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Comparative anatomical study of great vessels in arabian fetal sheep by rhodopas cast, angiography and dissection techniques

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Abstract

Circulation in the fetus has some anatomical features which is of clinical importance. The present study was carried out to investigate the great vessels and duct in the circulatory system of fetal sheep by three techniques of rhodopas cast, angiography, and dissection techniques. Thirty-six male and female fetuses were studied. The age estimation of fetuses was calculated through Crown Rump Length (CRL) measurements and by use of formula for sheep fetus. All fetuses were divided in three groups; group 1 (CRL=12.54±0.52 Cm, Age= 62.08±2.08 days), group 2 (CRL=22±1.31 Cm, Age= 81.9± 5.7 days) and group 3 (CRL=34.6±1.19 Cm, Age= 108.5± 5.38 days), respectively. The structure of the umbilical cord, course of the umbilical vein and arteries, portal vein, ductus venosus, caudal vena cava, aorta, pulmonary trunk, ductus arteriosus, and great arteries and veins of the neck, thoracic and abdominal cavity were studied. The results showed, the vessels and duct of arabian fetal sheep are similar to other ruminants, but there were some differences in arrangment of umblical cord and ductus venosus with equines, dromedary camel and human. Also the fetal sex and age had no effect on the arrangement of vessels and ducts. On the other hand, the results showed that all of the mentioned techniques are capable of assessing the blood vessels and ducts, but are complementary to each other.

Key words: Vessels, Rhodopas Cast, Angiography, Fetus, Sheep

Introduction

The circulatory system is one of the first active organs to grow in the developing embryo, consisting of a heart and a network of vessels that circulates blood in the tissue of body. In domestic mammals, the formation of blood vessels begins at the third week of pregnancy and first, in the yolk sac, and subsequently in the allantois (McGeady et al., 2017). The placenta, as an exchange organ, transfers oxygen, food and electrolytes between the mother's and the fetal circulation (Sadler, 2018). In ruminants, a small vein emerges from each cotyledon that eventually enters the left or right umbilical veins. Umbilical veins carry oxygenated blood to the fetus.

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Also an artery is inserted into each cotyledon, which is separated from the umbilical arteries. Umbilical arteries return oxygen-free blood and wastes to the placenta. Eventually, a pair of left and right umbilical veins form that enters the fetal cord. In domestic livestock, the umbilical cord consists of two umbilical veins, two umbilical arteries, and urachus duct. The umbilical veins move to the umbilical region and after entering the umbilical ring, the right umbilical vein is lost and only the left one continues in the abdominal cavity and emerges to the visceral surface of the liver (Noden and De Lahunta, 1985). In the fetal liver, most of the blood of the umbilical vein passes through the ductus venosus, which is located within the liver tissue and enters directly into the caudal vena cava. A small amount of left umbilical vein blood, enters the liver sinusoids and mix with the blood of the portal vein, which also by the left and right hepatic veins enters the caudal vena cava and then discharged into the right atrium. In the right atrium, the blood of caudal vena cava is directed to the oval foramen and transports to the left atrium via the oval foramen (Hyttel et al., 2010). Only a small part of blood of umbilical vein remains in the right atrium and mix white blood of the head, neck, and forelimbs carrying by way of the cranial vena cava, to continue into the right ventricle and with ventricular contraction into the pulmonary trunk. In the left atrium, the blood mixes with a small amount of blood that comes from the inactivated fetal lungs by way of pulmonary veins (Carlson, 2013). Subsequently, the blood enters the left ventricle and thence aorta and aortic arch. Due to the high pressure in the fetal lung, the blood of the pulmonary trunk shunted through the ductus arteriosus into the aorta and mix with blood from the left ventricle. This blood supplies the caudal part of the fetal body. Finally, through the arteries of the umbilical cord blood returned to the placenta (McGeady et al., 2017). The first goal of this study is to recognition and compare great vessels of arabian fetal sheep circulatory system with other domestic animals and human using three techniques, plastic corrosion cast, angiography, and dissection. Also, the results of the present study can identify the advantages and disadvantages of each of the above-mentioned techniques in male and female fetal sheep at different age of pregnancy.

Materials and methods

In this study, thirty-six male and female Arabian sheep embryos were collected from Ahvaz slaughterhouse. To remove clots from vessels, all specimens were washed by normal saline two- or three-time’s injections via the umbilical vein. Age estimation was calculated through the Crown Rump Length (CRL) by use of formula for sheep fetus (Noakes et al., 2001). All fetuses were divided in three groups consisted of 12 male and female fetuses; group 1 (CRL=12.54±0.52 Cm, Age= 62.08±2.08), group 2 (CRL=22±1.31 Cm, Age= 81.9± 5.7 day) and group 3 (CRL=34.6±1.19 Cm, Age= 108.5± 5.38 day), respectively. To study the umbilical cord by routine dissection, the amniotic membrane around the cord was opened longitudinally until the umbilical ring. Then Wharton's jelly was removed and the vessels of cord recognized. To study the course of umbilical veins, arteries and urachus, the abdominal cavity of the fetus was cleaved from the umbilical ring and continued through the abdominal midline.

After injection of rhodopas (prepared by laboratory drug stores, AX-90-10-Rhone-Poulenc-Company) via one of the umbilical arteries or veins, the specimens were kept in the refrigerator for 24 h at 4 °C and then immersed in commercial 37% hydrochloric acid for 24 h to digest soft tissues. Finally, the prepared plastic casts of vessels were studied (Nanbo, 1990, Tompsett, 1970). The specimens were photographed with a digital camera or/and a photostriomicroscope (Japan, Nikon SMZ 800). The angiography technique provides two-dimensional images of the vessels and ducts of the body (Gronvall and Graem, 1989). To prepare the contrast media, one liter of distilled water and barium sulfate powder was mixed to obtain the appropriate concentration. After injection contrast media via one of the umbilical arteries and/or veins, the fetuses were subjected to radiography.

Results

The results of the present study by the use of three techniques were as follow:

Structure details of the umbilical cord

According to this study the sheep umbilical cord is consisted of right and left umbilical veins, right and left umbilical arteries, and urachus duct that were embedded in Wharton's jelly (Fig. 1, 2). The distal part of the umbilical cord covered by a serous amniotic membrane, while the proximal part of it just close to the umbilical ring surrounded by the fetal skin. Our findings showed that the diameter and length of the umbilical cord increased progressively in three fetal groups. Also, the diameter of the umbilical arteries showed thicker than umbilical veins. The umbilical veins move in the umbilical cord and after entering and passing the umbilical ring, the right umbilical vein is lost, and only the left umblical artery continues in the abdominal cavity and emerges to the visceral surface of the liver (Figs. 3, 4). The urachus duct showed clear and glassy wall structure and was positioned between the two umbilical arteries, passing through the umbilical ring and directed to the caudal region of the abdominal cavity (Fig.4). The urachus duct was started from the allantois and after coursing in the umbilical cord and entering the abdominal cavity, attached to the apex of the bladder. The umbilical arteries veins move in the umbilical cord and after entering and passing the umbilical ring, were attached to internal iliac arteries, exactly on the lateral sides of the urinary bladder (Fig.9).

Umbilical vein course in the liver

After the umbilical vein enters the liver, a number of branches are separated for blood supply to the parenchyma of the right and left hepatic lobes and narrow bifurcations entered the left lobe of the liver (Fig.3). In the liver tissue the portal vein is attached to the umbilical vein, and then the umbilical vein passes directly into the liver parenchyma as a ductus venosus and connects to the caudal vena cava. The ductus venosus was a short, straight and whitout any branch duct that was attached to the ventral surface of the caudal vena cava. Concomitant whit ductus venosus, the left and right hepatic veins also join the caudal vena cava to drain the liver (Figs. 3,4,5,6).

The large vessels of the thoracic cavity

The caudal vena cava passes through the foramen vena cava of diaphragm and finally enters the sinus venarum of the right atrium of the heart. The cranial vena cava, also entered the sinus venarum of the right atrium. The aortic artery showed the aortic arch at the base and top of the heart after exiting the left ventricle. The pulmonary trunk was also exited the right ventricle and then connected to the aorta by a short and thick duct called ductus arteriosus. The ductus arteriosus and the pulmonary trunk form a perpendicular and sharp angle to the aorta. The pulmonary trunk was divided into two pulmonary arteries that moved to the hilus of the left and right lungs of the fetus and distributed into the lung tissue. Next, the aortic arch was continued to the caudal and dorsal regions of the thoracic cavity and on the left side of body of the thoracic vertebra. This is called the thoracic aorta. Broncho-esophageal artery and pair’s intercostal arteries were sequentially branched from the thoracic aorta. The thoracic aorta, along with the left azygos vein, passed through the aortic hiatus of diaphragm, which was located between the diaphragmatic crura and entered the abdominal cavity (Figures. 5,6,7,8).

Large branches of the abdominal aorta

The abdominal aorta was located on the left side of body of the lumbar vertebra and extended to the end of the abdomen and under the body of sacral bone. The large arteries that were branched from the abdominal aorta were as follows: coeliac artery, cranial mesenteric artery, right and left renal artery, right and left gonadal arteries (ovarian artery in female, and testicular artery in the male), caudal mesenteric artery and lumbar arteries. After detaching the caudal mesenteric artery, the aorta was placed beneath the sacrum and divided into five branches, namely, the left and right external iliac arteries, the left and right internal iliac arteries, and the median sacral artery. The external iliac arteries were longer and thick in diameter and separated from the abdominal aorta and continued to the hind limb called as the femoral artery. The median sacral artery was very narrow and branched just below the sacral vertebra from the abdominal aorta. The internal iliac arteries were short and narrow in diameter and separated from the abdominal aorta. The umbilical arteries were thick and branched from first part of internal iliac arteries. It should be noted that abdominal aorta and its visceral branches were clearly visible by three techniques (Figures. 5,6,7,8,9).

Large vessels of the head and neck area

The results showed that in the sheep fetus, only the brachiocephalic trunk was separated from the aortic arch in the thoracic cavity. Then the left and right subclavian arteries were separated from the brachiocephalic trunk, respectively. The brachiocephalic trunk proceeded to the beginning of the thoracic cavity called bicarotid trunk and was divided into the left and right common carotid arteries. The left and right common carotid arteries passed through the thoracic inlet and entered the left and right jugular canal and continued toward the head. Each of the common carotid arteries in the cranial region of the neck, just below the mandibular angle, was divided into the internal and external carotid arteries. The external carotid artery was much thicker than the internal carotid artery.

In the thoracic cavity, the main arteries were branched from the subclavian artery, namely; costocervical trunk, internal thoracic and superficial cervical artery. After the branching of the superficial cervical artery, the subclavian artery exits through the thoracic inlet, extending from the front of the first rib to the axillary region, renamed as the axillary artery. The axillary artery continued to supply the forelimb, called the brachial artery (Figs.5,6,7).

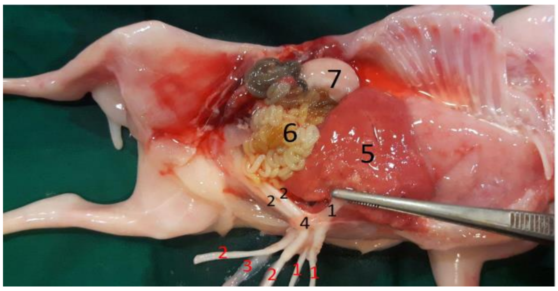

Figure 1; Opened of umbilical cord and umbilical vessels in the abdominal cavity, right ventral view, (CRL = 15 cm, Male). 1 - Umbilical vein 2- Umbilical arteries 3-urachus duct 4- Umbilical ring 5- Liver 6- Intestines 7- Right kidney.

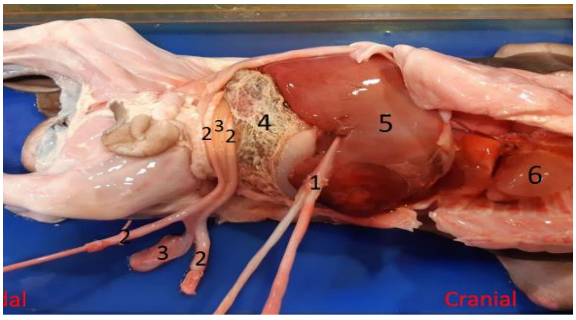

Figure 2; Opened of umbilical cord and umbilical vessels in the abdominal cavity, ventral view, (CRL = 15 cm, Male). 1- Left umbilical vein (Intra-abdominal part), 2- left and right umbilical arteries, 3- Urachus, 4- Mesentery and Intestines, 5- Liver (right lobe), 6- Heart.

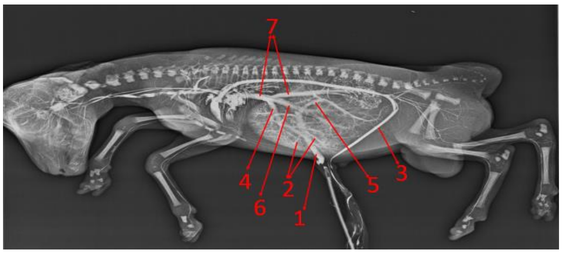

Figure 3; Radiography of circulatory system of fetal sheep, left lateral (CRL = 24 cm، male).
1- Umbilical vein 2- Branches of Umbilical vein 3- Umbilical arteries 4- Left hepatic vein 5- Portal vein 6- Ductus venosus 7- Caudal vena cava.

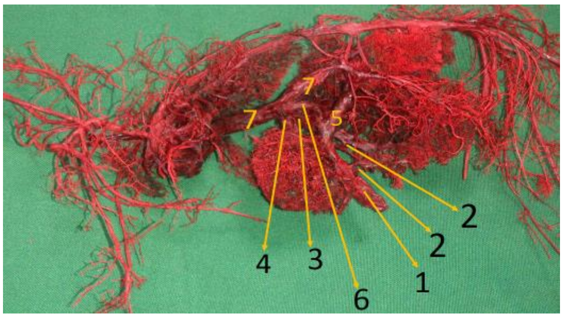

Figure 4; Plastic corrosion cast of the great vessels of fetal sheep, left lateral view (CRL = 35 cm، female) 1- Umbilical vein 2- Branches of Umbilical vein 3-Right hepatic vein 4- Left hepatic vein 5- Portal vein 6- Ductus venosus 7- Caudal vena cava.

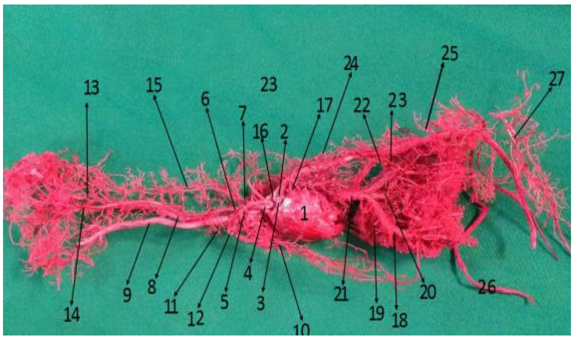

Figure 5; Plastic corrosion cast of the great vessels of fetal sheep, left lateral view (CRL = 32 cm, female).
1-Heart, 2- Ductus arteriosus, 3- Pulmonary trunk, 4- Brachiocephalic trunk, 5- subclavian artery, 6- Bi-carotid trunk, 7-Costocervical trunk, 8- Common carotid artery, 9- External jugular vein, 10- Internal thoracic artery, 11- Superficial cervical artery 12- Axillary artery, 13- Internal carotid artery, 14- External carotid artery, 15- Vertebral artery, 16– Aortic arch, 17- Azygos vein, 18- umbilical vein, 19- umbilical vein branches, 20- Ductus venosus, 21- Caudal vena cava, 22- Celiac artery, 23- Cranial mesenteric artery, 24- Dorsal intercostal artery, 25- Lumbar artery, 26- Umbilical artery, 27- External iliac artery.

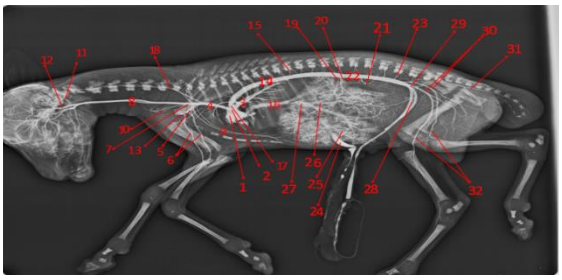

Figure 6; Radiography of circulatory system of fetal sheep, left lateral view (CRL = 26 cm, male).
1- Heart, 2- Pulmonary trunk, 3- Pulmonary artery, 4- Brachiocephalic trunk, 5- Subclavian artery, 6- Brachial artery, 7- Bicarotid trunk, 8- Common carotid artery, 9- Internal thoracic artery, 10- Superficial cervical artery, 11- Internal carotid artery, 12- External carotid artery, 13- Axillary artery, 14- Thoracic Aorta, 15- Dorsal intercostal arteries, 16- Caudal vena cava 17- Ductus arteriosus 18- Vertebral artery 19- Celiac artery, 20- Cranial mesenteric artery, 21- Renal artery, 22- Abdominal Aorta, 23- Lumbar artery, 24- Left umbilical vein 25- intra hepatic branches of Umbilical vein 26- Portal vein, 27- Ductus venosus, 28- Umbilical arteries, 29- Internal iliac artery, 30- External iliac artery, 31- Median sacral artery, 32- Femoral artery.

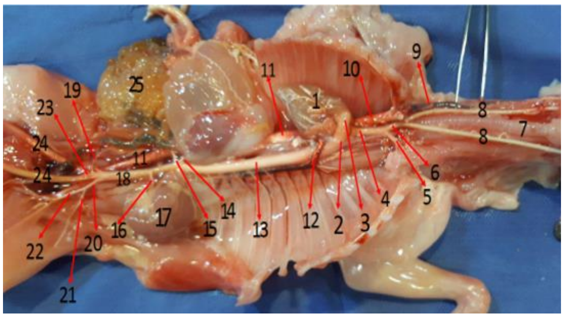

Figure 7; Dissection of the great vessels of fetal sheep, ventral view, (CRL = 14 cm, male).
1- Heart, 2- Ductus arteriosus, 3- Pulmonary trunk, 4 Brachiocephalic trunk, 5- subclavian artery, 6- Bicarotid trunk, 7- Trachea, 8- Common carotid artery, 9- External jugular vein, 10- Cranial vena cava, 11- Caudal vena cava, 12- Left azygos vein, 13- Aorta, 14- Celiac artery, 15- Cranial mesenteric artery, 16- Renal artery, 17- Kidney 18- Abdominal Aorta, 19- Caudal mesenteric artery 20- External iliac artery 21- Deep femoral artery, 22- Femoral artery 23- Internal iliac artery, 24- Umbilical artery 25- Intestines.

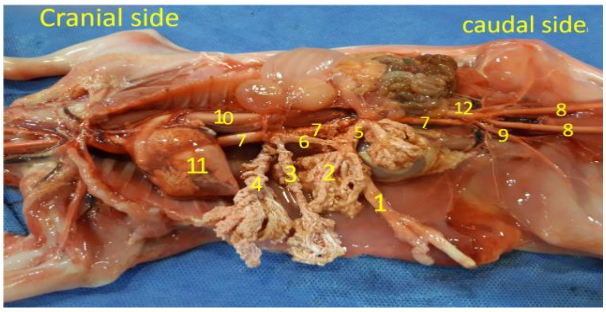

Figure 8; Dissection of the great vessels of fetal sheep, ventral view, (CRL = 35 cm, male).
1- Umbilical vein 2- Branches of Umbilical vein 3- Right hepatic vein 4- Left hepatic vein 5- Portal vein 6- Ductus venosus 7- Caudal vena cava 8- Umbilical arteries 9- External iliac artery 10- Thoracic Aorta 11-Heart 12- Abdominal Aorta.

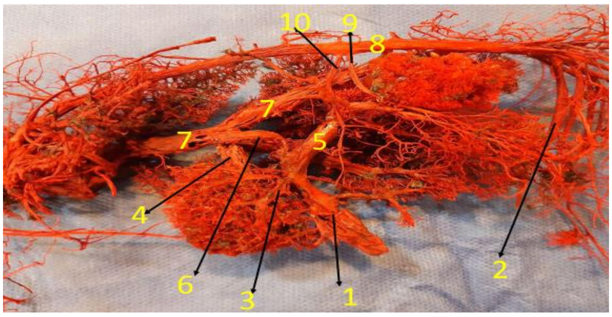

Figure 9; Plastic corrosion cast of the great vessels of fetal sheep, left lateral view (CRL = 36 cm, female). 1- Umbilical vein 2- Umbilical arteries 3- Branches of Umbilical vein 4- Left hepatic vein 5- Portal vein 6- Ductus venosus 7- Caudal vena cava 8- Abdominal Aorta 9- Cranial mesenteric artery 10- Celiac artery.

Discussion

According to available sources, sheep have been used as experimental models in many biological and human circulation research (Rudolph, 2018). Therefore, the study of blood circulation in sheep fetuses are of practical importance. There are many studies on the anatomy of the circulatory system of fetal and adult humans and some animals that have been performed by plastic corrosion cast, radiography, and routine dissection. These include; the study of human neonatal vasculature (Tompsett, 1970), comparison of sheep placenta (Krebs et al., 1997), comparison of placenta in ruminants (Leiser and Pfarrer, 1989), coronary arteries of the adult human heart by using corrosion cast (Reddy and Lokanadham, 2013), mouse fetal circulatory vessels by corrosion cast (Kondo et al., 1993), large vessels of fetal rat by corrosion cast (Ratajska et al., 2003, Navarro et al., 1998), maternal placenta and fetal sheep arteries at different embryonic stages and scanning electron microscopy (Hafez et al., 2010), rabbit celiac artery using corrosion cast (Nilgün, 2016) and Male Persian Squirrel (*Sciurus Anomalus*) (Akbari et al., 2016).

Based on the current study, the external feature of the sheep umbilical cord was similar to other reports in domestic animals and human kind. It was made of a proximal and distal portion that was covered by amnion and skin, respectively (McGeady et al., 2017). The results revealed that the details structure of the umbilical cord was included of two umbilical veins and arteries and urachus duct, which were embedded in Wharton's jelly and surrounded by an amniotic membrane. These findings are in agreement with reports about umbilical structures in other ruminants (Hyttel et al., 2010). Also the results of present study are consistent with the report on the morphological structure of the umbilical cord of the water buffalo (Bubalus Bubalis) (Ferreiraet et al., 2009). However the umbilical veins in horses and pigs are joined at the distal part of amniotic portion of umbilical cord, but in other species, the umbilical veins join when they enter the abdominal cavity (McGeady et al., 2017). Also, there is a report that names the contents of the umbilical cord of the horse as two umbilical arteries and two umbilical veins in the distal amniotic portion, and two umbilical arteries around the urachus duct in a spiral manner. In the present study, however, two umbilical arteries were located beside the urachus duct but they did not show spirally arrangment (Kumar et al., 2013). Another study in the camel and donkey fetuses, stated that the umbilical cord of the camel consists of two umbilical arteries, veins, and urachus duct. Whereas in the fetal donkey, they reported only one umbilical vein in the umbilical cord.

Therefore, the results of this study were in agreement with the umbilical cord structure of camel fetuses but differed with the umbilical cord of donkey (Shaker and Gammal, 2018). Also, in another report the structure of the camel fetal umbilical cord that studied by using the plastic corrosion cast method and dissection, which was consistent with the present study (Elgozouli and Osman, 2013). In humans firstly, two left and right umbilical veins and two umbilical arteries form in the placenta, but before entering the umbilical cord, the right umbilical vein disappears and only the left one remains that is surrounded by two umbilical arteries. The human umbilical cord is also without urachus ducts, unlike animals (Carlson, 2013), which is inconsistent with the present study. Based on current study, the course of umbilical vein and its ramifications in the liver, connection to the portal vein and course of the ductus venosus in sheep fetuses is similar to other findings in ruminants and carnivores (McGeady et al., 2017). Howevere in the liver of horse and porcine, the ductus venosus disappears before birth. Thus, from physiological stand points, the blood of umbilical vein enters completely into the liver sinusoids and subsequently enters the caudal vena cava through the hepatic veins (McGeady et al., 2017). Furthemore, some authors reported that during fetal period in the donkey, as the horse fetus, ductus venosus disappears. Therefore, it is not consistent with the findings of the present study, too (Shaker and Gammal, 2018). Elgozouli and Osman, (2013) carried out a study on camel fetuses and stated that the blood was transferred from the placenta to the fetus by two large umbilical veins, which were discharged to the intra-abdominal venous sinus. In the present study, venous sinus was not observed by using all three techniques. In another report (Edelstone et al., 1980) for the study of the amount of blood gases, the number of blood vessels present in the fetal liver of the sheep matched the current study. The ductus venosus has been studied in many mammals, such as neonatal dogs (Tisdall al., 1997), human embryo (Mavrides et al., 2001), man and goat (Dickson, 1957), mouse embryos (Maki et al., 2002) and rats has also been established (Momma et al., 1992). Also, there is a report about ducts venous in the cat using plastic corrosion cast and angiography techniques (White and Burton, 2001). It has also been found that fetuses of guinea pigs and amphibians lack the ductus venosus (Carter et al., 1992). Several authors who studied the ductus venosus of sheep fetuses, observed a smooth muscle sphincter at histological sections (Coceani et al., 1984). However, Mavrides et al., 2002, in a study performed on human fetuses aged 13-17 weeks, failed to observe the ductus venosus sphincter by using electron microscopy and immunohistological techniques. Regarding other reports, the isthmus part of the fetal ductus venosus of the sheep, consists of connective tissue and a small amount of smooth muscle tissue that does not form a complete circular layer of muscle cells in the ductus venosus (Tchirikov et al., 2003). The same author, in a study on human embryos, reported that 3 to 7 cells thick constitute a contractile body at the entrance of the ductus venosus. This smooth muscle structure was horseshoe-shaped and nodes and nerve fibers along with small arteries, can also be seen in the opening of ductus venosus (Tchirikov et al., 2005). In the present study, due to using only macroscopic methods, no evidence of sphincter was found in any of the used methods. In this study, the great vessels of the head, neck and thoracic cavity such as the caudal vena cava, pulmonary trunk, aorta, ductus arteriosus, pulmonary arteries, pulmonary veins, jugular vein, azygos vein, and the brachiocephalic artery and its branches were studied by three methods. There is a report in fetal camel that mentioned structures were studied which was consistent with the present study (Elgozouli and Osman, 2013). Some authors studied the presence of ductus arteriosus and pulmonary arteries in sheep fetuses, which was in agreement with the present study (Kiserud et al., 2000). Another author studied the major branches of the aortic arch of sheep and goats by dissection methods (Khakwani et al., 2018). In the present study, the aortic arch course and ramifications are consistent with the anatomical sources of thoracic aortic ramifications in large and small ruminants (Nickel and Seiferle, 1997. Konig and Liebich, 2007). Also the results about aortic arch branches and great vessels in the neck and head in fetal sheep were consistent with reports from various sources on adult sheep (Dyce et al., 2017). According to the sources of anatomy, the internal carotid artery disappeared postnatal but is still present in the fetal period (Konig and Liebich, 2007). However, our findings showed that in fetuses of the third group, the internal carotid artery was found to be much narrower than the external carotid artery with all three techniques. Some authors, studied morphology of the ductus arteriosus in dog using angiography (Tchirikov et al., 2006). A study compared macro-anatomy of the azygous vein between humans, dogs and sheep and concluded that the azygous vein was most similar between humans and dogs. But the most anatomical differences were between humans and sheep (Zhaleh et al., 2016). The results about tributaries, course and also drainage site in the right atrium of left azygus were adopted with this report. Ductus arteriosus were also studied by several authors on sheep fetuses (Mcmurphy et al., 1972. Wild et al., 1989). In the present study, ductus arteriosus were observed with all three techniques.

The results of present research were similar with existing anatomical sources for the vascular arrangement of the abdominal aorta in domestic animals, especially sheep and adult ruminants (Nickel and Seiferle, 1997, Konig and Liebich, 2007). Also, the results of this study on fetal umbilical arteries are consistent with the fetal camel and donkey (Shaker and Gammal, 2018). Abdominal aorta bifurcations and terminal aortic bifurcations in European rabbits were studied by the plastic corrosion cast method (Mazensky and Flesarovan, 2017). Also, Elmetwally, 2016, studied vessels in sheep pregnancy period, that was similar with the result of present study. The findings of this study regarding the terminal branching’s of the abdominal aorta were similar with those in human fetuses (Sadler, 2018). Also some authors studied ramification of abdominal aorta in human fetuses and stated that the sex of the fetus did not show differences in the branching of abdominal aorta (Szpinda et al., 2011), which was consistent with the present study. In addition, another author examined terminal branches of abdominal aorta in the Iranian male squirrel using the rhodopas technique. They stated that the abdominal aorta was divided into internal and external common iliac arteries and middle sacral artery (Akbari et al., 2016). However, in the present study, the left and right internal and external iliac arteries were directly separated from the terminal part of abdominal aorta.

In Conclusion, this study showed that arabian sheep fetus can be a suitable model for the study of vessels and ducts of circulatory system. The sex and age of fetuses did not affect the vascular arrangement. Also, the fetal vessels and ducts were clearly visible by all three methods, but each of these methods had its characteristics. The plastic corrosion cast method provides a clearer, three-dimensional view of the vessels and provides more details of the large and small fetal vessels. While large vessels are easily seen in radiographic images because of their size and volume, small vessels were not well characterized due to their proximity and contrast agent density. Our experience showed that the dissection technique is a relatively laborious and time-consuming way of seeing large vessels, but shows the size and topography of vessels with adjacent organs in a natural and real way.

However, the results of this study showed that these three methods are complementary to the study of the fetal circulatory vessels, suggesting that all three techniques should be used to study the vessels and ducts.

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Conflict of interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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مطالعه‌ی مقایسه‌ای آناتومی عروق بزرگ جنین گوسفند عربی توسط تکنیک‌های تهیه قالب پلاستیکی رودوپاس، آنژیوگرافی و تشریح

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چکیده

گردش خون در جنین دارای برخی ویژگی‌های آناتومیکی می‌باشد، که اهمیت کلینیکی دارد. پژوهش حاضر با هدف بررسی آناتومی عروق و مجاری گردش خون در جنین گوسفند به وسیله سه تکنیک قالب هضمی پلاستیکی رودوپاس، آنژیوگرافی و تشریح بر روی تعداد ۳۶ جنین نر و ماده مطالعه شد. تخمین سن جنین‌ها با اندازه‌گیری طول فرق سر دنبالچه و با استفاده از فرمول تعیین سن گوسفند انجام شد. تمام جنین‌ها به ترتیب در ۳ گروه تقسیم شدند: گروه ۱) طول فرق سر دنبالچه ۰/۵۲ ± ۱۲/۵۴ سانتی‌متر، سن ۲/۰۸ ± ۶۲/۰۸ روز، گروه ۲) طول فرق سر دنبالچه ۱/۳۱±۲۲ سانتی‌متر، سن ۵/۷±۸۱/۹ روز، و گروه ۳) طول فرق سر دنبالچه ۱/۱۹±۳۴/۶، سن ۵/۳۸±۱۰۸/۵ روز. هر سه گروه از نظر ساختار آناتومیکی بند ناف، مسیر سیاهرگ‌ها و سرخرگ‌های نافی، سیاهرگ پرتال، مجرای سیاهرگی، سیاهرگ میانخالی پسین، آئورت، تنه ششی، مجرای شریانی، سرخرگ‌ها و سیاهرگ‌های بزرگ ناحیه گردن، سینه و شکم مطالعه شدند. نتایج نشان داد که عروق و مجاری جنین گوسفند عربی مشابه سایر نشخوارکنندگان است، اما برخی تفاوت‌ها در آرایش طناب نافی و مجرای سیاهرگی در مقایسه با اسب، شتر و انسان داشتند. همچنین جنس جنین‌ها تأثیری در آرایش عروق و مجاری نداشت. از سوی دیگر مشخص شد که هر یک از تکنیک‌های فوق، توانایی مطالعه عروق و مجاری جنین را دارند ولی این سه تکنیک می‌توانند به عنوان مکمل یکدیگر به کار روند.

کلمات کلیدی: عروق، قالب رودوپاس، آنزیوگرافی، جنین، گوسفند

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