B.SC. II PAPER IV
Hons & Subs
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Aortic arch.

Aortic arch originated from ventral aorta. During formation of the heart in vertebrates embryo, a ventral aorta appears mid-ventrally below the pharynx which soon established connection with conus arteriosus. The ventral aorta runs anteriorly (upward) and divides to form two aortic arches. These two arches turn posteriorly above the pharynx as dorso-lateral aortae or radices aortae. which join together at mid line and form dorsal aorta. The two anterior extensions of the ventral aorta are called as external carotid arteries whereas the anterior extensions of the dorso-lateral aortae are called as internal carotid arteries.

In the embryo of all craniates 6 pairs of aortic arches develop from the main arch in antero-posterior sequence, but in adult their number become reduced. These arches connect the ventral aorta with lateral dorsal aorta of their sides. The 1st and 2nd pair of arches are called as mandibular and hyoid arch respectively while the remaining ones are called as 3rd, 4th, 5th and 6th arches.

Modification of Aortic arches :

The aortic arches are highly developed in those vertebrates where respiration is branchial (by gills), but it reduced or modified in higher animals with the change in their respiratory

organs. Though the arches appears to be different in various groups, but their developmental study shows that they are built on same fundamental plan.

In Cyclostomata:

(i) Aortic arches in this group are more than 6 pairs
   (a) 8 pairs in Lamprey
   (b) 15 pairs in myxinoid

(ii) The arches are in the form of afferent and efferent branchial arteries; afferent arteries carry the blood from ventral aorta to gills and efferent carry blood from gills to lateral dorsal aortae.

In Fishes:

(i) Aortic arch consists of afferent and efferent branchial arches.

(ii) Primitive Elasmobranch (Heptanchus) has 7 pairs of aortic arches. Most of the fish embryos consist basic plan of 6 pairs of arches but in their adult life number of arches reduced. In adult Elasmobranch the 1st gill slit forms non functional spiracle and subsequently the mandibular arch (1st arch) is modified or reduced/lost, while the remaining arches i.e. 2nd, 3rd, 4th, 5th and 6th branchial loops are present.

(iii) In teleost, both mandibular (1st) and hyoid (2nd) arches are reduced or disappear but remaing four pairs of arches are present in the form of afferent and efferent branchial arches.

(iv) In Dipnoi, the basic plan is also similar. However,

[In elasmobranch a typical each arch bears an afferent and two efferent arteries in each gill but in the teleost there is only efferent for each arch in each gill]

with the development of lungs in this group of fishes, a pair of pulmonary arteries are developed from the efferent vessel of most posterior aortic arch i.e. 6th arch, to supply blood to the lungs.

Tetrapoda — In tetrapods further reduction in the number of aortic arch has been found and due to absence of internal gills the aortic arch do not break up into afferent and efferent arteries.

In Amphibia :

In the larva due to presence of gills the basic plan of aortic arch is similar but in adult it is greatly modified. In adults —

(i) mandibular and hyoid arches are absent

(ii) 3rd arch forms the carotid and 4th forms the systemic arch.

(iii) 5th arch is either reduced or lost while 6th give rise to pulmo-cutaneous artery.

(A) In Urodales :

They retained external gills in addition to lungs and accordingly their aortic arches shows partial modification to that of piscine condition.

(i) The first two arches (I & II) disappear

(ii) The remaining four pairs i.e. III, IV, V and VI usually present except in (Necturus, Siren, Amphiuma some, in which V arch is incomplete or reduced or absent.

(iii) the lateral dorsal aortae/radices aortae (ductus Caroticus is present between 3rd and 4th arch

which connects the carotid arch with systemic arch
(iv) 6th arch forms pulmonary artery carrying blood to lung.
(v) Ductus arteriosus or ductus Botali persists and connects the 6th arch with dorsal aorta

(B) In Anura:
(i) In adult I, II, and V arches disappear.
(ii) Only III, IV and VI arches persist.
(iii) 3rd arch along with a part of ventral aorta forms carotid arch and 4th along with the lateral dorsal aorta forms systemic arch.
(iv) ductus caroticus between 3rd and 4th arches also lost.
(v) Pulmocutaneous artery arises from 6th arch but ductus arteriosus disappear.

In Reptiles:

With the disappearance of gills in adult of reptiles the aortic arches develops on typical plan from which the arches of other amniotes evolved.

In adult reptilians -

(i) Only 3rd, 4th and 6th arches persist
(ii) Due to partial division of ventricle the ventral aorta and distal part of conus arteriosus divide to form 3 trunks — right and left systemic arches (4th) and pulmonary artery (6th).
(iii) Right systemic arch arises from the left side of the ventricle whereas the left systemic originated from the right side of ventricle. The systemic trunk behind the

heart to form common dorsal aorta.

(iv) Pulmonary artery originated from the right side of the ventricle.

(v) 3rd arch forms the carotid arch, the common carotid artery (formed by the 3rd arch and part of ventral aorta) of both sides connected with right systemic arch.

(vi) ductus caroticus disappear in all except snakes and some lizards.

(vii) 6th arch becomes pulmonary artery; with few exception e.g. sphenodon and some turtle, ductus arteriosus disappear

In Birds:

(i) 3rd, 4th and 6th arches persist with certain modification.

(ii) With the division in ventricle the conus arteriosus and ventral aorta split into two vessels —

(a) systemic aorta arises from the left ventricle and

(b) pulmonary aorta arises from the right ventricle.

(iii) 3rd arch forms the carotid.

(iv) 4th arch forms systemic arch only on right side, while some part of its left side forms left sub-clavian artery and the rest along with lateral dorsal aortae disappear.

(vi) 6th forms the pulmonary artery.

In Mammals:

(i) Ventricle completely divided, conus arteriosus and ventral aorta also divide into two vessels —

(ii) left ventricle gives rise to a systemic aorta while right ventricle gives rise to pulmonary aorta.

(iii) Only 3rd, 4th and 6th persist with some modification

(iv) 3rd arch forms carotid, from 4th arch systemic arch arise on left side only; some parts of 4th arch of right side forms right sub-clavian artery and remaining parts disappear, 6th forms pulmonary aorta

(v) Ductus caroticus and ductus arteriosus absent.

The vessels emerging from heart become completely separated in birds and mammals, so there is no intermixing of oxygenated and deoxygenated blood.

Conclusion:

The comparative study of aortic arches clearly indicate its phylogenetic importance. In the embryo of all vertebrates the structure and number of the aortic arch is similar and changes takes place only in adult. Its study also reveals that there is gradual reduction in the number of aortic arches during the development of higher vertebrates from the lower vertebrates.