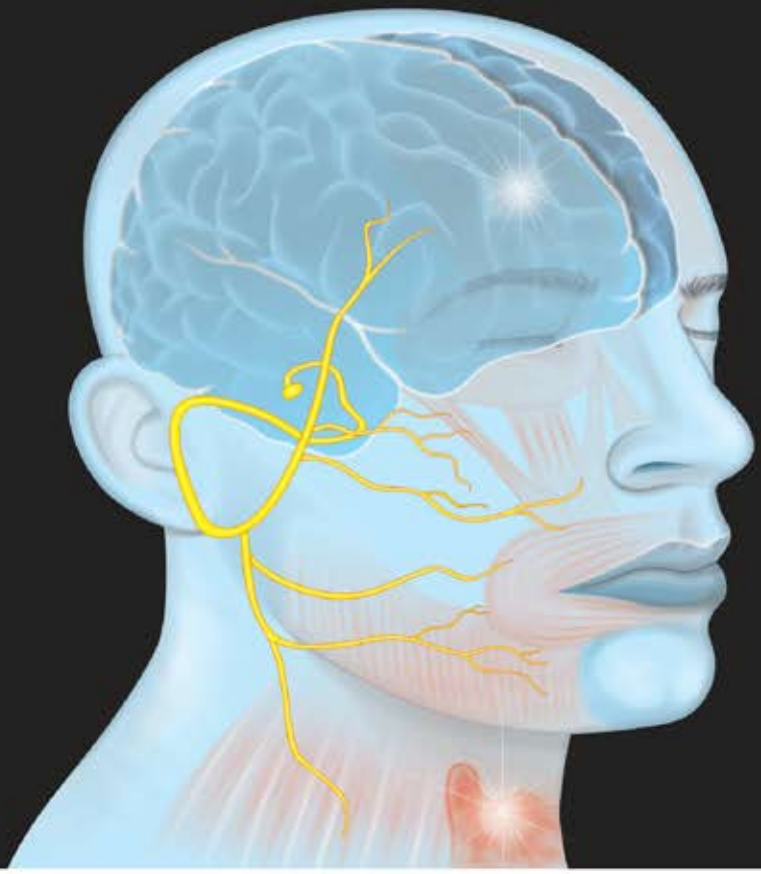
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Symptom Oriented Otolaryngology Head & Neck Surgery

Head & Neck and Laryngology

Volume 1



Chief Editors
Randall P Morton
Zahoor Ahmad
Malcolm Giles

Foreword
Eugene N Myers

JAYPEE

Symptom Oriented Otolaryngology Head and Neck Surgery

Vol. 1

Head & Neck and Laryngology

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Foreword

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The Health Sciences Publisher
New Delhi | London | Panama

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Clinical and Surgical Anatomy of the Major Salivary Glands

4

Patrick J Bradley

Chapter Overview

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4.2 Surgical Anatomy of the Parotid Gland
4.3 Surgical Anatomy of the Facial Nerve
4.4 Surgical Approaches to the Facial Nerve
4.5 Parapharyngeal Space (PPS)
4.6 Accessory Parotid Tissue
4.7 Surgical Management of Parotid Tumors
4.8 Surgical Anatomy of the Submandibular Gland
4.9 Follow-up after Complicated Surgery

Pearls and Pitfalls

Pearls

- Precise knowledge of the anatomy of the major salivary glands is essential when performing exploration and excision surgery.
- Aim of surgical excision of benign salivary gland neoplasms:
  - To establish a precise diagnosis, and to guide the clinician toward an optimal mode of treatment
  - To assess and predict the patients' ultimate prognosis
- Facial nerve branches may be injured by division, stretching, compression, ligature entrapment, thermal and electrical injuries as well as devascularization from stripping of the perineural sheath.
- Facial nerve monitoring or electrical stimulation during salivary gland surgery is no substitute for a detailed knowledge of surgical anatomy.

Pitfalls

- Facial nerve monitoring can provide false reassurance for unskilled/inexperienced surgeons.
- Examples of a facial nerve branch passing deep to the retromandibular vein have been reported.
- The tragal pointer is an unreliable landmark that fails to point to the facial nerve trunk 80% of the time.
- Capsular dissection is not suitable except for the small, lateral, freely mobile parotid mass with an FNAC showing a benign neoplasm of salivary origin.

4.1 INTRODUCTION

Benign *salivary gland neoplasms* are relatively common, and present frequently to many clinicians almost on a daily basis; malignant disease is less common and is usually referred to specialist surgical centers for management. The *parotid gland* is the most frequent site involved by primary salivary gland neoplasms, benign and malignant, as well as a frequent site for metastatic disease both from head and neck primary, as well as distant, sites. The *submandibular gland* is a less common site for primary salivary gland neoplasms, but where sialadenitis +/– sialoliths (stones) are the most common indication for surgery in the community (Moeller, et al., 2013). The overall estimated incidence of primary benign

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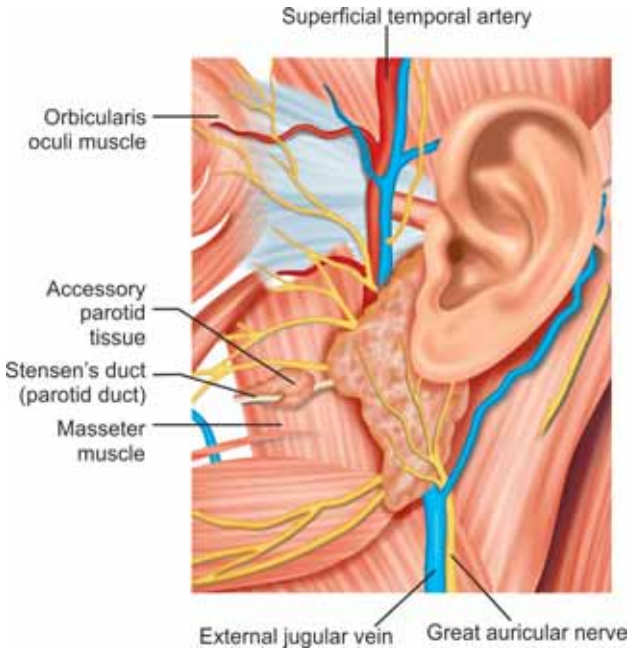


Fig. 4.1: Location of the parotid gland and accessory parotid tissue.

salivary gland neoplasm is estimated to be 70–75, and malignant neoplasms 8–14 per million population per year in the United Kingdom (Bradley and McGurk, 2013).

4.2 SURGICAL ANATOMY OF THE PAROTID GLAND

Parotid Location

The gland is located in a space between the posterior border of the *mandibular ramus* and the *mastoid process* of the *temporal bone* (Fig. 4.1). The external auditory meatus and the *temporomandibular joint*, with the glenoid fossa and the *zygomatic process* of the temporal bone, lie posterior and superior to the gland. The gland is frequently located inferiorly in the neck—as low as the hyoid. On its deep (medial) surface lies the styloid process of the temporal bone. Inferiorly, the parotid usually overlaps the angle of the mandible and its deep surface overlies the *transverse process of the atlas* (C-1) vertebra (Chapter 3).

Fibrous Capsule

The gland is surrounded by a fibrous *capsule*. This fascia passes up from the neck and was thought to split to enclose the gland. The deep layer is attached to the mandible and the temporal bone at the tympanic plate and styloid and mastoid processes. This superficial layer is now considered to be part of the *superficial musculoaponeurotic system* (SMAS) (Taylor and Yoo, 2003). Anteriorly, the superficial layer of the parotid capsule is thick and fibrous, but, more posteriorly, it becomes a thin translucent membrane. This superficial layer of the parotid capsule appears to be continuous with the fascia overlying the platysma muscle. Anteriorly, it forms a separate layer overlying the masseteric fascia, which is itself an extension of the deep cervical fascia. The peripheral branches of the *facial nerve* and the *parotid duct* lie within a loose cellular layer between these two sheets of fascia.

Superficial Lobe

The superficial surface of the gland is covered by skin and platysma muscle. Some terminal branches of the great auricular nerve also lie superficial to the gland tissue (lateral to the SMAS layer), with a variable number piercing the fascia to enter the gland itself. At the superior border of the parotid lie the superficial temporal vessels with the artery in front of the vein. The *auriculotemporal branch* of the *mandibular nerve* runs at a deeper level just behind the *superficial temporal vessels*, closely applied to the neck of the mandible

Deep or Medial Lobe of the Parotid Gland (Parotid Bed)

The deep (medial) surface of the parotid gland lies on the parotid bed. Anteriorly lies the *masseter muscle* and the posterior border of the mandibular ramus from the angle up to the condyle. As the gland wraps around the ramus, it is related to the *medial pterygoid muscle* at its insertion on to the deep aspect of the angle. More posteriorly, the parotid is molded around the *styloid process* and, from below upward, the styloglossus, stylohyoid, and stylopharyngeus muscles. Behind this, the parotid lies on the posterior belly of the *digastric muscle* and the sternocleidomastoid muscle. The digastric and the styloid muscles separate the gland from the underlying *internal jugular vein*, the external and internal carotid arteries and the glossopharyngeus, vagus, accessory and hypoglossal nerves and the sympathetic chain.

Local Ligaments from the Styloid Process

The fascia that covers the muscles in the parotid bed thickens to form two named ligaments. The *stylomandibular*

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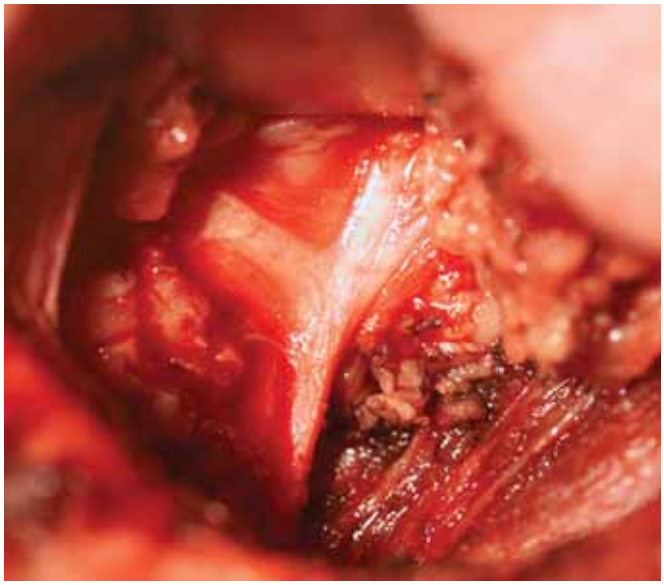


Fig. 4.2: Example of the left facial nerve trunk and the upper and lower divisions.



Fig. 4.3: Clinical picture of an exposed facial nerve trunk, divisions and branches.

ligament passes from the styloid process to the angle of the mandible. The *mandibulostylohyoid ligament* (the angular tract) passes between the angle of the mandible and the *stylohyoid ligament* for varying distances generally reaching the hyoid bone. These ligaments separate the parotid gland anteriorly from the posterior pole of the superficial lobe of the submandibular gland.

Parotid Duct

The *parotid duct* emerges from the anterior border of the parotid gland and passes horizontally across the masseter muscle (Fig. 4.1). The surface markings of the duct are obtained by line from the tragal cartilage to bisect a line drawn from the alar base to the commissure. The middle third of this line is the surface marking of the parotid duct. Anastamoses between the buccal and zygomatic branches of the facial nerve cross the duct. At the anterior border of the masseter, the duct bends medially to perforate the *buccal fat pad* and the *buccinator muscle* at the level of the second molar tooth. The duct then bends again to pass forward for a short distance before entering the oral cavity at the parotid papilla.

4.3 SURGICAL ANATOMY OF THE FACIAL NERVE

The *facial nerve* exits the temporal bone or skull base at the *stylomastoid foramen*. The nerve lies approximately 9 mm from the posterior belly of the digastric muscle and 11 mm from the bony external meatus. The facial nerve trunk then passes downward and forward, over the styloid process and the associated muscles for approximately 1.3 cm before entering the substance of the parotid gland. The first part of the facial nerve gives off the posterior auricular nerve supplying the auricular nerve, which innervates the auricular muscles, and also branches to the posterior belly of the digastric and stylohyoid muscles. On entering the parotid gland, the facial nerve separates into two divisions: the temporofacial and the cervicofacial (Fig. 4.2). This portion of the nerve is referred to as the "*pes anserinus*" ("the foot of the goose"). From these two divisions, the facial nerve further divides into five named branches (Fig. 4.3). The peripheral branches of the facial nerve form anastomoses between adjacent branches to form the parotid plexus. Researchers studied (Davis, et al., 1956) these patterns in 350 cadaveric facial nerves and described six patterns; in only 6% of cases was there any anastomosis between the mandibular branch and the adjacent branches. Another study (Miehlke, Stennert and Chilla, 1979) also described eight branching patterns where no anastomoses between the branches were seen in 48% of patients.

There are two divisions of the facial nerve trunk and five main branches that emerge from these divisions:

- *Temporal branches*: These may number three or four, crossing the zygomatic arch anteriorly to the superficial

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vessel. The main areas of anastomosis are between the middle and posterior branches. The nerve contributes to the supply of the auricular muscles and supplies muscles of the forehead and orbicularis oculi.

- *Zygomatic branches*: These branches may number up to three in number and run below the lower border of the zygomatic arch. They contribute to the innervation of the orbicularis oculi, to muscles of the nose and to muscles associated with the upper lip.
- *Buccal branch*: This nerve may originate from the *cervicofacial division* (35%), the temporofacial division (21%) and both the cervicofacial and *temporofacial divisions* (34%) or from both the cervicofacial and temporofacial divisions with additional anastomosis between these branches (10%). Generally, there are only one branch, but occasionally there may be two.
- Where the nerve is single, it is usually (75%) found below the origin of the parotid duct, but it may cross the duct in 25% of cases in its anterior course. Where there are two branches (15%), one branch passes above and one below the parotid duct. Passing beneath the zygomatic muscle, the buccal branch of the facial nerve supplies the buccinator muscle and muscles of the upper lip.
- *(Marginal) mandibular branch*: This nerve has two branches (55–65% of cases), the lower branch being the larger. A single branch occurs in 25% of cases, three branches in approximately 10% or four branches in 3%. *Anastomosis* with the buccal and the cervical branches occur in 6–15% of cases. The marginal branch emerges from the inferior border of the parotid gland in >85% of cases. Near its termination, it frequently anastomoses with the mental nerve (28%). Because of the poor anastomosis of the marginal mandibular branch of the facial nerve with other facial rami in its peripheral distribution, injury to this nerve causes a permanent paralysis of the musculature supplied.

  In the majority of cases (52%), the marginal mandibular branch of the facial nerve was found running along the angle and inferior border of the mandible. It can run below the angle and body of the mandible (32%). A branch of the lower division of the facial nerve is consistently found crossing the mandible within 1 cm of the posterior edge of the angle of the mandible. When below the body of the mandible, its maximum distance was found to be 1.6 and 1.4 cm respectively. The marginal mandibular branch of the facial nerve was found to be superficial to the facial artery and (anterior) facial vein in virtually 100% of cases (Batra, Mahajan and Gupta, 2010). Rarely, reports of the nerve passing deep to the *retromandibular vein* have appeared.
- *Cervical branch*: In 80% of cases, this appears as a single branch at the lower pole of the parotid gland and always passes downward at a variable distance behind the angle of the mandible, the furthest being 1.4 cm. The nerve passes behind the superficial portion of the submandibular gland at the level of the hyoid bone where it divides into a number of branches which supplies the *platysma muscle*. In the other 20%, the nerve is represented by two branches.

As implied in these descriptions, the facial nerve branch distribution has several variations (Fig. 4.4). There is a variable communication (connexion) between the branches of the cervical plexus (great auricular nerve, transverse cervical nerve) and the marginal branch of the facial nerve.

4.4 SURGICAL APPROACHES TO THE FACIAL NERVE

The extratemporal facial nerve trunk can be dissected proximally (Table 4.1) (de Ru, et al., 2001), or distally (Yu, 2001; O'Regan, et al., 2008).

Antegrade (Proximal) Technique

The two most competing surgical landmarks (Fig. 4.4) used to identify the facial nerve trunk are the tympanomastoid suture line and the posterior belly of the digastric muscle (Witt, Weinstein and Rejto, 2005).

Lying superficial to the facial nerve trunk is the *stylomastoid artery*, which should be identified and secured prior to further manipulation of the surrounding tissues, because hemorrhage from a ruptured artery will stain the surrounding tissues and hamper "safe surgery" (Upile, et al., 2009). Should the main trunk not be identifiable or safely approached at the stylomastoid foramen, alternative means to identify the nerve must be undertaken.

Retrograde (Distal) Technique

Another approach is to locate a branch of the facial nerve distally and follow it posteriorly until other branches are identified and, ultimately, one of the divisions is found and then the facial nerve trunk.

a. The options available include identification of the marginal mandibular branch which usually passes

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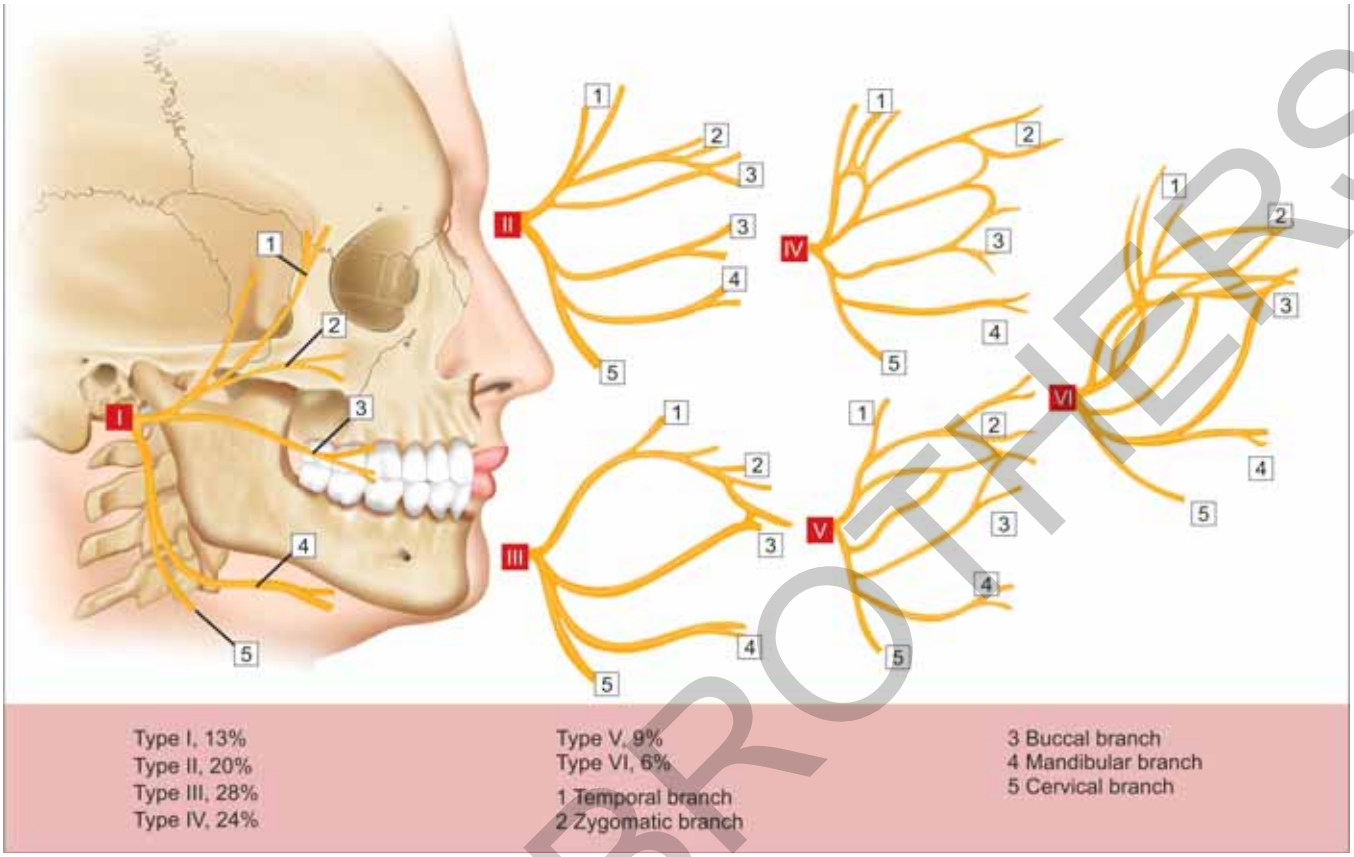


Fig. 4.4: Common variations in facial nerve branch anatomic deployment. Landmarks for the right facial nerve trunk. Note the "floating" tragus, indicative of the variability that pertains to this landmark.
Source: Davies, et al., 1956.

Table 4.1: Optional approaches to locate the facial nerve trunk.

1. The *tympanomastoid suture* line: The nerve trunk is usually 2–4 mm deep to the inferior end of the tympanomastoid suture line. This landmark may not be visualized, and is best identified by palpation.
2. The posterior belly of the *digastric muscle*: The facial nerve trunk is located 0.5–1.5 cm deep and above the muscle attachment in the digastric groove.
3. The tragal pointer: The facial nerve trunk is located 1–2 cm deep and slightly anteroinferiorly. The tragal pointer has a blunt and variable tip that can change with retraction. It is the least consistent landmark to use, not pointing in the appropriate direction in some 80% of cases.
4. The styloid process: The facial nerve trunk is located in the soft tissue inferior and superficial. If used to identify the nerve, the possibility of the surgeon "getting lost" is likely and runs the risk of nerve injury.
5. "Retrograde technique": Identify a single branch of the facial nerve and dissect in a backward fashion until the facial nerve division is first found and then followed by the facial nerve trunk.

Source: Bradley and Beasley, 2011.

superficial to the retromandibular vein or its two divisions, the posterior branch which unites with the posterior auricular vein and the anterior branch which passes forward to join the facial vein, which has been encountered and divided, when elevating the parotid off the sternocleidomastoid muscle (SCM).

b. The *buccal branch* can be identified at the anterior border of the parotid gland, at a point horizontal from the nasal alar rim to the inferior rim of the external auditory canal.
c. The zygomatic branches can be identified as the nerve crosses the zygomatic arch, usually at the mid-portion

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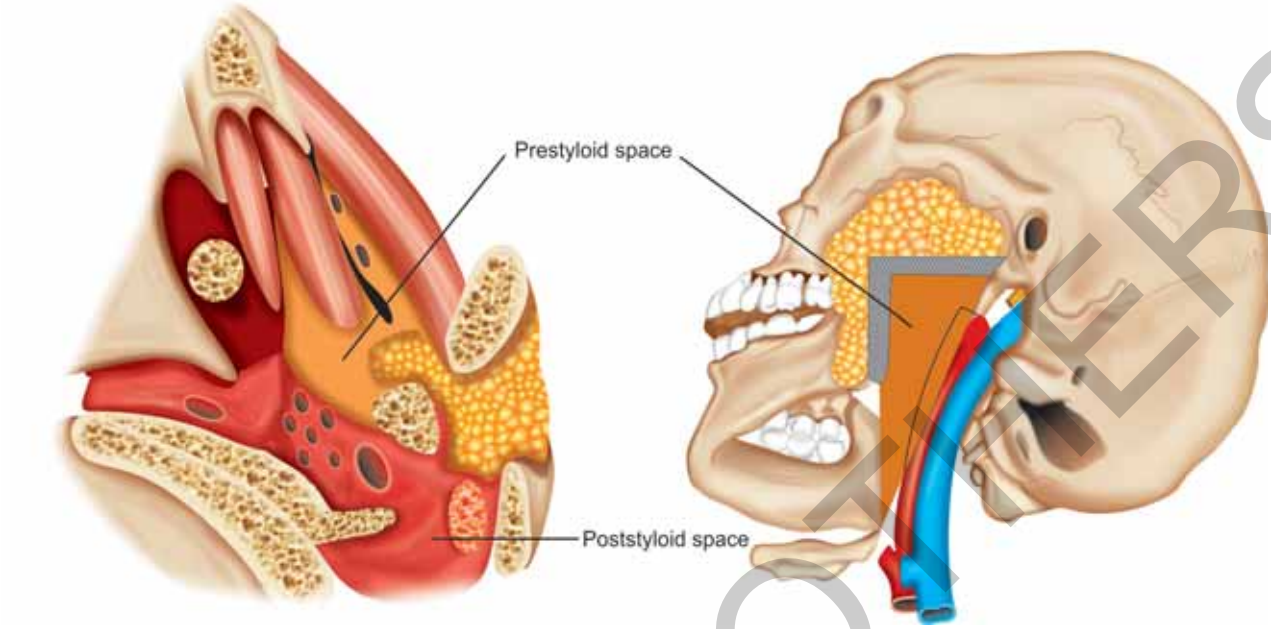


Fig. 4.5: Parapharyngeal space—pre- and poststyloid spaces.

of the arch, between the outer canthus and the temporomandibular joint.

Transmastoid Approach to Identify the Facial Nerve Trunk

Should the above approaches fail, the transmastoid approach can be used, opening the mastoid air cells, such as is performed in a cortical mastoidectomy, identifying the facial nerve in the middle ear and drilling the bone in a caudal manner to reach the tympanomastoid suture.

Source: Bradley and Beasley, 2011.

4.5 PARAPHARYNGEAL SPACE (PPS)

The parapharyngeal space is a potential space located bilaterally in the upper cervical region. The PPS is not readily accessible to routine clinical examination and is clinically "silent" unless affected by pathologic processes such as infections or tumors. The potential wide spectrum of benign and malignant neoplasms encountered in this complex, deep, anatomic region contributes to the challenge of surgical treatment.

Boundaries: The PPS is described as an inverted pyramid with its base at the skull base and the apex at the greater cornu of the hyoid bone (Fig. 4.5).

- The *superior boundary* is a small area of the temporal and sphenoid bones, which includes the carotid canal, the *jugular foramen*, and the hypoglossal foramen. The fascia covering the medial pterygoid muscle borders this region of the skull base laterally; medially, there is the attachment of the *pharyngobasilar fascia* and, posteriorly, the prevertebral fascia. Anteriorly, the medial and lateral borders converge.
- The *inferior boundary* is formed by the greater horn of the hyoid and the facial attachments of the posterior belly of the digastric muscle and the sheath of the submandibular gland.
- The *posterior boundary* is the prevertebral fascia.
- The *medial boundary* is formed by the *pharyngobasilar fascia* overlying the superior constrictor muscle. Medial to the fascial layer is the tonsil.
- *The lateral boundary*: (a) in the upper part of the PPS from before backwards is the ramus of the mandible, the fascia of the medial pterygoid muscle, and the retromandibular portion of the deep lobe of the parotid gland; and (b) below the mandible, the lateral boundary is the fascia overlying the posterior belly of the digastric muscle.
- The *anterior boundary* is the pterygomandibular raphe and below is the submandibular space.

Spaces or Compartments

The *prestyloid space*—the anterior component of the PPS—contains fat and parotid salivary tissue, whereas the *retrostyloid space* contains the carotid complex and, thus, this space potentially runs inferiorly into the upper

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Table 4.2: Contents of the parapharyngeal space compartments.

Structure	*Prestyloid*	*Post- or retrostyloid*
Arteries	Internal maxillary Ascending pharyngeal	Internal carotid
Veins		Internal jugular
Nerves	Auriculotemporal	CN IX, X, XI, XII Cervical sympathetic chain
Lymph nodes		Present
Glomus tissue		Present
Salivary tissue	Parotid tissue	

mediastinum (Fig. 4.5). These compartments are separated by the *tensor veli palatini* muscle and fascia that arises from the styloid process to the fascia to cover the tensor veli palatini muscle, crossing posteriorly into the parapharyngeal fat.

Prestyloid Space

The *prestyloid space* extends superiorly into a blind pouch formed by the joining of the medial pterygoid fascia to the tensor veli palatine fascia. Most of the space is occupied by fat. It contains the inferior alveolar, lingual and auriculotemporal nerves and maxillary artery. Neoplasms in the space are limited to salivary gland, fat, and nerve origin (Table 4.2).

Retrostyloid or Poststyloid Space

The retrostyloid—or *poststyloid space*—contains the carotid artery with the internal jugular vein related to the posterolateral part of the artery at the skull base. Cranial nerves (CN) XI, X, XI, and XII and the sympathetic chain also occupy this space.

Deep Lobe of Parotid

The "*deep*" parotid lobe is defined as the parotid tissue that lies medial to the plane of the facial nerve. Less than 20% by volume of parotid salivary tissue is located in deep to the facial nerve and, therefore, tumors located here are uncommon. Those located in proximity to the lateral lobe present in either the retromandibular area or as a parapharyngeal mass.

Lymphatic Drainage

The lymph of the parotid gland drains mainly into the deep and superficial *parotid lymph nodes*. Occasionally, a lymph collector may drain from the anterior/inferior portion of the parotid, via the masseter muscle, to the submandibular lymph nodes. Drainage of the posterior part of the parotid gland into the accessory chain can also occur, but this is very rare. The efferent lymph collectors of the deep and superficial parotid lymph nodes are closely related to the lymph nodes of the accessory chain. This explains the frequent occurrence of secondary metastases of the parotid gland in this area. The *node of Rouviere* refers to the highest retropharyngeal lymph node accessory lymph chain, and part of which is adjacent to the jugular foramen.

The parotid lymph nodes (Figs. 4.6A and B) consist of approximately 20–30 lymph nodes located mainly lateral to the facial nerve (McKean, Lee and McGregor, 1985). They can be divided into:

- Superficial supra-aponeurosis lymph nodes (adjacent to the external jugular vein)
- Superficial subaponeurotic lymph nodes
- Deep intraparenchymal lymph nodes (0–3 in number)

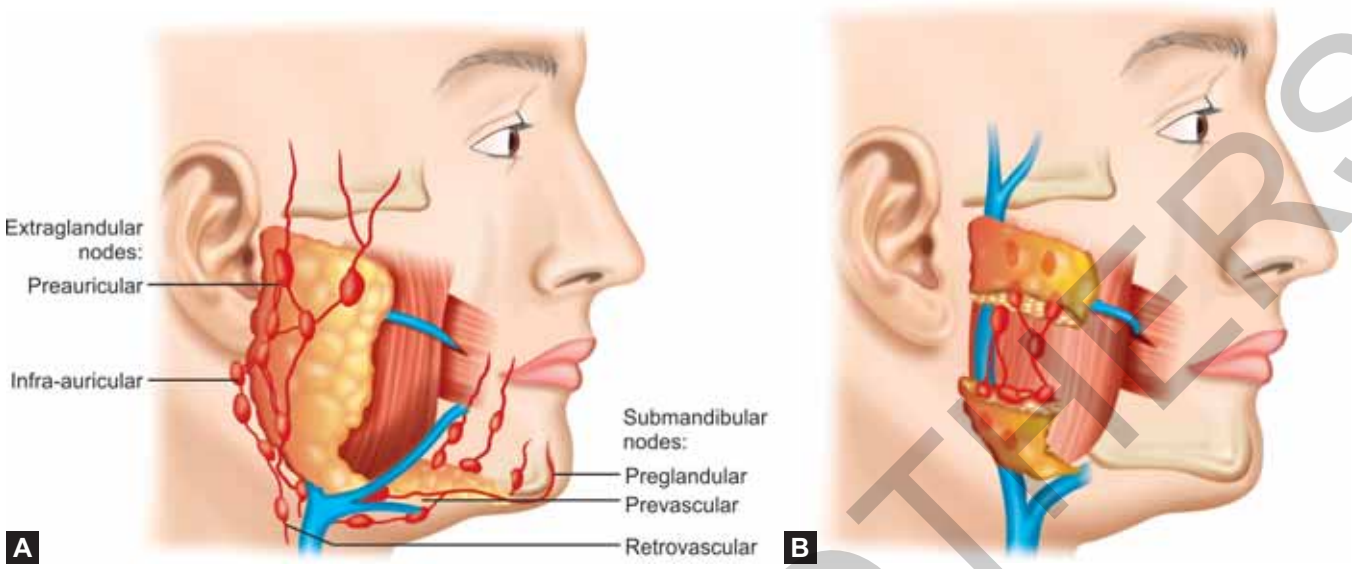
Areas that drain to the parotid lymph nodes:

- Parotid gland
- Cheek
- Eyelids
- Conjunctiva
- Lacrimal gland
- Upper lip
- Retromolar trigone
- Gingival
- External auditory canal
- Eustachian tube
- Skin of the scalp/forehead/pinna

4.6 ACCESSORY PAROTID TISSUE

The *accessory parotid lobe* is a salivary gland separated from the main parotid gland (Fig. 4.1), and is identified in 21–56% of individuals. It is located approximately 0.6 cm anterior to the main parotid duct, with its own duct emptying into the main parotid duct. It typically occurs along the central one-third of a diagonal line extending from the tragus to a point mid-way between the tragus to a mid-point between the ala of the nose and the vermilion border of the upper lip. Accessory parotid glands have been described as either round or triangular in shape, lying on the masseter muscle and almost always containing anastomotic zygomatic and buccal branches of the facial nerve within the substance. Although this tissue is susceptible to most salivary pathology, tumors of the

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Figs. 4.6A and B: (A) Lymphatic distributions around the parotid and submandibular glands. (B) lymphatic distributions intra-parotid gland.

accessory parotid gland are more frequently malignant than those of the other parotid glands themselves (De Riu, et al., 2011).

4.7 SURGICAL MANAGEMENT OF PAROTID TUMORS

Several techniques are described (Table 4.3):

- *Lateral or superficial parotidectomy* is a surgical procedure that excises the parotid salivary tissue that lies lateral to the plane of the facial nerve and its branches.
- *Partial lateral or partial superficial parotidectomy* frequently includes smaller tumors (<4 cm), located in the lateral lobe of the parotid gland, and which are clinically and fine-needle aspiration cytology (FNAC) benign. It is reported that such operations result in less complications (Witt, 2002). This, or a procedure described as endoscopic-assisted partial superficial parotidectomy, has been performed on 30 patients and there was no recurrence at follow-up at 26–50 months (Sun, et al., 2009)
- *Extracapsular dissection (ECD)* is currently controversial and is only recommended and advocated by enthusiasts (McGurk, Thomas and Renehan, 2003; Klintworth, et al., 2010). The majority of these enthusiasts has been in surgical practice for many years and can perform the full range of parotid surgeries when indicated (Bradley, 2004; Tweedie and Jacob, 2009). *In general, patients that may be suitable for this approach have a small-sized, clinically lateral and freely mobile parotid mass whose FNAC confirms a benign neoplasm of salivary origin.*
- *Deep lobe parotidectomy* involving dissection of the deep lobe is necessary when tumors are located within the deep lobe and/or are *parapharyngeal space*

Table 4.3: A suggested classification system for parotid gland surgery.

Extracapsular excision	
Partial lateral parotidectomy	
Upper segment	± Deep lobe dissection
Middle segment	± Deep lobe dissection
Lower segment	± Deep lobe dissection
Accessory parotid excision	
Lateral or superficial parotidectomy	
Selective deep lobe parotidectomy	
Total parotidectomy	± Partial facial nerve excision, ± Neck dissection
Radical parotidectomy	+ Facial nerve excision, ± Neck dissection, ± Flap repair
Extended radical parotidectomy	+ Facial nerve excision, ± neck dissection, ± bone, muscle, skin, ± flap repair

Source: Tweedie, et al., 2009.

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tumors. This technique is performed after elevation, with or without removal of the lateral lobe of the parotid gland. The tumor is dissected free from the branches of the facial nerve using a fine hemostat or scissors, using bipolar coagulation. Careful handling of the deep lobe parotid tissue and the capsule of the tumor will reduce the risk of rupture. There is evidence suggesting that benign tumors of the parapharyngeal space have thicker capsules than similar tumors located in the lateral parotid lobe (Harney, et al., 2003). A higher rate of temporary and permanent palsy can be expected after surgery in this area.

- *Transcervical transparotid approach* is reserved for special situations: The majority of deep lobe tumors located in the retromandibular region and most parapharyngeal space tumors are amenable to surgical resection by a transcervical transparotid approach. A radiologic classification has been suggested for the surgical approaches to tumors of the deep lobe parotid, which is based upon the CT images whether the tumor is located prestyloid or retrostyloid and its relationship to the pterygoid plates (Kanzaki and Nameki, 2008).
- *Mandibulotomy approach* is infrequently necessary even for large benign tumors, and is more likely necessary when the diagnosis is uncertain, a vascular tumor may be likely, with recurrent benign tumors or when considered to be the best approach for safety reasons. A paramedian or median mandibulotomy is the preferred route of access to tumors of the parapharyngeal space. Recently, other techniques have been described using lateral mandibulotomy, and even the use of a visor incision approach involving a subcutaneous division of the mandible (Teng, et al., 2003; Kolokythas, et al., 2009).
- *Accessory parotidectomy* is required for benign lesions clinically palpable along Stensen's duct, clinically separate from the parotid tissue or in close proximity to the periphery of the parotid tissue. Local incisions either on top of the tumor externally or tumor removal internally are to be discouraged. Imaging and FNAC must be performed before embarking on surgical excision (Klotz and Coniglio, 2000).

Patient Information and Informed Consent for Parotidectomy

Most patients undergoing parotid or salivary gland surgery for benign neoplasms anticipate that the procedure will be uneventful, with any untoward mishap being unlikely. However, the possible complications (Table 4.4) need to be conveyed to the patient.

Table 4.4: Complications following parotid gland excision (all causes).

Nerve damage	*Temporary*	*Permanent*
Facial N (VII)–(Complete)	2–76%	1–3%
Greater auricular (sensation)	2–100%	
Frey's syndrome	8–33%	
Other Complications		
Hematoma	2–9%	
Salivary fistula	2–18%	
Sialoceles	5–11%	
Wound infection	5–6%	
Hypertrophic scar	3–6%	
Residual stone (symptoms)	2–14%	

Source: Capaccio, et al., 2009.

1. *Parotidectomy* patients should be warned about the possibility of facial nerve injury (which may take them weeks to recover from), hematoma, seroma, divot defect or cosmetic changes to the cheek area, scar, anesthesia about the cheek, hyperhidrosis or Frey's syndrome, "*First-bite syndrome*" (Kawashima, et al., 2008) and the possibility of tumor recurrence; other sequelae or complications which are more rare need not be mentioned unless one is specifically asked. It is useful to have data of one's own patient's outcomes to support patient's enquiries on the likelihood of such events happening. Moreover, having written preoperative advice, listing the possibilities, is advisable (Marshall, Quraishi and Bradley, 2003; Bradley, 2001)
2. For *accessory parotid lobe surgery*, the patient needs to be informed of the needle biopsy (FNAC), imaging and clinically evaluation, but the result on final histology may be different and could indicate a malignancy. The aim is complete surgical removal, and this may be possible locally, but if the tumor is found to be more deeply seated, then exploration may require excision of the lateral lobe of the parotid in continuity, or may require excision of the deeper muscle and possibly a branch of the facial nerve (temporal and zygomatic branches).
3. If an *extracapsular dissection (ECD)* is planned, patients should be informed that this procedure is currently not a standard surgical procedure practiced by the majority of parotid surgeons worldwide. The

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long-term results of ECD have not been reported—mainly with regard to the risk of a recurrent parotid tumor. Should the surgery prove difficult, then it may be necessary to abandon the intended procedure of ECD and revert to a lateral parotidectomy or a modification of such surgery to ensure complete tumor removal (Smith and Komisar, 2007; Witt and Rejto, 2009).

Tips and Tricks—Parotid Gland Surgery

- When identifying the facial nerve trunk should the *stylomastoid artery* be injured, it bleeds profusely (Upile, et al., 2009). Apply pressure to stop the bleed, seek the aid of suction, using a fine-bore sucker, reposition the retractors to aid with exposure, and carefully suck the bleeding end of the blood vessel into the sucker, then using bipolar diathermy, cauterize the vessel. The use of fine artery forceps or burning of tissue blindly will tend to only increase "the surgeon's panic," and likely result in injury to the facial nerve.
- Especially when ECD is performed, the use of *facial nerve monitoring*, absolute hemostasis and a wide surgical approach may aid with better visualization and ability to mobilize the tumor from its surrounding parotid tissue.
- For deep lobe tumors
  - To acquire adequate access, the mandible can be lateralized and moved upward by the use of a bone-hook.
  - Division of the stylomandibular ligament is a useful step to assist advancement of the mandible. Take care not to aggressively dislocate the temporomandibular joint; this can result in "permanent" or severe disabling trismus.
  - Division of the posterior belly of digastric muscle may also help.
  - If there is "excessive deep lobe manipulation and mobilization of the tumor," then, serious consideration should be given to fracturing the styloid process off the skull base to minimize tumor rupture.
- For accessory parotid lobe surgery, place a facial nerve monitor initially on all such patient's to aid identification of nerve branches. Employ an extended lateral parotidectomy incision superiorly and inferiorly initially. Elevate the skin, lateral to the SMAS layer as far anteriorly as possible, so that the palpable lesion can be identified and excised without any difficulty. Control the surgical bleeding with bipolar diathermy.
- In case of mandibulotomy, a team approach using an oromaxillofacial surgeon will ensure that the mandible is divided and repaired without any long-term sequelae. Identification and avoidance of trauma to the hypoglossal nerve is important to minimize local oral morbidity. Ensure that the closure of the surgical defect is tension free, and employing distant tissue will ensure a watertight closure, and reduce postoperative hospitalization and nursing care significantly.
- For deep lobe tumors, there is a higher risk of traction trauma being inflicted to the facial nerve—temporary and/or permanent palsy may result (Table 4.4).

There are three *Major Events* that may occur during surgery:

- Inability to identify the facial nerve trunk: most commonly, this is related to being an inexperienced surgeon. Call for help. In fact, the "Surgical Apprentice" should start with a parotid expert—observe and learn the tricks.

  If alone, pack the wound and have a break; return refreshed and commence again as if commencing the surgery "all over again"! Uncontrolled bleeding during the preceding operating time usually discolors the tissues red and tends to "hide the nerve." If the nerve still cannot be identified, then consider that the facial nerve trunk has been divided at the stylomastoid foramen.
- The facial nerve or facial branch has been inadvertently divided—all efforts should be made to perform a direct, tension free end-to-end anastomosis.
- The *tumor rupture* during manipulation or when being delivered as a specimen. This, psychologically, is a "disaster" and negates the whole purpose of the surgery. Most often, this happens because of inexperience, rough handling of the tumor tissue itself, too limited a surgical approach, overenthusiastic retraction using large Langenbecks and not skin hooks, trainees who wish to watch the surgery while at the same time functioning as the chief assistant—looking over the skin flap and retracting at an angle rather than retaining a perpendicular blade.
  - The importance of capsular rupture and tumor spill for subsequent recurrences has been questioned (Natvig and Soberg, 1994; Henricksson, et al., 1998). Many authors have concluded that either it is hard to implant tumor or a thorough irrigation following the excision is most effective in removing the tumor debris. Dissenters cite the high rate of reported multiple nodules with recurrent

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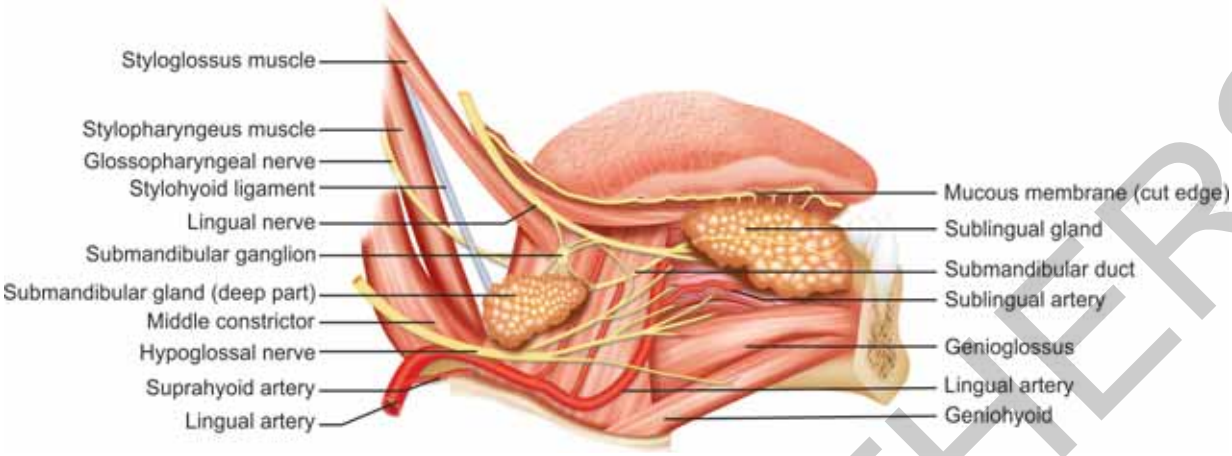


Fig. 4.7: Cranial nerve anatomy around the submandibular gland.

pleomorphic adenoma and recurrence in the scar (Carew, et al., 1999; Conley and Clairmont, 1979). Historical data (mean follow-up, 7 years) identified recurrences in 5% of cases with capsular rupture and tumor spill, thus suggesting that in most cases (95%) a recurrence will not materialize (Witt, 2002).

- What to do if the tumor is seen exuding from the ruptured capsule as the tumor is being delivered
  - Stop the procedure and do not allow the tumor mass to make contact with the deeper or proximal parotid tissue. Suction the exuding tissue and decompress the tumor mass before it "explodes." It may be possible to suture close the rupture with a fine Prolene®/Vicryl®, or a suggested alternative; in this novel approach, take a piece of fascia from the sternocleidomastoid or another area, and using "tissue glue" seal the defect closed. Then proceed with surgery as planned, mobilizing from a different area.
  - Performing parotid surgery, if the tumor explodes and tumor tissue is spilled "far and wide" about the surgical field, the remaining tumor and tissue should be removed before performing any other maneuver. All spilled tumor tissue visible should be removed, picked from the area. The surgical bed should then be irrigated thoroughly. Water, saline, hypertonic saline, hydrogen peroxide and antiseptics, such as Betadine®, have all been recommended. If a lesser procedure was being performed, then proceeding to a total parotidectomy should be considered.

4.8 SURGICAL ANATOMY OF THE SUBMANDIBULAR GLAND

The submandibular gland comprises a large superficial lobe lying within the digastric triangle in the neck and a smaller deep lobe lying within the floor of the mouth posterior. The two lobes are continuous with each other around the posterior border of the mylohyoid muscle (Fig. 4.7). The two lobes form a horseshoe shape, and embryologically arise from a single epithelial outgrowth. The gland is a mixed seromucinous gland.

Superficial Lobe

1. The superficial lobe lies within the *digastric triangle*. Its anterior pole reaches the anterior belly of the digastric muscle and the posterior pole reaches the stylomandibular ligament. Superiorly, the superficial lobe lies medial to the body of the mandible. Inferiorly, it often overlaps the intermediate tendon of the digastric muscles and the insertion of the stylohyoid. The lobe is partially enclosed between the two layers of the deep cervical facia that arises from the greater cornu of the hyoid bone and is in intimate proximity of the facial vein and artery. The superficial layer of the fascia is attached to the lower border of the mandible and covers the inferior surface of the superficial lobe. The deep layer of fascia is attached to the mandible and, therefore, covers the medial surface of the lobe. The inferior surface, which is covered by skin, subcutaneous fat, platysma, and the deep fascia, is crossed by the facial vein and the cervical and mandibular branches of the facial nerve. These loop down from

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the angle of the mandible and subsequently innervate the lower lip. The submandibular lymph nodes lie between the salivary gland and the mandible.

2. The lateral surface of the superficial lobe is related to the *submandibular fossa*, a concavity on the medial surface of the mandible, and the attachment of the medial pterygoid muscle. The facial artery grooves its posterior part lying, at first, deep to the lobe and, then, emerging between its lateral surface and the mandibular attachment of the medial pterygoid muscle from which it reaches the lower border of the mandible.
3. The medial surface is related anteriorly to the mylohyoid from which it is separated by the *mylohyoid nerve* and *submental vessels*. Posteriorly, it is related to the styloglossus, the stylohyoid ligament, and the *glossopharyngeal nerve* separating it from the pharynx. Between these, the medial aspect of the lobe is related to the *hyoglossus muscle* from which it is separated by the styloglossus muscle, the *lingual nerve*, and the deep lingual vein. More inferiorly, the medial surface is related to the stylohyoid muscle, the *hypoglossal nerve*, and the posterior belly of the digastric muscle.

Deep Lobe

The deep lobe of the gland arises from the superficial lobe at the posterior free edge of the *mylohyoid muscle* and extends forward to the posterior aspect of the *sublingual gland*. It lies between the mylohyoid muscle inferolaterally, the hyoglossus and styloglossus muscles medially, the lingual nerve superiorly and the hypoglossal nerve and the deep lingual vein inferiorly (Fig. 4.7).

Submandibular Duct

The submandibular duct is approximately 5-cm long in an adult. The wall of the duct is thinner than that of the parotid duct. It arises from numerous tributaries in the superficial lobe and emerges from the medial surface of this lobe just behind the posterior border of the mylohyoid. It courses the deep lobe, passing upward and slightly backward for 5 mm before running forward between the mylohyoid and the hyoglossus muscles. As it passes forward, it runs between the sublingual gland and genioglossus to open into the floor of the mouth on the summit of the sublingual papilla at the side of the lingual frenum just below the tip of the tongue. It lies between the lingual and hypoglossal nerves on the hyoglossus muscle (Fig. 4.6). At the anterior border of the hyoglossus muscle, it is crossed by the lingual nerve.

Lymphatic Drainage

The lymph nodes of the anterior and superior part of the submandibular gland drain into the submandibular lymph nodes. From the posterior part of the submandibular gland, 1–2 lymph collectors drain to the subdigastric and principal lymph nodes, together with the facial artery. The submandibular gland does not contain lymph nodes within its capsule, in contrast to the parotid gland (Fig. 4.7). It is possible to preserve the submandibular gland and its function when performing a neck dissection for oral cavity tumors by removing the five soft-tissue compartments (preglandular, prevascular, deep submandibular glands, postvascular, and postglandular) in sublevel Ib. The average harvest of 5.7 (range, 1–15) lymph nodes per case was retrieved at oncologic exploration of oral cavity primary disease (total 30 cases of neck dissection) (DiNardo, 1998; Dhiwaker, et al., 2011).

Surgical Management of Submandibular Salivary Tumors

This is usually for a swelling or mass, in the region of the submandibular gland, that is discrete and has been slowly growing over many years. Investigations such as FNAC and CT scan suggest a salivary gland tumor diagnosis. Complete excision of the entire gland with the surrounding tissue is sufficient to remove most tumors (Munir and Bradley, 2007).

Patient Information and Informed Consent

Patients with submandibular tumors should be advised that the swelling is likely to be a benign tumor, but that complete excision of the tumor and the gland will inform as to its true nature and ensure its cure by removal. Histologic examination of the excised specimen will reveal the exact nature of the lesion and its prognosis. The specific material complication to be discussed is damage to the marginal branch of the facial nerve.

Submandibular Gland Excision: Complications

In submandibular gland surgery, complications are uncommon. Hemorrhage and hematoma are most frequent. Injury to the local nerves: mandibular branch of the facial nerve, lingual nerve or, less commonly, the *hypoglossal nerve* (Table 4.5).

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Table 4.5: Complications following submandibular gland excision (all causes).

Nerve damage	*Temporary*	*Permanent*
Marginal VII nerve	1–23%	1–8%
Hypoglossal nerve	1–2%	3%
Lingual nerve	2–6%	2%
Other complications		
Hematoma	2–4%	
Salivary fistula	< 1%	
Sialoceles	1–3%	
Wound infection	3–8%	
Hypertrophic scar`	2–5%	
Residual/retained stone	2–8%	

Source: Capaccio, et al., 2009.

Tips and Tricks—Submandibular Gland Surgery

When performing a submandibular gland excision, use the same principles as identified for parotid surgery. Consider performing a local zonal removal of nodal areas Ia and Ib and IIa neck dissection.

- Not infrequently, a benign tumor, most usual a pleomorphic adenoma, will be readily visualized and identifiable, appearing almost separate from the substance of the submandibular gland itself. Although it is tempting to locally excise the tumor itself, that would probably result in an incomplete excision and the histology on final analysis may be malignant.
- Occasionally, the FNAC may be inconclusive, and such a local excision may result in undertreatment. If the clinical likely diagnosis is suspicious of a possible malignancy, serious consideration to performing a selective neck dissection, of levels Ib, IIa, and III, should be recommended to the patient (Munir and Bradley, 2007).

4.9 FOLLOW-UP AFTER COMPLICATED SURGERY

Patients should be informed as to what has happened and what steps were taken to reduce the likelihood of local recurrence. In patients considered to be at risk, approximately 3 months after surgery an ultrasound examination and/or an MRI should be performed as a baseline investigation and should only be repeated if the patient develops local symptoms or presents with a palpable skin or deeper nodule. Performing routine scanning at intervals will usually increase the patient's anxieties, and the potential for proceeding with litigation is increased. The recommendation for advising radiotherapy in such a scenario is not recommended as the risk of recurrence is small, and radiotherapy may be better reserved for overt disease rather than likely disease.

Key Surgical Points

- Standard lateral and total parotidectomy for treatment of benign parotid disease using precise visual magnification is safe, demonstrates good results, and has a low perioperative and long-term morbidity in experienced hands.
- The more parotid tissue sacrificed at surgery, the higher the rates of transient facial nerve dysfunction and Frey's syndrome.
- The major outcomes (capsular exposure, tumor-facial nerve interface, capsular rupture, recurrence and permanent facial nerve dysfunction) from surgical treatment of mobile, superficial pleomorphic adenomas <4 cm are not significantly altered by the surgical approach used.
- Focal capsular exposure is a near-universal finding for cases of small (<4 cm), mobile pleomorphic adenoma predominantly of the lateral lobe, regardless of the extent of parotid tissue sacrifice.
- If there is rupture of the tumor during surgery—all tumor should be removed, and the wound irrigated. All patients should be informed of the happening with explanation of what steps were taken to minimize recurrence. A baseline ultrasound and magnetic resonance imaging be taken at 3 months, and repeated if symptoms or signs manifest. *Radiotherapy is not advocated*.
- The majority of benign salivary neoplasms of the parapharyngeal space can be excised using a transparotid-transcervical approach with preservation of the facial nerve.
- In the presence of a proven benign tumor of the submandibular gland, the minimum surgery should entail excision of the entire gland. If the diagnosis is in doubt or the lesion is large (> 2 cm), then a selective neck dissection—as a minimum excising level IB—should be performed.
- The use of facial nerve monitoring may not be very beneficial, if experience has not been gained as a matter of routine. The use of a facial nerve monitor is not a substitute to a good knowledge of anatomy and experience gained in salivary gland surgery.

Source: Bradley and Beasley, 2011.

However if the tumor has not been completely removed, or the surgery was abandoned, and the patient had been referred from "elsewhere" within 7–10 days, then re-exploration of the area is to be recommended before wound healing has completed and scarring has commenced.

Following parotid surgery for a benign or a malignant process, the surgical defects are left unreconstructed. Numerous techniques are available to reconstruct a

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resultant contour defect and mitigate the effects of Frey's syndrome. Microvascular surgery offers an important adjunct to the reconstructive options of various parotidectomy defects. For best results, facial nerve reconstruction or paralysis rehabilitation must be initiated at the time of the excision procedure, if possible, and, if not, then shortly thereafter (Militsakh, et al., 2013).

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ISBN 978-93-85891-89-2