

Ocular and Olfactory Forebrain Abnormalities within a Neonatal Alpaca (*Vicugna pacos*)

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ABSTRACT. A 5-day-old Huacaya alpaca cria (*Vicugna pacos*) was euthanized due to deteriorating health. At birth, the cria had ophthalmologic abnormalities, but had appropriate mentation. At 2 days of age, the cria gradually stopped suckling and began to circle. At 5 days old, the owner elected euthanasia due to declining clinical condition. Grossly, the right iris had a scalloped pupillary margin, and the right olfactory bulb was malformed. Histopathology revealed persistent hyperplastic primary vitreous bilaterally and iridal abnormalities, as well as aplasia of the olfactory ventricle, olfactory tract, and olfactory foramen on the right side.

KEY WORDS: alpaca, congenital, eye, olfactory ventricle.

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A 5-day-old female Huacaya alpaca cria (*Vicugna pacos*) weighing 5.5 kg was brought to the University of Florida Veterinary Medical Center for euthanasia and necropsy due to ocular abnormalities and deteriorating mental status. The 5-year-old hembra is 1 of 6 alpacas on the farm and believed to be primiparous. The sire fathered 20 crias to full term last year; 1 was born with wry face. There was no history of trauma during parturition, no history of treatment during gestation, no history of toxin exposures on the farm, and an unknown vaccination history. The cria appeared to receive an adequate amount of colostrum. The cria was acting appropriately for the 1st 2 days of life. The owner then noted a decline in activity, described as a decreased nursing drive, difficulty walking, and decreased defecation. The owner elected euthanasia after the cria continued to deteriorate, and was presented to the University of Florida Veterinary Medical Center for necropsy.

On post-mortem examination, the cria was found to be in good physical condition with appropriate muscle and fat stores. The calvaria lacked a foramen to accommodate the right olfactory nerve within the frontal bone, and compared to the contralateral side, the cavity for the olfactory bulb was notably shallower (Fig. 1). There was no discernible olfactory bulb or olfactory tract on the right side (Fig. 2). The optic tracts looked subjectively small bilaterally. The leptomeningial surface of the base of the brain, right cerebral hemisphere, and cerebellum were covered by brown-to-black foci consistent with melanosis, a common finding in black-faced animals [2, 10].

The pupillary margin of the right eye was irregularly scal-

loped with a marked decrease in height of the iris ventrally. A 10 mm by 5 mm irregular white to tan focus was visible in the posterior aspect of the right eye. Also, noted was a 4 mm diameter cloudy, irregular area on the corneal surface of the left eye, consistent with corneal ulceration.

Histologic examination of serial sections of the right and left frontal lobes revealed that the right forebrain lacked an olfactory ventricle and olfactory tract when compared to the left (Figs. 3 and 4). The left olfactory foramen had a circumference of 6,590 μm and an area of 0.3 mm^2 . Additionally, there was hyphema of the right eye, and the iris of the right eye was irregularly shaped, with one side being 25% the length of the other side. The shorter side had a thickened iridal stroma at its base, causing narrowing of the filtration angle. There was bilateral retinal detachment, with hyperplasia of the retina pigment epithelium (RPE) and proteinaceous fluid separating the retina and RPE. There was atrophy of the detached retinas, characterized by loss of the inner plexiform layer and blending of the inner and outer nuclear layers. Multifocally and bilaterally, the retinas were atrophied and projected into the vitreous chamber. Multifocally, the atrophied retina formed rosettes. Macrophages with erythrophagocytosis were scattered around the optic disc. Multiple blood vessels and frequently pigmented spindle cells bilaterally formed a core that extended from the optic cup to the posterior lens capsule, forming trabeculae that extended along the posterior lens capsule to the ora serrata (Fig. 5).

The true prevalence of congenital abnormalities in alpacas is not known, as many animals with severe abnormalities are euthanized at birth. However, surveys of alpaca breeders suggest that musculoskeletal abnormalities, particularly of the skull, are among the most common congenital defects [11]. Two crias have been briefly reported with bilateral olfactory bulb and optic nerve hypoplasia, as well as a lack of foramina for the olfactory nerves bilaterally [11]; however, this report does not describe the status of the olfactory ven-

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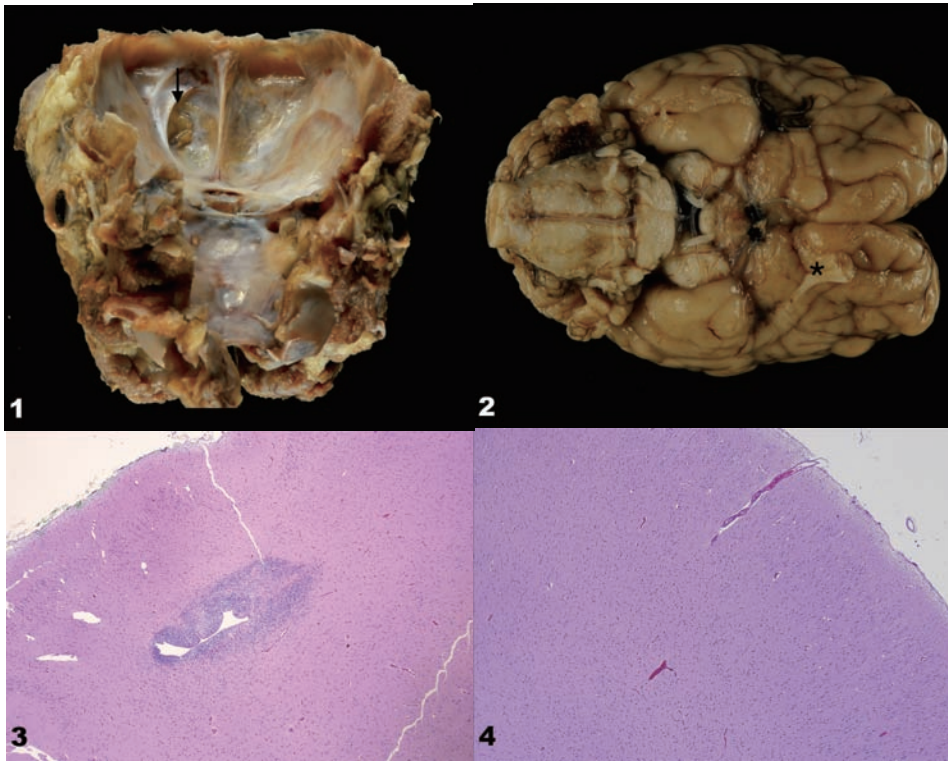


Fig. 1. Skull. The arrow denotes the fossa cranii rostralis and fossae ethmoidales on the left, with the remnants of the bulbus olfactorius. All are missing on the right.

Fig. 2. Brain. The asterisk marks the pedunculus olfactorius on the left side, which is missing on the right.

Fig. 3. Left and right forebrain, respectively. The left shows a normal olfactory ventricle, which is absent on the right. Hematoxylin and eosin staining.

Fig. 4. Left and right forebrain, respectively. The left shows a normal olfactory ventricle, which is absent on the right. Hematoxylin and eosin staining.

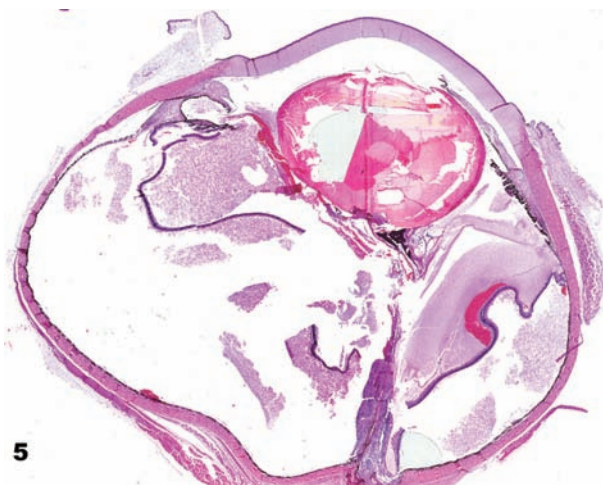


Fig. 5. Right eye. The persistent hyperplastic primary vitreous extends from the optic nerve to the caudal portion of the lens. Hematoxylin and eosin staining.

tricle or the eyes. Ocular defects reported include colobomas, vitreous fibrosis and ossification, cataracts, retinal dysplasia, retinal detachment, and hyaloid arterial remnant [6].

The hyaloid artery is an embryonic branch of the ophthalmic artery that supplies the developing lens with blood. Normally, this regresses; however, the time to regression can differ between species. In humans, the hyaloid arteries are expected to regress prior to birth, but in rodent species, remnants may persist beyond 16 days [8]. Unpublished work by Dr. Stephen Purdy found that a population of seven crias (100% of the sample population) retained a remnant of the hyaloid vasculature up to three days of age. Follow up examinations found that these regressed by 2 weeks of age in all animals [14]. Further studies of a larger population of animals, especially from multiple bloodlines, would be necessary to determine the expected age regression. While the persistent arteries are likely part of the other ophthalmologic abnormalities we found in this crias, they may be part of normal development. Considering the age of this animal, the hyaloid arterial remnant is likely a persistent hyperplastic primary vitreous (PHPV). The loss of the inner plexiform layer and blending of the nuclear layers are consistent with retinal detachment instead of retinal hypoplasia [7]. Retinal

rosette formation is consistent with dysplastic change [13].

The olfactory ventricle is an inconsistent structure across species. In humans, the ventricle has been described as a cavity lined with ependymal cells with a role in neuroblastic migration into the olfactory bulb during embryogenesis [3]. Previously, it had been thought that within humans the olfactory ventricles would close as early as 19 weeks during gestation, and that normally the ventricle is closed prior to birth [16]. However, numerous incidental findings of patent olfactory ventricles within humans have been discovered by magnetic resonance imaging (MRI). Retrospectively, a series of 122 MRIs in humans found that 72 cases (59%) had some remnant of a patent olfactory ventricle (unilateral or bilateral) [16].

In addition to incidental findings, several congenital diseases are associated with olfactory aplasia or malformations in humans. Microdeletions of 6q27 are occasionally associated with olfactory bulb aplasia; however, these also have hydrocephalus and aplasia of the corpus callosum [5]. De Morsier's syndrome, also known as septo-optic dysplasia, has optic nerve and olfactory bulb hypoplasia as well as thinning of the corpus callosum and/or absence of septum pellucidum. Kallmann's syndrome is a defect in the migration of olfactory neurons [4] and affects similar forebrain structures, but patients also develop hypogonadotropic hypogonadism with multiple structural congenital defects [12]. However, the lesions in this case do not match any of these conditions, leaving us unable to determine an analogous human case.

Within fish and other mammals (sheep, pigs, and goats) olfactory ventricles are found until two weeks of life, and occasionally persist into adulthood as well [15]. However, no studies have examined the olfactory ventricle in alpacas, and little work has been published about the neurophysiology of the forebrain of the alpaca, or other camelid species. It is unknown if these regress in adults, or persist as a microscopic structure in the forebrain.

The rapid deterioration of the cria's health cannot be attributed solely to the abnormalities found within the eyes and forebrain, and no specific cause for ill thrift was found. However, the defects within the sensory organs could make nursing more difficult, leading to hypoglycemia.

While not typically considered a traditional production animal in the United States, alpacas have been growing in popularity in the last several years. Since its inception in 1988, the membership in the Alpaca Owners and Breeders Association has grown from 38 to over 4,000, with over 100,000 alpacas registered in the last 20 years [1]. The increasing number of alpaca farmers within the United States coupled with the difficulty of bringing in new stock from South America creates a founder effect in the pool of breeding alpacas. This genetic bottleneck may lead to increased congenital defects in crias [9].

This particular combination of defects has not, to our knowledge, been previously described in this species. While this case was unilateral, the presence of another report of similar cranial lesions [11] suggests that alpacas may be predisposed to olfactory malformations, and careful examination of this area should be performed in alpacas presented

for necropsy.

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