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The heart and its valves in the Caspian miniature horse: a topographic study

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The Caspian miniature horse is one of the rare small breeds in the north of Iran. In the present study, the position of the heart and its valves were determined topographically in 4 miniature horses. We found that Caspian miniature horses have general similarities, with certain topographical variability, with other horses. (Folia Morphol 2009; 68, 1: 36–39)

Key words: horse, anatomy, heart

INTRODUCTION

The Caspian miniature horse, an indigenous breed of horse from the north of Iran, is believed to be the ancestor of many current breeds [4]. It is suggested that the miniature horse is possibly the offspring of a natural hybridization between E. caballus and E. przewalski [6, 7]. The postural statuses of miniature horses are similar to those of non-miniature horses. Apart from height, however, minor anatomical differences have been reported between miniature horse and Equus caballus [3].

The location of the heart and the areas of auscultation relative to the underlying valves are very important in detecting the heart sound, as well as in echocardiography [2, 9, 10]. However, little is known about the topographical position of the heart and areas of auscultation of Caspian miniature horses. The purpose of the present study was to determine the topographical location of the heart and its valves in the Caspian miniature horse by anatomical dissection.

MATERIAL AND METHODS

Four miniature horses were obtained from the Caspian Miniature Horse Centre, Khojeer, Iran in 2005. The animals were anesthetized, and the carotid artery was exposed and canulated for exsanguination. Three out of four horses were fixed by injection of embalming fluid into the carotid artery. A solution was made with the following substances: 200 g Potassium acetate and 100 g Thimole dissolved in 500 mL of H_2O; 1000 mL Formalin (40%); 500 mL Phenol (liquid); 500 mL Dettol; 1000 mL Glycerine. Ethyl alcohol 95% was added to the solution to obtain 20 L.

The embalmed horses were kept at 3°C for 30 days. The fourth horse was dissected fresh after exsanguination. Dissection was carried out in the standing position. The skin was removed and the thorax was dissected layer by layer on both sides. After removing the muscles, the position of the lung and cardiac notch were determined with regard to the ribs.

To determine the topographical position of the heart and its valves, the 2^{nd}, 3^{rd}, 4^{th}, 6^{th}, 7^{th}, 9^{th}, and 11^{th} ribs were removed by cutting below the vertebral end and above the costochondral junction parallel to the line of pleural reflection.

To expose the heart, the lungs were also removed. The pulmonary, aortic, and bicuspid valves were demonstrated on the left side by partly removing the wall of the pulmonary artery, the aorta, and the left atrium. The tricuspid valves were exposed on the right side when the wall of the right atrium was

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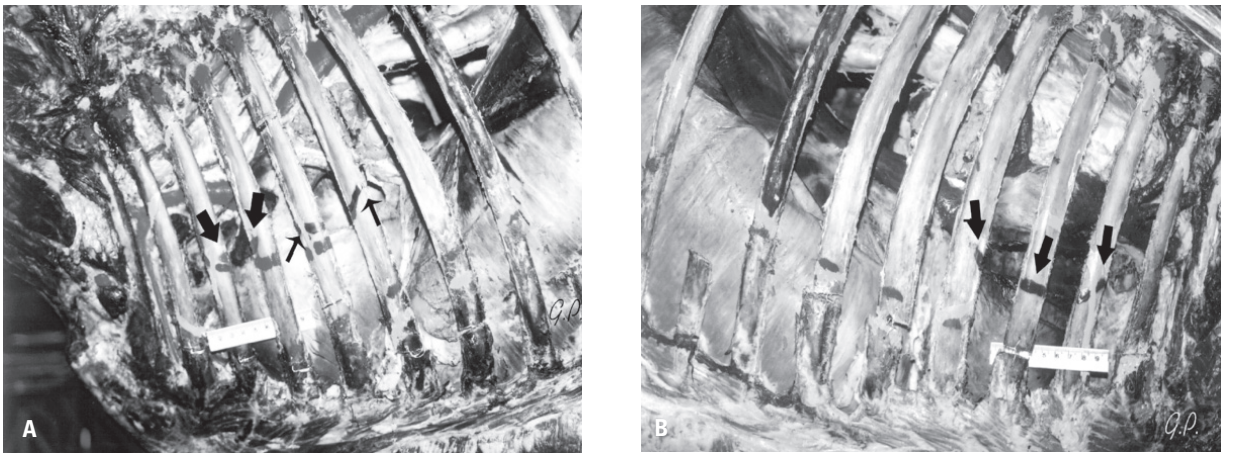

Figure 1. Dissection of the thorax in a Caspian miniature horse; **A.** Left side. Thick arrows, demonstrate the position of the pulmonary valve at the 3rd and 4th ribs, thin arrows demonstrate the position of the bicuspid valve at the 5th and 6th ribs; **B.** Right side. Arrows demonstrate the position of the tricuspid valve at the 3rd, 4th, and 5th ribs.

partly removed. The ribs were placed in their original position. The base of the heart, the apex, and location of the valves were marked on the ribs and were clearly measured according to the ribs and intercostal spaces (Fig.1A, B).

All stages of the dissection were photographed and the procedure was recorded.

RESULTS

Cardiac notch

The cardiac notch on the right side at its maximum width was extended from the 3rd to 5th rib. On the left side, the maximum width was mainly extended from the 3rd to 5th rib, but in one case the cranial limit was at the 2nd rib and in another case the caudal limit was at the 6th rib. The distance of the cranial and the caudal limits on the left and the right side from the costochondral junction is demonstrated in Table 1.

Base of the heart

The base of the heart was extended from the 2nd intercostal to the 5th intercostal spaces on the right side. On the left side, it was extended from the 2nd to the 5th intercostal spaces in one case and from the 2nd to the 6th intercostal spaces in two other cases. The distance from the costochondral junction at the 6th rib varied from 13 to 17 cm.

Apex of the heart

The apex of the heart was situated at the level of the 5th costochondral junction. In two cases it was extended briefly to the 4th intercostal cartilage space.

Different parameters and position of pulmonary, aortic, bicuspid, and tricuspid valves were as follows and are demonstrated in Table 2.

Pulmonary valve

The pulmonary valve was exposed on the left side of the thoracic cavity. The length of the valve mea-

Table 1. The boundary of the cardiac notch of the left and right side in the Caspian miniature horse. All measurements are given in centimetres [cm]

5th rib	4th rib	3rd rib	Distance from costochondral junction	Side
3.5–7	11.5–16	0–3	Cranial limit	Right side
2.5–8	11.5–16	0–13	Caudal limit	
7.5–14	13–14.5	7–13	Cranial limit	Left side
7–14.5	10.5–13	11–12.5	Caudal limit	

Table 2. Different parameters of the cardiac valves in the Caspian miniature horse. All measurements are given in centimetres [cm]

Distance from costochondral junction	Location	Length of valve	Cardiac valves
3.5–9.5 — 4th rib	Caudal border of 4th rib to cranial border of 5th rib	3–4	Aorta
13.5 — 2nd rib	1st rib to the middle of 4th rib	4	Pulmonary
11.5–14 — 5th rib	5th rib to 6th rib	5.5–6.5	Bicuspid
7–11 — 4th rib	Caudal border of 3rd rib to 5th rib	10	Tricuspid

sured 4 cm and extended from the 3rd to the cranial half of the 4th rib. It was situated 9.5 to 13.5 cm from the costochondral junction at the 3rd intercostal space (Fig. 1A).

Aortic valve

The aortic valve was exposed on the left side, after removing the pulmonary artery and cutting a window in the aortic valve below the brachiocephalic trunk. In two cases, it extended from the caudal border of the 4th rib to the cranial border of the 5th rib (4th intercostal space). In one case, the cranial limit was at the cranial border of the 4th rib. The length of the valve was 3 to 4 cm and was situated 9.5 to 12.5 cm from the 4th costochondral junction.

Bicuspid valve

The bicuspid valve was exposed on the left side. It extended from the 5th rib to the 6th rib. The length varied from 5.5 to 6.5 cm. The distance from the costochondral junction varied from 11.5 to 14 cm at the 5th intercostal space (Fig.1A).

Tricuspid valve

The tricuspid valve was exposed on the right side. It extended from the caudal border of the 3rd rib to the 5th rib. The length was 10 cm. The distance from the costochondral junction varied from 7 to 11 cm at the 4th rib (Fig. 1B).

DISCUSSION

The cardiac notch. The area of the heart which was not covered by the lung was mainly extended on both sides from the 3rd to the 5th rib at its maximum width, which is similar to what has been described for the horse [1, 5, 8]. However, unlike that of the horse, there was variation from the 2nd to the 6th rib on the left side. The cranial and caudal boundary of the cardiac notch is shown in Table 1.

The results indicates that the cranial border of the notch on the right side begins at the costochondral junction of the 3rd rib or a little higher (0 to 3 cm), and the maximum height of the notch 11.5 to 16 cm from the costochondral junction is at the 4th rib. The caudal border extends steeply and ventrally to reach the caudal border of the 5th rib at a level of 2.5 to 8 cm from the costochondral junction.

The cranial border of the notch on the left side begins at 11 to 12.5 cm from the costochondral junction of the 3rd rib, and the maximum height of the notch is at the 4th rib, 10.5 to 14.5 cm from the costochondral junction. The caudal border of the notch extends steeply to reach the 5th rib at 7 to 14.5 cm from costochondral junction.

Knowing the position of the cardiac notch might be important from a topographical point of view as there seems to be lack of information on this parameter on other breeds of horse.

The position of the **base** of the heart was from the 2nd to the 5th intercostal spaces on the right side but it may reach the 6th intercostal space on the left side in the Caspian miniature horse.

The report on the horse shows that the base of the heart extends from the 2nd intercostal space or the 3rd rib to the 6th or sometimes the 7th rib [5]. This seems slightly greater than the Caspian miniature horse.

The **apex** of the heart in the horse is at the level of the 5th costochondral junction [5]. However, it has been reported that it might be situated in the 6th costal cartilage [3]. Our result shows that the apex of the heart in the Caspian miniature horse is at the 5th costochondral junction, like that of the horse, but it might be situated at the 4th costochondral junction, which seems to be slightly more cranial than that of the horse.

The **pulmonary valve** in the Caspian miniature horse was extended from the 3rd to the cranial half of the 4th rib, which is slightly more caudal than that

of the horse, which extends from the 3rd rib to the 3rd intercostal space [1]. The position of the **aortic valve,** similar to that of the horse, was medial to the pulmonary artery [1]. The cranial limit of the aortic valve may begin from the cranial border of the 4th rib and extends to the cranial border of the 5th rib, which shows the location is at 5th intercostal space; this seems to be different from that of the horse, which is reported to be situated from the 5th rib to the 5th intercostal space [5].

The **bicuspid valve** is similar to what has been reported in the horse [1, 5].

Tricuspid valve. In the Caspian miniature horse, the tricuspid valve extended from the 3rd rib to the 5th rib, which seems to be different than that of the horse, in which it is mainly situated at the 6th rib [1, 5].

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