BILATERAL ECCENTRIC FIXATION – FACT OR FIXATION?

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Abstract
It has been found that bilateral eccentric fixation occurs in a significant number of amblyopes. The literature concerned with this condition and possible aetiological factors is reviewed. A retrospective study of 347 amblyopes was carried out and those patients with bilateral eccentric fixation are discussed and the possible reasons for this conditions are examined.

Key words
Bilateral eccentric fixation, eccentric fixation, amblyopia, visuscopy, normal visual acuity, simultaneous (bilateral) microstrabismus.

INTRODUCTION

Eccentric fixation is a well recognised monocular condition in the amblyopic eye in unilateral squint. Recently however eccentric fixation as a purely monocular phenomenon has been challenged, as case reports of bilateral eccentric fixation have occurred in the literature. These cases present a similar clinical picture to unilateral eccentric fixation, but with persistent sub-normal vision and eccentric fixation also being found in the so-called "sound" eye.

AIM

To discuss the relevant literature associated with bilateral eccentric fixation and review the results of clinical research of patients with this condition.

REVIEW OF LITERATURE

von Noorden and Mackenson (62)[1] first reported the phenomenon of bilateral eccentric fixation without strabismus, in cases of long-standing bimacular disease. The loss of macular function creates the need to fix with an area outside the central scotoma so that, with time, the principal visual direction and motor behaviour may become associated with the extrafoveal area.

von Noorden (63)[2] was the first to describe two cases of bilateral eccentric fixation with strabismus, in the absence of organic macular disease.

The phenomenon was further described by Hermann and Priestley (65)[3] who speculated that in certain cases, amblyopia and eccentric fixation is a bilateral disease in which bifoveal instability is present in both eyes, but with only one eye becoming significantly amblyopic.

Malik *et al* (68 & 72)[4,5] postulated that neonatal macular haemorrhage could lead to bilateral eccentric fixation and felt that the original lesion recovers structurally but leaves a functional defect which is then amenable to treatment.

Bilateral eccentric fixation has also been reported by Gupta and Sood (73)[6], in the presence of microstrabismus with identity – where there is no demonstrable squint on cover test, but eccentric fixation is present.

Mein (75)[7] commented that if "bilateral eccentric fixation does occur in cases of bilateral amblyopia without a manifest strabismus on cover test, and with demonstrable binocular single vision, then it would appear that microtropia with identity can occur bilaterally and is not confined to one eye."

METHOD

A retrospective study of patients attending the Orthoptic Clinic at the Sydney Eye Hospital over an 8 month period was carried out. During this period, a total of 347 amblyopes were seen, of which 45 had bilateral eccentric fixation.

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These patients were given a routine ophthalmological examination including atropine or cycloplegic refraction and fundus check. A routine orthoptic examination was also given, including visuscopy which was performed on all patients by at least two orthoptists and was repeated on successive visits. BOTH eyes were subjected to very careful scrutiny.

Special tests were performed on some of these patients, including dark adapted visual acuity with the neutral density filter, colour vision with either the Ishihara or Matshubara Colour Vision Tests, Haidinger's Brushes and Visual Evoked Response.

Treatment, including glasses, occlusion, surgery, was given where indicated. No pleoptic treatment was given.

RESULTS.

Of the 347 amblyopes (i.e. those patients with 6/9 or less vision) 149 (42.9%) had bilateral amblyopia and 45 had bilateral eccentric fixation. 4 cases were excluded as the vision in one eye was 6/5 and another 2 cases were excluded because of the presence of pathology, leaving a total of 39 cases (11.2%). Since this survey was completed a further 8 cases have been seen, giving a total of 47 cases with bilateral eccentric fixation.

Sex Distribution.

Of the 47 cases, 30 (64%) were female and 17 (36%) were male.

Age Distribution.

The age range of patients at their first visit was from 5 months to 27 years. The average age at first attendance was 6 years.

Refractive Error.

This has been taken in terms of *retinoscopy* for use in this paper because it has been found that the glasses ordered do not necessarily reflect the amount of error present. Refractive errors have been taken as the *spherical equivalent* (the sum of the power of the spherical lens plus half of the power of the cylinder) for use in the tables and figures below.

TABLE 1

REFRACTIVE ERROR
(by retinoscopy – unknown in 12 eyes)

amount of error	no. of eyes	%age
+6.25 and over	36	43.9
+2.25 to +6.00	30	36.6
–2.00 to +2.00	9	11.0
–2.25 to –6.00	4	4.9
–6.25 and over	3	3.6

It can be seen in Table 1 that the majority of eyes have a refractive error in the higher plus range.

Astigmatism of 1.25 dioptres or more was present in 32 eyes.

Anisometropia of 2 dioptres or more was present in 8 patients.

Type of Strabismus.

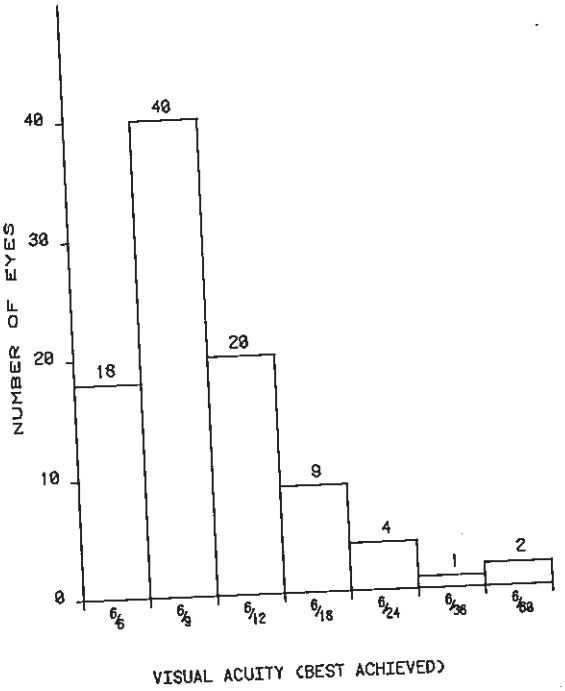
32 cases (68%) had convergent squint – 18 of which were microsquint

8 cases (17%) had divergent squint – 5 of which were microsquint

2 cases (4%) had no demonstrable squint

5 cases (11%) had simultaneous squint (see comment below)

FIG. 1



Visual Acuity.

Figure 1 shows the distribution of the final (best achieved) visual acuity. It can be seen that 83% of eyes had an acuity of 6/12 or better, in fact 62% had 6/9 or better, showing that there can be a significant incidence of eccentric fixation even with higher levels of vision.

Figures 2 and 3 show the correspondence between:

i) the final visual acuity and the age at first correction

ii) the final visual acuity and the degree of error.

FIG. 2

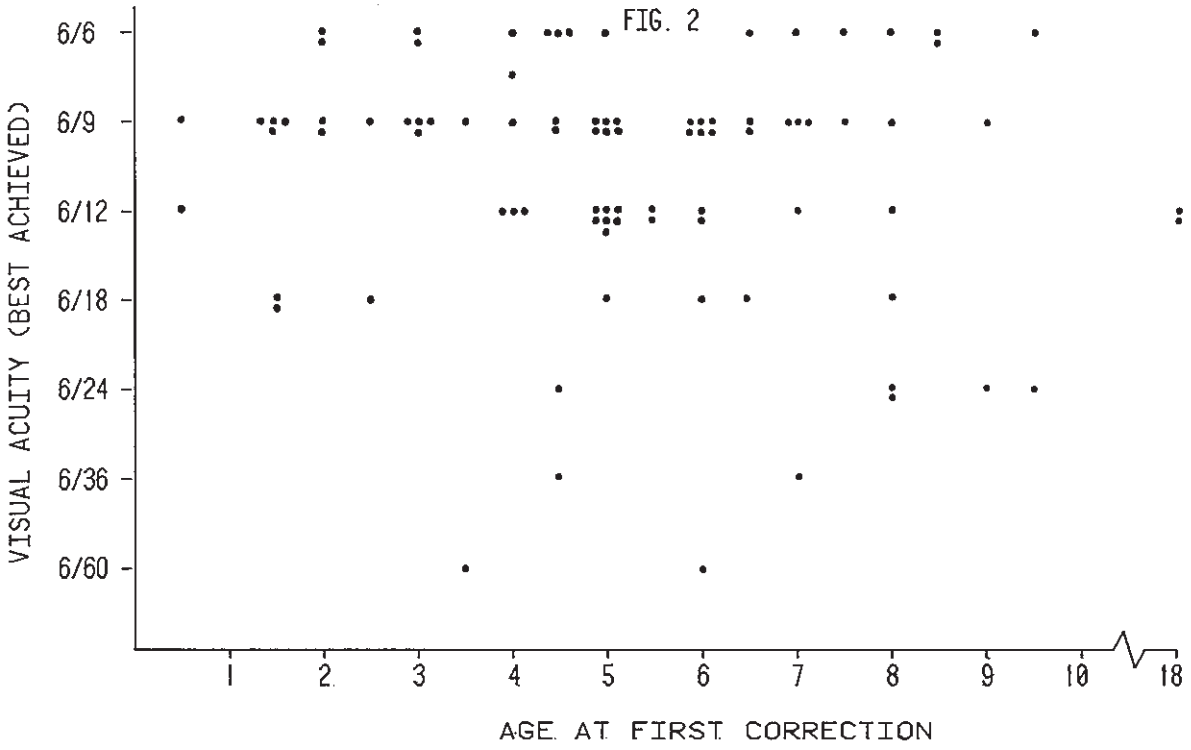
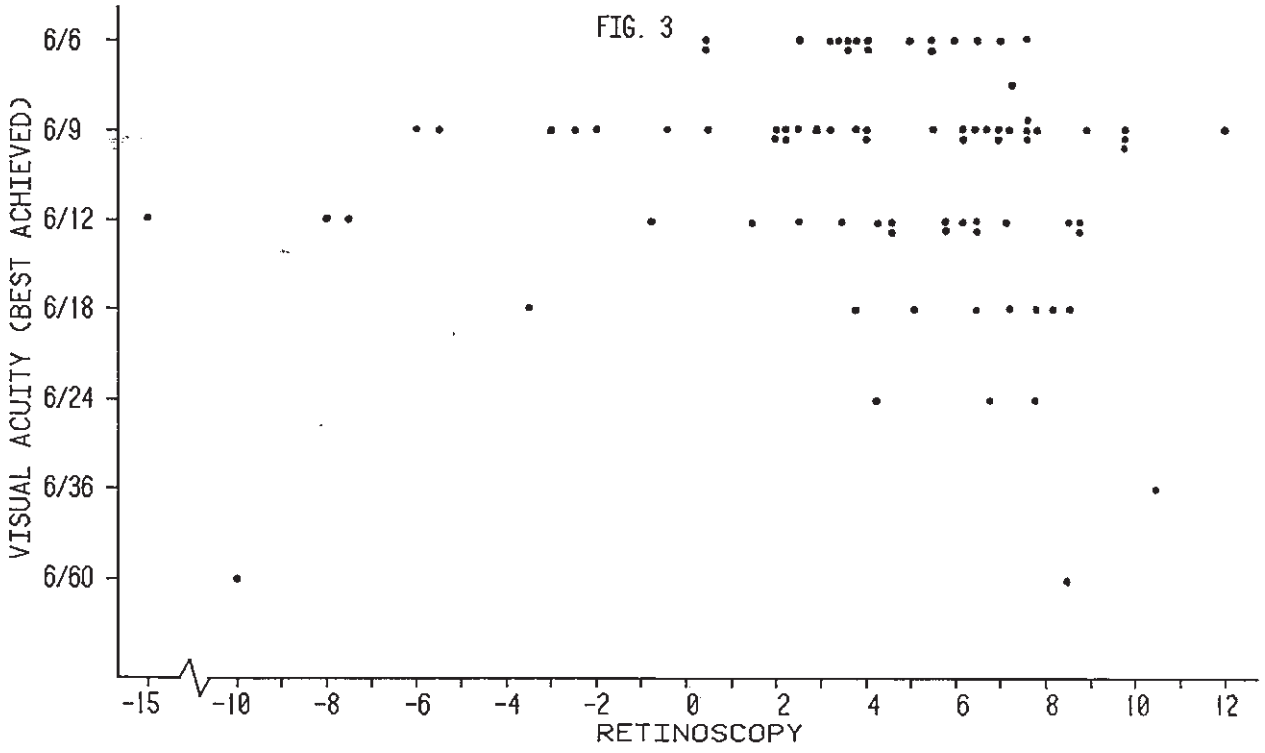

VISUAL ACUITY (BEST ACHIEVED)
6/6
6/9
6/12
6/18
6/24
6/36
6/60
1
2
3
4
5
6
7
8
9
10
18
AGE AT FIRST CORRECTION

FIG. 3


VISUAL ACUITY (BEST ACHIEVED)
6/6
6/9
6/12
6/18
6/24
6/36
6/60
-15
-10
-8
-6
-4
-2
0
2
4
6
8
10
12
RETINOSCOPY

It can be seen from both the above that there is no direct relationship between the best achieved acuity and either of the other two variables.

Fixation.
Parafoveal – 62 eyes (66%) – 5 with nystagmus
Macular – 27 eyes (29%) – 10 with nystagmus
Paramacular – 2 eyes (2%)
greater than paramacular – 3 eyes (3%) – 2 with nystagmus

Special Tests.
The special tests as mentioned before were performed on some of these patients, none of whom gave conclusively abnormal results.

Comment.
Several patients have initially presented with a unilateral microstrabismus with bilateral amblyopia and eccentric fixation. These patients have shown a most unusual response when following occlusion they demonstrated a *bilateral* or *simultaneous microstrabismus,* usually greater in the more amblyopic eye. In accordance with Mein (75)[7] a microtropia with identity could also exist in the better eye, as there is eccentric fixation in the absence of any demonstrable squint. Hermann and Priestley's concept of bifoveal instability could explain the phenomenon of bilateral squint where following occlusion of the better eye the latent instability and any underlying deviation could become manifest resulting in a bilateral squint. After cessation of occlusion, most patients reverted to their original squinting pattern.

DISCUSSION.

Hermann and Priestley (65)[3] stated that in a large series of amblyopes, about 10% will show bilateral eccentric fixation and amblyopia. Malik *et al* (68 & 72)[4,5] found similar figures of 8.5% and 9.8% respectively. The figure found in this survey – 11.2% – corresponds closely with these.

There have been several possible theories as to the aetiology of bilateral eccentric fixation.

Pathology.
1. *Neonatal Macular Haemorrhage* – Malik *et al.* (68 & 72)[4,5] suggested that macular haemorrhage at birth, which later resolved structurally, could leave a functional defect and therefore decreased foveal sensitivity. Enoch (59)[8] put forward the theory of receptor amblyopia caused by malorientation of the foveal receptors. Burian (59)[9] in his discussion of that paper, suggested that this malorientation could be as a result of neonatal macular haemorrhage. Surveys have been carried out since then by von Noorden *et al.* (73)[10] and Lowes *et al.* (76)[11] with 4-5 year follow-ups of children with this condition. The findings in both reports gave no support to the existence of organic amblyopia or strabismus following neonatal macular haemorrhage.

2. *Foveal Hypoplasia* – Duke Elder[12] states that decreased visual acuity may be partly due to a lack of retinal development, e.g. foveal hypoplasia. This condition is usually associated with other eye disorders (albinism, aniridia) however, there have been rare reports of isolated foveal hypoplasia, unassociated with these conditions. Curren and Robb (76)[14] and Yoshizumi *et al.* (79)[15] found that in these cases the following characteristics were seen:

i) decreased or absent foveal reflex
ii) poorly defined pigmentation in the macular area
iii) abnormally small vessel-free area
iv) bilaterally reduced vision
v) noticeable nystagmus.

In this present series of bilateral eccentric fixators the above characteristics were found in 14 cases (29.8%) as follows:

i) decreased or absent foveal reflex – 10 eyes – 10.6%
ii) poorly defined macular – 5 eyes – 5.3%
iii) small vessel-free area – 4 eyes – 4.3%
iv) bilaterally reduced vision – all cases
v) nystagmus – 14 eyes – 14.9% – present on visuscopy.

Thus in some cases of amblyopia, this condition may exist in lesser degrees, with reduced vision being the most obvious manifestation. Duke Elder[13] states that this condition may occur in cases of high hypermetropia.

Refractive Error. (Ametropic Amblyopia)

1. Duke Elder[12] states that vision may remain at a sub-normal level when refractive errors are not corrected until late in childhood. However, in reference to Figures 2 and 3 it can be seen that there appears to be no direct relationship between the best vision achieved and either the degree of error or the age at first correction. Abraham (64)[16] found that most patients in his survey achieved a visual level of 6/9, when a significant refractive error was present. However, this level of acuity can

still be classified as amblyopia and there is still a high possibility of eccentric fixation being present. In this survey, 40 (85%) of patients had 6/9 or better vision in one or both eyes, in the presence of bilateral eccentric fixation.

2. Hill and Ikeda (71)[17] reported on experiments performed on cats to test the response characteristics of retinal ganglion cells to focussed and blurred imagery. On testing the receptive field of an individual ganglion cell under focussed circumstances, they found that sensitivity was greatest at the field centre and declined markedly with increasing eccentricity. The cats were then tested with increasing powers of plus and minus lenses in front of the eye. As the power (refractive error) increased, the central responsiveness of the receptive field declined and the field periphery became relatively more active. In further experiments, Ikeda and Wright (74)[18] found that the ganglion cells in the central area of the retina behave slightly differently. Not only does the responsiveness of the field centre decrease, but also that of the periphery, to the point where the cell will no longer respond. They found that the response of these cells can be abolished altogether by only a small error of refraction (usually less than 8 dioptres).

In other words the foveal neurones in the retina require well focussed stimuli in order to respond effectively. If the same characteristics apply to human ganglion cells, this could possibly result in eccentric fixation. Higher refractive errors could play an important part in the aetiology of bilateral eccentric fixation as shown in this survey where 44% of eyes had a retinoscopy of over +6.25 dioptres and a further 8.5% had a retinoscopy of over −2.25 dioptres.

Is 6/6 normal vision?

An observation made by Hermann and Priestley (65)[3] was that the fixing eye of an amblyope, on critical examination, often does not have steady foveal fixation, but rather is unsteady central or parafoveal. They also noted that 6/6 or better vision is rarely reached in the "normal" eye of an amblyope. In this present study, only 50% of amblyopes had steady central fixation in the "normal" eye, and 50% had unsteady or eccentric fixation. Only 197 cases (56.7%) had 6/6 vision or better in the "normal" eye. The significance of this figure is shown when compared to the statistics of a series of normals taken from Brown and Jones (77)[19] where 86.9% of children tested had 6/6 or better vision in one or both eyes.

Kandel *et al.* (77)[20] stated that in a group of amblyopes, the dominant eye frequently demonstrates a minute amount of eccentricity that is not found in a group of normal eyes. They found that in most normal subjects with central fixation the foveal acuity was 6/4, and therefore superior to the generally accepted standard of 6/6. This being the case, a visual standard of 6/6 could still be attained in the presence of eccentric fixation as can be seen in this survey where 36% of patients with bilateral eccentric fixation had 6/6 vision one eye. The observer should therefore not assume central fixation to be the case without very careful scrutiny, irrespective of vision.

CONCLUSION.

It is apparent that critical examination of the fixation pattern of BOTH eyes of an amblyope, reveals a significant incidence of bilateral eccentric fixation (11.2%).

Various theories have been postulated to explain this phenomenon.

Neonatal macular haemorrhage has been cited as a possible cause however, surveys following up babies with this condition have found no results to support this theory.

Lack of retinal development, e.g. foveal hypoplasia, could explain bilateral amblyopia especially in cases of high hypermetropia (Duke Elder[13]) and the resultant eccentric fixation.

In this survey, the presence of a significant refractive error could explain the bilateral eccentric fixation in a marked number of cases (44% had a retinoscopy of +6.25 or over). It can be seen from the results, and Abraham (64)[16] also found that there is no direct relationship between the best achieved vision and the age at first correction. Thus if a significant refractive error is present, bilateral amblyopia and eccentric fixation could result, even with EARLY correction. Experiments conducted by Hill and Ikeda (71)[17] and Ikeda and Wright (74)[18] could possibly explain how this eccentric fixation results when higher refractive errors are present.

Following Mein (75)[7], if bilateral eccentric fixation is present even if there is no demonstrable squint, microtropia with identity could be a bilateral phenomenon. As some patients have shown in this survey, it is possible even to have a simultaneous or bilateral microtropia.

A question that arises is whether the "normal" eye of an amblyope is the same as the normal eye of a normal subject. Kandel *et al.* (77)[20] have shown that a normal eye's fovea can attain a visual

level of 6/4. Therefore, the previously accepted standard of 6/6 could still be achieved in the presence of eccentric fixation. In the light of this study, it would seem apparent that the fixation pattern of BOTH eyes of an amblyope should be carefully examined and re-checked at each visit, irrespective of visual acuity.

Thus in the amblyopic patients we treat, can we make the assumption of "normal" and "amblyopic" eye? Also I feel that the criteria of "fixing" eye and "normal vision = 6/6" should be challenged.

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REFERENCES.

1. von NOORDEN, G. K., and MACKENSON, G., "Phenomenology of Eccentric Fixation", Am. J. Oph., 62: 642-661, (1962).
2. von NOORDEN, G. K., "Bilateral Eccentric Fixation", Arch. Ophthal., 69: 25-31, (1963).
3. HERMANN, J. S., and PRIESTLEY, B. S., "Bifoveal Instability, The Relationship to Strabismic Amblyopia", Am. J. Oph., 60: 452-459, (1965).
4. MALIK, S. R. K., SOOD, G. C., GUNGULI, G., and SINGH, G., "Bilateral Eccentric Fixation", Brit. J. Oph., 52: 153-156, (1968).
5. MALIK, S. R. K., SEN, D. K., and CHOUDRY, S., "Pathogenesis and Management of Bilateral Eccentric Fixation", Indian J. Oph., 20 (1): 4-10, (1972).
6. GUPTA, S. D. and SOOD, S. C., "Microstrabismus with Bilateral Eccentric Fixation – A Case Report", Indian J. Oph., 21 (2): 66-67, (1973).
7. MEIN, J., "Bilateral Eccentric Fixation", Brit. Orthop. J., 32: 14-20, (1975).
8. ENOCH, J. M., "Receptor Amblyopia", Am. J. Oph., 48: 262-274, (1959).
9. BURIAN, H. M., in discussion, Enoch, J. M., Ibid.
10. von NOORDEN, G. K. KOUDADOUST, A., "Retinal Haemorrhages in Newborns and Organic Amblyopia". Arch. Ophthal., 89: 91-93, (1973).
11. LOWES, M., EHLERS, N., and KARUP, J., "Visual Functions After Perinatal Macular Haemorrhage" Acta Ophthal., 54: 227-232, (1976).
12. DUKE-ELDER, Sir S., Ed., Systems of Ophthalmology, Vol. V, Ophthalmic Optics and Refraction, London, Henry Kimpton, 1970, pp. 255-287.
13. DUKE-ELDER, Sir S., Ed., Systems of Ophthalmology, Vol. III, Normal & Abnormal Development, Part II, Congenital Deformities, London, Henry Kimpton, 1970, p. 653.
14. CURRAN, R. E., and ROBB, R. M., "Isolated Foveal Hypoplasia", Arch. Oph. 94: 48-50, (1976).
15. YOSHIZUMI, M. O., THOMAS, J. V., and HIROSE, T., "Foveal Hypoplasia and Bilateral 360-degree Peripheral Retinal Rosettes", Am. J. Oph., 87: 186-192, (1979).
16. AGRAHAM, S. V., "Bilateral Ametropic Amblyopia". J. Ped. Oph., 1: 57-61, (1964).
17. HILL, R. H., and IKEDA, H., " 'Refracting' a Single Retinal Ganglion Cell", Arch. Ophthal., 85: 592-596, (1971).
18. IKEDA, H., and WRIGHT, M. J., "Is Amblyopia due to Inappropriate Stimulation of the 'Sustained' Pathway During Development?". Brit. J. Oph., 58: 165-175, (1974).
19. BROWN, S., and JONES, D., "A Survey of the Incidence of Defective Vision and Strabismus in Kindergarten Age Children – Sydney 1976". Aust. Orth. J., 15: 24-28, (1977).
20. KANDEL, G. L., GRATTEN, P. E., BEDELL, H. E., "Monocular Fixation and Acuity in Amblyopic and Normal Eyes", Am. J. Optom., Phys. Opt., 54: 598-608, (1977).