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A COMMON TRUNK OF THE CORONARY ARTERIES IN A BOVINE HEART (BOS PRIMIGENIUS F. TAURUS, LINNÉ 1758)

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Abstract

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Absence of the initial trunk of the left coronary artery was incidentally observed during a routine dissection of a bovine heart specimen from a 2–3-year-old steer at slaughter. The coronary arterial circulation was studied subsequently in detail and found to arise from a common trunk for both coronary arteries. Both its origin from the aorta and position in its initial course correspond to those for the right coronary artery. The origin and initial portion of a left coronary artery was not detected macroscopically but instead was represented by a continuation of this thickened initial segment adjacent to the conus trunci pulmonalis. The latter is regularly a connection between the right coronary artery and the ramus interventricularis paraconalis of the left coronary artery as found in the normally developed coronary circulation of bovine. Comment is presented regarding the possible genesis of this anomaly.

Cattle, absence, left coronary artery, anomaly

Anomalies of the coronary arteries in mammals have been described rather frequently and they are more numerous than anomalies of cardiac veins. Similar findings were reported by Hackensellner (1954) who investigated 1000 human hearts and detected anomalies of coronary arteries in 21 cases. According to Godglück (1942) anomalies in animals have been detected less frequently than in man. Most of these have been reported in cattle, horse, dog, pig and cat. The cases described in literature may be classified as follows:

1. Variations in ramification of the coronary arteries - both coronary arteries originate from the aorta but one of them or both show irregularities in ramification and course of their secondary branches in the cardiac wall. These cases may often go unnoticed or they have been considered unimportant. Six such variations have been described by Hackensellner (1954).
2. Aneurysms of the coronary arteries (described in cattle by Joest in 1906 and Rubli (1933, 1944)). By this aneurysm the left coronary artery was connected with the right ventricle. A similar connection of the left coronary artery aneurysm with the left ventricle in cattle has been described by Reid (1922). Raschke (1915)

found in a bovine an aneurysm of the right coronary artery bulging into the right ventricle. Schauder (1924) described another interesting case in a bovine: an unusually large left coronary artery embedded in the interventricular septum. Dilated coronary arteries with no further contact with the ventricular lumen have been described by Schlegel (1933) and Löbel (1937).

3. Anomalies in the origin of coronary arteries:

a) Supernumerary coronary arteries - they origin from the aorta at other locations. Goerttler (1950) found in man a supernumerary coronary artery for the area of conus trunci pulmonalis in 30–40 % of necropsied cases. Hackensellner (1954) viewed the occurrence of this supernumerary coronary artery as a variation similar to the occurrence of a separately originating a. septi cordis (ramus septalis). Wilson (1965) described a case of supernumerary left coronary artery in the ox, where both a. coronariae sinistrae originated in the right sinus aortae above the valvula semilunaris dextra.

b) Displacement of the origin of coronary arteries in man has been described by Hackensellner (1954), Edwards (1968) and others. This type of anomaly can also be found in cases described by Wilson (1965) and Vitums (1973) in the ox.

c) A common trunk of origin of both coronary arteries is characterized only by an unusual origin and course of the initial segment of the respective vessel with its branching in the cardiac wall being common. The common trunk may serve as the continued anastomoses of the right and left coronary arteries. This anastomose often extends from the cranial aspect of the conus trunci pulmonalis (Konusanastomose - Grätzer 1926). Such cases have been found in the dog (Day 1959), in the ox (Červený and Kaman 1963; Nie 1968; Černý 1976), and in man (Richter 1937; Hackensellner 1954).

d) Absence of one coronary artery: in such cases a characteristic feature is the absence of the vessel at its origin and possibly a thicker common trunk at the site marking the typical location of the missing coronary artery. This deviation has been described in man (Richter 1937; Hackensellner 1554; Tofilo 1961).

e) Origin of one of the coronary arteries from the pulmonary trunk: such origin of a. coronaria dextra was found by Wolffhügel (1901), Vitums (1963), Fischer and Pirie (1965), Nie (1968) and Mieok and Londen (1969). A dual origin of a. coronaria dx. from the aorta and from a. pulmonalis was found in an ox by Vitums (1973).

4) Variations in the ostium width and caliber of coronary arteries have been described, too (Donskov 1926). Such cases should be evaluated in context of the anatomical characteristics of the species. Such enlarged vessels are usually observed to compensate for an underdevelopment of the other.

Observations

At routine dissection of the heart during an anatomy course in one heart specimen the absence of the initial part of the left coronary artery was detected between the pulmonary trunk and the left auricle. The heart of a 2-3-year-old steer was taken for dissection at the slaughterhouse. No other cardiac pathological changes or anomalies were found. By a detailed dissection and study of the arterial circulation in this heart the following branching of the coronary arteries was revealed:

A common trunk of origin for both coronary arteries arose from the aorta about 1 cm above the position of the right semilunar valvule in the middle of the right aortic sinus, where regularly the right coronary artery arises.

No trace of an origin of the left coronary artery was detected either in the left

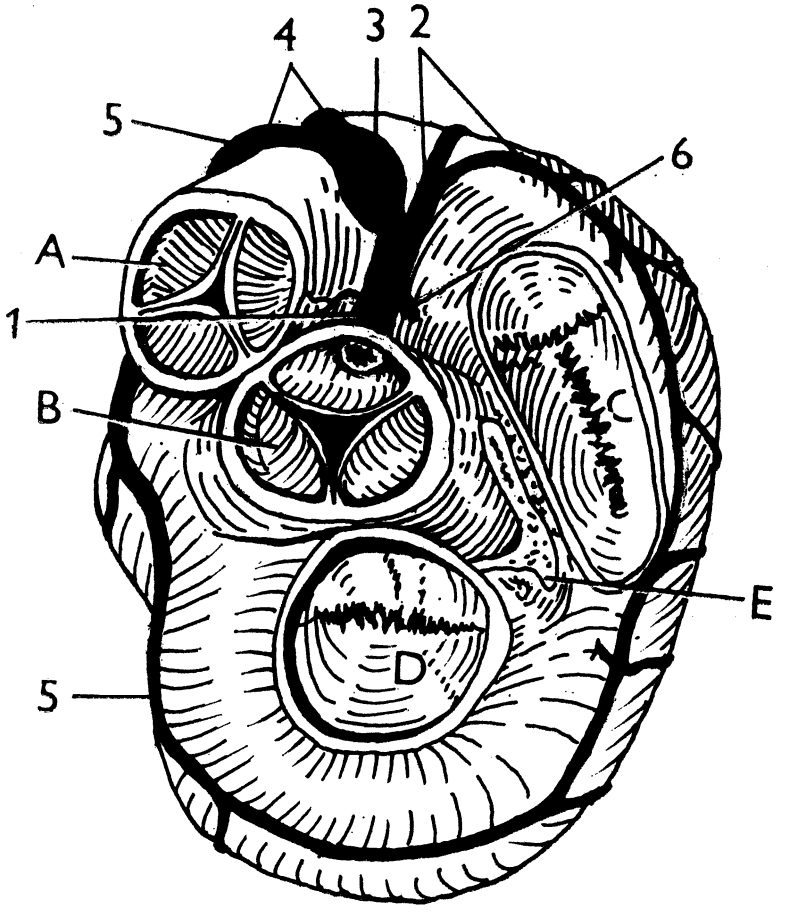

Fig. 1. Ramification of anomalous coronary arteries in the bovine heart under study (dorsal aspect of the septum atrioventriculare) A — ostium trunci pulmonalis with valves, B — ostium aortae, C — ostium atrioventriculare dextrum et valva tricuspidalis, D — ostium atrioventriculare sinistrum et valva bicuspidalis, E — os cordis dextrum, 1 — common origin trunk of the right and left coronary artery, 2 — a. coronaria dextra, 3 — aneurysm on the anastomosis between a. coronaria dextra and a. coronaria sinistra on the conus trunci pulmonalis, 4 — branched and reinforced anastomose on the conus trunci pulmonalis that compensated for the initial trunk for a. coronaria sinistra, 5 — ramus circumflexus (a. coronariae sinistrae), 6 — ramus septi (a. coronariae dextrae).

aortic sinus, at the site of usual origin of this artery, or at any other site related to the bulbus aortae. The common trunk for both coronary arteries gave off a branch less than 1 mm in diameter at about 5 mm from its origin. This branch was finished in the wall of the pulmonary trunk conus between the initial portion of aorta and the pulmonary trunk and the ramus septalis which branched as usual in the interventricular septum. The common trunk for both coronary arteries coursed initially in the same way as the right coronary artery in a normally developed arterial circulation of the heart. It was about 12 mm in diameter and 2 cm long, and it coursed adjacent

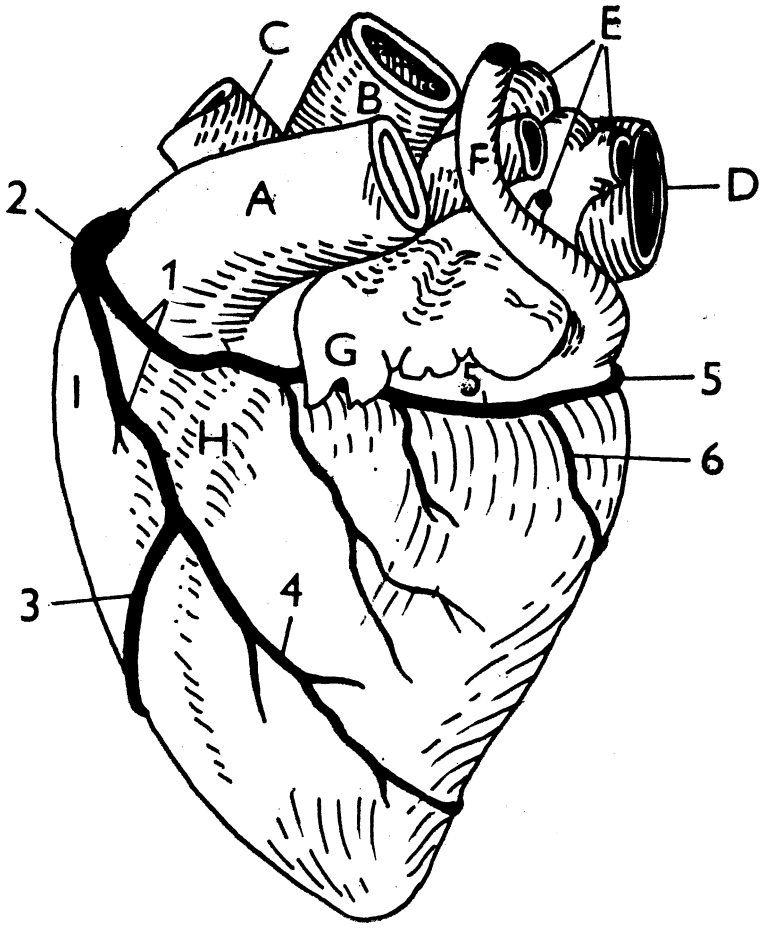

Fig. 2. Ramification of branches of a. coronaria sinistra in the bovine heart under study (view of the facies auricularis). A — truncus pulmonalis, B — arcus aortae, C — truncus brachiocephalicus, D — vena cava caudalis, E — venae pulmonales, F — v. azygos sinistra, G — auricula sinistra, H — sulcus interventricularis paraconalis, I — conus trunci pulmonalis, 1 — branched and reinforced anastomose on the truncus coni pulmonalis, 2 — aneurysm of this anastomose between a. coronaria dextra and a. coronaria sinistra, 3 — ramus interventricularis paraconalis, 4 — branch for the area of apex cordis, 5 — ramus circumflexus (a. coronariae sinistrae), 6 —ramus intermedius.

to the pulmonary trunk and right ventricle toward the right ventricular margin (margo ventricularis dexter). Here it divided forming two branches. The right branch formed by its course and branching the right coronary artery and the left branch coursed on the cranial margin of the conus trunci pulmonalis to the left.

The right branch (serving as the a. coronaria dextra) was about 0.5 cm thick and coursed toward sulcus coronarius above the right ventricle. In this groove it continued nearly to the sulcus interventricularis subsinosus. Here it branched as usual in the wall of the right ventricle, right atrium and right auricle.

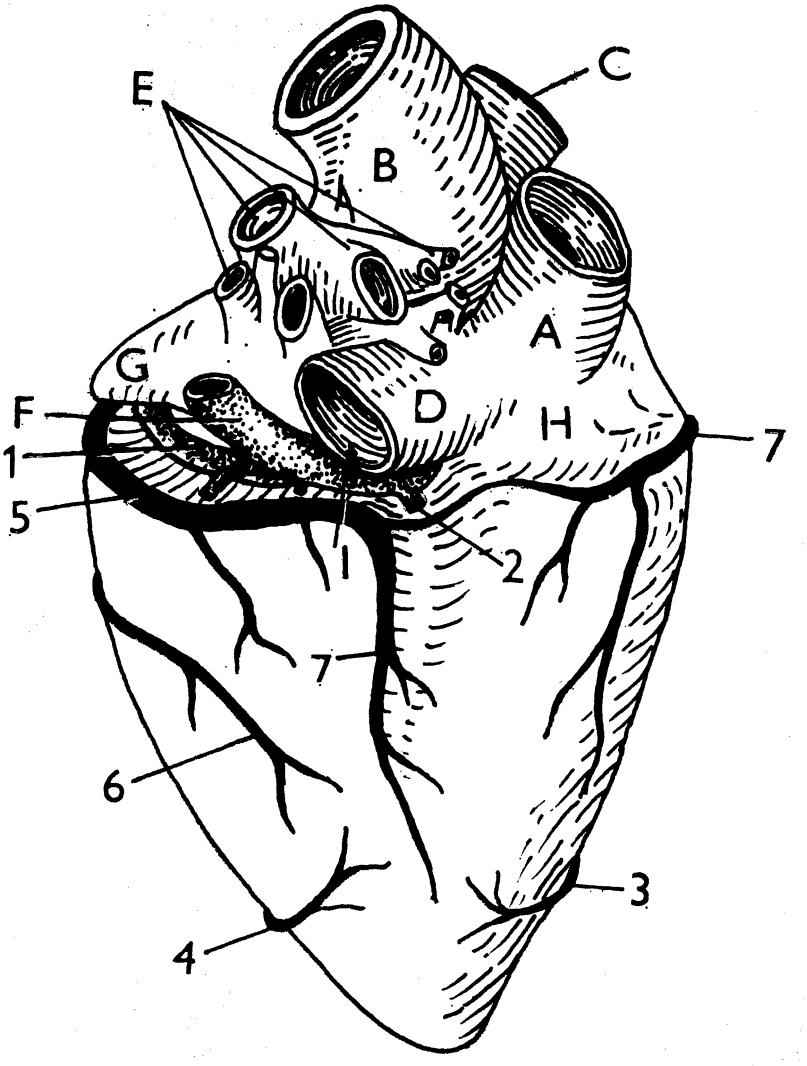

Fig. 3. Ramification of the anomalous coronary arteries in the bovine heart under study (view of facies atrialis). A — vena cava cranialis, B — arcus aortae, C — truncus brachiocephalicus, D — v. cava caudalis, E — venae pulmonales, F — v. azygos sinistra, G — atrium sinistrum, H — atrium dextrum, I — sinus coronarius cordis, 1 — v. cordis magna, 2 — v. cordis media, 3 — ramus interventricularis paraconalis, 4 — branch for the area of apex cordis, 5 — ramus circumflexius (a. coronariae sinistrae), 6 — ramus intermedius, 7 — a. coronaria dextra.

The left branch had first a course similar to that of the anastomose between a. coronaria dextra and ramus interventricularis paraconalis a. coronariae sinistrae in the normal arterial circulation of cattle, without any deviations (see Fig. 4). However, its diameter was substantially larger. At its origin it was ca 0.6 cm thick and soon became a 1.5 cm broad and 2.5 cm long aneurysm, giving off a ventral and a dorsal branch. The ventral branch represented the ramus interventricularis

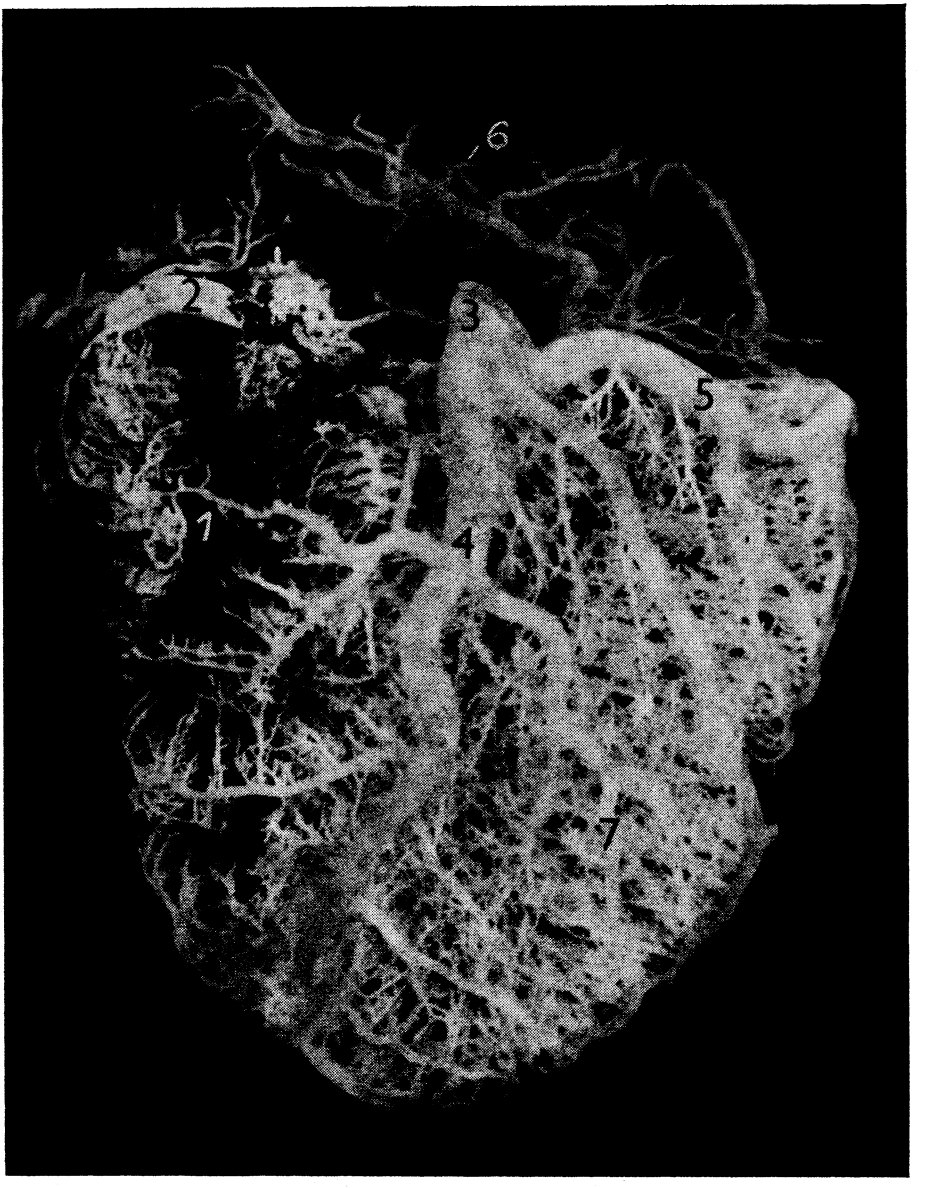

Fig. 4. Corrosive preparation of the coronary arteries of a normal bovine heart. 1 — regularly occurring anastomose of a. coronaria dextra and a. coronaria sinistra on the conus trunci pulmonalis, 2 — a. coronaria dextra (origin from the aorta), 3 — a. coronaria sinistra (origin from the aorta), 4 — ramus interventricularis paraconalis, 5 — ramus circumflexus (a. coronariae sinistrae), 6 — arterial branches of the heart atria, 7 — arterial branches of the heart ventricle walls.

paraconalis; it was about 5 mm thick and passed across on the conus trunci pulmonalis towards the groove of the same name at about half-way along its course. Here it turned into the sulcus interventricularis paraconalis and branched in the wall of the right and left ventricles. On the surface of facies auricularis it gave off a conspicuous straight superficial branch directed toward the apex cordis. It continued through the margo ventricularis sinister to facies atrialis. Its functional distribution seemed within normal ramification of the ramus interventricularis paraconalis of the left coronary artery. The dorsal branch represents the ramus circumflexus a. coronariae sinistrae; it was about 7 mm thick and coursed over the conus trunci pulmonalis more horizontally than the preceding branch. It passed into the sulcus coronarius above the left ventricle and continued on the surface of facies atrialis into the sulcus interventricularis subsinosus as the ramus interventricularis subsinosus. The area of cardiac wall supplied by both coronary arteries approximated the situation with normally originating coronary arteries.

Discussion

Anatomical arrangement of the arterial system of the coronary circulation described herein is classified as an anomaly of the origin of coronary arteries from the aorta. Both coronary arteries arose from a common trunk which originated from the anlage for the right coronary artery. This common trunk had a typical point of origin as the right coronary artery and immediately gave off the ramus septalis with the same diameter and distribution as in a normal heart (where it is a branch of the right coronary artery). No signs of secondary extinction or hypoplastic basis of a. coronaria sinistra were found, either in the aortic wall or in the wall of the truncus pulmonalis. The connection of this common trunk of origin was made through regularly occurring anastomoses between the right coronary artery and ramus interventricularis paraconalis a. coronariae sinistrae which, in case of a stenosis or obstruction of the initial portion of one of the coronary arteries, connects to the more distal branching of the affected coronary artery (Richter 1937, Day 1959 and others).

This typical anastomose, crossing the conus trunci pulmonalis on its cranial aspect, has been often mentioned in descriptions of anomalies where both coronary arteries originate from a common trunk. The importance of this anastomose has been stressed by Grätzer (1926) for substitution of blood circulation in an affected heart; he named this connection »Konusanastomose«. It is found rather frequently in similar cases with coronary arteries originating from the aorta by a common trunk, be it a trunk originating at the site of the right coronary artery (Day 1959; Červený and Kaman 1963; Černý 1976) or a trunk originating at the site of the left coronary artery (Richter 1936; Hackensellner 1954). An adaptation of the coronary circulation through such »Konusanastomose« may occur after a complete but gradual obstruction of one of the coronary arteries due to sclerotic changes in their wall (Richter 1937). It is difficult to determine whether in the present case agenesis of the embryonic bud of the left coronary artery or secondary extinction of the beginning portion of a. coronaria sinistra occurred. It may be hypothesized, based on regular ramification of both coronary arteries in the wall of the heart specimen under study, and the anastomose regularly occurring on the cranial margin of conus trunci pulmonalis, that this anastomose was rebuilt to a substitute trunk of origin for both main branches of the left coronary artery and thus compensated for the lack of the initial part of the left coronary artery. It can be assumed that an impaired development had occurred only after the basic bran-

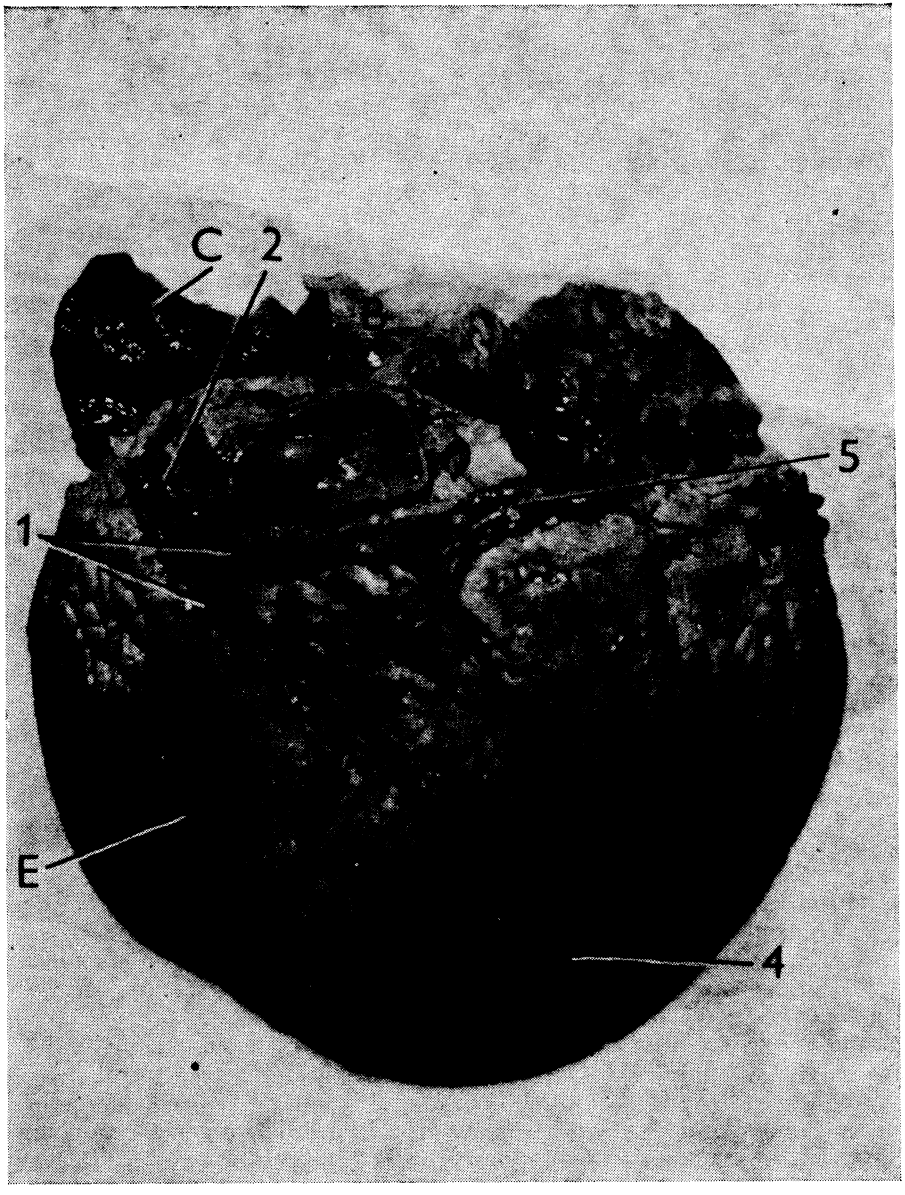

Fig. 5. Facies auricularis of the bovine heart under study with anomalous coronary arteries. A — truncus pulmonalis, B — aorta, C — auricula dextra, D — auricula sinistra, E — ventriculus dexter, F — sulcus interventricularis paraconalis, 6 — conus trunci pulmonalis, 1 — branched reinforced anastomose of the conus trunci pulmonalis, 2 — sectioned aneurysm of the anastomose between a. coronaria sinistra and a. coronaria dextra on the conus trunci pulmonalis, 3 - ramus interventricularis paraconalis, 4 — branch for the area of apex cordis, 5 — ramus circumflexus (a. coronariae sinistrae), G — ramus marginis sinistri.

ching of both left and right coronary arteries. Our further hypothesis is that a secondary extinction of the initial portion of the left coronary artery occurred and that this lack of its further development was compensated for by the described »Konusanastomose«.

Společný kmen věnčitých tepen na srdci skotu (*Bos primigenius* f. *taurus* Linné 1758)

Nutritivní tepenný oběh na studovaném srdci skotu je zajištěn ze společného kmene pro obě věnčité tepny. Tento společný kmen odpovídá i odstupem z aorty i polohou v počátečním úseku a. coronaria dextra. Odstupový úsek a. coronaria sinistra na studovaném srdci nebyl makroskopicky zjištěn a je nahrazen zesílenou anastomosou nad conus trunci pulmonalis, která je pravidelnou spojkou mezi a. coronaria dextra a ramus interventricularis paraconalis a. coronariae sinistrae na normálně vyvinutém tepenném oběhu srdce skotu. Tento typ anomálie řadíme do skupiny: anomálie odstupu věnčitých tepen. V diskusi se pokoušíme vysvětlit genesi této anomálie.

Совместный ствол венечных артерий сердцо крупного рогатого скота
(*Bos primigenius* f. *taurus* Linné 1758)

Питательное артериальное кровообращение на изучаемом сердце крупного рогатого скота обеспечено от совместного для обеих венечных артерий ствола. Упомянутый совместный ствол соответствует также отхождением от аорты и пложением на исходном участке a. coronaria dextra. Участок отхождения a. coronaria sinistra на изучаемом сердце макроскопически не был установлен и он заменен усиленным анастомозом над conus trunci pulmonalis, являющимся регулярным соединением между a. coronaria dextra и ramus interventricularis paraconalis a. coronariae sinistrae на нормально развитом артериальном кровообращении сердца крупного рогатого скота. Данный тип аномалии включаем в группу: аномалии отхождения венечных артерий.

В разделе обсуждения дается попытка объяснения генеза данной аномалии.

References

ČERNÝ, H.: Anomalous origin and course of the coronary arteries in cattle. Acta vet. Brno, **45**, 1976: 3–9.
ČERVENÝ, Č. – KAMAN, J.: Common stem of coronary arteries in a calf. Anat. Anz., **113**, 1963: 29–35.
DAY, S. B.: A left coronary artery originating from a single coronary stem in a dog. Anat. Rec. **134**, 1959: 55–59.
DONSKOV, V. A.: K voprosu o varijacijach i anomalijach venečnych artěrij s ich značenijem dlja serdca i vsego organizma. Sb. trudov Irkutsk. univ., **11**, 1926: 96–101.
EDWARDS, J. E.: Congenital malformationes of the heart and great vessels. In: Pathology of the heart and blood vessels. S. E. GOULD, 3rd. ed. C. C. Thomas, Springfield, Illinois, 1968, 326 pp.
FISCHER, E. W. – PIRIE, H. M.: Cardiovascular lesions in cattle. Ann. N. Y. Acad. Sci., **127**, 1965: 606–622.
GOERTTLER, K.: Entwicklungsgeschichte des Menschen. Springer-Verlag, Berlin - Göttingen - Heidelberg, 1950, 432 pp.

GODGLÜCK, G.: Über den Abgang der rechten Kranzarterie aus der Pulmonalis und gleichzeitiger Reduction der Pulmonalisklappen bei einem Rinde. Arch. Tierkeilk., **77,** 1942: 231–243.
GRÄTZER, G.: Der Seitenbahnenkreislauf an einem Herzen mit einer Krantzschlagader. Virch. Arch., **262,** 1926: 608–614.
HACKENSELLNER, H. A.: Koronaranomalien unter 1000 auslesefrei untersuchten Herzen. Anat. Anz., **101,** 1954: 123–130.
JOEST cited from GODGLÜCK, G.
LÖBEL cited from GODGLÜCK, G.
MARCATO, A.: Origine dell »arteria coronaria destra dell'arteria polmonare ed ectasia generale delle arterie coronaire in un bovino. Nuova Veterinaria, **18,** 1939: 16–17.
MIEOK, W. H. W. – LONDEN, J. G. vau: Afwijkende oorsprong van de arteria coronaria sinistra. Tijdschr. Diergeneesk., **94,** 1969: 1370–1372.
NIE, C. J. van: Anomalous origin of the coronary arteries in animals. Path. vet., **5,** 1968: 313 to 326.
RASCHKE, O.: Kongenitale Anomalie der rechten Ventrikelwand und Koronararterie beim Rinde. Zeitschr. f. Fleisch u. Milchhygiene, **25,** 1915: 354–356.
REID, C.: Abnormal left coronary artery of the haert communicating directly with the cavity of the left ventricle near the apex. Journ. of Anat., **57,** 1922: 12–17.
RICHTER, O.: Über das Fehlen einer Kranzarterie. Virchows Arch., **299,** 1937: 637–641.
RUBLI, H.: Einzigartige Missbildung der Arteria coronaria sinistra beim Kalbsherzen. Anat. Anz., **77,** 1933: 169–177.
RUBLI, H.: Noch eine Missbildung der Arteria coronaria sinistra beim Kalbsherzen. Anat. Anz., **78,** 1934: 47–51.
SCHAUDER, W.: Missbildung der Coronararterie beim Rind. Anat. Anz., **58,** 1924: 540–548.
SCHLEGEL, M.: Ausgebreitetes Rankenangiom beider Kranzarterien des Herzens und ihrer verzweigungen beim Rind. Berliner Tierärztliche Wochenschrift, **1,** 1933: 21–23.
TOFILO, P. I.: Redkij slučaj krovosnabženija serdca čelověka odnoj (pravoj) venečnoj arterii. Arch. anat. gist. i embriol., **40,** 1961: 82–83.
VINK, H. H. – VOS, J. J. – HEIDA, G. – VRIES, L.: Oorsprong der Kroonslagadaren uit de longslagader. Ned. T. Geneesk., **85,** 1941: 4440–4441.
VITUMS, A.: Anomalous origin of the right coronary artery in a cow. Zbl. Vet. Med., **10,** 1963: 185–194.
VITUMS, A.: Dual origin of the left coronary artery in a newborn calf. Anat. Anz., **133,** 1973: 73–75.
WILSON, P.: An unusual variation of the coronary arteries. Anat. Anz., **116,** 1965: 299–302.
WOLFFHÜGEL, K.: Ursprung der A. coronaria cordis aus der A. pulmonalis bei einem Rind. Zeitschr. Fleisch- u. Milch-Hyg., **12,** 1901: 38.