CT and MR imaging findings of tumors and tumor-like conditions of the Lacrimal sac

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Learning objectives

• To know the basic anatomy and spatial relationship of the lacrimal sac.

• To be familiar with the wide spectrum of tumors and tumor-like conditions of the lacrimal sac.

• To review the CT and MR imaging findings of various tumors and tumor-like conditions of the lacrimal sac according to systematic categorization of the diseases.

Background

Tumors and tumor-like conditions of the LS are uncommon and are not familiar to most of the general radiologists. Knowledge of their basic clinical and radiologic features would help differentiate between tumors and non-tumorous conditions and also between benign and malignant diseases.

Imaging findings OR Procedure details

I. Basic Anatomy and Spatial Relationship of the Lacrimal Sac

The lacrimal drainage system (Fig 1 on page 6)

Canaliculi (Superior and Inferior in each lid)

Valve of Rosenmüller (prevents the retrograde flow of tears)

Lacrimal sac in the bony lacrimal fossa

Nasolacrimal duct

Valve of Hasner (distal end of the nasolacrimal duct)
The lacrimal sac\textsuperscript{1-2} is a 1 to 2 mm wide and 13- to 15-mm vertically oriented structure that lodges in the bony lacrimal fossa. This fossa is formed by the frontal processes of the maxillary bone and the lacrimal bone. The body of the lacrimal sac extends from the medial canthal tendon inferiorly to the nasolacrimal duct. Its superficial surface is covered by a fibrous expansion derived from the medial palpebral ligament, and its deep surface is crossed by the lacrimal part of the Orbicularis oculi, which is attached to the crest on the lacrimal bone. Like the nasolacrimal duct, the sac is lined by stratified columnar epithelium with mucus-secreting goblet cells, with surrounding connective tissue.

**Normal CT appearance of the lacrimal sac (Fig 2 on page 7)**

CT has contributed significant to the assessment of mass lesions in the area of the lacrimal sac and duct. Besides delineation of the lacrimal sac and bone, CT provides detailed assessment of the surrounding structures including the orbits, paranasal sinuses and nasal cavity.

**Normal MR appearance of the lacrimal sac (Fig 3 on page 7)**

MR imaging provides superior soft tissue contrast and details and characterization of the lesions. Signal intensity of the lacrimal sac is iso intensity on T1WI, iso to high intensity on T2WI and well enhanced after gadolinium administration. These signal intensities of the lacrimal sac are same compared with those of the nasal mucosa.

**II. Spectrum of Tumors and Tumor-like Conditions of the Lacrimal Sac (Table 1)**

Tumors and tumor-like conditions of the LS were defined as masses that involved the LS primarily or secondarily. They were grouped under three categories: Infectious or inflammatory diseases, benign or malignant neoplasms and miscellaneous conditions.

**Infectious diseases**

The most common infectious process of the lacrimal drainage system is dacryocystitis. Narrowing obstruction of the lacrimal drainage system causes decreased tear out flow, bacterial proliferation, and infection. Acquired nasolacrimal duct obstruction has been divided into primary and secondary causes\textsuperscript{3}. Primary acquired nasolacrimal duct obstruction is more often affected in women than men (>80%). The width of the bony canal may be related to the obstruction due to inherent narrower inferior bony lacrimal canal in women. Other contributing etiologic factor may be inflammatory changes and hormonal changes\textsuperscript{4}. Secondary acquired nasolacrimal duct obstruction may be caused
by dacryoliths, foreign bodies, chemotherapy, previous trauma (Fig 4 on page 8) and
intranasal use of cocaine.

Dacryocystitis (Fig 5 on page 9) appears as a cystic mass at the inferomedial
orbit. Perilesional inflammation and peripheral enhancement can be seen in acute
dacryocystitis and it is compatible with an abscess. A granuloma may occur in chronic
infection of the lacrimal sac and simulate a neoplasm. After treatment of infection, a
striction may be formed in the duct and dacryocele may be occurred. CT demonstrated
mass with a central low density area reflecting fluid and may show iso density mass
reflecting dirty fluid in the inflamed cyst. Using MR imaging, acute dacryocystitis shows
hypointensity on T1WI, hyperintensity on T2WI, and peripheral contrast enhancement in
the region of the lacrimal sac that are imaging characteristics of an abscess.

**Inflammatory disease**

The lacrimal drainage system is susceptible to several systemic inflammatory conditions.
Sarcoidosis may involve almost every organ system, including multiple ocular and
orbital sites as well as the lacrimal drainage system. Wegener granulomatosis is
also a multiorgan disease and especially involving upper respiratory tract that has
manifestations including paranasal sinus disease, purulent or bloody drainage, and
mucosal ulceration. Eye manifestations occur in 50% of patients presenting with
dacryocystitis, lacrimal sac masses, and tearing.

**Benign or malignancy of neoplasms**

Lacrimal drainage system tumors are extremely rare. Stefanyszyn et al surveyed
370 lacrimal sac tumors in the previous reported literature, of which 202 (55%) were
malignant.

**Primary neoplasms**

Benign primary tumors of the lacrimal drainage system expand into the lumen of the
lacrimal sac and lacrimal drainage apparatus. On clinical examination, they are
generally well circumscribed, mobile beneath the skin, and firm on palpation. Papilloma
shows irregular filling defect reflecting their irregular contour on the dacryocystography.
Oncocytoma and benign mixed tumors demonstrate appear as sharply margined mass
within the lacrimal sac. Other benign lesions, such as polyps (Fig 6 on page 10),
pyogenic granuloma, solitary fibrous tumor (Fig 7 on page 11), fibrous histiocytoma
and neurofibroma can be seen in the lacrimal sac.
The primary malignant tumors of the lacrimal sac present a histopathologically diverse group of tumors. The majority are represented by carcinomas including squamous cell carcinoma (Fig 8 on page 13), undifferentiated carcinoma, transitional carcinoma, adenoid cystic carcinoma (Fig 9 on page 13), oncocytic adenocarcinoma, mucoepidermoid carcinoma and adenocarcinoma (Fig 10 on page 14). The most common malignant epithelial neoplasm was squamous cell carcinoma, which comprised 19% of all tumors. Squamous cell carcinomas (Fig 8 on page 13) may characteristically appear hypointense on T2WI\(^1\) differ from iso- or hyperintense MR appearance of the other tumors on T2WI. Other malignant tumors, such as melanoma (Fig 11 on page 15), lymphoma (Fig 12 on page 16), hemangiopericytoma and metastasis (Fig 13 on page 17) may be found in the lacrimal sac. These tumors are nonspecific imaging findings except malignant melanoma. Melanoma (Fig 11 on page 15) shows hyperintensity on T1WI and hypointensity on the T2WI with marked enhancement after contrast administration.

**Secondary neoplasms**

The secondary tumors involving or extending in the lacrimal sac cause mass effect and displacement of the lacrimal apparatus and secondary obstruction. These tumors include osteoma, mucocele, giant cell granuloma, inverted papilloma, fibro-osseous lesions, dermoid (Fig 14 on page 18), epidermoid (Fig 15 on page 19), compound Nevus (Fig 16 on page 21), angiofibroma (Fig 17 on page 21) and vascular malformation including AVM (Fig 18 on page 22), varix (Fig 19 on page 24) and lymphangioma (Fig 20 on page 24). The secondary malignant tumors that invade the lacrimal sac cause lacrimal symptoms besides symptoms from primary sites. The secondary malignant tumors includes paranasal sinus tumors, lymphoma of the orbit, metastatic disease and malignant eyelid tumors, such as basal cell carcinoma (Fig 21 on page 25), squamous cell carcinoma, sweet gland carcinoma and Sebaceous cell carcinoma (Fig 22 on page 26).

On CT, benign lesions typically do not demonstrate bone erosion. A large, irregular tumor with bone destruction indicates malignancy most often represented by carcinoma. MRI provides superior soft tissue contrast and details and adds some additional information. The irregular margins and infiltration of adjacent soft tissues that is characteristics of malignant neoplasms may be better appreciated using MR imaging because MRI provides superior soft tissue contrast resolution. A tumor is characterized by low signal intensity in T1WI and intermediate signal intensity on T2WI. Fluid, such as in a mucocele or inflammation demonstrates low or high signal intensity on the T1WI (depending on the protein content) and a high signal intensity on the T2WI.
Miscellaneous condition

Congenital dacryocele, mucocele, dacrocytocele, or amniotocele (Fig 23 on page 27)\(^\text{16}\) refer to a sterile accumulation of mucus or amniotic fluid may become trapped in the lacrimal sac and nasolacrimal duct with complete obstruction of the valve of Hasner, occurred bilaterally. On CT, dacryoceles are described as cyst like structures originating from the lacrimal sac and associated with a dilated nasolacrimal duct. On MR imaging, a mucocele is seen as a well-encapsulated, multilobulated, and septated mass in the lacrimal sac demonstrating hypointensity on T1WI and hyperintensity on T2WI\(^\text{17}\). Congenital atresia of the lacrimal puncta in which the puncta are absent but the remaining lacrimal drainage system is patent, duplication of a canaliculus, and diverticulae of the lacrimal drainage system may all be seen in young patients as well as in older individuals.

Images for this section:
Fig. 1: Normal left dacryocystogram, anteroposterior (AP) view.

Fig. 2: Normal CT anatomy of the lacrimal sac and fossa. Left image (3D reconstructed CT scan) shows lacrimal fossa (arrows) formed by the frontal process of maxillary bone and lacrimal bone. Axial (left upper) and coronal (left lower) CT scan shows the normal lacrimal sac and fossa (arrows).
**Fig. 3:** Normal MRI anatomy of the lacrimal sac. The lacrimal sacs (arrows) on all series of the MR images show same signal intensities compared with those of the nasal mucosa. (A) Coronal fat suppressed T2-weighted image (B) Coronal T1-weighted image (C) Coronal T1-weighted image with gadolinium enhancement (D) Axial T1-weighted image (E) Axial T1-weighted image
**Fig. 4:** Fig 4. Post traumatic dacryocystocele. (A) and (B) axial and (C) coronal noncontrast CT scan show soft tissue mass like lesion (arrow) at the lacrimal sac with multiple facial bone fracture involving lacrimal fossa and bony nasolacrimal canal.
Fig. 5: Acute dacryocystitis (A) Axial (D) Coronal contrast enhanced CT scan show solid and cystic mass (arrow) at the lacrimal sac. (B) Axial T1 weighted image, (C) Contrast enhanced axial T1 weighted image, (E) Coronal and (F) Axial T2 STIR image. MR images show ill defined enhancing soft tissue mass (arrow) with rim enhancing cystic area (asterisk). Perilesional edema and enhancement are also noted in the ipsilateral periorbital area.
**Fig. 6:** Sinonasal polyp. Noncontrast (A) axial and (B) coronal CT scan show well defined mass with bony erosion involving right lacrimal sac and right nasolacrimal duct, extension into the and right nasal cavity. (C) Axial T1WI shows well defined isointense mass and (D) fat suppressed axial T2WI also shows well defined homogeneous mild hyperintensity mass. (E) The mass shows rim enhancement without intratumoral enhancement on T1WI after contrast administration.
**Fig. 7:** Solitary fibrous tumor. (A) and (B) Noncontrast axial CT scan shows well defined ovoid isodense mass with mild bony remodeling (arrow head) at the lacrimal fossa. (C) After contrast administration, the tumor is homogeneously strong enhancement.

**Fig. 8:** Squamous cell carcinoma. (A) Axial T1WI shows ill defined homogeneously isointense mass involving lacrimal sac. (B) Axial T2WI shows heterogeneous relatively hypointensity in the mass. (C) Gadolinium enhanced T1WI and (D) fat suppressed coronal T1WI shows infiltrative homogeneously well enhancement of the mass. (E) Axial CT scan with enhancement shows ill defined heterogeneously well enhancing mass with bone erosion.
**Fig. 9:** Adenoid cystic carcinoma. Noncontrast (A) axial and (B) coronal CT scan show ill defined mass with bony erosion involving right lacrimal sac and right nasolacrimal duct, extension into the and right anterior maxillary sinus. (C) Axial T1WI shows ill defined isointense mass and (D) fat suppressed axial T2WI also shows ill defined homogeneous hyperintensity mass. (E) The mass shows homogeneously enhancement on T1WI after contrast administration.
Fig. 10: Adenocarcinoma. (A) Axial T1WI shows relatively ill defined lobulated contour homogeneously isointense mass involving left lacrimal sac. (B) Axial fat suppressed T2WI shows heterogeneous relatively iso to hypointensity in the mass. (C) Fat suppressed T1WI after gadolinium administration shows homogeneously moderate enhancement of the mass. (D) Noncontrast and (E) contrast enhanced axial CT scan shows ill defined heterogeneously well enhancing mass with bone erosion.
Fig. 11: Malignant melanoma (A) Axial T1WI shows relatively well defined heterogeneously hypointense mass involving left lacrimal sac. (B) Axial T2WI shows internal heterogeneous hyperintense area in the mass. (C) Gadolinium enhanced fat suppressed axial T1WI shows relatively well defined heterogeneously well enhancement of the mass. (D) Nonenhanced axial CT scan shows well defined homogeneously hyperdense mass with bone remodeling at the bony lacrimal fossa. (E) Contrast enhanced axial CT scan shows heterogeneously well enhancement in the tumor.
Fig. 12: Marginal zone B cell lymphoma. (A) Axial T1WI shows relatively well defined homogeneously isointense mass involving left lacrimal sac. (B) Axial T2 STIR image shows homogeneous relatively hyperintensity in the mass. (C) Gadolinium enhanced fat suppressed axial T1WI shows well defined homogeneously poorly enhancement of the mass. (D) ADC map shows diffusion restriction (arrow) in the tumor that is refer to hypercellularity of the lymphoma. (E) Axial CT scan with bone window setting shows no definite bone erosion.
**Fig. 13:** Acute lymphoblastic leukemia involvement. Contrast enhancing axial CT scan shows well defined homogeneously enhancing mass involving bilateral lacrimal sac.
**Fig. 14:** Dermoid cyst with inflammation. (A) Axial T1WI shows round homogeneously hyperintense mass in the anteromedial orbit adjacent to the lacrimal sac. The hyperintensity on T1WI represents fat. (B) T2 STIR image shows homogeneously hypointense of the tumor and preserved lacrimal sac. (C) Gadolinium enhanced fat suppressed T1WI shows rim and partial enhancement of the mass. (D) Diffusion weighted image demonstrated diffusion restriction of the tumor. Noncontrast (E) axial and (F) coronal CT scan show well defined fat density round mass without bony erosion.
Fig. 15: Epidermoid cyst. (A) Noncontrast axial CT scan show isodense oval mass at the lacrimal sac. (B) contrast enhanced axial CT scan shows no enhancement of the tumor.
Fig. 16: Compound nevus. (A) axial CT scan shows well defined irregular soft tissue mass (B) after contrast administration, well enhancement is notes in the mass.
**Fig. 17:** Giant cell angiofibroma. Noncontrast (A) axial and (B) coronal CT scan shows well defined soft tissue mass in the anteromedial orbit without bone erosion. (C) Axial T1WI shows isointense mass in the anteromedial orbit with lacrimal sac involvement and (D) axial T2WI also shows well defined homogeneous hyperintensity mass. (E) The mass shows strong heterogeneously enhancement on T1WI after contrast administration.
Fig. 18: Arteriovenous malformation. (A) Noncontrast axial CT scan shows ill defined mass in the anteroinferior orbit involving lacrimal sac. (B) Curvilinear strong enhancing
structures are seen in the tumor after contrast administration, suggesting arteriovenous malformation.

**Fig. 19:** Orbital varix with phlebolith. (A) Axial and (C) coronal enhancing CT scan shows well defined subtle enhancing mass (arrow) in the anteromedial orbit. (B) Noncontrast axial CT scan with bone window setting shows a calcification (arrow head) at the peripheral portion of the mass in the lacrimal sac. (D) Axial enhancing CT scan demonstrate other ill defined infiltrative lesions around optic nerve with a phlebolith and adjacent to medial wall of the orbit with pressure remodeling (arrow heads).
**Fig. 20:** Organized lymphangioma. (A) Noncontrast and (B) contrast enhanced axial CT scan shows infiltrative soft tissue mass with poorly enhancement. (C) Direct coronal CT image shows engorged venous structures (asterisk) in the intraconal space. (D) Axial T1WI shows infiltrative isointense mass and (E) axial fat suppressed T2WI shows heterogeneous bright hyperintense mass in the orbit and periorbital area. (F) The mass shows mild heterogeneously enhancement after contrast administration on fat suppressed T1WI.
Fig. 21: Basal cell carcinoma. (A) Noncontrast and (B) contrast enhanced axial CT scan shows ill defined soft tissue mass with heterogeneously enhancement. (C) Axial CT image with bone window setting shows suspected osseous nasolacrimal bone erosion (arrow head). (D) Axial T1WI shows infiltrative isointense mass and (E) Axial fat suppressed T2WI shows heterogeneous mild hyperintensity mass in the lacrimal sac. (F) Infiltrative heterogeneously enhancement after contrast administration on fat suppressed T1WI.
Fig. 22: Invasive Sebaceous carcinoma (A) Noncontrast and (B) contrast enhanced axial CT scan shows ill defined soft tissue mass with heterogeneously enhancement. (C) Coronal CT image shows mass destroys medial wall of the orbit with intraorbital extension. (D) Coronal T1WI shows infiltrative isointense mass and (E) coronal fat suppressed T2WI shows heterogeneous mild hyperintense mass in the lacrimal sac. (F) The mass shows mild heterogeneously enhancement and infiltrative invasion into the orbit after contrast administration on fat suppressed T1WI.
**Fig. 23:** Mucocele. 2 year-old girl. Noncontrast (A) axial and (B) coronal CT scan show bilateral soft-tissue lesion with adjacent bony remodeling in the opening of nasolacrimal duct.
Conclusion

Familiarity with CT and MR imaging findings of various tumors and tumor-like conditions of the LS would guide the physician to the appropriate management plan through narrowing the differential diagnoses.

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References


