Anatomy of the Neck in Postmortem Angiography

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The anatomy of the vessels of the neck region can be depicted in the human corpse by postmortem angiography in a convincing manner. The branches of the aortic arch as the tributaries of the extra- and intracranial arteries can be opacified without relevant hindrances, as can the neck-related vein system that drains the head. Limitations may be experienced in the visualization of very small arteries such as the anterior or posterior spinal arteries in the cervical spine. The anatomy of the branches of the subclavian artery is highly variable, which refers particularly to those branches that are ascribed to the thyrocervical trunk. The visualization of anatomic variations is a tremendous advantage of postmortem angiography, allowing systematic cadaver-based studies on their nature and prevalence.

12.1 Arterial Blood Supply of the Neck

The neck is traversed on each side by two large arteries, whose final destination is the head and the arm; these are the carotid artery and the subclavian artery, which are branches of the aortic arch. On the left side, both arteries derive separately from the aortic arch, whereas on the right side they have a common trunk (the innominate artery).

The main branches of the subclavian artery are (Figs. 12.1 and 12.2)

- the vertebral artery, which ascends into the transverse processes of the cervical vertebrae, and the foramen magnum, which ascends into the cranial cavity; together with the internal carotid artery, it supplies the brain (*see* Chap. 11)
- the internal thoracic artery (*see* Chap. 14),
- the thyrocervical trunk
- the costocervical trunk
- the dorsal scapular artery (inconstantly).

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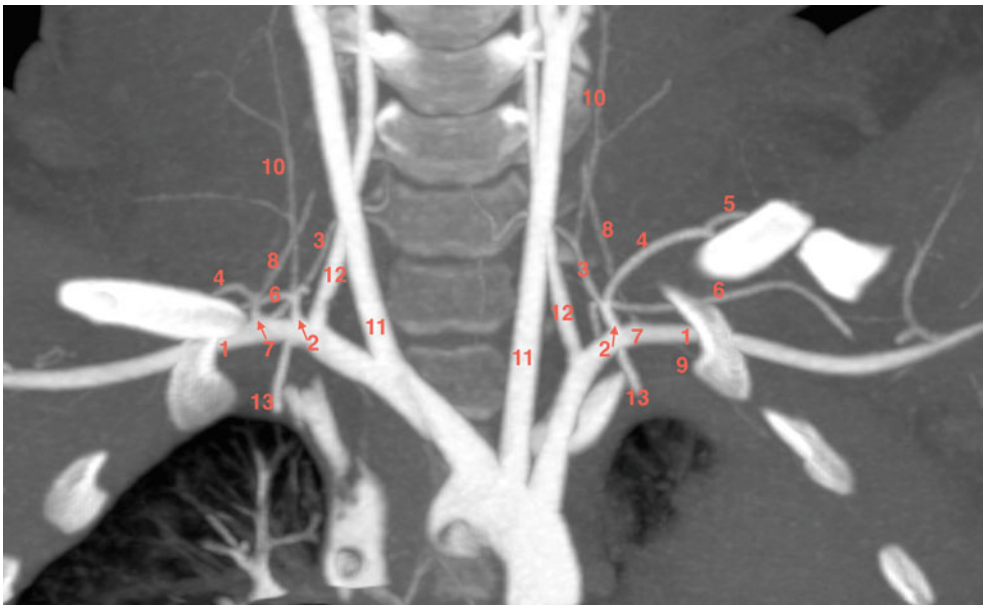

Fig. 12.1 Coronary multiple detector computed tomography (MDCT) reconstruction of the arterial phase of multiphase postmortem CT angiography (MPMCTA) at the level of the subclavian artery (*1*). Thyrocervical trunk (*2*) with inferior thyroid artery (*3*), transverse cervical artery (*4*) dorsal scapular artery (*5*), suprascapular artery (*6*). Costocervical trunk (*7*) with deep cervical artery (*8*) and supreme intercostal artery (*9*). Note that the ascending cervical artery (*10*) as a branch of the inferior thyroid artery leaves on the right side directly from the thyrocervical trunk. Originating from the costocervical instead of thyrocervical trunk on the right side. Common carotid artery (*11*), vertebral artery (*12*), internal thoracic artery (*13*)

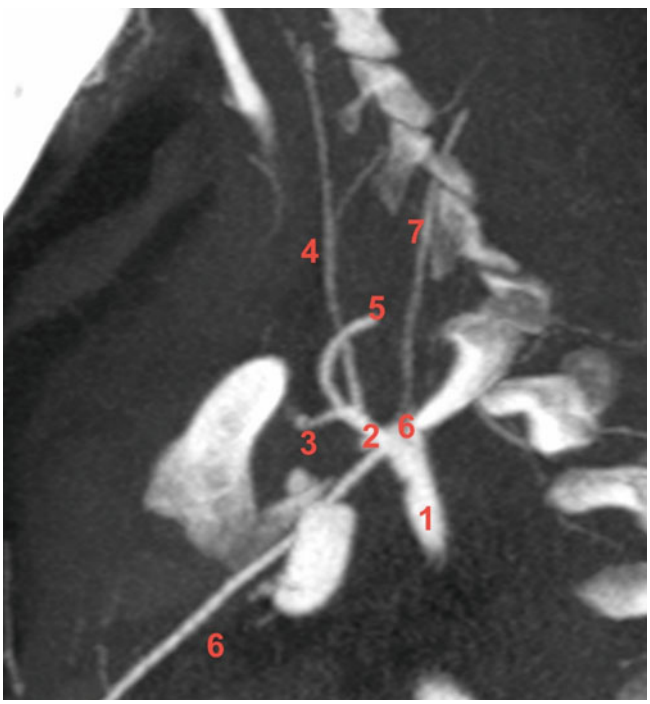

Fig. 12.2 Sagittal MDCT reconstruction of the arterial phase of MPMCTA at the level of the left subclavian artery (*1*). Thyrocervical trunk (*2*) with suprascapular artery (*3*), inferior thyroid artery (*4*), transverse cervical artery (*5*). Costocervical trunk (*6*) with deep cervical artery (and supreme intercostal artery, which is not visualized). Note that the deep cervical artery (*7*) runs between the transverse processes of C7/Th1

12.1.1 Common Carotid Artery

The common carotid artery rises without lateral branches behind the sternocleidomastoid muscle and divides at the level of the upper border of the thyroid cartilage—approximately equal to the height of vertebra C4—in its two terminal branches. It is accompanied by the internal jugular vein and the vagus nerve, which are jointly surrounded by fibrous connective tissue in the carotid sheath (the artery on the medial side, the vein on the lateral side).

While the common carotid artery is very deeply seated at the lower part of the neck (covered by the deep cervical fasciae and the sternocleidomastoid, sternohyoid, sternothyroid, and omohyoid muscles), its course becomes more superficial in the upper part.

In the so-called carotid triangle behind the sternocleidomastoid muscle, the artery is crossed by the sternocleidomastoid branch of the superior thyroid artery and near its termination by the superior and middle thyroid veins (Fig. 12.3); The anterior jugular vein crosses the artery just above the clavicle (Fig. 12.3) but is separated by muscular tissue. The inferior thyroid artery crosses behind the lower part of the vessel (Fig. 12.1).

At the lower part of the neck, on the right side of the body, the right recurrent laryngeal nerve crosses obliquely behind the artery; the right internal jugular vein diverges from the artery. On the left side, however, the left internal jugular vein approaches and often overlaps the lower part of the artery.

In case of collateralization of the common carotid artery, superior and inferior thyroid arteries as well as the deep cervical artery and the descending branch of the occipital artery may take over; the vertebral artery assists intracranial collateralization in these cases.

There are rare variations regarding the artery's bifurcation level (39 % at the superior border of the thyroid cartilage, 40 % at the body of the hyoid bone—see Fig. 12.4) [1]. As a very rare occurrence the absence of either an external or internal carotid or the absence of even the common carotid combined with the origin of the external and internal carotids from the aortic arch has been reported [2].

Inferior to its bifurcation, the common carotid releases no branches — although some studies report that the superior thyroid artery may arise in many cases from the terminal common carotid instead of the external carotid artery (variations are between 1 and 52 %; [1, 3–5] *see* example in Fig. 12.4). Likewise, the inferior thyroid artery may arise from it [6, 7].

On occasion, the right common carotid, when arising from the aorta, runs behind the trachea or the esophagus to the right side of the neck [2].

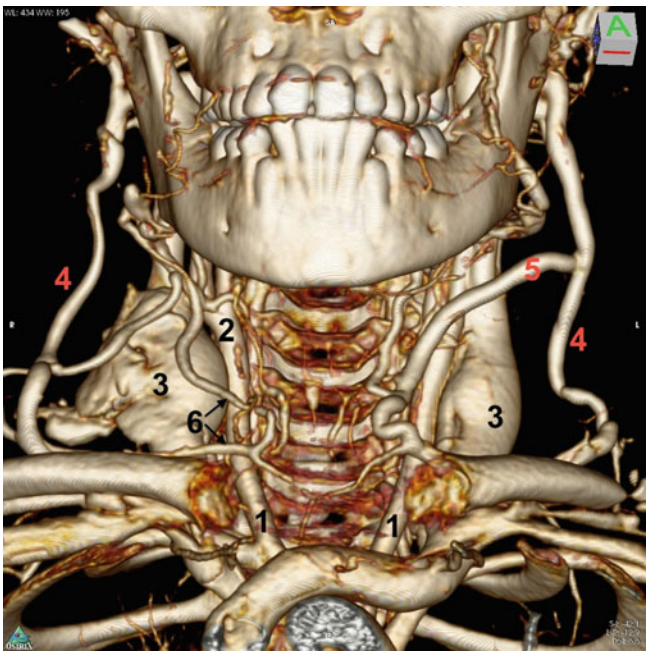

Fig. 12.3 Three-dimensional VR reconstruction of the anterior neck region. Dynamic phase of MPMCTA. Common carotid arteries (*1*) crossed by median thyroid veins (*6*). Bifurcation of right common carotid artery crossed by superior thyroid vein (*2*). Internal (*3*) and external (*4*) jugular veins. Left side anterior jugular vein (*5*)

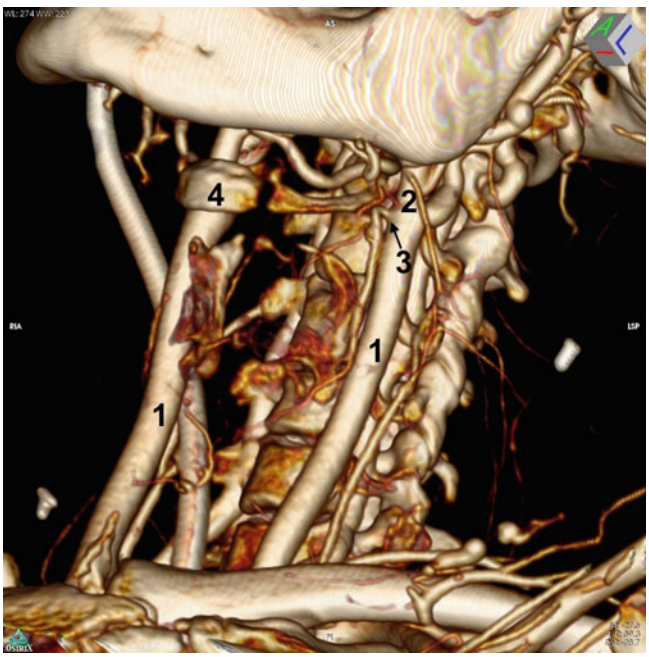

Fig. 12.4 Three-dimensional reconstruction of the left anterior neck region. Arterial phase of MPMCTA. Common carotid arteries (*1*), bifurcation of right common carotid artery (*2*) at the level of the hyoid bone (*3*). Note the origin of the left superior thyroid artery from the common carotid artery (*4*)

12.1.2 Subclavian Artery and Neck-Related Branches

The subclavian artery passes between the middle and the anterior scalene muscles in contrast to the subclavian vein, which runs in front of the anterior scalene muscle. The right subclavian artery arises from the innominate artery behind the right sternoclavicular articulation; however, in some cases it arises above the level of this joint (Fig. 12.5) and occasionally below it.

As a variation, the right artery may arise either as the first, second, third, or even the last branch from the aorta; in the majority of cases, however, it is the first or last. Being the second or third, it passes behind the right carotid; being the last, it passes behind the trachea, esophagus, and right carotid to the right side before following its standard course (Fig. 12.6). In very rare instances, this vessel arises from the thoracic aorta as low as the fourth thoracic vertebra. Occasionally, it perforates the scalenus anterior muscle; more rarely it passes in front of that muscle. The artery may ascend as high as 4 cm above the clavicle or any intermediate point between this and the upper border of the bone; the right subclavian usually ascends higher than the left (*see* Fig. 12.5).

The thyrocervical trunk (Fig. 12.7) is a branch of the subclavian artery arising from the first portion of this vessel, i.e., between the origin of the subclavian artery and the inner border of the scalenus anterior muscle. It is located distally to the vertebral artery and proximally to the costocervical trunk. It is a very short vessel that soon after its origin divides into three branches:

- inferior thyroid artery
- suprascapular artery
- transverse cervical artery

A lot of variations exist regarding the anatomy of the thyrocervical trunk [8]. It may consist of two branches or even be reduced to a branch of a single of its vessels (*see* Fig. 12.5). Sometimes particular branches have switched to another trunk or they originate directly from the subclavian artery. Figure 12.8 demonstrates a rare variation: a common trunk of the left internal thoracic artery and the thyrocervical trunk [9].

The suprascapular artery and transverse cervical artery both head laterally and cross anterior to the scalenus anterior muscle and the phrenic nerve. The dorsal scapular artery (Figs. 12.5, 12.7, and 12.8) branches from the transverse cervical artery in 25–30 % of cases from the transverse cervical artery [8, 10] (*see* a different origin on the left and right side in Fig. 12.1); in the remaining cases it is derived from the subclavian artery. It supplies the levator scapulae and rhomboid muscles.

The inferior thyroid artery (*see* Figs. 12.5, 12.7, and 12.8) ascends to the inferior portion of the thyroid gland and supplies the thyroid and the larynx and parts of the trachea (i.e., the inferior laryngeal artery that ascends upon it) and the esophagus (branches that anastomose with esophageal branches from the aorta). It also releases the ascending cervical artery (muscular and spinal twigs).

The thyroidea ima artery ascending from the brachiocephalic trunk to the thyroid gland is rarely present (in only 1.5–12.2 % of the population), but it may cause bleeding in neck surgery or in case of tracheotomy [2, 11, 12].

The costocervical trunk (Fig. 12.9) rises from the subclavian artery on the back side laterally from the internal thoracic artery. The trunk supplies the first and second intervertebral spaces and the deep neck muscles. It is relatively short in humans and divides into

- the deep cervical artery and
- the supreme intercostal artery.

The deep cervical artery (*see* Fig. 12.9) runs between the transverse processes of C7 and Th1 (releasing a spinal branch which enters the intervertebral foramen) and anastomoses with the descending branches of the occipital artery and the branches of the vertebral artery.

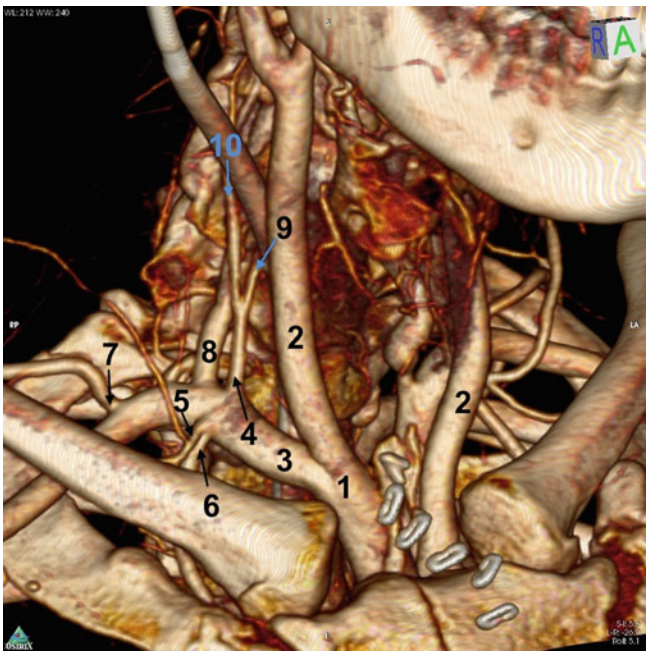

Fig. 12.5 Three-dimensional VR reconstruction of the right anterior neck region. Arterial phase of MPMCTA. Innominate artery bifurcation (*1*), common carotid arteries (*2*), right subclavian artery (*3*). Note the variation of the thyrocervical trunk (*4*) with the inferior thyroid artery (*9*) and the ascending cervical artery (*10*). Atypical trunk with suprascapular and transverse cervical artery (*5*) adjacent to the origin of the internal thoracic artery (*6*). Dorsal scapular artery (*7*), vertebral artery with atypical lateral origin (*8*)

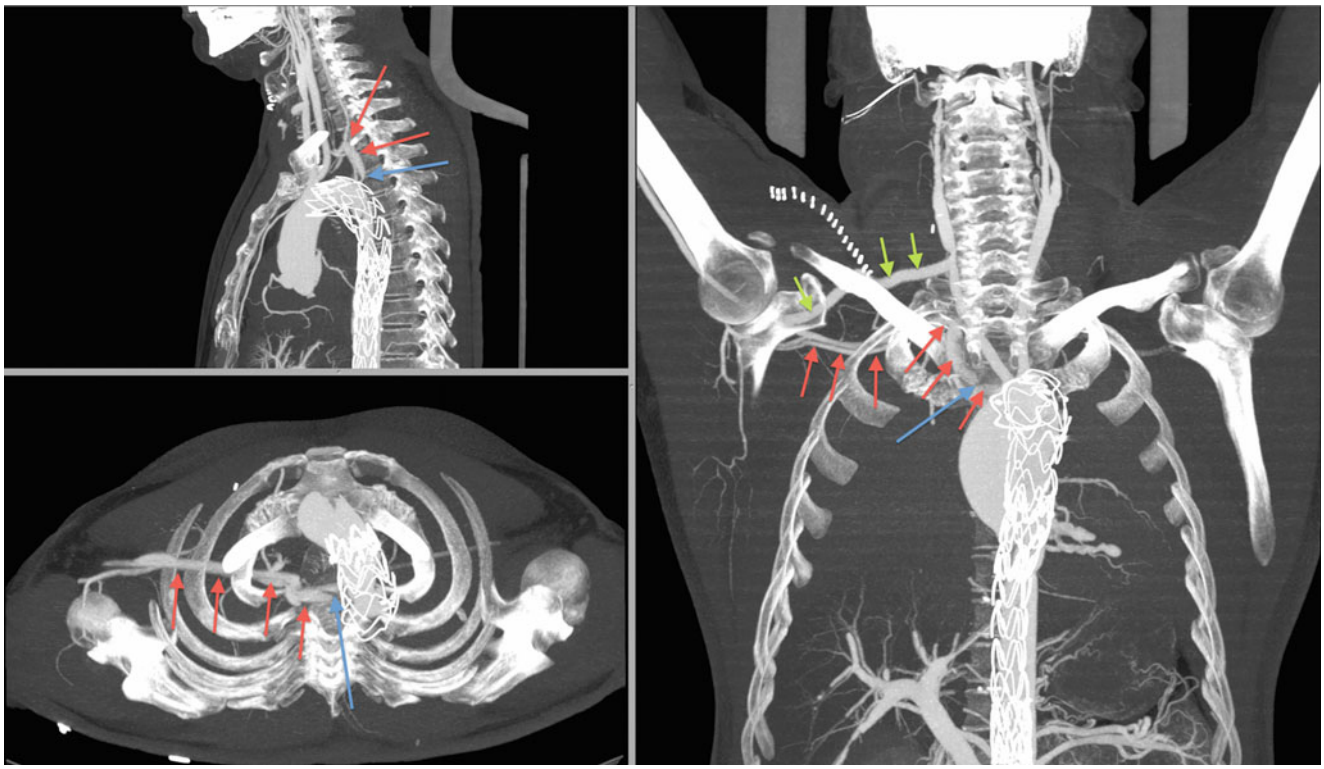

Fig. 12.6 Three-dimensional multiplanar reconstruction (MPR) of the thoracic arteries, arterial phase of MPMCTA. Variation of the right subclavian artery branching from the thoracic aorta distal from the left subclavian artery and passing behind the trachea and the esophagus to the right side (*red arrows*). Aortic dissection type Stanford A with involvement of the atypical vessel (dissection: *blue arrow*). Hybrid intervention with thoracoabdominal stenting of the aorta in the petticoat technique and right side carotid-subclavian bypass (*green arrows*)

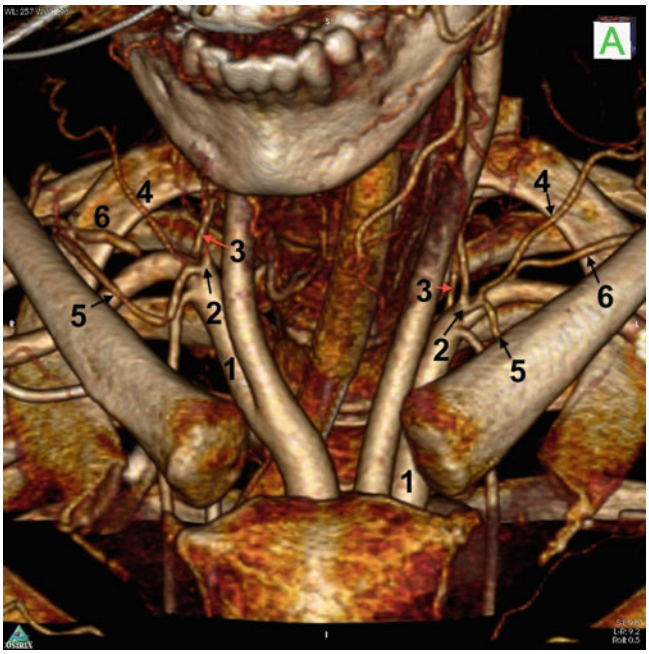

Fig. 12.7 Three-dimensional VR reconstruction of the anterior neck region. Arterial phase of MPMCTA. Subclavian arteries (*1*), thyrocervical trunk (*2*), inferior thyroid artery (*3*), transverse cervical artery (*4*), suprascapular artery (*5*), dorsal scapular artery (*6*)

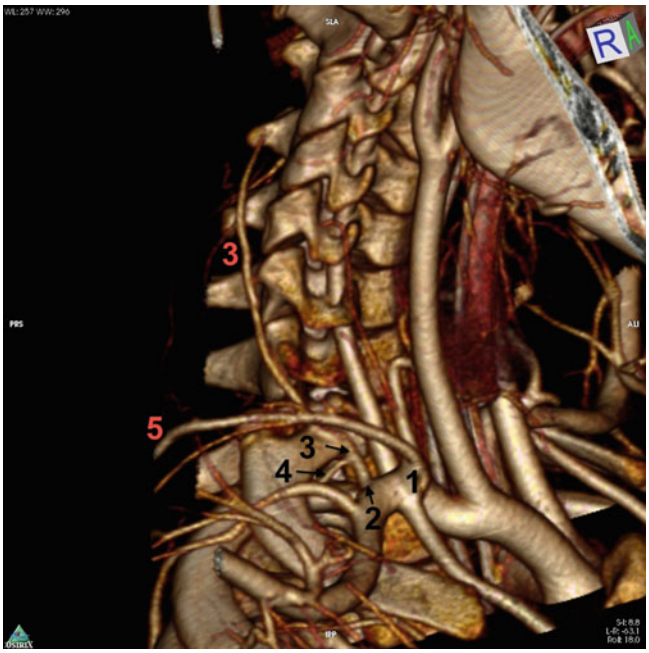

Fig. 12.9 Three-dimensional VR reconstruction of the anterior neck region (virtual removal of the clavicles). Arterial phase of MPMCTA. Thyrocervical trunk (*1*), costocervical trunk (*2*) with deep cervical artery (*3*), and supreme intercostal artery (*4*); transverse cervical artery (*5*)

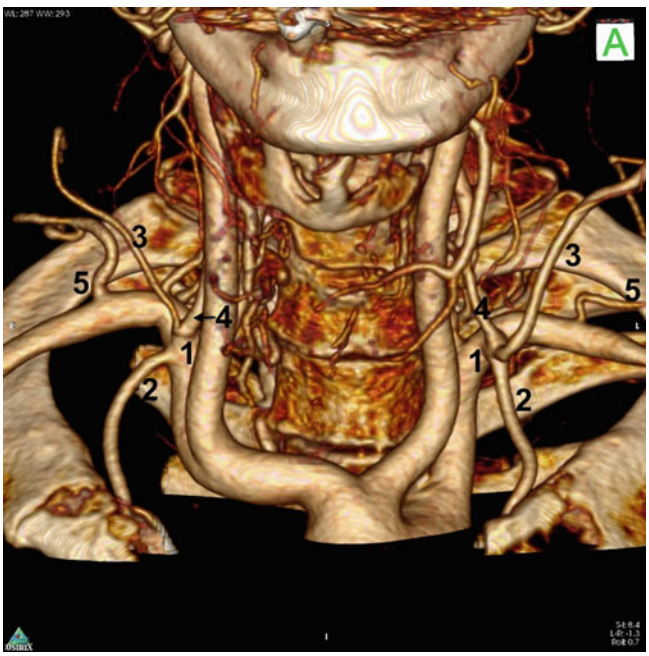

Fig. 12.8 Three-dimensional VR reconstruction of the anterior neck region; virtual removal of the manubrium sterni and clavicles. Arterial phase of MPMCTA. Note the thyrocervical trunk with only two branches on both sides (*1*), and the atypical common trunk with the internal thoracic artery on the left (*2*), plus the transverse cervical artery (*3*), the inferior thyroid artery (*4*), and the dorsal scapular artery (*5*). The suprascapular artery is not demonstrated in this case

12.2 Venous Blood Supply of the Neck

Regarding the veins, two layers can be distinguished: in the top layer two major cutaneous veins are usually embedded on each side in the subcutaneous adipose tissue. Both the external jugular vein and the anterior jugular vein descend to the venous angle and take the blood of the occipital region and the muscles of the lateral neck.

The external jugular vein is formed by the junction of the posterior branch of the retromandibular vein and the posterior auricular vein (Fig. 12.10). It receives

- the posterior external jugular,
- the transverse cervical,
- the transverse scapular, and
- the anterior jugular veins.

In the substance of the parotid gland, a large branch of communication from the internal jugular vein joins it. The external jugular vein drains into the subclavian vein lateral to its junction with the internal jugular vein.

The posterior external jugular vein (Figs. 12.11 and 12.12) collects the blood from the skin and superficial muscles in the upper and back part of the neck.

The venous angle is the junction of the internal jugular vein and the subclavicular veins on both sides. The external and the anterior jugular veins converge with it. In the venous angles, also the large lymphatic vessels terminate. The right lymph duct drains into the right venous angle, and the left thoracic duct, which collects lymph other than from the right thorax, arm, head, and neck, drains into the right angle.

In the lower layer, called deep veins, again two vessels on each side can be found. The internal jugular vein (*see* Figs. 12.10 and 12.11) is formed at the base of the skull by the junction of the superior petrosal sinus and the sigmoid sinus. The course of the internal jugular veins is similar to that of the respective carotid arteries. At the root of the neck, the right internal jugular vein crosses the first part of the subclavian artery at a little distance from the common carotid artery, while the left internal jugular vein usually overlaps the common carotid artery. The internal jugular veins unite with the subclavian veins, forming the innominate (brachiocephalic) veins. The left vein tends to be smaller than the right one. A pair of valves is usually placed about 2.5 cm above their termination.

Their catchment area comprises almost the entire blood system of the head, including the brain via the sigmoid sinus. In addition, it collects the blood from the superficial and deep facial areas, which are drained by the facial vein, lingual vein, and retromandibular vein that open near the mandibular angle into the internal jugular veins at a common trunk. In addition, it receives inflow from the superior and medium thyroid veins. The initial as well as the terminal segment may be extended, which is referred to as the inferior and the superior jugular bulbs.

Because of their relative superficial position, which is not protected by bone or cartilage, the jugular veins are used for venous lines but also show a potentially high vulnerability.

The vertebral vein (Figs. 12.11 and 12.12) is formed from the internal vertebral venous plexuses in the vertebral canal and emerges at the transverse foramen of the sixth cervical vertebra, finally opening into the innominate vein near its origin.

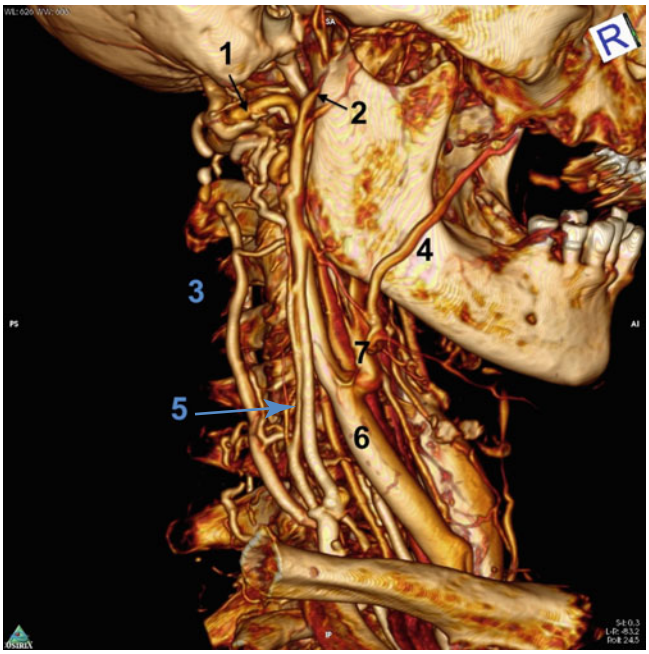

Fig. 12.10 Three-dimensional VR reconstruction of the right anterior neck region, venous phase of MPMCTA. Posterior auricular vein (*1*), posterior branch of retromandibular vein (*2*), posterior jugular vein (*3*), facial vein (*4*), external jugular vein (partly doubled) (*5*), internal jugular vein (*6*) and retromandibular vein (*7*)

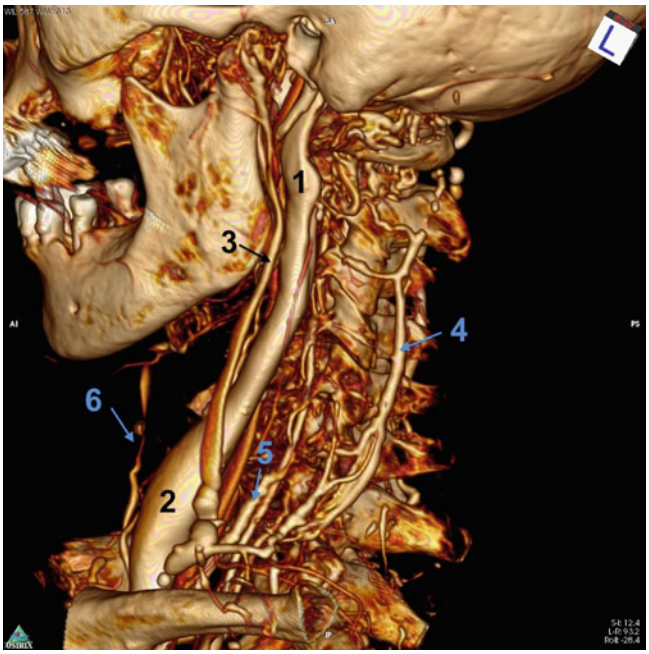

Fig. 12.12 Three-dimensional VR reconstruction of the left anterior neck region, venous phase of MPMCTA. Left internal jugular vein, superior bulb (*1*) and inferior bulb (*2*), external jugular vein (*3*), posterior jugular vein (*4*), vertebral vein (*5*), anterior jugular vein (*6*)

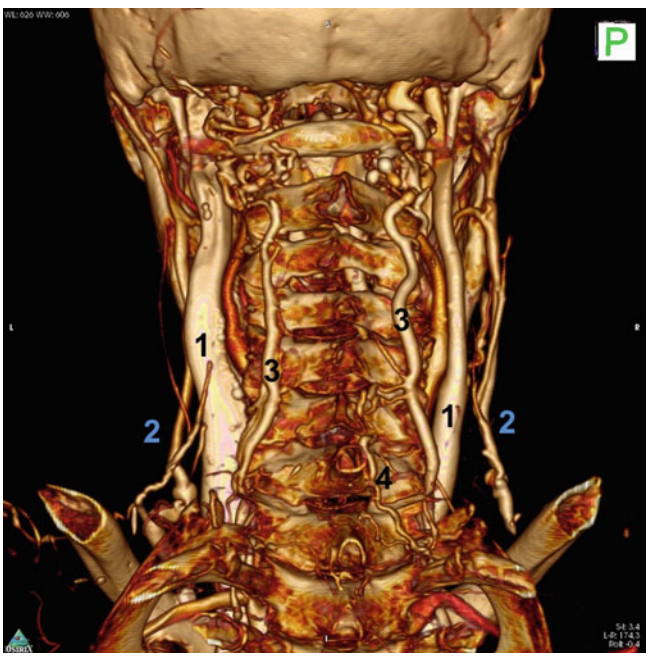

Fig. 12.11 Three-dimensional VR reconstruction of the back side neck region, venous phase of MPMCTA: internal jugular veins (*1*), external jugular vein (*2*), posterior jugular vein (*3*), right vertebral vein (*4*)

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