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ORIGINAL PAPER

Clinical and optical coherence tomographic findings and outcome of treatment in patients with presumed tuberculous uveitis

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Abstract *Purpose* To define the clinical characteristics and optical coherence tomographic (OCT) features, and to assess the outcome of treatment, in patients with presumed tuberculous uveitis (PTU). *Methods* All patients diagnosed with PTU at King Abdulaziz University Hospital between January 1998 and May 2006 were reviewed. The diagnosis was made when findings were consistent with possible intraocular tuberculosis with no other cause of uveitis suggested by history, symptoms, or ancillary testing, strongly positive tuberculin skin-test results, and response to antituberculous therapy. *Results* Fifty-one patients (73 eyes) were identified. There were 34 males (66.7%) and 17 females (33.3%) with a mean age of 40.1 ± 11.0 years (range 16–68 years). Fifty-eight eyes (79.5%) had panuveitis and 15 eyes (20.5%) had posterior uveitis at presentation. Clinical manifestations included vitritis (71.2%), macular edema (63%), retinal periphlebitis (35.6%), multifocal choroiditis (20.5%), and granulomatous anterior uveitis (17.9%). All patients received antituberculous therapy and systemic corticosteroids. After a mean follow-up of 18.9 ± 21.9 months (range 6–96 months), all eyes showed resolution of inflammation, with no recurrences, associated with significant improvement in visual acuity (VA) (P = 0.007). There was a significant positive correlation between initial and final VAs (r = 0.7856, $P < 0.001$). Thirty-one eyes with macular edema were examined at baseline and at follow-up with OCT. There were three patterns of macular edema: diffuse (DME) (28.5%), cystoid (29%), and serous retinal detachment (45.2%). Initial VA of 20/40 or better was significantly associated with central macular thickness (CMT) of 300 μm or less (P = 0.0065) and DME (0.0484). At final follow-up, there was a significant reduction in CMT ($P < 0.001$) associated with a significant improvement in VA (P = 0.0091). *Conclusions* Antituberculous therapy combined with systemic corticosteroids leads to resolution of inflammation and elimination of recurrences of PTU. OCT is useful in monitoring the efficacy of treatment in patients with macular edema.

Keywords Macular edema · Optical coherence tomography · Tuberculosis · Uveitis

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Introduction

The clinical manifestations of intraocular tuberculosis include chronic granulomatous anterior uveitis,

vitritis, retinal periphlebitis, neuroretinitis, solitary or multiple choroidal tubercles, multifocal choroiditis, subretinal abscess, endophthalmitis, and panophthalmitis [1–12]. Diagnosis of ocular involvement with tuberculosis is considered in the setting of:

1. isolation of *Mycobacterium tuberculosis* from ocular fluid or a tissue specimen by microbiological or histopathological study;
2. as presumed ocular disease suggestive of tuberculosis with proven active systemic disease; or
3. as presumed ocular disease without evidence of active systemic disease [3].

In the last two situations diagnosis of ocular tuberculosis remains largely presumptive. In nearly all reported cases, diagnosis of intraocular tuberculosis was only presumptive [2, 3, 6–8]. Furthermore, ocular tuberculosis may occur in patients with no systemic disease [2, 3, 6, 7, 9, 10]. Clinically, intraocular tuberculosis can be due to direct infection or indirect hypersensitivity mechanisms to mycobacterial antigens when there is no defined active systemic lesion elsewhere or the lesion is thought to be inactive [3, 10].

Uveitic macular edema is a major cause of visual loss in patients with uveitis [13]. Optical coherence tomography (OCT) is a noninvasive, quick, and reproducible method of producing high-resolution, cross-sectional images of the retina. Recently, it was demonstrated that OCT provides information concerning internal retinal structure and enables quantitative measurement of macular retinal thickening in patients with macular edema [14–18]. Therefore, it is ideally suited to measurement of retinal thickness in the diagnosis and follow-up of patients with uveitic macular edema. Antcliff et al. [19] demonstrated that OCT is as effective as fundus fluorescein angiography at detecting uveitic cystoid macular edema but is superior in demonstrating the distribution of fluid within the retina. Markomichelakis et al. [20] identified three patterns of fluid distribution in eyes with uveitic macular edema:

1. diffuse macular edema (DME), which is characterized by increased retinal thickness, disturbance of the layered retinal structure, or sponge-like low reflective areas;
2. cystoid macular edema (CME), which is characterized by the formation of clearly defined intraretinal cystoid spaces; and
3. serous retinal detachment (SRD) which is seen as a clear separation of the neurosensory retina from the retinal pigment epithelium.

The objective of this study was to define the clinical characteristics, optical coherence tomographic features, management, and long-term follow-up results in patients with presumed tuberculous uveitis.

Patients and methods

The medical records of patients who received a diagnosis of presumed tuberculous uveitis seen and followed-up by one of the authors (AMA) at the retina/uveitis clinic, King Abdulaziz University Hospital, Riyadh, Saudi Arabia, between January 1998 and May 2006 were retrospectively reviewed. Patients were presumed to have tuberculous uveitis if they fulfilled the following criteria:

1. ocular findings consistent with possible intraocular tuberculosis with no other cause of their uveitis suggested by history, symptoms, or ancillary testing.
2. strongly positive tuberculin skin-test results ($\geq$15 mm area of induration/necrosis).
3. response to antituberculous therapy.

At presentation, all the patients had the following ophthalmic examination: best-corrected Snellen visual acuity (VA), applanation tonometry, slit-lamp examination of the anterior segment, fundus biomicroscopy, indirect ophthalmoscopy, intravenous fluorescein angiography, and posterior segment ultrasound in patients with media opacities interfering with adequate ophthalmoscopy. Snellen VAs were converted to the logarithm of the minimum angle of resolution (logMAR) for statistical analysis; vision of counting fingers (CF) was assigned a logMAR value of 2.0. Patients with macular edema and clear media were examined at baseline and at follow-up with optical coherence tomography (OCT3 Stratus, Carl Zeiss Ophthalmic Systems, Humphery Division, Dublin, California, USA). The OCT examination was performed using the high-resolution retinal mapping program. Six scans with a length of 6 mm each, centered at the fovea and with 30 degrees displacement from each other, were performed. The thickness of the central area with a 1-mm diameter was used for calculations. When two types of macular edema

coexisted in one eye, the case was categorized according to the most severe type.

All the patients underwent general examination at the department of internal medicine. The following laboratory tests were performed: complete blood count with differential, erythrocyte sedimentation rate, blood sugar, blood chemistry, serum angiotensin-converting enzyme, chest X-ray or computerized tomography of the chest, tuberculin skin test (five tuberculin units), Venereal Disease Research Laboratory test, fluorescent treponemal antibody absorption test, and search for acid-fast bacilli in sputum and urine.

The following medical and demographic data were recorded: patient age, sex, race, medical history, medications on presentation, results of the ophthalmological examination, and the results of diagnostic laboratory evaluation. In addition, details of systemic and surgical treatment were noted.

Statistical methods

Association between two categorical variables was investigated using the chi-squared test or the exact test, as appropriate. The Mann–Whitney test was used to compare means from two independent groups. Student's *t*-test was used to compare two proportions from the same sample. The Wilcoxon signed-rank test was used to test whether there was a significant change in OCT thickness. One-way analysis of variance (ANOVA) was used to compare means for more than two groups. Post-ANOVA pairwise comparisons of means were based on the Bonferroni method. Odds ratios and corresponding 95% confidence limits for relative risk were computed to investigate direction and degree of association. A 95% confidence interval which did not include a value of 1.0 indicated statistical significance. For the other statistical tests, a *P*-value less than 0.05 indicated statistical significance. A scatter graph and the Pearson's correlation coefficient were used to investigate the linear relationship between two interval variables. StatsDirect software, StatPac Gold software, and EPI Info 2000 software were used for statistical analyses.

Results

Presumed tuberculous uveitis was diagnosed in 51 patients (73 eyes). Thirty-four patients (66.7%) were males, and seventeen (33.3%) were females. The age at presentation ranged from 16 to 68 years with a mean of 40.1 ± 11.0 years and a median of 40 years. Thirty-two were Saudi, eight from Bangladesh, seven from India, and four from Pakistan. The uveitis was bilateral in 22 patients and unilateral in 29 patients.

Fifty-eight eyes (79.5%) had panuveitis, and 15 (20.5%) had posterior uveitis at presentation. Slit-lamp examination at presentation revealed granulomatous anterior uveitis in 13 eyes (17.9%) manifested as mutton-fat keratic precipitates in 13 eyes (Fig. 1) and iris nodules in four eyes (Fig. 2). Posterior synechiae of the iris at presentation were observed in 25 eyes (34.2%). The posterior segment findings at presentation or during pars plana vitrectomy were vitritis in 52 eyes (71.2%), macular edema in 46 eyes (63%) (Fig. 3), retinal periphlebitis in 26 eyes (35.6%) (Fig. 4), multifocal choroiditis in 15 eyes (20.5%) (Fig. 5), retinal neovascularization in ten eyes (13.7%) (Fig. 6), vitreous hemorrhage in eight eyes (11.0%), and traction retinal detachment in two eyes (2.7%).

All the patients had strongly positive tuberculin skin tests results. The area of induration ranged from 15 to 80 mm with a mean of 25.2 ± 11.9 mm and a median of 20 mm at 48 h. Chest radiographs were normal in 46 patients and showed old pulmonary tuberculosis in five patients. Nine patients gave a family history of tuberculosis.

All patients received antituberculous therapy including isoniazid 300 mg day^{-1}, rifampin 600 mg day^{-1}, ethambutol 15 mg kg^{-1} day^{-1}, and pyrazinamide 25–30 mg kg^{-1} day^{-1} for the first 2 months. Thereafter, rifampin and isoniazid were used for

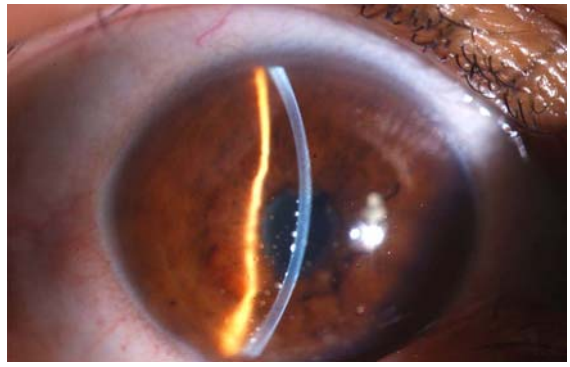

Fig. 1 Slit-lamp biomicroscopy showing mutton-fat keratic precipitates

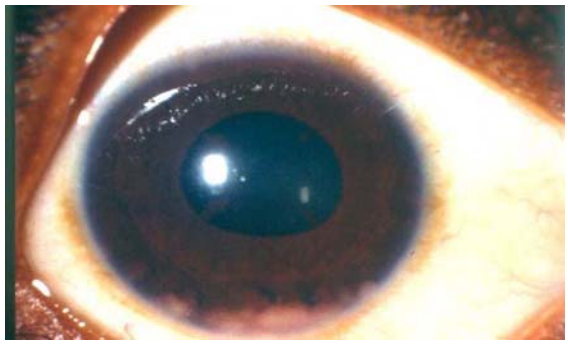

Fig. 2 Slit-lamp biomicroscopy showing large iris granulomas in the inferior angle

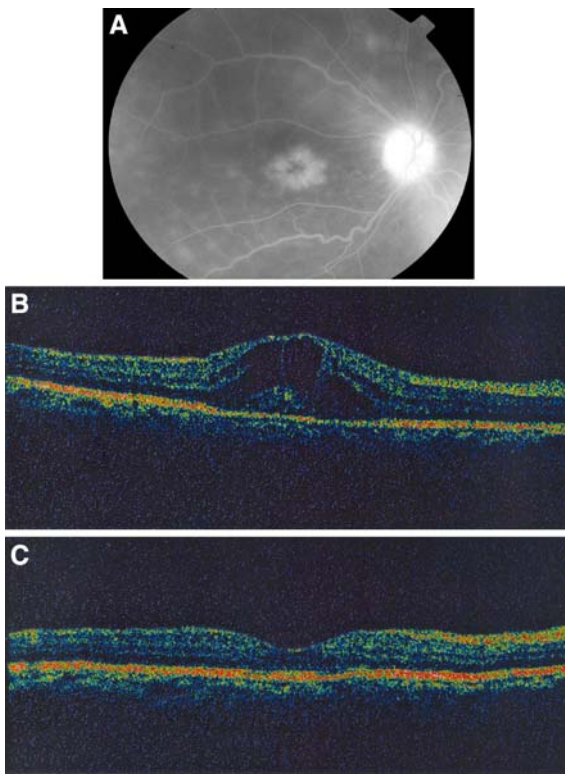

Fig. 3 (**a**) Fluorescein angiography of the right eye showing cystoid macular edema. (**b**) Optical coherence tomography (OCT) showing cystoid macular edema. Central macular thickness was 588 μm. Visual acuity was 20/100. (**c**) Two months after starting antituberculous therapy and systemic corticosteroids, OCT displays normal anatomy of macula with a reduction of central macular thickness to 239 μm. Visual acuity improved to 20/40

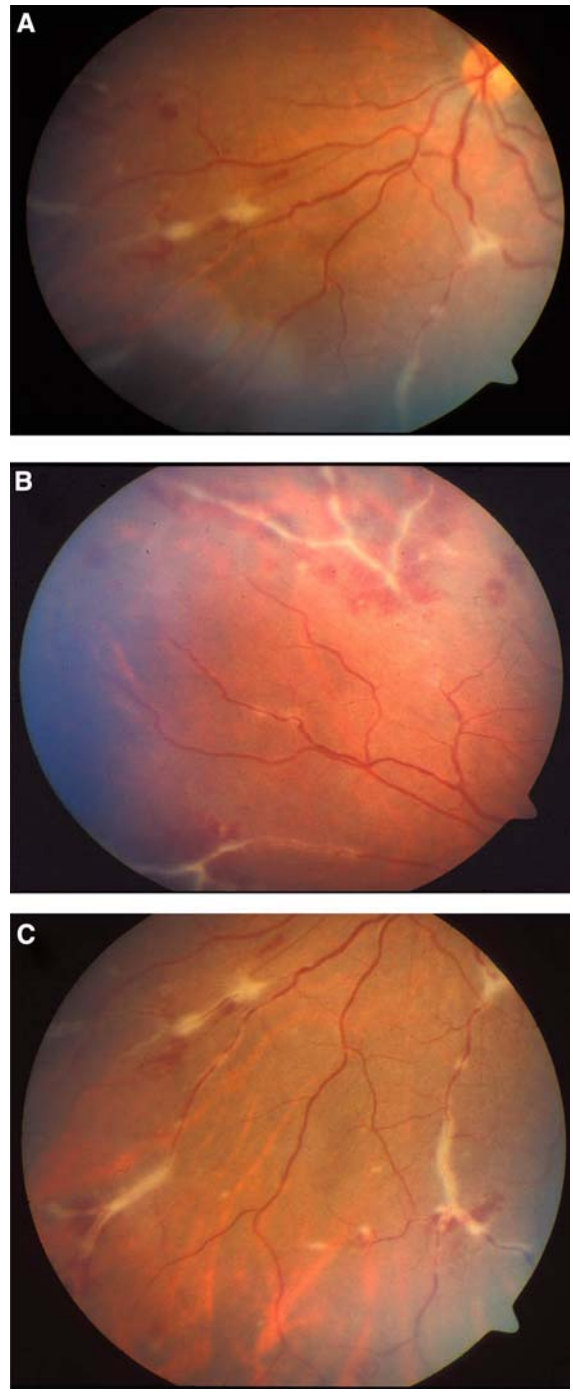

Fig. 4 Fundus photographs of the left eye (**a**–**c**) demonstrating thick perivenous sheathing with intraretinal hemorrhages

another 4–7 months. In addition, all patients received systemic prednisone (1 mg kg^{-1} day^{-1} until a clinical effect was seen then a slow reduction was established). The duration of systemic corticosteroid therapy ranged from 2 to 8 months with a mean of 4.2 ± 4.1 months and a median of 2.5 months.

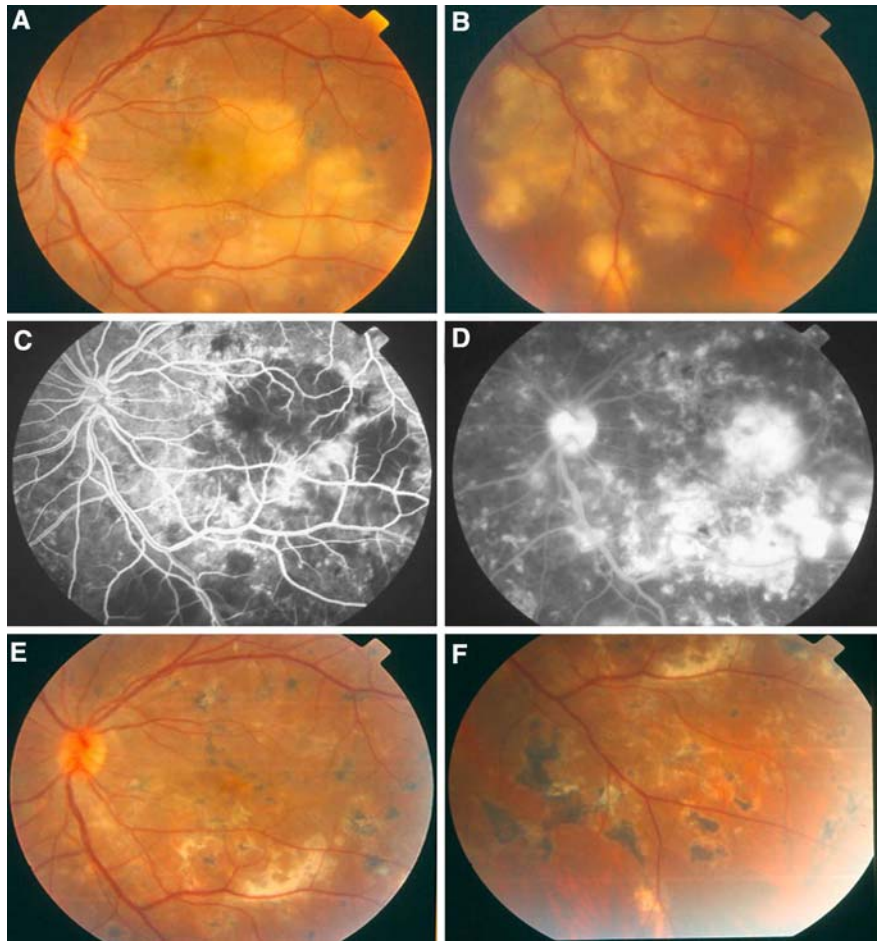

Fig. 5 (**a**, **b**) Fundus photographs of the left eye at presentation showing multiple areas of choroiditis. (**c**, **d**) Fluorescein angiography showing the lesions to be hypofluorescent initially (**c**) followed by late hyperfluorescence (**d**). Visual acuity at this stage was counting fingers. (**e**, **f**) Fundus photographs taken 3 months after antituberculous therapy and systemic corticosteroids showing healed lesions. Visual acuity at this stage was 20/30

Twenty-one eyes that showed retinal new vessel formation and peripheral capillary closure with or without vitreous hemorrhage were treated with full panretinal photocoagulation. Vitrectomy was performed in a total of 11 eyes—for severe non-clearing vitreous hemorrhage in nine eyes and traction retinal detachment in two eyes. Endolaser panretinal photocoagulation was used in all eyes that underwent vitrectomy.

The follow-up period ranged from 6 to 96 months with a mean of 18.9 ± 21.9 months, and a median of 12 months. All eyes showed resolution of inflammation without any recurrence during the follow-up period. Full panretinal photocoagulation resulted in complete involution of neovascularization in eyes with retinal periphlebitis and peripheral capillary non-perfusion. Vitrectomy resulted in retinal reattachment and in a vitreous cavity which stayed clear until the last follow-up. The distribution of initial and final visual acuity is illustrated in Table 1. Of the 73 eyes, 39 (53.4%) achieved visual acuity of 20/40 or better. The frequencies above the left to right diagonal line represent eyes that had improvement in visual acuity, those below the line experienced worsened vision, and those along the diagonal line had no change in visual acuity. Therefore, 39 eyes (53.4%) had improved vision, five eyes (6.8%) had worsened vision, and there was no change in vision for 29 eyes (39.8%).

Thirty-three eyes (45.2%) had visual acuity of 20/200 or worse at presentation and only 15 eyes (20.5%) had final visual acuity of 20/200 or worse. The difference between the two percentages was statistically significant ($P = 0.0072$; t-test for two proportions from same sample). In addition, only 15 eyes (20.5%) had visual acuity of 20/40 or better at presentation and 39 eyes (53.4%) had final visual acuity of 20/40 or better. The difference between the two percentages

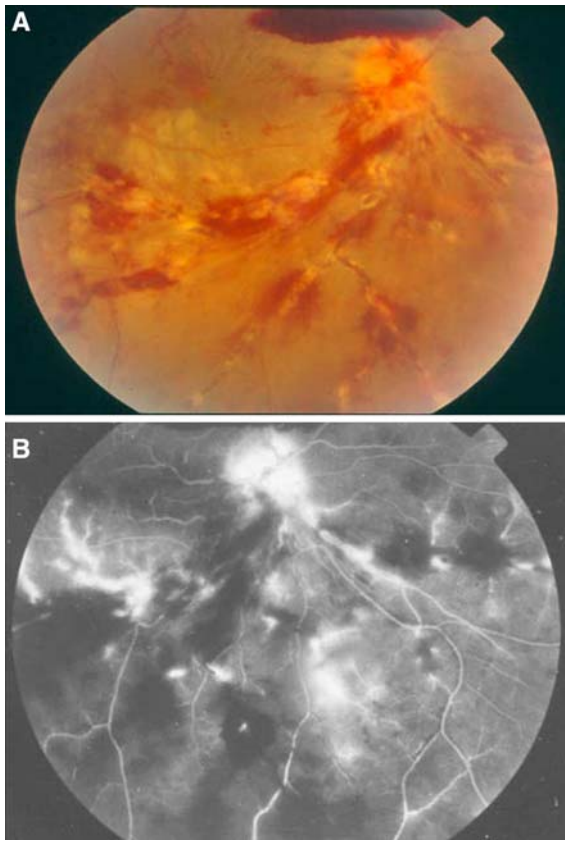

Fig. 6 (**a**) Fundus photograph of the right eye demonstrating thick perivenous sheathing with intraretinal hemorrhages, cotton-wool spots, neovessels on optic nerve head, and preretinal hemorrhage above optic nerve head. (**b**) Fluorescein angiogram showing leakage from the retinal veins and neovessels on optic nerve head and retinal nonperfusion

Table 1 Changes in visual acuity in 73 eyes after treatment

Final Visual Acuity	Visual Acuity at Presentation			Total
	≤20/200	20/100 – 20/50	≥20/40	
≥20/40	8	18	13	39
20/50 - 20/100	13	4	2	19
≤20/200	12	3	0	15
Total	33	25	15	73

was statistically significant ($P = 0.007$; *t*-test for two proportions from same sample).

Univariate analysis demonstrated a significant association between final visual acuity of 20/40 or better and initial visual acuity of better than 20/200. Of the 40 eyes with initial visual acuity of better than 20/200, 31 (77.5%) achieved final visual acuity of 20/40 or better. Of the 33 eyes with initial visual acuity of 20/200 or worse, only eight (24.2%) achieved final visual acuity of 20/40 or better. The difference between the two percentages was statistically significant ($P < 0.001$; chi-squared test) (odds ratio = 10.76; 95% confidence interval = 3.22–37.76). There was also a significant positive correlation between logMAR visual acuity at presentation and logMAR visual acuity at final follow-up ($r = 0.7856$, $P < 0.001$; Pearson's correlation coefficient).

Overall 37 eyes (50.68%) developed complications. The ocular complications encountered were cataract in 31 eyes (42.46%), glaucoma that necessitated medical treatment in four eyes (5.5%), subretinal neovascular membrane in one eye (1.4%), and hypotony in one eye (1.4%).

Optical coherence tomography findings

Twenty-three patients (31 eyes) with macular edema were examined at baseline and at follow-up with OCT. At baseline, there were three patterns of macular edema: DME in eight eyes (25.8%) (Fig. 7), CME in nine eyes (29%) (Fig. 3), and SRD in 14 eyes (45.2%) (Fig. 8). OCT revealed that low reflective areas were localized in the outer retinal layers. The central macular thickness (CMT) ranged from 212 to 801 μm with a mean of 409 ± 134.7 μm, and a median of 400 μm. The mean CMT values differed significantly between eyes with DME (266.9 ± 48.4 μm), eyes with CME (431.9 ± 115.2 μm), and eyes with SRD (475.5 ± 121.9 μm) ($P < 0.001$; one-way ANOVA). Post-ANOVA pairwise comparisons of means indicated that the mean CMT value in eyes with DME was significantly less than that in eyes with CME ($P < 0.001$), and in eyes with SRD ($P < 0.001$).

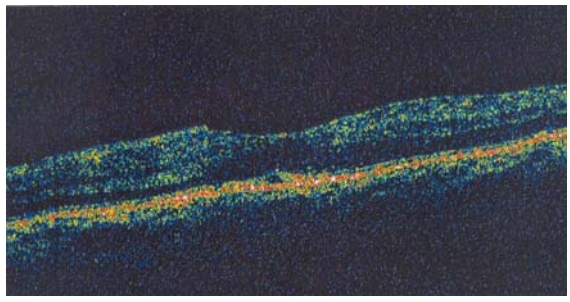

Fig. 7 Diffuse macular edema. Central macular thickness was 342 μm

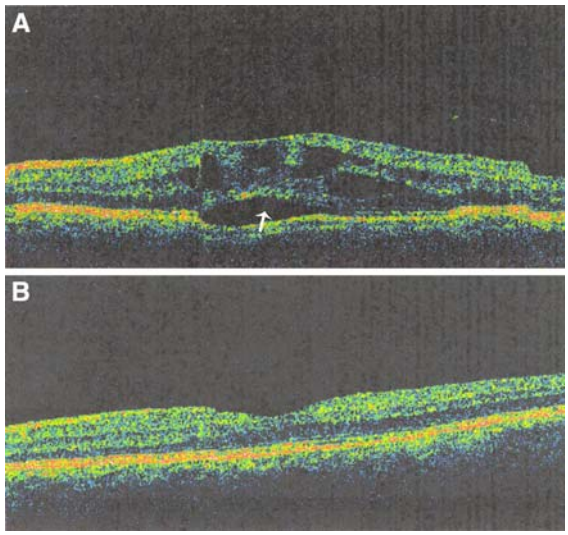

Fig. 8 (**a**) Optical coherence tomography (OCT) showing serous retinal detachment (*arrow*) and cystoid macular edema. Central macular thickness was 611 μm. Visual acuity was 20/200. (**b**) Three months after starting antituberculous therapy and systemic corticosteroids, OCT displays normal anatomy of the macula with reduction of central macular thickness to 280 μm. Visual acuity improved to 20/40

The association between CMT and OCT pattern of macular edema at presentation is shown in Table 2. The prevalence rate of CMT of 300 μm or less was significantly higher in eyes with DME (75%) than in eyes with CME (11.1%) and in eyes with SRD (0%) ($P < 0.001$; exact test). On the other hand, the prevalence rate of CMT of more than 400 μm was significantly higher in eyes with SRD (71.4%) and in eyes with CME (55.6%) than in eyes with DME (0%) ($P = 0.0035$; exact test).

The associations between best-corrected visual acuity at presentation and CMT and OCT pattern of macular edema are shown in Table 3. The prevalence rate of CMT of 300 μm or less was significantly higher in eyes with visual acuity of 20/40 or better (57.1%) than in eyes with visual acuity of 20/50 to 20/100 (0%) and in eyes with visual acuity of 20/200 or less (27.3%) ($P = 0.0065$; exact test). The prevalence rate of DME was significantly higher in eyes with visual acuity of 20/40 or better (57.1%) than in eyes with visual acuity of 20/50 to 20/100 (7.6%) and in eyes with visual acuity of 20/200 or less (27.3%) ($P = 0.0484$; exact test).

There was no correlation between logMAR visual acuity and CMT at presentation ($r = 0.2108$; $P = 0.2550$; Pearson's correlation coefficient). However, the mean CMT values differed significantly between eyes that had visual acuity of 20/40 or better (311.0 ± 113.1 μm; $n = 7$), eyes that had visual acuity of 20/50 to 20/100 (445.8 ± 103.7 μm; $n = 13$), and eyes that had visual acuity of 20/200 or less (427.8 ± 158.0 μm; $n = 11$) ($P = 0.0277$; one-way ANOVA). Post-ANOVA pairwise comparisons of means indicated that mean CMT value for eyes that had visual acuity of 20/40 or better was significantly less than that for eyes that had visual acuity of 20/50 to 20/100 ($P = 0.0091$) and for eyes that had visual acuity of 20/200 or less ($P = 0.0353$).

The follow-up period ranged from 6 to 36 months, with a mean of 10.4 ± 9.3 months and a median of 6 months. The distribution of initial and final visual acuity is illustrated in Table 4. Eleven eyes (35.5%) had visual acuity of 20/200 or worse at presentation and only two eyes (6.5%) had final visual acuity of 20/200 or worse. The difference between the two percentages was statistically significant ($P = 0.0093$; *t*-test for two proportions from same sample). In addition, only seven eyes (22.6%) had visual acuity of 20/40 or better at presentation and 20 eyes (64.5%) had final visual acuity of 20/40 or better. The

Table 2 Association between central macular thickness and optical coherence tomography types of macular edema at presentation

Central macular thickness (μm)	Type of edema			*P*-value (exact test)
	DME	CME	SRD	
≤300	6 (75%)	1 (11.1%)	0 (0%)	<0.001*
301–400	2 (25%)	3 (33.3%)	4 (28.6%)	0.9300
>400	0 (0%)	5 (55.6%)	10 (71.4%)	0.0035*

*Statistically significant at the 5% level

DME, diffuse macular edema; CME, cystoid macular edema; SRD, serous retinal detachment

Table 3 Visual acuity at presentation in relation to central macular thickness and optical coherence tomography pattern of macular edema

Variable	Visual acuity at presentation			*P*-value (exact test)
	≤20/200	20/100–20/50	≥20/40	
Central macular thickness (μm)				
≤300	3 (27.3%)	0 (0%)	4 (57.1%)	0.0065*
301–400	2 (18.2%)	6 (46.2%)	1 (14.3%)	0.2711
>400	6 (54.5%)	7 (53.8%)	2 (28.6%)	0.5878
Type of edema				
DME	3 (27.3%)	1 (7.6%)	4 (57.1%)	0.0484*
CME	3 (27.3%)	6 (46.2%)	0 (0%)	0.1070
SRD	5 (45.4%)	6 (46.2%)	3 (42.9%)	0.9898

*Statistically significant at the 5% level

DME, diffuse macular edema; CME, cystoid macular edema; SRD, serous retinal detachment

Table 4 Changes in visual acuity for 31 eyes after treatment

Final Visual Acuity	Visual Acuity at Presentation			Total
	≤20/200	20/100 – 20/50	≥20/40	
≥20/40	3	10	7	20
20/50 – 20/100	6	3	0	9
≤20/200	2	0	0	2
Total	11	13	7	31

difference between the two percentages was statistically significant ($P = 0.0091$; *t*-test for two proportions from same sample).

At the final follow-up, all 31 eyes had a significant reduction in CMT ($P < 0.001$; Wilcoxon test) (Figs. 3, 8). The CMT ranged from 170 μm to 595 μm, with a mean of 259.3 ± 78.4 μm and a median of 239 μm. There was a significant positive correlation between CMT at presentation and change in CMT at final follow-up ($r = 0.814$; $P < 0.001$) (Fig. 9). The mean change in CMT values differed significantly between eyes with DME (41.5 ± 31.9 μm), eyes with CME (158.3 ± 95.8 μm), and eyes with SRD (206.1 ± 92.7 μm) ($P < 0.001$; one-way ANOVA). Post-ANOVA pairwise comparisons of means indicated that the mean change in CMT value in eyes with DME was significantly less than that in eyes with CME and in eyes with SRD ($P < 0.001$ for both comparisons).

There was no correlation between change in logMAR visual acuity and reduction of CMT ($r = 0.043$, $P = 0.8184$; Pearson's correlation coefficient). However, the mean CMT at final follow-up in eyes that achieved visual acuity of 20/20 (211.6 ± 8.3 μm; $n = 5$) was

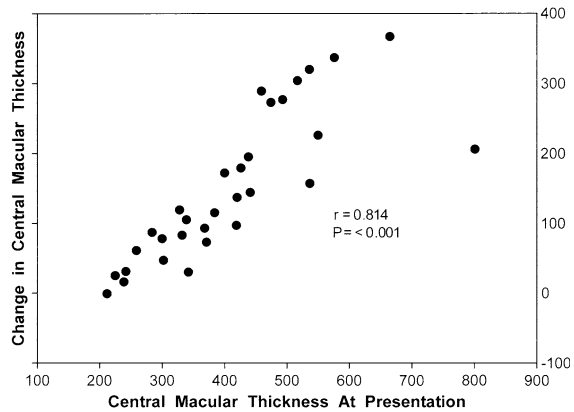

Fig. 9 Correlation between central macular thickness at presentation (μm) and change in central macular thickness (μm) for 31 eyes

significantly less than that in eyes that achieved visual acuity worse than 20/20 (268.4 ± 82.6 μm; $n = 26$) ($P = 0.032$; Mann–Whitney test).

There was no significant association between final visual acuity of 20/40 or better and CMT and OCT pattern of macular edema at presentation. However, there was a significant association between final visual acuity of 20/40 or better and initial visual acuity of 20/40 or better ($P = 0.0038$; exact test) (Table 5).

Discussion

In this series, a presumption of tuberculous uveitis was made on the basis of the presence of characteristic ocular lesions in the context of evidence of

Table 5 Associations between final visual acuity of 20/40 or better and initial visual acuity and optical coherence tomography findings at presentation

Variable	Final visual acuity of ≥20/40 (%)	*P*-value (exact test)
Central macular thickness (μm)		
≤300	5/7 (71.4)	
301–400	5/9 (55.7)	
>400	10/15 (66.7)	0.7915
Type of edema		
DME	4/8 (50)	
CME	7/9 (77.9)	
SRD	9/14 (65.3)	0.4975
Initial visual acuity		
≤20/200	3/11 (27.3)	
20/100–20/50	10/13 (76.9)	
≥20/40	7/7 (100)	0.0038*

*Statistically significant at the 5% level

DME, diffuse macular edema; CME, cystoid macular edema; SRD, serous retinal detachment

previous exposure to *Mycobacterium tuberculosis* (all cases had strongly positive tuberculin skin-test results), no other cause suggested by history, symptoms, or ancillary testing, and a strongly favorable clinical response after initiation of antituberculous therapy combined with systemic corticosteroids. In addition, a family history of tuberculosis suggests a diagnosis of tuberculous uveitis. The specificity of the tuberculin skin test for *Mycobacterium tuberculosis* increases with larger skin reactions and with a history of exposure to an active case of tuberculosis [10]. An induration greater than 14 mm is unlikely to be because of previous Bacilli Calmette–Guérin (BCG) vaccination [21].

The clinical manifestations of presumed tuberculous uveitis in our patients included vitritis in 52 eyes (71.2%), macular edema in 46 eyes (63%), retinal periphlebitis in 26 eyes (35.6%), multifocal choroiditis in 15 eyes (20.5%), and granulomatous anterior uveitis in 13 eyes (17.9%). These findings are consistent with the results of previous studies of presumed tuberculous uveitis [1–12]. Several studies demonstrated that retinal periphlebitis is a common manifestation of presumed intraocular tuberculosis [1, 3, 6, 8]. The characteristic features are mild degree of cellular infiltrate in the anterior chamber, mild vitreous infiltrate, severe retinal periphlebitis, and a marked tendency to peripheral capillary closure leading to new vessel formation [1, 3, 6, 8]. In a previous study we demonstrated that aggressive treatment of retinal periphlebitis associated with presumed intraocular tuberculosis with systemic corticosteroids, and antituberculous therapy, full panretinal photocoagulation, and early vitrectomy, when necessary, results in improvement of anatomic and visual outcome [8].

The treatment of ocular inflammation associated with tuberculosis should be directed against both the infection and the inflammatory reaction [22]. In the current series all the patients were treated with systemic corticosteroids combined with antituberculous therapy. All eyes showed resolution of inflammation with no recurrences after stopping systemic corticosteroids and antituberculous therapy. In addition, there was a significant improvement in visual acuity. Rosen et al. [3] reported a series of patients with presumed intraocular tuberculosis in which one patient with retinal vasculitis associated with strongly positive tuberculin skin-test result and no evidence of active systemic disease at presentation developed miliary tuberculosis with choroidal tubercles following treatment with systemic corticosteroids alone. To avoid this complication they strongly advocated the concomitant use of specific antituberculous therapy if presumed intraocular tuberculosis is suspected, even in the absence of active systemic disease. Moreover, several studies demonstrated that patients with presumed tuberculous uveitis who were treated only with systemic corticosteroids continued to have recurrent episodes of active inflammation or showed worsening, and inflammation was controlled only by concomitant treatment with antituberculous therapy [1, 2, 4, 5]. Although the inflammation can be controlled initially by the use of systemic corticosteroids alone, elimination of recurrences in patients treated with antituberculous drugs strongly favors the use of specific therapy in patients with presumed tuberculous uveitis [4]. Antituberculous therapy in these patients could help by killing the intraocular microorganisms; thus resulting in reduced antigen load and resultant inflammation. The reduced antigen load would reduce the hypersensitivity reactions also, which probably results in eliminating the recurrences in these patients [4]. Recently, Rao et al. [23] demonstrated selective distribution of *Mycobacterium*

tuberculosis in the retinal pigment epithelium of the enucleated eye of a case of panuveitis. Such findings suggest preferential location of *Mycobacterium tuberculosis* in the retinal pigment epithelium in eyes with panuveitis resulting from tuberculosis and also that recurrences in tuberculous choroiditis could result from reactivation of sequestered organisms in the retinal pigment epithelium. Prevention of such recurrences and elimination of the sequestered organisms require a longer course of treatment with systemic antimycobacterial agents, preferably for at least 6–9 months [23].

The advent of OCT has shown that uveitic macular edema may occur at different levels, including the outer retina and the subretinal space [14–20]. In this study, we identified three OCT patterns of macular edema in patients with presumed tuberculous uveitis: DME (25.8%), CME (29%), and SRD (45.2%). Markomichelakis et al. [20] described similar patterns of macular edema in patients with uveitis. Serous macular detachment is an important feature of macular edema that affects visual acuity and is not readily detected during slit-lamp biomicroscopy or by fundus fluorescein angiography. In our study, the incidence of SRD was higher than in previous studies of uveitic macular edema [19, 20].

Our analysis indicated that the mean CMT in eyes with DME was significantly less than that in eyes with CME and SRD. Visual acuity at presentation correlated significantly with CMT and OCT pattern of macular edema. Good initial visual acuity of 20/40 or better was significantly associated with CMT of 300 μm or less and DME. None of the eyes that had visual acuity of 20/40 or better at presentation had CME. Similarly, Markomichelakis et al. [20] demonstrated the presence of a negative correlation between visual acuity and macular thickness and the presence of CME in patients with uveitic macular edema. Previous electron microscopic studies of human eyes with CME showed widespread intracytoplasmic swelling of Müller cells and secondary neuronal degeneration [24]. These histopathological findings indicate that eyes with CME may suffer more profound visual loss than those with DME. In the current study there was a significant reduction of CMT after treatment; this was associated with a significant improvement in visual acuity. Our analysis indicated also that initial visual acuity was significantly associated with final visual acuity, with those eyes possessing better visual acuity at presentation more likely to have a better final visual acuity and, conversely, those eyes with poor acuity at presentation more likely to have poor final visual acuity. OCT findings at presentation, however, did not predict final visual acuity.

In conclusion, tuberculosis is a readily treatable disease and the consequences of delay in either ocular or systemic diagnosis can be very serious for the patient. It is important to have a high index of suspicion of the diagnosis in patients with unexplained chronic uveitis and this will be influenced by the socio-economic circumstances, family history, ethnic origin, and previous medical history of the patient. Treatment with antituberculous therapy combined with systemic corticosteroids induced resolution of inflammation with no recurrences and a significant reduction of CMT that was associated with a significant improvement in visual acuity. OCT seems to be the technique of choice for understanding the anatomy of uveitic macular edema, for determination of intraretinal damage, and for follow-up and monitoring of the effectiveness of treatment regimens on uveitic macular edema.

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