ORIGINAL ARTICLE

The Evolution of an Optic Nerve Head Granuloma Due to Sarcoidosis

S. J. Hickman^a, F. Quhill^b, and I. M. Pepper^b

^aDepartment of Neurology, Royal Hallamshire Hospital, Sheffield, UK; ^bDepartment of Ophthalmology, Royal Hallamshire Hospital, Sheffield, UK

ABSTRACT

Sarcoidosis can affect the optic nerves by means of optic disc oedema secondary to posterior uveitis, optic disc oedema secondary to raised intracranial pressure, optic neuritis, optic atrophy secondary to compression or infiltration from a primary central nervous system lesion, and primary granuloma of the optic nerve head. The authors report the use of optical coherence tomography in assessing the response to immunosuppression in a 57-year-old woman with an optic nerve head granuloma.

ARTICLE HISTORY

Received 30 November 2015
Accepted 18 December 2015

KEYWORDS

Neurosarcoidosis; optic nerve; retinal oedema; optical coherence tomography; corticosteroids

Case

A 57-year-old woman presented with a 2-week history of floaters and intermittent blurred vision in both eyes that had become constant on the day of admission. She had a 16-year history of sarcoidosis. She initially presented with chest pain and was found to have hilar lymphadenopathy on a chest radiograph. The diagnosis was confirmed histologically on trans-bronchial biopsy. She had had an episode of vertigo 6 years after this and was found to have a positive antinuclear antibody at this time. She had been maintained since on hydroxychloroquine.

On examination, her visual acuity was 6/24 in her right eye and 6/18 in her left eye. She could only read the test plate of the Ishihara plates with each eye. She had an enlarged right blind spot. She had bilateral vitreous cells. She had a swollen left optic disc with haemorrhages. Her right optic disc was swollen and haemorrhagic, was infiltrated with an optic nerve head and peripapillary granuloma, and was surrounded by retinal thickening (Figure 1). Spectral-domain optical coherence tomography (OCT) demonstrated the granuloma, but also intra-retinal oedema, pinpoint hyper-reflective dots suggestive of inflammatory cells,

subretinal fluid, and vitreous cells. The neurological examination was otherwise normal.

Post-gadolinium magnetic resonance imaging revealed numerous small areas of enhancement within the parenchyma of both cerebral hemispheres, particularly in the region of the centrum semiovale, and subtle enhancement of the right optic nerve. At lumbar puncture she had an opening pressure of 25 cm of cerebrospinal fluid (CSF). The CSF contained $17 \times 10^6/L$ white blood cells (100% lymphocytes), 0.53 g/L protein and 3.0 mmol/L glucose compared with a serum glucose of 4.2 mmol/L. There were no oligoclonal bands in either the CSF or serum. A chest radiograph was unremarkable.

A diagnosis of neurosarcoidosis was made with a right optic nerve head and peripapillary granuloma and left optic disc oedema. She was treated initially with 3 days of 1 g per day intravenous methylprednisolone, followed by a slowly reducing taper of oral prednisolone and the subsequent addition of weekly oral methotrexate.

One month after presentation her visual acuity was 6/18 in each eye. She could still only see the test plate of the Ishihara plates with her right eye but could see 5/17 with her left eye. The right optic nerve head granuloma had shrunk considerably,

CONTACT Dr. Simon J. Hickman ✉ simon.hickman@sth.nhs.uk ☎ Consultant Neurologist, Department of Neurology, Royal Hallamshire Hospital, Glossop Road, Sheffield S10 2JF, United Kingdom.

Color versions of one or more of the figures in the article can be found online at www.tandfonline.com/ioph

© 2016 Taylor & Francis

Figure 1. (a) Right fundus at presentation, demonstrating optic disc swelling and haemorrhage, an optic nerve head and peripapillary granuloma, and retinal thickening. (b) Spectral-domain OCT image confirming the presence of the granuloma (arrow), pinpoint hyper-reflective dots suggestive of inflammatory cells (arrowhead), retinal oedema, sub-retinal fluid (*), and vitreous cells.

Figure 2. (a) Right fundus 1 month after commencement of treatment, demonstrating resolution of the optic disc swelling, partial resolution of the granuloma and retinal thickening, but the development of a partial macular star. (b) Spectral-domain OCT image showing less prominence of the granuloma (upward arrow), but ongoing sub-retinal fluid (+) and an epiretinal membrane (downward arrow).

with some resolution of the intra-retinal oedema and sub-retinal fluid, but a partial macular star had formed, as had an epiretinal membrane (Figure 2). There was only mild residual left optic disc swelling.

By 5 months, her visual acuity was 6/12+2 (7/17 of the Ishihara plates) in her right eye and 6/9 (8/17 of the Ishihara plates) in her left eye. The granuloma had virtually disappeared, and there had been resolution of the intra-retinal oedema and sub-retinal fluid, although she had developed optic disc pallor and presumed inner retinal atrophy (Figure 3). The left optic disc was now mildly atrophic.

By 14 months her visual acuity was 6/9–2 (12/13 of the Ishihara plates) in her right eye and 6/9

–1 (11/13 of the Ishihara plates) in her left eye. The granuloma had completely disappeared, although the inner retinal atrophy had become more pronounced (Figure 4).

Discussion

Sarcoidosis has a propensity to involve the eyes. Ocular involvement has been reported in 21–80% of cases^{1,2} with ocular manifestations including episcleritis, iris nodules, anterior uveitis, intermediate uveitis, panuveitis, cataract, vitreous opacities, epiretinal membrane, retinal vasculitis, branch retinal vein occlusions, and multifocal choroiditis.^{1,3} Neuro-

Figure 3. (a) Right fundus 5 months after commencement of treatment, demonstrating optic disc pallor and near complete resolution of the granuloma. (b) Spectral-domain OCT image showing resolution of the retinal thickening and sub-retinal fluid but the development of presumed inner retinal atrophy (*).

Figure 4. (a) Right fundus 14 months after commencement of treatment, demonstrating optic disc pallor and complete resolution of the granuloma. (b) Spectral-domain OCT image showing the development of more inner retinal atrophy (*).

ophthalmological sarcoidosis has been reported to cause cranial neuropathies, Horner's syndrome, tonic pupil, and anterior and posterior optic pathway disease.⁴

Ingestad and Stigmar divided optic nerve involvement due to sarcoidosis into five categories: optic disc oedema secondary to posterior uveitis; optic disc oedema secondary to raised intracranial pressure; optic neuritis; optic atrophy secondary to compression or infiltration from a primary central nervous system lesion; and primary granuloma of the optic nerve head.⁵

In this case there was left optic neuritis and a right optic nerve head and peripapillary granuloma. The granuloma was associated with marked retinal oedema, a cellular retinal infiltrate, and sub-retinal fluid, visible on OCT. This proved to be steroid responsive, with resolution of the granuloma and retinal changes and improvement in vision but the development of inner retinal atrophy.

Previous cases reported in the literature in English of optic nerve head granuloma are listed in the Table 1.^{4–28} The reports were found by entering “optic nerve head granuloma” in MEDLINE and by review of the reference lists of the identified reports. Review of the 34 cases identified, including the present case, reveals that the mean age at presentation was 34 years (range: 11–59) with an equal gender mix of 17 males and 17 females. Of the 15 cases where racial origin was reported, there were 10 Black/African American cases (66.7%), 3 White Caucasian cases (20%), and 2 South Asian cases (13.3%). Twenty-seven cases (79.4%) were unilateral and 7 (20.6%) had bilateral optic nerve head granulomas at presentation. The optic nerve head granuloma was the first presentation of sarcoidosis in 23/34 of the cases (67.6%), although, when

reported, 16/19 (84.2%) had extra-ocular manifestations of the disease. The presenting visual acuity was 20/20 or better in 11/41 (26.8%) affected eyes and 20/200 or worse in 11/41 (26.8%). There were additional ocular features of sarcoidosis in 37/41 (90.2%) of the affected eyes.

Histological examination of an involved optic nerve head from a case that required enucleation after the development of painful anterior uveitis and secondary glaucoma showed non-caseating granulomatous inflammation protruding forward through the scleral canal with an overlying retinal detachment.¹⁷ In a further case following enucleation the optic nerve head anterior to the lamina cribrosa was oedematous with a large nodule of epithelioid cells and lymphocytes adjacent to the outer nuclear layer of the retina. A further nodule was present in the centre of the optic cup. Near the optic nerve head the retinal vessels were markedly distended with numerous haemorrhages.⁷ In an autopsy case, the optic nerve head and surrounding retina were heavily infiltrated by a non-necrotising granulomatous reaction extending from the inner retinal layers and the surface of the optic disc into the vitreous. This was associated with lymphocytic and neutrophilic perivascular infiltration as well as non-caseating epithelioid cell nodules and giant cells. There was also prominent folding of the peripapillary retina.¹⁵

The type of treatment was reported in 29 of the cases. The vast majority (23/29, 79.3%) were treated with corticosteroids, with 3/29 (10.3%) receiving additional immunosuppression with methotrexate. Three older cases did not receive any treatment. Outcome visual acuity was recorded for 27/41 affected eyes, with 10/27 (37.0%) recovering to 20/20 or better, but 9/27 (33.3%) were 20/200 or worse at last follow-up.

Table 1. Previous case reports and case series of optic nerve head granuloma due to sarcoidosis.

Study	Age in years, gender, and racial origin (where stated)	Unilateral or bilateral granulomas	Previous diagnosis of sarcoidosis	Initial visual acuity	Additional ocular features apart from the granuloma	Extra-ocular clinical features of sarcoidosis	Treatment	Length of follow-up	Final visual acuity
Goldberg and Newell, 1944 ⁶	24, male, African American	Unilateral	No	20/50	New vessels, subhyaloid, macular, and peripheral haemorrhages, and irregular constricted veins	Parotid gland enlargement, generalised and hilar lymphadenopathy	None	5 months	20/30
Laval, 1952 ⁷	48, female, White Caucasian	Unilateral	No	PL	Anterior chamber cells, posterior synechiae, distended retinal blood vessels, retinal haemorrhages, retinal nerve fibre layer oedema, and retinal nodules	None	None	None - enucleated on presentation	PL
Brunste, 1958 ⁸	35, male	Bilateral	No	6/6 OU	Pigmented precipitates on posterior corneal surfaces, white excrescences of the irises, and moderate venous congestion OU	Hilar lymphadenopathy	Corticotropin	1 year	6/18 OD, "normal" OS
Kojima, 1969 ⁹	11, male	Unilateral	Yes	0.06	Macular star and venous thrombosis	Chest—type of involvement not stated	Oral steroids, and vitamins B ₁ and E	1 year	0.9
Ingestad and Stigmar, 1970 ⁵	26, male	Unilateral	No	0.1	Venous congestion, macular oedema and periarterial "yellow spots" with later haemorrhages, exudates, small vessel sheathing, and posterior vitreous detachment	Lung infiltrates and hilar lymphadenopathy, then later parotid swelling and diabetes insipidus	Prednisolone	20 months	NPL
Lattes and Scheie, 1970 ¹⁰	25, female, African American	Unilateral	No	6/6	Small vessels on surface of granuloma, haemorrhages, and whitish deposits on retinal veins	Lung interstitial fibrosis and hilar lymphadenopathy	None	8 months	6/6
	37, male, African American	Unilateral	Yes	"Blind"	None	Epilepsy and hilar lymphadenopathy	Steroids	4 years	Not stated—patient died due to status epilepticus
Jampol et al., 1972 ¹¹	29, female, African American	Bilateral	Yes	20/20 OU	Peripapillary retinal folds, distended retinal veins OU and a single retinal haemorrhage OS	Left lung infiltrate, cervical and hilar lymphadenopathy	Prednisone	3 months	Not stated

(Continued)

Table 1. (Continued).

Study	Age in years, gender, and racial origin (where stated)	Unilateral or bilateral granulomas	Previous diagnosis of sarcoidosis	Initial visual acuity	Additional ocular features apart from the granuloma	Extra-ocular clinical features of sarcoidosis	Treatment	Length of follow-up	Final visual acuity
Kelley and Green, 1973 ¹²	31, male, African American	Unilateral	Yes	PL	New vessels and peripapillary choroiditis, with later uveitis, synechiae, cataract, and glaucoma	Headaches, left lateral rectus palsy, enlarged parotid glands, left-sided neural deafness, cervical and hilar lymphadenopathy	Steroids	15 years	NPL and enucleated
Turner et al., 1975 ¹³	29, female, White Caucasian	Bilateral	Yes	6/12 OD 6/9 OS	OD: Dilated capillaries, engorged retinal veins, candle-wax spots; cotton wool spots, haemorrhages, peripheral venous sheathing, and macular oedema OS: Dilated capillaries, engorged retinal veins, candle-wax spots, two small discrete retinal lesions, and nerve fibre bundle defects	Papular erythema of the legs, fever, polyarthralgia, facial palsy, knee effusions, hypercalciuria, and hilar lymphadenopathy	Prednisone then dexamethasone	9 months	Not stated
Burns, 1976 ¹⁴	22, female, African American	Unilateral	Yes	20/200	Localized exudative apparent retinal detachment and sub-retinal haemorrhages	Amenorrhoea, polydipsia, polyuria, polyphagia, skin nodules, supraclavicular and hilar lymphadenopathy	Prednisone	4, months	20/15
Gass and Olson, 1976 ¹⁵	41, male	Bilateral	Yes	20/25 OD NPL OS	OD: Vitreous cells, retinal exudates and haemorrhages OS: Keratic precipitates, aqueous ray, posterior synechiae, and cataract	Epilepsy, ataxia, nystagmus, personality change, right-sided facial weakness, skin nodules, and an abnormal chest radiograph	Triamcinolone	20 months	20/80 OD NPL OS—patient died due to status epilepticus following an assault
Lustgarten et al., 1983 ¹⁶	32, female, African American	Unilateral	No	20/30 worsening to NPL	Initial swelling and papillophlebitis, then CRVO, increased granuloma size, and vitreous opacities	None	Prednisone	13 months	NPL

(Continued)

Table 1. (Continued).

Study	Age in years, gender, and racial origin (where stated)	Unilateral or bilateral granulomas	Previous diagnosis of sarcoidosis	Initial visual acuity	Additional ocular features apart from the granuloma	Extra-ocular clinical features of	Treatment	Length of follow-up	Final visual acuity
Beardsley et al., 1984 ¹⁷	23, male	Unilateral	No	20/200 worsening to 20/400	Vitreous opacities, peripapillary retinal detachment, perivenous exudates, and cotton-wool spots	Hypercalciuria and hilar lymphadenopathy	Prednisone	9 months	20/20
	16, male	Unilateral	No	HM worsening to NPL	Vitreous opacities, peripapillary serous retinal detachment, and perivascular exudates, with later severe anterior uveitis and secondary glaucoma	Hilar lymphadenopathy	Periocular triamcinolone and prednisone	9 months	NPL and enucleated
	24, female	Unilateral	No	20/20	Flare and cells in the anterior chamber, exudates extending along the retinal blood vessels with overlying vitreous debris	Malar skin eruption	Prednisone and isoniazid	18 months	20/15
	33, male	Bilateral	No	20/25 OU worsening to 20/40 OU	None	Hepatosplenomegaly, diffuse interstitial pulmonary markings, hilar and right paratracheal lymphadenopathy	Prednisone	4 months	20/40 OU
Karma and Mustonen, 1985 ¹⁸	42, female	Unilateral	Yes	1.0 worsening to 0.1	Initial nodular uveitis then iris granulomas, dilated leaking capillaries, nodes on the lower temporal vein and along scar margins of healed granulomas in the peripheral retina. Later vitreous opacification	Skin purple plaques, joint symptoms, liver dysfunction, and hilar lymphadenopathy	Prednisone	3 years	0.1
	35, female	Unilateral	Yes	1.0 worsening to CF	Initial lacrimal gland enlargement, corneal keratic precipitates, peripapillary iris atrophy, vitreous cells and snowball-like opacities, candle-wax exudates, and chorioretinitic lesions in the lower periphery. Later serous retinal detachment	Epilepsy, lupus pernio, submandibular gland enlargement, lung infiltration, and hilar lymphadenopathy	Prednisone	2 years	CF

(Continued)

Table 1. (Continued).

Study	Age in years, gender, and racial origin (where stated)	Unilateral or bilateral granulomas	Previous diagnosis of sarcoidosis	Initial visual acuity	Additional ocular features apart from the peripapillary retina	Extra-ocular clinical features of sarcoidosis	Treatment	Length of follow-up	Final visual acuity
Katz et al., 1991 ¹⁹	56, female	Unilateral	No	20/50	Fullness of the peripapillary retina	Middle cranial fossa gadolinium-enhancing mass on MRI	Corticosteroids	Not stated	Not stated
Sivakumar and Chee, 1998 ²⁰	41, male, South Asian	Unilateral	No	6/18	RAPD, keratic precipitates, anterior chamber cells, flare, retrolental cells, vitritis, snowballs, and focal retinal vasculitis with perivascular sheathing	Hilar lymphadenopathy	IVMP followed by prednisolone	2 years	6/6
Farr et al., 2000 ²¹	31, female, African American	Unilateral	No	20/25 worsening to 20/400	Conjunctival nodules and haemorrhages peripheral to the granuloma	Hilar lymphadenopathy	Prednisone	18 months	20/25
Asensio Sanchez et al., 2003 ²²	59, male	Unilateral	No	0.6	Macular folds	⁶⁷ Gallium uptake in the lungs and lacrimal glands	Prednisone	1 year	Not stated
Frohman et al., 2003 ²³	50, female	Unilateral	No	NPL	Periphelebitis and macular exudate	Not stated	Not stated	Not stated	Not stated
	30, female	Bilateral	No	20/20 OU	Busacca nodules OU	Not stated	Not stated	Not stated	Not stated
	32, female	Unilateral	No	20/70	Lacrimal gland enlargement, ptosis, uveitis, vitreous snowballs, and optic disc shunt vessels	Not stated	Not stated	Not stated	Not stated
Ismail et al., 2005 ²⁴	40, male, Malay	Unilateral	No	6/24	Mild anterior chamber reaction, moderate vitritis with a few snowballs and vitreous strands, tortuous retinal vessels with sheathing of the superior branch of the retinal vein, and multiple yellow-white choroidal lesions in the peripheral retina	⁶⁷ Gallium uptake in the right lacrimal gland with "Panda sign"	Topical dexamethasone and prednisolone	Not stated	6/6
Al-Jamal and Kivelä, 2008 ²⁵	27, male	Unilateral	No	0.33 worsening to CF	Vitreous opacities and an exudative retinal detachment	Lung infiltrates and hilar lymphadenopathy	IVMP followed by prednisolone	1 year	0.1
Jafferji and Biswas, 2008 ²⁶	49, female	Unilateral	No	6/24	Hard exudates, optic nerve head vascular tortuosity with haemorrhages, and pars plana exudates	None	IVMP followed by prednisolone and methotrexate	24 months	6/5

(Continued)

Table 1. (Continued).

Study	Age in years, gender, and racial origin (where stated)	Unilateral or bilateral granulomas	Previous diagnosis of sarcoidosis	Initial visual acuity	Additional ocular features apart from the granuloma	Extra-ocular clinical features of sarcoidosis	Treatment	Length of follow-up	Final visual acuity
Koczman et al., 2008 ⁴	24, male, African American	Unilateral	No	20/25	Keratoconjunctivitis sicca and panuveitis	Testicular involvement and hilar lymphadenopathy	IV corticosteroids then prednisone and methotrexate	Not stated	20/15
Moschos and Gueux-Crosier, 2008 ²⁷	19, male, Black	Bilateral	No	1.0 OD 0.8 OS	OD: No other changes OS: Corneal keratic precipitates, iris nodule, optic disc leakage, and multifocal choroidal lesions	Hilar lymphadenopathy	Not stated	Not stated	Not stated
Goldberg et al., 2014 ²⁸	41, female	Unilateral	Yes	CF	Infiltrative lesion on the choroid with thickening of peripapillary retina and attenuation of the photoreceptor ellipsoid zone on OCT	Not stated	Not stated	Not stated	Not stated
	38, male	Unilateral	No	20/50	Vitritis and cotton wool spots with retinal oedema on OCT	Not stated	IVMP followed by prednisone	6 weeks	20/20
Present case	57, female, White Caucasian	Unilateral	Yes	6/24	Vitreous cells, intra-retinal oedema, retinal inflammatory infiltrate, and sub-retinal fluid	Vertigo and hilar lymphadenopathy	IVMP followed by prednisolone and methotrexate	14 months	6/9–2

Note. CF = counting fingers; CRVO = central retinal vein occlusion; HM = perception of hand movements; IV = intravenous; IVMP = intravenous methylprednisolone; MRI = magnetic resonance imaging; NPL = no perception of light; OCT = optical coherence tomography; PL = perception of light; RAPD = relative afferent pupillary defect.

Poor recovery was associated primarily with additional ocular pathology such as uveitis,^{7,12,15,17,18} central retinal vein occlusion,¹⁶ and retinal detachment,^{18,25} with only one case of poor outcome directly due to the optic nerve head granuloma.⁵

There was been one other report of the use of OCT to investigate optic nerve head granuloma.²⁸ In the two cases reported, the granulomas were associated with peripapillary retinal oedema, as in the present case, although one of these cases had choroidal inflammation as well. Follow-up OCT was carried out after 12 months in one case demonstrating normalisation of the peripapillary outer retinal layers and decreased optic nerve head height with the development of optic nerve head gliosis. OCT is therefore a useful tool for demonstrating the additional retinal pathology that is usually present with optic nerve head granulomas in sarcoidosis and for monitoring the response to treatment, since visual outcome in these cases seems principally related to the additional ocular features of sarcoidosis rather than direct effects of the optic nerve head granuloma itself.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

References

- [1] Lee SY, Lee HG, Kim DS, Kim J-G, Chung H, Yoon YH. Ocular sarcoidosis in a Korean population. *Korean Med Sci* 2009;24:413–419.
- [2] Ohara K, Okubo A, Sasaki H, Kamata K. Intraocular manifestations of systemic sarcoidosis. *Jpn J Ophthalmol* 1992;36:452–457.
- [3] Pefkianaki M, Androudi S, Praidou A, Sourlas V, Zakynthinos E, Brazitikos P, Gourgoulisanis K, Daniil Z. Ocular disease awareness and pattern of ocular manifestation in patients with biopsy-proven lung sarcoidosis. *J Ophthalm Inflamm Infect* 2011;1:141–145.
- [4] Koczman JJ, Rouleau J, Kardon RH, Wall M, Lee AG. Neuro-ophthalmic sarcoidosis: the University of Iowa experience. *Semin Ophthalmol* 2008;23:157–168.
- [5] Ingestad R, Stigmar G. Sarcoidosis with ocular and hypothalamic pituitary manifestations. *Acta Ophthalmologica* 1971;49:1–10.
- [6] Goldberg S, Newell FW. Sarcoidosis with retinal involvement. *Arch Ophthalmol* 1944;32:93–96.
- [7] Laval J. Ocular sarcoidosis. *Am J Ophthalmol* 1952;35:551–554.
- [8] Brunste E. Ocular sarcoidosis: report of five cases with fundus changes. *Dan Med Bull* 1958;5:217–227.
- [9] Kojima K. Fundus involvement in sarcoidosis. *J Clin Ophthalmol* 1969;23:790–793.
- [10] Laties AM, Scheie HG. Sarcoid granulomas of the optic disk: evolution of multiple small tumors. *Trans Am Ophth Soc* 1970;68:219–233.
- [11] Jampol LM, Woodfen W, McLean EB. Optic nerve sarcoidosis. *Arch Ophthalmol* 1972;87:355–360.
- [12] Kelley JS, Green WR. Sarcoidosis involving the optic nerve head. *Arch Ophthalmol* 1973;89:486–488.
- [13] Turner RG, James DG, Friedmann AI, Vijendram M, Davies JPH. Neuro-ophthalmic sarcoidosis. *Br J Ophthalmol* 1975;59:657–663.
- [14] Burns CL. Unusual ocular presentation of sarcoidosis. *Ann Ophthalmol* 1976;8:69–71.
- [15] Gass JDM, Olson CL. Sarcoidosis with optic nerve and retinal involvement. *Arch Ophthalmol* 1976;94:945–950.
- [16] Lustgarten JS, Mindel JS, Yablonski ME, Friedman AH. An unusual presentation of isolated optic nerve sarcoidosis. *J Clin Neuro-Ophthalmol* 1983;3:13–18.
- [17] Beardsley TL, Brown SV, Syndor CF, Grimson BS, Klintworth GK. Eleven cases of sarcoidosis of the optic nerve. *Am J Ophthalmol* 1984;97:62–76.
- [18] Karma A, Mustonen EMA. *Neuro-Ophthalmology* 1985;5:231–246.
- [19] Katz B, Newman S, Wall M. Disc edema, transient obscurations of vision, and a temporal fossa mass. *Surv Ophthalmol* 1991;36:133–139.
- [20] Sivakumar M, Chee SP. A case series of ocular disease as the primary manifestation in sarcoidosis. *Ann Acad Med Singapore* 1998;27:560–566.
- [21] Farr AK, Jabs DA, Green WR. Optic disc sarcoid granuloma. *Arch Ophthalmol* 2000;118:728–729.
- [22] Asensio Sánchez VM, Corral Azor A, Bartolomé Aragón A, De Paz García M. [Sarcoidosis of the optic nerve]. *Arch Soc Esp Oftalmol* 2003;78:165–168.
- [23] Frohman LP, Guirgis M, Turbin RE, Bielory L. Sarcoidosis of the anterior visual pathway: 24 new cases. *J Neuro-Ophthalmol* 2003;23:190–197.
- [24] Ismail S, Embong Z, Hitam WHW. Gallium scan in diagnosing ocular sarcoidosis. *Malay J Med Sci* 2005;12:64–67.
- [25] Al-Jamal RT, Kivelä T. Progressive visual loss and an optic disc tumour in a young man. *Acta Ophthalmol* 2008;86:341–343.
- [26] Jafferji SS, Biswas J. Optic nerve head sarcoid granuloma treated with intravenous methyl prednisolone. *Oman J Ophthalmol* 2008;1:28–31.

- [27] Moschos MM, Guex-Crosier Y. Anterior segment granuloma and optic nerve involvement as the presenting signs of systemic sarcoidosis. *Clin Ophthalmol* 2008;2:951–953.
- [28] Goldberg NR, Jabs DA, Busingye J. Optical Coherence Tomography Imaging of Presumed Sarcoid Retinal and Optic Nerve Nodules. *Ocul Immunol Inflamm* 2015; Aug 24. [Epub ahead of print]. doi:[10.3109/09273948.2014.971972](https://doi.org/10.3109/09273948.2014.971972)