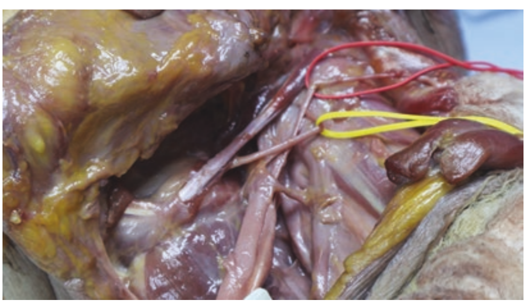

Fig. 2.4 Submandibular triangle or level Ib of neck harbours the submandibular gland, posterior belly of digastric muscle, hypoglossal nerve (yellow vessel loupe), and lingual nerve

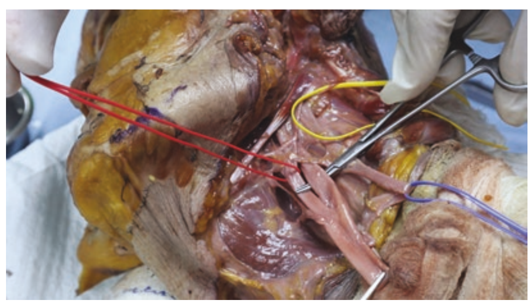

Fig. 2.5 Posterior belly of digastric muscle is visualized, external carotid (red vessel loupe), and IJV (blue vessel loupe)

bleeding from the injured facial artery and tongue deviation and atrophy due to hypoglossal nerve palsy. Further dissection at level Ib and II exposes the posterior belly of digastric muscle, carotid artery (internal and external carotid arteries), and internal jugular vein (Figs. 2.5 and 2.6).

During submandibulectomy, traction on the submandibular glands inferiorly pulls the submandibular duct and gives the appearance of lingual nerve as a 'V' shape. This is due to the duct which crosses the nerve from laterally to medially as it ascends forward (Fig. 2.7). Most commonly, the submandibulectomy is performed for pleomorphic adenoma of the submandibular gland's tumour (Fig. 2.8). It is a benign tumour and prone to recurrence if the capsule of the mass is breached during surgery. The hypoglossal nerve (Fig. 2.9) and lingual nerve are two most critical nerves to be identified and preserved during a submandibulectomy.

Fig. 2.6 Submandibular gland (arrow) is retracted inferior-laterally revealing the digastric tendon (white star). External jugular vein (black star) is visualized superficially to sternocleidomastoid muscle

Tongue carcinoma is another critical head and neck malignancy as the incidence is on the rise, especially in certain geographic locations such as India where the habit of betel nut chewing predominates. Clinical presentation varies with ulcerative growth, hypoglossal nerve palsy, or tongue muscle atrophy and fasciculation (Fig. 2.10). The management of tongue carcinoma is difficult as the majority of tumours are aggressive and tend to recur, especially in the neck. The anatomy of oral cavity (Fig. 2.11) is delicate as multiple structures within the oral cavity are involved with the process of mastication, taste, swallowing, and speech articulation. Clinical examination with palpation of the tumour mass (Fig. 2.12) and normal-looking adjacent tissues is critical to rule out infiltration by the tumour. Surgical treatment is the mainstay of the treatment of tongue malignancy. Depending on the location of the tumour, T stage, depth of infiltration (DOI), and histological grade, surgi-

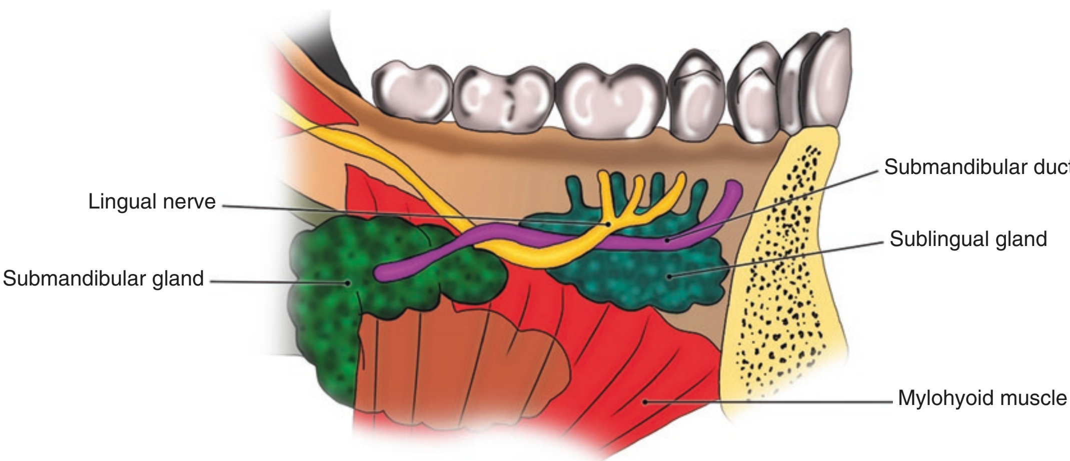

Fig. 2.7 Anatomical relationship of submandibular duct and lingual nerve observed during submandibulectomy. The submandibular duct crosses the lingual nerve from lateral to medial and from posterior to anterior direction. This is an important relationship as during the surgery the traction on the submandibular gland and its duct inferiorly will cause the lingual nerve to appear as 'V' shape. This facilitates identification and preservation of the lingual nerve

Fig. 2.8 The submandibular gland benign tumour and pleomorphic adenoma in a young patient. (**a**) Right submandibular pleomorphic adenoma in a young female patient. (**b**) The right submandibular mass occupies level Ib, II and III neck region

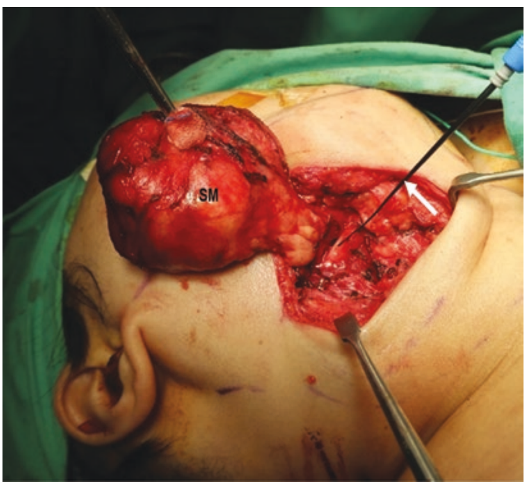

Fig. 2.9 Submandibular mass (SM) retracted superiorly exposing the hypoglossal nerve at the tip of the nerve stimulator probe (arrow)

cal types can be determined early with the incorporation of neck dissection due to high risk of micrometastatic tumour deposit in the neck. Surgery includes partial glossectomy, hemiglossectomy, subtotal glossectomy, and total glossectomy for the primary tumour of the tongue (Fig. 2.13), and supraomohyoid or anterolateral neck dissection for neck metastases. Occasionally, resection of floor of mouth and flap reconstruction, is necessary in higher stage tumours, where there is evidence of involvement in CT scan findings (Fig. 2.14).

There are a few types of mandibulectomy such as hemimandibulectomy, segmental mandibulectomy, and marginal mandibulectomy (Fig. 2.15). The indications of each type of mandibulectomy are different. This mainly depends on the location of the tumour, size, and grade of

Fig. 2.10 Some examples of tongue carcinoma and its associated features. (**a**) Ulcerative mass at left lateral tongue. (**b**) Ipsilateral hypoglossal nerve palsy as evident with deviation of tip of tongue to the right. (**c**) Fasciculation and atrophy of right tongue due to right hypoglossal nerve palsy. (**d**) Tongue carcinoma of the left side with tip-of-tongue involvement

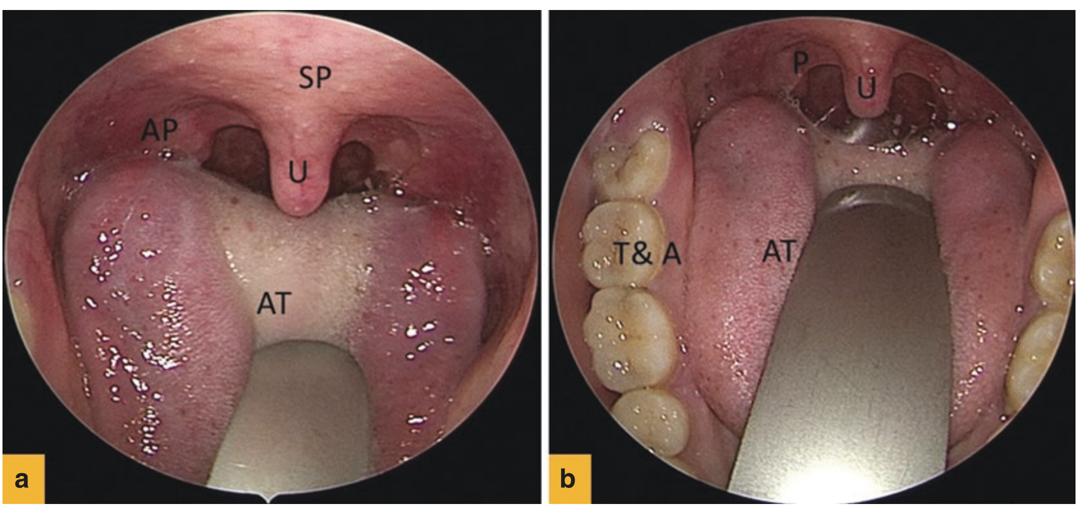

Fig. 2.11 (**a**, **b**) Normal anatomy of the oral cavity, anterior two-thirds of tongue (AT), soft palate (SP), uvula (U), anterior pillar (AP), teeth and alveolus (T&A), lip, floor of mouth, buccal mucosa, hard palate, and retromolar trigone

Fig. 2.12 Palpation of tongue mass and adjacent surrounding areas is important to rule out the involvement by malignancy

the tumour. If the tumour lies close to the mandible but on CT scan imaging there is no invasion of the mandibular cortex, then marginal mandibulectomy is recommended. If there is significant invasion of the mandibular cortex, then segmental mandibulectomy should be performed. Hemimandibulectomy is indicated when the tumour is extensive, and its location is direct on the mandible.

In selected cases, only a mandibulotomy (Fig. 2.16) is necessary as an approach to excise the tumour, for instance, the tongue carcinoma that has invaded the floor of mouth. In order to achieve free negative margins, mandibulotomy is an excellent approach.

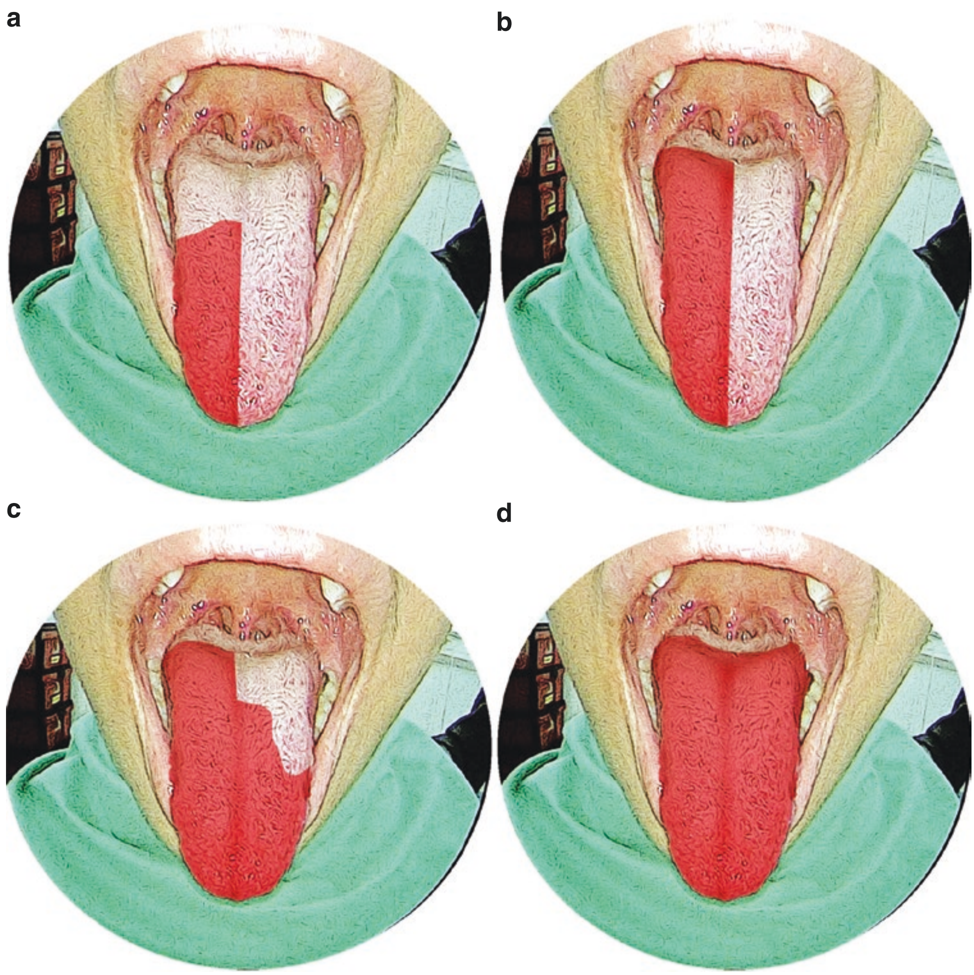

Fig. 2.13 Right partial glossectomy (**a**), right hemiglossectomy (**b**). A right subtotal glossectomy (**c**), total glossectomy (**d**)

Fig. 2.14 Post-operative tongue surgery, hemiglossectomy with free flap reconstruction (star). Right side of tongue is maintained (arrow)

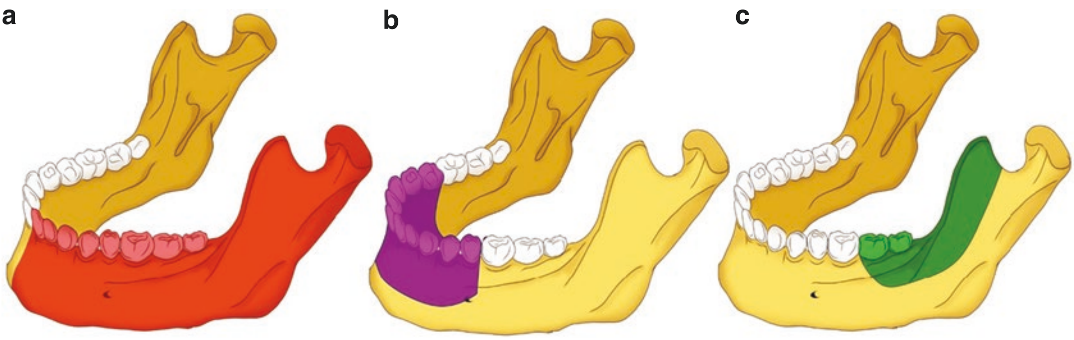

Fig. 2.15 Types of mandibulectomy. (**a**) Left hemimandibulectomy. (**b**) Marginal mandibulectomy (anterior). (**c**) Marginal mandibulectomy (left lateral)

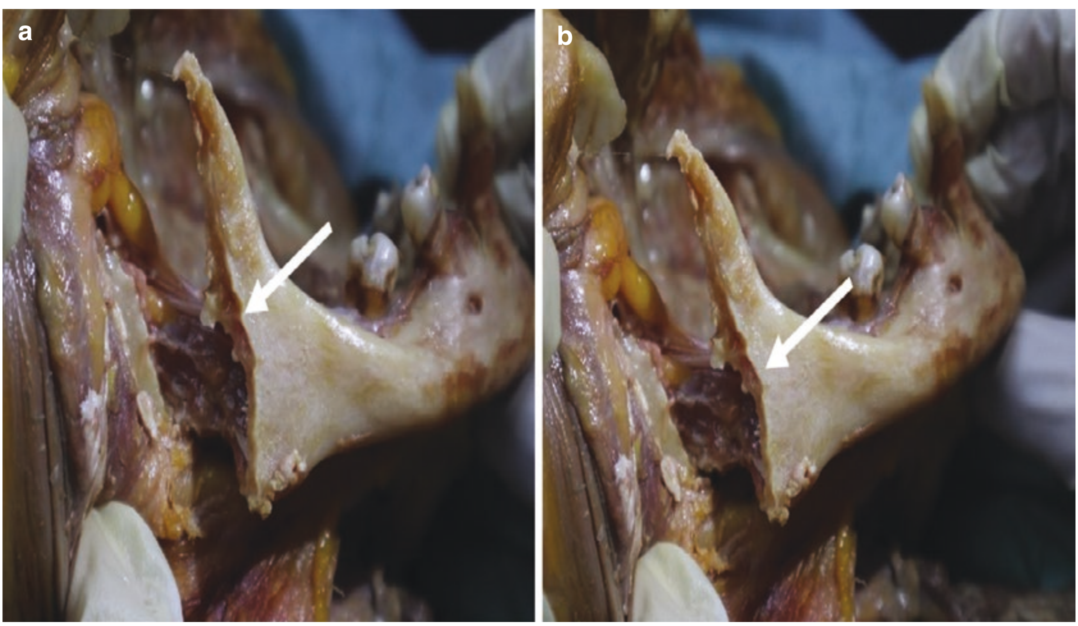

Fig. 2.16 (**a**, **b**) A lateral mandibulotomy is a cut on the mandible. This is an ideal approach for resection of the posterior or lateral tongue tumour, which is deeply invasive

2.2 Principle of Surgery for Head and Neck Cancer

It is highly critical for a surgeon to perform a safe surgery. A safe surgery encompasses a surgery that was conducted effectively without any serious complications or related morbidity. Any unwanted morbidities from a surgical procedure will impair patients' function and quality of life. In addition, it will also add significant cost and burden to the institution as the hospital stay will be prolonged and more human resource will involve in the management of the case. In order to perform the surgery safely, a surgeon should be well versed with the anatomical details of the organs involved. Additionally, the skills of the surgeon plus the availability of supporting staffs and instruments also influence the outcomes and conduct of any surgery.

A significant component of surgical planning involves evaluation of the tumour for resectability. Some tumours are resectable, whereas others are not. A number of tumour characteristics impart unacceptable functional consequences or a technical inability to clear the disease if surgery were to be attempted in extensive tumour [1]. The imaging tools like CT scan, MRI, and PET scan provide important findings such as primary tumour location, size of the tumour, neck node involvement, and involvement of adjacent critical structures. This is highly crucial for surgical mapping preoperatively and intraoperatively, to ensure that each type of surgery is able to address the adjacent structures that are affected by tumour, so that the procedure can be performed according to the principle of oncologic surgery with minimal related surgical morbidities.

Knowing the details of the involvement of the tumour will allow its en bloc resection. This allows for a complete evaluation of the tumour surfaces and more adequate assessment of the tumour margin by the pathologist. Even though negative surgical margin is the primary end point of the surgery, the function of residual unresected organs and aesthetic should be considered. This is important to avoid the unnecessary tissue resection. Although tumour transection can allow for a more complete assessment of tumour depth and extent by the surgeon intraoperatively, it should be optimized so that unnecessary resection of intact normal structures can be avoided [1]. This is important in terms of preservation of muscles and neurovascular structure, as some of them if sacrificed can result in detrimental consequences that may significantly compromise the patient's quality of life.

Given the anatomy of the head and neck, a surgeon often encounters cranial nerves during the course of surgical resection. The last four cranial nerves are located deep at the level II of the neck. Surgical procedures like neck dissection, submandibulectomy, and excision of vagal schwannomas or branchial cyst will expose these four cranial nerves, and hence they are at risk of injury. The carotid sheath is intimately related with these cranial nerves, and their injury can cause massive bleeding, most commonly from the IJV and its branches. The neural management is difficult in malignancy cases in contrast to benign cases, where the nerves should be identified and preserved. In an extensive malignant tumour, the nerve may or may not be preserved depending on the patient factors and tumour factors. The guidelines are somewhat ambiguous with respect to the management of nerves involved with gross disease. If gross invasion is present and the nerve can be resected without significant morbidity, it should be sacrificed with an adequate proximal and distal stump [1].

Mandibulectomy and mandibulotomy (Figs. 2.15 and 2.16) are critical operations in head and neck surgical oncology. This resection of mandible is necessary in the setting of oral carcinoma with mandibular cortex erosion, malignant parotid tumour located on the mandible, or submandibular carcinoma which is adherent to the mandible. The involved mandible needed to be removed during the resection of the primary tumour in order to reduce the risk of local recurrence. This is due to the presence of micrometastatic tumour deposit in the mandible that may spread the cancer cells to the adjacent structures.

The choices of mandibulectomy depend on the extent of tumour involvement and whether to obtain an adequate tumour-free margin. Additionally, the extent of mandibulectomy is determined by clinical, radiographic, and intraoperative findings. For instance, the guidelines state that marrow space involvement by the tumour is an indication for segmental mandibulectomy. This may be obvious, in some cases, based upon the clinical examination or preoperative imaging. However, determining the extent of resection can be somewhat more difficult in patients with tumours abutting the mandible/periosteum without obvious gross invasion [1]. In this case, the mandible can be debrided or shaved with bone debrider as in marginal mandibulectomy.

Marginal mandibulectomy deficiencies are caused by the removal of a single mandible cortex, whereas segmental mandibulectomy defects are caused by the removal of a whole segment of the mandible, both cortices and medullary space. Defects in the anterior arch, lateral portion of the body, or tibia can all be found after a segmental mandibulectomy [2]. When possible, osseocutaneous microvascular free flaps can be used to repair the ensuing mandibular flaws, avoiding the functional and aesthetic issues that come with a mandibular discontinuity defect.

2.3 Types of Head and Neck Surgery

2.3.1 Oral Cavity Surgery

Many pathologies can arise from the oral cavity. Oral cavity is subdivided into eight anatomic subsites:

(a) Lips
(b) Alveolus
(c) Teeth
(d) Buccal
(e) Tongue
(f) Floor of mouth
(g) Hard palate
(h) Retromolar trigone

There are myriads of pathology that can arise within the oral cavity, which can cause significant complications if not properly treated. Among the pathologies that can arise within the oral cavity include leukoplakia, erythroplakia, ranula, minor salivary gland tumour, and tongue carcinoma. All these lesions can impair the mastication, swallowing, and speech articulation especially if surgical resection involves a significant bulk of the tongue.

Leukoplakia is characterized by a white patch that cannot be rubbed off and is a risk factor for oral cavity carcinoma. It is commonly encountered in a smoker. In the majority of cases, it is a superficial lesion that can be easily excised. The treatment mainly involves transoral laser resection of the leukoplakia patch. Cautery can also be used to resect the mass safely, and at the same time bleeding can also be controlled via coagulation mode. The surgical resection of leukoplakia is both diagnostic and therapeutic.

For oral cancers (Fig. 2.17), a proper surgery is required and is more technically challenging especially in higher stage tumour. Surgery remains the foundation of management for tumours of the oral cavity. Tumour resection should be performed with allowable clinical clearance of 1 cm of adjacent mucosa structures (Fig. 2.18). In T2 tumour, hemiglossectomy may suffice, but for T3 and T4 tumours, either subtotal glossectomy or total glossectomy should be performed. The resection however is complicated as the tongue is a musculature organ and the estimated margin might be underestimated due to the traction used on the tongue pull during resection that overstretches the tongue. For all oral cavity tumours, elective neck treatment should be offered [3]. Additionally, if total glossectomy is to be performed, total laryngectomy also needs to be carried out in order to prevent chronic aspiration.

Tongue carcinoma is an aggressive tumour, and if early aggressive treatment is not implemented, the likelihood of locoregional failure is high. Several other histopathological factors, such as tumour thickness, extracapsular spread of nodal metastasis, and invasion patterns, have been shown to be of prognostic importance. Oral tongue SCC with a tumour thickness greater than

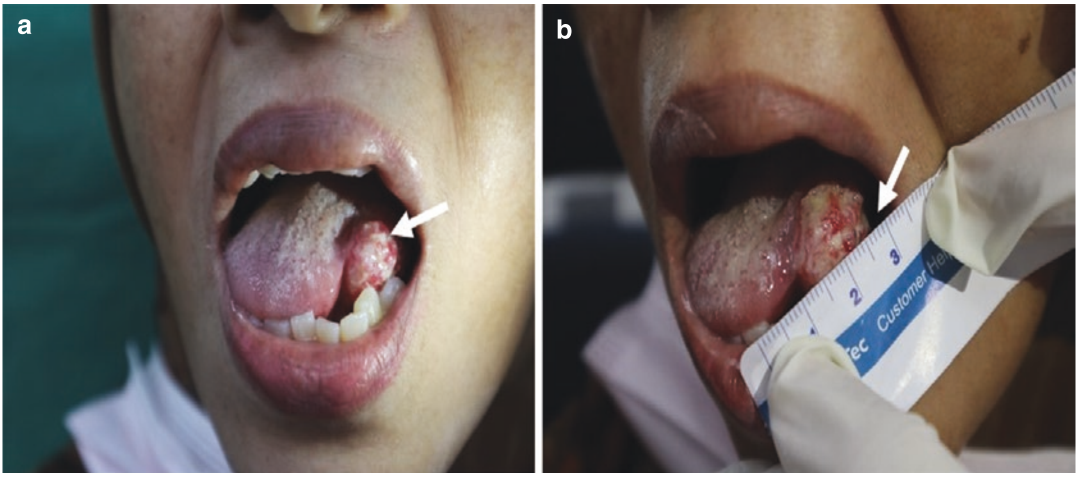

Fig. 2.17 An exophytic growth at left lateral tongue (**a**). This malignant mass needs to be measured for the purpose of staging (**b**)

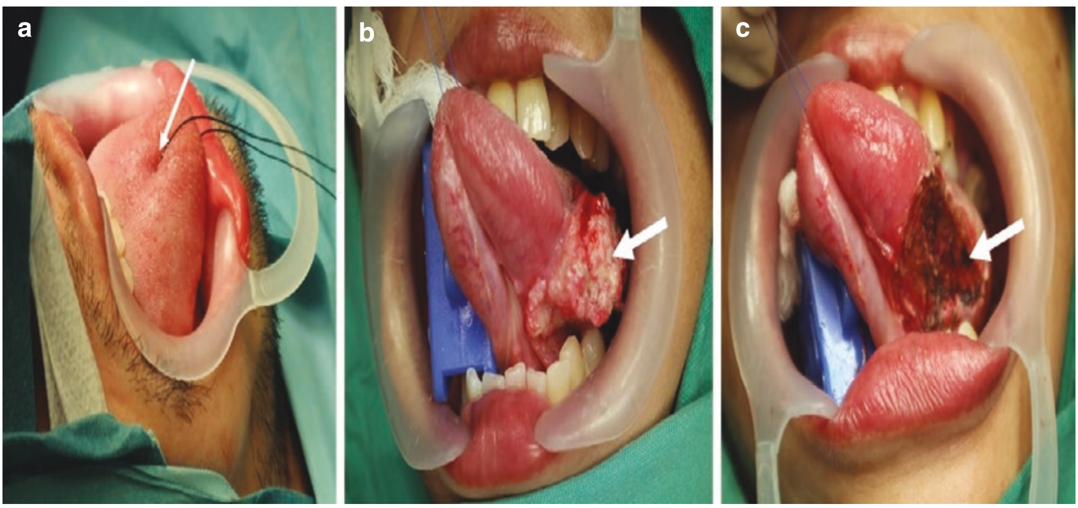

Fig. 2.18 Intraoperatively, tip of tongue is sutured for a retraction to facilitate mass resection (**a**). The malignant mass has spread inferiorly to dorsum tongue with the possibility of floor-of-mouth involvement (**b**). Post-excision biopsy of the mass (**c**)

4 mm is considered to represent a more than 20% risk of metastatic involvement of the cervical lymph node. The increased risk of local regional recurrence, distant metastases, and decreased survival is consistently associated with extracapsular spread in cervical lymph nodes [3]. This necessitates the optimum management of the neck. The lymphatic drainage of tongue and other subsites in the oral cavity thus needs to be comprehensively studied. The lateral tongue tumour should have ipsilateral neck dissection. If the tumour is located at the midline or base of tongue, the bilateral selective neck dissection should be performed.

Under the broad banner of surgery, a number of different options are available: conventional surgery, laser surgery, thermal surgery, and photodynamic therapy (PDT). The choices of the instruments mainly depend on the surgeon's preference and the availability. Curative surgery for oral cavity cancer involves tumour resection with an appropriate safety margin and subsequent tissue reconstruction to maintain function. Selected instruments may compromise the surgical margins because of the interference with tissue architecture during dissection. Others like facial nerve monitoring if used excessively can lead to neuropraxia and nerve paralysis, which can be disabling during early post-operative recovery.

Although oncologic control remains the primary objective of oral cavity cancer treatment, the function of post-treatment for surviving patients has been recognized as an important secondary outcome over the past decades. Oral cavity defect reconstruction ranges from primary closure to advanced microvascular reconstruction, including multiple types of tissue. The ability to tailor transferred tissue to particular defects has been greatly improved by free flap reconstruction [4]. There are multiple flaps that are available for head and neck cancer reconstruction. Importantly, each of this flap carries its own advantages and disadvantages based on the anatomic profile variation. For instance, the radial forearm free flap can be harvested as flap with long pedicle vessels as the radial artery and veins can be raised according to the length required for reconstruction. Fibula free flap provides ample osteo component for reconstruction of, for example, the mandible.

Thus, great depth of knowledge of the forearm is a must so that the flap can be harvested without unnecessary complications. Meticulous surgical techniques will help with the success of the flap reconstruction. There have been other choices of better flap for oral cavity reconstruction post-tumour surgery as a result of the expansion of microvascular techniques and instrumentations [5]. The complications that may arise from flap reconstruction are critical as it may result in fistula formation, infection, leakage, etc. Thus, a watertight closure is paramount and a refined technique for repairing difficult-access areas like base of tongue and retromolar trigone is a must [6].

Due to the anatomical complexity and limited field of view of the oral cavity, oral and maxillofacial surgery (OMFS) still poses a significant challenge for surgeons. Computer-aided surgery has been widely used to minimize the risks and improve the accuracy of surgery, with the great development of computer technologies [7].

2.3.2 Pharyngeal Surgery

Most of the pharyngeal surgery commonly practised is for oropharyngeal cancer like tonsillar carcinoma (Fig. 2.19). For the hypopharyngeal cancer, most of the time the preferred treatment of choice is chemoradiation. The surgery of hypopharyngeal area is challenging as it has limited access. The adjacent structures like soft palate, tongue, epiglottis and vertebra posteriorly need to be considered during surgical approach to this region (Fig. 2.20). In addition, the surgery can also have significant sequelae on patient's function like swallowing.

For oropharyngeal cancer, the endoscopic assisted surgery can be performed for the primary tumour, together with neck dissection in indicated cases. Knowing the related surrounding structures adjacent to tonsil is very critical for a conduct of safe surgery. The carotid artery lies very close to the tonsil posterolaterally, about 1.0 cm deep. Vigorous resection and dissection may cause injury or rupture to the carotid artery with heavy bleeding.

Additionally, several other branches of arterial and venous supply are in close proximity to

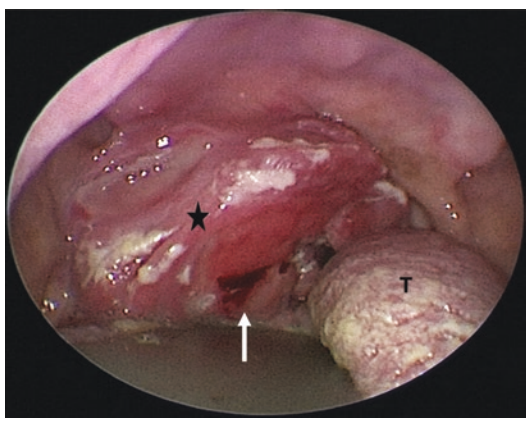

Fig. 2.19 An endoscopic examination of oral cavity and oropharynx showing a malignant mass (star) occupies the right soft palate and tonsillar region. There is minimal bleeding observed (arrow). The tongue (T) is on the left side of the view

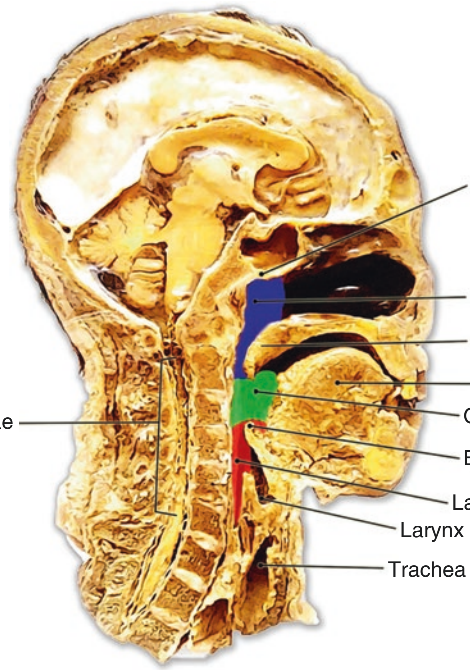

Fig. 2.20 The pharynx is divided into nasopharynx, oropharynx, and laryngopharynx. These three anatomic regions have significant relationship to anterior structures like nasal cavity, oral cavity, epiglottis, hyoid bone, and posterior structures such as the vertebrae

tonsil, which should be identified in order to prevent unnecessary bleeding intraoperatively. Imperatively, the vessel is highly useful for flap reconstruction needed in selected cases where a large of number of tissues and muscles have been resected.

Several nerves like glossopharyngeal nerves lie inferiorly to the inferior pole of the tonsil, and injury may also cause significant morbidity to patients like neuropathy and loss of functions.

The resection of the palatine tonsil deep into the pharyngobasilar fascia is a type 1 lateral oropharyngectomy (Fig. 2.21). It can include all or part of the palatoglossus arch to ensure a radical excision. The superior constrictor muscle is spared by this surgical procedure [8]. It is crucial to consider the patient's condition like presence of trismus or concomitant cervical vertebrae fractures or dislocation that may pose some difficulty for this approach. Patient's dentition may also result in unwanted complications associated with the surgery. Loosening of the tooth or presence of osteoradionecrosis may result in the increment of surgery-related morbidities.

Lateral oropharyngectomy type 2 is performed by removing the entire palatal tonsil, the muscle of the palatoglossus, the muscle of the palatopharynx, and the superior constrictor muscle (Fig. 2.22). The resection's deep limit is represented by the buccopharyngeal fascia, which covers the medial pterygoid muscle anteriorly and the parapharyngeal fat posteriorly. Assessment of adjacent structures' involvement by the tumour can be performed with MRI as it is an excellent imaging modality that delineates soft-tissue characteristics. The surgeon should be well versed with the anatomical details of pharyngeal area and highly trained in order to ensure success of the surgery.

Type 3 lateral oropharyngectomy is performed by removing the entire palatine tonsil, palatoglossus muscle, palatopharyngeal muscle, superior constrictor muscle, buccopharyngeal fascia, and parapharyngeal space fat content with extension to the pterygoid muscle. The muscles of the styloglossus and stylopharyngeus cross the dissection plane and should be fully or partially resected to ensure a safe margin from the tumour [8]. This procedure will result in more complication, especially if the patient is also a candidate for adjuvant radiation. The scarring and fibrosis from post-operative healing and induced by radiation will worsen dysphagia, impair neck movement and mastication, and so forth (Fig. 2.23).

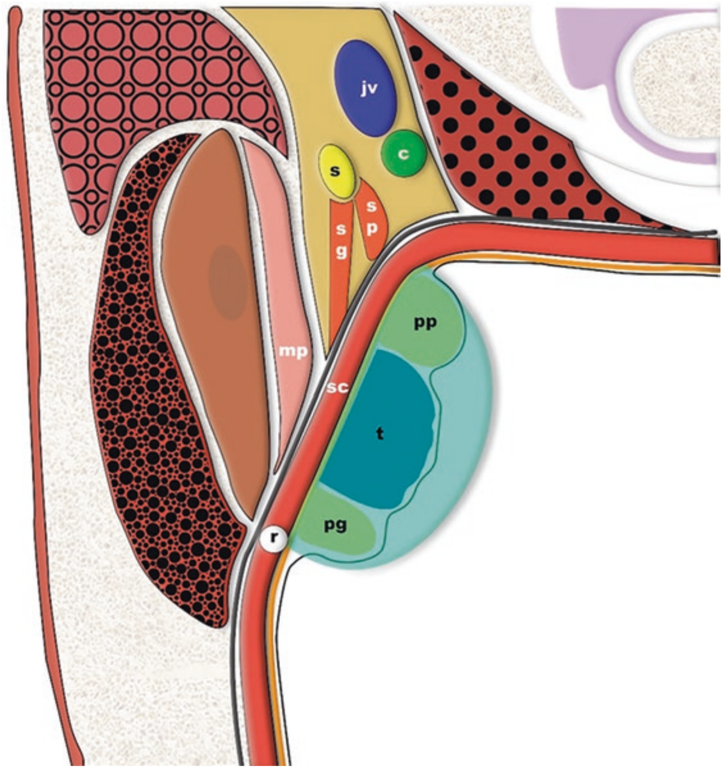

Fig. 2.21 Type 1 lateral oropharyngectomy

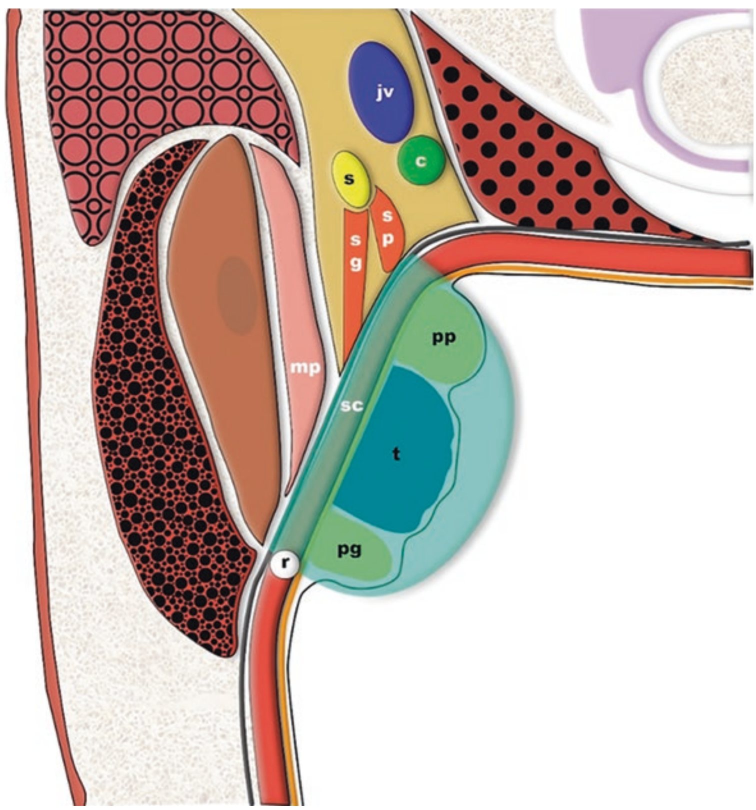

Fig. 2.22 Type 2 lateral oropharyngectomy

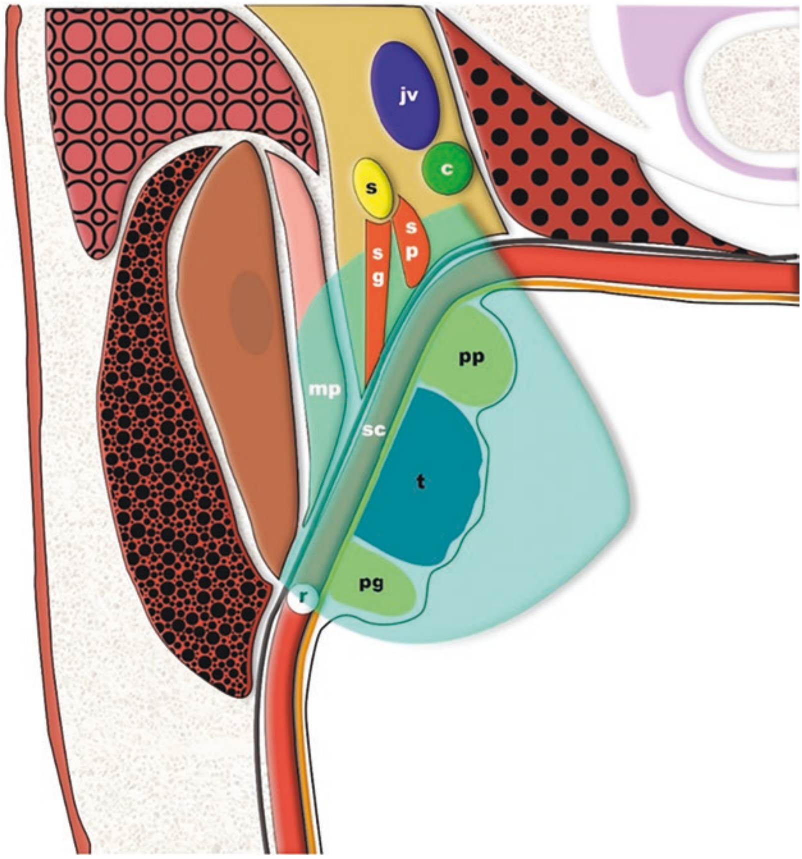

Fig. 2.23 Type 3 lateral oropharyngectomy

2.3.3 Transoral Robotic Surgery (TORS)

The application of TORS has been popularized due to the invention of a robotic system. It is a highly expensive system where a centre with good financial resource will be able to maintain and use these systems [9]. The da Vinci system is well known and has been increasingly used in the head and neck surgical oncology arena.

Minimally invasive approaches, such as transoral robotic surgery (TORS), avoid uninvolved tissue dissection and ensure safe resection without requiring an external incision of the lateral oropharyngeal wall, tongue base, and parapharyngeal tumours [10] (Figs. 2.24, 2.25, 2.26 and 2.27).

Complex transoral anatomy of the oropharynx and parapharyngeal spaces is one of the main challenges of using TORS. The inside-out anatomy of these spaces must be mastered by the robotic surgeon. Limited transoral robotic experience and poor anatomical understanding can cause significant morbidities [10]. Additionally, the issues of obstruction of the visual field and instrument collision are frequently encountered in the setting of TORS [9].

The lateral oropharyngeal wall, based on the styloid muscle diaphragm, was divided into three layers, from medial to lateral. The tonsillar vascularization and the lingual branch of the glossopharyngeal nerve are included in the first layer, medial to styloid muscles. The pharyngeal venous plexus, the glossopharyngeal nerve, and the lingual artery comprise the second layer, which is lateral to constrictor muscles. The third layer includes the parapharyngeal and submandibular

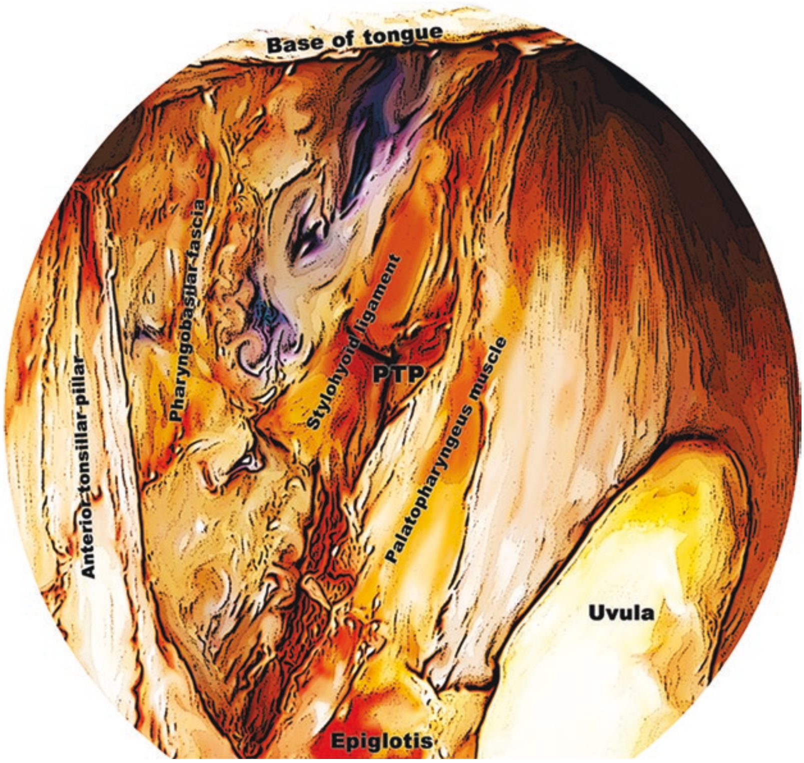

Fig. 2.24 The view of tonsillar fossa after tonsillectomy. *ATP* anterior tonsillar pillar, *BOT* base of tongue, *PTP* palatopharyngeal muscle, *U* uvula. Dotted line, palatopharyngeus muscle; dashed line, stylohyoid ligament; star, pharyngobasilar fascia

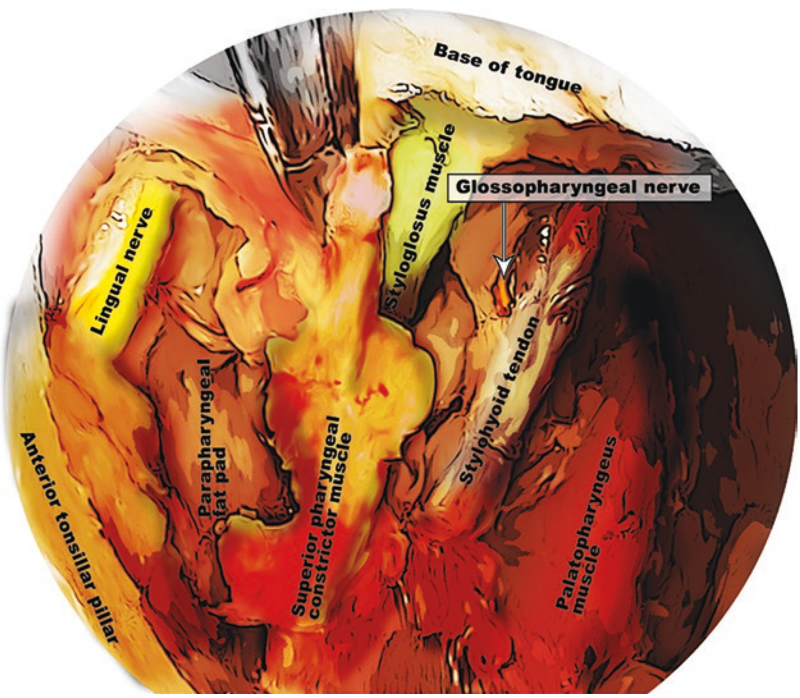

Fig. 2.25 The transoral view of the left parapharyngeal space and its content after resection of pharyngobasilar fascia. *IX* glossopharyngeal nerve, *PFP* parapharyngeal fat pad, *SGM* styloglossus muscle, *U* uvula

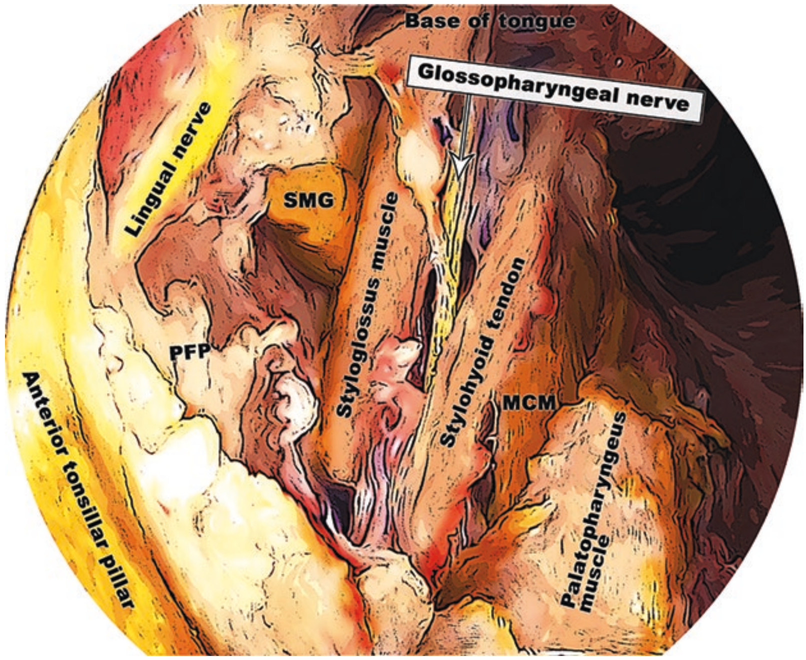

Fig. 2.26 The view of the deep parapharyngeal space after resection of the superior constrictor pharyngeus muscle and partial removal of the parapharyngeal fat pad. *IX* glossopharyngeal nerve, *MCM* median constrictor pharyngeus muscle, *PFP* parapharyngeal fat pad, *SMG* submandibular gland

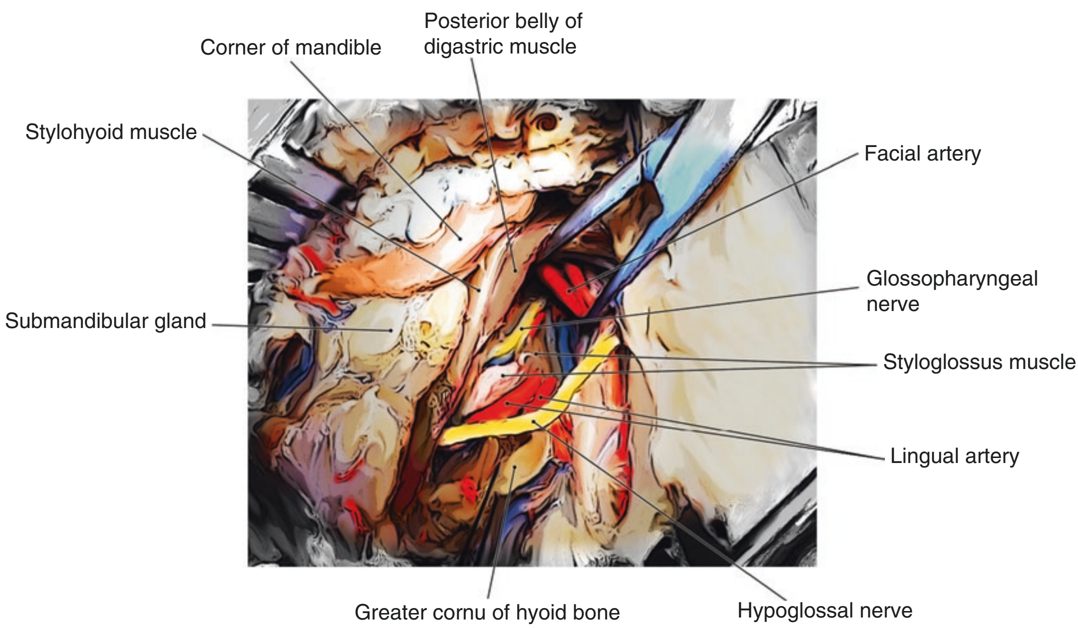

Fig. 2.27 Parapharyngeal structures at the level of tonsillar fossa from the lateral aspect of the neck. Stylohyoid muscle; posterior belly of digastric muscle; facial artery; submandibular gland

spaces, the carotid vessels, and the nerves of the lingual, vagus, glossopharyngeal, and hypoglossal, lateral to styloid diaphragm. The central and lateral parts containing the lingual artery and lingual branches of the glossopharyngeal nerve are divided into the base of the tongue [11].

Inside the tongue base, major neurovascular structures are placed laterally and deeply. Intrinsic and genioglossus muscle dissection is safe because on the lateral surface of the genioglossus muscle, covered by the hyoglossus muscle, the main trunk of the lingual artery lies. Lying on the external surface of the hyoglossus muscle, the hypoglossal nerve, with its concomitant vein, is more lateral [12]. Importantly, the location of the lingual artery was dramatically altered with tongue retraction in reference to the measured surface landmarks. The branches of the dorsal lingual artery were not found posterior to a horizontal line between the midway circumvallate papillate with retraction [13].

2.4 Laryngeal Surgery

Laryngeal surgery is always challenging as it is involved with airway manipulation. Airway manipulation in either way can result in serious airway obstruction and death, if not properly managed due to, for instance, significant airway oedema. Many instruments and endoscopes are required for a proper assessment of any airway pathologies (Figs. 2.28 and 2.29). A committed and strong cooperation with the anaesthetist is crucial for the conduct of a safe airway surgery. The requirement of endoscopes, intubation, and suction portal will narrow the access to control the airway efficiently. Thus, a surgeon needs to be well versed with the handling of endoscopes and other instruments to facilitate a safe and efficient surgery.

Laryngeal cartilages have intimate relationship with oesophagus, thyroid cartilage, carotid artery, IJV, and important nerves like recurrent laryngeal

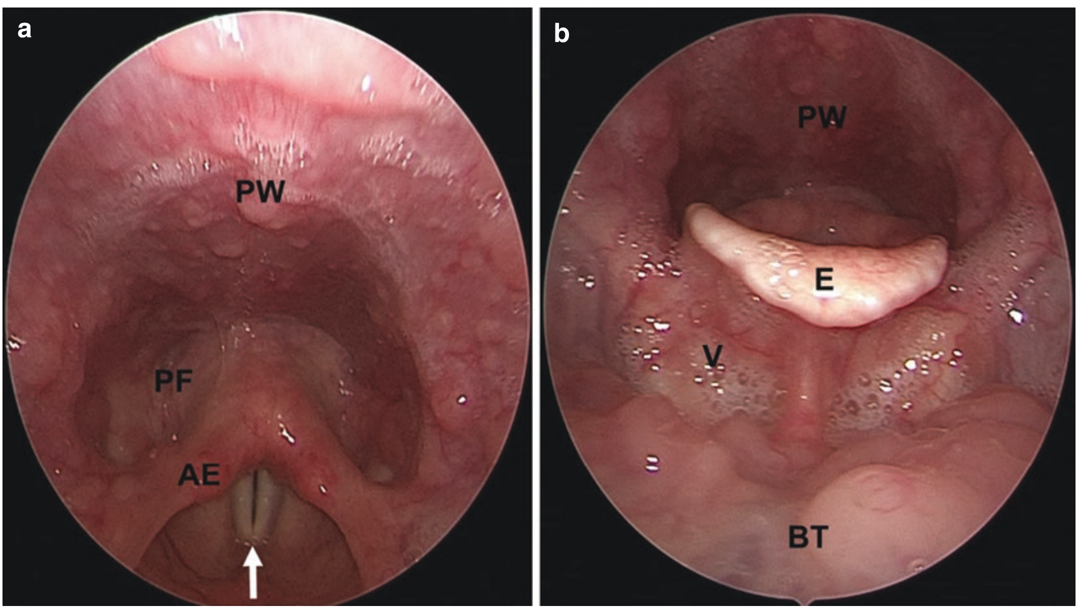

Fig. 2.28 (**a**, **b**) Endoscopic view of the larynx shows normal laryngeal structures like epiglottis (E) and aryepiglottic fold (AE). Other critical adjacent structures like valleculae (V), pyriform fossa (PF), posterior pharyngeal wall (PW), and base of tongue (BT) can also be assessed

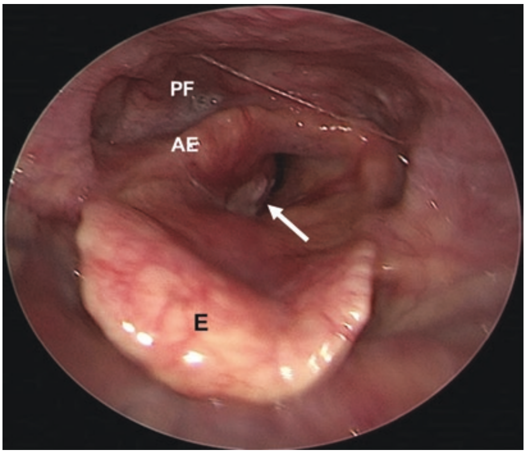

Fig. 2.29 An ulcerative white lesion (arrow) of the right vocal cord. This is proven to be a glottic carcinoma on the histopathological examination. The right vocal cord is fixed, which signifies a T3 tumour

Fig. 2.30 Markings of landmarks are critical during the surgery. This is a case planned for a laryngectomy where the incision site, thyroid notch, and stoma site have been identified

nerve. All of these important structures have significant functions and, if injured during surgery, can result in detrimental sequelae that can impair the patient's quality of life post-operatively.

There are different types of laryngeal surgery that necessitate, for example, the surgical removal of the epiglottis alone or in combination with structures like thyroid cartilage. Thus, knowledge of the anatomy of these adjacent structures and neurovascular supply to each of these structures is vital. Total laryngectomy, on the other hand, will involve the resection of trachea, construction of pharynx, and neck dissection. The surface anatomy of the neck is critical for the identification of structures, for example, during designing a skin incision for a laryngectomy case (Fig. 2.30). This again will require great anatomy knowledge and details of these structures involved and their vascular supply, innervation, and lymphatic drainage.

2.5 Nasal Cavity and Nasopharyngeal Surgery

Nasal cavity can be the origin of many important pathologies such as polyposis, benign tumour such as inverted papilloma or juvenile nasoangiofibroma (JNA), and malignancy like squamous carcinoma and lymphoma (Figs. 2.31, 2.32, and 2.33). Nasopharynx is the origin of nasopharyngeal carcinoma, which is highly prevalent in geographic areas like Southeast Asia, South China, Hong Kong, Japan, and Korea [14]. The tumour originates from the fossa of Rossenmuller, a groove posterior to the eustachian tube opening at the nasopharynx region.

The anatomy of osteomeatal complex and sinuses is critical as endoscopic surgery is commonly performed in this narrow area with the application of many surgical instruments. Aggressive and higher stage tumour mandates surgical excision via an external approach like maxillectomy. Total maxillectomy has a significant impact on patient aesthetics and functions, which needs to be properly addressed by surgeons, so that the treatment outcomes are optimal and quality of life is maintained. Nasopharyngeal carcinoma patients has a tendency for neck nodes metastasis (Figs. 2.34 and 2.35). The majority of these nasopharyngeal carcinoma patients will be treated with chemoradiation.

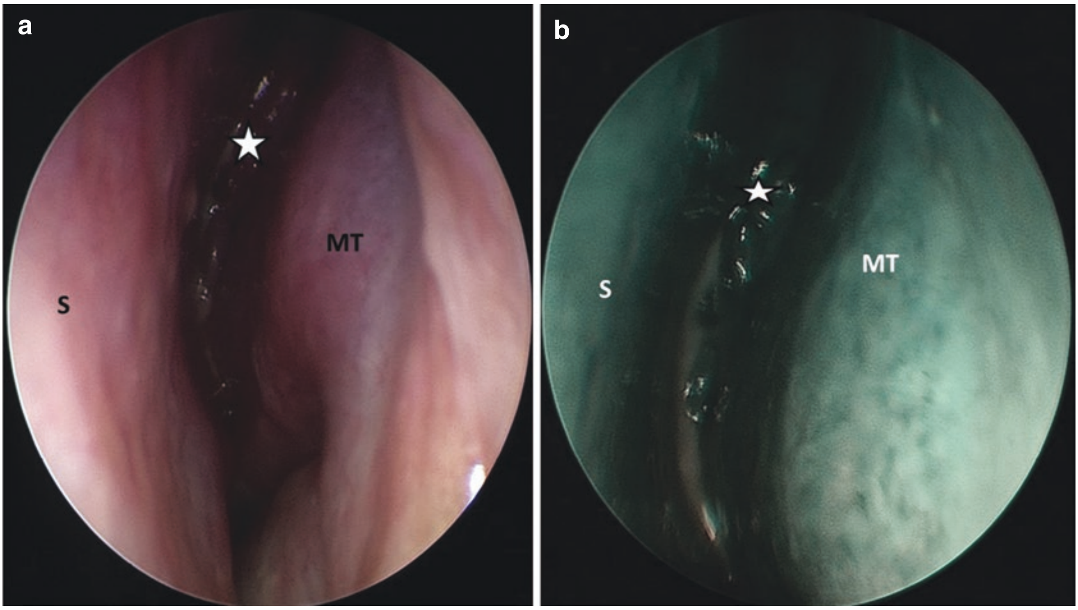

Fig. 2.31 (**a**, **b**) The nasal endoscopy of right nasal cavity showed a normal structure of middle turbinate (MT) and septum (S)

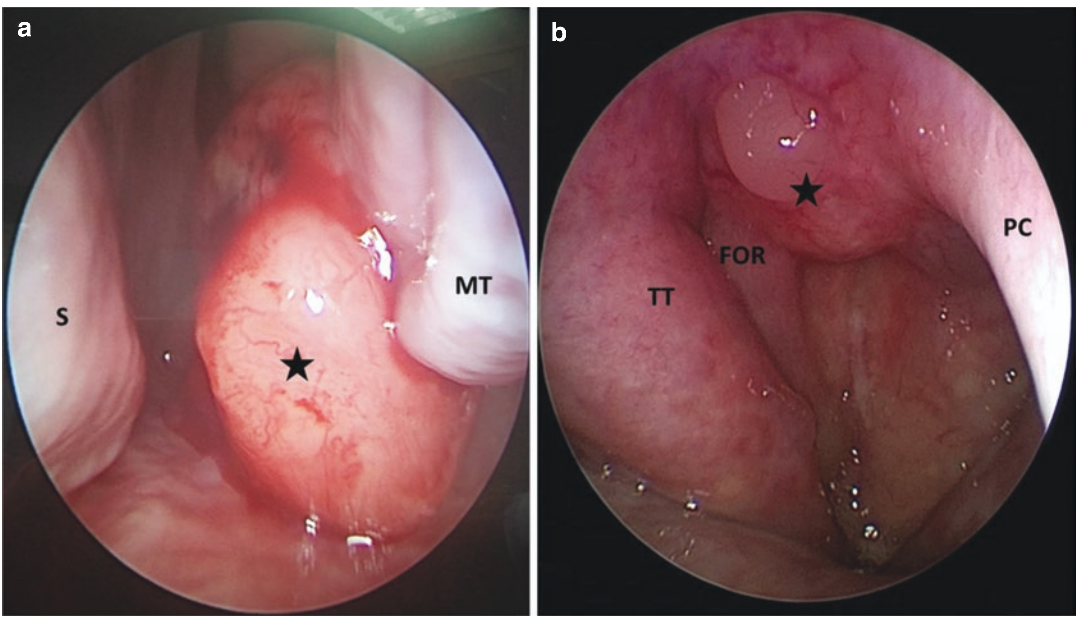

Fig. 2.32 (**a**, **b**) The nasal endoscopy showed tumoural mass arising from the right middle turbinate (MT). This tumoural mass is mildly vascularized and hyperaemic. There is mucosal mass at the left posterior pharyngeal wall (star) abutting the fossa of Rosenmuller (FOR), which is located posterior to the torus tubarius (TT). The end of septum is the region of posterior choanae (PC)

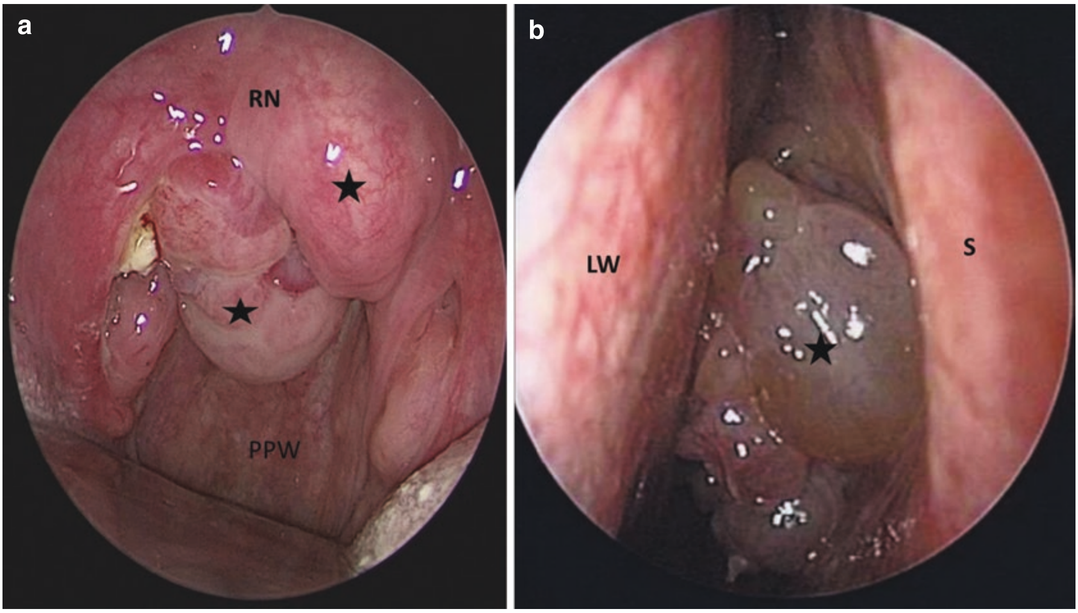

Fig. 2.33 (**a**, **b**) An endoscopic view showed an extensive mass (stars) arising from the posterior pharyngeal wall (PPW)

Fig. 2.34 The appearance of neck metastases (arrow) from the nasopharyngeal carcinoma in a young Chinese lady

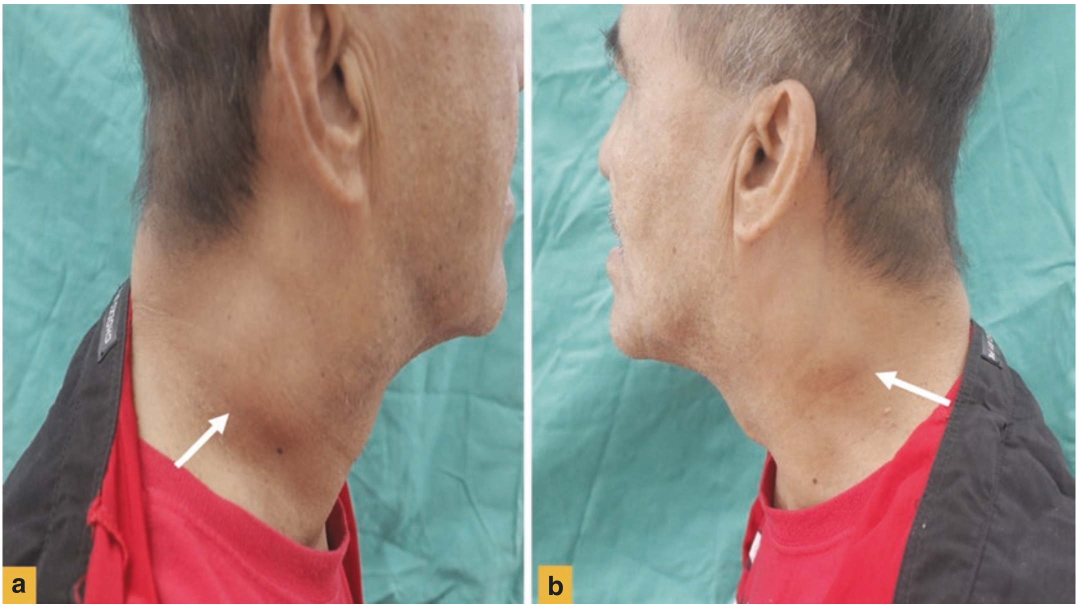

Fig. 2.35 (**a**, **b**) Multiple neck metastases are visualized on an elderly Malay male patient with nasopharyngeal carcinoma

2.6 Salivary Gland Surgery

Salivary glands comprise parotid glands, submandibular glands, and sublingual glands. Most of the surgery involves the parotid glands, i.e. parotidectomy, and the submandibular glands, i.e. submandibulectomy. Most of the pathology affecting the glands is pleomorphic adenoma.

Parotid glands are closely related to facial nerve, which runs between the superficial lobe and deep lobe of parotid glands. The identification and preservation of facial nerve are very important in parotidectomy so that facial asymmetry and persistent facial disfigurement can be avoided. This is especially true for the surgery of parotid, i.e. superficial parotidectomy for pleomorphic adenoma (Fig. 2.36). Thus, a complete facial nerve examination (Fig. 2.37) need to be performed preoperatively in every parotid cases going for parotidectomy.

The landmarks for identification of facial nerve in parotid surgery include

1. Tragal pointer
2. Posterior belly of digastric
3. Tympanomastoid suture

The peripheral branches of facial nerve need to be identified and preserved in all benign operated cases of parotid gland tumour. The injury and oedema induced during surgery can causes nerve paresis with the resultant functions like lid closure, blowing of cheek, and drinking fluids. Impairment of nerve functions will result in significant deterioration of patient's daily function and, hence, impair the quality of life of these patients. There are other

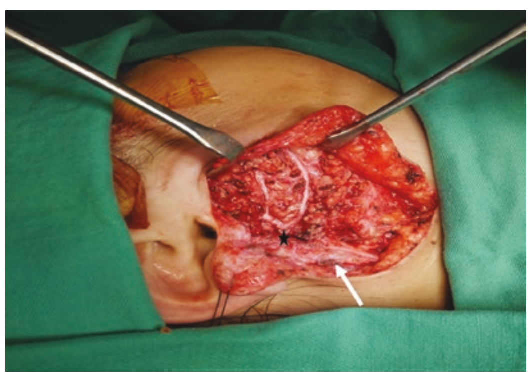

Fig. 2.36 In parotid gland surgery, the identification and preservation of the facial nerve trunk and its branches are crucial for good treatment outcomes and patient's quality of life

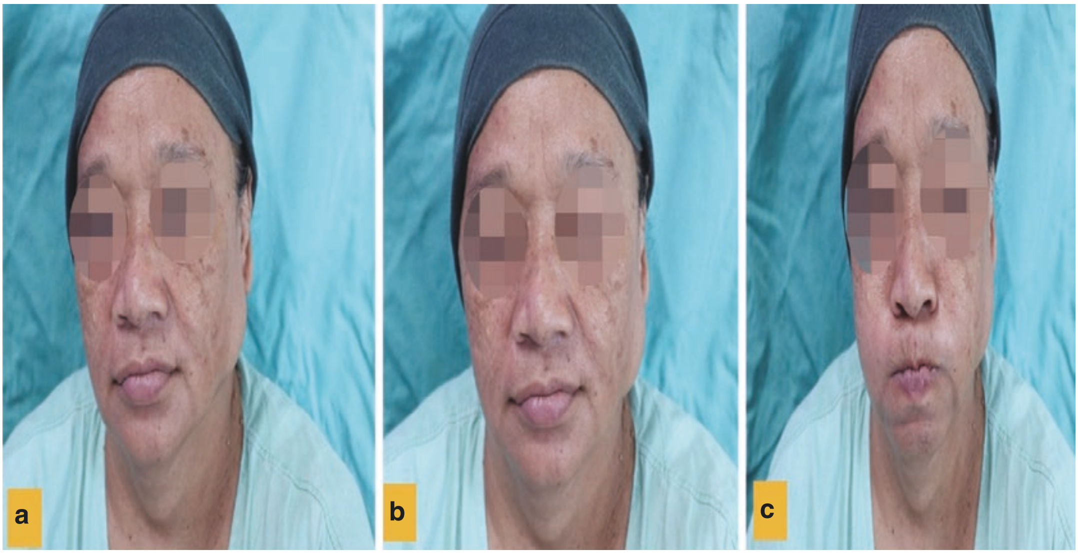

Fig. 2.37 Assessment of facial nerve and its function is critical before embarking on the parotidectomy. This includes the upper branch that supplies the orbicularis oculi and the buccal branch that supplies the buccinator muscle. (**a**) Preoperative facial nerve function should be assessed in all cases going for parotidectomy. (**b**) The upper temporozygomatic branch is intact. (**c**) Buccal branch is intact

critical complications from the parotid gland's surgery, e.g. Frey's syndrome and retromandibular depression.

Frey's syndrome is characterized by involuntary sweating, pain, and discomfort at the region of parotid bed due to the reinnervation of parasympathetic parotid glands to the sweat glands of the skin. The majority of patients do not report this symptom, unless more objective test like a Minor starch iodine test is carried out. Alternatively, the sternomastoid muscle lies inferolateral to parotid glands and can be used to prevent complications of Frey's syndrome. It can be harvested during the same surgery and rotates superoanteriorly to cover the surgical defect. By doing this, the flap will prevent reinnervation of the parasympathetic fibres. Additionally, this rotational flap will reduce the retromandibular depression that causes significant cosmesis embarrassment post-surgery (Fig. 2.38).

Submandibulectomy entails removal of the submandibular gland. In order to safely remove the submandibular glands, the adjacent structures also need to be addressed. The marginal mandibular nerve lies on the submandibular gland capsule. The facial artery and vein, which need to be ligated, lie deep to the glands. In addition, at the medial part of the glands, the hypoglossal nerve and the lingual nerve lie below the mylohyoid muscle and are at risk of injury. The submandibular mass can be malignant like lymphoma (Figs. 2.39 and 2.40) or benign pleomorphic adenoma (Fig. 2.41). The principle of surgery is similar, with a subplatysma flap elevation an dissection of the mass and preservation of neurovascular structures (Figs. 2.42, 2.43, and 2.44).

Fig. 2.38 Post-parotidectomy scar is visible at the neck region. Minimal retromandibular depression is also evident in both patients. These are some of the complications in patients who underwent parotid gland surgery

Fig. 2.39 There is an ulcerative mass overlying the anterior mandible and level Ib (arrow)

Fig. 2.40 The mass causes left marginal mandibular nerve paresis as evident by loss of depression of left lower lip. This signifies that it is a malignant mass

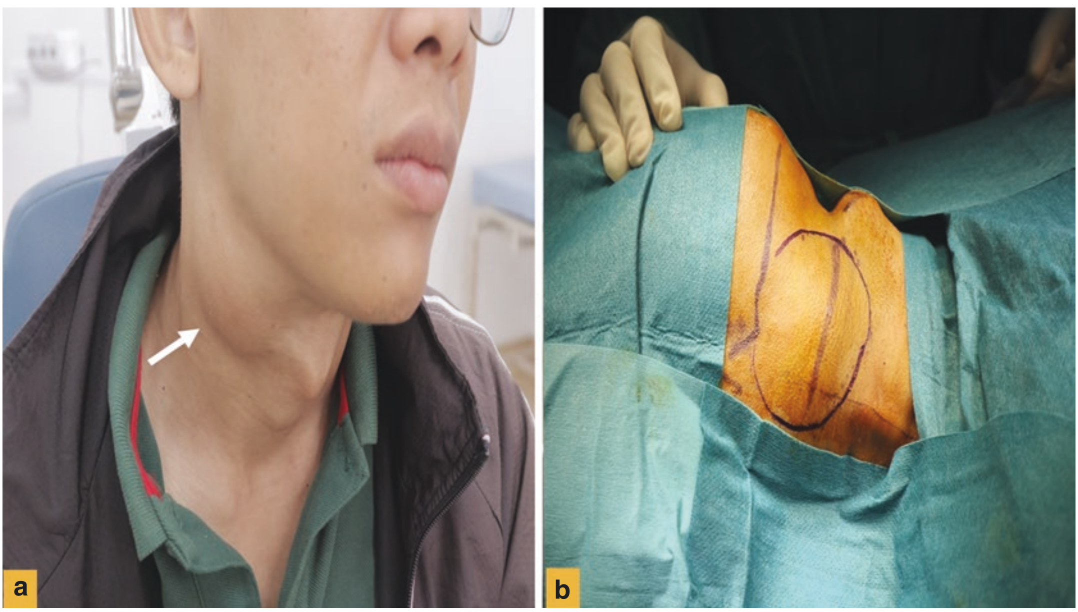

Fig. 2.41 This is a young male with a right submandibular gland's benign tumour, pleomorphic adenoma (**a**), which necessitates a submandibulectomy (**b**) for this patient

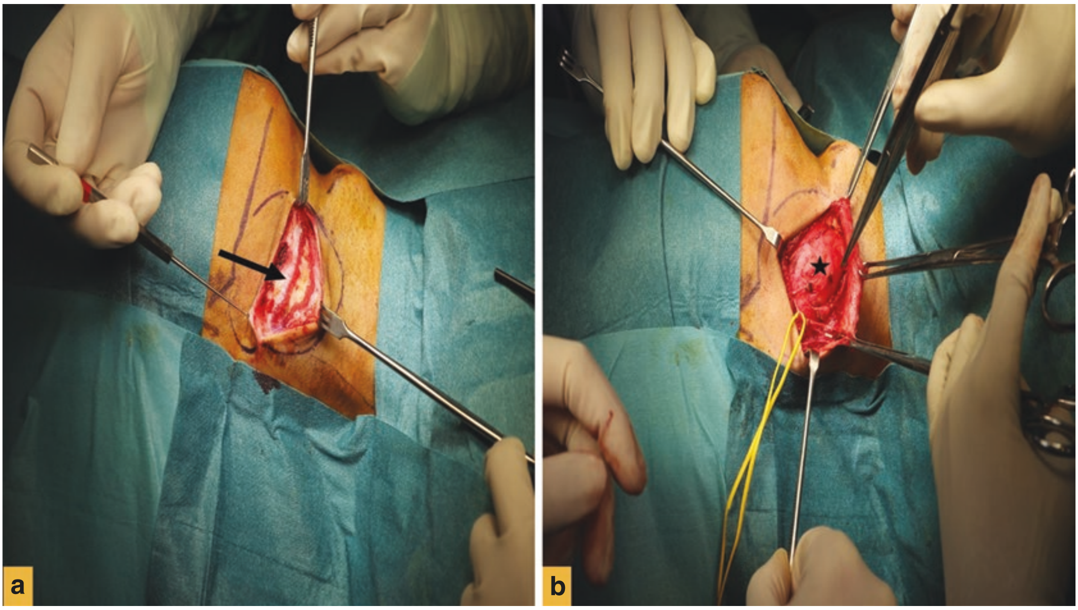

Fig. 2.42 During a submandibulectomy, a subplatysmal skin flap is raised. The platysma muscle is evident (arrow) as in (**a**). The submandibular mass (star) is visualized in (**b**)

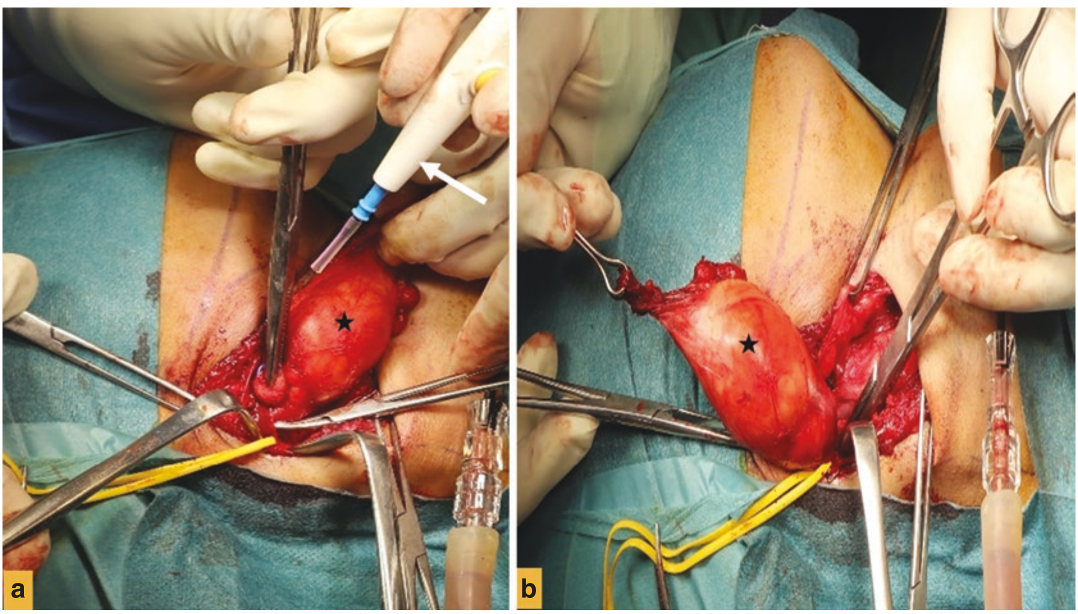

Fig. 2.43 The submandibular mass (star) is retracted and dissected (**a**, **b**)

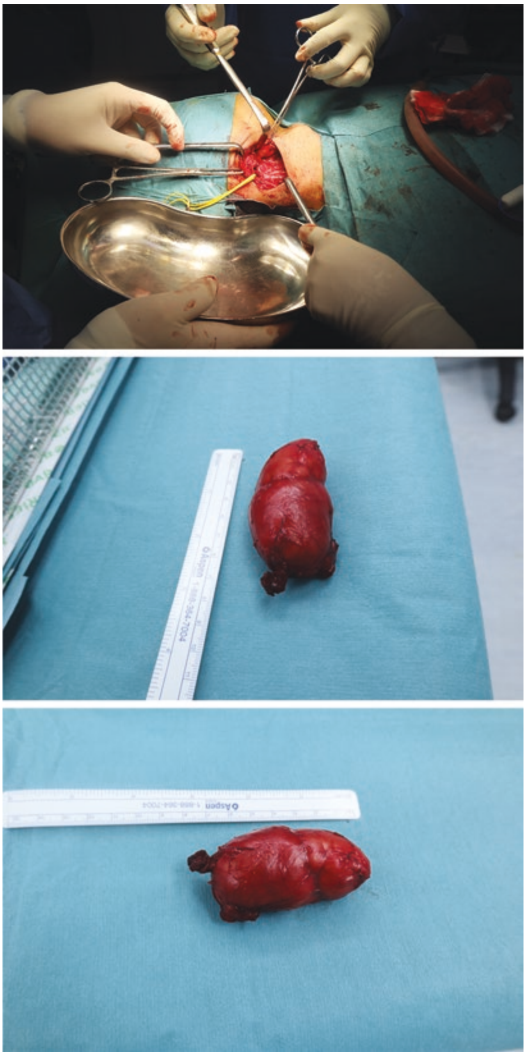

Fig. 2.44 The mass has been removed, and the surgical defect is visible as in the photograph

2.7 Thyroid Gland Surgery

Thyroid surgery can now be performed today with a mortality that varies little from the risk of general anaesthesia alone. Unfortunately, decades later, complications still do occur. To obtain excellent results, surgeons must have a thorough understanding of the anatomy of head and neck and pathophysiology of thyroid disorders. They should be well versed in the preoperative and post-operative care of patients; have a clear knowledge of the anatomy of the neck region; and use an unhurried, careful, and meticulous operative technique. Like in any head and neck surgery, surgeons operating by a clock have no place in thyroid surgery. A meticulous and organized approach is mandatory [15].

The importance of anatomical structures and its relationship in the thyroid gland surgery is for the identification and preservation of the recurrent laryngeal nerve and parathyroid glands. The Zuckerkandl tubercle (ZT) is a lateral projection from the lateral thyroid lobe that during thyroid surgery is a constant landmark for finding the recurrent laryngeal nerve. Located in the cricothyroid junction, it is the condensed thyroid parenchyma [16]. In most cases, the Zuckerkandl tuberculum was identified, with prevalence to the right. Its identification has made it possible to identify the recurrent laryngeal nerve immediately and safely, setting the time of the operation and, in particular, the possible injury to the recurrent nerves [17].

A classification system with 37% of the nerves crossing the superior thyroid pedicle within 1 cm of the superior thyroid pole was defined by Cernea et al. (type 2). More recently, 1057 SLNs studied at the time of thyroidectomy were analysed by Friedman et al. They suggested a classification system with three anatomical variations, including type 1 with the nerve running superficially to the lower constrictor muscle, type 2 with the nerve penetrating the lower part of the lower constrictor, and type 3 with the nerve penetrating the upper part of the lower constrictor muscle and remaining covered by the muscle on its course to the cricothyroid muscle [18].

Total thyroidectomy is performed with anelevation of sublatysma skin flap, lateralize/cut on the strap muscle, dissection of the mass with preservation of the recurrent laryngeal nerve, and exposure and preservation of trachea and cartilages (Figs. 2.45, 2.46, 2.47 and 2.48). The parathyroids must be identified from a surgical point of view and preserved with an intact blood supply. The plane of dissection along the thyroid capsule is used for medial-to-lateral dissection. In the usual locations, the parathyroids are identified. They are seen with a yellow tan to caramel colour as tiny bean-shaped structures. This medial-to-lateral dissection, while preserving the blood supply, allows identification and mobilization away from the thyroid [18]. Robotic thyroid surgery is a relatively new technique that provides the patient with the aesthetic advantage of a surgery without a scar in the anterior cervical region. The use of this technique, however, forces the surgeon to view the anatomy from a different

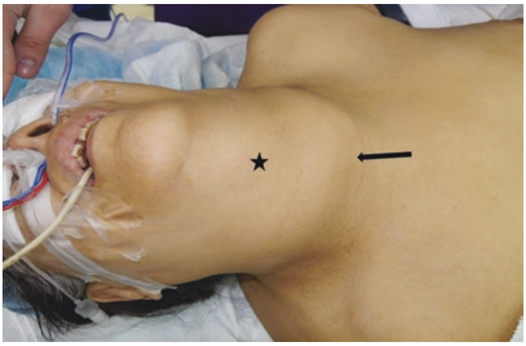

Fig. 2.45 A malignant thyroid tumour in a young lady planned for a total thyroidectomy

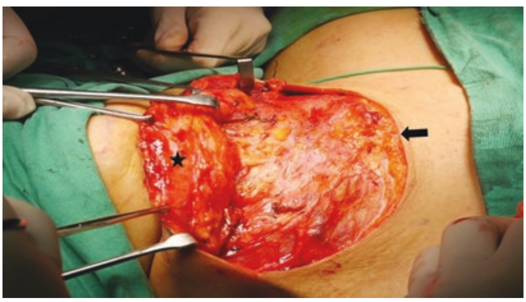

Fig. 2.46 A collar skin incision is performed, and the subplatysmal skin flap (star) is raised superiorly

Fig. 2.47 After removal of the thyroid mass, the tracheostomy tube needs to be secured as preoperatively there is presence of vocal cord palsy. With manipulation during the surgery on the recurrent laryngeal nerve, there is risk of bilateral vocal cord paresis with an airway obstruction

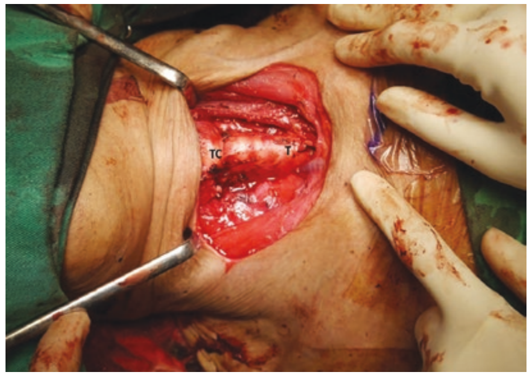

Fig. 2.48 Post-thyroidectomy, the tracheal ring (T) and thyroid cartilage (TC) are visualized

vantage point, concomitantly providing the surgeon with a challenge with respect to dissection and sound oncologic ablation [13].

2.8 Neck Dissection

Neck dissection is a critical surgery in the head and neck surgical oncology arena. Most of the head and neck tumours will have neck involvement at certain stages of the tumour management. It is very important to have a thorough understanding of the anatomical structures of the neck and critical landmarks that can be used as a guide during clinical assessment, procedure, and surgical dissection.

Critically, the status of neck lymph nodes remains the single most important prognostic factor, in these cases. The management of neck metastases has evolved over the years. This has ultimately led to the conservative approaches of selective neck dissections depending on the primary site of the tumour, type of tumour, and characteristic features of the metastases themselves [19]. The neck is divided according to triangles and also the neck node levels. The classification of the triangle is crucial for the knowledge of details of structures and its neurovascular supply. The neck node level is important for a proper planning of types of surgical intervention. Particularly relevant is the lymphatic drainage to the neck node level, from the primary anatomic region. Different subsites of anatomic region will drain to different areas of the neck, which trans-

Fig. 2.49 A cadaveric dissection specimen showed critical structures in the neck including the omohyoid muscle, common carotid artery (CCA), internal jugular vein (IJV), spinal accessory nerve (SAN), and sternocleidomastoid muscle (SCM)

lates to the different areas of neck metastases. The better understanding of the lymphatic drainage of head and neck region by Rouviere et al. made it possible to predict the pattern of lymphatic drainage in a cancer involving a particular region, and neck dissections thus became more and more conservative and selective [15].

Neck dissection is classified based on which neck node level is removed during surgery. The surgical step is performed in a way that is in reference to a specific point or surgical landmarks. The correct landmarks are critical to ensure an optimum clearance of the tumour and its risk areas of micrometastatic deposits. For instance, the landmark in the posterior triangles is the Erb's point where the greater auricular nerve exits at the posterior border of sternocleidomastoid muscle. The spinal accessory nerve enters the posterior triangles approximately 2.0 cm above the Erb's point [20]. This landmark is used during neck dissection in order to identify and preserve the SAN (Fig. 2.49).

Salvage neck dissection is necessary in selected cases of recurrent tumour. This poses surgical difficulty as the normal anatomical pattern has been disturbed due to the fibrosis post-surgery or due to chemoradiation. In order to limit significant morbidity from a comprehensive neck dissection that is commonly employed for recurrent tumour, some cases can be addressed safely with selective neck dissection. This is especially true if recurrent neck metastases are single, small in size, and located at one level only. Although a comprehensive neck dissection like modified radical neck dissection (Fig. 2.50) has been the standard treatment for individuals with recurrent or persistent neck disease following chemoradiation, there is growing evidence that most patients can be effectively treated with a selective neck dissection [21].

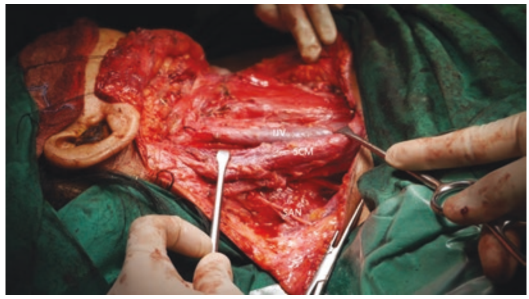

Fig. 2.50 Post left modified radical neck dissection with spinal accessory nerve (SAN), internal jugular vein (IJV), and sternocleidomastoid (SCM) is preserved

2.9 Ear and Temporal Bone Surgery

Temporal bone surgery and middle-ear surgery are challenging due to close relationship with the facial nerve. Facial nerve runs in the middle ear at the medial wall before passing through to the stylomastoid foramen and entering the parotid gland. The mastoid segment of the nerve runs in a line starting from fossa incudis where short process of incus lies to the anterior end of the digastric ridge. Because the facial nerve follows a fairly predictable path within the temporal bone, unintentional injuries are uncommon in skilled hands [22].

A refined surgical technique is thus necessary for a safe surgery and minimizing the complications to the middle ear and adjacent structures (Figs. 2.51, 2.52 and 2.53).

2.9.1 Paediatric Surgery

Paediatric head and neck surgery is technically demanding due to multiple critical factors that need a careful consideration. Generally, paediat-

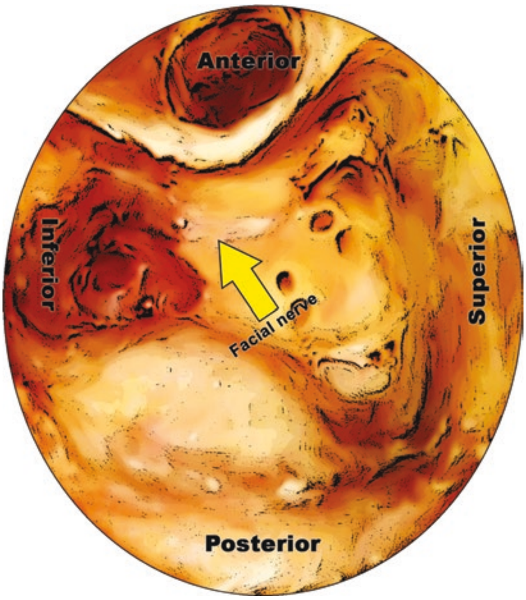

Fig. 2.51 During mastoidectomy, identification of facial nerve (arrow) as it runs in the temporal bone is critical. This avoids inadvertent injury to the facial nerve during dissection

ric head and neck anatomy is significantly different to the adult anatomy. The laryngeal cartilages have different sizes, location, angulation, and other characteristics. The epiglottis and trachea are different in shape and size, which influences the detailed techniques of the surgery. The nerves such as facial nerve are also located more superficially in the neck in contrast to the adult facial nerve. The colour of facial nerve in a child is not as white as in an adult. This makes identification of the nerve difficult during the parotid gland's surgery. All these factors need to be considered by surgeons when managing paediatric head and neck tumour pathology in order to ensure an efficient and safe surgery.

Many innovative techniques have paved the way for the development of paediatric head and neck surgery as a specialty, including endoscopic diagnosis and minimally invasive treatment of piriform sinus fistula, ultrasound-guided intervention of vascular malformation, and oesophageal repair and reconstructive surgery [23]. The

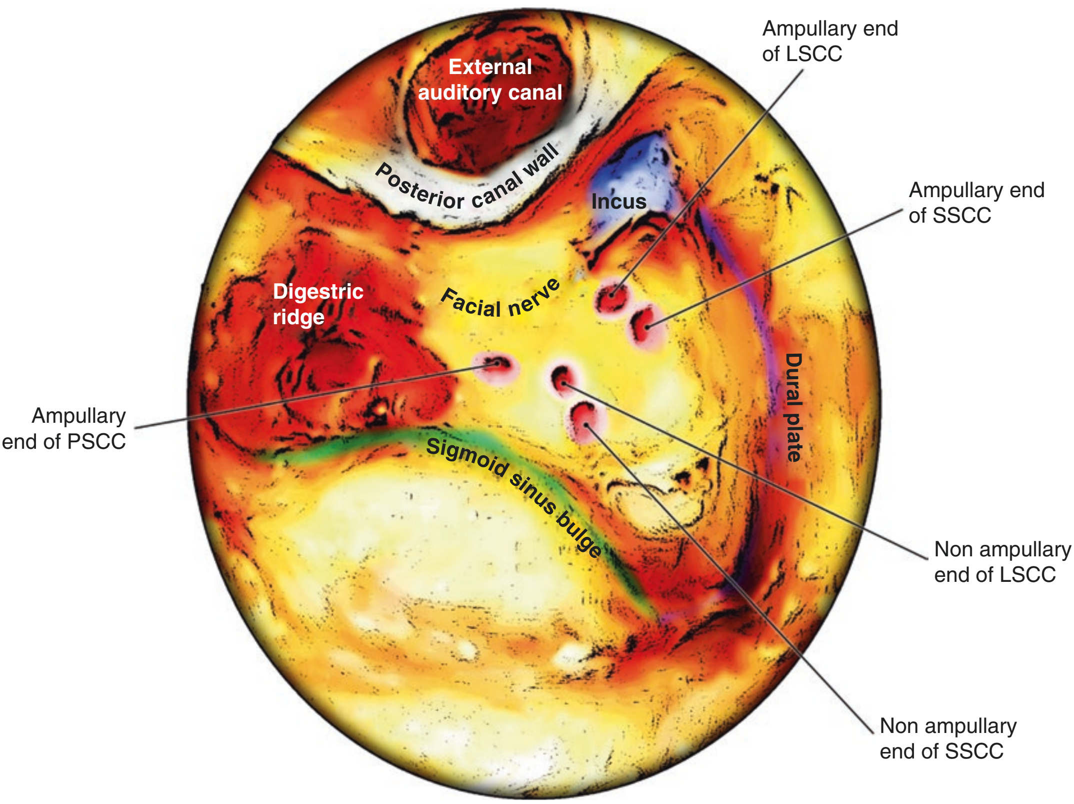

Fig. 2.52 The critical surgical landmarks during the mastoidectomy include the semicircular canal, sigmoid sinus, digastric ridge, incus, and posterior canal wall

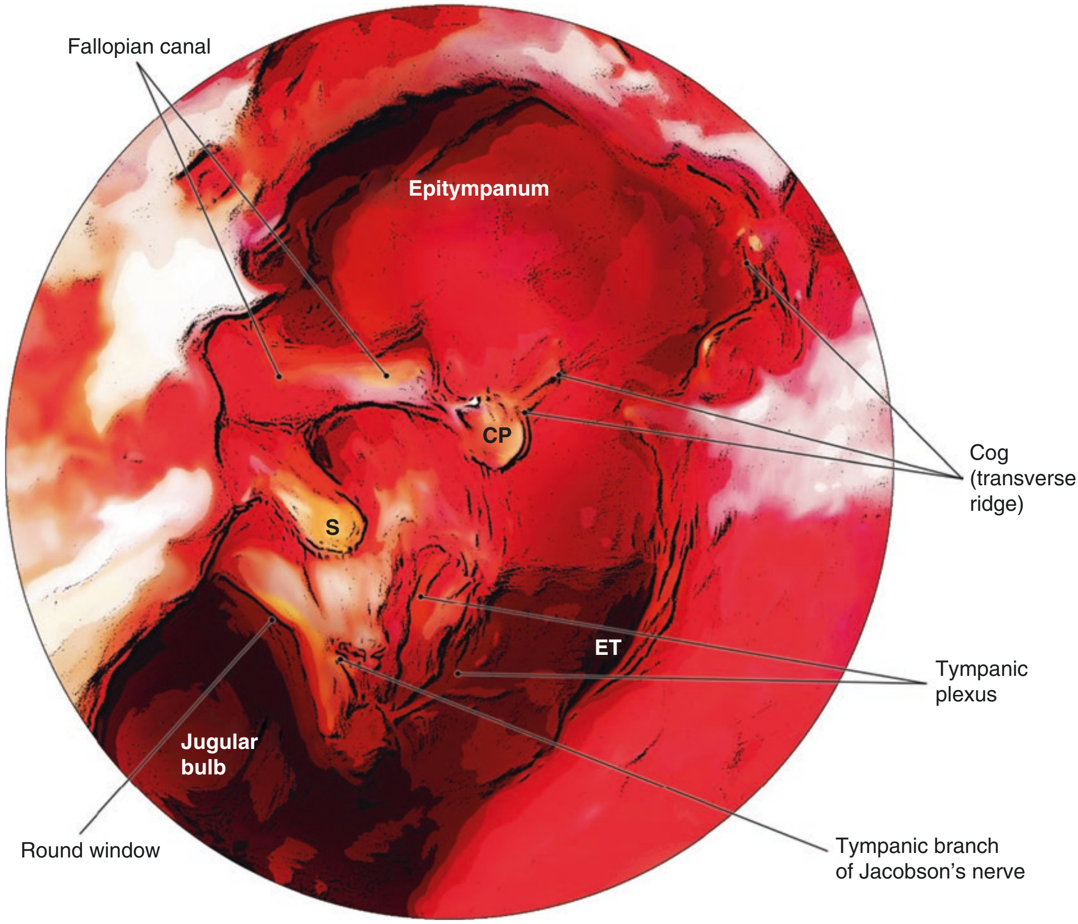

Fig. 2.53 The knowledge of anatomical details of structures in the middle ear and adjacent structures is crucial for the conduct of a safe surgery

multidisciplinary team approach to the management of head and neck diseases in children has also been advocated in an attempt to maximize patient benefits with minimum costs.

2.10 Anatomical Versus Surgical Landmarks

Anatomical knowledge of the head and neck region is crucial in ensuring the performance of good surgery. Surgical landmarks play a vital part during dissection and extirpation of specific structures and organs. In some tumour cases, the adjacent structures should be preserved, whereas in case of malignant tumour, the adjacent structures that are affected by the tumour should be sacrificed [24]. This is important to achieve better oncological outcomes in the management of malignant tumour.

2.11 Techniques of Dissection

Dissection is a critical part for ensuring a safe surgery without causing any complications. This requires a complete set of required instruments as well as proper setting of the OT facilities, staffs, and attending assistants. The available instruments should be in the best form and functioning well, in order to reduce operative time. The skills of dissection can be enhanced with multiple methods, and more procedures are performed. Attendance in head and neck surgery hands-on workshop will be able to facilitate the skills and knowledge of junior head and neck surgeons.

Imperatively, the skill of the operating surgeon together with the thorough knowledge of the cases with reference to critical structures that need to be addressed during surgery is fundamental for ensuring optimal treatment outcomes. For young junior surgeons, a repeated practice such as during cadaveric dissection programme will help to enhance the surgical skills and improve the anatomical knowledge of that specific surgery. Training session in a high-volume centre with the availability of expertise further improves the dissection skill. A refined skill is necessary especially if head and neck surgeons also practise flap reconstruction for head and neck oncology cases.

2.12 Pearls and Pitfalls of Head and Neck Surgery

There are many approaches and surgical techniques that are available for a specific type of surgery. To choose which one is the best will depend on several criteria. This includes the expertise of the practising surgeon, the availability of instruments necessary for the procedures, the assistant nurse, and the committed cooperation from another related team, e.g. anaesthetist, medical, cardiothoracic, and plastic reconstructive.

Other crucial points that need to be considered include the clinician's knowledge of the cases, the patient's perception of his or her illness and the necessary treatments, a proactive resident, and trainees in the programme. The communication that exists among the managing team is essential in ensuring the success of the managed cases.

It is understood without saying that a thorough knowledge of the anatomical and surgical landmarks in combination with a refined surgical skill is a prerequisite for a safe and successful surgery.

2.13 Conclusion

Being well versed with the head and neck anatomy and surgical landmarks allows a surgeon to perform the surgery effectively. The experience of surgeons, availability of instruments, and a dedicated multidisciplinary team and staffs are pivotal in determining the success of any surgery. Patient's quality of life can be improved if the morbidities from the surgery can be minimized. This requires a diligent surgeon, effective communications, a refined treatment plan, as well as supportive family members.

References

1. Miller MC, Goldenberg D. Do you know your guidelines? Principles of surgery for head and neck cancer: a review of the National Comprehensive Cancer Network guidelines. Head Neck. 2017;39:791–6. wileyonlinelibrary.com. https://doi.org/10.1002/hed.24654.
2. Petrovic I, Ahmed ZU, Huryn JM, et al. Oral rehabilitation for patients with marginal and segmental mandibulectomy: a retrospective review of 111 mandibular resection prostheses. J Prosthet Dent. 2019;122(1):82–7. https://doi.org/10.1016/j.prosdent.2018.09.020.
3. Kerawala C, Roques T, Jeannon JP, Bisase B. Oral cavity and lip cancer: United Kingdom National Multidisciplinary Guidelines. J Laryngol Otol. 2016;130(S2):S83–9. https://doi.org/10.1017/S0022215116000499.
4. Pipkorn P, Rosenquist K, Zenga J. Functional considerations in oral cavity reconstruction. Curr Opin Otolaryngol Head Neck Surg. 2018;26(5):326–33. https://doi.org/10.1097/MOO.0000000000000474.
5. Patel UA, Hartig GK, Hanasono MM, Lin DT, Richmon JD. Locoregional flaps for Oral cavity reconstruction: a review of modern options. Otolaryngol Head Neck Surg. 2017;157(2):201–9. https://doi.org/10.1177/0194599817700582.
6. Crosetti E, Caracciolo A, Arrigoni G, Delmastro E, Succo G. Barbed suture in oral cavity reconstruction: preliminary results. Acta Otorhinolaryngol Ital. 2019;39(5):308–15. https://doi.org/10.14639/0392-100X-2130.
7. Chen X, Xu L, Sun Y, Politis C. A review of computer-aided oral and maxillofacial surgery: planning, simulation and navigation. Expert Rev Med Devices. 2016;13(11):1043–51. https://doi.org/10.1080/17434440.2016.1243054.
8. De Virgilio A, Kim SH, Magnuson JS, et al. Anatomical-based classification for transoral lateral

oropharyngectomy. Oral Oncol. 2019;99:104450. https://doi.org/10.1016/j.oraloncology.2019.104450.
9. Crosetti E, Arrigoni G, Manca A, Caracciolo A, Bertotto I, Succo G. 3D Exoscopic surgery (3Des) for transoral oropharyngectomy. Front Oncol. 2020;10:16. Published 2020 Jan 31. https://doi.org/10.3389/fonc.2020.00016.
10. Gun R, Durmus K, Kucur C, Carrau RL, Ozer E. Transoral surgical anatomy and clinical considerations of lateral oropharyngeal wall, parapharyngeal space, and tongue base. Otolaryngol Head Neck Surg. 2016;154(3):480–5. https://doi.org/10.1177/0194599815625911.
11. Mirapeix RM, Tobed Secall M, Pollán Guisasola C, et al. Anatomic landmarks in transoral oropharyngeal surgery. J Craniofac Surg. 2019;30(2):e101–6. https://doi.org/10.1097/SCS.0000000000004935.
12. Dallan I, Seccia V, Faggioni L, et al. Anatomical landmarks for transoral robotic tongue base surgery: comparison between endoscopic, external and radiological perspectives. Surg Radiol Anat. 2013;35(1):3–10. https://doi.org/10.1007/s00276-012-0983-2.
13. Cohen DS, Low GM, Melkane AE, et al. Establishing a danger zone: an anatomic study of the lingual artery in base of tongue surgery. Laryngoscope. 2017;127(1):110–5. https://doi.org/10.1002/lary.26048.
14. Mat Lazim N, Baharudin B. Risk factors and etiopathogenesis of nasopharyngeal carcinoma. In: Abdullah B, Balasubramanian A, Lazim NM, editors. An evidence-based approach to the management of nasopharyngeal cancer. Amsterdam: Academic Press; 2020. p. 11–30. ISBN: 9780128144039. https://doi.org/10.1016/B978-0-12-814403-9.00002-1.
15. Chintamani D. Editorial: "ten commandments" of safe and optimum thyroid surgery. Indian J Surg. 2010;72(6):421–6. https://doi.org/10.1007/s12262-010-0217-y.
16. Irkorucu O. Zuckerkandl tubercle in thyroid surgery: is it a reality or a myth? Ann Med Surg (Lond). 2016;7:92–6. Published 2016 Apr 6. https://doi.org/10.1016/j.amsu.2016.03.030.
17. Costanzo M, Caruso LA, Veroux M, Messina DC, Marziani A, Cannizzaro MA. Il lobo di Zuckerkandl: faro del nervo laringeo ricorrente [The lobe of Zuckerkandl: an important sign of recurrent laryngeal nerve]. Ann Ital Chir. 2005;76(4):337–41.
18. Miller FR. Surgical anatomy of the thyroid and parathyroid glands. Otolaryngol Clin N Am. 2003;36(1):221–227, vii. https://doi.org/10.1016/s0030-6665(02)00132-9.
19. Subramanian S, Chiesa F, Lyubaev V, Aidarbekova A, Brzhezovskiy V. The evolution of surgery in the management of neck metastases. Acta Otorhinolaryngol Ital. 2007;27(2):309–16.
20. Chintamani. Ten commandments of safe and optimum neck dissections for cancer. Indian J Surg. 2015;77(2):85–91. https://doi.org/10.1007/s12262-015-1277-9.
21. Coskun HH, Medina JE, Robbins KT, et al. Current philosophy in the surgical management of neck metastases for head and neck squamous cell carcinoma. Head Neck. 2015;37(6):915–26. https://doi.org/10.1002/hed.23689.
22. Kalaiarasi R, Kiran AS, Vijayakumar C, Venkataramanan R, Manusrut M, Prabhu R. Anatomical features of intratemporal course of facial nerve and its variations. Cureus. 2018;10(8):e3085. Published 2018 Aug 2. https://doi.org/10.7759/cureus.3085.
23. Ni X, Zhang J. Pediatric otolaryngology–head and neck surgery in China: present situation and future prospects. Pediatr Invest. 2019;3:137–40.
24. Swift AC. Principles and practice of head and neck oncology. J R Soc Med. 2003;96(11):566–7.