·Investigation·

Ocular involvement in leprosy: a field study of 1 004 patients

S C Reddy[1], *B D Raju*[2]

[1] Department of Ophthalmology, Rangaraya Medical College, Kakinada, Andhra Pradesh, India
[2] National Leprosy Eradication Programme, Kakinada, Andhra Pradesh, India
Correspondence to: S C Reddy. Department of Ophthalmology, International Medical University Clinical School, Jalan Rasah, 70300 Seremban, Negeri Sembilan, Malaysia. screddy98@hotmail.com
Received:2009-07-23 Accepted:2007-11-05

Abstract

• AIM: To determine the prevalence of ocular involvement and pattern of ocular morbidity in leprosy patients.

• METHODS: Leprosy patients were examined in their respective treatment centers by the ophthalmologist over a period of three years. After recording visual acuity, anterior segment was examined with torch light and magnifying loupe. Intraocular pressure was measured with Schiotz tonometer. Fundus was examined, after dilating pupils with tropicamide eye drops, with direct ophthalmoscope.

• RESULTS: Out of 1 004 patients examined, 530 were suffering from lepromatous leprosy, 413 from tuberculoid leprosy, 61 from borderline leprosy. Ocular lesions related to leprosy were noted in 606 (60.3%) patients. Corneal changes (81.1%) were the most frequently observed lesions followed by eyelid changes (42.1%). Potentially sight threatening lesions such as lagophthalmos (17.3%), corneal anaesthesia (36.1%), and iridocyclitis (14.7%) were seen in these patients. None of the patients showed any fundus changes related to leprosy. Cataract, not related to systemic disease, was noted in 177 (17.6%) leprosy patients. Blindness related to leprosy was seen in 169 (16.8%) patients; chronic iridocyclitis with its complications was the most common cause of blindness in these patients.

• CONCLUSION: Ocular involvement was seen in 60.3% of leprosy patients; corneal lesions being the most common. One or more potentially sight threatening lesions were seen in two-thirds of these patients. Blindness related to leprosy was seen in 16.8% of patients. Early referral of patients with eye problems and treatment of potentially sight threatening lesions and cataract will reduce the prevalence of blindness in leprosy patients.

• KEYWORDS: ocular lesions; leprosy; lagophthalmos; corneal anaesthesia; iridocyclitis; scleritis; blindness

Reddy SC, Raju BD. Ocular involvement in leprosy: a field study of 1 004 patients. *Int J Ophthalmol* 2009;2(4):367-372

INTRODUCTION

Leprosy, caused by Mycobacterium leprae, affects skin, nasal mucosa, peripheral nerves, anterior segment of the eye, and results in the disbilities and blindness if not treated in-time. Based on the clinical appearance of skin lesions, involvement of nerves and number of lepra bacilli in skin bipsy, the disease is classified as multibacillary or lepromatous leprosy (LL), paucibacillary or tuberculoid leprosy (TL) and borderline leprosy (BL). The eye is affected in this disease in four ways[1]: (i) by direct invasion of lepra bacilli which reach the ciliary body through blood stream and then spread into other structures, (ii) secondary to involvement of facial nerve and ophthalmic division of trigeminal nerve, (iii) in the form of hypersensitivity reaction to the antigenic substances released in the breakdown of lepra bacilli which are present in the circulating blood; and (iv) secondary to changes in the skin and support tissue of the lids, tear drainage system. One or more of the factors may be responsible for eye lesions, especially when the disease is long standing and in advanced stage.

There are over 10.7 million leprosy patients in the world; and it is anticipated that over 0.75 million new cases will be detected each year[2]. Leprosy is still considered a significant health problem in many countries, and India is one of them with high prevalence of registered patients (5 per 10 000 population)[3].

Most of the world's leprosy sufferers live in developing countries where the prevalence of many other diseases is high, and stigmatization limits the use of medical services resulting in the delay of treatment and hence, more chances of involvement of other systems by the disease. The involvement of eyes resulting in visual handicap is a great disaster for a leprosy patient, especially if he/she has already other deformities of hands or feet. The present study was conducted in East and west Godavari districts of Andhra Pradesh state, India with the collaboration of Zonal leprosy

officer, National Leprosy Eradication Program to determine the prevalence of ocular involvement and pattern of ocular morbidity in leprosy; and to provide necessary treatment (medical and surgical) for the needy patients.

MATERIALS AND METHODS

Before stating this project, an audio visual lecture was given by the ophthalmologist to all the medical officers, non medical supervisors and non medical assistants working in four government leprosy control units and three leprosy mission hospitals, East and West Godavari districts explaining the clinical features of different ocular lesions related to leprosy and their management. Following this, they were assigned to pick up the leprosy patients with eye problems from their centers and assemble them on the scheduled dates in their respective treatment centers for eye check up by the ophthalmologist. This cross-sectional prospective study was carried out during the week ends (once a month) over a period of three years.

The patients were explained the purpose and conduct of the study, and consent was taken for eye examination. They were examined in their respective treatment centers. Age and gender of patients, type and duration of the disease and any erythema nodosum leprosum (ENL) reactions and treatment taken were noted. The detailed examination was done by ophthalmologist. After taking the history of eye problems, visual acuity was tested on Snellen E chart in a well illuminated room. Those with vision less than 6/6 were tested again using pinhole or with spectacles in patients using glasses, to see for further improvement of vision. Detailed examination of the ocular adnexa (eyebrows, eyelids, lacrimal sac), anterior segment of the eye (conjunctiva, sclera, cornea, anterior chamber, iris, pupil, lens) was done with torch light and binocular loupe (Eagle Focus™ 2.25x, Eagle Vision, Memphis, USA).

Lagophthalmos was tested by asking the patient to close the eyelids gently and any exposure of sclera/cornea was noted. The presence or absence of Bell's phenomena was noted for consideration of treatment in these patients. Corneal sensation was tested with a sterile fine cotton whip. If there was lagophthalmos preventing blink reflex, they were asked about subjective sensation of touch on the cornea. Intraocular pressure was measured with Schiotz tonometer under topical anaesthesia (xylocaine eye drops 40g/L). Then, both pupils were dilated with tropicamide eye drops (10g/L) and fundus examination was done with direct ophthalmoscope in a semi dark room. All the findings were documented on a proforma for analysis. Patients requiring medical treatment were treated at the centre itself. Those requiring prescription of glasses, surgery for lagophthalmos and cataract were referred to the nearest government hospital for further management.

The following definitions were used in this study:

Corneal sensation normal-when there is spontaneous blinking/ patient feels the sensation of touch; corneal sensation diminished (hypoaesthesia)-when there is delayed blinking/ patient feels less sensation of touch; corneal sensation absent (anaesthesia)-when there is no blinking/ patient does not feel sensation of touch.

Chronic iridocyclitis-history of redness, pain and diminution of vision in the eye, small irregular pupil with posterior synechiae/ iris atrophy.

Complicated cataract-evidence of past iridocyclitis with lenticular opacity reducing the vision to less than 6/18.

Refractive error-visual acuity less than 6/6 which improves with pinhole/ glasses.

Presbyopia-difficulty in near vision/ reading small print.

WHO categories of visual impairment[4]: no visual impairment (6/6-6/18), visual impairment (<6/18-6/60), severe visual impairment(<6/60-3/60),blind<3/60-perception/ no perception of light).

Potentially sight threatening (PST) lesions[5]-lagophthalmos, exposure keratitis, corneal anaesthesia, central corneal ulcer/ opacity, chronic iridocyclitis which can cause loss of vision and blindness if they are not monitored or treated carefully.

Academic lesions-madarosis/nodules/infiltration of eyebrows/ eyelids, superficial keratitis, corneal opacity in the periphery since they usually do not cause loss of vision.

RESULTS

A total of 1 004 patients were examined in all the treatment centers, of whom 766 (76.3%) were males and 238 (23.7%) were females; 530 (52.8%) were suffering from lepromatous leprosy, 413 (41.1%) from tuberculoid leprosy and 61 (6.1%) from borderline leprosy. The mean age of patients was 48.5 years (range 14-76 years); 79.5% of them were above the age of 40 years (Table 1). The mean duration of the disease in LL patients was 13.6 years (range 6/12 - 38 years), in TL patients 12.8 years (range 4/12 - 32 years) and in BL patients 5.9 years (range 2/12 - 6 years). Patients with more than 10 years disease (759, 75.6%) completed dapsone monotherapy, and the rest were taking/completed multi drug therapy at the time of examination.

Ocular lesions related to leprosy (at least one pathology in one eye) were seen in 606 (60.3%) patients; 66.6% in TL patients (275 out of 413), 58.3% in LL patients (309 out of 530) and 36.1% in BL patients (22 out of 61). Corneal lesions were the most common (81.1%) seen in leprosy patients, followed by eyelid lesions (42.1%). Academic lesions such as partial or total madarosis/nodules/infiltration

Table 1 Sex and age distribution of patients (n =1004)

	Lepromatous leprosy (n =530)	Tuberculoid leprosy (n =413)	Borderline leprosy (n =61)	Total (n=1004)
Sex				
Males	419	296	51	766
Females	111	117	10	238
Age (yr)				
11-20	18	15	1	34
21-30	60	62	5	127
31-40	149	107	16	272
41-50	186	129	23	338
51-60	93	82	13	188
61-70	20	16	2	38
71-80	4	2	1	7

of eyebrows/eyelids, superficial keratitis were observed in 54.7% of patients, while the PST lesions such as lagophthalmos in 17.3%, corneal anaesthesia in 36.1%, and iridocyclitis in 14.7% of patients. None of the patients showed any fundus changes related to leprosy. Multiple ocular lesions were observed in one or both eyes of these patients. Hence, the total number of lesions shown in Table 2 are much more than the number of patients examined.

In addition to lagophthalmos, lower motor neuron type of facial palsy was noted in 12 patients (1.2%) in our study: ipsilateral in 11 (7 in TL patients and 4 in LL patients) and bilateral in 1 LL patient. Lateral tarsorrhaphy was performed in all the patients with exposure keratitis and prophylactic lubricants and topical antibiotics were given to prevent corneal ulceration. Temporalis muscle sling operation was performed in the case of bilateral facial palsy with lagophthalmos by the plastic surgeon in one of the leprosy hospitals. Lagophthalmos patients with good Bell's phenomenon were advised lid excercises in addition to topical lubricants. Ectropion of lower lid was corrected by lateral tarsal strip procedure.

Thirty-seven out of 54 patients (68.5%) who had ENL reaction showed one or more ocular lesions related to the reaction (Table 3). Among the ocular lesions which are not related to leprosy, cataract (immature/mature/traumatic cataract) was the most common eye disease (177, 17.6%) followed by refractive errors (Table 4). There were another 33 patients who were operated for cataract in one or both eyes (using aphakic glasses) in this study. In patients who had unilateral aphakia, intracapsular cataract extraction was performed in the other eye and glasses were prescribed after six weeks post operatively. In other patients with mature cataract, standard extracapsular cataract extraction with posterior chamber intraocular lens implantation was performed. There were no significant post operative complications in these patients.

For visual acuity purpose, the eyes are taken into consideration because vision may be good in one eye , and

Table 2 Prevalence of ocular lesions in leprosy (n=1004)

Eye lesions	LL (n=530)	TL (n=413)	BL (n=61)	Total (n=1004)	%
Eyebrows					
Total madarosis	148	8	3	159	15.8
Partial madarosis	79	22	6	107	10.6
Infiltration	46	13	2	61	6.1
Nodules	28	-	-	28	2.8
Eyelids					
Total madarosis	121	4	2	127	12.6
Partial madarosis	44	5	1	50	5.0
Nodules	9	-	-	9	0.9
Patch on the lids	5	-	-	5	0.5
Lagophthalmos	69	95	10	174	17.3
Unilateral	25	38	3	66	6.6
Bilateral	44	58	6	108	10.7
Ectropion of lower lid	19	36	2	57	5.7
Conjunctiva					
Chronic conjunctivitis	17	6	1	24	2.4
Conjunctival leproma	1	-	-	1	1.0
Sclera					
Episcleritis	10	1	1	12	1.2
Scleritis	14	1	-	15	1.5
Cornea					
Corneal anaesthesia	152	192	19	363	36.1
Corneal hypoesthesia	108	141	34	283	28.2
Exposure keratitis	19	31	4	54	5.4
Corneal ulcer	3	7	-	10	1.0
Band shaped keratopathy	8	1	-	9	0.9
Corneal opacity	20	25	4	49	4.9
Sclero keratitis	6	-	-	6	0.6
Superficial keratitis	4	4	-	8	0.8
Interstitial keratitis	8	3	-	11	1.1
Healed pannus	18	4	1	23	2.3
Iris and Pupil					
Chronic iridocyclitis	104	29	5	138	13.7
Unilateral	35	17	2	54	5.4
Bilateral	69	12	3	84	8.3
Acute iridocyclitis	7	2	1	10	1.0
Iris pearls	2	-	-	2	0.2
Iris nodules	2	-	-	2	0.2
Sluggishly reacting pupil	39	20	8	67	6.7

LL= lepromatous leprosy, TL= tuberculoid leprosy, BL= borderline leprosy

Table 3 Ocular lesions in patients with erythema nodosum leprosum reaction (n=37)

Ocular lesion	n
Nodules on eyebrows	10
Infiltration of eyebrows	7
Nodules on eyelids	5
Lagophthalmos	10
Episcleritis	2
Scleritis	2
Acute iridocyclitis	3
Chronic iridocyclitis	7
Iris pearls	2
Conjunctival leproma	1

Table 4 Ocular lesions not related to leprosy (n=1004)

Eye disease	n
Refractive error/presbyopia	148
Immature cataract	124
Mature cataract	46
Aphakia	33
Tr. Cataract with adherent leucoma	7
Pterygium	63
Bitot spots	13
Retinitis pigmentosa	6
Chronic simple glaucoma	5
Chalazion	2
Blepheritis	1
Divergent squint	1
Synchisis scintillans	1
Coloboma of iris and choroids	1

poor in the other eye of the same patient. Thus, one patient may be blind in one eye only, and other patient may be blind in both eyes. The visual impairment according to WHO criteria, in 2 008 eyes (1 004 patients) at the time of examination is shown in Table 5. Severe visual impairment was observed in 20.8% of eyes. Out of 294 eyes with vision less than 3/60, 22 eyes had no perception of light (due to anterior staphyloma/ phthisis bulbi following perforated corneal ulcer, secondary glaucoma/atrophic bulbi following chronic iridocyclitis).

Blindness due to ocular lesions related to leprosy was seen in 16.8% of patients; 12.4% of patients were blind in one eye while 4.8% were blind in both eyes (Table 6). Chronic iridocyclitis with its complications (band keratopathy, secondary glaucoma, atrophic bulbi, complicated cataract) was the most common cause of blindness followed by lagophthalmos with its complications (exposure keratitis/ corneal ulcer/opacity). The corneal lesions included interstitial keratitis -8, perforated corneal ulcer resulting in phthisis bulbi -10, / adherent leukome -14,/ anterior staphyloma -7). Cataract (not related to leprosy) was responsible for vision less than 3/60 in 11.2% of patients.

Table 5 Visual impairment, according to WHO criteria, at the time of examination in 2008 eyes of 1004 patients

Who categories	Level of vision	*n*	%
No impairment	6/6–6/18	841	41.9
Visual impairment	<6/18–6/60	456	22.7
Severe visual impairment	<6/60–3/60	417	20.8
Blind	<3/60–PL/NPL	294	14.6

PL =perception of light, NPL =no perception of light

Table 6 Causes of blindness in leprosy (*n* =1004)

Eye disease	Unilateral blindness	Bilateral blindness	Total	%
Lesions related to leprosy				
Chronic iridocyclitis	59	39	98	9.8
Lagophthalmos with Corneal ulcer/opacity	24	5	29	2.9
Corneal diseases	35	4	39	3.9
Scleritis	3	-	3	0.3
Lesions not related to leprosy				
Cataract	62	41	113	11.2
Uncorrected high myopia	-	3	3	0.3
Retinitis pigmentosa	-	3	3	0.3
Chronic simple glaucoma	-	2	2	0.2

DISCUSSION

The prevalence of ocular involvement in leprosy is influenced by many variables such as geographical regions, climate, environmental conditions, ethnic groups, social status [6]; type and duration of the disease, type and duration of treatment received, type and number of reactions of leprosy [7-10]; newly diagnosed patients[11,12] /institutionalized patients[13]/ noninstitutionalized patients [14]. When all types of ocular lesions (cataract, glaucoma, pterygium, retinal lesions *etc.* which are not related to leprosy) are included in the report the prevalence of eye lesions in leprosy will be higher; similarly when the percentage of eye findings are calculated among the patients with ocular involvement only (and not among the total number of patients examined) the prevalence rate of eye lesions will be again higher than the real figures[15]. The expertise of the person (ophthalmologist or medical officer/ field staff working in leprosy) examining the eyes will also determine the frequency of eye lesions in leprosy because the ophthalmologist can diagnose the ocular lesions at an early stage , and thus the prevalence of these lesions will be higher when compared to other two groups of people.

The prevalence of ocular lesions, academic lesions (madarosis), PST lesions (lagophthalmos, corneal anaesthesia, anterior uveitis) in leprosy (%) reported from different countries is shown in Table 7. The wide variation of the prevalence of the ocular lesions in the above table could probably be due to a combination of the variables described above. The prevalence of ocular lesions seen in our study (60.3%) is lower than eight studies, but higher than sixteen studies given in the above table.

Bilateral lagophthalmos was seen in much more frequently in TL patients (14%, 58 out of 413) than in LL patients (8.3%, 44 out of 513). However, in a survey of 2114 lagophthalmos cases Yan *et al* [36] reported 61% cumulative incidence of bilateral lagophthalmos in multibacillary patients and only 35% of the same in paucibacillary patients. Bilateral lower motor neuron facial nerve palsy was noted in one of our tuberculoid leprosy patient. A similar observation was reported in two patients of borderline tuberculoid leprosy by Inamdar and Palit[37] .

The ocular lesions related to ENL reaction were seen in 68.5% (37 out of 57) of patients with such reaction. A higher percentage of such lesions (89.7% , 44 out of 54) were reported in similar patients by Shorey *et al* [10]. Acute infiltration of the iris can result in iris pearls: small, glistening, white lepromas that usually form near the papillary margin. Sometimes they detach from the iris and float in the anterior chamber [38]. Iris pearls were seen in two of our patients of lepromatous leprosy who had ENL reaction.

A small conjunctival leproma in the inferior temporal quadrant near the limbus was seen in a lepromatous leprosy patient with ENL reaction in our study. Rathinam and Prajna[39] recently reported a lepromatous leprosy patient with subconjunctival leproma, anterior uveitis, hypopyon and leprosy granuloma over the iris, who had recurrent episodes of ENL reaction. Spaide *et al* [30] reported that pupil in leprosy patients react less to the light stimulation; and we also found similar observation of sluggishly reacting pupil in

Table 7 Prevalence of ocular lesions in leprosy reported from different countries (%)

Country	*n*	Ocular lesions	Madarosis	Lagoph-thalmos	Corneal anaesthesia	Anterior uveitis
Brazil [16]	100	72.0	59.0	13.0	36.0	19.0
Burma [20]	256	69.5	48.0	12.5	3.1	-
Cameroon [33]	218	77.5	25.7	10.1	13.5	2.3
Ghana [18]	250	46.0	12.8	8.4	3.6	-
India [19]	385	46.2	-	1.8	-	17.1
India [27]	430	24.6	5.8	0.4	-	0.7
India [32]	742	23.8	18.1	4.0	3.2	2.3
Kenya [31]	199	52.7	19.0	34.1	20.0	7.5
Malawi [23]	8325	6.4	-	3.1	2.9	1.7
Malaysia [25]	444	51.8	25.0	47.0	0.4	0.6
Nepal [11]	260	37.3	10.0	34.6	0.4	1.1
Nepal [29]	466	74.2	33.0	27.2	-	5.1
Nepal [34]	58	57.0	22.4	10.3	15.5	10.3
Nigeria [35]	456	48.0	-	12.6	-	2.2
Pakistan [13]	143	73.0	65.7	25.0	30.8	21.6
Papua New Guinea [28]	109	52.3	44.9	5.5	12.8	6.4
Sri Lanka [21]	630	47.1	-	6.3	-	17.4
South Africa [22]	223	61.4	30.5	19.7	7.6	0.9
Tanganyika [17]	1212	8.3	-	17.3	-	28.8
Uganda [24]	890	21.1	8.2	5.6	-	3.1
USA [14]	61	74.0	-	11.0	16.0	7.0
USA [30]	55	74.5	58.2	3.6	60.0	20.6
Vietnam [26]	51	76.4	15.7	27.4	-	19.6
PRESENT STUDY	1004	60.3	44.1	17.3	36.1	14.7

these patients. This could probably be due to autonomic dysfunction of the iris as suggested by Swift and Bauschard[40]. Though completion of appropriate course of anti leprosy treatment changes the status of the individual patient from 'under active treatment' to 'cured' in the registers of many leprosy control programs, it does not prevent subsequent development of disabling complications, particularly those of the eye [41,42]. The presence of ocular lesions in patients who have completed treatment in the present study can be explained by this hypothesis.

Although ocular leprosy is basically an anterior segment disease, lesions of posterior segment behind the ora serrata Although ocular leprosy is basically an anterior segment disease, lesions of posterior segment behind the ora serrata do occasionally occur by direct spread from ciliary body. Four types of retinal lesions have been described in the literature in leprosy patients - (i) descrete, circular, waxy, occasionally pedunculated nodules on the retina projecting into the vitreous, which are of the same size and appearance of iris lepromatous pearls, (ii) white, waxy, highly refractile deposits in the periphery of retina with sheathing of neighbourhood retinal vessels. These are present when the rest of the eye is heavily infected [43], (iii) dull, hypopigmentd, flat and descrete patches of dots to one quarter of the disc size which are deep to the retinal vessels, scattered all over the fundus, grouped at places but sparsely situated at the macula and in the extreme periphery of retina[44]; (iv) a raised, rounded, yellowish lesion in the lower temporal periphery, one quarter disc size, posterior to ora serrata[45]. We did not find any such lesions in any of our patients.

A lower prevalence of blindness (2.9%, 33 out of 1137 patients [46] and 10.4%, 50 out of 480 patients [35]) has been reported in leprosy patients than observed in our study (16.8%). The prevalence of blindness due to lesions related to leprosy (bilateral 12.4% and unilateral 4.8% of patients) observed in our study is much higher than 6% of bilateral and 2.6% unilateral blindness of the same reported by Zhang *et al* [47] in their study of 1 045 patients. Other causes not related to leprosy was responsible for blindness in 12% of our patients while the same was reported to be in 3.3% of patients by the above authors. Approximately 0.5%-1% of leprosy patients would be blind owing to the lesions related to the disease, and an additional 1%-2% owing to causes other than leprosy [3]. The most common causes of visual disability and blindness in leprosy are corneal disease secondary to lagophthalmos and corneal anaesthesia, chronic anterior uveitis and cataract. In our study, chronic iridocyclitis with its complications was the most common cause related to leprosy, responsible for blindness in these patients.

In conclusion, early detection, effective treatment, and proper control of reactions are essential to reduce the eye complications in leprosy patients. The existing eye lesions may deteriorate and dormant lesions may recur in patients after release from treatment. Therefore, follow up of these

patients for life is equally important to prevent blindness in these patients. Improving primary eye care training of health workers of leprosy control units/ leprosy hospitals so that they can detect ocular involvement early and refer the patients to eye specialist; frequent regular eye check up of leprosy patients by ophthalmologist; in-time treatment of potentially sight threatening lesions and unrestricted use of cataract surgical services in the hospitals will reduce the prevalence of visual impairment and blindness in leprosy patients.

ACKNOWLEDGEMENTS

The authors express their sincere thanks to the Director of Medical and Health Services, Government of Andhra Pradesh for giving permission to conduct this study; to all the medical officers, non medical supervisors and non medical assistants working in government leprosy control units, and to all the staff working in leprosy mission hospitals of East and West Godavari districts of Andhra Pradesh state for their co-operation in successful completion of this study.

REFERENCES

1 Brand MB. Care of the eyes in Hansen's disease, 2nd ed, The Star, Gills W. Long HD Centre, Carville, USA 1987:1

2 World Health Organization. Leprosy-global situation. WHO Wkly Epidemiol Rec 2000;28:231-266

3 Courtright P, Lewallen S. Ocular manifestations of leprosy. In: Johnson GJ, Minassian DC, Wale Ra, West SK (eds). The epidemiology of eye disease, London, Arnold 2003:306-317

4 World Health Organization. International statistical classification of diseases and related health problems. Tenth revision, Geneva 1992:456-457

5 Lamba A, Santoshkumar D, Arthanariswaran R. Ocular leprosy: a new prospective. *Ind J Lepr* 1983;55(4):490-494

6 Ffytche TJ. The continuing challenge of ocular leprosy. *Br J Ophthalmol* 1991;75 (2):123-124

7 Rajan MA. Eye in multidrug therapy. *Ind J Lepr* 1990;62(1):33-38

8 Fiftche TJ. Residual sight threatenibg lesions in leprosy patients completing multidrug therapy and sulphone monotherapy. *Lepr Rev* 1991;62(1):35-43

9 Hogeweg M, Kiran KU, Suneetha S. The significance of facial patches and type I reaction for the development of facial nerve damage in leprosy: a retrospective study of 1226 paucibacillary leprosy patients. *Lepr Rev* 1991;62(2):143-149

10 Shorey P, Krishnan MM, Dhawan S, Garg BR. Ocular changes in reactions in leprosy. *Lepr Rev* 1989;60(2):102-108

11 Lubbers WJ, Schipper A, Hogeweg M, De Soldenhoff R. Eye disease in newly diagnosed leprosy patients in eastern Nepal. *Lepr Rev* 1994;65(3):231-238

12 Daniel E, Koshy S, Rao PS. Ocular complications in newly diagnosed borderline lepromatous and lepromatous leprosy: baseline profile of Indian cohort. *Br J Ophthalmol* 2002;86(12):1336-1340

13 Khan T, Awan AA, Kazmi HS, Shah AA, Muhammad S, Muhammad S. Frequency of ocular complications of leprosy in institutionalized patients in NWF of Pakistan. *J Ayub Med Coll Abbottabad* 2002;14(4):29-33

14 Dana MR, Hochman MA, Viana Ma, Hill CH, Sugar J. Ocular manifestations of leprosy in a noninstitutionalized community in the United States. *Arch Ophthalmol* 1994;112(5):626-629

15 Acharya BP. Ocular involvement in leprosy-A study in mining areas of India. *Ind J Ophthalmol* 1978;26(2):21-24

16 Shields JA, Waring III GO, Monte LG. Ocular findings in leprosy. *Am J Ophthalmol* 1974;77(8):880-890

17 Mc Laren DS, Shaw MJ, Dalley KR. Eye disease in leprosy patients: A study in central Tanganyika. *Int J Lepr Other Mycobact Dis* 1961;29(1):20-28

18 Chatterjee S, Chaudhury DS. Pattern of eye diseases in leprosy patients of northern Ghana. *Int J Lepr Other Mycobact Dis* 1964;32:53-63

19 Balakrishnan E. Survey of ocular complications in lepromatous leprosy. *J All India Ophthalmol Soc* 1966;14(5):214-216

20 Gyi K. The eye in leprosy. Union Burma. *J Life Sci* 1968;1(2):248-249

21 Weerekoon L. Ocular leprosy in Cylone. *Br J Ophthalmol* 1969;53(7):457-465

22 Welsh NH, Pretorius M. The ocular signs in leprosy: results of a survey in a leper institute. *S Afr Med J* 1970;44 (Suppl):9-12

23 Ticho U, Ben Sira I. Ocular leprosy in Malawi. *Br J Ophthalmol* 1970;54 (3): 107-112

24 Emiru VP. Ocular leprosy in Uganda. *Br J Ophthalmol* 1970;54(11):740-743

25 Weerekoon L. Ocular leprosy in West Malaysia. *Br J Ophthalmol* 1972;56(2): 106-113

26 Hornblass A. Ocular leprosy in south vietnam. *Am J Ophthalmol* 1973;75(3): 478-480

27 Sehgal VN, Aggarwal DP, Sehgal N. Ocular leprosy. *Indian J Med Res* 1976;64 (11):1600-1606

28 Dethlefs R. Prevalence of ocular manifestations of leprosy in Port Moresby, Papua New Guinea. *Br J Ophthalmol* 1981;65(4):223-225

29 Malla OK, Brandt F, Anten JGF. Ocular findings in leprosy in an institution in Nepal (Khokna). *Br J Ophthalmol* 1981;65(4):226-230

30 Spide R, Nattis R, Lipka A, D'Amico R. Ocular findings in leprosy in the United States. *Am J Ophthalmol* 1985;100(3):411-416

31 Adala Hs, Kagame K. Ocular leprosy in Kenya. *East Afr Med J* 1988;65 (9): 593-601

32 Soshamma A, Suryawanshi N. Eye lesions in leprosy. *Lepr Rev* 1989;60 (1): 33-38

33 Mvogo CE, Nella-Hig AL, Ellong A, Achu JH, Nkeng PF. Ocular complications in leprosy in Cameroon. *Acta Ophthalmol Scand* 2001;79(1):31-33

34 Nepal BP, Shrestha UD. Ocular findings in leprosy patients in Nepal in the era of multidrug therapy. *Am J Ophthalmol* 2004;137(5):888-892

35 Mypet C, Soloman AW. Prevalence and causes of blindness and low vision in leprosy villages of north eastern Nigeria. *Br J Ophthalmol* 2005;89(4):417-419

36 Yan LB, Chang Gc, Li WZ. Analysis of 2114 cases of lagophthalmos in leprosy. *Chin Lepr J* 1993;9(1):6-8

37 Inamdar AC, Palit A. Bilateral facial palsy in Hansen's disease. *Lepr Rev* 2003;74(4):383-385

38 Allen JH. Pathology of ocular leprosy.II - Miliary lepromas of iris. *Am J Ophthalmol* 1966;61(5 Pt 2):987-992

39 Rathinam S, Prajna L. Hypopyon in leprosy uveitis. *J Postgrad Med* 2007;53(1): 46-47

40 Swift TR, Bauschard FD. Pupillary reactions in lepromatous leprosy. *Int J Lepr Other Mycobact Dis* 1972;40(2): 142-148

41 Courtright P, Hu LF, Li HY, Lewallen S. Multidrug therapy and eye disease in leprosy: a cross sectional study in the People Republic of China. *Int J Epidemiol* 1994;23(4):835-842

42 Lewallen S, Tungpakom NC, Kim SH, Courtright P. Progression of eye disease in 'cured' leprosy patients: implications for understanding the pathophysiology of ocular disease and for addressing eyecare needs. *Br J Ophthalmol* 2000;84 (8): 817-821

43 Choyce DP. Diagnosis and management of ocular leprosy. *Br J Ophthalmol* 1969;53(4):217-223

44 Chatterjee S, Chaudhury DS. Hypopigmented patches in fundus in leprosy. *Lepr Rev* 1964;35:88-90

45 Singh M. Anterior leprotic retinitis of Trantas: A case report. *Med J Malaysia* 1985;40(2):139-141

46 Thompson KJ, Allardic GM, Babu GR, Roberts H, Kerketta W, Kerketta A. Patterns of ocular morbidity and blindness in leprosy-a three centre study in Eastern India. *Lepr Rev* 2006;77(2):130-140

47 Zhang YL, Zheng Z, Li W, Ye G. A survey of blindness and poor vision in leprosy patients. *Chin Med J* 2003;16(5):682-684