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## AN ANALYSIS OF ONE HUNDRED CASES OF STRABISMUS TREATED ORTHOPTICALLY\*

BY

R. U. GILLAN

WALSALL AND WEST BROMWICH

AN orthoptic department was started at the West Bromwich and District Hospital in March, 1941, not without some trepidation, as to whether the amount of work would justify the inception of such a department, and as to whether the work itself was really worth while. Fears regarding the amount of work were quickly dispelled by the rapid accumulation of a large waiting-list which

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increased by arithmetical progression with each succeeding month. Fears regarding the worth-whileness of the work were also speedily allayed. For the first time, one felt, squints were being given a square deal and not merely the sporting chance of recovery which might or might not follow the prescription of glasses, the patients as often as not being lost sight of until such time as parental solicitude or the patient's *amour propre*, boiled up into a demand for the surgeon's art, to bring an errant eye back to the straight and narrow path from which it had deviated.

At the same time, the mere existence of a waiting-list of 100 patients, even coupled with a warm feeling of self-approbation at work well done, or at least well intended, were insufficient to set at rest the still-small voice of scepticism which clamoured for appeasement, the more so since many of the pundits declared the whole thing to be vanity and vexation of spirit. It was, therefore, decided that the first 100 cases to pass through the complete course of treatment should be scrutinised, analysed and generally submitted to a ruthless evaluation of their binocular assets. This number was accomplished by November, 1943, and the scrutiny was conducted in February, 1944. The findings thereof form the basis of this article.

The main points upon which information was sought were:—

1. The deviation present at the conclusion of treatment compared with that present at the commencement, whether without or with recourse to operation.
2. The degree of binocular vision present at the conclusion of treatment compared with that existing at the commencement of treatment.

In other words it was sought to discover whether treatment produced:—

1. Orthopsis;
2. Stereopsis,

these being the two objectives which it seemed one was seeking to attain in the treatment of squints.

The material for review then, consisted of 100 consecutive cases, 51 females and 49 males, of ages from 5 to 12 years, the average being 9 years. The deviations present were from 3°-60°. Ninety-four were convergent and six were divergent. The average deviation was 19.45°. All were given orthoptic treatment, the duration of treatment being from 1 month to 16 months—the average being 4.67 months, treatments being given twice weekly.

#### Cases treated by orthoptic treatment only

Sixty-three cases were so treated.

(1) *Development of orthopsis*:—

23 of these became perfectly straight, the final deviation being 0°, the original deviations being from 3°-25°,—average 10°.

25 became almost straight, the final deviation being less than  $5^{\circ}$ , the original deviations being from  $3^{\circ}$ - $20^{\circ}$ ,—average  $10.35^{\circ}$ . 15 did not become straight, the final deviation being over  $5^{\circ}$ , the original deviations being from  $10^{\circ}$ - $30^{\circ}$ ,—average  $16.8^{\circ}$ .

These figures would appear to indicate that deviations of up to  $25^{\circ}$  may be successfully treated by orthoptic means alone, that success is more likely at the  $10^{\circ}$  level, but that not all cases of  $10^{\circ}$  or even less can be successfully treated.

The percentage of complete success in developing orthopsis in this group of 63 deviations of from  $3^{\circ}$ - $30^{\circ}$ , is 36.5 per cent.

(2) *Development of stereopsis* :—

36 cases developed good binocular and stereoscopic vision as tested by the synoptophore, cover testing, and Worth's lights. All of these commenced with simultaneous perception and fusion.

7 cases developed fair S.V., 5 commencing with S.P.F., 1 with S.P. and weak fusion, and 1 with no S.P.

20 cases developed no S.V., 1 commencing with S.P.F., 10 with no S.P., and 9 with abnormal retinal correspondence.

These figures would appear to indicate that the development of a good degree of S.V. is dependent upon having an original fair degree of binocular vision—S.P.F. or better—but that even some of those commencing with this degree may not develop good S.V.

### Further analysis

Further analysis shows that, of the 23 cases becoming straight, all commenced with S.P.F.; of the 25 cases becoming almost straight, 14 commenced with S.P.F., the remainder comprising 2 with S.P. and W.F., 3 with no S.P., and 5 with A.R.C.

of the 15 cases not becoming straight, 2 commenced with S.P.F., 9 with no S.P. and 4 with A.R.C.

It would appear therefore that the development of orthopsis by means of orthoptic treatment alone, depends to a large extent upon the degree of binocular vision obtaining at the commencement of treatment as well as on the degree of deviation; indeed that the possession of S.P.F. is an essential pre-requisite for success.

The possession of an original S.P.F. and the development of G.S.V. does not, however, mean that full orthopsis will necessarily be attained. Analysis of those 36 cases developing G.S.V. shows that 21 became straight and 15 near-straight, the average original deviation of the former being  $15^{\circ}$  and of the latter  $10^{\circ}$ .

*Results of orthoptic treatment alone.*—The findings are that,

STRABISMUS TREATED ORTHOPTICALLY

of 100 cases, 36 became straight or near-straight and developed G.S.V. by means of orthoptic treatment alone, and it appeared that an essential condition of successful treatment was the pre-existence of S.P.F. and a squint of not more than 25°—preferably much less, viz., 10°.

Cases treated by orthoptic treatment plus operation

Thirty-seven cases were so treated.

(1) *Development of orthopsis* :—

6 of these became perfectly straight, the final deviation being 0°, the original deviations being from 20°-35°—average 29°.

17 became near-straight, the final deviation being 5° or less, the original deviations being from 15°-60°—average 33.1°.

14 cases did not become straight, the final deviations being over 5°, average original deviation 35.8°.

Results of Treatment by Orthoptic Treatment alone and of Orthoptic Treatment plus Operation.

	No. of cases	Straight	Straight and stereoscopic	Nearly straight	Nearly str. and stereo.	Not straight	Not stereo.
Orthoptics only	—	23	—	25	—	15	—
	63	—	—	—	—	—	—
	—	—	21	—	15	—	27
Orthoptics plus op.	—	6	—	17	—	14	—
	37	—	—	—	—	—	—
	—	—	4	—	5	—	28
Total	—	29	—	42	—	29	—
	100	—	—	—	—	—	—
	—	—	25	—	20	—	55

Of the 100 cases therefore :—

25 became perfectly straight and fully stereoscopic.

20 became almost straight and fully stereoscopic.

26 became straight or almost straight without becoming fully stereoscopic.

29 did not become either straight or stereoscopic.

(2) *Development of stereopsis* :—

10 cases developed G.S.V., 6 commencing with S.P.F. and 3 with no S.P.

7 cases developed F.S.V., 6 commencing with S.P.F. and 1 with no S.P.

3 cases developed P.S.V., 2 commencing with S.P.F. and 1 with no S.P.

17 cases developed no S.V., all commencing with no S.P. and 2 with A.R.C.

Further analysis shows that of the 10 cases developing G.S.V., all became straight or near-straight except one; of the 7 cases developing F.S.V., 5 became straight or near-straight; and that of the remaining 20 developing poor or no S.V., 8 only became straight or near-straight.

That is, the majority of those having G.S.V. became straight and remained straight, and the majority of those not having S.V. did not become straight; which would seem to indicate that the development of S.V. is an important factor in maintaining straightness of the eyes following operation.

### Controls

In order to meet the criticism that perhaps some of the cases might have become straight without treatment, it was thought desirable to check the results of treatment against a series of comparable cases which had no treatment except the wearing of glasses. Cases on the waiting-list provided a ready means of doing this. A consecutive series of 50 cases was chosen, all of which had been on the waiting-list for over 5 months, some longer—up to 26 months—the average being 9·2 months; 33 were males, 17 were females, their ages being from 4-13—average 6·2 years. The angles of deviation were from 5°-55°—average 22·40°. In not a single case had the squint become reduced to nil, *i.e.*, there was no case of spontaneous cure.

In eleven cases, there was a reduction of the squint, the average commencing squint being 24°, and the average resulting squint being 17°—average reduction 6·7°.

The remainder were either stationary or had got worse.

Nine cases had S.P.F. and 4 had weak S.P. to commence with. The remainder had no S.P. or worse. It goes without saying that no further degree of binocular vision was developed during the waiting period, but this was confirmed in all cases by the usual tests.

A comparison of the group treated by orthoptic treatment, with the group treated by glasses alone shows an incomparable superiority of results in the former group as against the latter, *viz.*, 36·5 per cent. cures as against 0 per cent.

**Nature of refractive errors found and results of wearing glasses in the series of 100**

Of the 100 cases treated by orthoptic means, 87 were hypermetropic in one or both eyes, the errors being from 0.25D. to 6.0D.—average 2.75D. In 44 of these there was an astigmatism of over 0.50D., the majority being from 1-2D.

Twelve cases were emmetropic.

One was myopic, with a divergent strabismus.

There did not appear to be any relationship between the degree of squint and the degree of error present. Thus the highest error of 6D. and 5D. had a deviation of 5° and the highest deviation of 60° had an error of 0.50D. and 1.0D. Nor was divergent strabismus found to be necessarily associated with myopia, since of the 6 divergers, one was myopic—3 were emmetropic and 2 were hypermetropic of low degree.

The results of correction by glasses were as follows:—

3 cases only were straight with glasses at the commencement of treatment by orthoptics, the original deviations being from 5°-15°—average 10°; all three commenced with S.P.F. and developed G.S.V.

25 cases showed a reduction of squint, the average commencing squint being 18.4° (5° to 50°), and the average squint with glasses being 8.1° (5° to 20°), the average reduction in squint being 11°. Twenty of these commenced with S.P.F. and 18 developed G.S.V.

44 cases showed no alteration in the degree of squint, the average degree in this series being 21.7° (3° to 60°); 14 of those commenced with S.P.F. and 13 developed G.S.V.

Of those cases becoming straight with glasses, therefore 100 per cent. commenced with S.P.F. and developed G.S.V.

Of those cases showing a reduction with glasses, 80 per cent. commenced with S.P.F. and 72 per cent. developed G.S.V.

Of those cases showing no reduction with glasses, 31 per cent. commenced with S.P.F. and 27 per cent. developed G.S.V.

These figures would appear to show that the cases developing orthopsis as a result of wearing glasses only, are those with the lower degrees of squint, *viz.*, 5° to 15°, but that the possession of S.P.F. and a capacity for the development of G.S.V. is an essential condition of this eventuality.

Of the 44 cases showing no reduction with glasses, however, 13 were of 10° or less, and 5 of these commenced with S.P.F. and developed G.S.V. with treatment, so that not all such cases become straight with glasses. As a result of orthoptic treatment,

however, all 5 became straight, which would seem to indicate the value of orthoptics over the simple wearing of glasses.

### Conclusions

A survey of this kind naturally leads one to consider whether it sheds any light on the causation of concomitant strabismus in childhood. Is it due to a defect in the neuro-muscular mechanism, whereby orthopsis cannot be maintained, the capacity for binocular vision being unaffected, or is it a failure of the capacity for binocular vision, the neuro-muscular mechanism being intact, but having no stimulus to maintain orthopsis?

Regarding the first possibility, the existence of hypermetropia with consequent over-accommodation, associated with over-convergence has been adduced as an explanation of the development of internal strabismus, but as against this, hypermetropia is a normal condition in childhood, 60 per cent. of children at 10 years of age being hypermetropic (Parsons); there is an ample reserve of accommodation to compensate for it, *viz.*, 14D. at 10 years (Parsons). All cases of internal strabismus are not hypermetropic, and the degree of strabismus appears to bear no relationship to the degree of hypermetropia. Correction of the hypermetropia does not appear to correct the squint in the majority of cases. Also one frequently encounters cases of high hypermetropia—10D. and over—in which there is no history of strabismus. It would appear, therefore, that although hypermetropia may be a factor in determining an inward deviation of the eye rather than an outward one, it is not the main aetiological factor.

There is no question of failure of movement. Eye movements are full in all directions. There is no failure of comitancy. There is, however, a failure in the orientation of the eyes with regard to each other. This might conceivably be due to some failure in the neuro-muscular mechanism, in which case, if the strabismus is corrected by operation, the eyes should remain straight, but it would appear that in the absence of good binocular vision, the tendency is for them not to do so.

Regarding the second possibility; the absence of stereoscopic vision is the one factor common to all cases. Those cases having the greatest capacity for education or re-education in respect of stereoscopic vision, are the ones having the best prognosis as regards cure. Thus those cases having S.P.F. to commence with and developing G.S.V., form the majority of cases becoming straight and remaining straight, whether treated by means of glasses only, or by means of orthoptic treatment plus glasses, or by orthoptic treatment plus glasses plus operation. It would,

therefore appear that the absence of or failure of S.V. is the chief factor in the causation of concomitant strabismus.

Objections to this theory spring to mind at once: What about the strange phenomenon of abnormal retinal correspondence the existence of which would appear to indicate that the brain is determined to see binocularly in spite of unocular recalcitrancy. Binocular vision is not stereoscopic vision, however, and no such cases seem capable of developing stereoscopic vision. Suppression would seem to be more easily achieved for macular vision than for peripheral vision and macular vision is essential for stereoscopic vision (*vide Brit. Jl. Opth.*, October, 1938). Another objection is that if failure of stereoscopic vision is the cause of the strabismus, then re-establishment of stereoscopic vision should correct the strabismus in all cases. It does not, however, necessarily follow that this must be so, since with the establishment of a squint, new factors may be initiated, which have nothing to do with the original cause. A disorientation of the eyes has taken place, which is not necessarily amenable to correction, even by the establishment of stereoscopic vision, and may require an operation to produce correction, but this would not invalidate the primacy of stereoscopic failure in the causation of the condition. Following upon operation, it is those cases having good stereoscopic vision which are most likely to remain straight.

### Summary

The genesis of the survey is described, namely a desire to ascertain at first hand the effects of orthoptic treatment in developing: 1, Orthopsis; 2, Stereopsis.

2. An analysis is made of 63 cases treated by orthoptic means only, the findings being that 36 became straight or nearly straight and developed good stereoscopic vision. The conclusion is reached that an essential pre-requisite to successful treatment by orthoptics only, is the existence of S.P.F. and a strabismus of not more than 25°, preferably much less, *viz.*, about 10°.

3. An analysis is made of 37 cases treated by orthoptic treatment plus operation, the findings being that 23 became straight or nearly straight, and 17 developed good or fair stereoscopic vision, and the conclusion is reached that G.S.V. is an important factor in maintaining orthopsis even where operation has been performed.

4. Analysis is made of a control series of 50 cases which were under observation for an average of 9 months, and had no treatment except the prescription of glasses. The findings are that none of these developed orthopsis or stereoscopic vision.

5. An analysis is made of the refractive findings in the 100

cases under review, and of the effects present as a result of wearing glasses at the commencement of treatment by orthoptics. The findings are that 3 only were straight with glasses, 25 showed reduction, and 44 showed no change, and the conclusion is reached that the lower degrees of squint are most likely to become straight with glasses, but then an essential condition of this eventuality is the pre-existence of S.P.F. and a capacity for developing G.S.V.: that not even all such became straight, but that with the addition or orthoptic treatment they are very likely to do so.

6. The possible causation of strabismus in the light of these findings is discussed, and the conclusion is reached that the absence of or failure of S.V. is the main aetiological factor in the production of concomitant strabismus.

7. Some objections to this theory are discussed, but are not thought to invalidate it.

My best thanks are due to Miss M. Levinge, Orthoptist at the West Bromwich and District Hospital, without whose willing and enthusiastic help this investigation would have been impossible.

#### Abbreviations

S.V. = Stereoscopic Vision.  
G.S.V. = Good Stereoscopic Vision.  
F.S.V. = Fair Stereoscopic Vision.  
P.S.V. = Poor Stereoscopic Vision.  
S.P. = Simultaneous Perception.  
S.P.F. = Simultaneous Perception and Fusion.  
W.F. = Weak Fusion.  
A.R.C. = Abnormal Retinal Correspondence.

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## PENETRATION OF PENICILLIN INTO THE EYE \*

BY

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*and*

C. H. STUART-HARRIS, Lieut.-Col., R.A.M.C.

A FEW observations have been made on the penetration of penicillin into the eye after administration in various ways. Aqueous humour was collected by one of us (R.E.W.) and examined in the laboratory (C.H.S.-H.) by techniques designed to reveal the presence of substances inhibitory to bacteria. Table I shows clinical details, mode of administration of penicillin and interval between therapy and collection of aqueous humour.

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# AN ANALYSIS OF ONE HUNDRED CASES OF STRABISMUS TREATED ORTHOPTICALLY

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