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FEATURES OF THE SUBCLAVIAN ARTERIES AND THEIR BRANCHING IN THE DOMESTIC PIG

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Abstract

Taking into consideration that literature asserts that pigs share common vascular and cardiac traits with humans and represent an important experimental animal model for research advances, our study addresses the need to establish if the subclavian arteries in pigs present intraspecific variations concerning their branching and topography. The study was performed using a research group of 12 carcasses of commercially slaughtered crossbreed adult pigs (7 males and 5 females), weighting between 80 and 110 kg, obtained from different breeders. We have performed a stratigraphic dissection using common techniques in order to access the heart and the origin of the main arterial vessels, followed by the injection of a colored plastic material (latex) in order to highlight the features found in the targeted arterial branching. After the injection, the dissected pieces were fixed by immersion in a 2% formaldehyde solution, for 48 hours, also allowing the colored latex to solidify. This permitted the completion of the dissection and a good examination of the arterial branching and of is topographic relations. Our results indicate that in pigs the right subclavian artery is a constant branch, which in swine emerges from the brachiocephalic trunk, while the left subclavian artery, also constant, detaches directly from the aortic arch. The caliber and lumenum of the right subclavian artery is significantly smaller by comparison to its left counterpart. None of the subjects sampled in our study presented the external thoracic artery as a branch of the subclavian arteries. Our results indicate that the subclavian arteries in pigs do not present the same intraspecific variety noted in human, which is can be accounted for by the significantly short life span of this species, due to commercial slaughter.

Key words*: anatomy, vascular branching, subclavian arteries, pig.*

I NTRODUCTION

The subclavian arteries are an important topic in human cardiology, in relation to aortic arch and cardiac pathology and surgery (Xiao-Guang Tong et al., 2015; Chuankui Li et al., 2014; Rodriguez-Lopez et al., 2006; Görich et al., 2002; Bavinck etal., 1986; de Leval et al., 1981). The literature indicates the existence of many intraspecific variations of the emerging aortic branches' number and topography (Herrera et al., 2012; Muller et al., 2011; Alsai and Ramada, 2010; Bhattarai and Poudel, 2010; Jakanani and Adair, 2010; Berko et al., 2009; Jesudian et al., 2009; Fritsch, 2008; Gosling et al., 2008; Bathia et al., 2005; Carp C, 2002; Sora et al., 2002; Li et al., 2000; Papilian, 1979)

Taking into consideration that various authors (such as Zaragoza et al., 2011; Suzuki et al., 2009) assert that pigs share common vascular and cardiac traits with humans and represent an important experimental animal model for research advances, our study addresses the need to establish if the subclavian arteries in pigs present intraspecific variations concerning their branching and topography.

MATERIALS AND METHODS

The study was performed using a research group of 12 carcasses of commercially slaughtered crossbreed adult pigs (7 males and 5 females), weighting between 80 and 110 kg, obtained from different breeders.

We have performed a stratigraphic dissection using common techniques in order to access the heart and the origin of the main arterial vessels, followed by the injection of a colored plastic material (latex) in order to highlight the features found in the targeted arterial branching.

Prior to this treatment, the pulmonary arteries were ligatured, preventing the intrusion of the latex material into the lungs.
The colored latex was introduced by direct injection into the left ventricle of the heart, until it became visible in the common carotid arteries and the antebrachial median arteries.
After the injection, the dissected pieces were fixed by immersion in a 2% formaldehyde solution, for 48 hours, also allowing the colored latex to solidify. This permitted the completion of the dissection and a good examination of the arterial branching and of is topographic relations.

RESULTS AND DISCUSSIONS

In the examined subjects, the left subclavian artery is the second branch given off from the aortic arch. It presents a slight dorsal flexure, in between the folds of the precardiac mediastinum, along the left side of the trachea and the cranial vena cava. The origin of the left subclavian artery was identified in the dissected specimens, at 1-2 cm from the detachment of the brachiocephalic branch (Figure 25).

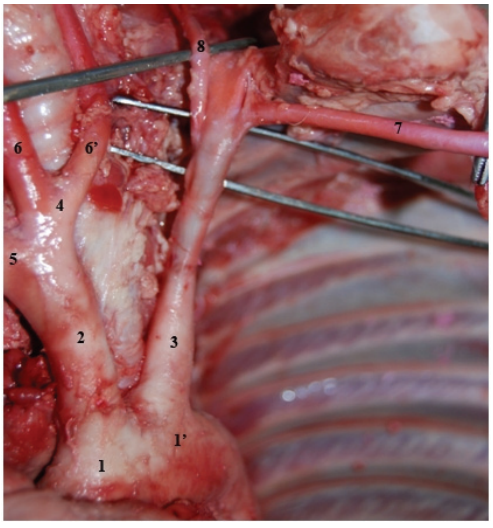

Fig.25.Aortic arch and emergence of the left subclavian artery and brachiocephalic trunk:
1.Aorta; 1'.Aortic arch; 2.Brachiocephalic trunk; 3.Left subclavian artery; 4.Bicarotic trunk; 5.Right subclavian artery; 6, 6'.Common carotid arteries; 7.Left internal thoracic artery; 8.Left omocervical artery.

The latter orients itself dorsally and slightly towards the left, and once it reaches the cranial border of the first rib it is continued, just like its symmetrical counterpart, by the axillary artery.

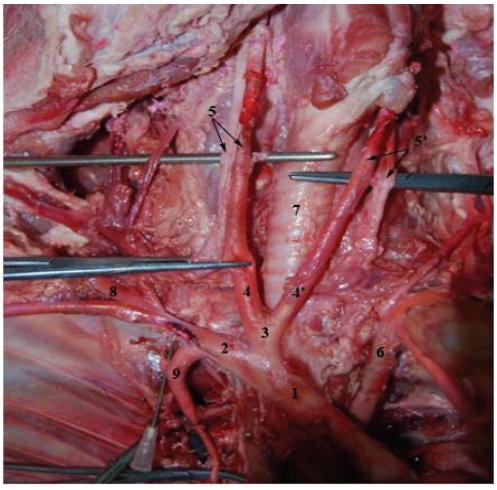

Fig.26. Left and right subclavian arteries:
1.Brachiocephalic trunk; 2.Right subclavian artery; 3.Bicarotid trunk; 4, 4'.Emergence of the common carotid arteries; 5, 5'.Common carotid arteries and vagosympathetic trunks; 6.Left subclavian artery; 7.Trachea; 8.Axillar artery; 9.Costocervical trunk.

On most subjects, the left subclavian artery gives off: the costocervical arterial trunk, the deep cervical artery, the vertebral artery, the omocervical or superficial cervical artery and the internal thoracic artery (Figure 26).

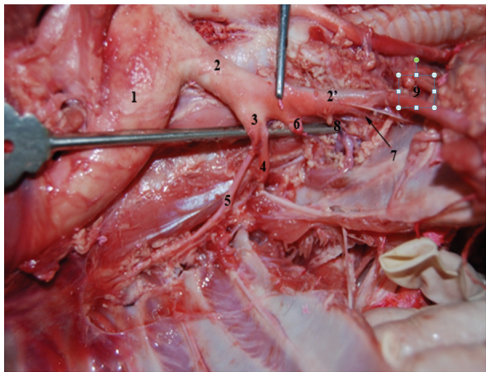

Fig.28.Dorsal branches of the left subclavian artery:
1.Aortic arch; 2, 2'.Left subclavian artery; 3.Costocervical trunk; 4.Dorsal scapular artery ; 5.Supreme intercostal artery; 6.Deep cervical artery; 7.Vetebral artery (intertransverse artery; 8.Muscular artery; 9.Internal thoracic artery.

Following the evaluation of the fixed samples, we have succeeded to identify several aspects

regarding the branches of the left subclavian artery. We have noted that three of the branches had a mainly dorsal orientation: the costocervical trunk, the deep cervical artery and the vertebral artery (Figure 28).

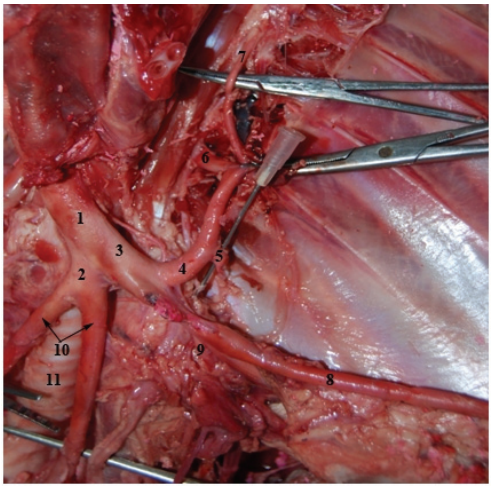

Fig.31. Left subclavian artery
1.Brachiocephalic trunk; 2.Bicarotic trunk; 3.Right subclavian artery; 4.Right costocervical trunk; 5.Right deep cervical artery; 6.Dorsal scapular artery; 7.Right intercostal artery; 8.Internal thoracic artery; 9.Dorsal muscular arterial branch; 10.Common carotid arteries; 11.Trachea.

In most subjects, the arterial costocervical trunk divided after a short path in the supreme intercostals artery and the dorsal scapular artery (Figure 26). In two cases, this was also the emerging point for the deep cervical artery (Figure 31) This terminal bifurcation is located at the level of the 2nd intercostals space.

At a short distance from the emission of the costocervical trunk, lays the origins of the deep cervical artery and of the vertebral artery (Figure 28).

It is worth mentioning that at the terminal level of the left subclavian artery and its continuation with the axillary artery, the subclavian gives off in the dorsal direction a strong arterial branching which we have named muscular artery (Figure 31).

The ventral branches of the subclavian artery are: the superficial cervical artery and the internal thoracic artery (Figure 25).

No samples of those that we have dissected the external thoracic artery, a situation in which we do not exclude the possibility of it being one of the several branches given off by the omocervical artery, which is well developed (Figure 29)

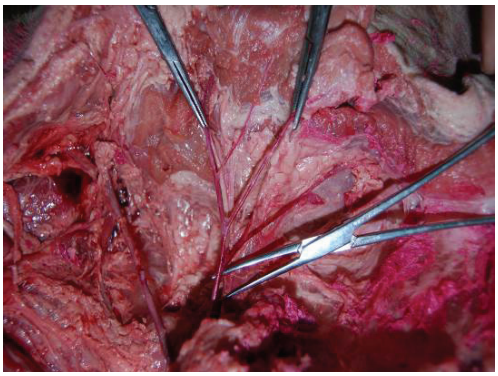

Fig.29.Branches of the omocervical artery

The right subclavian artery is the only branch given off by the brachiocephalic trunk. We have identified its origin at the level of the first rib, were this artery is emitted under a narrow angle (Figure 26 and Figure 31).

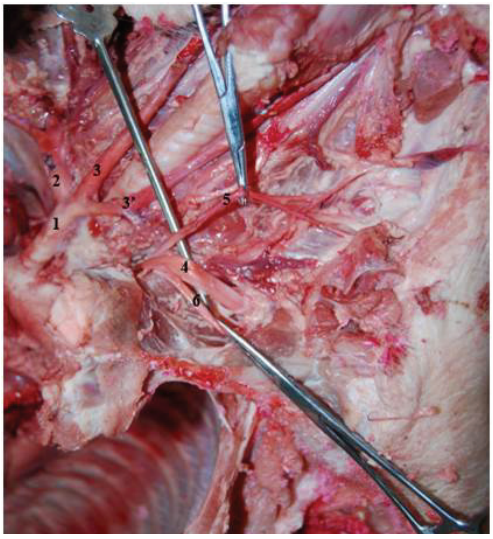

Fig.32.Branches of the left axillary artery
1.Brachiocephalic trunk; 2.Right subclavian artery; 3, 3'.Common carotid arteries; 4.Left axillary artery; 5.Muscular branch; 6.Left omocervical artery.

In our specimens, the emission of the right subclavian artery marked the beginning of a very short bicarotid trunk (3-4cm) which split into two common carotid arteries.

On its path, the right subclavian artery also

gives off, just like its left counterpart, dorsal and ventral branches (Figure 30 and Figure 31).

In addition to this, close to the origin of the subclavian right artery is located the origin of the omocervical branch and of the vertebral artery.

As seen in Figure 31, the right costocervical trunk detaches itself at the level of the great curve of the right subclavian artery.

The terminal segment of the right subclavian artery is placed at the level of the cranial border of the first rib, from which point it is continued by the axillary artery (Figure32).

Our results indicate that in pigs the right subclavian artery is a constant branch, which in swine emerges from the brachiocephalic trunk, while the left subclavian artery detaches directly from the aortic arch.

These observations confirm the general data present in literature (Chirilean et al., 2010a, 2010b; Damian, 2001; Cotofan et al., 2000; Barone, 1996; Constantinescu et al., 1982; Sisson and Grossman, 1964), according to some of which, due to this asymmetry, the brachiocephalic trunk should be called right brachiocephalic trunk.

We have also noted that the left subclavian artery gives off the internal thoracic artery when leaving the precardiac mediastinum, and, in most subject, the latter presented itself as a strong branch, which correlates to its older, functional name of internal mammary artery (Baron, 1996) (Figure 28).

Our results show that the left subclavian artery in all subjects has a relatively large calibre, which still does not surpass that of the brachiocephalic trunk, confirming previous results (Damian, 2014; Tuns, 2014).

The left subclavian artery in all of the dissected specimens presented a constantly larger calibre than that of the right homologue. This is correlated with literature data indicating the fact that the blood flow of the area of distribution of the left subclavian artery is significantly larger that of the right one (Damian, 2001; Coţofan et al., 2000; Popovici et al., 1998)

Because of the important girth presented by the right subclavian artery in all of our research samples, we ascertain that this artery can be considered the main terminal of the brachiocephalic trunk, along with the bicarotid trunk.

Consistent with previous literature data (Tuns et al., 2014; Tuns, 2014), we have also noted that the common carotid arteries have a smaller calibre than the subclavian arteries. This particularity referred mostly to the left subclavian artery and to a lesser extent to the right one. From this point of view we can also take into account the internal thoracic arteries, which had a similar calibre to that of the common carotid arteries.

When discussing the branches given off by left and right subclavian arteries, the main pattern presented by our samples confirm literature data, with the exception of some variations.

While certain authors state that the dorsal branches of the right subclavian artery (Barone, 1996) or of both subclavian arteries (Sisson and Grossman, 1964) may be joined in a common trunk, none of our subjects presented this feature.

Also, while most of our subjects presented separate left deep cervical and left costo-cervical arteries, coinciding with certain authors (Damian, 2001), two of them presented the left cervical artery as emerging from the costocervical trunk, a situation that has also been described by other authors (Barone, 1996).

As noted in previous studies (Tuns, 2013,2014) the origin of these branches do not have a strictly dorsal and ventral placement along the walls of the subclavian, thus we consider that their classification in literature (such as Damian, 2011) according to the position of emergence into dorsal and ventral branches has a purely didactic role.

Our results also suggest that, although the branches of the subclavian arteries in pigs do present some intraspecific variations, they do not attaint the level noted in humans (Gosling, et al., 2008, Fritsch, 2008; Papilian, 1979). This situation can be accounted for by the significantly short life span of this species, due to commercial slaughter, which also accounts for the lack of case reports of corresponding pathology, as in humans variability of branch emission in these arteries have direct consequences on cardiovascular pathology

CONCLUSIONS

Our study confirms that subclavian arteries in pigs present a constant asymmetrical emergence: the left subclavian artery originates directly in the aortic arch, while the right one is given off by the brachiocephalic trunk. The right subclavian artery is the only branch detached from the arterial brachiocephalic trunk and it marks the cranial limit of this short vessel.

The calibre and lumenum of the right subclavian artery is significantly smaller by comparison to its left counterpart, but they are both larger than the common carotid arteries.

At the terminal segment of the left subclavian artery, we have noticed that this artery gives off a strong branch which we have name muscular branch.

None of the subjects sampled in our study presented the external thoracic artery as a branch of the subclavian arteries, and the left deep cervical artery presented itself either as a direct branch of the subclavian artery, or a branch of the costocervical trunk. These variations, however, are less important than in humas, a fact which possibli stems from this species short economical lifespan.

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