ANATOMY OF THE SALIVARY GLANDS IN THE HEAD AND NECK

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Introduction

Salivary glands are exocrine glands that produce, modify, and secrete saliva into the oral cavity. These glands are classified into two main types: major salivary glands, which include the parotid, submandibular, and sublingual glands, and minor salivary glands, which are distributed throughout the mucosa of the upper aerodigestive tract and most of the oral cavity.

Human salivary glands secrete between 0.5 and 1.5 liters of saliva daily. Saliva plays a crucial role in facilitating chewing, swallowing, and speech, as well as lubricating the oral mucosa and serving as a medium for taste perception. It aids in the digestion of starches and triglycerides through enzymes like amylases and lipases. Additionally, saliva serves a protective function against infections with its various organic components, such as immunoglobulin A (IgA), lysozymes, autolysin, and lactoferrin. Saliva also contains bicarbonates that neutralize bacterial acids and safeguard the oral cavity and esophagus from gastric acids, thereby playing an essential role in preventing infections and dental caries.

Structure and Function

Anatomical Location

- **Parotid Gland (PG):** The largest of the major salivary glands, located between the sternocleidomastoid and masseter muscles, extending from the mastoid tip to the angle of the mandible. Its superficial layer contains the facial nerve, retromandibular vein, and external carotid artery, making it a critical site for surgical considerations. Stensen's duct extends from the anterior part of the gland, crosses the masseter muscle, and opens into the oral cavity near the second maxillary molar.
- **Submandibular Gland (SMG):** The second-largest salivary gland, situated below the mandible between the anterior and posterior bellies of the digastric muscle. It consists of smaller anterior and larger posterior lobes, connected by the mylohyoid muscle. Wharton's duct, its primary excretory duct, opens at the sublingual caruncle, with the hypoglossal nerve running parallel to it.
- **Sublingual Gland (SLG):** Positioned beneath the floor of the mouth, this gland lies between the mandible and genioglossus muscle and superior to the mylohyoid muscle. Unlike other major glands, it lacks a single primary duct and instead has numerous small ducts (Rivinus ducts) that directly open into the mouth. Bartholin's duct may also connect to the submandibular duct at the sublingual caruncle.

Architecture and Function

Salivary glands consist of acinar cells, ductal cells, and myoepithelial cells. Despite their varied locations, they share a common structure of branched ducts leading to secretory acini that produce saliva.

1. **Acinar Cells:** These cells are classified into serous, mucinous, and seromucous types. The parotid gland contains predominantly serous acini, producing watery saliva. The

submandibular and sublingual glands are mixed, with the submandibular gland containing more serous acini and the sublingual gland having more mucinous acini.

2. **Ductal System:** Saliva is modified as it passes through the ductal system, which consists of intercalated, striated, and excretory ducts. Intercalated ducts secrete bicarbonate and absorb chloride, while striated ducts regulate sodium and potassium levels. The excretory ducts have the largest diameter and deliver saliva to the oral cavity.

Myoepithelial cells encase the acini and ducts, contracting to facilitate saliva flow. The glands are supported by an extracellular matrix, immune cells, stromal elements, and nerve fibers, ensuring efficient function.

The unique combination of structural features and cellular composition enables salivary glands to perform critical roles in digestion, oral lubrication, taste, and protection against microbial infections.

Embryology

The development of salivary glands begins around the 6th to 8th week of gestation when interactions between the oral ectoderm and the adjacent mesenchyme trigger the thickening of the epithelial layer. This process leads to branching morphogenesis, characterized by systematic stages of proliferation, clefting, differentiation, migration, programmed cell death, and complex interactions among mesenchymal, epithelial, endothelial, and neuronal cells. Similar branching processes are observed in other organ systems, such as the lungs, kidneys, and mammary glands. By the 14th week of gestation, the terminal buds at the ends of the branched ductal structures develop into acini.

The parotid gland is the first to form but the last to be enclosed in connective tissue due to the development of lymphatic tissue within the gland. This unique feature makes it the only salivary gland with an enclosed lymphatic system. Submandibular glands become well-differentiated between the 13th and 16th weeks, displaying microvilli, desmosomes, and a basal lamina surrounding the epithelium. Myoepithelial cells also begin to emerge during this period. By the 16th week, striated and intercalated ducts are evident, and gland development concludes by the 28th week, when acini begin producing secretory products. At birth, the glands are fully functional.

Blood Supply and Lymphatics

Parotid Gland

The parotid gland receives its blood supply from the external carotid artery, which ascends from the carotid bifurcation along the posterior aspect of the digastric muscle. This artery bifurcates into the superficial temporal artery, which runs to the scalp, and the maxillary artery, which supplies blood to the infratemporal and pterygopalatine fossae. Additionally, the transverse facial artery branches off the superficial temporal artery, supplying the parotid gland, duct, and masseter muscle.

Venous drainage occurs through the retromandibular vein, formed by the union of the maxillary and superficial temporal veins. This vein traverses the parotid gland anterior to the facial nerve and joins the external jugular vein. Anatomical variations may result in the retromandibular vein splitting into anterior and posterior branches. The anterior branch may unite with the posterior facial vein to form the common facial vein, while the posterior branch drains into the external jugular vein via the post-auricular vein.

Submandibular Gland

The submandibular gland primarily receives its blood supply from the facial artery, a branch of the external carotid artery. The facial artery runs medially to the posterior belly of the digastric muscle, projecting through the gland capsule before crossing the mandible at the facial notch and ascending into the face.

Lymph nodes associated with the submandibular gland are located between the gland and its fascia, rather than within the gland itself. These nodes are closely linked to the facial artery and vein and drain into the deep cervical and jugular lymphatic chains.

Sublingual Gland

The sublingual gland is supplied by the submental and sublingual arteries, which branch from the lingual and facial arteries. Venous drainage parallels the arteries and empties into the submandibular lymph nodes, which manage the lymphatic drainage of the gland.

Nerves

Salivary glands receive both parasympathetic and sympathetic innervation, each playing distinct roles. Parasympathetic innervation promotes serous saliva production and ion secretion, while sympathetic innervation enhances protein secretion and regulates glandular blood flow, as well as local inflammatory and immune responses.

- **Parotid Gland:** Innervation is provided by the glossopharyngeal nerve (cranial nerve IX). Parasympathetic fibers originate in the otic ganglion and join the auriculotemporal nerve to reach the gland.
- **Submandibular and Sublingual Glands:** Parasympathetic fibers originate from the superior salivatory nucleus in the pons and travel via the facial nerve (cranial nerve VII). They pass through the chorda tympani, exit the skull through the petrotympanic fissure, and join the lingual nerve before synapsing in the submandibular ganglion. Sympathetic innervation stems from the superior cervical ganglion, with postganglionic fibers reaching the glands along blood vessels branching from the carotid plexus.

Minor salivary glands are not regulated by neuronal input but secrete saliva continuously, ensuring consistent lubrication of oral surfaces, even when major glands are inactive.

Surgical Considerations

Identifying the facial nerve is critical during parotid and submandibular gland surgeries to prevent complications. In parotidectomies, careful tumor removal with tissue margin preservation is prioritized while safeguarding facial nerve function. Reliable anatomical landmarks for locating the nerve include bony structures like the tympanomastoid fissure, while soft tissue landmarks are less consistent. In submandibular and sublingual gland surgeries, understanding the anatomy of the floor of the mouth is essential. The lingual nerve’s proximity to Wharton’s duct makes it particularly susceptible to injury during procedures for conditions like sialolithiasis.

Clinical Significance

Salivary gland dysfunction is often associated with systemic conditions, such as diabetes, hormonal imbalances, arteriosclerosis, and neurologic disorders. Common issues include:

1. **Xerostomia:** Caused by medications, systemic conditions, or damage to the glands, it can lead to increased susceptibility to infections and dental caries. Treatments include sialogogues like pilocarpine and cevimeline, which stimulate saliva production, or saliva substitutes.

2. **Sjogren Syndrome:** An autoimmune disorder that commonly affects postmenopausal women, causing xerostomia, dry eyes, arthritis, and fatigue.

Pathologies

- **Sialadenitis:** Inflammation of the salivary glands caused by infection, trauma, or autoimmune conditions. Mumps is a common viral form, presenting with parotid swelling, fever, and pain.
- **Sialolithiasis:** Formation of calcified stones within the glands, often in Wharton's duct, leading to pain, swelling, and inflammation, especially during salivary stimulation. Severe cases may result in infection and pus formation.

Salivary gland disorders, whether structural, inflammatory, or neoplastic, highlight the importance of understanding their anatomy, physiology, and clinical implications for effective diagnosis and treatment.

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