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# Craniofacial Venous Plexuses: Angiographic Study

Anne G. Osborn<sup>1</sup>

Venous drainage patterns at the craniocervical junction and skull base have been thoroughly described in the radiographic literature. The facial veins and their important anastomoses with the intracranial venous system are less well appreciated. This study of 54 consecutive normal cerebral angiograms demonstrates that visualization of the pterygoid plexus as well as the anterior facial, lingual, submental, and ophthalmic veins can be normal on common carotid angiograms. In contrast to previous reports, opacification of ophthalmic or orbital veins occurs in most normal internal carotid arteriograms. Visualization of the anterior facial vein at internal carotid angiography can also be normal if the extraocular branches of the ophthalmic artery are prominent and nasal vascularity is marked.

The angiographic anatomy of the cranial dural sinuses and subependymal veins has been thoroughly discussed in the radiographic literature. While many authors have described the venous drainage patterns of the craniocervical junction [1-3], middle cranial fossa [4, 5], cavernous sinus area [6-9], tentorium [4], and orbit [10, 11], no systematic examination of the facial veins has been performed. This study describes the normal angiographic anatomy of the superficial and deep facial veins. Their anastomoses with the intracranial basilar venous plexuses are briefly reviewed and the incidence of their visualization on normal cerebral angiograms is outlined.

## Material and Methods

Fifty-four consecutive normal cerebral angiograms were selected for study. A total of 84 vessels was injected for a variety of clinical indications including seizures, headache, syncope, and transient cerebral ischemia. There were 67 common carotid and 17 internal carotid studies. Selective external carotid angiograms were not obtained. Common carotid angiography was performed using 10 ml 60% Conray (Mallinckrodt) injected at a rate of 8 ml/sec. For the selective internal carotid studies, 8 ml at 7 ml/sec was used. Subtraction masks were made of each study and all films from the late arterial through late venous phase were examined. Midvenous phase films in the lateral projection were also selected from each angiogram for routine single order subtraction prints. The type of cavernous or paracavernous venous drainage as well as visualization of the pterygoid plexus and the various facial veins was noted.

## Normal Gross Anatomy

Sphenobasal emissary channels pass through the foramina ovale, spinosum, and lacerum to connect the cavernous sinus with the pterygoid venous plexus, an extensive network of small vascular channels that overlies the lateral pterygoid muscle (fig. 1). The pterygoid plexus also communicates with the ophthalmic veins through the inferior orbital fissure, with the anterior facial vein via a deep facial branch, and receives tributaries corresponding to branches of the ptery-

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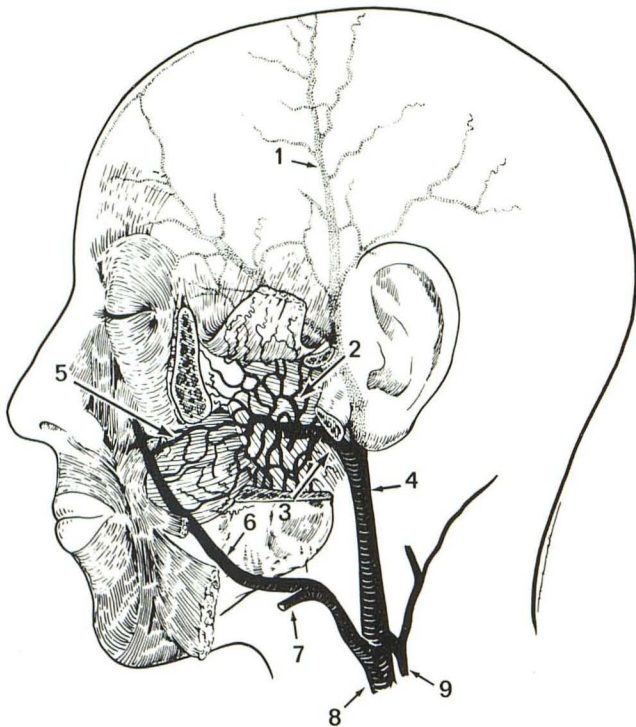


Fig. 1.—Anatomy pterygoid venous plexus. 1 = superficial temporal vein; 2 = pterygoid plexus; 3 = maxillary vein; 4 = retromandibular vein; 5 = deep facial vein; 6 = anterior facial vein; 7 = submental vein; 8 = internal jugular vein; 9 = external jugular.

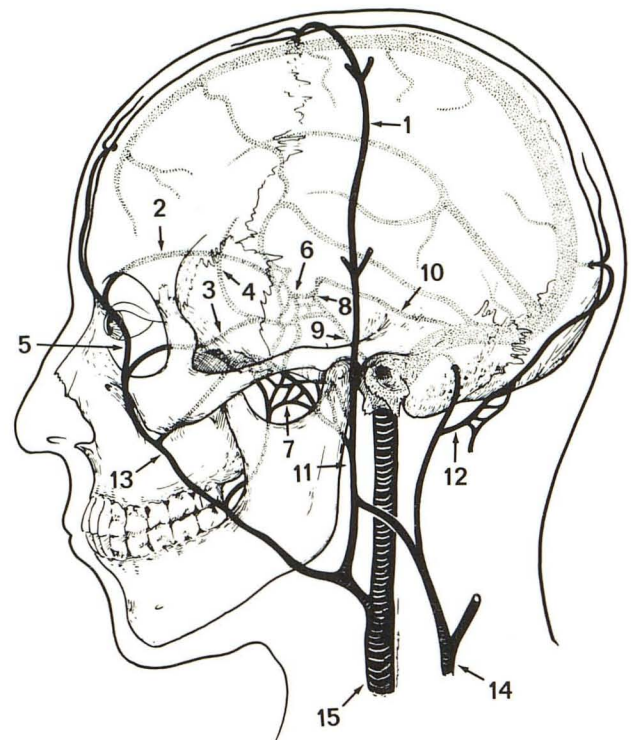


Fig. 2.—Anatomy of superficial facial veins, deep venous plexuses, and their anastomoses with intracranial venous system. 1 = superficial temporal vein; 2 = superior ophthalmic vein; 3 = inferior ophthalmic vein; 4 = superficial middle cerebral vein; 5 = angular vein; 6 = cavernous sinus; 7 = pterygoid plexus; 8 = basilar plexus; 9 = inferior petrosal sinus; 10 = superior petrosal sinus; 11 = retromandibular vein; 12 = occipital vein; 13 = anterior facial vein; 14 = external jugular vein; 15 = internal jugular vein.

gopalatine maxillary artery segment. The pterygoid plexus drains posteriorly into a short trunk called the maxillary vein (fig. 1). The maxillary vein then courses posteroinferiorly and unites with the superficial temporal vein to form the retromandibular vein. This vessel is usually a major tributary of the external jugular vein (fig. 2). The pterygoid plexus may also drain via the posterior and common facial veins into the internal jugular vein [12].

The anterior facial vein begins near the medial palpebral angle as a direct continuation of the angular vein. It descends obliquely across the face, crosses over the masseteric muscle, then curves over the inferior border of the mandible. During its course the anterior facial vein receives tributaries from the orbit, lips, facial muscles, and submental region.

The facial vein usually crosses the external carotid artery to drain into the internal jugular vein although it may also become a tributary of the external jugular system. The anterior facial vein anastomoses with the pterygoid plexus via the deep facial vein and with the cavernous sinus via the angular and ophthalmic veins (figs. 1 and 2).

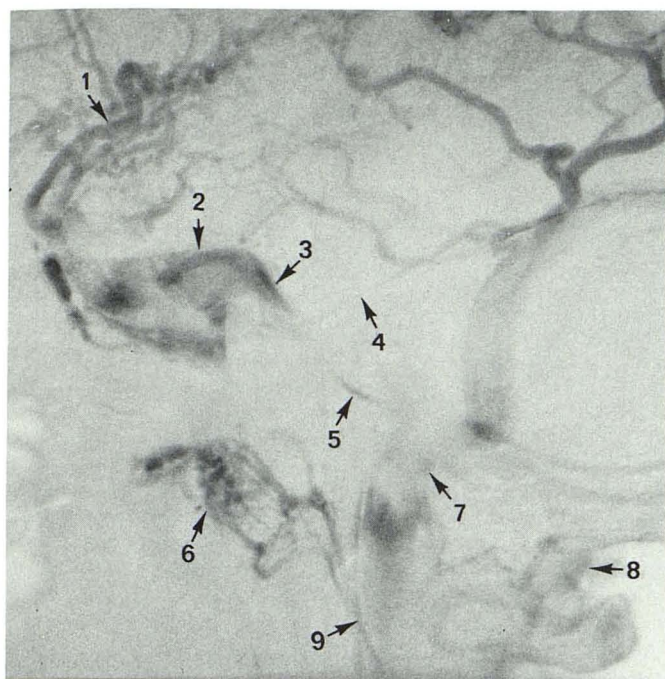
#### Normal Angiographic Anatomy and Results

Visualization of many deep facial veins, particularly the pterygoid plexus, is directly dependent on the intracranial

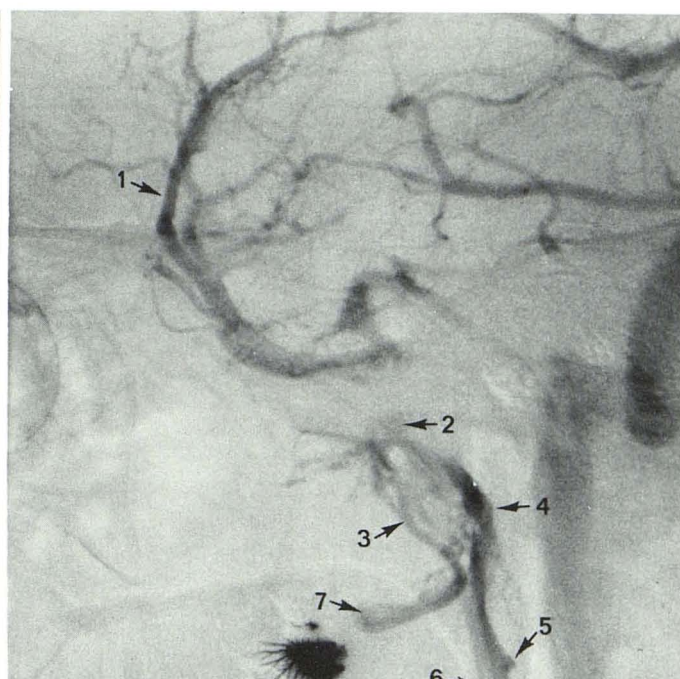
drainage patterns. If the basilar vein of Rosenthal, vein of Labbé, or superficial cortical veins are prominent, neither the cavernous sinus nor the pterygoid plexus may be opacified [13–15]. The cavernous sinus was visualized in 35 (41.7%) of the 84 angiograms, draining into the petrosal sinuses, basilar or pterygoid plexus, or a combination of these vessels (fig. 3).

Superficial middle cerebral venous tributaries were identified on 61 of 84 studies. These vessels often cross the greater sphenoid wing, draining directly into sphenoidal emissary veins that exit from the skull (usually through the foramen ovale) to communicate with the pterygoid plexus [7]. This sphenobasal pattern was identified in 21 (34.5%) of the 61 angiograms (fig. 4). Both the cavernous sinus and pterygoid venous plexus may be bypassed if the superficial middle cerebral vein drains into the transverse sinus instead (fig. 5). This sphenopetrosal configuration was present in eight (13%) of 61 of the angiograms. Combinations of the different basal drainage patterns may also exist, resulting in variable visualization of the pterygoid plexus (fig. 6). Combined drainage patterns were identified in 24.5% (15/61) of the examinations.

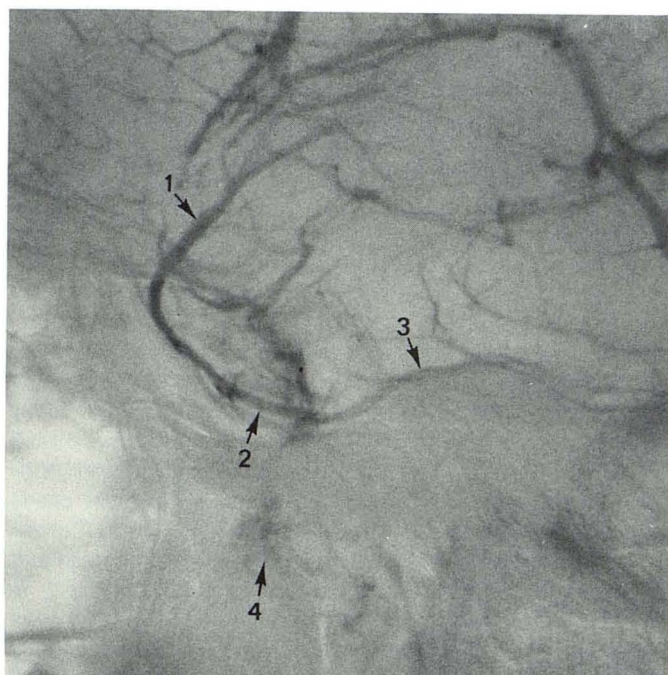
The superior and inferior ophthalmic or small orbital veins were identified in 31 of the 67 common carotid angiograms and 12 of 17 internal carotid studies (fig. 7). The direction



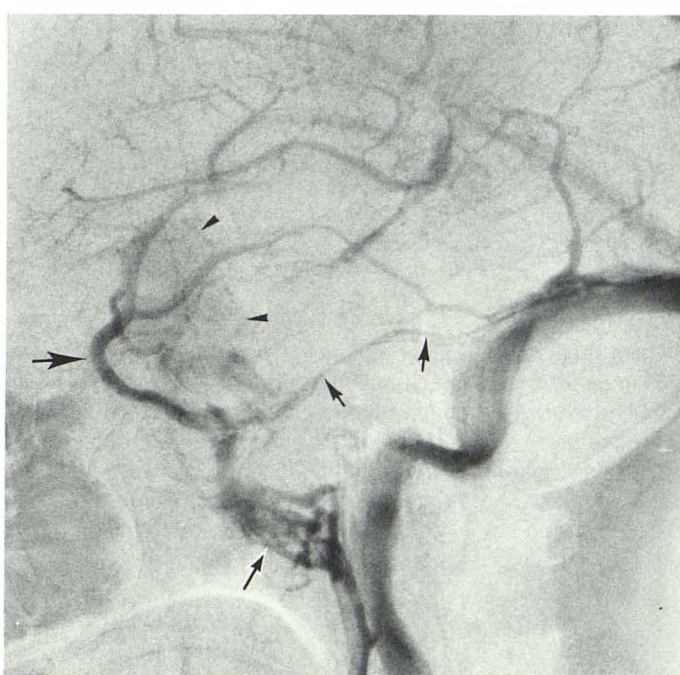
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4



5



6

Fig. 3.—Normal left internal carotid angiogram, midvenous phase, lateral view. 1 = superficial middle cerebral veins; 2 = cavernous sinus; 3 = basilar plexus; 4 = superior petrosal sinus; 5 = inferior petrosal sinus; 6 = pterygoid plexus; 7 = internal jugular vein; 8 = suboccipital venous plexus; 9 = maxillary vein.

Fig. 4.—Normal left common carotid angiogram, venous phase, lateral view. Dominant sphenobasal drainage pattern. Superficial middle cerebral vein drains into pterygoid plexus and petrosal sinuses, largely bypassing cavernous sinus. 1 = superficial middle cerebral vein; 2 = sphenobasal emissary veins passing through foramen ovale; 3 = pterygoid plexus; 4 = maxillary vein; 5 = superficial temporal vein; 6 = retromandibular vein; 7 = pharyngeal vein.

Fig. 5.—Normal left internal carotid angiogram, venous phase, lateral view. Predominant sphenopetrosal drainage pattern. 1 = superficial middle cerebral vein; 2 = sphenopetrosal vein; 3 = superior petrosal sinus; 4 = pterygoid plexus (faintly opacified).

Fig. 6.—Left internal carotid angiogram, venous phase, lateral view, in patient with suprasellar meningioma (arrowheads). Combined sphenobasal-sphenopetrosal pattern. Single large superficial middle cerebral vein (large black arrow) drains into pterygoid plexus (outlined arrow) and superior petrosal sinus (small black arrows). This case is a particularly striking example of combined basilar drainage.

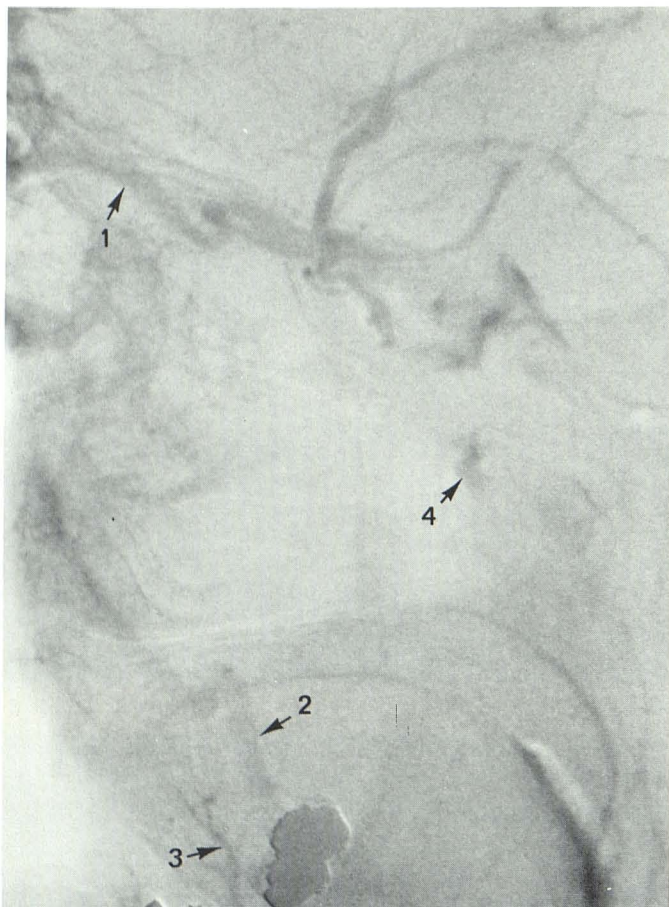


Fig. 7.—Normal left common carotid angiogram, venous phase, lateral view. 1 = superior ophthalmic vein; 2 = anterior facial vein; 3 = lingual veins; 4 = pterygoid plexus.



Fig. 8.—Normal left common carotid angiogram, venous phase, lateral view. 1 = anterior facial vein; 2 = submental vein; 3 = common facial vein.

of flow through the ophthalmic veins was extra- to intracranial in all these normal examinations. Superficial veins such as the anterior or common facial, lingual, or thyroidal veins were apparent on 19 of 67 common carotid angiograms (fig. 8). The anterior facial vein was identified on only one of the 17 internal carotid studies; in this particular angiogram the extraocular and ethmoidal branches of the ophthalmic artery were unusually prominent.

### Discussion

Although variations in venous drainage patterns around the cavernous sinus and skull base have been widely recognized [4–9], the connections that normally exist between the intracranial veins, dural sinuses, and facial veins are less well appreciated. While recognizing that the cavernous sinus is not invariably opacified at carotid angiography, some authors have stated that drainage into the pterygoid plexus indicates possible posterior obstruction of the cavernous sinus [6]. We have found that visualization of the pterygoid venous plexus is both common and normal.

Visualization of the ophthalmic and facial veins on selective external carotid studies has been documented by other

investigators. However, some have stated that visualization of the superior ophthalmic vein following selective internal carotid angiograms is a rarity except when the extraocular ophthalmic artery branches are prominent [10]. In contrast, we found that opacification of the superior or inferior ophthalmic veins or small orbital veins occurs in most cases when serial subtraction films are carefully studied. If anastomoses between ethmoidal branches of the ophthalmic and maxillary arteries are prominent and nasal vascularity is marked, the anterior facial vein may also be visualized even on selective internal carotid angiograms. The facial, lingual, submental, and even superior thyroidal veins are frequently visualized after common carotid studies. Visualization of the ophthalmic, pterygoid, and other facial veins at cerebral angiography is therefore normal. Identification of these structures should not be considered indicative of a vascular abnormality.

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