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THE ARTERIAL VASCULARISATION OF SEPTUM INTERVENTRICULARE IN BACTRIAN CAMEL (*Camelus bactrianus*)

Guoqiang Yuan[1], Yuanqing Xu[1], Chun Yang[1], Zhongtian Bai[1], Jibin He[2], Baoping Shao[1], Shanting Zhao[1] and Jianlin Wang[1]

[1]School of Life Science, Lanzhou University, Lanzhou, 730000 Gansu, China

[2]Alashan Right Banner Station of Agriculture and Stockbreeding, 737300, Inner Mongolia, China

ABSTRACT

The blood supply of the septum interventriculare in bactrian camel was studied in 10 healthy hearts by means of injecting A. coronaria sinistra and A. coronaria dextra with red and white coloured 15% ABS (Acrylonitrile, Butadiene and Styrene, Lanzhou Petrochemical Company, Gansu, China), followed by corrosion with concentrated hydrochloric acid, and then the vascular cast were described and measured. The major blood supply of the septum interventriculare was found to be derived from ramus interventricularis subsinuosus, ramus nodi atrioventricularis and ramus interventricularis paraconalis. The coronary supply of the heart is of the "left coronary type", since branches from ramus interventricularis paraconalis supplied most of the septum interventriculare. The septum interventriculare is a critical site of collateral circulatory channels in the heart of bactrian camel.

Key words: Arterial vascularisation, bactrian camel, septum interventriculare

The septum interventriculare, because of its special location, behaves as part of the left ventricle during aortic and pulmonary artery constriction (Molaug *et al*, 1981). Abnormal interventricular septal motion in human leads to the delay of left ventricular activation (Dillon *et al*, 1974; Fujii *et al*, 1974; Abbasi *et al*, 1974). Besides, it has also anatomical significance due to the location of the Atrioventricular node (Thomas and George, 1958).

The bactrian camel is a kind of animal living in the desert and semi-desert areas of China. Although there are reports of the arterial supply of the septum interventriculare in the dromedary camel (Ghazi and Tadjalli, 1993; Taha and Abel-Magied, 1996), there is no such information in the bactrian camel. In addition, a number of domestic animals, including equine, ruminants, porcine and carnivores, species differences exist with regard to the arterial supply of septum interventriculare (Ghoshal, 1975a, b, c and d).

The objective of this study was to define the origin and course of arteries which supply the septum interventriculare in the bactrian camel.

Materials and Methods

Ten hearts of adult male and female healthy bactrian camels were obtained from a slaughter house of the Right Alashan Banner Food Company in Inner Mongolia Autonomous Region, China. The fresh hearts were perfused with normal saline, to which heparin was added to prevent coagulation via A. coronaria sinistra and A. coronaria dextra. Then red and white coloured 15% ABS (Acrylonitrile, Butadiene and Styrene, Lanzhou Petrochemical Company, Gansu, China) were carefully injected into A. coronaria sinistra and A. coronaria dextra, respectively (Yuan *et al,* 2009). Following injection, the material was kept at +5°C for 24 h so as to provide solidification of ABS. The heart was corroded in 30% HCl to remove decayed flesh. The vascular casts obtained were washed in fine running water. Photographs were taken for process of corrosion. The measurements were carried out by utilising a digital calipre (Digimatic Callipre, China, 150 mm).

Anatomical nomenclature of the coronary arteries used was those of the fifth edition of the *Nomina Anatomica Veterinaria* (International Committee on Veterinary Gross Anatomical Nomenclature (ICVGAN), 2005).

Results

The heart is supplied by A. coronaria sinistra and A. coronaria dextra which originate from the left

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aortic sinus and the right aortic sinus, respectively (Fig A, 1, 2). A. coronaria sinistra originates between Truncus pulmonalis and Auricular sinistra with the approximate diameter of 16.9 mm at the origin. It gives off two branches including ramus interventricularis paraconalis and ramus circumflexus sinister which course in Sulcus interventricularis paraconalis and Sulcus coranarius for about 40.1 mm from its origin, respectively (Fig A a, b).

Septum interventriculare receives most of its blood supply from ramus interventricularis paraconalis (Fig B). The diameter and length of ramus septum interventriculare coming from ramus interventricularis paraconalis vary greatly. The first ramus septum interventriculare originating from ramus interventricularis paraconalis was the largest one with mean diameter of 5.0 mm (Fig A, c; Fig C, c). The approximate distance between it and the origin of ramus interventricular paraconalis was 14.9 mm. It was divided into comparatively smaller four branches after running 7.5 mm in an anteroposterior direction, slightly caudally (Fig C, c). The longest one (about 64.42 mm) anastomosed with ramus septum interventriculare of the A. coronaria dextra after reaching in the middle portion of the septum interventriculare. Meanwhile, numerous fine branches were given off in its course. It was found that it has smaller diameter (about 2.6 mm), but extended a long distance about 56.9 mm in the direction of Apex cordis in one sample. The first ramus septum interventriculare was mainly responsible for supplying the proximal and middle portion of septum interventriculare. The second ramus septum interventriculare originated from ramus coni arteriosi is relatively small with a diameter of about 1.9 mm (Fig. A, dr). It extended approximately 10.4 mm in the direction of Apex cordis into the septum interventriculare by giving rise to several fine branches. It supplied blood to the surface part of the septum interventriculare.

Another four rami septum interventeiculare originated from the underside of ramus interventricular paraconalis and entered into Sulcus interventricularis paraconalis immediately in the caudal direction (Fig A, e, f, g and h; Fig C, d, e, f and g). The first two extended a distance of about 43.0 mm and supplied the middle part of septum interventriculare without anastomosing with ramus septum interventriculare of the ramus interventricularis subsinuosus. The last two extended for about 48.4 mm and gave off fine branches ending in the Apex cordis (Fig A, g, h; Fig C, f,

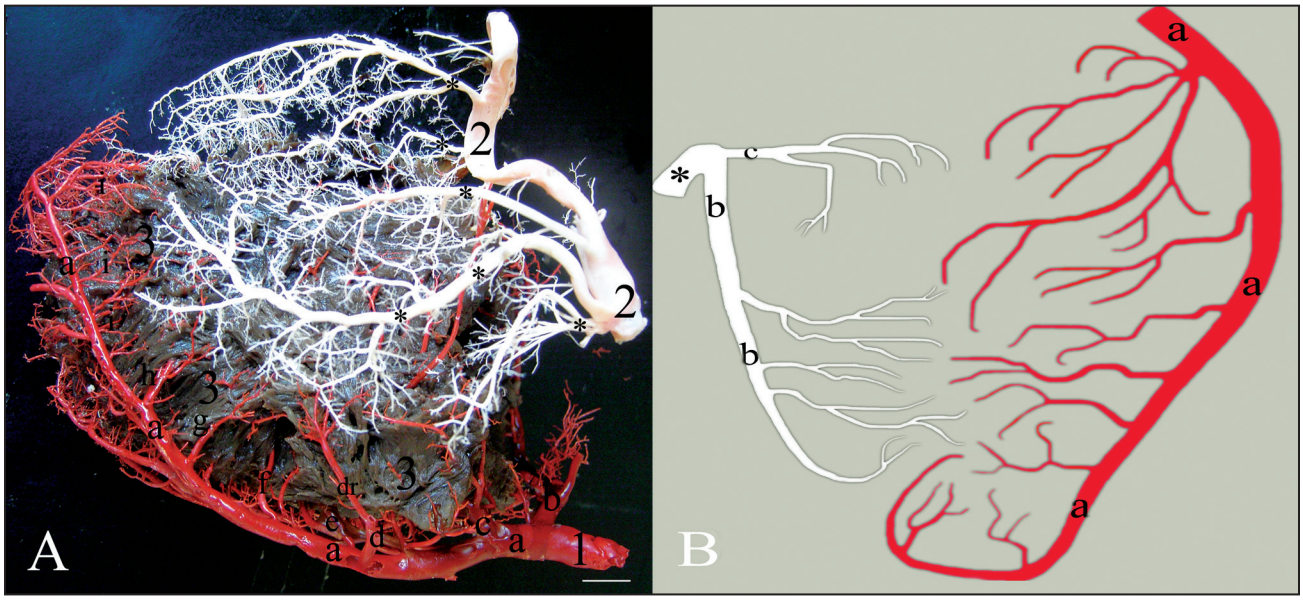

Fig A. Anterior review of heart showing the origin of ramus septum interventriculare coming from ramus interventricularis paraconalis (ventriculus dexter has been removed by corrosion). 1, A. coronaria sinistra; 2, A. coronaria dextra; 3, septum interventriculare; a, ramus interventricularis paraconalis; b, ramus circumflexus sinister; c, the first ramus septum interventriculare from ramus interventricularis paraconalis; d, ramus coni arteriosi; dr, branches from ramus coni arteriosi; e, f, g and h, ramus septum interventriculare; i, fine ramus septum interventriculare, * means branches from A. coronaria dextra supplies ventriculus dexter. Bar=10mm.

Fig B. Drawing of the blood supply of the normal bactrian camel septum interventriculare. Note the preponderance of supply by the ramus interventricularis paraconalis and anastomosis within the septum interventriculare. *, A. coronaria dextra; a, ramus interventricularis paraconalis; b, ramus interventricularis subsinuosus; c, ramus nodi atrioventricularis.

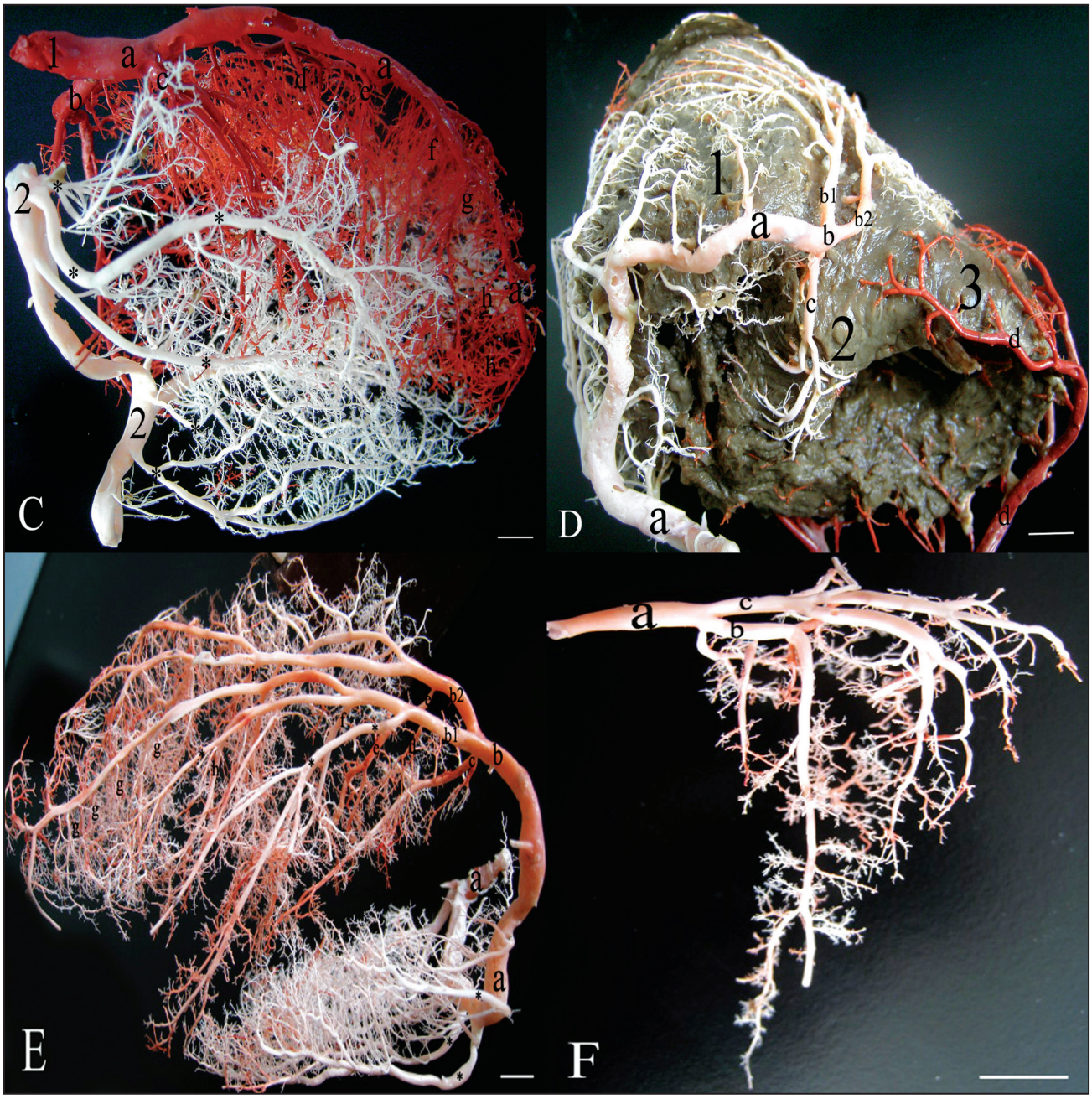

Fig C. Posterior view vessels cast of the heart showing the origin of ramus septum interventriculare coming from ramus interventricularis paraconalis. 1, A. coronaria sinistra; 2, A. coronaria dextra; a, ramus interventricularis paraconalis; b, ramus circumflexus sinister; c, the first ramus septum interventriculare from ramus interventricularis paraconalis; d, e, f and g, ramus septum interventeiculare; h, fine ramus septum interventriculare, * means branches from A. coronaria dextra supplies Ventriculus dexter. Bar=10mm.

Fig D. Basal view of the heart showing the origin of ramus interventricularis subsinuosus and ramus nodi atrioventricularis. 1, Ventriculus dexter; 2, septum interventriculare; 3, Ventriculus sinister; a, A. coronaria dextra; b, ramus interventricularis subsinuosus; b1, b2, branches of ramus interventricularis subsinuosus, c, ramus nodi atrioventricularis; d, ramus circumflexus sinister. Bar=10mm.

Fig E. Vessels cast of A. coronaria dextra showing the origin of ramus septum interventriculare from ramus interventricularis subsinuosus. a, A. coronaria dextra; b, ramus interventricularis subsinuosus; b1 and b2 branches of ramus interventricularis subsinuosus; c, the first ramus septum interventriculare from ramus interventricularis subsinuosus; *, branches supplying Ventriculus dexter. Bar=10mm.

Fig F. Vessels cast of ramus nodi atrioventricularis. a, ramus nodi atrioventricularis; b and c, branches of ramus nodi atrioventricularis. Bar=10mm.

g). Moreover, they anastomosed with branches of ramus septum interventriculare coming from ramus interventricularis subsinuosus. They supplied the distal region of septum interventriculare and septum interventriculare near the Apex cordis.

In addition, fine rami septum interventriculare that have a diameter of 0.9 mm were given off by ramus interventricular paraconalis in the distal one third of septum interventriculare (Fig A, i; Fig C, h). Some of them that reach the area of Apex cordis ascended for a distance about 26.3 mm, anastomosed with branches of ramus septum interventriculare which came from ramus interventricularis subsinuosus. They also supplied septum interventriculare near the Apex cordis.

A. coronaria dextra originated from the right aortic sinus above the left border of Valvula semilunaris with a mean diameter of 11.1 mm at its origin (Fig A, 2; Fig D, a). It ran to the right between Truncus pulmonalis and Auricula dextra and then spitted abruptly into ramus nodi atrioventricularis and ramus interventricularis subsinuosus in the atrioventricular junction after extending for about 117.4 mm in the right Sulcus coronaries (Fig D, b, and c).

The ramus septum interventriculare coming from A. coronaria dextra originated from ramus interventricularis subsinuosus and ramus nodi atrioventricularis.

The ramus interventricularis subsinuosus gave off a ramus septum interventriculare which enters into Sulcus interventricularis subsinuosus (Fig E, c). The ramus septum interventriculare diagonally ran for about 51.9 mm with a diameter of 2.7 mm at its origin. It also gave off a number of fine branches during its course in the septum interventriculare. It supplied the proximal area of septum interventriculare.

The ramus interventricularis subsinuosus divided into two branches after running a distance of about 8.4 mm along its course in Sulcus interventricularis subsinuosus (Fig E, b1, b2). These two branches were nearly parallel to each other to the apex cordis and extended for a different distance. The first branch extending a comparatively long distance reached the apex cordis with the diameter of about 2.8 mm at its origin (Fig E, b1). It divided into two branches which supplied septum interventriculare. In addition, it also gave off numerous fine branches supplying the distal area of septum interventriculare and apex cordis. The anastomosis between these fine branches and ramus septum interventriculare originating from ramus interventricular paraconalis was observed in this area. Besides, it gave off two branches supplying the distal part of the Ventriculus dexter. The second one ran a short distance without reaching Apex cordis (Fig E, b2). It gave off the first branch after running a distance of about 17.1 mm in the margin of the Sulcus interventricularis subsinuosus. Furthermore, many fine branches were given off by it in the distal area of the septum interventriculare. It also supplied the distal area of the Ventriculus sinister by giving off two branches.

Ramus nodi atrioventricularis gave off two branches in its course after extending a distance of 16.8 mm (Fig F, b and c). The first branch ran for about 9.9 mm, then turned caudally 90 degree and continued to extend a distance of about 42.2 mm in the direction of the Apex cordis (Fig F, b). Its diameter was about 1.5 mm at the origin. After passing for a distance of about 7.8 mm, the second one divided into two comparatively small twigs (Fig F, c). The end of them turned caudally 90 degree after extending a nearly same distance of about 11.8 mm. The ramus nodi atrioventricularis supplied Atrioventricular node and the upper portion of septum interventriculare.

The ramus septum interventriculare originated from ramus interventricularis subsinuosus supplies to the upper and distal part of the septum interventriculare.

Discussion

Contrary to previous reports that septum interventriculare was supplied by ramus interventricularis paraconalis only in the Angora Rabbit (Bahar *et al*, 2007), that of bactrian camel received its blood supply from ramus septum interventeiculare, which originated from ramus interventricularis subsinuosus and ramus nodi atrioventricularis, both branches of A. coronaria dextra, as well as ramus interventricularis paraconalis, a branch of A. coronaria sinistra. This study was consistent with previous findings in beaver (Bisaillon, 1981), monkey (Buss *et al*, 1982), cat and dog (Habermehl, 1994), and donkey (Ozgel *et al*, 2004). In addition to the penetrating branches from the ramus interventricularis paraconalis and subsinuosus, there are branches from neighbouring arteries in the free ventricle penetrate the septum interventriculare for various distances in human being (Thomas and Georgee, 1958). These findings were not detected in the present study in the bactrian camel.

The septum interventriculare and its conduction system in bactrian camel were

divided into two portions according to the origin of ramus septum interventriculare. The upper portion including the proximal region of septum interventricular, atrioventricular node and the bundle of Hiss was mainly supplied by branches from ramus interventricularis subsinuosus and ramus nodi atrioventricularis, partly from the first ramus septum interventriculare of the ramus interventricularis paraconalis. The lower portion, which includes the middle and distal area of the septum interventricular and most of the two bundle branches, accounts for the most part of the septum interventricular. This area was mainly supplied by ramus septum interventriculare from ramus interventricularis paraconalis and partly by fine branches from ramus interventricularis subsinuosus. It was obvious that the right coronary system was more predominant than vascularisation of the Atrioventricular node, which is in accordance with previous studies in human being (Thomas and Georgee, 1958; Arid *et al*, 2000). Occlusion of the A. coronaria dextra and A. coronaria sinistra may lead to disturbances in atrioventricular conduction and bundle branches, respectively.

Anastomosis was found within the septum interventriculare between A. coronaria sinistra and A. coronaria dextra. It is most frequently found in the lower portion of the septum interventriculare and around the Apex cordis. Collateral circulation which is formed by means of anastomoses between ramus septum interventriculare may compensate for occlusion.

Previous studies have shown that domestic animals can be divided into two types namely "bilateral coronary type" and "left coronary type", which means that the septum interventriculare was vascularised equally by both coronary arteries and mainly by A. coronaria sinistra, respectively (Nickel *et al*, 1996). Besides, it was found that the coronary type of rats did not belong to the above mentioned two types since A. coronaria dextra is responsible for the septum interventriculare (Icardo and Colvee, 2001). Although this study revealed that the septum interventriculare of bactrian camel was vascularised by both A. coronaria sinistra and A. coronaria dextra, we still believed that the pattern of distribution of coronary belongs to "left coronary type", since the former was more dominant than the latter. This result is in consonance with previous studies in dromedary camel (Ghazi and Tadjalli, 1993; Taha and Abel-Magied, 1996).

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The influences of camel milk on the immune response of chronic hepatitis B patients

The level of Th1-type cytokine IFN-gamma in camel milk drinking group was significantly higher than that in the non-drinking camel milk group ($P<0.05$), however, the level of Th2-type cytokines IL-4 in camel milk drinking group was significantly lower than that in the non-drinking camel milk group ($P<0.01$). Both IFN-gamma and IL-4 levels in camel milk drinking group were near to those in the normal control group. The HBV-DNA negative rate of the camel milk drinking group (90.91%) was significantly higher than that of the non-drinking group (3.23%) ($P<0.01$). The HBsAg negative rates of the camel milk drinking group (54.55%) was also higher than that of the non-drinking group (1.61%)($P<0.01$).The ALT level of 44 cases in the camel milk drinking group (100%)and 7 cases in the non-drinking group(11.29%) turned back to the normal level, there was a significant difference between the two group ($P<0.01$). Camel milk regulates the expression of Th1/Th2-type cytokines, and corrects the imbalance of Th1/Th2 cytokine network, which could strengthen the cellular immune response, inhibit the replication of virus DNA, and promote the recovery of the chronic hepatitis B patients.

(Source: H Saltanat; H Li; Y Xu; J Wang and F Liu (2009). Chinese Journal of Cellular and Molecular Immunology, 2009 May; 25(5): 431-3)