Chapter 2
Imaging Vascular Lesions of the Orbit and Face

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Imaging can be crucial in establishing a diagnosis of any mass or lesion. This is especially apparent with orbital lesions where direct physical examination can be limited. The aim of this chapter focuses on describing radiographic features of various vascular lesions and malformations commonly found in the orbit and face. Logically, a good basis of understanding of various imaging modalities, especially magnetic resonance (MR) imaging, is critical in appreciating the features highlighted in the representative images.

Interpretation of MR images can be complicated; however, the basics of MR imaging can be readily adopted and utilized by an experienced clinician. On T1-weighted images, fluid is dark (hypointense), fat is bright (hyperintense), and soft tissues tend to be gray depending on the intrinsic water and fat content of the respective tissues. T1-weighted images usually show normal anatomy but can also be useful demonstrating pathology, especially after contrast administration. On T2-weighted images, fluid is bright (hyperintense). Many pathologic processes cause edema that increases water content making the T2-weighted images of the lesions brighter. More sophisticated sequences and techniques can add value to an imaging study and aid in bringing out pathologic features.

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2.1 Hemangiomas

Hemangiomas are common vascular tumors involving the head and neck. While oftentimes the diagnosis can be made on clinical observation, imaging modalities such as MR can be important in confirming the diagnosis. Furthermore, understanding the typical radiographic appearance of hemangiomas can guide us in identifying and distinguishing them from other vascular malformations.

Classic hemangiomas have a typical bimodal course in clinical observation, characterized by rapid growth followed by slow resolution during which the vascular tumor is replaced by a fibroadipose deposition. This pattern is also reflected in the appearance of hemangiomas on MR imaging. During the proliferative, biologically active phase, they have a characteristically different appearance than during the involuting phase [1].

The radiographic appearance of a hemangioma in the proliferative phase is characterized by a lobulated, solid mass with uniform, robust enhancement and the presence of intralesional flow voids (Fig. 2.1a). Flow voids are an MR equivalence of high flow, characteristic of arterial flow seen in various arterial

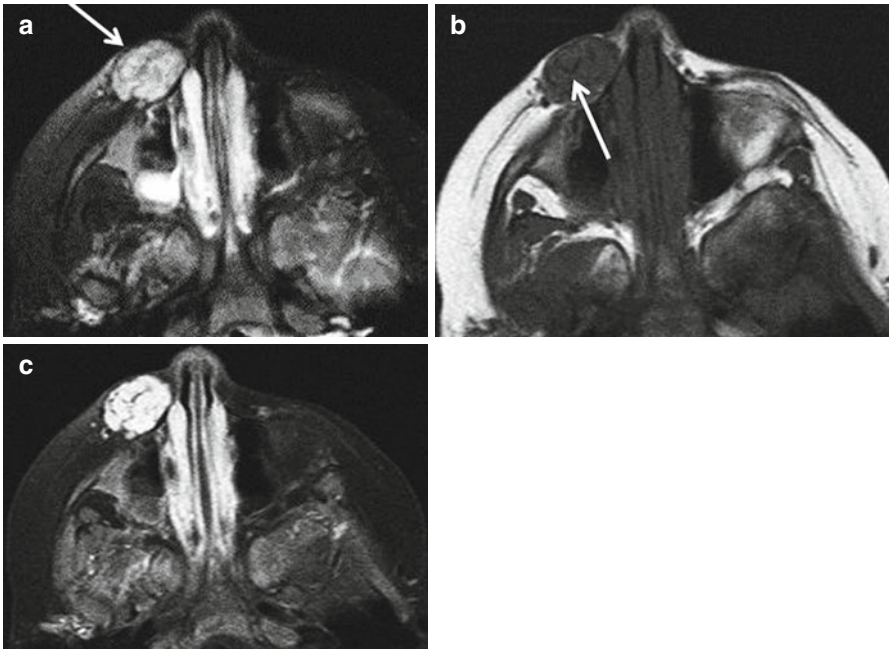

Fig. 2.1 Hemangioma: (**a**) axial T2-weighted MRI shows a lobulated high-signal mass (*arrow*) located in the right nasolabial fold. (**b**) The lesion has intermediate signal on the non-contrast T1-weighted image. The *arrow* demonstrates a serpiginous area of low signal within the hemangioma that is characteristic of a "flow void" indicating a "high-flow" vascular lesion. (**c**) Axial T1-weighted image performed after contrast administration and with fat-suppression shows that the mass avidly enhances which also increases the conspicuity of the dark flow voids

malformations and proliferative hemangiomas. On MR imaging, flow voids are dark spots within the lesion, readily identifiable in bright T2-weighted images and post-contrast enhancement T1-weighted images. On T1-weighted imaging, hemangiomas are dark, lobulated masses that then enhance with contrast with the intralesional flow voids (Fig. 2.1b). T2-weighted images of hemangiomas show a bright, high signal, lobulated mass with dark flow voids. Robust enhancement of hemangiomas is also characteristic on computed tomography (CT) imaging [2–4] (Fig. 2.1c).

During the involuting phase, hemangiomas transition to a low-flow vascular lesion. As a consequence, the dark flow voids are absent on imaging. Involuting hemangiomas maintain a characteristic lobulated appearance and continue to show robust, uniform enhancement on post-contrast T1-weighted images. The presence or absence of flow voids not only indicates activity of the hemangioma but also can guide treatment options [5, 6].

2.2 Vascular Malformations

Capillary malformations consist of birthmarks or port wine stains. They are typically seen in the V1 or V2 distribution of the face. Secondary to the benign nature of the lesion, imaging is not often indicated. On MR imaging, capillary malformations are characterized as very thin or linear and serpiginous. Capillary malformations are low flow and therefore do not exhibit flow voids. On T2-weighted images, capillary malformations display bright, thin, linear flow confined superficially to the skin [7] (Fig. 2.2).

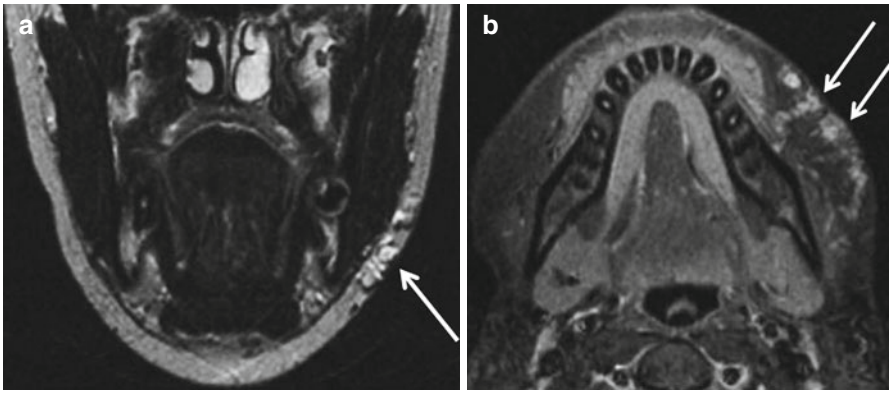

Fig. 2.2 Capillary malformation: (**a**) coronal T2-weighted image performed through the oral cavity illustrates subtle increased T2 signal involving the cutaneous and subcutaneous tissue overlying the left mandible (*arrow*). There is no deep extension into the deep musculature. (**b**) Axial T2-weighted MRI obtained through the same region shows thin serpiginous enhancement in the dermis and subdermal region (*arrows*). The enhancement is due to the increased capillary component of this type of low-flow vascular malformation

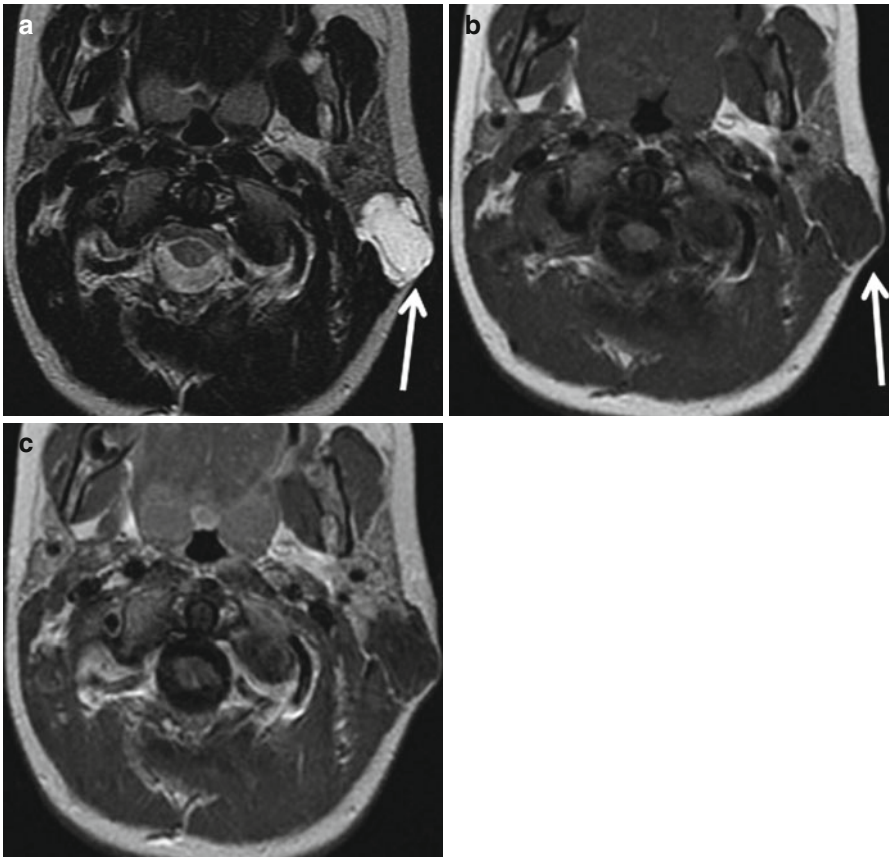

Fig. 2.3 Lymphatic malformation: (**a**) axial T2-weighted imaged demonstrates a high-signal mass (*arrow*) involving the posterior aspect of the parotid gland extending posteriorly and abutting the anterior aspect of the sternocleidomastoid muscle. (**b**) Non-contrast axial T1-weighted images show that the mass is low signal (*arrow*). The presence of high T2 and low T1 signal indicates that the mass is cystic. (**c**) The contrast-enhanced T1-weighted images show that the mass does not enhance indicating there is no vascular solid component, thereby confirming the clinical suspicion of a lymphatic malformation

Lymphatic malformations, formerly known as lymphangiomas or cystic hygromas, have a very classic MR appearance. Similar to hemangiomas, lymphatic malformations are characterized by a lobulated mass with a high signal on T2-weighed images and low signal on T1-weighted images (Fig. 2.3a, b). However, unlike hemangiomas, there is no post-contrast enhancement, and because this is a low-flow lesion, flow voids are naturally absent. Lymphatic malformations are essentially a sack of fluid, but there can be multiple septations which also do not exhibit enhancement on imaging (Fig. 2.3c). The soft, pliable nature of these malformations allows them to involve multiple anatomical locations and displace normal structures [8].

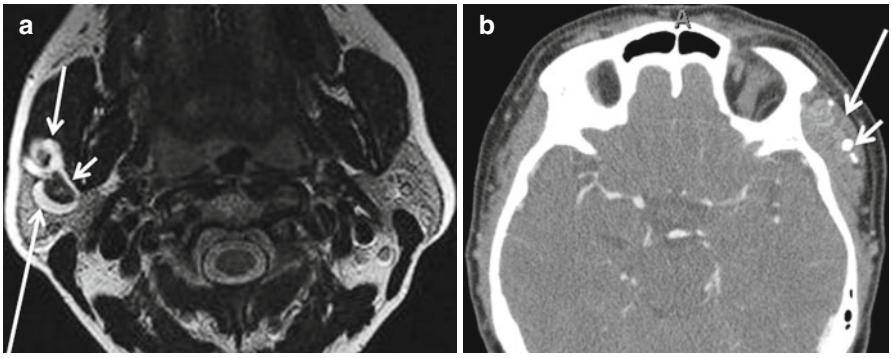

Fig. 2.4 Venous malformation: (**a**) axial T2-weighted image shows heterogeneous mass in the right parotid gland. (*large arrow*) The mass is predominantly increased T2 signal and extends into the right masseter muscle indicating an intramuscular component. (*intermediate arrow*) The high-signal mass contains focal areas of low signal (*short arrow*) that is due to clot within the venous malformation. (**b**) Contrast-enhanced CT in a different patient show enlargement of the left temporalis muscle. (*long arrow*) There are focal areas of increased attenuation due to calcified phleboliths indicating a venous malformation involving the left temporalis muscle. (*short arrow*)

Venous malformations, formerly known as cavernous angiomas, are the most common vascular malformations. Like their lymphatic counterparts, MR imaging of a venous malformation usually shows a lobulated mass with a high T2-weighted signal (Fig. 2.4a). Again, because venous malformations are low-flow lesions, flow voids would be absent. Distinguishing features of venous malformations are a classic intramuscular location and the presence of phleboliths (Fig. 2.4b). Phleboliths represent calcifications within the malformation. With any intramuscular lesion with a high T2-weighted signal, a venous malformation would be a high likelihood diagnosis. However, a venous malformation elsewhere in the soft tissues would make the diagnosis difficult to distinguish from a lymphatic malformation. A key difference would be the presence of phleboliths and the presence of slow, post-contrast enhancement of the venous malformation. Because there is low venous flow, the diagnosis can be confirmed with ultrasonography. Also, because there is slow flow in the venous malformations, clots can develop which appear as low signal densities with the mass on T2-weighted images [9, 10].

True arterial malformations are a rare diagnosis. The classic example is that of a carotid-cavernous fistula. Images with MR or contrast-enhanced CT would demonstrate considerable enlargement of the superior ophthalmic vein (Fig. 2.5). CT angiography would better define the anatomic details; however, conventional angiography is the diagnostic test of choice, especially if endovascular treatment is being considered [11].

Mixed versions of malformations exhibit features of their components. Arteriovenous malformations are characterized by large flow voids owing to high, arterial flow encountering slow, venous flow. Time resolved angiography or direct angiography can be beneficial in distinguishing venous from arterial in these malformations. Venolymphatic malformations appear as a lobulated lesion with internal

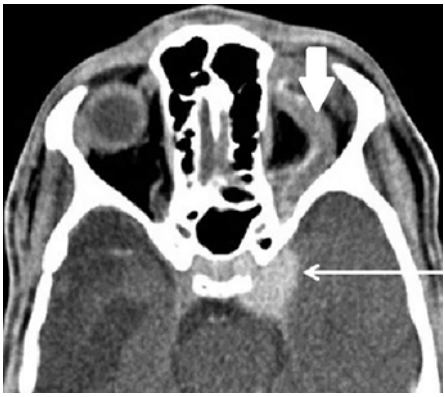

Fig. 2.5 Cavernous-carotid fistula (CCF): axial contrast-enhanced CT show an enlarged and asymmetrically enhancing left cavernous sinus. (*long arrow*) This is associated with a markedly enlarged and tortuous super ophthalmic vein. (*short arrow*) The enlarged vein is due to "reversed" arterialized flow from the direct CCF

blood-fluid levels. Again, because both components are low flow, flow voids are absent. Capillary lymphatic malformations look like lymphatic malformations but do exhibit post-contrast, linear enhancement characteristic of capillary malformations. With mixed vascular malformations, there are three or more components. Diagnosis is aided by identifying key elements such as enhancement, flow voids, and phleboliths [12].

2.3 Summary

Imaging of hemangiomas and vascular malformations is oftentimes crucial in establishing a proper diagnosis and guiding treatment options. The presence or absence of flow voids is especially important from a therapeutic standpoint as high-flow malformations demonstrating flow voids are typically treated endovascularly. Low-flow malformations, without flow voids, can be treated with direct injection or sclerotherapy. Future chapters will further address these lesions with their respective treatments.

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