Vision screening in preschool children: comparison of orthoptists and clinical medical officers as primary screeners

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Abstract

Objective—To see if there were differences in referral rates and abnormalities detected from two areas that were operating different preschool vision screening programmes.

Design—Cohort study using case notes of referrals.

Setting—Community based secondary referral centres in the county of Avon.

Patients—263 referrals from a child population of 7105 in Southmead district, an area that used orthoptists as primary vision screeners; 111 referrals from a child population of 2977 in Weston-super-Mare, an area that used clinical medical officers for screening.

Main outcome measures—Amblyopia and squint detection rates, together with false positive referral rates.

Results—The amblyopia detection rate in Southmead district was significantly higher than in Weston-super-Mare (11/1000 children *v* 5/1000), as was the detection rate of squint (11/1000 *v* 3/1000). However, the false positive referral rate from Southmead was significantly lower than that from Weston-super-Mare (9/1000 *v* 23/1000).

Conclusion—Preschool vision screening using orthoptists as primary screeners offers a more effective method of detecting visual abnormalities than using clinical medical officers.

Introduction

The principal purpose of preschool vision screening is the prevention of amblyopia.^{1,2} Amblyopia, which may be defined as defective visual acuity in a healthy looking eye that cannot be made normal with spectacles,³ is the commonest visual disability of childhood, affecting 2-5% of the population.⁴ The condition develops as a result of an abnormal range in one or both eyes during the development of the visual pathway, which is thought to be completed by the age of 9.⁵ The two most common causes of this abnormal image are strabismus (squint) and unequal refraction in the two eyes.

Amblyopia, if not prevented or left untreated, deprives the person of true binocular vision and hence the ability to perceive depth accurately. This visual impairment may limit a person's ability to take part fully in sporting activities and make him or her ineligible for certain occupations.⁵ In addition, decreased depth perception puts the other eye at increased risk of injury⁶ and has been estimated to account for blindness in 25 people a year in the United Kingdom. By definition, the diagnosis of amblyopia requires the measurement of visual acuity in each eye. This is difficult in children under 3,⁷ and Hall concluded that no method of screening infants could be recommended.⁸ After this age children are able to cooperate

more with vision testing and distance vision can be assessed using, for example, Sheridan-Gardiner cards.

Amblyopia has been recognised for over 200 years and treatment has changed little. The mainstay of treatment is to force the child to fixate with the amblyopic eye by occluding the preferred eye. Success rates of 50-90% have been reported⁹⁻¹⁰ and are thought to decrease with the age of the child,^{5,11} although the age effect has been questioned.¹² Treatment is not without its critics, and Ingram^{3,13} in particular has cast doubts on its effectiveness and the ability of programmes to select children who will respond. Occlusion also causes harm, in that almost universally children find it unpleasant and resist treatment, and school age children particularly fail to comply.^{4,5} Occlusion may also rarely induce amblyopia¹⁴ and squint in the preferred eye.

PRESCHOOL VISION SCREENING PROGRAMMES

Preschool vision screening is routine in almost all health districts in England and Wales, but a wide variety of programmes exist.¹⁵ Differences in test conditions, skills of examiners, test types, and referral criteria¹⁶ result in tremendous variation in referrals from primary screening of between 1% and 22% of children seen.¹⁷ There is widespread concern^{18,19} that current programmes in the United Kingdom produce too many false negative and false positive results and that they are unsatisfactory.^{3,8} Only a few districts, however, use orthoptists as primary screeners.¹⁸ MacLellan and Harker showed that preschool vision screening by health visitors and doctors produced referrals that were inappropriate in 70% of cases but that rescreening by orthoptists could decrease this by 25%.²⁰ Hall *et al*, in a small study in nurseries, found that orthoptic screening could double the number of visual problems detected in children previously screened²¹—a finding similar to that of Cameron and Cameron.²²

PRESCHOOL VISION SCREENING IN BRISTOL

The population of Bristol and its surrounding area is served by three district health authorities: Southmead (population 231 000), Frenchay (population 219 000), and Bristol and Weston (population 363 000). Before 1983, children in the three districts were seen for primary developmental screening under the following schedule: at age 6 weeks they were seen by the clinical medical officer, at 9 months and 2 years they were seen by the health visitor, and at 3½ years they were seen again by the clinical medical officer. The clinical medical officers examined for squint at the age of 6 weeks and examined for squint defects of ocular movement and tested the visual acuity of each eye at 3½ years. The health visitors did not do any formal vision screening. All children with abnormalities or suspected abnormalities of vision detected at this primary screening were referred to secondary assess-

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ment and treatment centres with facilities for full orthoptic and ophthalmic assessment. On behalf of all three districts these secondary centres were centrally organised by the orthoptic and ophthalmological department at the Bristol Eye Hospital. The secondary centres themselves were staffed by orthoptists and sited in various locations throughout the city and surrounding area—for example, there were five in Southmead district.

In 1983 orthoptists, concerned that clinical medical officers were missing children with visual problems and referring others unnecessarily, persuaded one of the health authorities to alter its service. In that district, Southmead, clinical medical officers stopped screening children for visual abnormalities when they saw them at 3½; instead, vision screening was undertaken by orthoptists, who saw the child at the age of 3. Secondary referral of abnormalities, however, remained the same, children continuing to be referred to the secondary assessment and treatment clinics (figure). The other health authorities in Bristol remained unconvinced that primary orthoptic screening was worth while and continued to use clinical medical officers as before. Therefore, since 1983 neighbouring districts in Bristol have used different personnel for primary vision screening of preschool

children but the same mechanism for secondary assessment and treatment.

Subjects and methods

In 1988 a study was set up to examine whether there were differences in referral rates and abnormalities detected resulting from the use of different personnel for primary vision screening. Two cohorts were selected on the basis of area of residence and dates of birth. One cohort was all children of Southmead district born between July 1981 and June 1984, and the other was children living in the town of Weston-super-Mare (which is part of Bristol and Weston district) born between the same dates. The town of Weston-super-Mare was chosen as it was considered large enough to allow adequate comparison and was geographically distinct, being served by a single secondary assessment and treatment centre. The two areas were socioeconomically similar: both had only a small proportion of people in the lower social classes and from ethnic minorities. For both cohorts the notes of all children referred to secondary assessment centres were obtained and data on initial diagnosis, treatment, and outcome recorded on a standard form by a single observer (AS).

The size of each cohort was calculated from the Avon child health computer system. This system coordinates immunisation and child health surveillance, including vision screening, and contains data on which primary vision screening clinic parents would like children to be sent appointments for and whether or not the child attended. By using this system it was therefore possible to define a cohort of children who attended each primary screening clinic.

Results

ALL REFERRALS

From the three year cohort in Southmead there were 263 referrals to the secondary centres (table I). The corresponding figure from the Weston-super-Mare cohort was 111 (table II). The sizes of the two cohorts were 7105 children in Southmead and 2977 children in Weston-super-Mare. Hence the total referral rates to the secondary centres from the two areas were the same (37/1000 children).

AMBLYOPIA DETECTION RATES

In the secondary referral clinics 81 of the 263 children from Southmead were diagnosed as amblyopic. This figure included 31 children who also had a squint. Thus the detection rate for amblyopia was 11/1000 children (95% confidence interval 9 to 14/1000). The corresponding figure for Weston-super-Mare was 14 children diagnosed as having amblyopia, six of whom also had a squint, giving a rate of 5/1000 (2 to 7/1000). Thus the relative detection rate in the Southmead cohort compared with the Weston-super-Mare cohort was 2.4 (1.4 to 4.1).

Table III shows the severity of amblyopia at initial diagnosis for both cohorts. The proportion of amblyopic children with 6/9 vision was higher in the Southmead cohort than in the Weston-super-Mare cohort. Differences, however, were not significant ($\chi^2=2.95$; $0.5>p>0.1$).

Analysis of outcome (table IV) showed no significant differences between the two groups ($\chi^2=0.8$; $p>0.5$). Thus the increased level of referral from Southmead did not occur as a result of referring less treatable children. With the exclusion of children whose extent of improvement was unknown, 61% of children (55/90) achieved improvement of two or more Sheridan-Gardiner lines and 12% (11/90) improvement of four or more lines. Children in all categories of severity of

Possible referral routes in Southmead and Weston-super-Mare. Referrals included in study were those to centres enclosed within dashed boxes

TABLE I—Initial diagnosis made by secondary referral clinics after referral from Southmead. Figures are numbers of children referred

Amblyopia	Type of squint					Total
	None	Convergent	Divergent	Other	Not known	
Right eye	21	13	3	0	0	37
Left eye	29	13	2	0	0	44
None	122	25	15	7	0	169
Not known	9	3	1	0	0	13
Total	181	54	21	7	0	263

TABLE II—Initial diagnosis made by secondary referral clinics after referral from Weston-super-Mare. Figures are numbers of children referred

Amblyopia	Type of squint					Total
	None	Convergent	Divergent	Other	Not known	
Right eye	6	1	0	0	0	7
Left eye	2	5	0	0	0	7
None	91	2	0	0	0	93
Not known	2	0	0	1	1	4
Total	101	8	0	1	1	111

TABLE III—Initial visual acuity of amblyopic eye as determined by secondary referral centres. Figures are numbers (percentages) of children

Area of residence of cohort	Initial visual acuity					Total
	6/9	6/12-6/18	6/24-6/36	<6/36	Not known	
Southmead	18 (22)	42 (52)	13 (16)	7 (9)	1 (1)	81 (100)
Weston-super-Mare	1 (7)	10 (71)	1 (7)	1 (7)	1 (7)	14 (100)

TABLE IV—Change in visual acuity of amblyopic eye from initial assessment to when last seen by secondary centre. Figures are numbers (percentages) of children

Area of residence of cohort	No of Sheridan-Gardiner lines improved					Total
	0	1	2	3	≥4	
Southmead	7 (9)	22 (27)	23 (28)	15 (19)	10 (12)	81 (100)
Weston-super-Mare	2 (14)	4 (29)	4 (29)	2 (14)	1 (7)	14 (100)

amblyopia when initially seen achieved improvement. Hence it was not possible to predict from initial visual acuity which of the children would respond and which of them would not.

SQUINT DETECTION RATES

Seventy five children referred from Southmead were diagnosed by the secondary centres as having a squint (with or without amblyopia). The detection rate for this condition in the Southmead cohort was therefore 11/1000 children (95% confidence interval 8 to 13/1000). In the Weston-super-Mare cohort eight children were found to have a squint, representing a detection rate of 3/1000 children (1 to 5/1000). Thus the relative detection rate for squint in the Southmead cohort compared with the Weston-super-Mare cohort was 3.9 (1.9 to 15.3). The study orthoptist used the records held by the secondary centres to make a subjective assessment of the outcome of treatment of squint in the two cohorts. Outcome was recorded as no change (same), improved, worse, and not known. The results suggested that in 42% of children with a squint (35/83) the condition improved during the period of the study (table V).

TABLE V—Change in squint of children from initial assessment to when last seen by secondary centres. Figures are numbers (percentages) of children

Area of residence of cohort	Change in squint				Total
	Same	Improved	Worse	Not known	
Southmead	36 (48)	30 (40)	8 (11)	1 (1)	75 (100)
Weston-super-Mare	3 (38)	5 (63)	0	0	8 (100)

FALSE POSITIVE REFERRALS

False positive referrals were defined as children found by the secondary centres to have neither amblyopia nor a squint. A total of 122 false positive referrals came from Southmead and 91 from Weston-super-Mare, representing false positive referral rates of 17/1000 (95% confidence interval 14 to 20/1000) and 31/1000 (24 to 37/1000) from the two cohorts respectively. There were therefore 1.8 times more false positive referrals from the Weston-super-Mare cohort (1.4 to 2.0) than from the Southmead cohort.

SOURCES OF REFERRAL

Orthoptists at the secondary centres thought that most referrals to them occurred after the 3 or 3½ year screening examination of children. However, health visitors and general practitioners may refer children directly to the secondary centres. In addition, clinical medical officers or orthoptists may refer children after a consultation outside routine vision screening. From the case notes it was impossible to determine the extent of these referrals, as it was not recorded whether the

child had been identified in the screening programme or at an alternative consultation. It was, however, possible to determine who had referred the child to the secondary clinics (table VI). In both the Southmead and Weston-super-Mare cohorts the proportion of children referred by personnel not directly concerned in screening was closely similar (11% (30/263) and 12% (13/111)). That referral could take place outside the screening examination meant that our study was underestimating the difference in performance between the two screening programmes. This, however, is not critical to interpretation of the results, as we were concerned with how the two screening programmes were working in practice.

TABLE VI—Source of referrals to secondary centres. Figures are numbers (percentages) of children

Area of residence of cohort	Source of referral				Total
	Orthoptist	Health visitor	Clinical medical officer	Not known	
Southmead	233 (89)	24 (9)	0	6 (2)	263 (100)
Weston-super-Mare	0	11 (10)	98 (88)	2 (2)	111 (100)

UPTAKE RATES

In the Southmead cohort the number of children actually seen at the 3 year vision screening was 5176 (73%). This was slightly below the proportion of Weston-super-Mare children (2530; 85%) who were seen for developmental screening at 3½ years. This difference should not have seriously affected the results but would have produced a slight bias in favour of finding a higher prevalence of visual abnormalities in the children from Weston-super-Mare—that is, in the opposite direction from the actual result found.

COST OF ORTHOPTIC SCREENING

Primary vision screening by orthoptists in Southmead required 15 sessions a month. Based on the midpoint of the 1990 pay scale for orthoptists plus 15% for national insurance and superannuation, the cost of each of these sessions was roughly £33. Therefore, the additional cost to the NHS of providing salaries for orthoptic screening in Southmead district was just under £6000. Though salaries are likely to be the largest part of the total cost, there are also costs of calling children, organising clinics, capital costs, and travel. Using orthoptists as primary screeners, however, has meant that clinical medical officers do not undertake this examination, so giving them more time with the child addressing other issues or allowing them to see more children per session.

SUMMARY OF RESULTS

The differences in detection rates, when applied to the child population of Southmead district, imply that, without primary vision screening by orthoptists, in Southmead each year 10 fewer children with amblyopia would have been discovered, 13 fewer children with a squint would have been discovered, six fewer children with a combination of amblyopia and squint would have been discovered, and there would have been 32 more false positive referrals.

Discussion

Our results suggest that the use of orthoptists as primary screeners improved detection rates of visual abnormalities and lowered the rate of false positive referrals to secondary clinics. This conclusion is based on the assumption that the prevalence of amblyopia and squint was similar in the two areas.

Graham examined the epidemiology of squint in

Cardiff and found no correlation between prevalence and social class, housing, or nutrition.²³ Johnson *et al* found that low birthweight babies have an increase in ocular defects but that this accounts for only a small proportion of children with visual defects.²⁴ Those data plus the magnitude of the differences in prevalence found in our series and the similarity of the two areas studied suggest that there was a real difference in performance between the two screening programmes.

Our study did not include all referrals made from the two cohorts (figure). This was because general practitioners were able to bypass the secondary clinics and refer directly to hospitals. In the case of children from Weston-super-Mare, however, these children would almost certainly have been seen at Weston-super-Mare General Hospital. As this is also the site of the secondary assessment clinic, the records are kept together and were thus included in the study. Referrals of children from the Southmead cohort to either the Bristol Eye Hospital or Southmead Hospital were not extracted and therefore were not included in the study. The likely effect of this incomplete ascertainment was to bias the results towards finding a higher prevalence of abnormalities in Weston-super-Mare.

There is no absolute yardstick for the diagnosis of amblyopia and squint. Although automated methods for diagnosis are being developed, diagnosis depends on the skill of the person performing the assessment. In this study the arbiters of whether a condition was present were orthoptists at secondary centres. As children from Southmead were themselves referred by orthoptists, this may have made orthoptists at secondary centres more likely to agree that an abnormality was present, so biasing the results. If this had occurred we might have expected a high proportion of children from Southmead to have mild degrees of amblyopia diagnosed. There was no significant difference in severity of amblyopia between the two groups, however, which suggests that such a bias did not seriously affect the results.

Orthoptic screening required that children attended for a visit that was solely for vision screening. Therefore, vision screening did not take place after or alongside other developmental measurements. This had two potential benefits which would bias the results towards orthoptic screening: orthoptists could concentrate on vision screening exclusively in the session, and there was less time for children to become bored with the screening and refuse their cooperation, which is essential for visual acuity measurement. On the other hand, orthoptic screening on a separate occasion would have inconvenienced the families.

Both orthoptists and clinical medical officers used Sheridan-Gardiner cards and the cover test for squint detection. Orthoptists, however, also used prism testing to assess binocular function and a test of three dimensional visual perception (Frisby test). The advantage these tests give in detecting abnormalities is unknown, and it is therefore not possible to say how much the performance of clinical medical officers might be improved if they were to use them. However, it seems unlikely that the additional tests used could

account for such a large difference in the detection and false positive rates.

We commented above that there is debate about the effectiveness of treatment for amblyopia. Our study shows that orthoptists are better at detecting visual abnormalities but it cannot answer the question whether the treatments themselves are effective without knowledge of the natural course of the condition. Despite reports suggesting that treatment is effective in 50-90% of cases,^{9,10} there is enough doubt to justify a randomised trial. Until this is done, however, we conclude that the balance of the evidence is in favour of treatment, and hence detection is important.

This study comes at an important time. The Hall report has recently recommended that preschool vision screening should be confined to history and observation.⁸ The reasons given were the poor performance of current programmes and the belief that using orthoptists as primary screeners would result in the detection of some abnormalities previously missed but that "the yield would probably be small." In the light of the results of this study this recommendation may need to be reviewed.

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