2.1 Cervical Segment

There are two common carotid arteries. The left common (LC) carotid artery arises from the aortic arch and the right common (RC) carotid artery from the brachiocephalic trunk. The common carotid arteries run cranially in the carotid space, surrounded by the three layers of the deep cervical fascia, called the carotid sheet. Approximately at the level of the hyoid bone, usually between the C4 and C6 vertebral bodies, each common carotid artery divides into the internal carotid artery (ICA) and external carotid artery (ECA). Cases of a higher bifurcation, up to the first cervical vertebra (Lie 1968), or lower, in the upper thoracic levels (Vitek and Reaves 1973), have been reported. The carotid sheet is a well-defined structure below the carotid bifurcation, though it is incomplete or absent at the level of the oral-nasal pharynx (Harnsberger 1995). The infraphyoid segment of the carotid space contains the common carotid artery, which is located in the so-called anterior triangle, defined by the sternocleidomastoid muscle, laterally and posteriorly, and by the superior belly of the omohyoid and the posterior belly of the digastric muscle, inferiorly and superiorly. The suprahyoid segment of the carotid space contains the ICA, more laterally and posteriorly the jugular vein, cranial nerves (IX, X, XI, and XII), the sympathetic plexus, and the chain of the lymph nodes (Fig. 2.1). Near the skull base, the borders of the carotid space are as follows: laterally, the parotid space; anteriorly and medially, the parapharyngeal and retropharyngeal spaces, respectively; posteriorly, the perivertebral space (Fig. 2.1c).

The first segment of the ICA (carotid bulb) is slightly enlarged, becoming smaller and narrower 1–2 cm distally. The bulb can be enlarged, particularly in older, atherosclerotic patients, and tortuosity of the distal segment is frequent in very young and older patients. This tortuosity can be congenital or related to dysplastic or atherosclerotic changes. At its origin, the ICA commonly lies posterior and lateral to the ECA. More distally, it is medial to the ECA (Fig. 2.1a, b) (see chapter 3).

2.2 Petrous Segment

The ICA enters the base of the skull at the carotid foramen, anteriorly to the jugular fossa and jugular vein. It runs entirely in the petrous bone, first with a vertical course for about 1 cm, then horizontally medially and slightly upward. Through its course, the ICA lies anteriorly medially and below the tympanic cavity and cochlea. It emerges from the petrous bone, near its apex, running above the cartilage covering the foramen lacerum (Figs. 2.2 and 2.3) and enters the cavernous sinus.

There are two branches: the caroticotympanic and mandibular arteries. The caroticotympanic artery is an embryonic remnant that supplies the middle ear cavity. There is possible anastomosis with the tympanic branch of the ascending pharyngeal artery (APhA). The caroticotympanic artery can be involved in tumors of the skull base, particularly in tympanojugular paragangliomas.

The mandibular artery is an embryonic remnant that usually divides into two branches: one runs in the pterygoid canal, anastomosing with the vidian artery; the other is more inferior, anastomosing with the pterygovaginal artery. This artery can be involved in the vascularization of angiofibromas. Apart from the above pathological situations, these branches are not commonly visible on an angiogram.
2.3 Cavernous Segment

This runs in the space (Taptas 1982; Bradac et al. 1990) formed by a division of the dura into two layers: the lateral one is the medial wall of the middle cranial fossa; the other is medial and in close contact in its inferior part with the peristeum of the sphenoid bone (periosteal layer). In this space, the ICA is directed first forward and upward, then curving posteriorly and slightly medially to the anterior clinoid process. The ICA lies laterally to the sella turcica and pituitary gland, separated by the medial layer of the dura. The ICA is surrounded by a venous plexus, and it has a close relationship with cranial nerves III, IV, and VI and the first and second branch of the trigeminal nerves. The nerves run close to the lateral
2.4 Supraclinoid Segment

The supraclinoid segment begins where the artery goes through the dura and enters the subarachnoid space, running posteriorly, superiorly, and slightly laterally between the anterior clinoid process laterally and the optic nerve medially. The dural ring surrounding the ICA, where the artery enters the subarachnoid space, is closely adherent to the artery laterally, but it is frequently less adherent medially, forming a thin cavity (carotid cave). Aneurysms arising below the dural ring (intracavernous aneurysms) can, however, expand the cave and extend superiorly into the subarachnoid space (cave aneurysms) (Kobayashi et al. 1995; Rhoton 2002).

At the level of the anterior perforated space (APS), the artery divides into the anterior and middle cerebral arteries. The supraclinoid segment can be subdivided into

- The MHT arises from the medial surface of the C5 segment of the ICA. It gives off a branch supplying the neurohypophysis (inferior hypophyseal artery), which is recognizable on an angiogram as a slight blush. It also gives off dural branches for the clivus and tentorium (clival and tentorial branches). The tentorial branch has been called the artery of Bernasconi and Cassinari (1957), who first reported its angiographic visualization. These dural branches anastomose with meningeal branches of the contralateral ICA and inferiorly with clival branches of the APhA. There are also possible anastomoses with branches of the middle meningeal artery.

- The ILT arise from the lateral surface of the C4 segment; it supplies cranial nerves III, IV, and VI and partially the ganglion Gasseri. It gives off dural branches for the dura of the cavernous sinus and adjacent area. In the supply of this area, there is a balance between the ICA system, represented by the ILT, and branches of the ECA, represented by the middle meningeal artery, accessory meningeal artery, artery of the foramen rotundum, and recurrent meningeal artery of the ophthalmic artery. One system can be dominant over the other. Anastomoses are frequently present.

The ILT and MHT are very fine branches (Fig. 2.4), not always recognizable on a lateral angiogram. They can be dilated and well visible when involved in the supply of pathological processes, especially meningiomas and dural arteriovenous fistulas.
a proximal and distal part, termed C2 and C1. From the origin of its branches, the supraclinoid segment can be more precisely subdivided as follows (Gibo et al. 1981): the ophthalmic segment, from the origin of the ophthalmic artery to the origin of the posterior communicating artery (PcomA); the communicating segment, from the origin of the PcomA to the origin of the choroidal artery; and the choroidal segment, from origin of the anterior choroidal artery to the terminal bifurcation of the ICA.

**2.4.1 In the Ophthalmic Segment Arise the Ophthalmic Artery and Superior Hypophyseal Arteries**

**2.4.1.1 The Ophthalmic Artery**

The ophthalmic artery (OA) arises on the superior-medial surface of the ICA. It runs below the optic nerve (Hayreh and Dass 1962a, 1962b; Hayreh 1962) and enters,
Fig. 2.4 (a) Carotid angiogram. Lateral-oblique view. Origin of the ophthalmic artery from the cavernous portion of the ICA (large arrow). Meningohypophyseal trunk (MHT) and inferolateral trunk (ILT). (b) ICA angiogram, lateral view. There is no ophthalmic artery. MHT, ILT. (c) ECA angiogram, lateral view of the same patient in B. Origin of the ophthalmic artery from the middle meningeal artery (MMA). There is also a possible supply from the anterior deep temporal artery (arrow). Middle deep temporal artery (arrow with dot). Superficial temporal artery (STA). In the later phase, the ocular complex (arrowhead) and blush of the choroid plexus (white arrow) are recognizable. (d) Different patient: origin of the MMA from the ophthalmic artery. Carotid angiogram, lateral view: ophthalmic artery (O). Lacrimal artery (arrowhead), from which arise the frontoparietal and temporal branches of the MMA (arrows). AP view, ophthalmic artery (O). Branches of the MMA (bidirectional arrow). (Patient with small aneurysm at the level of the posterior communicating artery)
together with the nerve, the orbita through the optic canal. Initially, the artery runs inferolaterally to the optic nerve (first segment), then crosses the nerve forming a bend below or above the nerve (second segment), and runs further medially and parallel to it (third segment). It gives off three types of branches: ocular, orbital, and extraorbital.

The ocular branches include the central retinal artery and the ciliary arteries supplying partially the optic nerve and the ocular bulb. These are the first branches arising where the artery crosses the nerve.

The orbital branches include the lacrimal artery, which supplies the lacrimal gland and conjunctiva. An important branch, sometimes present, is the recurrent meningeal artery, which runs backward and passes through the superior orbital fissure, anastomosing with branches of the middle meningeal artery (MMA).
Anastomosis of the lacrimal artery with the anterior deep temporal artery can be an important collateral circulation via the OA in occlusion of the ICA (Fig. 3.12). Other branches are the muscular arteries, which supply the muscle and orbital periosteum.

The extraorbital branches are numerous. They include the posterior and anterior ethmoidal arteries. The posterior arise from the first segment, the anterior from the third. These branches have an ascending course, pass through the lamina cribrosa, supplying the dura of the basal anterior cranial fossa. The anterior falx artery arises from the anterior ethmoidal artery and supplies the falx, anastomosing with the falx branches of the MMA. There are anastomoses between the ethmoidal arteries and the internal maxillary artery (IMA) through its sphenopalatine branches. From the latter arise small vessels with an ascending course; they anastomose with the corresponding descending branches that arise from the ethmoidal arteries. These arteries are typically involved in the vascularization of meningiomas of the basal anterior cranial fossa (Bradac et al. 1990) and in frontobasal dural fistulas (Figs. 3.25, 13.6, and 13.13).

Other arteries of this group are the supraorbital (frequently the most prominent), the dorsonasal, the medial palpebral, and the supratrochlear. These branches anastomose with branches of the ECA, in particular with the facial artery, infraorbital branch of the IMA, and frontal branches of the superficial temporal artery. Such anastomoses may be collateral via the OA toward the ICA when the latter is occluded (Fig. 3.12).

On an angiogram (Vignaud et al. 1972; Huber 1979; Morris 1997; Osborn 1999), the OA is always visible; it is better defined in the lateral view. From its origin, it runs superiorly for 1–2 mm, then anteriorly, forming a slight curve with inferior convexity. About 2 cm from its origin, the OA curves abruptly and crosses the optic nerve. Among its branches, the central retinal and ciliary arteries are sometimes recognizable, arising at the level of the above-described curve (Fig. 2.5). Thus, in embolization procedures involving the OA, the microcatheter should be advanced distally to the above-described curve. The blush corresponding to the plexus of the ocular choroid is always visible as a crescent-shaped structure. The ethmoidal arteries are occasionally evident, especially in the lateral view. The anterior falx artery is also easily identifiable, when present, on a lateral angiogram. These arteries can be well developed if involved in pathological processes (Figs. 3.25, 13.6, and 13.13). The other branches are difficult to recognize under normal conditions.

To explain some variants of the OA, it is useful to recall the most important aspects of its embryogenesis (Hayreh and Dass 1962a, 1962b; Hayreh 1962; Lasjaunias and Berenstein 1987). The definitive OA develops from three sources: the primitive dorsal OA, arising in the intracavernous portion of the ICA and entering the orbita through the superior orbital fissure; the primitive ventral OA, arising from the anterior cerebral artery and entering the orbita through the optic canal; and the stapedial artery (StA), which gives off an orbital branch entering the orbita through the superior orbital fissure. Inside the orbita and around the optic nerve, an arterial anastomotic circle is formed among these three arteries. In the further evolution, the proximal segment of the primitive ventral OA disappears, arising now from the supracavernous portion of the ICA. This artery will become the definitive OA. The primitive dorsal OA regresses, and the intraorbital branches of the StA are annexed by the definitive OA. In this process, important changes can involve the StA, some details of which are presented here.
The StA is the main branch of the hyoid artery (embryonic vessel), arising from the petrous segment of the ICA, which in this phase of embryogenesis is still very small and incompletely developed. The StA enters the middle cranial cavity, passing through the tympanic cavity and dividing into intracranial and extracranial branches (Moret et al. 1977; Lasjaunias and Berenstein 1987). The intracranial branch (supraorbital artery) is anteriorly directed, supplies the dura of the middle cranial fossa, and extends into the orbita, with a medial and lateral (lacrimal) branch. These branches enter the orbita through the superior orbital fissure. In some cases, the lacrimal artery penetrates as an isolated branch through the foramen of Hyrtl, located in the greater wing of the sphenoid bone. The second branch (maxillomandibular artery) is extracranial and passes through the foramen spinosum, anastomosing with the embryonic ECA, from which arise later the IMA and the MMA.

The StA disappears, but in some cases its first segment can persist as a small artery (caroticotympanic branch of the ICA). The extracranial segment becomes the MMA, arising from the developed final IMA; the intracranial segment in the middle cranial fossa partially regresses and is partly annexed by the MMA. The blood flow is now reversed, being intracranial. The intraorbital segment is annexed by the OA.

The embryological evolution can vary and lead to a series of conditions with different angiographic patterns (McLennan et al. 1974; Moret et al. 1977; Lasjaunias and Berenstein 1987; Morris 1997; Perrini et al. 2007). We describe here the most frequent.

- The proximal part of the primitive ventral OA does not regress and so the OA arises from the anterior cerebral artery. This is a very rare condition.
- The primitive ventral OA disappears instead of the primitive dorsal OA, leading to an intracavernous origin of the OA (Figs. 2.4 and 4.8c, d).
- The proximal part of the OA disappears, though the intraorbital section of the StA remains and is connected at the level of the superior orbital fissure with the MMA. In such cases, the OA is only visible on the ECA, not ICA, angiogram (Fig. 2.4b, c).
- The lacrimal branch can persist as an isolated branch of the MMA (meningolacrimal artery), entering the orbita through the foramen of Hirtl and supplying partially the intraorbital structures, while the ocular and neuronal branches arise from the OA. In such cases, the orbital vascularization is partially visible on the ECA and ICA angiogram. There are commonly no anastomoses between these two systems. In other cases, the MMA gives off a branch, which enters the orbita through the superior orbital fissure and anastomoses with the lacrimal branch of the OA.
- Another condition is characterized in addition to the MMA by the presence of the recurrent meningeal artery (Figs. 13.8, 3.20, and 3.25). This is a meningeal branch, arising from the OA in its initial segment or from the lacrimal branch; it runs posteriorly through the superior orbital fissure, supplying the dura in the area of the cavernous sinus and tentorium, where it anastomoses with other branches involved in the supply of this region.
- The MMA arises from the OA, and so it is only recognizable on the ICA angiogram. This occurs when the intracranial part of the MMA does not develop; the proximal part of the intraorbital-transsphenoidal segment of the StA does not regress and anastomoses with the lacrimal branch of the OA (Fig. 2.4d).
- The MMA originates in the petrous segment of the ICA: this occurs when the first and intracranial segments of the STA do not regress and the extracranial portion of the MMA does not develop. In the skull CT, the foramen spinosum is not present, and the MMA is only visible on the ICA angiogram.

2.4.1.2 The Superior Hypophyseal Artery

The superior hypophyseal artery (SHA) is a group of small branches arising commonly from the posteromedial surface of the ophthalmic segment of the ICA. The SHA supplies the infundibulum, anterior lobe of the pituitary gland, and partially the optic nerve, chiasma, and floor of the III ventricle. The SHA is not recognizable on a normal angiogram. The ophthalmic segment is a typical site of aneurysms (carotid-ophthalmic and SHA aneurysms).
2.4.1.3 Supply of the Pituitary Gland

The adenohypophysis is supplied by the superior hypophyseal arteries. These run toward the pituitary stalk, where they connect with a network of capillaries continuing in venules forming the so-called venous portal system, through which flow the releasing and release-inhibiting hormones from the hypothalamus to the adenohypophysis. The neurohypophysis is supplied by the inferior hypophyseal artery. Each half of the pituitary gland drains into the corresponding cavernous sinus, which continues into the inferior petrosal sinus.

2.4.2 In the Communicating Segment Arises the PcomA

The PcomA arises from the posterior surface of the ICA. It runs posteriorly and medially to join the posterior cerebral artery (PCA) in a close relationship with cranial nerve III, which is laterally and sometimes medially located (Gibo et al. 1981). An anomalous origin from the OA has been reported (Bisaria 1984).

Commonly, the PcomA is slightly smaller than the PCA. The PcomA may, however, be very large, continuing directly into the PCA. This variant is termed the “fetal” origin of the PCA. Indeed, in the embryonic phase, the PCA takes its origin from the ICA, while the connection of the PCA with the basilar artery through the P1 segment develops later. In the further evolution, the PcomA (pars carotica of the PCA) becomes hypoplastic or regresses entirely, while the P1 segment (pars basilaris of the PCA) becomes well developed. This evolution occurs in about 70% of cases (Zeal and Rhoton 1978; Huber 1979; Pedroza et al. 1987).

A slight widening of the origin of the PcomA is not rare. It has been described in 6.5% of normal angiograms (Hassler and Saltzmann 1967), and it has been interpreted as an early stage of aneurysm formation. Other studies (Epstein et al. 1970) made on autopsy specimens have demonstrated neither an aneurysmal nor preaneurysmal aspect.

From the PcomA arise many perforating branches. Since the first description by Duret (1874), many anatomical studies have been performed (Foix and Hillemand 1925a, b; Lazorthes and Salamon 1971; Saeki and Rhoton 1977a, b; Zeal and Rhoton 1978; Gibo et al. 1981; Pedroza et al. 1987; Tatu et al. 2001; Ono et al. 2015), and these arteries have been variously termed tuberothalamic, premammillary, and anterior thalamoperforating arteries. The latter definition seems to be the most appropriate and is the one we will adopt. Many branches are present, also in cases of a smaller PcomA. Among them, there is sometimes a large branch arising in front of or beside the mammillary body (Gibo et al. 1981; Pedroza et al. 1987). These perforators supply the posterior part of the chiasma, the optic tract, and the mammillary body; they enter the posterior perforated substance, supplying the hypothalamus, subthalamus, and anterior thalamus. Some authors (Gibo et al. 1981) have found that they supply also the posterior limb of the internal capsule.

A precise angiographic study of the PcomA is possible only by performing carotid and vertebral angiograms. Depending on its caliber and flow effects, the PcomA is visible on both lateral angiograms or on only one (Figs. 2.6, 7.3, 7.9, 6.8, 15.9 and 15.10). The perforators on the lateral vertebral angiogram are evident as small branches, running upward and slightly backward (Fig. 7.6). In the angio-MRI, the PcomA, P1, and PCA complex can be well identified (Figs. 7.2 and 7.9d). Perforators are not commonly visible.

2.4.3 In the Choroidal Segment Arise the Anterior Choroidal Artery and Often Perforators Directly from the ICA

2.4.3.1 The Anterior Choroidal Artery

In all cases studied by Rhoton et al. (1979), the anterior choroidal artery (AChA) arose from the posterior surface of the ICA (2–4 mm distal to the PcomA) and, more laterally, to the site of origin of the PComA. The AChA can be divided into a cisternal segment, from its origin to the choroid fissure, and a distal plexal segment (Goldberg 1974; Rhoton et al. 1979). The cisternal segment, from which arise the main supplying branches for the parenchyma, has an average length of 25 mm (Otomo 1965; Rhoton et al. 1979). The artery runs first posteromedially below the optic tract, then
turns laterally into the circumpeduncular cistern around the midbrain; it then runs toward the lateral geniculate body, where it curves sharply, entering the temporal horn through the choroid fissure and joining the choroidal plexus. The artery extends posteriorly, reaching the atrium, where it can anastomose with branches of the posterolateral choroidal artery. Rarely, it extends anteriorly toward the foramen of Monro, supplying the plexus and anastomosing with the posterior medial choroidal artery.

The AChA gives off many branches: perforator branches arise from the cisternal segment and penetrate the APS, posteriorly to the perforators of the A1 segment and ICA and medially to those of the MCA. The supplied vascular territories can be divided into superior, lateral, and medial groups (Abbie 1933; Carpenter et al. 1954; Rhoton et al. 1979; Duvernoy 1999; Tatu et al. 2001). The superior group supplies the optic tract, the medial part of the globus pallidus, the tail of the nucleus caudatus, sometimes the genu of the internal capsule (Goldberg 1974), and the inferior part of the posterior limb of the internal capsule, together with its retrolenticular and optic radiations. According to some authors (Hupperts 1994), the AChA also supplies the parietal periventricular area. The lateral group supplies the uncus, amigdala, and hippocampus (Rhoton et al. 1979). The medial group supplies the anterolateral midbrain and lateral geniculate body (Rhoton et al. 1979).

There is a marked interchangeability in the vascular territories described among the AChA, ICA, PCA, PcomA, and MCA (Rhoton et al. 1979). Moreover, there are rich anastomoses between the AChA and PCA via the choroidal arteries and through branches on the surface of the lateral geniculate body and on the temporal lobe near the uncus. All these factors make it difficult to predict the effect of occlusion of the AChA (Rhoton et al. 1979; Friedman et al. 2001).

The artery is commonly well visible on anteroposterior (AP) and LL angiograms. On the lateral angiogram, the artery runs backward, forming an upward convex curve. It runs further downward and enters the choroid fissure (plexal point). The plexal segment extends posteriorly into the temporal horn toward the atrium and lateral ventricle, showing a typical blush in the late arterial-capillary phase. On the AP angiogram, the AChA runs first medially and then laterally, surrounding the cerebral peduncle, mixing with perforators of the middle cerebral artery (Figs. 2.6–2.8).

Many anomalies concerning the origin and development of the AChA have been described. A few cases of origin have been reported from the PcomA or middle cerebral artery (Carpenter et al. 1954; Otomo 1965; Herman et al. 1966; Lasjaunias and Berenstein 1990).
2.4 Supraclinoid Segment

and from the ICA proximal to the PcomA (Moyer and Flamm 1992) as well as a case of aplasia (Carpenter et al. 1954). In a more recent extensive study (Takahashi et al. 1990) considering also previous works (Theron and Newton 1976; Saeki and Rhoton 1977; Takahashi et al. 1980), the anomalies concerning the development of the AChA were classified into two groups: hypoplastic and hyperplastic forms. In the first, which is less common, the distal segment (plexal) is hypoplastic and thus not recognizable on an angiogram. In the hyperplastic group, the artery is well developed, taking over partially or completely the vascular territory of the PCA (Fig. 2.8). In some cases, it is difficult to establish whether the situation is one of hypertrophic branches of the AChA or a duplicated PCA (Fig. 7.10).

2.4.3.2 The Perforators of ICA

The perforators of the ICA also arise from the choroidal segment of the ICA, typically from its posterior wall.

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**Fig. 2.7** (a) Lateral carotid angiogram. Anterior choroidal artery with its cisternal (C) and plexal (P) segments. (b) Carotid angiogram, AP view. Course of the anterior choroidal artery (arrowhead)

**Fig. 2.8** Carotid angiogram (oblique view) in a patient with aneurysm treated with coils. Anterior choroidal artery (arrowhead). Large perforators directed superiorly are well evident (arrow with angle) as well as a large uncal branch (arrow). The “clip” projecting on the ICA was used to treat a contralateral aneurysm.
They enter the APS and supply the genu of the capsula interna, its posterior limb, and the adjacent part of the pallidum. They can replace perforators of the AChA and parts of perforators of the MCA and vice versa. The perforators are rarely evident on an angiogram.

2.5 Congenital Anomalies of the ICA

These are very uncommon. They are characterized by an anomalous origin from the aortic arch, an aberrant course, and hypo- or aplasia of the artery.

- Cases of hypo- or aplasia can be suspected in CT or MRI, showing, respectively, a small or absent carotid canal and reduction or absence of blood flow. Various type of collateral circulation may be present, involving the circle of Willis. A particular form is characterized by the persistence of the primitive maxillary artery, arising at the cavernous portion of the ICA, leading to an intrasellar anastomosis connecting both ICAs (Lasjaunias and Berenstein 1987; Gozzoli et al. 1998) (Fig. 2.9). This anomaly is very rare; however, it should be taken into consideration in particular in patients in whom a transsphenoidal surgery for intrasellar adenoma is planned. Cases associated with hypopituitarism have been reported (Mellado et al. 2001; Moon et al. 2002).

- Other anomalies are the embryogenic persistence of the connection between the carotid and verteobasilar circulation, which normally disappears. Considering these in the craniocaudal direction, the first is represented by the so-called fetal PCA (see Sect. 2.4.2 and Chap. 7). The second most frequent, with an incidence of 0.1–0.2% (Lie 1968; Huber 1979), is the primitive trigeminal artery, which connects the cavernous portion of the ICA with the basilar artery. The primitive trigeminal artery runs in a parasellar or intrasellar fashion and can have contact with the trigeminal nerve. It may be associated with other vascular malformations, particularly aneurysms (Ahmad et al. 1994). The vertebral and proximal basilar arteries are frequently hypoplastic or can be normally developed (Ohshiro et al. 1993). Conversely, this connection may be a collateral circulation from the basilar artery toward the ICA in the case of agenesis of this artery (Lasjaunias and Berenstein 1987) (Fig. 2.10).

- Other less frequent carotid-basilar anastomoses are persistent otic, hypoglossal, and proatlantal arteries. The otic artery connects the petrous ICA with the basilar artery. There are only a few angiographic reports about this anomaly (Reynolds et al. 1980). The persistent hypoglossal artery arises from the cervical ICA at the level of C1–C2 (Kanai et al. 1992), runs dorsally, entering the hypoglossal canal, which is enlarged (visible on the CT skull base), and joins the vertebral artery. The association with aneurysm has been reported (Brismar 1976; Kanai et al. 1992). The vertebral arteries are hypoplastic or absent (Fig. 2.10). The persistent proatlantal artery arises from the cervical ICA or from the ECA, runs dorsally, reaches the atlas and runs horizontally above it, where it connects with the extradural vertebral artery, which is hypoplastic or absent.

- Another rare condition is the origin of the superior cerebellar artery, anterior inferior cerebellar artery, and posterior inferior cerebellar artery from the cavernous portion of the ICA (Scotti 1975; Haughton et al. 1978). This has been interpreted (Lasjaunias and Berenstein 1990) as a partial trigeminal persistence.

- A particular form of aberrant ICA is that in which the artery passes through the temporal bone, more posteriorly than in normal cases, laterally to the jugular bulb and adjacent to the stylomastoid foramen. As it enters the middle ear cavity, the ICA sharply turns medially and anteriorly. This anomaly has been interpreted as an agenesis of the terminal part of the cervical ICA, with the formation of a collateral circulation between the enlarged tympanic branch of the APhA and the caroticotympanic branch remnant of the StA. CT of the skull discloses the presence of a soft tissue mass protruding in the tympanic cavity. Angiographic study clarifies the diagnosis with a small suspected tympanic paraganglioma (Lo et al. 1985; Osborn 1999) (Fig. 2.11).
2.5 Congenital Anomalies of the ICA

**Fig. 2.9** Aplasia of the ICA. (a) CT and MRI showing, respectively, that the canal of the horizontal portion of the petrous segment of the ICA on the left is absent and the typical flow signal is only recognizable on the right. (b) Right carotid angiogram, AP view. There is filling of the cavernous portion of the left ICA through intrasellar anastomosis (arrowhead) corresponding to the primary maxillary artery. There is further filling of the middle cerebral artery. The A1 segment is aplastic.
Fig. 2.10 Embryogenic connections between the ICA and vertebrobasilar circulation. (a) Persistent primitive trigeminal artery connecting the cavernous portion of the ICA with the basilar artery. The connection is visible on the carotid and vertebral angiograms. (b) Persistent hypoglossal artery arising from ICA, entering the hypoglossal canal (arrow) and anastomosing with the vertebral artery.
2.5 Congenital Anomalies of the ICA

Fig. 2.11 Aberrant course of the ICA. (a) Lateral and AP angiogram of internal carotid artery. Origin of the APhA (arrow) from the ICA. The ICA runs more posteriorly on the lateral angiogram and more laterally in the AP view. (b) CT, coronal and axial view. The ICA enters the middle ear cavity and is visible as a small, rounded, soft-tissue structure (arrow).
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