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ARTERIAL SUPPLY OF THE PINEAL GLAND OF AKKARAMAN SHEEP

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Arterial vascularisation of the ovine pineal gland was investigated by latex injection preparations of the common carotid artery in 20 adult Akkaraman sheep brains under stereo light microscope. It was observed that the arterial supply comes exclusively from branches of the caudal cerebral artery. The pineal gland was found to contain a rich vascular network. This network also received a few branches from the caudal choroid rami.

Key words: Anatomy, arterial supply, pineal gland, sheep

The pineal gland secretes a hormone called melatonin, which co-ordinates and regulates mammalian reproduction (Jenkins, 1972). Since the pineal gland does not have a blood–brain barrier, melatonin is transported into the peripheral tissues and organs by both the blood and the cerebrospinal fluid. In addition to light and neuronal stimulation, the pineal gland has important roles in the functioning of arterial vascularisation. Arterial blood of the pineal gland is supplied by the network of dense blood vessels (Dyce et al., 1987; Murakami et al., 1998; Dursun, 2000). The gland has a blood vessel network which is formed by capillary anastomosis (Murakami et al., 1998). While the posteriomedial and posteriolateral arteries are known to supply blood to the gland in humans (Walter and Hendelman, 1994; Crossman and Neary, 1995; Duvernoy et al., 2000), the lateral choroid artery, middle cerebral artery, medial posterior choroidal artery and caudal cerebral arteries have been reported to carry blood to the gland in animal species (Hebel and Stromberg, 1976; Hodde and Veltman, 1979; Chunhabundit and Somana, 1991; Teo et al., 1993; Nasu et al., 1994; Kleiter and Lametschwandther, 1995; Vinos et al., 1995; Murakami et al., 1998). The pineal gland in the rat is vascularised through a network composed of several capillary arteries which arise from the caudal cerebral artery (Hodde and Veltman, 1979; Murakami et al., 1998). The caudal choroid artery arises from the caudal cerebral artery (Reither, 1981).

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Anatomy of the circulation and neuronal system varies among species. Because many studies of the pineal gland reported conflicting results and major variations among species, the arterial vascularisation of the pineal gland is not clearly known.

Materials and methods

The cerebellar arteries of 20 Akkaraman sheep, obtained freshly from the Kırıkkale slaughterhouse, were studied. The specimens were of both sexes and adults. The encephalon was removed from the cranial cavity, the arteries were washed with saline solution and injected with red coloured latex. Then they were immersed in 10% formalin solution for fixation. Finally, dissection was performed and vessels vascularising the pineal gland were documented. A microsurgery set and a stereomicroscope were used in the study. Measures were taken by the use of ocular micrometer. The 'Nomina Anatomica Veterinaria' (International Committee on Veterinary Gross Anatomical Nomenclature, 1994) was employed for the anatomical terms.

Results

The pineal gland is located between the rostral colliculi of the tectum of mesencephalon, just above the third ventricle of the cerebrum, and extends caudally along the medial line. The pineal gland was conical in 50% of the animals studied, oval in 40% and polymorph in 10% (Fig. 1*a*). In this study, the caudal cerebral artery was shown to play an important role in arterial vascularisation of the pineal gland. The caudal cerebral artery arises from the caudal communicating artery, just in front of the oculomotor nerve (Fig. 2*a, b*). In all samples, the caudal cerebral artery was found to give off branches for the supply of blood to the crus cerebri, rostral colliculi and pineal gland. In addition to these branches, the caudal cerebral artery provides thin and short vessels near its origin mostly to the crus cerebri. After travelling about 2 mm, in caudodorsal direction, the caudal cerebral artery splits into four branches that course in the same direction. In all 16 samples, the first branch terminated in the pineal gland while the other two branches terminated in the tectum of mesencephalon (Fig. 2*h*). The first branch gives off 1–2 thin vessels to the crus cerebri during its course to the pineal gland. In the middle of the pineal gland, the caudal cerebral artery bends caudally and forms an S-shaped twist on the dorsal surface of the gland. The left caudal cerebral artery makes anastomosis with a small branch from the caudal choroid rami at the dorsolateral surface of pineal gland (Fig. 3, arrow). The left caudal cerebral artery terminates by giving two branches towards the outside edge and the underside of the pineal gland at the upper left edge of the gland, two branches to the rostral and one branch to the lateral right at the middle of the S-shaped twist, two branches at the caudal end of the S-shaped twist and one long branch that goes in

rostrolateral direction at the caudal course of the S-shaped twist. The above-described termination pattern of the left caudal cerebral artery was observed in 14% of the samples where the artery splits into four branches.

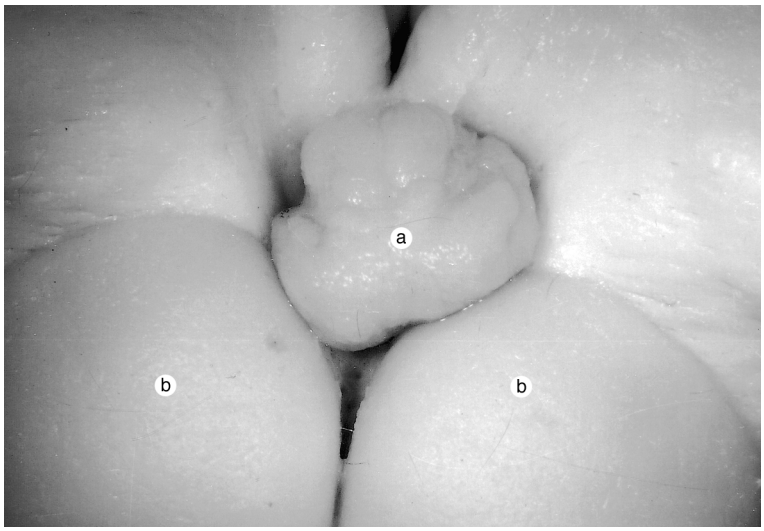

Fig. 1. Dorsal view of the pineal gland in Akkaraman sheep: (a) pineal gland; (b) rostral colliculi

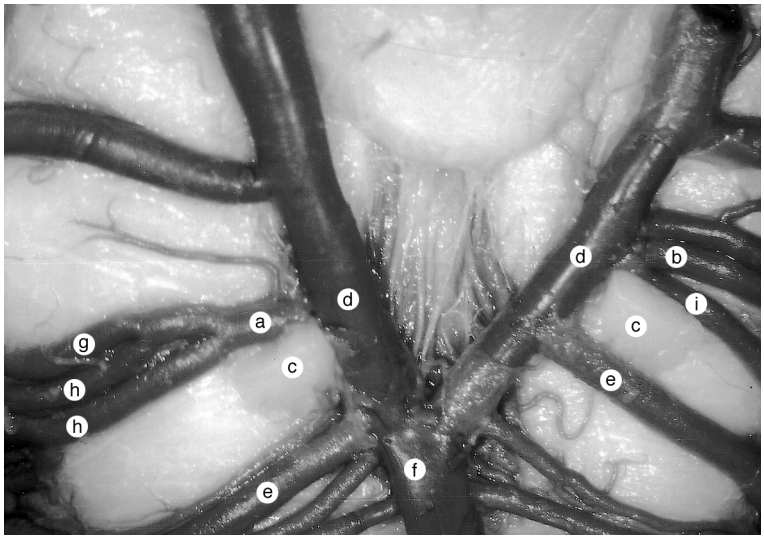

Fig. 2. Basal view of the arteries supplying the pineal gland in Akkaraman sheep: (a) arteria cerebri caudalis dexter; (b) a. cerebri caudalis sinister; (c) oculomotor nerve; (d) a. communicans caudalis; (e) a. cerebelli rostralis; (f) a. basilaris; (g) pineal branch of the a. cerebri caudalis dexter; (h) branches of the a. cerebri caudalis dexter for the tectum of mesencephalon; (i) rami choroidei

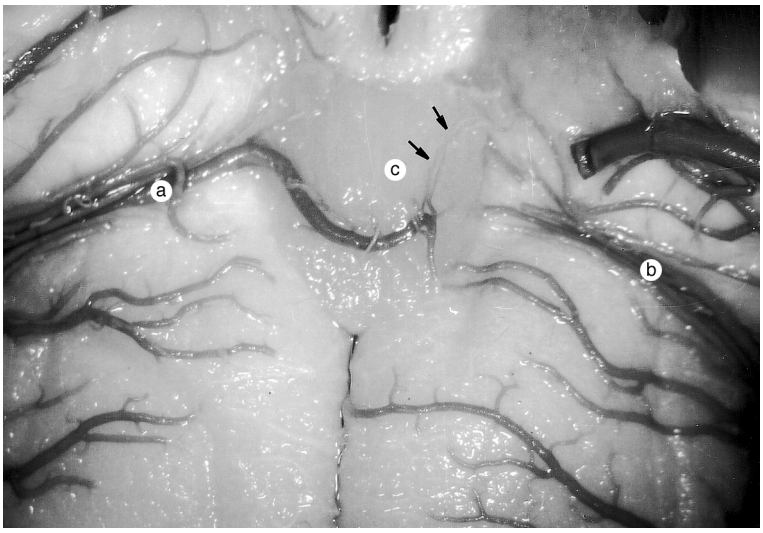

Fig. 3. Dorsal view of the arteries supplying the pineal gland in Akkaraman sheep: (a) branches of the a. cerebri caudalis sinister; (b) branches of the a. cerebri caudalis dexter; (c) pineal gland, arrow: anastomosing branches between the caudal choroid rami and the a. cerebri caudalis sinister

In four samples (20%) where the caudal cerebral artery splits into two branches, the branch that is thicker and goes caudally, forks 10 mm after its origin and terminates in the rostral and caudal parts of the rostral colliculi by giving off many winding vessels. Although no vessel was found to supply the dorsal part of the pineal gland, thin vessels were found to spread to the pineal recess. The thin vessels that branch off the caudal choroid rami on the left make anastomosis with the vessels separated from the caudal cerebral artery to supply the gland both at the pineal recess and at the dorsolateral surface of the pineal gland. Different from the left artery, the right caudal cerebral artery splits into two branches soon after it originated from the caudal communicating artery. The rostral branch supplies thin vessels to the ventral part of the pineal gland. After giving off thick branches that supply the rostral colliculi, the rostral branch of the right caudal cerebral artery terminates in the pineal recess and in the rostral part of the pineal gland by giving off small vessels. The rostral branch that starts just in front of the oculomotor nerve splits into two vessels after a short course. The caudal one of these vessels supplies the dorsal part and front edge of the rostral colliculi and terminates before reaching the pineal gland. The other vessel provides thinner shoots to the craniolateral part of the rostral colliculi and to the ventral part of the pineal gland. While the course of the right caudal cerebral artery described above was observed 80% of the samples, in three animals the origins and branching pattern of the right and left rostral cerebral artery were the same, while in one animal the rostral cerebral artery arose from the caudal com-

municating artery as three roots. Despite the variations in the branching patterns, in all samples the left caudal cerebral artery was found to supply mainly the middle and dorsal parts of the pineal gland and the branches of the right caudal cerebral artery were observed to spread into the pineal recess. Although it was not significant, some vessels from the pia mater and a thin branch from the caudal choroid rami were shown to provide arterial blood to the pineal gland.

Discussion

Although the localisation of the pineal gland is similar in sheep and other species (Crossman and Neary; 1995; Dursun, 2000), its morphology has been found to be different: 50% are conical, 10% polymorph and 40% look like a large wheat grain shape as described by Dursun (2000).

Despite the presence of a dense network of blood vessels on the pineal gland from the pia mater, it was suggested that the pia mater might function as a covering layer and supply the gland by diffusion (Dyce et al., 1987; Murakami et al., 1998; Dursun, 2000). However, the blood from the pia mater may not be enough for the vascularisation of the pineal gland.

In animal species arterial blood is supplied to the pineal gland mainly by the lateral choroid artery (Kleiter and Lametschwandther, 1995), the middle cerebral artery (Chunhabundit and Somona, 1991) and the caudal cerebral artery (Hodde and Veltman, 1979; Teo et al., 1993; Nasu et al., 1994; Vinos et al., 1995). In all sheep used in this study, the pineal gland was found to be supplied by vessels from the caudal cerebral artery that made anastomosis with the caudal choroid rami. In 12 sheep, the caudal choroid rami were shown to carry blood to the gland through a thin branch.

Consequently, despite variations in vascularisation pattern, it was concluded that mainly the caudal cerebral artery and a thin branch from the caudal choroid rami supplied the pineal gland. There is anastomosis between these arteries, the left caudal cerebral artery supplies mainly the dorsal part of the gland, the right caudal cerebral artery supplies the pineal recess and there is no vessel from the pia mater to supply the pineal gland.

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