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Original Article

Comprehensive Study on Relative Afferent Pupillary Defect

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Abstract

Introduction: Relative afferent pupillary defect (RAPD) or Marcus-Gunn pupil is an important clinical finding in examination of the visual system.

Aim: The aim of this study was to (1) analyze various etiological factors of RAPD and (2) to assess the significance of grade of RAPD and visual prognosis.

Method of Study: All patients with RAPD examined of the cause, grading of RAPD done by swinging torch light test and best-corrected visual acuity measures during each visit till the study period.

Results: Fifty patients with RAPD studied, 33 patients had optic nerve pathology, 14 patients had retinal pathology two patient with macular cause, and 1 had vitreous hemorrhage. Out of 33 patients with optic nerve pathology, 11 had Grade 4 RAPD, two out of 11 patients had good visual outcome. Fourteen retinal cause patient had severe grade relative afferent pupillary and poor visual outcome. Two macular and one vitreous patient had lesser grade of relative afferent pupillary and had good visual outcome.

Conclusion: RAPD has multifactorial etiology, severe grade (Grades 3 and 4) relative afferent pupillary have poor visual outcome compared to lesser grade (Grades 1 and 2). Patients who presented early with relative afferent pupillary subjected to appropriate management attained better visual outcomes. This study necessitates detection of relative afferent pupillary at the earliest and to institute prompt treatment for better visual recovery.

Key words: Anterior ischemic optic neuritis, Central retinal artery occlusion, Central retinal vein occlusion, Grading of relative afferent pupillary defect, Optic neuritis, Relative afferent pupillary defect, Optic nerve, Retinal detachment, Swinging flash light test, Traumatic optic neuritis

INRODUCTION

The relative afferent pupillary defect (RAPD) or Marcus-Gunn pupil is an extremely sensitive and significant objective clinical finding in the examination of the visual system.[1] Various techniques used to quantify or measure afferent pupillary defects are use of neutral density filters,[1] cross-polarized filters, and subjective grading based on the amount of initial contraction and subsequent re-dilation of each pupil using swinging flash light.[2] Even in an unconscious patient, the determination of an RAPD can be made by swinging flash light test.

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Grading OF RAPD

Severity of RAPD is graded by swinging flash light test (Dejong Textbook of Neurology).

GRADE 1 – Weak initial pupillary constriction followed by greater dilatation.
GRADE 2 – Initial pupillary stall followed by greater dilatation.
GRADE 3 – Immediate pupillary dilatation.
GRADE 4 – No reaction to light.

Aim of the Study

The aims of this study were as follows:

1. Analyze various etiological factors of RAPD.
2. Asses the significance of grade of RAPD and visual prognosis.

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Study Type

This is a prospective randomized, observational, and non-interventional hospital-based study.

Study Period

September 1, 2020 to December 31, 2020.

METERIALS AND METHODS

The Institutional Ethical Committee approval for conducting the study was obtained. Fifty patients presenting with clinical diagnosis of RAPD to the Ophthalmology Department of Government Vellore Medical College were included in the study. After obtaining informed consent from, the patient following evaluation was done in patients with RAPD.

1. Complete ocular history.
2. Best-corrected visual acuity measured during each visit and at the end of the study.
3. Swinging flash light test.
4. Detailed slit-lamp examination.
5. Intraocular pressure and color vision.
6. Field charting.
7. Posterior segment evaluation by direct ophthalmoscope, IDO, and 90 D.

Inclusion Criteria

The following criteria were included in the study:

1. All patients with RAPD.
2. All age group.
3. Both gender.

Exclusion Criteria

The following criteria were excluded from the study:

1. Anatomically abnormal pupil.

Statistical Methods

Mean (SD) and frequency (percentage) was used for continuous and categorical variable respectively. Fisher's extract test or Chi-square test was used to assess the difference between the categorical variable. Student *t*-test or Mann–Whitney U-test was used to test mean difference between the two continuous variables. $P < 0.05$ considered as statistically significant. All statistical analysis was done by statistical software STATA 11.0.

RESULTS

Out of 50 patients with RAPD, 33 patients had optic nerve pathology, 14 patients had retinal pathology, two patients had macular pathology, and one patient had vitreous hemorrhage as the etiology for RAPD.

Optic Nerve Causes for RAPD

In our study, 33 patients accounted for optic nerve causes for RAPD of which 13 patients had optic atrophy (three patients had primary optic atrophy, three of them had secondary optic atrophy, and seven patients had consecutive optic atrophy). Nine patients with optic neuritis (ON) and eight patients with traumatic optic neuropathy (TON) presented with RAPD. Of the eight patients with TON, three patients had fracture of the optic canal with displacement in one patient with RAPD. One patient had pituitary macroadeoma and hence was diagnosed as compressive optic neuropathy [Figure 1].

Grading of RAPD in Optic Nerve Causes

Out of 33 patients with optic nerve pathology having RAPD, 11 of them had Grade 4 RAPD (nine patients had optic atrophy and two patients had TON). Both of the patients with TON came to our hospital with history of defective vision only after 1 week following trauma and they had bony fracture of the optic canal with displacement. Six patients had Grade 3 RAPD (four patients had optic atrophy and two patients with anterior ischemic optic neuropathy). In our study, large number of patients (14 patients) presented with Grade 2 RAPD, of which six patients diagnosed as TON, seven had ON, and one patient diagnosed as compressive optic neuropathy. Two patients with ON presented with Grade 1 RAPD [Table 1].

Visual Outcome in Optic Nerve Diseases

In our study, optic atrophy patients presented with Grade 3 and Grade 4 RAPD had poor vision at the time of presentation and they did not show improvement in vision even after 3 month of follow-up. On patients presented with Grade 1 and Grade 2 RAPD, though they had poor vision at presentation that they had good visual improvement at end of 3 months. Two patients with TON had Grade 4 that RAPD had poor visual outcome since they presented late to our hospital. Two patients of TON who had poor vision initially with Grade 2 RAPD had fracture of the optic canal with bony displacement and on surgical, correction had good visual improvement. One patient diagnosed had pituitary macroadenoma had Grade 2 RAPD that had poor vision and after surgical removal had vision improvement to BCVA 6/60 [Table 2].

Retinal Causes of RAPD

In our study, six patients with ischemic central retinal vein occlusion (CRVO), four patients with central retinal artery occlusion (CRAO), and three patients with retinal detachment had RAPD at presentation [Figure 2].

Grading of RAPD in Retinal Diseases

All patients with retinal pathology had Grade 3 and Grade 4 RAPD. All the four patients with retinal detachment had Grade 4 RAPD. Two patients each with CRVO and CRAO had Grade 3 RAPD and four patients with CRVO and two patients with CRAO had Grade 4 RAPD [Figure 3].

Visual Outcome in Retinal Disease

All four patients with retinal detachment who presented with Grade 4 RAPD had poor vision since they came very late after their visual detoriation; hence, there was no visual improvement. Even patients with CRAO and ischemic central retinal vein patients had no improvement on treatment [Table 3].

Macular and Vitreous Causes of RAPD

Two patients had chronic central serous chorioretinopathy with Grade 1 RAPD and they had good visual improvement on treatment with topical anti-inflammatory drugs. One patient had dense vitreous hemorrhage with Grade 1 RAPD and when the patient was treated by vitrectomy patient had good visual recovery.

DISCUSSION

Marcus-Gunn pupil or RAPD occurs when there is a unilateral disturbance in the anterior afferent visual pathway, including retina, optic nerve, optic chiasma, and optic tract RAPD, which has multifactorial etiology involving the visual pathway. The standard technique for detecting RAPDs is the alternating light test.[3]

Normal Responses

When a light is shone alternately in each eye, the normal pupillary response is an initial pupillary constriction followed by redilatation; this response occurs each time the light moves from one eye to the other. The initial constriction does not occur due to the brief time in darkness when the light crosses the nose. The initial constriction occurs because each retina is in the dark when the other eye is being stimulated; when the light moves, the retina signals an increase in light intensity and the pupils constrict.

Clinical Testing

The alternating light test should be done in a dark room with the patient looking at a distant fixation target. A bright light should be used, the light should be shown in each eye symmetrically – the amount of time on each eye should be the same and the angular displacement of the stimulus from the line of sight should be the same for each eye.

Criterion for RAPD

When diagnosing an RAPD, the most reliable component of the pupillary response to look for is asymmetry of the initial constriction. An eye with an RAPD will show a smaller initial constriction and will redilate to a larger size, but the asymmetry of redilatation will be less reproducible than the difference in initial constriction. The best indicator that an eye has an RAPD is aconsensual response of its pupil that is less than the direct response. Since there is possibility of a unilateral efferent defect or asymmetric contraction anisocoria, we should not rely too much on a comparison of the direct responses of the two pupils. If we look at only one pupil and see a direct response of that pupil that is greater than its consensual response, we might merely be seeing contraction anisocoria, not an RAPD in the other eye.

Conditions Leading to an RAPD[4]

1. Optic nerve disorders: Mild ON with no or minimal loss of vision can lead to a very severe RAPD, unilateral or asymmetric optic neuropathies are common causes of an RAPD, arteritic, and non-arteritic anterior ischemic optic neuropathy, TON (due to direct ocular trauma, orbital trauma, or during head trauma damage can occur to optic nerve as it passes through the optic canal into the cranial vault).
2. Glaucoma: Glaucoma is usually a bilateral disease and RAPD occurs if one optic nerve is more damaged.
3. Optic nerve tumor: Primary tumors of the optic nerve (such as glioma, or meningioma) or tumors that compress the optic nerve (such as sphenoid wing meningioma and pituitary lesions).
4. Orbital disease: This could include compressive damage to the optic nerve from thyroid related orbitopathy (i.e., compression from enlarged extraocular muscles in the orbit), orbital tumors, or vascular malformations.
5. Optic nerve infections or inflammation: Cryptococcal infection can cause a severe optic nerve infection in the immunocompromised individuals.
6. Surgical damage to the optic nerve: Damage following an orbital hemorrhage related to eye, orbital, sinus, or plastic surgery; damage following neurosurgical procedures such as a pituitary tumor resection; and damage related to the migration of an orbital plate after surgical correction of a blow-out fracture.
7. Retinal causes: Unilateral retinal detachment, vein occlusion, and arterial occlusion.

In our study, out of 50 patients studied 33 patients had optic nerve pathology, 14 patients had retinal pathology, two patients had macular pathology, and one patient had dense vitreous hemorrhage.

In our study, two patients had ethambutol-induced retrobulbar neuritis with Grade 1 RAPD and on stopping ethambutol and treatment with steroids patient had good visual recovery. Among eight patients with TON, six

Table 1: Grading of relative afferent pupillary defect in optic nerve causes

Disease	Grade 1	Grade 2	Grade 3	Grade 4
Optic atrophy	-	-	4	9
Traumatic optic neuritis	-	6	-	2
Optic neuritis	2	7	-	-
Anterior ischemic optic neuritis	-	-	2	-
Compressive optic neuritis	-	1	-	-

Table 2: Visual outcome in optic nerve diseases

Disease	Grade	Vision at present	Vision at 1 week	Vision 3 months
Optic neuritis	Grade 1	PL and 1/60	6/6	6/6
	Grade 2	1/60–4/60	6/36–6/24	6/12–6/9
Traumatic optic neuritis	Grade 2	HM–2/60	6/60–6/36	6/12–6/9
	Grade 4	PL	HM	HM
Anterior ischemic optic neuritis	Grade 2	1/60	5/60	6/60
Compressive optic neuritis	Grade 2	CFCF	6/60	6/60
OA	Grade 3	1/60–2/60	NI	NI
	Grade 4			

Table 3: Visual outcome in retinal disease

Disease	Grade	Vision day 1	Vision 3 months	Vision 6 months
Ischemic central retinal vein occlusion	Grade 3 Grade 4	HM–1/60	NI	NI
Central retinal artery occlusion	Grade 3 Grade 4	CFCF–2/60	NI	NI
Total retinal detachment	Grade 4	PL-ve	PL-ve	PL-ve

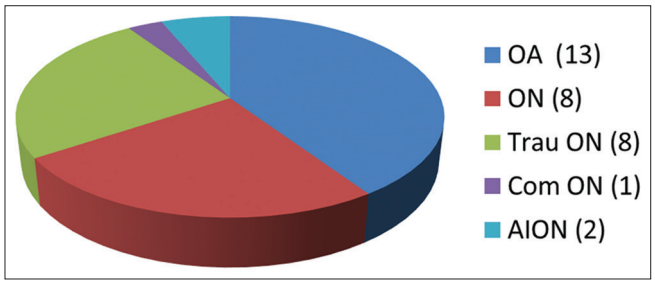

Figure 1: Causes of relative afferent pupillary defect

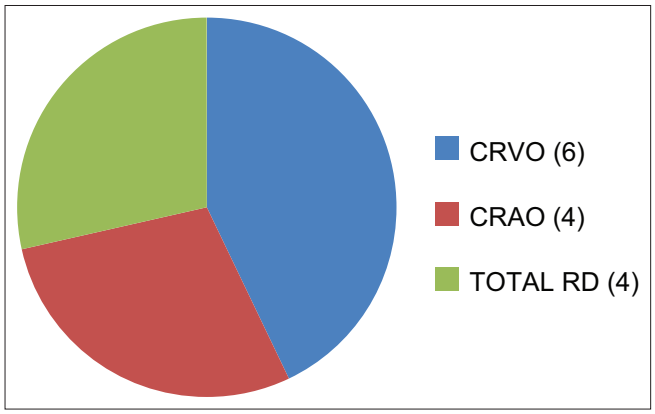

Figure 2: Retinal causes of relative afferent pupillary defect

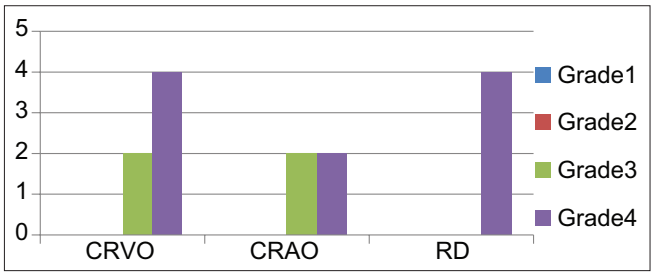

Figure 3: Grading of relative afferent pupillary defect in retinal diseases

patients had Grade 2 RAPD who presented on day of trauma and had good visual recovery with treatment. Two patients had Grade 4 RAPD and they presented 1 week after trauma and their visual recovery was poor.

One patient with Grade 2 RAPD diagnosed to have pituitary macroadenoma and after surgery, she had visual improvement. Hence, RAPD has diagnostic significance in intracranial abnormalities. Two patients with Grade 3 RAPD diagnosed as anterior ischemic ON and was treated with IV steroids and continued with oral steroids. Though there was only partial visual recovery, it helps in preventing blindness in fellow eye.

Patients with optic atrophy and retinal disease had Grade 3 and Grade 4 RAPD and they had no visual recovery. Two patients with chronic CSCR had Grade 1 RAPD and they had good visual recovery. The above finding and

observation indicate that the early detection of disease process and its prompt treatment gives better visual outcome to the patient.

CONCLUSION

1. From this study, we conclude that RAPD has multifactorial etiology involving the visual pathway and prompt recognition and investigation helps in diagnosing the underlying etiology.
2. Patients with Grade 1 and Grade 2 have better visual outcome than patients with Grade 3 and Grade 4.
3. Patient who presented early with RAPD subjected to appropriate management attained better visual outcome.
4. Hence, RAPD has diagnostic and prognostic significance.
5. This study, therefore, necessitates the importance of detecting such cases at primary level and its earliest referral to tertiary center for prompt treatment and good visual recovery.

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