

Ocular Anomalies of Incomplete Albino Hereford Cattle

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Introduction

Cutaneous albinism has been observed, and described in a number of breeds of cattle; however, the ophthalmologic findings have often been incomplete.^{2,25} In an albino herd from Holstein parents, no pigment was evident in the skin, eyes, horns and claws, and the cattle exhibited photophobia.³ A single heifer of black-pied parentage demonstrated complete lack of pigment in the skin, hair, and iris, and the trait apparently was inherited as a recessive.⁹ In another herd of cattle, calves lacked pigmentation of the skin, iris and hair, until sexual maturity, when some pigment, referred to as a "ghost pattern" was present.² Histologic examination of those animals revealed no pigment in the retina but some pigment in the iris and ciliary body.²

The skin in 3 albino Holstein cattle was described as pink and the muzzles, claws and horns were unpigmented. The hair was creamy-white and in later life no pigmentation occurred. The irides were greyish-blue and photophobia was evident.⁹ The trait would have been recessive because the parents were related.⁹

The results of 43 matings indicated that albinism was inherited as a simple recessive and that the ghost pattern was due to structural anomalies of the hair rather than to pigmentation.²¹ Three albino Holstein cattle reported with albinism in Japan had originated from a common sire whose ancestors had been imported from the United States. A single albino calf of the Murbodner breed in Austria had originated from an accidental mating of a son to his dam; the skin and hair showed no pigmentation and the irides were pink.²²

The iris color of albino Brown Swiss cattle was white, pupils were red and photophobia was extreme. Eyes, skin, horns, claws, and hair were unpigmented. The trait was

inherited as a recessive because test mating of albino x albino resulted in albino offspring, and normal x albino resulted in normal coat color.^{24,25}

Albinism has been reported in Hereford cattle.¹⁹ Brother-sister matings produced 3 albino offspring with light pigmentation on the medial hind legs but no ghost pattern. Albinism and dwarfism were observed together in these animals but these two traits were believed to be independent.^{6,20} The partial albino cattle exhibited a blood abnormality identical to that in Chediak-Higaski of man, and they had increased susceptibility to disease.^{20,26} Breeding experiments with these cattle revealed that the trait was inherited as a recessive.²⁰

The clinical findings of heterochromia irides, tapetum fibrosum hypoplasia, and typical colobomata of the optic nerve head and nontapetal fundus were described in albino Hereford cattle. The incomplete albinism, exhibited by virtually complete white hair coats with occasional spots of pigmented hair and blue irides, was inherited as an autosomal dominant trait.^{11,12}

This paper reports the histologic findings of the heterochromia irides, tapetal fibrum hypoplasia, and typical colobomata of the optic nerve head and nontapetal fundi in albino Hereford cattle.

Materials and Methods

Fifteen albino and three pigmented control cattle were examined periodically by indirect ophthalmoscopy and photography for two years. The congenital, nonprogressive, ocular anomalies observed clinically were compared with those detected histologically.

Each of eighteen cattle was each euthanatized by an overdose of intravenous sodium pentobarbital and then immediately necropsied. The globes were immediately fixed

Table 1: Gross Pathological Changes

No.	Iris Color	Ciliary Body	Fundus		Optic Nerve
			Tapetal	Non-Tapetal	
1	Grey	reduced pigment	light green	reduced pigment	normal
2	Grey black section ventral	"	"	"	Coloboma
3	Blue periphery and white center	"	"	"	Coloboma
4	Coloboma iris white periphery and black center	"	"	"	large Coloboma
5	blue	"	"	"	normal
6	blue with grey and black spots	"	"	"	normal
7	irregular black and grey	"	"	"	normal
8	blue	"	"	"	normal
9	blue	"	"	"	normal
10	grey	"	"	"	normal
11	blue	"	"	"	Coloboma
12	blue periphery white center	"	"	"	Coloboma
13	blue	"	"	"	Coloboma
14*	blue periphery white center	"	"	"	large Coloboma
15	light black	"	"	"	Coloboma
16	black	normal	normal	normal	normal
17	black	"	"	"	"
18	black	"	"	"	"

* Both eyes had microphthalmia

TABLE 2: HISTOPATHOLOGICAL FINDINGS IN INCOMPLETE ALBINO CATTLE EYES

No.	Cornea	Sclera	Iris	Ciliary Body	Choroid	Retina	Fundus
1	Normal	Normal	Only posterior layer was pigmented	Reduced pigmentation	Lacked pigmentation	Normal	Hypoplastic tapetum coloboma at ventral aspect (4d.d.)
2	Normal	Normal	Only posterior layer was pigmented	Reduced pigmentation Absence of copra nigra	Lacked pigmentation	Disorganized	Coloboma at ventral aspect and presence of rosette (5d.d.)
3	Normal	Normal	Dense pigmentation of posterior iris with other layers lacking pigment	Reduced pigmentation	Lacked pigmentation	Disorganized retina	Hypoplastic tapetum and large cystic coloboma (5d.d.) at ventral aspect
4	Normal	Normal	Only posterior layer pigmented	Reduced pigmentation	Lacked pigmentation	Normal	Hypoplastic tapetum with coloboma at ventral aspect (2d.d.)
5	Normal	Normal	Only posterior layer pigmented	Reduced pigmentation	Lacked pigmentation	Normal	Normal
6	Normal	Normal	Only posterior layer pigmented	Normal	Lacked pigmentation	Normal	Normal except hypoplastic tapetum
7	Normal	Normal	General pigment reduction on all layers	Reduced pigmentation	Reduced pigmentation	Normal	Hypoplastic tapetum and coloboma at the ventral aspect (2d.d.)
8	Normal	Normal	Only posterior layer pigmented	Faintly pigmented	Lacked pigmentation	Normal	Coloboma dipping into choroid (1d.d.)
9	Normal	Normal	Posterior layer only pigmented	Faintly pigmented	Lacked pigmentation	Normal	Remnant of hyaloid artery

Table 2.

No.	Cornea	Sclera	Iris	Ciliary Body	Choroid	Retina	Fundus
10	Normal	Normal	Posterior layer pigments with scattered in the stroma and Anterior layer	Faintly pigmented	Lacked pigmentation	Normal	Coloboma at ventral aspect (3d.d.)
11	Normal	Normal	Only posterior layer is pigmented	Faintly pigmented Absence of corpora nigra	Lacked pigmentation	Normal	Large cystic coloboma at ventral aspect (5d.d.)
12	Normal	Normal	Only posterior layer is pigmented	Faintly pigmented	Lacked pigmentation	Normal	Large cystic coloboma (5d.d.) at ventral aspect
13	Normal	Normal	Only posterior layer is pigmented	Faintly pigmented	Lacked pigmentation	Normal	Coloboma (3d.d.) and hypoplastic tapetum
14	Normal	Normal	Posterior layer heavily pigmented	Faintly pigmented	Lacked pigment	Disorganized	Coloboma (4d.d.)
15	Normal	Normal	Posterior layer only pigmented	Faintly pigmented	Lacked pigment	Normal	Coloboma (3d.d.) and hypoplastic and tapetum
16	Normal	Normal	Normal	Normal	Normal	Normal	Normal
17	Normal	Normal	Normal	Normal	Normal	Normal	Normal
18	Normal	Normal	Normal	Normal	Normal	Normal	Normal

in 10% buffered neutral formalin. The tissues were cut 8μ thick, then routinely processed and stained with hematoxylin and eosin.

Results

The gross and histologic findings of the 18 cattle are summarized in Tables I and II. The iris color ranged from blue and white to a combination of blue, white, and brown or grey (Figures 1 and 2). The irides were thinner than normal and permitted transillumination. Radial iridal blood vessels could be detected in all quadrants of the blue and white portions, but only infrequently in the grey and brown portions. Corpora nigra, especially the dorsal portions, were present in all but two cattle, but they were reduced in size.

The ciliary body pigmentation was reduced in comparison to the controls. The tapetal fundi were usually a red-yellow; however, infrequent tapetal areas were a yellow-green similar to that of the controls. These two albino cattle with yellow-green tapetal fundi resulted from a Holstein and Jersey cow mated to an incomplete albino bull (Hereford). The nontapetal fundi were incompletely pigmented permitting detection of the underlying choroidal vasculature.

The size of optic nerve head and nontapetal fundi colobomata which varied markedly, might have increased in the second generation of albino cattle. The small colobomas were more readily detected by ophthalmoscopy before necropsy because of the 14 to 15 x magnification, absence of underlying choroidal vasculature, and deviated retinal blood vessels. The white colobomata extended from the ventral aspects of the optic nerve head in the 6 o'clock position. The demarcations between the coloboma and adjacent nontapetal fundus were distinct and the coloboma did not contain overt choroidal vasculature (Figures 3 and 4).

Histologically, the albino cattle irides contained few melanocytes within the stroma. The posterior epithelium was heavily pigmented. The sphincter musculature was well developed; however, the dilator muscles seemed to be reduced in number.

Pigmentation in ciliary body epithelium and choroid was reduced. The tapetum fibrosum cells were normal in appearance but the tapetal layer was usually only two to three cell layers thick.

The typical colobomata of the optic nerve head and

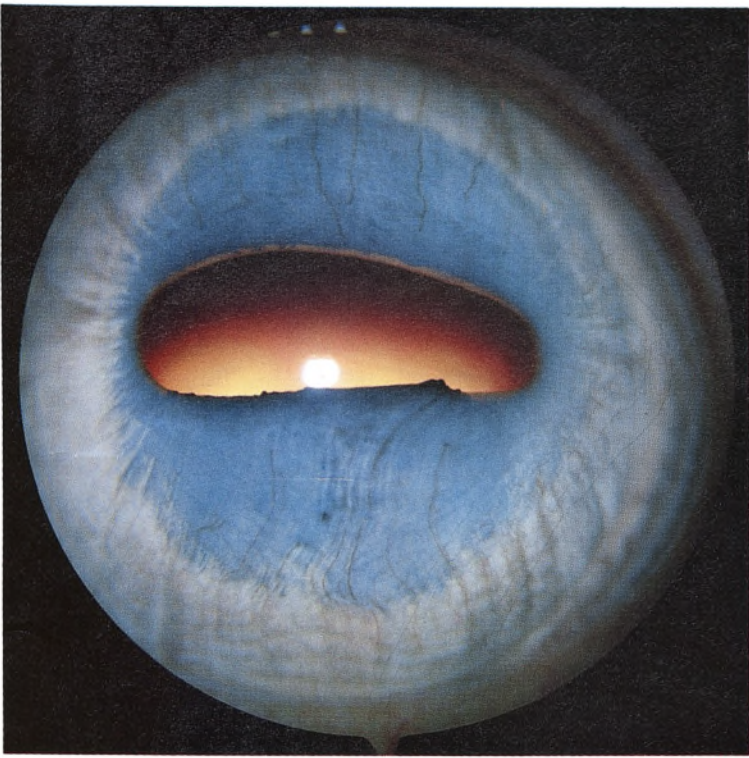


Figure 1: Iridal heterochromia with blue centrally and white basally. Note the presence of blood vessels within the iridal substance.

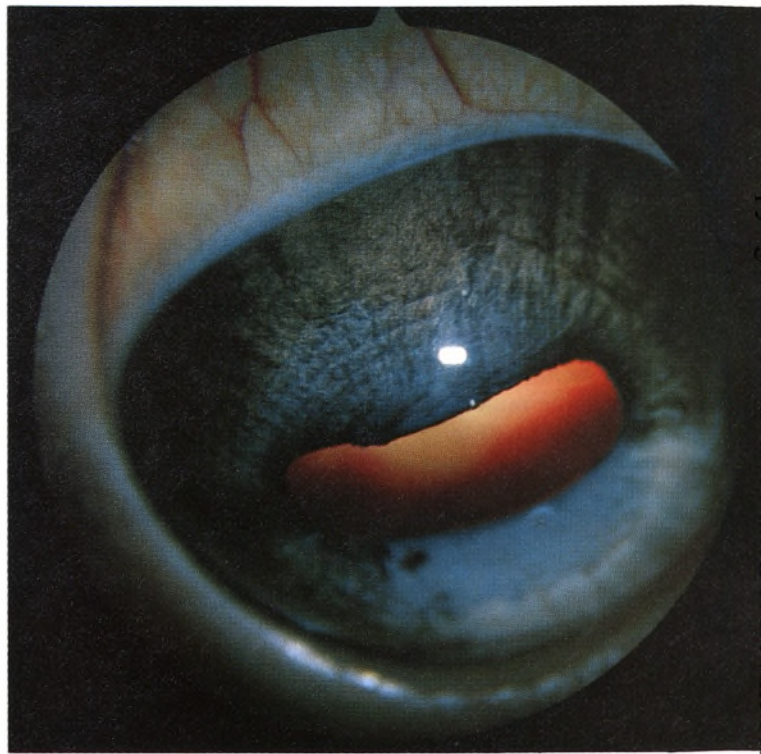


Figure 2: Iridal heterochromia with areas of grey-brown, blue and white.

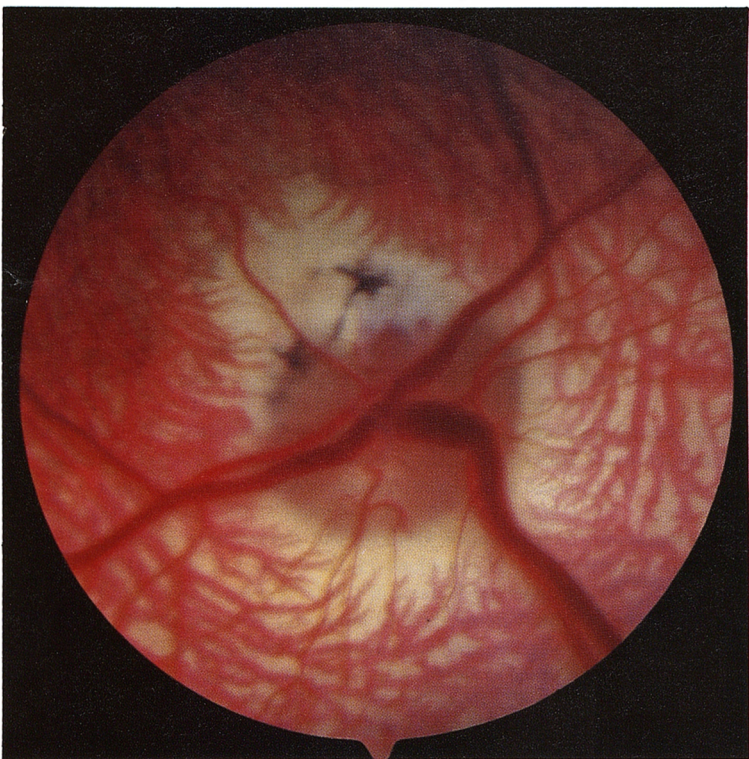


Figure 3: Ocular fundus with the tapetal fundus permitting view of the choroidal vasculature above the optic nerve head. The typical (6 o'clock position) coloboma is immediately beneath the optic nerve head and has two (2) foci of pigmentation.

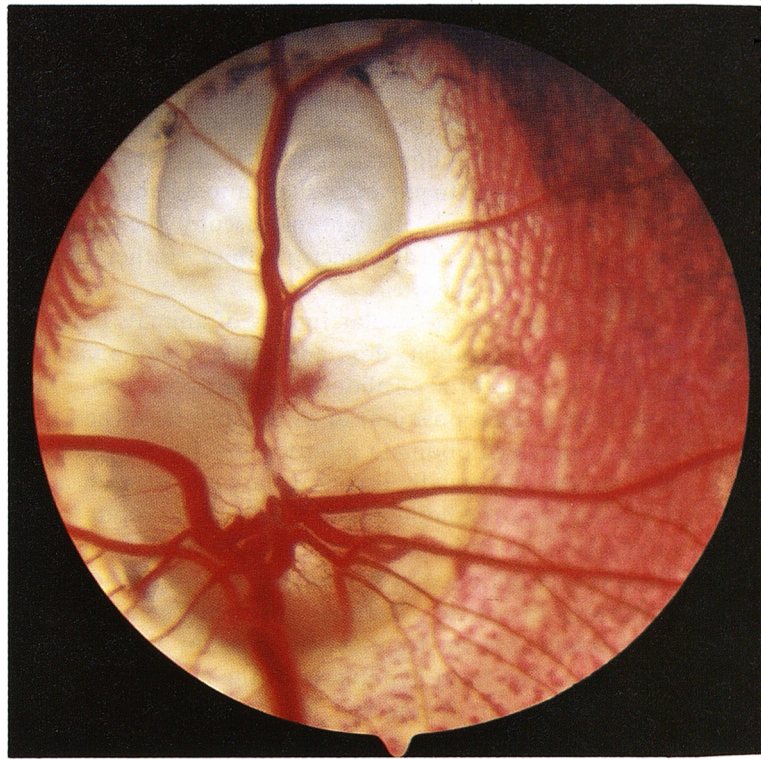


Figure 4: The large typical coloboma of the optic nerve head is traversed by a large retinal artery and vein. The coloboma has distinct borders and no overt choroidal vasculature.

nontapetal fundi were arbitrarily divided into small and large types. In the small colobomata the retina was thinned primarily by loss of photoreceptors, outer nuclear layer, and to a lesser extent the inner nuclear layer. Occasional retinal rosettes occurred in the colobomas. The retinal pigment epithelium formed occasional irregular, raised foci. There was no choroid in the coloboma, and the sclera was normal.

In the large, typical colobomata the changes of the optic nerve head, retina, choroid, and sclera were pronounced. The ventral optic nerve head was marked by irregular depressions of varying depths. In some optic nerve heads the ventral aspects were highly disorganized and multiple cysts of eosinophilic material were distributed throughout.

The retina within the large colobomata were either thickened and disorganized on a thin glial membrane. The retinal pigment epithelial layer was incomplete and replaced with occasional irregular groups of cells. The choroid was absent in the colobomata and the sclera was thinner than normal.

Discussion

Heterochromia irides in animals, which can be a variation of the normal, and associated with merling in the dog and white coat color in many species. Heterochromia irides in complete albinism in cattle, for instance in a Guernsey bull, is evidenced by a nearly white iris with a pink periphery.¹⁴ In contrast, the iris coloration in the complete albino Hereford usually is a basal white and a peripheral blue. The iridal stroma, reasonably devoid of melanocytes, accounts for the basal white.¹⁵ The blue portion about the pupil is attributed to the thin stroma (white) superimposed on the posterior iridal pigmented epithelium.

The hypoplasia of the tapetum fibrosum layer was manifested by the light yellow tapetum lucidum that was not sufficiently developed to prevent visualization of the underlying choroidal vasculature. By light microscopy, the tapetum fibrosum was only 4 to 8 microns thick, rather than the normal 10 to 50 microns.

Colobomata of the ocular fundus of animals have been described in the rabbit, dog, and cattle. Colobomata may involve the equatorial on about the optic nerve head either as typical (6 o'clock position) or as atypical (elsewhere). The ocular fundus colobomata reported in Charolais cattle are also typical and usually involved the optic nerve head.¹

Ocular fundus colobomata are believed to result from an incomplete or improper closure of the fetal or choroidal fissure of the optic cup, which occurs at about the 30th day of gestation in cattle. Retinal rosettes form in many colobomata similar to that observed in the collie eye syndrome. The focal hypoplasia of the choroid and sclera probably result from the lack of complete retinal development.

Summary

The ocular anomalies of fifteen Hereford albino cattle were observed clinically and compared with those detected histologically. Iris color ranged from blue and white to a combination of blue, white and brown or grey. The irides

were thinner than normal and permitted trans-illumination. The tapetal fundi were usually a red-yellow, and the nontapetal fundi were incompletely pigmented. Optic nerve head and nontapetal fundi colobomata varied markedly in size.

The typical colobomata of the optic nerve head and nontapetal fundi were arbitrarily divided into small and large types. In the small colobomata, the retina was thinned primarily by loss of photoreceptors, outer nuclear layer, and to a lesser extent the inner nuclear layer. There was no choroid in the coloboma, and the sclera was normal. In the large typical colobomata, changes of the optic nerve head, retina, choroid, and sclera were pronounced. The ventral optic nerve head was marked by irregular depressions of varying depths. The retina within the large colobomata were either thickened and disorganized on a thin glial membrane. The retinal pigment epithelial layer was incomplete and replaced with occasional irregular groups of cells. The choroid was absent in the colobomata and the sclera thinner than normal.

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