

Aortic Arches - Embryological Development

Aortic Arches

These embryonic structures form during the development of the arterial system in intrauterine life. An aortic arch is a branch from the arterial aortic sac to the dorsal aorta. It travels in the centre of each pharyngeal arch, embedded in mesenchyme. Initially there are five pairs of arches, but these undergo structural changes and differentiation to form the definite vascular patterns for the head and neck, aorta, and pulmonary circulation.

During the *fourth and fifth* weeks of embryological development, when the pharyngeal arches form, the aortic sac gives rise to arteries – the aortic arches. The aortic sac is the endothelial lined dilation just distal to the truncus arteriosus; it is the primordial vascular channel from which the aortic arches arise. Each pharyngeal arch has its own cranial nerve and its own artery, hence we can conclude that the growth of the the aortic and pharyngeal arches are very closely related. The aortic arches terminate in the right and left dorsal aortae. The dorsal aortae remain paired in the region of the arches, however below this region they merge to form a single vessel (the descending/thoracic/abdominal aorta).

The pharyngeal arches and their vessels appear in a *cephalo-caudal* order, so they are not all present at the same time. As a new arch forms the aortic sac contributes a branch to it. In the initial stage there are pairs of aortic arches, which are numbered **I, II, III, IV, and V**. This system becomes altered in further development.

The **truncus arteriosus** divides into the **ventral aorta** and **pulmonary trunk** by the aortic-pulmonary septum. They represent the outflow channels of the heart. After this, the aortic sac then forms right and left horns. The right horn becomes the **brachiocephalic artery** and the left becomes the **proximal (ascending)** part of the **aortic arch**.

The **1st Arch** and **2nd Arch** start to regress by approximately day 27, however portions of each persist as the **maxillary artery**, and the **hyoid** and **stapedial arteries**, respectively. By day 29 both these arches completely disappear. Around the time regression of the 1st and 2nd arches, the 3rd is large and 4th and 6th arches are forming. Soon the 3rd, 4th and 6th arches all appear large. Because of division of the truncus arteriosus, the 6th arches are now continuous with the pulmonary trunk, with the **primitive pulmonary artery** present as a major branch.

Changes to Aortic Arches

As development continues, the aortic arch system loses its original symmetry. The following changes occur:

- **3rd Arch** : forms **common carotid artery, first (cervical) part of internal carotid artery** (*rest of internal carotid arises from dorsal aorta*), and **external carotid artery**.
- **4th Arch**: on *LEFT* – forms **part of arch of aorta** (between the left common carotid and left subclavian arteries).

On *RIGHT* – forms proximal part of right subclavian artery, distal part of subclavian formed by right dorsal aorta and seventh intersegmental artery.

- **5th Arch**: either never forms or regresses after incomplete formation.
- **6th Arch (Pulmonary Arch)**: on *RIGHT* – forms proximal part of **right pulmonary artery**, *distal part of arch loses connection with dorsal aorta*.

On *LEFT* – forms **left pulmonary artery**, *distal part of arch persists* in intrauterine life as **ductus arteriosus**.

Other notable changes:

- The dorsal aorta between the third and fourth arches is obliterated. This part also known as the **carotid duct**.
- The right dorsal aorta disappears between origin of the *seven intersegmental artery* and the junction with the *left dorsal aorta*. *Brachiocephalic and common carotid arteries elongate due to folding and growth of embryo.
- Left subclavian artery shifts upwards along the aorta, from the level of the seventh intersegmental artery, to lie close to origin of the left common carotid artery.

Recurrent Laryngeal Nerves

It is also quite vital to note that the course of these nerves (*branches from the Vagus Nerve*), changes due to the caudal shift of the heart and disappearance of different parts of the aortic arches. Initially they supply the sixth pharyngeal arches, but when the heart descends, they hook around the sixth aortic arch and ascend back up to innervate the larynx.

- On the *right* – the nerve moves up and hooks around the *right subclavian artery*.
- On the *left* – the nerve does *NOT* move up, because the distal part of the sixth aortic arch still persists on this side as the ductus arteriosus, and it hooks around the *arch of the aorta*. (see images)

We can see that the changes and derivatives of the aortic arch system plays a significant role in developing the most significant arterial vascular system of the human body. Knowing what structures form from which arch can help us understand embryological defects, which can arise from abnormal growth. The images above show the transformation of the original aortic arch system into the definite vascular pattern.

Links