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Macroanatomical Investigation of Arteria Coronaria and Myocardial Bridges in Tuj and Hemshin Sheep

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ABSTRACT

In the study, it was aimed that the macroanatomic features of the coronary arteries and myocardial bridges were investigated in Tuj and Hemshin sheep. 10 hearts of male Tuj sheep and 10 hearts of male Hemshin sheep were used as the study material. It was applied the latex injection and corrosion cast techniques. It was observed that the hearts were vascularized by arteria (a.) coronaria dextra and a. coronaria sinistra. A. coronaria sinistra was dominant in 8 Tuj and 9 Hemshin sheep, a. coronaria dextra was dominant in 2 Tuj and 1 Hemshin sheep. The r. interventricularis subsinuosus was formed by ramus (r.) circumflexus sinister in 8 Tuj and 9 Hemshin sheep, by r. circumflexus dexter in 1 Tuj sheep and by r. proximalis atrii dextri in 1 Tuj and 1 Hemshin sheep. There were myocardial bridges on the r. interventricularis paraconalis in all of the hearts. There was a statistical difference in the length of the myocardial bridges on the sulcus interventricularis paraconalis between the hearts of Tuj and Hemshin sheep (P< 0.05).

Key words: Coronary artery, Myocardial bridge, Sheep.

INTRODUCTION

Hemshin and Tuj sheep are the native breed in Turkey. Hemshin sheep are raised in Artvin and Rize cities in the Eastern Blacksea Region and Tuj sheep are raised in Kars, Ardahan and Iğdır cities in the Eastern Anatolia Region (Yenikurt and Demirtaş, 2016).

Sheep heart is used in various anatomic (Aksoy *et al.,* 2018) and experimental (Vincenti *et al.,* 2014) studies. In literature (Vincenti *et al.,* 2014) it is believed that owing to its anatomical features are similar to human heart, the sheep heart can set a model for the studies conducted in human medicine. Besides the importance of using sheep heart as an experimental model, there were macroanatomic and morphometric studies on coronary arteries and myocardial bridges of various sheep breeds (Teke *et al.,* 2017; Aksoy *et al.,* 2018; Gomez *et al.,* 2018). However, no studies on coronary arteries and myocardial bridges were found in Tuj and Hemshin sheep. In this study, macroanatomic and morphometric values of coronary arteries and myocardial bridges were investigated in Tuj and Hemshin sheep.

MATERIALS AND METHODS

In the study, a total of 20 hearts were used, 10 being from Hemshin sheep and 10 being from Tuj sheep among 6-10 month-old male sheep. Hearts were obtained from the slaughterhouses in Kars and Artvin/Ardanuç, respectively. Coronary arteries were examined by corrosion cast technique (Karadağ and Soygüder, 1989) and by latex injection technique. After latex injection and corrosion cast, origin, diameter of origin and vascularized areas of the coronary arteries were determined. The length of the myocardial bridges on the coronary arteries and the origin diameters of the coronary arteries were measured by digital caliper (0.00 BTS.UK). The results were photographed with camera (Pentax k-x). Coronary arteries were named according to Nomina Anatomica Veterinaria (2012).

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Statistical analysis

The values descriptive statistic of morphometric findings were statistically analyzed in the SPSS (20.0 version) package programme. Independent Samples T test was applied to determine the differences of the measurements between the hearts of Tuj and Hemshin sheep.

Abbreviations

Arteria (a.) coronaria sinistra: ACS, ramus (r.) interventricularis paraconalis: RIP, r. circumflexus sinister: RCS, r. interventricularis subsinuosus: RIS, r. proximalis atrii sinistri: RPAS, r. intermedius atrii sinistri: RIAS, r. distalis atrii sinistri: RDAS, r. proximalis ventriculi sinistri: RPVS, r. marginis ventricularis sinistri: RMVS, r. distalis ventriculi sinistri: RDVS, r. collateralis sinister proximalis: RCSP, r. collateralis sinister distalis: RCSD, r. septalis: RS, ramus ventriculi dextri: RVD, a. coronaria dextra: ACD, r. circumflexus dexter: RCD, r. proximalis atrii dextri: RPAD, r. intermedius atrii dextri: RIAD, r. distalis atrii dextri: RDAD, r. coni arteriosi: RCA, r. proximalis ventriculi dextri: RPVD, r. marginis ventricularis dextri: RMVD, r. distalis ventriculi dextri: RDVD, truncus: tr., rr.: rami, v.: vena, atrium dextrum:

AD, atrium sinistrum: AS, ventriculus dexter: VD, ventriculus sinister: VS, aorta: AO, tr. pulmonalis: TP, ostium v. pulmonalis: VP, ostium v. cava caudalis: VCa, ostium v. cava cranialis: Vcr.

RESULTS AND DISCUSSION

The arterial vascularization of the heart in Tuj and Hemshin sheep were provided by a. coronaria dextra and a. coronaria sinistra (Fig 1/ACS and Fig 2/ACS), as reported in Kıvırcık sheep (Doğruer and Özmen, 2012) and Awasi sheep (Aksoy *et al.,* 2018). Aksoy *et al.* (2018) reported that there was a third coronary artery originated from the aorta in four sheep heart. Türkmenoðlu (1996) was reported that RCA which originated from aorta and ACD anastomosed with RCA which emerged from RIP in 2 kangal dogs. Similarly, it was seen that a third branch sprang from the auricular side of aorta and this branch was thin and vascularized to tr. pulmonalis in 1 Hemshin and 2 Tuj sheep. This vessel anastomosed with RCA which originated from RIP in 1 Tuj sheep, like kangal dogs (Türkmenoğlu, 1996).

In 8 Tuj and 9 Hemshin sheep, ACS was found to be dominant in accordance with the literature (Aksoy and Karadağ, 2002; Likitha *et al.,* 2018). On the contrary, ACD has been reported to be dominant in Buffalo (Tecirlioğlu *et al.,* 1977), donkey (Özgel *et al.,* 2004), Malakan horse (Gürbüz *et al.,* 2016) and one goat (Barszcz *et al.,* 2019). In 2 Tuj and 1 Hemshin sheep, it was observed that ACD was dominant. However, no information on ACD being dominant in sheep in the literature.

In Tuj and Hemshin sheep, the diameter of ACS was measured as 5.08 and 5.07 mm and the diameter of ACD was 2.97 and 2.69 mm, respectively. Yang *et al.* (1989) measured the diameter of ACS as 3.42 mm, ACD as 2.98 mm in goat. While the diameter of ACD was consistent with the goat, the diameter of ACS was found to be thicker than the goat in Tuj and Hemshin sheep.

A. Coronaria sinistra

ACS was divided into RIP and RCS (Fig 3/ACS). Also, ACS divided into 3 branches in 4 Tuj and 1 Hemshin sheep. Akbulut *et al* (2014) have reported that ACS divided into 2 branches in Zavot cattle, 3 branches in 18.5% of the cat hearts (Monfared *et al.,* 2013). In present study, while ACS was divided into 3 branches in 25% of total sheep hearts supports researchers (Monfared *et al.,* 2013) and in the other hearts, ACS divided into 2 branches which is in accordance with the literature (Akbulut *et al.,* 2014). In addition, in the study, it was determined that r. angularis separated from the angle between RCS and RIP in 1 Tuj sheep, like cat (Aksoy and Karadağ, 2002; Monfared *et al.,* 2013), horse and dog (Nickel *et al.,* 1981).

R. Circumflexus sinister

After the origin of the RCS, it directed to caudal, and coursed to level of sulcus interventricularis subsinuosus by surpassing margo ventricularis sinister in sulcus coronarius under the auricula sinistra (Fig 3/RCS). Then RCS entered the sulcus interventricularis subsinuosus and formed the RIS in 8 Tuj and 9 Hemshin sheep. RCS divided into RPAS in 3 Tuj and 5 Hemshin sheep, RIAS in 9 Tuj and 7 Hemshin sheep and RDAS in 9 Tuj and all Hemshin sheep for atrium sinistrum, RPVS in 8 Tuj and 9 Hemshin sheep, RMVS and RDVS in all sheep for ventriculus sinister (Fig 4/RCS). RCS coursed subepicardially and then intramyocardially about 1.0-2.0 cm away from its origin (Fig 3/2,3). The diameter of the RCS was measured as 3.13 ± 0.57 mm and 2.99 ± 0.43 mm in Tuj and Hemshin sheep, respectively.

In the study, it was found that, the RPAS emerged from the ACS in 5 Tuj and 5 Hemshin sheep (Fig 5/4), the RCS in 3 Tuj and 5 in Hemshin sheep (Fig 3/1). Also it was determined that RPAS arised from the angle between ACS and RCS in 2 Tuj sheep. In one of the Tuj sheep, there were no RIAS and RDAS and the vascularization of atrium

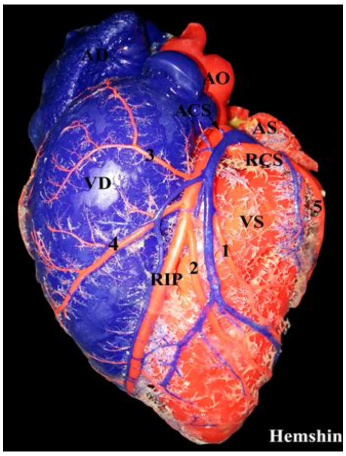

Fig 1: The view of facies auricularis of heart of Hemshin sheep (Corrosion cast).
1. RCSP **2.** RCSD **3.** R. coni arteriosi **4.** Unnamed arter originated from RIP **5.** RMVS.

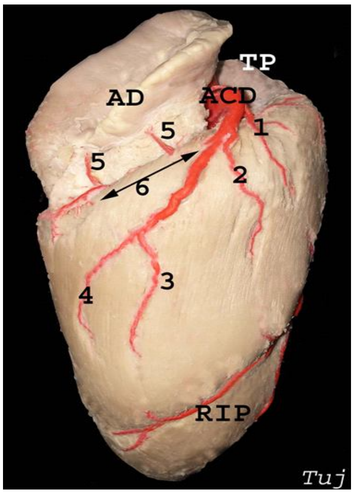

Fig 2: ACD and its branches in Tuj sheep (Latex injection).
1. R. coni arteriosi **2.** RPVD **3.** RMVD **4.** RDVD **5.** RIAD **6.** Myocardial bridge on r. circumflexus dexter.

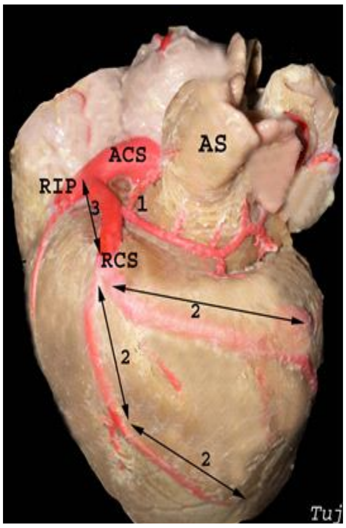

Fig 3: The vessels originated from ACS and the single branch of responsible for vascularization of the atrium sinistrum was RPAS in one Tuj sheep.

1. RPAS **2.** The course of RCS and its branches was intramyocardially **3.** The course of RCS was subepicardially.

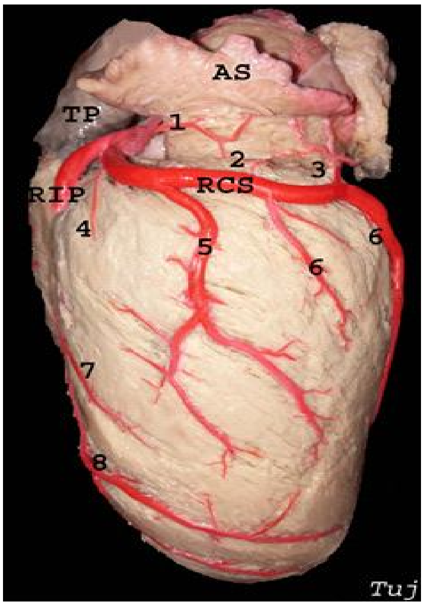

Fig 4: The view of the level of margo ventricularis sinister in Tuj sheep.

1. RPAS, **2.** RIAS, **3.** RDAS, **4.** RPVS, **5.** RMVS, **6.** RDVS.

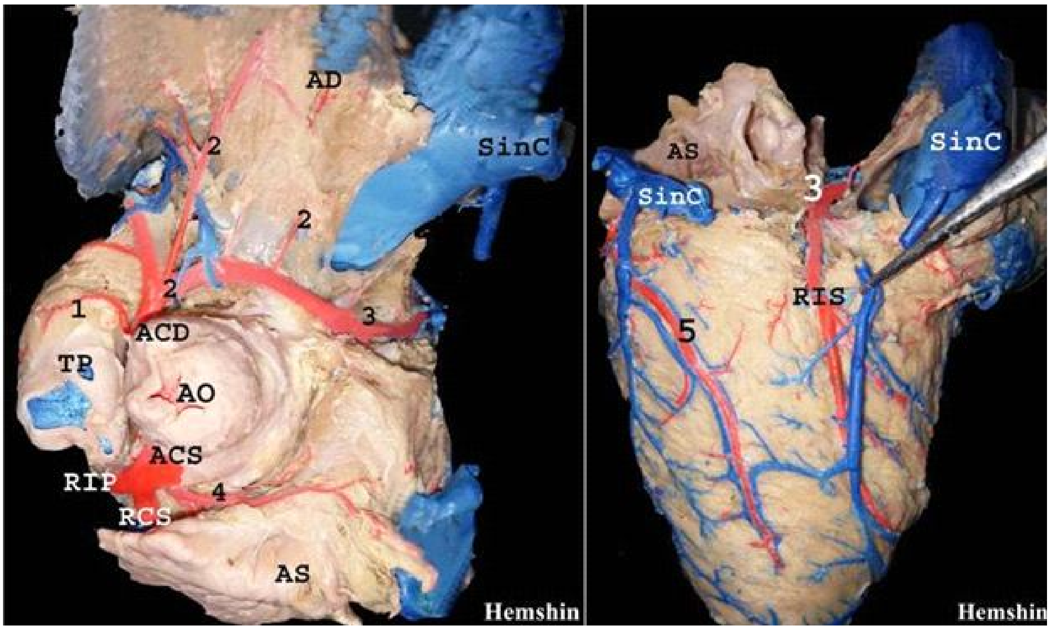

Fig 5: Different coursing of RIS (3, RIS) that originated with RPAD in one Hemshin sheep. It coursed from septum interatriale to sulcus interventricularis subsinuosus.

SinC. Sinus coronarius, **1.** RCA, **2.** RPAD, **3.** RIS, **4.** RPAS, **5.** RDVS.

sinistrum was supplied by only RPAS in this heart (Fig 3/1). Also it was determined that there was no RIAS in 3 Hemshin sheep and the vascularization of lateromedial wall of atrium sinistrum was supplied by RDAS in one of these hearts and by RPAS in 2 of these hearts.

R. interventricularis subsinuosus

RCS coursed in sulcus coronarius in 8 Tuj and 9 Hemshin sheep (Fig 6/RCS) and it entered the sulcus interventricularis subsinuosus and formed RIS (Fig 7/RIS) as reported earlier by Karadağ and Soygüder (1989). However, in 1 Tuj sheep, RIS was formed as a continuation of the RCD, as indicated by horse (Gürbüz *et al.,* 2016), cats (Aksoy, 2000; Nur and Aksoy, 2000), buffalo (Tecirlioğlu *et al.,* 1977), one humped camel (Taha and Abel-Magied, 1996), donkey (Özgel *et al.,* 2004) and one goat (Barszcz *et al.,* 2019). Additionally, it was determined that the RIS was formed by a thick branch of separated from RPAD in 1 Tuj and 1 Hemshin sheep

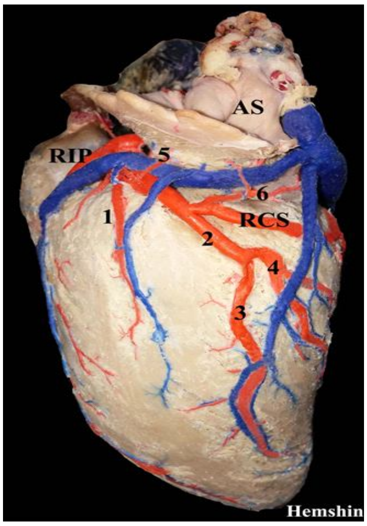

Fig 6: The view of the heart from margo ventricularis sinister in Hemshin sheep.

1. RPVS, **2.** The joint origin of the RMVS and RDVS, **3.** RMVS, **4.** RDVS, **5.** RIAS, **6.** RDAS.

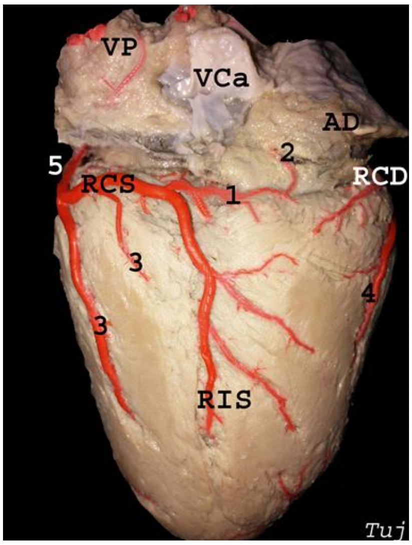

Fig 7: The view of facies atrialis of heart of Tuj sheep.

1. RVD, **2.** The absence of RDAD and the region vascularized by r. ventriculi dextri's branch, **3.** RDVS, **4.** RDVS, **5.** RDAS.

(Fig 5/3,RIS). In these hearts, after the separation from RPAD, it coursed between the atrium dextrum and the aorta and entered the proximal of sulcus interventricularis subsinuosus by passing through the septum interatriale and formed to RIS. No information has been found that coronary vessels, RIS, can also be separated from RPAD in the literature.

R. Interventricularis paraconalis

RIP divided into RS for vascularization of septum interventriculare, RCA for vascularization of conus arteriosus, RCSP and RCSD for vascularization of ventriculus sinister and some branches for vascularization

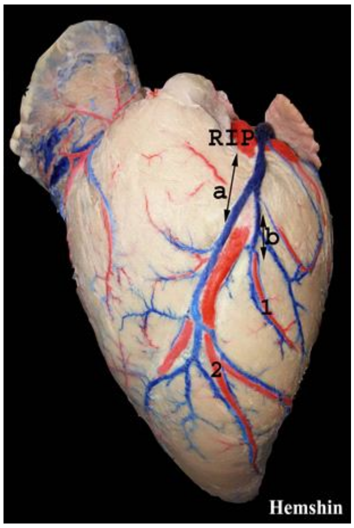

Fig 8: The view of the facies auricularis of heart of Hemshin sheep and myocardial bridges.

a. Myocardial bridge on the RIP, **b.** Myocardial bridge on the RCSP, **1.** RCSP, **2.** RCSD.

of ventriculus dexter (Fig 8/RIP). The diameter of RIP was seen as mean 3.49 ± 0.51 mm and 3.32 ± 0.40 mm in Tuj and Hemshin sheep, respectively.

RS sprang from ACS in 5 Tuj and 4 Hemshin sheep and it originated from RIP in 4 Tuj and 6 Hemshin sheep. RS originated from the angle of between RIP and RCS in 1 Tuj sheep. It was also observed that the vascularization of septum interventriculare was provided by rr. septales which originated from RIP, RIS and ACD.

A. Coronaria dextra

In accordance with the findings of Tecirlioðlu *et al,* (1977), Karadag and Soyguder (1989), it was found that, ACD was divided into RPAD, RIAD, RDAD for vascularization of atrium dextrum respectively and RCA, RPVD, RMVD, RDVD for vascularization of ventriculus dexter, respectively and RS for vascularization of septum interventriculare (Fig 2/ACD).

Ramus circumflexus dexter

It was observed that the RCD was continuation of the ACD (Fig 2). RCD coursed through the ventral surface of the atrium dextrum and ended at the level of sulcus interventricularis subsinuosus. One of the Tuj sheep, it was determined that the RCD coursed to sulcus coronarius and entered the sulcus interventricularis subsinousus and formed the RIS. Similar findings were made in one of the goat (Barszcz *et al.,* 2019).

RPAD vascularized to the medial wall of the atrium dextrum. The strongest of the atrial branches of the ACD was RPAD. Additionally, RPAD formed RIS in 1 Tuj and 1 Hemshin sheep (Fig 5/3, RIS). In these hearts, RPAD coursed between the atrium dextrum and the aorta and entered the proximal of sulcus interventricularis subsinuosus by passing through the septum interatriale and formed to RIS.

Myocardial brigdes

Kervancıoglu *et al.* (2002) have reported that the myocardial bridges were found on the branches of ACS in 67.7% of the sheep hearts and 66.6% of goat hearts, on the branches of ACD in 32.3% of sheep hearts, 33.3% of goat hearts. In present study, myocardial bridge was found on the branches of ACD in 75% of the hearts (Fig 2/6), on the proximal of RIP in 100% of the hearts (Fig 8/a).

Hadziselimovic *et al.* (1974) reported that the myocardial bridge which found on the RIP was 0.4-1.0 cm away from the sulcus coronarius in 9 out of 10 hearts. These values were measured as 0.7 cm in sheep and goat by Dursun *et al.* (1992) and 0.4 cm in sheep and goat by Tıpırdamaz (1987). This length was determined as 1.22 and 1.09 cm in Tuj and Hemshin sheep, respectively.

Kosinski *et al.* (2011) determined the length of the myocardial bridges on the RIP as 16.6 mm in domestic pig. Dursun *et al.* (1992) have calculated this length as approximately 1.3-1.2 cm in sheep and goat. The length of the myocardial bridges on the RIP was measured as 2.38 cm in Tuj sheep and 1.86 cm in Hemshin sheep. While the findings of Dursun *et al.* (1992) and Kosinski *et al.* (2011) and the result of obtained from Hemshin sheep are similar, it was determined that this myocardial bridge in Tuj sheep is longer. When the length of myocardial bridges in Tuj and Hemshin sheep were statistically compared, it was seen that the difference was statistically significant ($P < 0.05$).

The myocardial bridge was found on the RIS in sheep and goat (Dursun *et al.,* 1992), in cattle (Akbulut *et al.,* 2014) and in Awassi sheep (Aksoy *et al.,* 2018). Unlike this findings, no myocardial bridge was found on the RIS in the Tuj and Hemshin sheep.

CONCLUSION

As a result, this study, in which the macroanatomical properties of the coronary arteries and myocardial bridges were determined in Tuj and Hemshin sheep, is thought to contribute to anatomical studies in order to eliminate the literature deficiency in terms of species. At the same time, it can contribute to the formation of sheep heart as a model for educational purposes. Thus, it was concluded that it may help to better identify the coronary arteries.

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REFERENCES

Akbulut, Y., Demiraslan, Y., Aslan, K., Gürbüz, İ., Koral Taşçı, S. (2014). Zavot ırkı sığırlarda arterler ve kalp kası köprüleri. Kafkas Universitesi Veteriner Fakültesi Dergsisi. 20(2): 287-293.

Aksoy, G. (2000). Evcil Kedi ve Beyaz Yeni Zelanda Tavşanlarında Kalp ve Kalp Arteria'ları Üzerinde Anatomik Bir Araştırma. Doktora Tezi. *Yüzüncü Yıl Üniversitesi Sağlık Bilimleri Enstitüsü,* Van.

Aksoy, G. and Karadağ, H. (2002). Evcil kedi ve Beyaz Yeni Zelanda tavşanlarında kalp ve kalp arteria'ları üzerinde anatomik bir araştırma. Eurasian Journal of Veterinary Sciences. 18: 1-2: 33-40.

Aksoy, G., Özüdoğru, Z., Özdemir, D. (2018). A macroanatomic investigation of the coronary arteries and myocardial bridges in Awassi sheep. Eurasian Journal of Veterinary Sciences. 34 (3): 171-177.

Barszcz, K., Jordanow, O.S., Czopowicz, M., Mickiewicz, M., Moroz, A., Kaba, J., Polguj, M., *et al* (2019). Topography of coronary arteries and their ramifications in the goat. Biologia. doi. org/10.2478/s11756-019-00208-z.

Doğruer, A. and Özmen, E. (2012). Kıvırcık koyunlarında koroner arterler üzerine makroanatomik bir çalışma.Atatürk Universitesi Veteriner Bililimleri Dergisi. 7(1): 35-45.

Dursun, N., Aştı, R.N., Tıpırdamaz, S., Erden, H., Çelik, İ. (1992). Evcil memeli hayvanlarda kalp kas köprüleri üzerinde makroskopik araştırmalar. Eurasian Journal of Veterinary Sciences. 8 (2): 12-17.

Gomez, F.A., Cortes, L.S., Ballesteros, L.E. (2018). Morphological characterization of coronary arteries in African sheep (*Ovis orientalis*). Differential analysis with those of humans and other animal species. Folia Morphologica. Doi: 10. 5603/FM.a2018.0054.

Gürbüz, İ., Demiraslan, Y., Aslan, K. (2016). A macroanatomic investigation on the arterial vascularization of the Malakan Horses's heart. Atatürk University Journal of Veterinary Sciences. 11(3): 288-295.

Hadziselimovic, H., Secerov, D., Gmaz-Nikulin, E. (1974). Comparative anatomical investigations on coronary arteries in wild and domestic animals. Acta Anatomica. 90: 16-35.

International Comitte on Veterinary Gross Anatomical Nomenclature. (2012). General Assembly of the World Association of Veterinary Anatomists. Nomina Anatomica Veterinaria. 5th ed, Gent.

Karadağ, H. and Soygüder, Z. (1989). Doğu Anadolu Kırmızısı Sığırında kalp ve kalp arteria'ları üzerinde anatomik bir araştırma. Veterinary Journal of Ankara University. 36(2): 482-495.

Kervancıoğlu, P., Özbağ, D., Demirant, A. (2002). Myocardial köprülerin koroner arterlere göre dağılımının ve aorta'ya olan uzaklığının insan, köpek, koyun ve keçide karşılaştırılmalı olarak incelenmesi. Dicle Tıp Dergisi. 29: 1-2.

Kosinskii, A., Grzybiak, M., Piwko, G., Kozlowski, D. (2011). Myocardial bridges in domestic pig- morphological aspects. Polish Journal of Veterinary Sciences. 14(3): 411-416, 2011.

Likitha, B.L., Purushotham, G., Kumar, D.P., Lakshman, M. (2018). Gross morphology and morphometry of coronary arteries in sheep (*Ovis aries*). Pharma Innovation. 7(4): 452-456.

Monfared, A.L., Moosavi, S., Bazdar, A. (2013). The macroanatomy of coronary arteries in the Irinian native cats. Global Veterinaria. 10(4): 413-416.

Nickel, R.A., Schummer, A., Seiferle, E. (1981). The Anatomy of the Domestic Animals. Volume 3, the circulatory system, Verlag Paul Parey, Berlin Hamburg.

Nur, İ.H. and Aksoy, G. (2000). Van kedisinin koroner arterleri üzerinde makroanatomik ve subgros bir araştırma. Van Veterinary Journal. 11(1): 83-92.

Özgel, Ö., Çengelci Halıgür, A., Dursun, N., Karakum, E. (2004). Macroanatomy of coronary arteries in donkeys (*Equus asinus L.*). Anatomia Histologia Embryologia. 33(5): 278-283.

Taha, A.A.M. and Abel-Magied, E.M. (1996). The coronary arteries of the dromedary camel (*Camelus dromedarius*). Anatomia Histologia Embryologia. 25: 295-299.

Tecirlioğlu, S., Dursun, N., Uçar, Y. (1977). Mandada kalp ve kalp arteria'ları üzerinde anatomik araştırmalar. Veterinary Journal of Ankara University. 24(3/4): 361-374.

Teke, B.E., Özüdoğru, Z., Özdemir, D., Balkaya, H. (2017). Hasak koyunlarında kalp kas köprüleri ve koroner arterler. Journal of Bahri Dagdas Animal Research. 6(1): 1-12.

Tıpırdamaz, S. (1987). Akkaraman koyunları ve kıl keçilerinde kalp ve kalp arteriaları üzerinde karşılaştırmalı çalışmalar. Eurasian Journal of Veterinary Sciences. 3(1): 179-191.

Türkmenoğlu, İ. (1996). Köpekte r. coni arteriosi'nin farklı orijin olgusu. Veteriner Bilimler Dergisi. 12(2): 121- 123.

Vincenti, L.D., Westcott, R., Lee, C. (2014). Sheep (*Ovis aries*) as a model for cardiovascular surgery and management before, during and after cardiopulmonary bypass. Journal of American Association for Laboratory Animal Science. 53(5): 439-448.

Yenikurt, H. and Demirtaş, H. (2016). Koyun Yetiştiriciliği. http://www.veteriner.cc/koyun/hemsin.asp, Erişim tarihi: 12.09.2018.

Yang, K.Q., Zhang, G.P., Chen, H.Q., Zhang, L.R., Xue, Z.N. (1989). Observation and measurement of the coronry arteries of goat. Hua Xi Yi, Ke DA Xue Xue Bao. 20(2): 175-7.