Lacrimal Sac

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1. Core Definition

The **lacrimal sac**, also known as the **dacryocyst**, represents a crucial component of the human lacrimal drainage system. It is essentially an oval-shaped, membranous reservoir specifically designed to collect tears and other ocular fluid from the surface of the eye. This structure serves as an intermediary conduit, facilitating the passage of tears from the conjunctival sac into the nasal cavity, thereby playing a vital role in maintaining ocular surface health and clarity. Its strategic position and specialized function underscore its importance in the continuous process of tear flow and foreign body removal.

Functionally, the lacrimal sac acts as a temporary holding chamber before the tears are further transported. Tears, produced primarily by the lacrimal gland, wash over the eye's surface, gathering debris, pathogens, and excess fluid. These collected tears then drain into the lacrimal puncta, through the canaliculi, and ultimately into the lacrimal sac. This continuous flow prevents accumulation of fluid and particulate matter, ensuring optimal visual function and protecting the delicate ocular tissues from irritation and infection.

The integrity and proper functioning of the lacrimal sac are paramount for efficient tear drainage. Any obstruction or dysfunction within this structure can lead to a range of ocular discomforts and potentially serious infections, highlighting its significance in the broader context of eye health. Its unique anatomical features allow it to effectively manage the volume of tears produced, ensuring a balanced and healthy ocular environment.

2. Anatomical Location and Structure

Anatomically, the lacrimal sac is precisely situated within a specific bony depression known as the **lacrimal fossa**. This fossa is formed by two distinct facial bones: the lacrimal bone posteriorly and the frontal process of the maxilla anteriorly. This protected location safeguards the delicate sac from external trauma while facilitating its connection to the surrounding drainage pathways. The sac itself measures approximately 12-15 mm in length and 4-6 mm in width, tapering inferiorly.

The lacrimal sac is the superior, dilated portion of the nasolacrimal duct, which is the final conduit for tear drainage into the nasal cavity. It features a fundus, which is its rounded superior end, and a body that continues inferiorly into the nasolacrimal duct. The medial wall of the lacrimal sac is intimately related to the ethmoid air cells and the middle meatus of the nose, a proximity that becomes clinically significant in cases of infection or inflammation. Laterally, it receives the superior and inferior lacrimal canaliculi, which are small tubes that collect tears directly from the

lacrimal puncta located on the eyelids.

The wall of the lacrimal sac is composed of an outer fibrous layer, an intermediate muscular layer (orbicularis oculi muscle fibers), and an inner mucosal lining. The mucosal lining is typically pseudostratified columnar epithelium with goblet cells, similar to the respiratory epithelium, which secretes mucus to aid in tear transport and provides a protective barrier. The rich vascular supply and lymphatic drainage of the region also contribute to its functional integrity and its response to various pathological conditions.

3. Physiological Role in Tear Drainage

The primary physiological role of the lacrimal sac is to serve as a collection point and pumping mechanism within the tear drainage pathway. After tears are produced by the lacrimal glands and spread across the ocular surface by blinking, they accumulate in the medial canthus of the eye. From there, they enter the superior and inferior lacrimal puncta, which are small openings located on the medial aspects of the upper and lower eyelids. These puncta lead into the lacrimal canaliculi, which converge and empty into the lacrimal sac.

The process of tear drainage is largely facilitated by the blinking mechanism. Each blink causes the orbicularis oculi muscle to contract, compressing the lacrimal sac. This compression creates a negative pressure within the sac, effectively drawing tears from the canaliculi into the sac (a suction pump action). As the blink completes and the muscle relaxes, the elastic recoil of the sac, combined with the action of the lacrimal fascia, propels the tears inferiorly into the nasolacrimal duct. This active pumping mechanism ensures efficient and continuous drainage of tears from the eye.

Beyond simply transporting tears, the lacrimal sac also plays a role in draining the eye of foreign bodies, dust, and other irritants. The constant flow of tears, driven by this pumping action, helps to flush away these undesirable particles, preventing them from causing damage or infection to the ocular surface. This protective function is critical for maintaining ocular comfort, visual acuity, and overall eye health, acting as a crucial first line of defense against environmental insults.

4. Associated Anatomical Structures

The function and integrity of the lacrimal sac are inextricably linked to several surrounding anatomical structures. Superiorly and laterally, the lacrimal puncta and canaliculi are directly connected to the sac. The puncta, located at the tips of the lacrimal papillae on the medial edges of the eyelids, are the initial gateways for tear entry. The canaliculi, typically 8-10 mm long, can be visualized as delicate tubules that convey tears from the puncta to the lacrimal sac. These structures are crucial for the initial collection phase of tear drainage.

Inferiorly, the lacrimal sac is continuous with the nasolacrimal duct. This duct descends through the nasolacrimal canal, a bony passage formed by the maxilla, lacrimal bone, and inferior nasal concha, eventually opening into the inferior meatus of the nasal cavity beneath the inferior turbinate. The connection is regulated by a mucosal fold often referred to as the **Valve of Hasner** (or Plica Lacrimalis), which prevents reflux of nasal contents into the lacrimal sac.

The bony housing provided by the **lacrimal fossa**, formed by the lacrimal bone and the frontal process of the maxilla, offers critical support and protection to the lacrimal sac. Additionally, the lacrimal fascia, a fibrous sheath, encases the sac and connects it to the periosteum of the surrounding bones, contributing to its stability and supporting the lacrimal pump mechanism. The relationship with the orbicularis oculi muscle fibers, particularly the lacrimal part (Horner's muscle), is essential for the active tear drainage process.

5. Embryological Development

The embryological development of the lacrimal drainage system, including the lacrimal sac, is a complex process that begins early in gestation. The system originates from an ectodermal thickening known as the **lacrimal groove** or **nasolacrimal groove**, which appears between the lateral nasal and maxillary prominences during the 6th to 8th week of embryonic development. This groove eventually becomes a solid cord of ectodermal cells that sinks beneath the surface epithelium.

Through a process of canalization, this solid cord gradually hollows out to form a lumen. This canalization typically proceeds from superior to inferior. The upper portion of this canalizing cord forms the lacrimal sac and the canaliculi, while the lower portion differentiates into the nasolacrimal duct. The development is usually complete by the end of the third trimester, but the distal end of the nasolacrimal duct, particularly the Valve of Hasner, may remain imperforate at birth in a significant percentage of infants.

Incomplete or aberrant development of the lacrimal drainage system can lead to various congenital anomalies. The most common is congenital nasolacrimal duct obstruction (CNLDO), where the membrane at the distal end of the nasolacrimal duct fails to canalize completely. This condition often resolves spontaneously but can lead to epiphora (excessive tearing) and recurrent infections if persistent, underscoring the importance of proper embryological formation for lifelong ocular health.

6. Clinical Examination and Diagnostic Methods

Clinical examination of the lacrimal sac and drainage system is essential for diagnosing a range of ocular conditions. Initial assessment involves visual inspection for signs of swelling, redness, or discharge in the medial canthal area. Palpation of the lacrimal sac region can elicit tenderness or

the reflux of purulent material from the puncta, indicating infection (dacryocystitis) or obstruction.

Further diagnostic tests include the **Fluorescein Dye Disappearance Test (FDDT)**, where a drop of fluorescein dye is instilled into the conjunctival sac, and its disappearance is timed. Delayed disappearance suggests an obstruction in the drainage system. The **Jones Dye Test** involves instilling fluorescein and then attempting to recover it from the inferior meatus of the nose, confirming patency or identifying the level of obstruction.

More invasive but definitive diagnostic procedures include **lacrimal irrigation and probing**. During irrigation, a cannula is inserted into the punctum, and saline solution is flushed through the system. Patency is indicated by the patient tasting or feeling the saline in the throat, while obstruction is suggested by reflux from the same or opposite punctum. Imaging techniques such as **dacryocystography (DCG)**, using contrast dye, or more advanced methods like CT dacryocystography or MRI dacryocystography, can provide detailed anatomical information about the lacrimal sac and duct system, identifying the exact location and nature of any blockage or abnormality.

7. Pathologies and Clinical Significance

The lacrimal sac is susceptible to various pathologies, with significant clinical implications for ocular health. The most common condition is **dacryocystitis**, an inflammation or infection of the lacrimal sac. This typically arises from an obstruction of the nasolacrimal duct, leading to stagnation of tears and subsequent bacterial proliferation within the sac. Dacryocystitis can present as acute, characterized by pain, swelling, redness, and tenderness in the medial canthus, often with purulent discharge, or as chronic, presenting with persistent epiphora and occasional mucoid discharge.

Nasolacrimal duct obstruction (NLDO), both congenital and acquired, is another prevalent issue. Congenital NLDO is often due to the failure of the Valve of Hasner to open at birth, leading to excessive tearing in infants. Acquired NLDO can result from trauma, inflammation, tumors, or age-related narrowing of the duct. When the duct below the lacrimal sac is obstructed, the sac itself can dilate, forming a dacryocystocele, a mucoid cyst-like swelling.

Tumors of the lacrimal sac, though rare, are highly significant due to their potential for malignancy and aggressive local spread. Symptoms might mimic dacryocystitis, but persistent swelling, bleeding, or an unresponsiveness to conventional treatments should raise suspicion. Other less common conditions include lacrimal sac fistulas or diverticula. Understanding these pathologies is crucial for ophthalmologists to provide accurate diagnosis and timely intervention, preventing severe complications such as orbital cellulitis or vision loss.

8. Surgical Interventions

When conservative treatments for lacrimal sac pathologies prove ineffective, surgical interventions become necessary. For congenital nasolacrimal duct obstruction (CNLDO), massage of the lacrimal sac (Crigler massage) is often the first line of treatment. If this fails, **lacrimal probing**, where a thin wire is passed through the punctum, canaliculus, lacrimal sac, and into the nasolacrimal duct to open the obstruction, is typically performed, often with or without balloon dacryocystoplasty.

For acquired nasolacrimal duct obstruction or chronic dacryocystitis, the definitive surgical procedure is a **dacryocystorhinostomy (DCR)**. This operation creates a new direct pathway between the lacrimal sac and the nasal cavity, bypassing the obstructed nasolacrimal duct. DCR can be performed externally, involving an incision on the side of the nose, or endoscopically, through the nasal cavity, offering advantages of no external scar and reduced recovery time.

In cases of lacrimal sac tumors, a more aggressive surgical approach, such as **dacryocystectomy** (surgical removal of the lacrimal sac), may be required, often combined with adjunctive therapies like radiation or chemotherapy, depending on the tumor's nature and stage. Surgical management of lacrimal sac disorders aims to restore normal tear drainage, alleviate symptoms, prevent recurrent infections, and preserve ocular health and vision, ensuring a better quality of life for affected individuals.

9. Further Reading

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Lacrimal System - EyeWiki (American Academy of Ophthalmology)
Anatomy, Head and Neck: Nasolacrimal Duct - StatPearls (NCBI Bookshelf)
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