

Tonic pupil with giant cell arteritis

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SUMMARY A patient with giant cell arteritis and ischaemic optic neuropathy developed bilateral tonic pupils. This pupillary abnormality may result from ischaemia of the ciliary ganglia. Despite the propensity for patients with giant cell arteritis to develop vascular occlusions in the eye and orbit, tonic pupils have rarely been described, and several reasons for this are proposed. The arteries supplying the ciliary ganglia are frequently involved in giant cell arteritis, but their anastomotic pattern may confer protection from ischaemia. Tonic pupils may also be overlooked amidst the more dramatic manifestations of giant cell arteritis.

Damage to the ciliary ganglion or its postganglionic fibres produces characteristic signs.¹ These include: (1) a poor pupillary reaction to light, often with segmental paralysis of the iris sphincter; (2) a pupillary response to near vision that is often disproportionately better than the response to light; (3) accommodative paresis; and (4) supersensitivity of the denervated muscles to cholinergic stimulation.

Any pupil showing these features is often termed an 'Adie's pupil.' This is both historically incorrect² and frequently misleading. Far more useful is the term 'tonic pupil' and the classification adopted by Thompson³:

1. *Local tonic pupils*—where ocular or orbital disease produce denervation of the iris sphincter, often as an incidental feature of the disease (e.g., varicella infection, orbital trauma, orbital tumour).

2. *Neuropathic tonic pupils*—postganglionic parasympathetic denervation is part of a generalised neuropathic condition where widespread peripheral or autonomic neuropathy happens to involve the short ciliary nerves (e.g., diabetic, alcoholic, or hypertrophic neuropathy, syphilis, Miller-Fisher syndrome).

3. *Idiopathic tonic pupils or tonic pupils of obscure origin (Adie's syndrome)*—unassociated with neurological deficits other than impaired muscle stretch reflexes.

The spectrum of diseases that can produce a tonic pupil is enormous. However, with the exception of a brief report by Davis *et al.*⁴ we can find no mention in

the literature of the tonic pupil as a complication of giant cell arteritis (GCA). This is surprising in view of its propensity for ocular and orbital involvement.

We present a patient who developed bilateral tonic pupils as a manifestation of GCA and suggest an anatomical basis for the apparent rarity of this complication.

Case report

A 63-year-old previously healthy woman developed left temporo-occipital headache in October 1980. The pain was dull, not throbbing, constant, and accompanied by neck stiffness. During the following 2 months she experienced several episodes of severe pain in the left temporomandibular area, radiating into the left maxilla and exacerbated by chewing. Consultation with 2 dentists and a physician and a set of plain skull radiographs did not provide a diagnosis. In early December 1980 the scalp blood vessels in both temporal regions became prominent and pulsating but were not tender. Soon after this she saw a bright flash of light in front of the left eye and a 'grey blurry disc' appeared, obscuring vision. Vision failed over the next 48 hours and she sought medical help.

Examination showed visual acuity of 20/20 OD and hand motions at 3 feet (90 cm) OS in a small superior island of visual field. There was a left relative afferent pupillary defect. Slit-lamp examination results and intraocular pressure were normal. There was slight limitation of abduction of the left eye, but ocular motility was otherwise normal. The right fundus was normal. The left optic disc was pale and oedematous,

and the retina between the optic disc and the macula appeared infarcted. The clinical impression of ischaemic optic neuropathy and cilioretinal artery occlusion was supported by fluorescein angiography, which showed delayed filling of the cilioretinal artery in the left eye and patchy delay in choroidal filling at the posterior pole. The erythrocyte sedimentation rate (ESR) was 35 mm/h. Computerised tomographic scan, plain skull radiographs, and neurological examination were normal. A diagnosis of giant cell arteritis was made without temporal artery biopsy.

She was treated with prednisone 100 mg daily for 2 weeks, and the dose was tapered over the next 2 months. During the final 3 weeks of therapy while taking a small dose of prednisone the patient's headaches and neck pain returned. Two days after stopping prednisone she noted clouding of vision in the inferonasal quadrant of the visual field OD. She immediately started treating herself with 100 mg of prednisone a day, but vision OD continued to fail. Four days later the acuity was 2/200 OD in a temporal island, and no light perception OS. Pupils were sluggishly reactive to light OD and fixed to light OS, with good near responses OU. Intraocular pressure was 12 mm OU, and slit-lamp examination was normal. Eye movements were full. There was pale oedema of the disc OD, which leaked dye on fluorescein angiogram. The fundus was otherwise normal. The disc OS was pale and cupped. General and neurological examinations were normal. ESR (Westgren) was 8 mm/h, but a temporal artery biopsy taken 5 days after the onset of visual loss OD showed changes typical of giant cell arteritis.

The prednisone dosage was slowly reduced to 20 mg a day over 4 weeks. At this time acuity in the right eye was 8/100 and the temporal island of the visual field had expanded slightly. The intraocular pressure was 18 mm OD and 23 mm OS. Both pupils were 5 mm with a very slight light reaction OD and none OS. An excellent near response, however, was present in each eye, with segmental iris contractions. Slit-lamp examination was normal, with no evidence of inflammation, iris atrophy, or neovascularisation. Testing with 1/12% pilocarpine showed evidence of denervation supersensitivity OU (marked pupillary constriction within 1/2 hour).⁵

Over the next 6 months the patient's intraocular pressures rose to 30 mm OD and 44 mm OS. The disc OS showed more cupping. Treatment with timolol OD and timolol and pilocarpine OS was commenced and prednisone therapy continued at 20 mg per day.

By April 1982, 15 months after the second episode of ischaemic optic neuropathy, the right pupil was round, normal in diameter with brisk light and near reactions, and no segmental contraction. It still showed marked constriction to 1/12% pilocarpine.

The left pupil received 1% pilocarpine drops therapeutically and was small.

Discussion

The complications of giant cell arteritis result from ischaemia produced by obliterative granulomatous arteritis.⁶⁻⁸ There appears to be a close correlation between susceptibility to GCA and the amount of elastic tissue in the media and adventitia of the individual arteries of the head and neck.⁹ Thus there is a very high incidence of severe inflammation of the superficial temporal artery, extradural vertebral artery, and ophthalmic and posterior ciliary arteries. The internal carotid, external carotid, and central retinal arteries are less commonly involved, and there are only infrequent reports of intracranial artery involvement.^{9,10}

The predilection of GCA to affect orbital arteries is clinically well documented.^{6,11-14} Ocular involvement occurs in 40-50% of cases.^{6,15,16} Visual failure is the commonest and most feared manifestation, and if untreated becomes bilateral in 30-70% of cases.^{6,17-19} Transient ophthalmoplegia may be present in up to 15% of cases.^{15,16} Anterior segment ischaemia,^{6,14} ocular hypotony,²⁰ and orbital oedema and maxillary sinus oedema²¹ are also recorded as complications of orbital involvement.

Visual loss is usually due to ischaemic optic neuropathy from involvement of the short posterior ciliary arteries and branches of the ophthalmic artery.^{6,12,15,22} It is less commonly due to involvement of the retrobulbar central retinal artery^{6,9} or to infarction of the occipital cortex.⁹ Anterior ocular ischaemia and marginal corneal ulceration occur with involvement of the long posterior ciliary and anterior ciliary arteries, both terminal arteries of the muscular branches of the ophthalmic artery.^{6,14,23,24}

In contrast to the frequent and permanent visual loss in GCA, ophthalmoplegia is infrequent and often transient.²⁵ The reasons for this may also help explain the infrequency with which the tonic pupil is reported in GCA. The occurrence of transient diplopia in GCA may reflect transient ischaemia of the ocular muscles^{26,27} rather than of the ocular motor nerves.^{9,28,29} In the only complete pathological study of the ocular motor system in a patient with ophthalmoplegia from GCA, Barricks *et al.*²⁷ demonstrated ischaemia of all the extraocular muscles. Both ophthalmic arteries were occluded. The smaller orbital arteries, including the posterior ciliary and extraocular muscular branches of the ophthalmic artery, were consistently the site of granulomatous inflammation, and many were occluded by ante-mortem thrombus. It is these arteries that are the basis of the blood supply to the ciliary ganglion. The

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smallest calibre vessels were not involved. The extramuscular nerves and their smaller intramuscular branches appeared normal.

Barricks *et al.*²⁷ noted that the normal vasculature of the external ocular muscles is rich and anastomotic. This anatomical situation may account for the infrequency and transient nature of ophthalmoplegia in GCA, since widespread involvement of many arterial branches is needed to produce muscle ischaemia. We believe that a similar anastomotic pattern in part explains the infrequency of observations of tonic pupil in GCA.

The vascular system of the ciliary ganglion has been exquisitely detailed by Eliskova in 18 orbits.³⁰ The ganglion is supplied by one to 4 branches from neighbouring arteries, which include the posterior lateral ciliary artery (11 cases); the trunk of the lateral muscular artery, its small branches supplying the lateral and inferior rectus muscles (11 cases); special branches of the ophthalmic artery which supply blood to the retrobulbar space (7 cases); the central retinal artery (3 cases); and the vascular network of the optic nerve (2 cases).

The branches from the posterior ciliary artery supply the anterior half of the ganglion. Branches from the muscular trunk enter the lateral aspect of the ganglion, while those from the central retinal artery enter medially. The arteries of the ciliary ganglion also frequently supply blood to the short ciliary nerves and the inferior ramus of the oculomotor nerve. One ganglion may have up to 3 arterial sources and up to 4 individual branches (see Table 1).

The arteries supplying branches to the ciliary ganglion are all frequently involved in GCA. However, the presence of an anastomotic blood supply may confer protection from infarction or clinically recognisable damage. If ischaemia does occur it may be transient or reversible. In our patient there was both transient ophthalmoplegia and recovery of function in the tonic pupils. The pupils showed segmental iris contractions and evidence of aberrant regeneration (light-near dissociation)¹ after 4 months, and by 15 months the only evidence of ciliary ganglion or postganglionic fibre damage was denervation supersensitivity to 1/12% pilocarpine.

Regional corneal anaesthesia is another feature of damage to the ciliary ganglion and short ciliary nerve and is seen in most patients with Adie's tonic pupils.³¹ It is interesting to note that there are also occasional

reports of altered corneal sensation without obvious anterior segment ischaemia in GCA.³² The infrequency of these reports may again reflect protection of the ciliary ganglion from severe ischaemia.

An anastomotic blood supply does not seem sufficient to account for the remarkable infrequency with which tonic pupils are recorded in GCA. Just as ophthalmoplegia of any degree may be obscured by the more dramatic symptoms of severe visual loss, so a tonic pupil may be even more easily overlooked. Unless testing for denervation supersensitivity is performed, a dilated, poorly responsive pupil (even when unilateral) may be ascribed too readily to 'poor visual function' or to coexistent disease. It is likely that the tonic pupil is a more frequent manifestation of giant cell arteritis than previously recognised and that it is often overlooked.

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Table 1 Frequency of branches supplying ciliary ganglion

| No. of branches to one ganglion | 1 | 2 | 3 | 4 |
|---------------------------------|---|----|---|---|
| No. of cases | 5 | 10 | 2 | 1 |

From Eliskova.³⁰

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