Bilateral Optic Disc Colobomas with Orbital Cysts and Hypoplastic Optic Nerves and Chiasm

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A 3-month-old boy with bilateral optic disc colobomas and orbital cysts is presented. Both eyes appeared relatively normal in size. Ultrasonography on one side demonstrated a communication between the globe and cyst by way of the optic disc coloboma. On computed tomography and magnetic resonance imaging, the cysts' contents were similar to vitreous. The optic nerves and chiasm appeared markedly hypoplastic on neuroimaging tests. Fluorescein angiography, electroretinography, and visual evoked responses suggested that the visual deficit primarily was ascribable to optic nerve or anterior visual pathway dysfunction.

Key Words: Optic disc coloboma—Orbital cyst—Optic nerve hypoplasia—Chiasmal hypoplasia—Microphthalmos with cyst.

A patient with bilateral optic disc colobomas and orbital cysts underwent extensive evaluation including computed tomography (CT), magnetic resonance imaging (MRI), ultrasonography, fluorescein angiography, electroretinography (ERG), and visual evoked responses (VERs). The patient's findings are most compatible with "microphthalmos with cyst," an uncommon congenital malformation. Various reports describe the evaluation of microphthalmos with cyst using ultrasonography (1), CT scan (2-6), and MRI (7). In this case we used all of these imaging modalities in combination with fluorescein angiography and electrophysiologic tests for a more complete assessment of the disorder.

CASE REPORT

A 3-month-old boy, weighing 2.5 kg at birth, was referred to the Neuro-ophthalmology Service at the University of Pittsburgh for evaluation of bilaterally poor vision. The child's mother, a healthy nondiabetic, had a normal pregnancy and denied taking any medications, illicit drugs, or alcohol during pregnancy. Forceps delivery was required because of breech presentation. Apgar scores were 3 and 5 at 1 and 5 min, respectively. Oxygen was required for ~2 h postpartum and a 3-day course of phototherapy was given for hyperbilirubinemia. The parents gradually became aware of the child's inability to follow objects visually and noted a tendency for the eyes to cross.

On examination the child appeared healthy and well developed. He was unable to maintain fixation with either eye and had ~40 prism dipters of esotropia. Extraocular movements were otherwise full and without nystagmus. Hertel measurements
were 15 mm in the right eye and 16 mm in the left with a 76 mm base. Pupils measured 3.5 mm in both eyes. Direct light stimulation led to a minimal pupillary reaction in the right eye, but no response in the left. External and slit lamp examination were normal. Intraocular pressures by pneumotonometry were ~20 mm Hg in each eye. Indirect ophthalmoscopy of each eye revealed a blond fundus with no foveal reflex. Both discs appeared hypoplastic with a deep central excavation.

Computed tomography of the head showed normal intracranial structures. The septum pellucidum was present. Orbital views demonstrated bilateral retro-orbital cysts of radiographic density comparable to the vitreous cavity (Fig. 1). Orbital sections, in both the axial and coronal planes, showed thin-walled cystic structures posterior to each globe. The cyst on the left had an internally septated appearance (not shown in Fig. 1). No extension of the cystic structures into the optic canals could be found in any section and neither optic nerve could be definitely identified within the orbit. The chiasm appeared to be smaller than normal in size.

Magnetic resonance imaging studies were obtained using both T1- and T2-weighted pulse sequences. The orbital cysts were identified posterior to each globe. At the orbital apices, short segments of the optic nerves were recognized. However, optic nerve tissue could not be identified in the vicinity of the cysts. In all pulse sequences, the orbital cysts’ contents and the vitreous cavity had similar imaging characteristics (Fig. 2).

An examination under general anesthesia was performed. Pertinent findings included the following: corneal diameter of 10 mm × 10 mm in the right eye and 8.5 mm × 8 mm in the left eye; absence of lid, iris, or lens coloboma; and presence of poorly defined nerve heads (Fig. 3). The nerve fiber layer and macula were not discernible and the vascular arcades were poorly formed. No choroidal or retinal coloboma was seen.

Fluorescein angiography showed a hypofluorescent zone in the region of the optic nerve head bilaterally. The vascular arcades were present, but the macular capillary beds were poorly formed bilaterally. Ultrasonography confirmed the presence of the orbital cysts, and a channel connecting the right globe with the cyst, by way of the optic nerve, was well demonstrated (Fig. 4). Electroretinographic responses were recorded with a Ganzfeld system and Burian-Allen electrode, amplified (Grass P-511), and then recorded by computer. Both photopic and scotopic responses were reduced but present. (Responses were about one-half of the amplitude of a normal adult). Flash VERS were absent bilaterally. (Visual evoked responses were repeated later in an awake state; again, no cortical responses were recorded.)

The child underwent pediatric, neurological, and audiologic evaluation; beyond the visual deficits, no other abnormalities were found. Chromosome analysis showed a 46 XY karyotype with no structural aberrations. In follow-up, over a 2.5-year period, the child remained blind, but otherwise developed normally.

**DISCUSSION**

In 1930, Calhoun (8) reported a case with findings that appear remarkably similar to our patient’s. Calhoun described bilateral “holes of the...
FIG. 2. Magnetic resonance scan. A (upper left): Axial $T_1$-weighted image (TR = 500 ms, TE = 20 ms). B (upper right): Axial $T_2$-weighted image (TR = 2222 ms, TE = 100 ms). The vitreous and cysts’ contents have low signal intensity on $T_1$-weighted images and bright signal intensity on $T_2$-weighted images. C (lower left): Coronal $T_1$-weighted image (TR = 800 ms, TE = 20 ms) showing the vertically oriented thin optic nerves and chiasm (white arrow). D (lower right): Sagittal $T_1$-weighted image (TR = 500 ms, TE = 50 ms) showing the right globe, cyst, and thin optic nerve segment in the posterior orbit.

disc,” bilateral optic nerve colobomas, and a cyst of the optic sheath. Our case and Calhoun’s both have unusual ocular malformations that fit into the spectrum of abnormalities found in the condition termed “microphthalmos with cyst.” In this condition there is significant variability in the degree of microphthalmos. In some cases there is severe reduction in the size of the eye; in others, the size of the eye is relatively normal. In our case, both eyes were abnormal in size; cornea diameter was borderline normal on the right and somewhat subnormal on the left.

Microphthalmos with cyst is presumed to result from abnormal closure of the embryonic fissure and is sometimes associated with other developmental defects, such as cleft lip, palate, and facies, as well as proboscis lateralis (9-14). Reports of chromosomal defects associated with bilateral microphthalmos with cyst include a deletion defect of chromosome 18, a structural defect of chromosome...
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4, trisomy 2, and the 13q deletion syndrome (15–18). No inheritance pattern has been established. However, one family with affected members in the same generation has been reported (19).

The pathology of this entity has been determined from autopsy and enucleation specimens (9,10,12,15,18–21). Typically, the wall of the cyst is composed of collagenous fibers, and an interconnection between the cyst and normal sclera is usually recognized. The cavity is usually lined with a layer of poorly differentiated neuroepithelium and neuroglial tissue. The material within the cyst ranges in appearance from totally disorganized eosinophilic debris to cells displaying varying de-

**FIG. 3.** Fundus photographs of the right and left eyes. Each disc has a thin rim of neural tissue surrounding a deep central excavation.

**FIG. 4.** Ultrasonography of each eye and retrobulbar cyst. Left (A mode below, B mode above). Behind the globe (G), a septate structure (small arrow) appears to divide the cyst (C). An extraocular muscle is seen (large arrow) at the cyst’s border. Right: A channel is apparent (arrow) at the level of the right disc, allowing communication between the right eye and cystic structure posterior to it.
degrees of differentiation, including recognizable photoreceptor elements.

Cysts probably develop when the superior end of the embryonic fissure fails to close between the 10 and 13 mm stages of embryonic development. As the edges of the embryonic fissure begin to oppose one another, one or both of the edges evert, producing a cystic structure. If both edges evert, the cyst is more likely to have a septated or lobulated appearance (22).

Computed tomography helps to define the size of the globe and cystic structure as well to differentiate the cyst from other orbital masses (2-6). It may also demonstrate unsuspected cysts or other colobomatous defects in the contralateral eye of presumed unilateral cases (2). The typical appearance of the cystic structure by CT is that of a thin-walled cavity containing a material of similar density to that of cerebrospinal fluid or vitreous.

On MRI the signal characteristics of the contents of the cystic cavity in this malformation have been reported to be similar to vitreous (7). T1- and T2-weighted images confirmed this similarity in our case. The intraorbital optic nerves at the orbital apex and the optic chiasm were well demonstrated. In addition, the hypoplastic chiasm had an unusual vertical orientation, a finding previously reported by DeMorsier in a case of septo-optic dysplasia (23,24).

Ultrasoundography revealed a direct communication between the globe and the cyst. The other imaging modalities used did not allow such a demonstration, possibly because of computer partial voluming.

In our patient, we recorded an ERG signal in each eye, but could not elicit VERs. It is likely that our patient's retinal electrophysiology was relatively normal. The appearance of the retinal vasculature was grossly normal except at the macula, and this was confirmed using fluorescein angiography and color photography. Others have reported normal ERGs in cases of optic nerve hypoplasia (25,26). On our patient's ERG, amplitudes were about one-half of the amplitude of normal adult controls. Interestingly, Francois and DeRouck (25) stress that in normal infants, the amplitudes of scotopic ERGs are much lower during the first few months than in later life.

Generally with optic nerve/anterior visual pathway hypoplasia, there is some recordable VER. The relatively normal ERG but absent VER suggests that the neuronal pathways from the optic nerve to the occipital cortex were interrupted, most likely by the severe maldevelopment of the optic nerve. A possible explanation for this may be that the optic nerves were at one time present during fetal development but subsequently atrophied as a result of mechanical pressure by the enlarging retrobulbar cysts. A second hypothesis is that the optic nerves are small because the majority of the axonal fibers of the ganglion cells extended into the cystic cavity rather than along the optic stalk. Finally, the hypoplasia of the optic nerve and chiasm could have resulted from an accelerated or exaggerated degeneration of supernumerary retinal ganglion cell axons. While this process, also termed apoptosis, is part of normal ocular embryogenesis (27-29) its exaggerated occurrence has been proposed as a cause of optic nerve hypoplasia.

REFERENCES


