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NOTES ON THE BRANCHES OF THE AORTA (ARCUS
AORTAE) AND THE SUBCLAVIAN ARTERY
OF THE RABBIT

FRANCIS MARSH BALDWIN

One plate (VIII) of eleven figures.

Bensley¹ in his Practical Anatomy of the Rabbit (p. 365), in discussing the blood vessels of the thorax describes the arch of the aorta as "beginning at the base of the heart, — — — — passes forward, and then describing a curve, in the course of which it lies slightly to the left of the median plane, turns backward along the ventral surfaces of the bodies of the thoracic vertebrae. With the exception of the coronary arteries the first branches are the large paired vessels arising from the anterior wall. They comprise the *common carotid* and *subclavian arteries*. On the right side the carotid and subclavian arise from a short common trunk, the *innominate* artery. The left common carotid arises immediately to the left of this vessel or from its base. The subclavian artery (a. subclavia) is the first portion of the artery of the anterior limb. It passes from its point of origin laterad to the anterior margin of the first rib, where it is replaced by the axillary artery. Near its point of origin, it gives off several branches, the relations of which are subject to considerable variation."

"The large paired vessels" referred to above is not exact and leads to confusion, since even in the usual condition it applies to neither the right and left common carotid arteries, nor the paired subclavian arteries, but to an innominate artery on the right side, and the left subclavian artery on the other. That the left common carotid artery usually arises immediately to the left of the base of the innominate is perhaps correct, although in by far the greater number of rabbits dissected by the writer the origin of this vessel is well up on the mesial side of the innominate. In cases where the left common carotid artery arises to the left of the innominate, there would be three vessels arising from the cephalic curve of the aorta and not two (a pair) as above described, a condition normally found in the human. With reference to the subclavian arteries, the statement as to their

branches being subject to "considerable variation" is correct, but it seems important that the point should also be made, that great differences occur in these vessels on the right and left sides in the same animal.

Again, Parker and Haswell² describe correctly the relation of these vessels as they occur in the majority of cases, but the figure shown (p. 465) represents the condition in an abnormal individual, where the left common carotid artery originates as a branch from the arch of the aorta, and thus constitutes the third vessel from the arch, the innominate and the left subclavian being the other two. Since these discrepancies exist in the descriptions of the blood vessels of the region in the various texts, and in view of the variability of both the arteries given off by the arch of the aorta, and their subsequent subdivisions, especially those of the subclavian, it seems of sufficient interest to record their frequency and extent. Accordingly the following description is based upon the study of over one hundred specimens. Such records, of course, have no immediate practical value from the surgical or pathological sides, but from the educational considerations, especially from the standpoint of comparative anatomy, they are rather important. No doubt the variations which are described below are to be explained in part by the persistence of the foetal conditions, or in some cases by abnormalities of the vessels themselves, or to the development of extrinsic parts in their immediate region. Many of the changes brought about probably are due to different modes of transformation of the primary vessels of the branchial arches, especially the fourth, since both the aorta and the pulmonary artery are derivatives of this arch. Again, it is well known that the heart itself originally develops high up in the neck region of mammals, and is gradually shifted downwards, so that this gradual shifting might account for some of the variations noted.

Of one hundred and six rabbits dissected,* nineteen individuals showed marked variations from the usual condition, either in the branches from the aorta, or in respect to the subclavian and its branches on either side. There were others (fifteen) which showed minor variations but which could easily be placed in some of those showing marked variations, so that their condition is represented, partly at least, in some one or in a composite of the subjoined figures.

In what may be termed the usual condition the aorta (Fig. 1,A)

* My thanks are here given to Mr. Ralph L. Parker, for collaboration in the dissections.

after giving off the coronary arteries close to its junction with the left ventricle passes cephalad a short distance and then describes a curve or a half circle and passes down the back, a little to the left of the ventral vertebræ. From the cephalic curve (arch) a comparatively large innominate or brachio-cephalic artery extends upward and a little to the right and soon bifurcates forming the left common carotid artery which passes immediately across the trachea to the left side of the neck, and a common trunk which gives rise to the right subclavian and the right common carotid arteries. A second branch from the curve of the aorta is the left subclavian artery which passes laterad and forward to branch in various ways. Usually on this side the superior intercostal (costo-cervical) (Fig. 1, I) is the first branch to be given off, and this passes caudo-mediad. Just distal and in close juncture with the superior intercostal artery is the internal mammary artery, while just opposite arises the vertebral artery. Distally the subclavian artery soon divides into the transverse scapular (T) and axillary (X) arteries. On the right side the superior intercostal and mammary arteries arise from a common trunk, as also do the vertebral and transverse scapular arteries just opposite them. The axillary artery passes to the region of the forearm. In some cases the superficial cervical artery branches from the subclavian, but usually it is a branch of the transverse artery of either side.

Variations of the subclavian artery of the left side. A number of interesting variations are noted in the order and sequential relationships of the various vessels arising from the left subclavian. Frequently the arteries originating from the subclavian artery are in close proximity to each other so that a veritable corona of the vessels is formed. In some cases as shown in figures 6 and 11 this takes place at quite a distance from the arch of the aorta, and can be called the long corona type, while in others typified in figures 9 and 10 and perhaps less conspicuously in figure 8, the corona formation is closely approximated to the aortic arch. Where the corona is formed, the usual order of the vessels may be described as normal, *i.e.*, beginning with the vertebral artery originating on the cephalo-mesal surface of the subclavian, the transverse scapular, axillary, mammary, and intercostal arteries followed in the cycle clockwise. In one specimen an interesting departure is noted, in that the intercostal artery (Fig. 6, I) takes its origin from the vertebral so that there is formed in this case a very short innominate with the vertebral

artery. A number of cases are observed where the intercostal and mammary arteries formed a short innominate in common as is shown in figures 4 and 7. In one rabbit (Fig. 3, V) the vertebral artery of this side branches from the cephalic surface of the arch of the aorta at about its junction with the subclavian artery and in this case it is comparatively a much larger vessel than normal. In this specimen also the transverse scapular and mammary arteries have their origin some distance cephalad, and the interval between the intercostal and mammary arteries is very noticeable. In no case is there found an innominate formed by the left subclavian and the left common carotid arteries, which of course is the typical avian condition, and which has been described as occurring in most apes, and somewhat more rarely has been noted in the human. In three cases, however, varying in degrees, as shown in figures 6, 8 and 10, the left common carotid artery is a separate branch from the arch of the aorta, and in these the condition closely simulates the normal condition found in the human. In one instance the points of origin of the vertebral and the transverse scapular arteries are interchanged as shown in figure 2, and in another, figure 5, the vertebral artery arises from the latero-caudal surface of the subclavian in the same manner but distal to the intercostal and mammary cervical vertebræ. In the last specimen also a number of excessory blood vessels are noted, some of which parallel the mammary, others the intercostal arteries.

The subclavian artery of the right side. The blood vessels of this side which take their origin from the subclavian artery seem less variable in their relationships than those just described. There is the formation of what may be termed a corona in several instances, but this is with but one exception formed relatively close to the innominate, or to that portion close to the bifurcation of the innominate which forms the subclavian and right carotid arteries. Such a condition is typically shown in figure 5, where the vessels spread out in fan-shape formation about the subclavian. In one instance, the vertebral artery (Fig. 2, V) originates well cephalad and on the lateral surface of the right common carotid artery, so that its displacement from its usual position is rather striking. As regards the interrelation of the intercostal and internal mammary arteries all sorts of gradations of intervals exist from the formation of a conspicuous elongated innominate as is indicated in figure 3, or a much reduced innominate as shown in figure 11, to the more or less widely separated

intervals as represented in figures 8 and 9. The intercostal artery in the last case is really a branch of the innominate, and has no connection with the subclavian. Usually the superficial cervical artery of this side as in the normal condition is a branch of the transverse scapular artery, but in two cases it was greatly displaced; one originating from the subclavian (Fig. 3), and another curiously entering the common junction of the intercostal-mammary vessels as shown in figure 10. In one case the transverse scapular artery originates as a branch of the vertebral well cephalad of the latter's junction with the subclavian, as in figure 8, although in two other specimens this condition is barely suggested in the close proximity of the origins of the two vessels, as in figure 9.

The manner of branching of the two carotid arteries from the innominate is of interest although not more variable than might be expected. In the majority of specimens showing differences in other respects the two carotid arteries branch well up on the innominate. In several cases the point of origin of the left common carotid artery is close to the curve of the aorta and in three cases (Figs. 6, 8 and 10) the junction is really on the arch, thus giving rise to an additional vessel in these cases as indicated above, which simulates very closely that found normally in the human. Three individuals (Figs. 7, 9 and 10) show the formation of a thyreoid ima so-called, a small vessel arising on the innominate between the right and left common carotid arteries, which passes forward to the thyreoid gland and gives off small vessels to the neck muscles of the region and to the trachea. Its point of origin varies somewhat in the three animals but morphologically it bears the same position as has been described for a similar vessel in the human (McMurrich,³ p. 511), that is, it passes forward from the innominate between the common carotid arteries of either side. It should be said, however, that since the common carotids of either side in man differ slightly in their points of origin from those in the rabbit, the formation of this vessel in the rabbit does not contribute to the formation of a fourth vessel arising from the arch of the aorta, as is the case in man, but does form a fourth vessel from the innominate. In a single case, as shown in figure 11, the arch of the aorta gives rise to but one vessel, an innominate, which passes cephalad for some distance before it breaks to form, first, the left subclavian, and a little farther forward the left common carotid artery, and the brachio-cephalic artery. This peculiar

variation is interesting since it closely simulates the normal condition found in the horse. It may be explained by the fusion of the two aortic stems and the shortening of the fourth arch so that the left subclavian artery joins with the common stem during the transformation of the primary vessels. In one instance the left vertebral (Fig. 3, V) takes its origin well down on the left subclavian vessel so that it is almost in a position to be considered a separate branch from the arch of the aorta and could be interpreted as an additional vessel from the latter as has been recorded as a variation in the human (McMurrich, p. 511). It is easy to see how a slight displacement caudad of the left common carotid artery in this case would produce four distinct vessels originating from the arch of the aorta instead of the usual two.

SUMMARY

Although the usual number of blood vessels arising from the arch of the aorta in the rabbit is two — a so-called innominate or brachio-cephalic artery and a left subclavian artery — the variations from this condition herein described indicate the possibility of a considerable departure. In one individual (Fig. 11) a single vessel leaves the aortic arch and after passing a short distance forward subdivides successively to form the left subclavian, the left common carotid and the right subclavian arteries.

In a number of cases as shown in figures 6, 8 and 10 three vessels have their origin on the arch and in these the order is the brachio-cephalic, the left common carotid and the left subclavian arteries. In one individual (Fig. 3) the left vertebral replaces the left common carotid artery in the series, the carotid in this case having its origin on the innominate as normally. This case suggests the possibility of four vessels forming the series.

Conspicuous differences in the order and sequence of the vessels from the subclavian arteries of the two sides are noted. On the left side the vessels in a number of cases show a tendency to group themselves either proximally or distally in the form of a sort of corona as indicated in figures 6, 9 and 10. The formation of various innominate stalks common to certain arteries are found in some cases, while in others the intervals between certain arteries are rather noticeable. Less marked variations are noted in the vessels of the right side. The vertebral artery in one instance (Fig. 2) is displaced from its usual place to the lateral side of the right common carotid artery. The transverse scapular

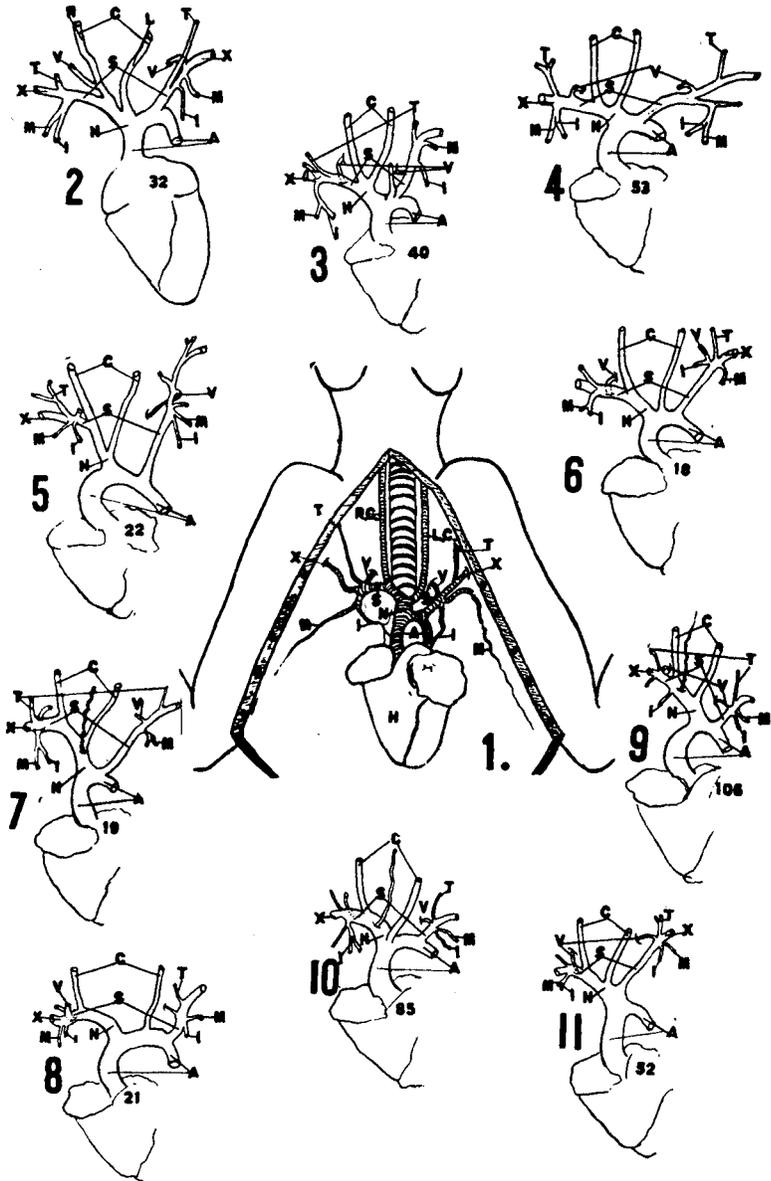
artery in two cases is a branch of the vertebral, while the superficial cervical which is normally a branch of the transverse scapular, in one case (Fig. 10) leaves the subclavian as a common stalk with the intercostal and mammary arteries.

In three cases a small so-called thyreoid ima is present and in these this passes forward from its origin between the two common carotids, thus having the same morphological position in the rabbits as a similarly described vessel occupies in the human.

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EXPLANATION OF PLATE VIII

ABBREVIATIONS

- A., Aorta, with its ascending transverse arch and descending (dorsal) portions.
 C., common carotid arteries, (R) right and (L) left.
 i., superior intercostal artery.
 H., heart.
 N., innominate artery.
 M., internal mammary artery.
 S., subclavian artery, right and left.
 T., transverse scapular artery, including the superficial cervical artery.
 V., vertebral artery, right and left.
 X., axillary artery, right and left.

1. Diagrammatic ventral view of the arteries of the thoracic regions of the rabbit, showing the various branches as they occur in the majority of specimens. The innominate (brachio-cephalic) (N) and the left subclavian (S) are the two usual branches of the arch of the aorta. The left subclavian gives origin to a number of arteries as here shown, while the innominate bifurcates to form the two common carotids and the right subclavian arteries.
2. Schematic ventral view of the arteries of rabbit 32 which conspicuously indicates the vertebral artery of the right side as a branch of the right carotid artery. Notice on the left side the transverse scapular and the vertebral arteries are morphologically interposed and the intercostal and mammary arteries are separated by quite an interval. The left common carotid is well down, at the base of the innominate almost constituting a separate branch of the arch of the aorta.
3. Ventral view of the arteries in rabbit 40. The vertebral artery of the left side is here formed close to the junction of the subclavian with the aortic arch, and thus forms what may be considered a third branch of the arch. The intercostal and mammary arteries of the left side are separated by a wide interval.
4. Rabbit 53 shows the formation of common stalks (innominates) for the intercostal and mammary arteries of both sides as well as the transverse and superficial cervical of the right. The brachiocephalic gives rise immediately to the left common carotid.
5. The arteries of rabbit 22 show differences in branches of the right and left subclavian vessels especially. The intercostal and mammary arteries originate separately on the right, the vertebral on the left is well cephalad of the other vessels, and makes a bend caudomesad as here shown. Accessory vessels are found on the left side also.
6. In rabbit 28 the formation of what may be termed a long corona of the left subclavian with a migration of the intercostal from the lateral surface of the subclavian to form a common stalk with the vertebral artery. The left common carotid artery is here a branch of the aortic arch so that three distinct branches are formed. The innominate is conspicuously long.
7. Specimen 19 shows among other variations the formation of the thyreoid ima, a small vessel originating on the innominate just caudad to the point of origin of the left common carotid artery and passing forward to the thyreoid gland of the neck.
8. Rabbit 21 shows interesting relationships of the innominate, left common carotid and left subclavian arteries, and shows the comparatively immediate subdivisions of the subclavian of either side. Such a condition may be designated as the short corona type.
9. Specimen 106 shows the so-called thyreoid ima and other minor variations especially in the interval between the intercostal and mammary arteries of the right side, and the formation of the short corona type of the left subclavian artery.

10. In rabbit 85 beside the thyreoid ima being present, the left subclavian takes its origin on the arch, and the superficial cervical of the right side passes out from the common stalk of the intercosto-mammary artery. The subclavian of the left side forms a short corona.
11. In rabbit 52 the innominate (brachio-cephalic) artery is the only vessel originating on the arch of the aorta, and subsequently subdivides as shown giving rise to a long corona typed left subclavian, left and right carotid arteries, and right subclavian artery. This condition thus typifies that found normally in the horse.