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The Morphology and Arterial Vascularization of the Pineal Gland in Donkeys

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Abstract: The heads of 6 adult donkeys used in applied anatomy lessons, which were preserved in formalin and which displayed no difference with regard to sex, constituted the study material. In donkeys, the glandula pinealis was determined to be a dark-coloured endocrine gland, either water-drop-shaped or fusiform in shape, situated just in front of both colliculi rostrales, which contribute to the formation of the tectum mesencephali and above the recessus pinealis, in between the corpus geniculatum laterale and colliculus rostralis. The mean craniocaudal, mediolateral and dorsoventral lengths of the pineal gland were measured as 4.56, 4.68 and 12.56 mm, respectively. The pineal gland was ascertained to be supplied mainly by the *A. cerebri caudalis*, which emanates from both sides of the *A. communicans caudalis* at an approximate distance of 5.8 mm to the fossa interpeduncularis, just in front of the origin of the *N. oculomotorius* and at the level of the middle 1/3rd of the crus cerebri. If present, the rami choroidei caudales, which stem from the *A. cerebri caudalis* and branches given off by the *A. communicans rostralis*, also contribute to the supply of the gland at the upper part of the glandula pinealis. Furthermore, in one of the cadavers examined, the terminal branches of the *A. cerebri caudalis* dexter and *A. cerebri caudalis* sinister, which supply the pineal gland, were determined to anastomose with each other, whereas in two other cadavers, the terminal branches of the indicated arteries were demonstrated to anastomose with the *A. communicans rostralis* which is enclosed by the pia mater.

Key words: Donkey, pineal gland, morphology, vascularisation

INTRODUCTION

Biogenic amines including serotonin, melatonin and norepinephrine are secreted from the pineal gland. Melatonin synthesis, which increases upon sympathetic stimulation, displays rhythmic diurnal fluctuations related to light impulses received by the retina. Accordingly, melatonin synthesis, which increases at night, decreases during daytime (Getty, 1975; Ersoy and Baysu, 1986; Taner, 1999; Dyce *et al*., 2002). Tumours, which destroy the pineal gland, in particular, cause the diminishment of the inhibition of the gonads. This phenomenon, in result, leads to pubertas precox, which is characterized by the development of primary and secondary sex characteristics at an unexpectedly early age. In conditions, such as jet lag, induced by a major rapid shift in environmental time as a result of air travel across time zones and work shift syndrome resulting from frequent changes in work or sleep schedules, sleep disorders develop due to the disturbance of the circadian rhythm. Such sleep disorders can be treated with melatonin (Taner, 1999; Hendelman, 2000; Frandson *et al*., 2003).

The pineal gland (*epiphysis cerebri*), which is considered to be part of the diencephalon, is localised within the median cavity between the thalamus and the 2 colliculi rostrales. It is separated from the splenium corporis callosi of the corpus callosum by the tela choroidea of the ventriculus tertius and forms the dorsocaudal margin of the skeleton of the ventriculus tertius (Sisson, 1938; Getty, 1975; Evans and Christensen, 1979; Taner, 1999; Dursun, 2000; Hendelman, 2000; Dyce *et al*., 2002; Dursun, 2002; Frandson *et al*., 2003; Yildiz *et al*., 2004).

The approximate size of the pineal gland is 3 mm in the dog (Evans and Christensen, 1979), 12 mm in cattle, 3-5 mm in sheep (Dursun, 2002) and 8 mm in humans (Taner, 1999) and the gland generally measures 10-12 mm in length and 7 mm in width (Sisson, 1938).

The shape of the pineal gland resembles a chisel in equidae (Dursun, 2000), a lancet (Dursun, 2000, 2002) or dagger (Evans and Christensen, 1979) incarnivores, a wheat grain in cattle and a flattened pea in sheep and goats (Dursun, 2000, 2002; Yildiz *et al*., 2004) and generally is either oval or fusiform (Sisson, 1938).

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The colour of the pineal gland varies from red to brown (Sisson, 1938) and is either brown or black in equidae and ruminants and grayish white-cream in pigs and carnivores (Evans and Christensen, 1979; Dursun, 2000, 2002).

The pineal gland is supplied by the *A. cerebralis caudalis*, which originates individually from the *A. communicans caudalis* (Hodde and Veltman, 1979; Murakami *et al*., 1988; Nasu *et al*., 1994; Aslan *et al*., 2003; Yildiz *et al*. 2004; Ozgel *et al*., 2007) and by the *A. cerebralis media* and the *A. choroidea* posterior medialis (Chunhabundit and Somona, 1991; Duvernoy *et al*., 2000; Hogendorf *et al*., 2001; Yildiz *et al*., 2004), which emanates from the branches of the *A.cerebralis posterior* (Teo *et al*., 1993), namely, the *A.cerebralis profunda* (Getty, 1975) and *A. cerebri caudalis*.

The present study, was designed to determine in the donkey the localisation, shape and size of the pineal gland (*epiphysis cerebri*), which bears great significance for both domestic and wild animals as well as for humans, to ascertain, which arteries supply this gland and to compensate for the lack of information concerning this issue.

MATERIALS AND METHODS

The heads of 6 adult donkeys used in applied anatomy lessons, which were preserved with formaldehyde and which displayed no difference with regard to sex, constituted the study material. The heads of the donkeys were applied latex coloured with red rotring ink (Sanford GmbH, D-22510 Hamburg), on both sides and in the proximity of the heart, through the *A. carotis communis* and *A. vertebralis*. Prior to dissection, the materials were kept at 4°C for 24 h for latex polymerisation. The findings obtained were photographed with a Canon Powershot S70 model digital camera. Anatomical terminology generally conforms to that prescribed by the edition of Nomina Anatomica Veterinaria (2005).

RESULTS

In donkeys, the pineal gland is a dark-coloured endocrine gland either water-drop-shaped or fusiform in shape, situated just in front of the 2 colliculi rostrales, which contribute to the formation of the tectum mesencephali, above the recessus pinealis and in between the corpus geniculatum laterale and colliculus rostralis. The mean craniocaudal, mediolateral and dorsoventral lengths of the gland were measured as 4.56, 4.68 and 12.56 mm, respectively.

Fig. 1: Ventral view of cerebellum and brain. a: Medulla oblongata, b: Cerebellum, c: Pons, d: Lobus piriformis, e: Corpus mamillare, f: Tuber cinereum, g: Chiasma opticum, 1: *A. basilaris*; 2: *A. caroticobasilaris*, 3: *A. carotis interna*, 4: *A. communicans caudalis*, 5: *A. cerebri caudalis*, 6: *A. cerebri rostralis*, 7: *A. intercarotica caudalis*, 8: *A. intercarotica rostralis*, 9: *A. cerebri media*, 10: *A. ethmoidalis interna*, 11: *A. communicans rostralis*

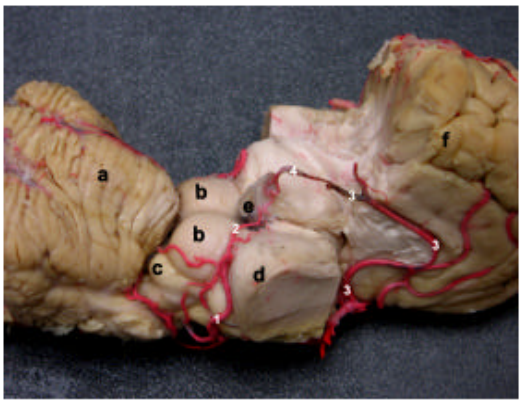

Fig. 2: Diencephalon and cerebellum. a: Cerebellum, b: Colliculus rostralis, c: Colliculus caudalis, d: Thalamus, e: Glandiula pinealis, f: Cerebrum, 1: *A. cerebri caudalis*, 2: Rami choroidei caudales, 3: *A. communicans rostralis*, 4: *A. pericallosi*

The pineal gland was ascertained to be supplied mainly by the *A. cerebri caudalis* (Fig. 1), which emanates from both sides of the *A. communicans caudalis* (Fig. 1) at an approximate distance of 5.8 mm to the fossa interpeduncularis, just in front of the origin of the *N. oculomotorius* and at the level of the middle 1/3rd of the crus cerebri. If present, the rami choroidei caudales (Fig. 2), which stem from the *A. cerebri caudalis* (Fig. 1 and 2) and branches given off by the

A. communicans rostralis (Fig. 1 and 2), also contribute to the supply of the gland at the upper part of the glandula pinealis.

The *A. cerebri caudalis* was determined to originate in association with the rami choroidei caudales (Fig. 2) on the left side in 2 and the right side in one of the cadavers examined and to have its origin as a single root and to give off branches further along its course in the remainder cadavers.

In the four cadavers in which the *A. cerebri caudalis* sinister was determined to originate from the *A. communicans caudalis* as a single root, the indicated artery was ascertained to bifurcate into 2 branches, one small and the other large, extending in craniodorsal and caudoventral direction, at the level of the crus cerebri, at an approximate distance of 3.13 mm to its origin. The small branch was demonstrated to extend to the colliculus rostralis and to give off its terminal branches at the level of the colliculus rostralis, colliculus caudalis and cerebellum. The larger branch was determined to run along below the lobus piriformis to the caudal margin of the tractus opticus. Along its course, this artery was later ascertained to pass the corpus geniculatum mediale, to give off small branches cranial to the colliculus rostralis and to terminate on the ventral margin of the pineal gland. In two of the cadavers examined, this main artery was determined to anastomose with the rami choroidei caudales after giving small branches to the pineal gland.

The rami choroidei caudales (Fig. 2), arising from the origin of the *A. cerebri caudalis* sinister, was determined to be present in 2 of the cadavers examined. This blood vessel was ascertained to measure approximately 1.36 mm in width and to run caudodorsally above the crus cerebri prior to extending in medial direction within the sulcus transverses, situated cranial to the colliculus rostralis. Subsequently, the vessel was determined to ramify into 2-3 small branches before reaching the ventral part of the pineal gland and after supplying the indicated organ, was ascertained to extend caudally on the median plane to the cerebellum prior to its anastomosis with the branch of the *A. cerebri caudalis* sinister.

In 5 of the cadavers examined, the *A. cerebri caudalis* dexter, after originating from the *A. communicans caudalis* as a single root, was determined to split into 2 branches, one extending craniodorsally and the other caudolaterally, at an average distance of 4.22 mm, on the dorsolateral surface of the crus cerebri. The prolongation of the main artery, extending in craniodorsal direction, was ascertained to reach the caudal margin of the tractus opticus, running along the ventrolateral surface of the crus cerebri and below the lobus piriformis and from here to first extend dorsally and then medially at the border between the crus cerebri and corpus geniculatum mediale, thereby reaching the ventral margin of the pineal gland. This artery was determined to give off a branch terminating in the pineal gland and to terminate after giving branches to the plexus choroideus ventriculi laterali situated within the ventriculus lateralis and to contribute to the vascularization of the glandula pinealis from both sides of the gland. The smaller branch further divided into 2 branches on the lateral surface of the crus cerebri and terminated through distribution to the crus cerebri, trigonum lemnisci and colliculus caudalis. The larger branch was determined to extend within the sulcus transversus and to give off several small branches along its course, which terminated in the colliculus rostralis, corpus geniculatum mediale and corpus geniculatum laterale, before terminating on the ventral margin of the pineal gland.

In one of the cadavers examined, the rami choroidei dexter was determined to be present, to measure 1.12 mm in width and to stem from almost the same region of the origin of the *A. cerebri caudalis* dexter. This blood vessel was determined to split into 2 branches at a distance of 1.69 mm to its origin and at the level of the crus cerebri. One of these branches measured 0.44 mm in width and extended transversally, whereas the other measured 1.38 mm in width and followed a caudodorsal course. The branch extending transversally was demonstrated to follow a medial course along the caudal margin of the corpus geniculatum mediale and to divide into its terminal branches on the medial margin of the corpus geniculatum mediale. The larger branch extending in caudodorsal direction was determined to extend to the cranial part of the trigonum lemnisci after its course along the crus cerebri and subsequently was demonstrated to extend craniomedially before following a medial course on the cranial margin of the colliculus rostralis. Later, it was demonstrated to extend to the glandula pinealis and to give small branches to the ventral margin of the gland. Further along its course, towards the median plane, this vessel was determined to extend caudally above the colliculus rostralis and colliculus caudalis and to anastomose with the terminal branch of the *A. cerebri caudalis* dexter, just in front of the cerebellum.

In one of the cadavers examined, the terminal branches of the *A. cerebri caudalis* dexter and *A. cerebri caudalis* sinister, which supply the pineal gland, were determined to anastomose with each other, whereas in 2 other cadavers, the terminal branches of the indicated arteries were ascertained to anastomose with the *A. communicans rostralis*, which was enclosed the pia mater.

Furthermore, in all of the cadavers examined, the *A. pericallosi* (Fig. 2), determined to stem from the dorsal surface of the *A.communicans rostralis*, in the falx cerebri situated within the sulcus longitudinalis cerebri and ascertained to extend within the sulcus corporis callosi, was also demonstrated to contribute to the arterial supply of the glandula pinealis at the upper part of the gland.

DISCUSSION

In the present study, the localisation of the pineal gland was determined to be just in front of the 2 colliculi rostrales, which contribute to the formation of the tectum mesencephali, above the recessus pinealis and in between the corpus geniculatum laterale and colliculus rostralis, in compliance with previous reports (Sisson, 1938; Getty, 1975; Evans and Christensen, 1979; Taner, 1999; Dursun, 2000; Hendelman, 2000; Dursun, 2002; Dyce *et al*., 2002; Frandson *et al*., 2003; Yildiz *et al*., 2004).

The shape of the pineal gland was determined to be either oval (resembling a large drop of water) or fusiform in the materials examined, similar to the reports of Sisson (1938) and Yildiz *et al*. (2004).

Furthermore, the mean length of the gland was ascertained to be 12.56 mm, close to the values reported by Dursun (2002) for cattle and those previously determined by Sisson (1938).

In compliance with previous reports (Hodde and Veltman, 1979; Murakami *et al*., 1988; Nasu *et al*., 1994; Aslan *et al*., 2003; Yildiz *et al*., 2004; Ozgel *et al*., 2007), in donkeys, the pineal gland was determined to be supplied by the *A. cerebri caudalis*, which springs from the *A. communicans caudalis* and the *A. choroidea caudales*, stemming from the *A. cerebri caudalis*, was also determined to contribute to the arterial supply of the gland (Chunhabundit and Somona, 1991; Duvernoy *et al*., 2000; Hogendorf *et al*., 2001; Yildiz *et al*., 2004). Furthermore, branches ramifying from the *A.communicans rostralis*, on which no previous report exists, were determined to contribute to the supply of the glandula pinealis at the dorsal part of the gland.

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