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**RETINAL DETACHMENT AND ITS TREATMENT
BY SURGICAL METHODS**

A Review of Four Hundred and Twenty-Five Cases

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INTRODUCTORY

THIS paper is based upon a study of the 425 cases of simple detachment of the retina admitted to the in-patient wards of the Royal London Ophthalmic Hospital between December 25, 1929, and January 7, 1933, a period of three years and fourteen days. From the commencement of this period until February 13, 1932, all cases were operated upon by cautery puncture; in the following six and a half months the majority were subjected to the Guist-Lindner method of multiple trephining; since August 26, 1932, all cases have been operated upon by diathermy following the technique of Larsson. Two hundred and twenty-one cases were operated upon by cautery puncture; a multiple trephining operation was performed on 79, a figure which includes 16 cases operated upon previously by Gonin's method; in 72 cases diathermy was used, five of the subjects having been operated upon before by cautery puncture, four by the Guist-Lindner operation and one by each of these methods. In 79 cases no operative measures were employed. It is the purpose of this paper to subject this large series of cases to analysis, and to compare operative results obtained by the methods of cautery puncture, multiple trephining and diathermy.

The Four Hundred and Twenty-five Cases

In this series 260 of the patients were males and 165 females. Their average age was 42·8 years, the youngest being a boy of eight and the oldest a woman aged 82 years. The cases have been divided into five refractive groups; namely, high myopes, intermediate myopes, low myopes, aphakics and emmetropes. Ninety-three cases had a myopia of over 10 dioptries, 86 a myopia of from 5-10 dioptries, 86 a myopia of less than 5 dioptries, 28 occurred in aphakic eyes and in no fewer than 132 cases the refraction was either emmetropic or slightly hypermetropic. The right eye was affected in 195 cases, the left in 168 and in 62 there was a detachment in each eye. Of the latter, 40 were cases of myopia showing an antecedent detachment in the other eye, nine occurred in aphakic subjects five of whom were previously myopic and four emmetropic, in four there was a condition of emmetropia—two of which had a traumatic detachment in each eye, whilst in nine of the cases there was a bilateral symmetrical detachment of the retina showing the clinical features which I described to the Ophthalmological Society of the United Kingdom last year (Vol. LII, p. 170). The above statistics are shown in the following table, the figures being expressed as percentages in the second column:—

TABLE I

General Statistics

		Per cent.
Males	260	61·2
Females... ..	165	38·8
Average age	42·8	42·8
High myopes (over 10 D.) ...	93	21·9
Intermediate myopes (5-10 D.)	86	20·2
Low myopes (0-5 D.)... ..	86	20·2
Emmetropes	132	31·1
Aphakics	28	6·6

} 62·3

Trauma, direct and indirect, appears to have played a small part in the aetiology of the myopic detachments and, as might be expected, has occasioned a much larger proportion of those occurring in emmetropia. Thus in the group of 265 myopes a history of recent local or general injury was obtained in 41, a percentage of 15·5, whereas in the 132 emmetropes direct or indirect trauma played a part in 58, a percentage of 43·9. In addition, in one of the emmetropes, two of the aphakics and six of the myopes the onset of detachment synchronised with a bout of severe coughing; in two of the high myopes it occurred when lifting a heavy weight, and in one of the low myopes whilst playing golf.

The influence of injury in the aetiology of retinal detachment is shown graphically in Diagram I, in which the ever decreasing importance of trauma as the degree of myopia increases is well demonstrated. The figure also shows that the moiety of direct, or

DIAGRAM SHOWING THE INFLUENCE OF TRAUMA, DIRECT AND INDIRECT, IN THE AETIOLOGY OF RETINAL DETACHMENT.

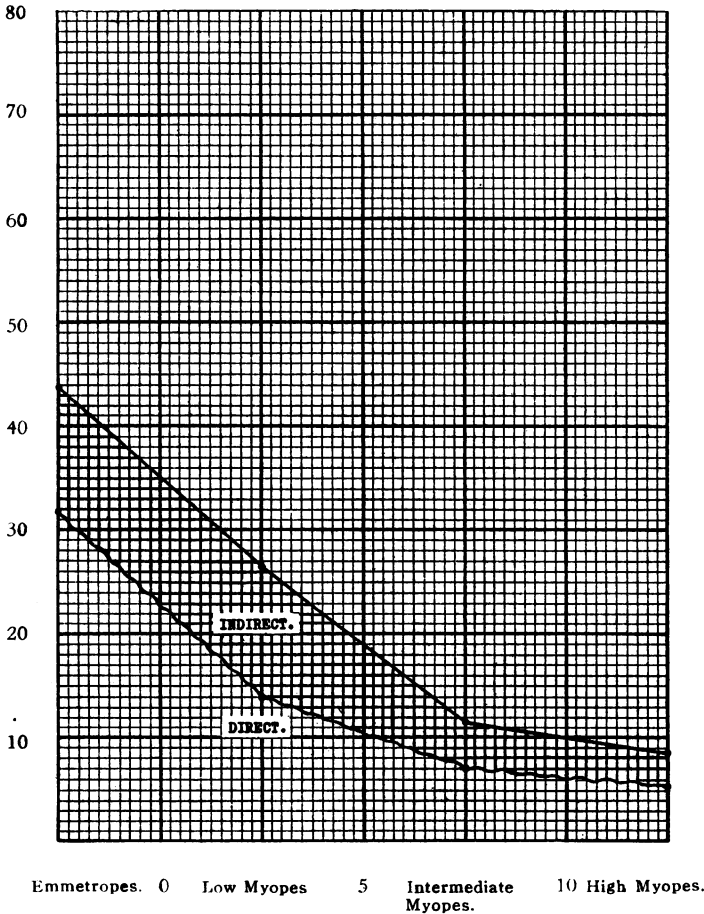


DIAGRAM I.

more severe injury, is of relatively still greater significance in emmetropia than is the element of indirect, or less severe trauma, and it decreases proportionally more rapidly than does the latter as the measure of myopia increases. Spontaneous detachment is therefore the rule in myopia, trauma of relatively frequent import as an aetiological factor of retinal detachment occurring in emmetropia.

Retinal Holes—Distribution and Incidence

In this series a retinal hole or holes were found in 324 cases, a percentage of 76·2. Of these 90·4 per cent. were in front of the equator of the globe, and in 23·8 per cent. of the cases the holes were multiple. According to their morphology retinal holes may be classified into five groups, namely,

- (1) Round holes.
- (2) Disinsertions at the ora serrata.
- (3) Arrow-head or horse-shoe-shaped holes.
- (4) Slit-like tears.
- (5) Irregular rents.

The typical round hole is definitely circular, has a sharply punched-out outline, varies in diameter from less than 0·1 mm. up to that of the disc itself and is not infrequently associated with foci of old choroido-retinitis, suggesting that this type of hole is inflammatory in origin. Oval, triangular and diamond-shaped tears together with degenerated fenestrated areas of the retina in which numerous minute rounded or honeycomb holes are present have been included in this group and so classified as rounded holes. The holes in this rather heterogeneous group are commonly multiple, this being the case in 22·6 per cent. of their incidence in this series; in addition in 13 per cent. the round hole was combined with one or other type of true hole, in 9·6 per cent. with fenestrated areas in the retina, and in 5·2 per cent. of this group fenestrated areas alone were present. The round hole is usually situated at a point about two disc diameters behind the ora serrata.

The disinsertion, or, as it is more correctly called, anterior retinal dialysis, a term suggested by Ringland Anderson, averages about 5·1 mm. in long axis—that is, subtends an arc of 30° at the ora serrata. In this series 58·7 per cent. of the disinsertions subtended an arc of 30° or less, 25·6 per cent. one of from 30° to 60°, 9·1 per cent. one of from 60° to 90°, and 4·1 per cent. an arc of from 90° to 180°. In two of this series the retina of half the circumference of the globe at the ora serrata was torn away and in one case there was a practically total anterior retinal dialysis. In only 7·4 per cent. of their incidence were the disinsertions multiple, and in 3·3 per cent. they were combined with other holes.

The arrow-head and horse-shoe holes are shaped as their names indicate, the point of the arrow or convexity of the horse-shoe being nearly always on the disc or central side of the base of the arrow-head or concavity of the horse-shoe. The peripheral tag of retina so delimited is frequently seen to project into the vitreous, suggesting the possibility of vitreous adhesion and traction in the genesis of



PLATE 1.

Retinal detachment in the right eye of a high myope (-20 D.) showing a horse-shoe-shaped hole combined with a radial slit-like tear in the supero-nasal quadrant. Appearance six weeks after the commencement of visual failure. The sub-retinal fluid has gravitated downwards, leaving the retinal holes on an apparently attached portion of the retina. Note the projection of the retinal tag into the vitreous.

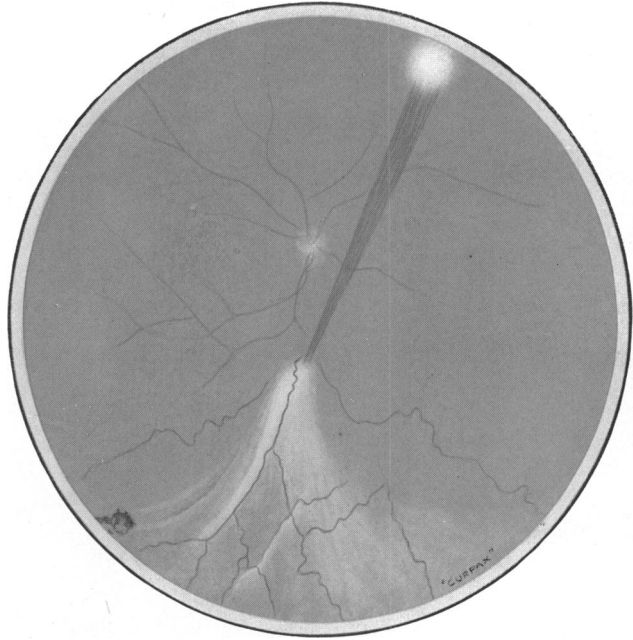


PLATE 2.

Retina pulled into the form of a cone infero-temporally by the coagulation and contraction of the vitreous following cautery puncture for a slit-like tear in the supero-nasal quadrant. Appearance six weeks after operation (semi-diagrammatic). A year later an irregular retinal hole was present at the site of the apex of the cone, and the vitreous strands had largely disappeared.

this type of rent. Averaging about 3 mm. from apex to base, the arrow-head hole tends to be large, its centre is usually situated about three disc diameters from the ora serrata and it is most frequently single, in this series being combined with other types of retinal hole in 13·3 per cent. and multiple in only 5·7 per cent. It is this type of retinal tear which in my experience is most frequently crossed by an intact retinal vessel which usually traverses the rent on a narrow "bridge" of retinal tissue. The resistance offered by the larger retinal vessels to hole formation is thus aptly demonstrated. That, in rare instances, one of the larger vessels may rupture at the moment of retinal hole formation, is shown by the fact that three of the cases in this series presented themselves clinically as examples of total spontaneous vitreous haemorrhage, the detachment and hole only being discovered some months later on the vitreous clearing. A lesser haemorrhage is probably of fairly frequent occurrence and may account for the coarser vitreous opacities which are practically a constant concomitant of simple retinal detachment. (Plate 1.)

The slit-like tears are usually small, their long axis is characteristically parallel to the meridian of the globe at that point and they are situated about a disc diameter and a half behind the ora. In 10 per cent. of their incidence in this series they were multiple, and in 20 per cent. combined with other holes. It is worth pointing out that the limbs of an arrow-head or horse-shoe rent may be mistaken for two radial tears, the point of the arrow or convexity of the horse-shoe being hidden behind the retinal tag or a secondary fold of detachment.

In the group of irregular holes have been placed those rents which could not be classified under the above headings. This type of hole is definitely associated with trauma, and therefore tends to be large, irregular in outline, and variable in position. In 10·5 per cent. of its incidence it was multiple, and in 26·3 per cent. combined with one or other type of retinal tear.

The distribution of the three chief types of retinal hole,—round, arrow-head and disinsertion, is shown in Diagram II. For the purpose of this figure each eye has been numbered as if it were a clock face, the left eye anti-clockwise so that corresponding retinal points should be obtained. In a given eye multiple holes of the same type occurring in one sector have been classified as a single hole, and tears placed on the boundary between two sectors have been included in the sector adjacent in which they show their maximum incidence. Grouped in this way there were 115 examples of the round hole, 113 of the disinsertion, 105 of the arrow-head, 20 of the radial slit-like tear, and 19 of the irregular rent.

A glance at this diagram shows that the temporal half of the globe is by far the commonest site for a retinal hole, 79·6 per cent. of all tears in the series occurring in this situation. The infero-nasal is

DIAGRAM SHOWING THE DISTRIBUTION OF THE THREE CHIEF TYPES OF RETINAL HOLE.

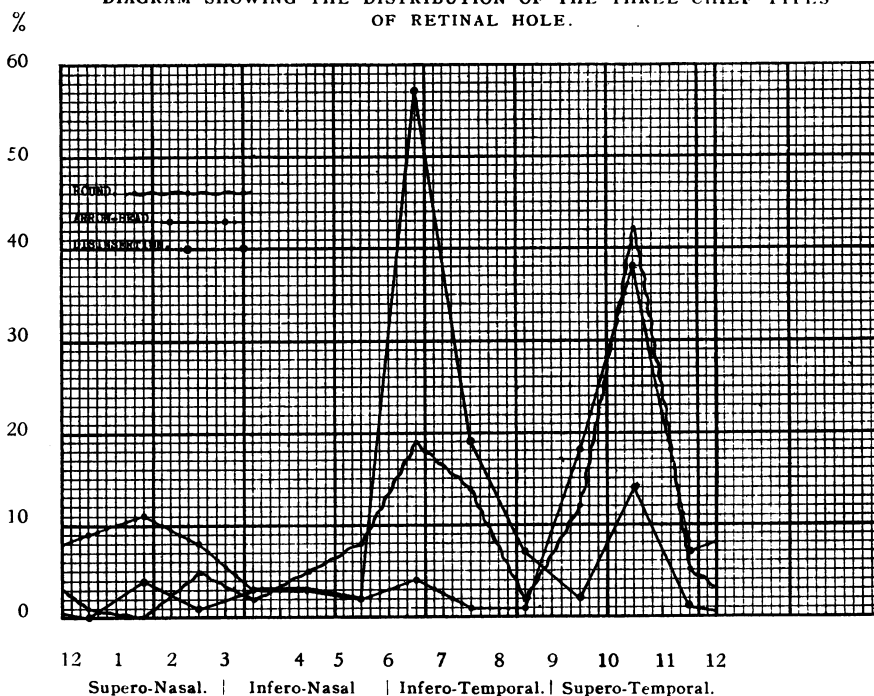


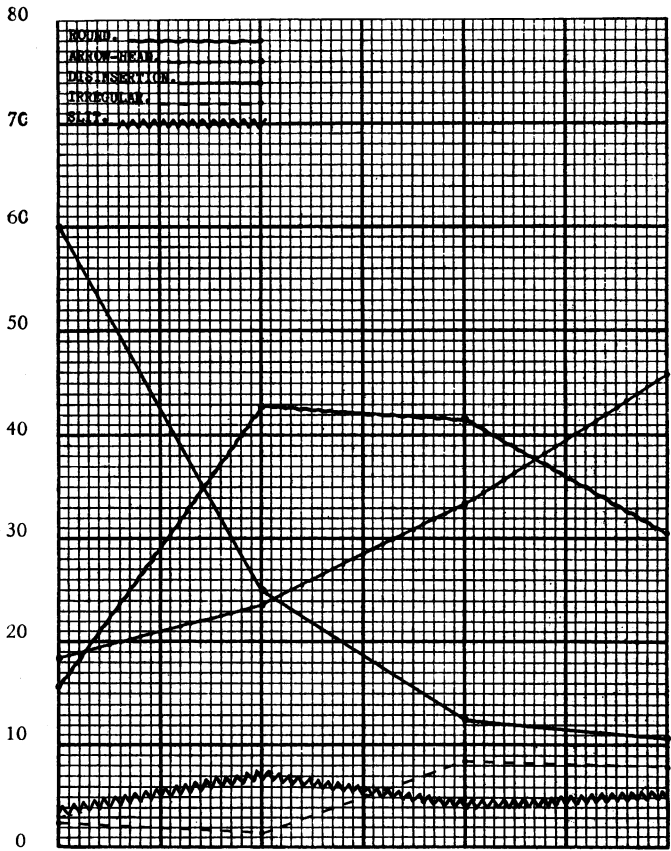
DIAGRAM II.

the quadrant in which a retinal hole is least commonly found, but a retinal detachment, of course, occurs here frequently as the sub-retinal fluid tends to gravitate downwards; hence the supero-nasal quadrant becomes the situation in which the retina is most likely to be found *in situ*. It is in the temporal half of the globe that the round hole has its main incidence, 82.6 per cent. occurring here, with 51.3 per cent. in the supero-temporal quadrant which is the site of election for this type of hole, its "peak" being in the sector 10-11. The disinsertion also occurs chiefly in the temporal half, but with this type of rent the infero-temporal quadrant is the site of election, 73.5 per cent. being located here, a marked "peak" occurring in the sector 6-7. The curve for this type of hole shows a small secondary rise in the sector 10-11; the majority of the anterior retinal dialyses occurring in the upper temporal quadrant have, in my experience, been associated with severe direct trauma to the eye. The arrow-head and horse-shoe holes were situated in the upper half of the globe in 86.6 per cent. of their incidence, and in the supero-temporal quadrant, their site of election, in 60 per cent. The sector in which they show their maximum incidence is, as with the group of rounded holes, that from 10-11. The slit-like and irregular rents were also

distributed chiefly in the temporal half of the globe, 80 per cent. of the former and 89.5 per cent. of the latter being in that situation. A small "peak" occurred for the radial slits in the sector 8-9, and from 10-11 for the irregular rents.

In Diagram III is shown the percentage incidence of the various types of retinal tear in the four main refractive groups, the class of aphakics being considered according to their refraction before operative removal of the lens. For the purpose of this diagram multiple holes of the same class occurring in a given eye have been regarded as a single example of the hole in question. Numbered in this way it will be observed that the round hole shows its main

% DIAGRAM SHOWING THE INCIDENCE OF THE FIVE TYPES OF RETINAL HOLE IN THE REFRACTIVE GROUPS.



Emmetropes. 0 Low Myopes. 5 Intermediate Myopes 10 High Myopes

DIAGRAM III.

incidence in the groups of low and intermediate myopes, in each of which it forms just over 40 per cent. of the tears, its curve falling steeply to 15·7 per cent. in the emmetropes, and more gradually to 30·3 per cent. in the class of high myopes. The curve for the arrow-head and horse-shoe-shaped rents shows a steady rise from 18·3 per cent. in the emmetropes to 45·8 per cent. in the high myopes, in which group it therefore becomes the retinal hole of most frequent occurrence. The disinsertion, on the other hand, is present chiefly in the emmetropic or slightly hypermetropic eye in which it forms no less than 60 per cent. of the tears, its curve then showing a steady decline throughout the range of myopia, until, in the group of high myopes, its incidence has fallen to only 10·8 per cent. The slit-like rents show a fairly even distribution throughout the refractive groups, whilst the curve for the irregular rents tends to rise slightly in the intermediate and higher grades of myopia.

Some further statistics of interest concerning retinal holes are shown in the following table in which the age and sex incidence together with the influence of trauma have been worked out for each type of retinal tear.

TABLE II

	Males Per cent.	Females Per cent.	Average age Years	Trauma Per cent.
Round ...	47·2	52·8	45·3	16·0
Arrow-head...	57·7	42·3	52·0	18·5
Slit ...	52·9	47·1	51·3	23·5
Disinsertion	70·3	29·7	31·1	39·0
Irregular ...	88·2	11·8	41·0	58·8

It is of interest to note that those rents which occur mainly in myopia—the round and the arrow-head—show a fairly equal sex, and a relatively late age incidence, whilst the influence of trauma is not marked. The figures for the radial slit-like tears follow closely those of the arrow-head type which suggests that they share a similar origin. The disinsertions, however, occur chiefly in males, at an earlier age, and a relatively high percentage are of traumatic origin. The irregular rents, in which the influence of injury is undoubted, naturally show a decided preference for those of the male sex.

The Pathogenesis of Retinal Holes

The following are the factors each of which may, in theory, determine the formation of a retinal hole—

- (1) Trauma, direct or indirect.
- (2) Degeneration, detachment and traction of the vitreous body.
- (3) Focal retinal necrosis from acute choroido-retinal inflammation.
- (4) Retinal degeneration.

It is, perhaps, unwise to draw conclusions regarding the pathogenesis of retinal holes from statistical evidence alone. It has been shown, however, that the arrow-head and horse-shoe rents occur in the upper half of the globe in 86.6 per cent., and present a rising curve of incidence as the degree of myopia increases. It is difficult, therefore, not to come to the conclusion that this type of retinal hole clinically agrees well with Gonin's conception of the origin of retinal tears—that is by the traction of degenerate vitreous stroma which has become anchored to a small area of retinal tissue through the action of a pre-existing inflammatory focus. The round holes, on the other hand, show neither the same preference for the upper half of the globe nor for the higher degrees of myopia, but are distributed mainly in the temporal half of the globe and in the low and intermediate grades of myopia. Although the rather uncommon rounded hole in which an isolated portion of retinal tissue appears to lie free in the vitreous in front of its centre probably has a similar origin, the sharply punched-out, definitely circular hole which is often associated with scattered foci of old choroido-retinitis is almost certainly derived from the breaking down of adhesions or a tearing of the retina around such an inflammatory focus. The single round hole in which the eye shows no evidence whatsoever of any previous inflammatory lesion in all probability results from the rupture of a retinal cyst. The small, multiple rounded holes which are usually contiguous and the atrophic fenestrated areas of the retina would appear to be the result of a simple primary retinal degeneration and it seems unlikely that the vitreous plays any active part either in the formation of these holes or in the ensuing detachment.

The disinsertion occurs mainly in emmetropic eyes and in the infero-temporal quadrant. A history of trauma is obtained in about 39 per cent. of the cases having this type of rent. In a proportion of these, no doubt, no factor other than that of direct violence is required, a delicate tissue yielding at its weakest point, close to its periphery and in its most exposed situation. In the remainder, and in the still larger number in which no history of injury is obtained, additional factors must be sought. The periphery of the retina is thinnest on the temporal side and it is here that the retina is earliest affected by cystoid degeneration. Two anterior retinal dialyses in this series were secondary to an inflammatory retinal

detachment, the sub-retinal exudate spreading inferiorly under the influence of gravity, lifting the retina from its bed and tearing it at its weakest point as a stamp is torn along its perforations. Ringland Anderson states that "the actual cause of anterior dialysis, apart from obvious cyclitis and severe trauma, is obscure. Structural features, and particularly the attachment of the vitreous base and the 'stretched' nature of the inferior temporal ciliary zone, appear to play a part in the mechanism that may produce dialysis. One has only to watch the development of a tear round a retino-vitreous adhesion or to see the alteration in shape and position of a hole in a posterior hyaloid membrane after cauterisation to realize the effect that vitreous traction may have on the retina. Such traction is particularly potent near the ora serrata owing to the firm attachment of the vitreous base. Once the pars ciliaris retinae and the ora serrata are torn from the retina by the adherent base of the vitreous, the retina lies loosely, and almost un-attached, on the choroid until the collection of fluid beneath it causes its detachment. Such a separation may be aided by the presence of cystoid degeneration which appears most early in this apparently predisposed zone."

The majority of the irregular rents are undoubtedly due to the effect of direct violence; the remainder probably result from the further splitting up of the retina along one or both limbs of an arrow-head rent, this type of hole taking on many diverse and bizarre shapes when the degree of myopia is high and the retina unduly atrophic.

From a consideration of the foregoing it would appear possible to classify simple detachment of the retina into four clinical types:—

(1) Detachments occurring in early life, more especially in the second and third decades. In these about 70 per cent. are in males; the refraction is typically non-myopic, and rather more than one-third are of traumatic origin. The detachment, which tends to be flattened rather than ballooned, commences below in relation to an anterior retinal dialysis situated in the lower temporal quadrant, and many show a marked tendency to become circumscribed by a zone of choroido-retinal adhesions, and hence remain stationary for long periods. A complicated cataract does not appear to develop unless the retina has become totally detached. As a sub-group of this class should be included those cases of bilateral symmetrical detachment of the retina, which I described in a previous paper, in which symmetrically placed disinsertions are present infero-temporally.

(2) Detachments commencing in later life, more especially in the fifth and sixth decades. In these the sexes are more equally affected; the refraction is typically myopic, chiefly of the intermediate and higher degrees, and trauma is of small significance in

the aetiology. The detachment, at first frequently ballooned, commences above in relation to an arrow-head or horse-shoe rent situated usually in the upper temporal, less frequently in the upper nasal quadrant, and, as a rule, spreads rapidly until the retina is totally detached, a complicated cataract developing within six to eighteen months and soon becoming complete.

(3) Detachments primarily inflammatory in origin but becoming of the simple type secondarily through the sub-retinal exudate lifting and tearing the retina at its weakest part, pathologically or otherwise, or possibly breaking down choroido-retinal adhesions around a previous focus of acute choroido-retinitis, or tearing the retina at the periphery of such a focus, and thus perpetuating the detachment by forming a direct communication between the pre- and sub-retinal spaces. Two of the detachments in this series were undoubtedly of this nature, and, as previously mentioned, a proportion of the true round holes may originate in this way, the remainder resulting from the rupture of a retinal cyst or from a simple degeneration of the retina. Detachments showing round holes occur mainly in the fourth and fifth decades, equally in the sexes, and in any type of eye, but more especially those with a low or intermediate degree of myopia. The detachment commences characteristically in the temporal half of the globe in relation to a round hole or holes situated most commonly in the supero-temporal, rather less commonly in the infero-temporal, quadrant.

(4) Detachments occurring in aphakia. In this series 19 were present in males and 9 in females. Thirteen followed cataract extraction at an average interval of 3·8 years and 15 after needling at an average interval of 25·1 years. These detachments are characterised by the relative rarity with which a retinal hole is found, in only 32·1 per cent. in this series; on account of this and the difficulty of accurate localisation when a rent is discovered owing to the altered refractive conditions, and also the frequency with which the periphery of the fundus is inaccessible to ophthalmoscopy because of remnants of posterior capsule, the operative prognosis is consistently bad.

Localisation of Retinal Holes

At Moorfields direct ophthalmoscopy is employed in the search for, and localisation of, retinal holes. With an intelligent patient an accurate account of the initial symptoms, photopsiae or positive scotoma, especially with regard to their position in the visual field, are of the utmost value as indicating the original position of the detachment and hence that of the retinal tear. The hole need not necessarily be found on that portion of the retina which is detached at the time of examination as the sub-retinal fluid in relation to a

detachment commencing above usually gravitates downwards, so that, in a detachment of some chronicity, the hole may be found on a flat, or apparently attached, portion of the retina. The tear may be hidden behind a large balloon or secondary fold of detachment, in which case it may sometimes be revealed by keeping the patient recumbent for a few days in an appropriate posture, or the sub-retinal fluid may be evacuated by a posterior scleral puncture. A posterior sclerotomy for this purpose was performed in nine cases of this series with the subsequent discovery of a hole in two.

The retinal hole having been located, it is necessary to calculate its distance from the ora serrata and to mark the meridian passing through its centre. The ora serrata is assumed to be visible to ophthalmoscopic examination when, with the pupil fully dilated, the eye is rotated as far as possible in the required direction. In an emmetrope or an eye with a low degree of myopia it lies at a distance of about 8 mm. from the limbus, in the intermediate and higher degrees of myopia, 9 mm. is allowed for this measurement; in all 1 mm. less is allowed for the nasal as compared with the temporal side of the globe. The diameter of the optic disc is 1.5 mm. and 1 D.D. (disc-diameter) is the conventional unit of measurement in fundus topography, the site of the retinal hole being calculated in terms of disc diameters from the ora serrata. To mark the meridian upon which the hole lies, a drop of a 2 per cent. solution of holocaine and adrenalin is put in the affected eye, and a pigment mark tattooed with Indian ink at the limbus on the side remote from the retinal hole but in the same line as this and the centre of the cornea. The ophthalmoscope is then employed to determine whether the mark so made, the centre of the cornea and the hole are in correct alignment. If this is the case a second mark is tattooed at the limbus at a point diametrically opposite the first. At operation a guiding thread of silk is knotted at the site of the first pigment mark, passed over the centre of the cornea and the second pigment mark so that its prolongation crosses the site of the retinal hole; the previously estimated distance of the latter from the ora serrata—added to the 8 or 9 mm. allowed for the distance from limbus to ora—then being measured off along the guiding line with a pair of calipers. Having thus ascertained the surface marking of the retinal hole, this spot is marked on the sclera by a touch of the actual cautery or by one or two turns of a 1.5 mm. trephine.

Cautery Puncture

At Moorfields the first operation for retinal detachment by Gonin's method was performed by Sir William Lister on December 27, 1929. Since that date and until this type of operative

procedure was superseded by that of multiple trephining and diathermy, 221 cases were so treated; 204, in which retinal holes were discovered, by a true Gonin operation, and 17 cases, in which no rent was found, by the so-called "blind" cautery puncture. It is outside the scope of a paper such as this to describe the details of Gonin's operation, suffice to say that Gonin's technique was followed exactly for the first six months when the somewhat fickle Paquelin cautery was replaced by the electric thermo-cautery with a consequent fall in the incidence of late vitreous haemorrhage. The results obtained with this type of operation are shown in the following table:—

TABLE III

Cautery Puncture

	(204 cases) Holes present.			(17 cases) "Blind" operation.		
	Cure	Improved	Failure	Cure	Improved	Failure
Emmetropia - - - (71)	24 (33·8%)	11 (15·5%)	36 (50·7%)	(4) 0	1 (25%)	3 (75%)
Myopia (0-5 D.) - (40)	12 (30·0%)	4 (10·0%)	24 (60·0%)	(1) 0	0	1 (100%)
Myopia (5-10 D.) - (44)	16 (36·4%)	4 (9·1%)	24 (54·5%)	(3) 0	0	3 (100%)
Myopia (over 10 D.) (41)	8 (19·5%)	1 (2·4%)	32 (78·1%)	(6) 0	1 (16·7%)	5 (83·3%)
Aphakia - - - - (8)	1 (12·5%)	1 (12·5%)	6 (75·0%)	(3) 0	0	3 (100%)

Thus, of all cases operated upon by cautery puncture, 27·6 per cent. were cured and 10·4 per cent. improved, the figures for the true Gonin operation being 29·9 per cent. and 10·3 per cent. respectively, whilst with the "blind" cautery puncture no cases were cured and two or 11·8 per cent. showed improvement either in visual acuity or visual field or in both. The large majority of the cases which are the subject of this paper have been followed up, and, for all types of operative procedure, the results given are based upon the condition found on clinical examination during the first three months of last year. This accounts for the figures in the above table of the cases showing improvement being rather smaller than those given in my previous papers dealing with Gonin's operation, as it is only to be expected that a majority of the cases deriving some immediate benefit from operation, but without complete reposition of the retina at the time of discharge from hospital, would fail to maintain the improvement. Such cases, therefore, and also those of primary cure with later relapse have been classified as failures in this paper. By "cured" it is, of course, understood that the retina was completely in place at the time of examination.

The following table shows some further statistics of interest relating to the successes obtained by Gonin's operation.

TABLE IV

Duration of detachment	Cure		Successes—number of operations	
	...	Per cent.	...	Per cent.
Under 6 weeks	...	40	One cautery puncture	... 62'3
6 weeks—three months	...	28	Two cautery punctures	... 31'2
3—6 months	...	22	Three cautery punctures...	4'9
Over 6 months	...	10	Four cautery punctures	... 1'6

The figures in the first column must be regarded as being approximate only as it has not been possible in every case to obtain an accurate history from the patient regarding the duration of visual failure. However, the figures show most graphically the importance of early interference when treating retinal detachment by operative means. In the second column is shown the number of separate cautery punctures performed upon the successful cases, the figures being expressed in percentages. It shows that the majority of the cures were obtained by one, or at the most, two cautery punctures.

Complications of cautery puncture, apart from the production of secondary rents and vitreous haemorrhage, were few. Thus, in the 221 cases so operated upon, 39, or 17·6 per cent., showed secondary holes, and 16, or 7·2 per cent., a complete vitreous haemorrhage. There were three examples of traumatic cataract, three of a diffuse sub-retinal haemorrhage, in one of which the development of a large opaque brownish mass beneath the retina suggested the diagnosis of thrombosis of a vorticosse vein, whilst in one case the cautery point fused and was left in the patient's retina, where it produced a really remarkable ophthalmoscopic picture. In addition ten cases showed a transient uveitis characterised by slight chemosis of the ocular conjunctiva, ciliary injection, keratic precipitates, cells in the anterior chamber, retraction of the iris and hypotonia. The majority of these cleared up in the course of a few days on atropine and hot bathings, in fact two of the cases having this complication were ultimately discharged from hospital cured, so it does not necessarily militate against a successful result: on the other hand, in one case it led to seclusion of the pupil, iris bombé and secondary glaucoma for which an iridectomy had to be performed five months later. In two cases in which operation was followed by a complete vitreous haemorrhage, in one in which a traumatic detachment was complicated by subluxation of the lens, and in one case where the affected eye received a severe blow fifteen months after cautery puncture, secondary glaucoma supervened, the eyes became blind and painful and excision had to be performed.

Secondary rents, by which term is meant fresh defects in the retina following upon, and apparently a direct result of the operative procedure, are of three types:—

(1) Irregular rents at the site of the cautery scar, due either to a further tearing of the retina in the neighbourhood of the original hole by the trauma of the operation or to a condition which Lindner alleges is allied to necrosis produced by the thermo-cautery in the adjoining part of the retina.

(2) Traction rents, which may be of two varieties. (a) Holes, usually of an irregular shape, but occasionally assuming an arrow-head form, and characteristically situated at a point more or less diametrically opposite the site of cautery puncture, which are apparently due to coagulation and contraction of the vitreous towards the scar with a consequent pull on the retina. (b) Dialyses in the neighbourhood of the operation scar which seem to be produced by a mal-reposition and shortening of the retina which again results in traction towards the cicatrix. (Plate 2.)

(3) The extension of an anterior retinal dialysis. In a small proportion of the cases operated upon for this type of rent, the retina continued to tear away from the region of the ora serrata in the neighbourhood of the cautery scar. The mechanism would again appear to be imperfect re-application, shortening of the retina with consequent traction towards the cicatrix.

In the 221 cases operated upon by cautery puncture there were 20 examples of the first type of secondary hole, 14 of the traction rent—eight being traction disinsertions, and five cases showed an extension of an anterior retinal dialysis. In one case five weeks after an apparently successful operation the patient returned with an enormous secondary dialysis above, with the retina reflected and folded upon itself so that its choroidal surface was presented to view. The choroid alone was visible above, then the reverse aspect of the retina, and below, through the dialysis, a small portion of attached and normally detached retina was visible giving the patient a restricted, crescentic area of eccentric vision in the upper part of the visual field.

Multiple Trephining

The first operation by the Guist-Lindner method was performed at Moorfields on February 13th, 1932. Seventy-nine cases were operated upon by this means; in 57 of these retinal holes were found and in 22 a so-called "blind" operation was performed. Of the 57 cases in which retinal holes were present 13 had previously been operated upon by Gonin's method and three of the 22 cases in which no defects were discovered had been subjected earlier to a "blind" cautery puncture. The Guist-Lindner technique was closely followed, a 1.5 mm. trephine being used. In 12 cases, however, Foster Moore's modification was employed in which a single hole is made with a 2 mm. trephine, the choroid separated

around this area for a distance of about 5 mm. radius with a grooved, blunt-ended instrument shaped like an iris repositior, and phenol (acidum carbolicum liquefactum, B.P. 1914) applied with the repositior to the exposed and separated area of choroid; in one of the cases so operated upon 2 per cent. silver nitrate was used as the caustic agent. The main essentials of the Guist operation of multiple trephining are to obtain complete haemostasis before trephining is begun; to avoid perforation of the choroid until the requisite number of trephine holes has been made, and to leave uncompleted any trephined area which shows no tendency to stop bleeding. The points of exit of the vorticosse veins should be borne in mind when trephining behind the equator of the globe and these areas avoided. The choroid must be fully exposed in at least one point in each trephine hole as it is useless to apply the caustic if an intact disc of sclera remains. A little solid cocaine applied to each area of exposed choroid before using the caustic was found helpful as the application of the caustic is very painful. With the exception of the cases mentioned above solid caustic potash was employed—the pointed stick being applied for about a second to each trephine hole and the excess immediately neutralised with a 1 per cent. solution of acetic acid. The operation is completed by perforating about a third of the number of trephined areas with a rather blunt-pointed instrument to evacuate the sub-retinal fluid and the wound then closed as in the case of a Gonin operation. As the operation, which is conducted under local anaesthesia, may last from one and a half to two hours, in apprehensive or restive patients an injection of omnopon gr. 1/3 and hyoscine gr. 1/100 an hour before operation was found advisable.

The results obtained with this type of operation are shown in the following table included in which are the 16 cases operated upon previously by cautery puncture:—

	(57 cases) Holes present.			(22 cases) "Blind" operation.		
	Cure	Improved	Failure	Cure	Improved	Failure
Emmetropia - - -	(16) 7 (43·8%)	3 (18·7%)	6 (37·5%)	(4) 2	1	1
Myopia (0-5 D.) -	(12) 1 (8·3%)	3 (25·0%)	8 (66·7%)	(2) 1	0	1
Myopia (5-10 D.) -	(12) 4 (33·3%)	1 (8·3%)	7 (58·3%)	(7) 1	0	6
Myopia (over 10 D.)	(15) 2 (13·3%)	0	13 (86·7%)	(7) 1	2	4
Aphakia - - - -	(2) 1 (50·0%)	1 (50·0%)	0	(2) 0	1	1

Of all cases operated upon by the Guist-Lindner method, 25·3 per cent. were cured and 15·2 per cent. improved, the figures for the cases in which retinal holes were found being 26·3 per cent. and 14·2 per cent. respectively, and for those in which no retinal defects were discovered 22·7 per cent. and 18·2 per cent. Of thirteen cases

having retinal holes and previously operated upon by Gonin's method, three, an emmetrope, one high myope and an aphakic were cured, and two, both low myopes, improved by a subsequent Guist operation, whilst in three subjects operated upon unsuccessfully by "blind" cautery puncture, one, an emmetrope, was afterwards cured by the caustic operation. It is only fair to the originators of this method to state that in seven of the cases the plan of operation was not carried through owing to early perforation of the choroid, if these cases, together with those operated upon by Foster Moore's modification in which one success was obtained, be excluded, the percentage of cures rises to 31·7.

In the 79 cases operated upon by these means, there were nine, or 11·4 per cent., examples of secondary rents and six, or 7·6 per cent., of a complete vitreous haemorrhage. In addition two cases had a moderately severe uveitis, two a vorticosse vein thrombosis and one a diffuse sub-retinal haemorrhage.

The diagnosis of a vortex vein thrombosis was made on the appearance two or three days after operation of intense congestion with general chemosis and a complaint of aching in the eye. At first there was only a faint reflex; later the appearance of a solid-looking detachment but without any inflammatory signs, the congestion and chemosis, which lasted several weeks, appearing to be obstructive in origin.

Diathermy

There are two main methods of treating retinal detachment by diathermy, that evolved by Weve of Utrecht and that introduced by Larsson of Stockholm. At Moorfields the latter method has been adopted, the first operation by this means being performed on August 26, 1932, by Mr. E. F. King, the late Senior Resident Officer. Since that date and until January 7, 1933, which closes the period under review in this paper, 72 cases were so operated upon, a figure which includes 5 cases previously operated upon by cautery puncture in two of which the subsequent detachment occurred in the other eye, four cases operated upon before by the Guist-Lindner method, and one case which had been subjected to each of these types of operative procedure.

The apparatus used at Moorfields up to January 6, 1933, was a standard diathermy machine supplied by Messrs. Schall, the indifferent electrode being a lead plate and the active electrode a platinum wire 35 mm. long, 0·66 mm. in diameter, and bent in the centre at an angle of 130°. Subsequently an apparatus made by John Weiss and Son to the design of Frank Flynn has been used, and, as suggested by the latter, the surface of the sclera has been kept moist with distilled water during actual cauterisation whereby

charring of the surface of the sclera is avoided, and possibly a more constant effect on the choroid obtained. The operation is conducted under local anaesthesia, a sub-conjunctival and sub-Tenon's capsule injection of novocaine and adrenalin being given in the neighbourhood of the retinal hole. The exposure of the sclera and the careful marking thereon of the site of the retinal rent is conducted as in a Gonin operation, muscles being retracted or actually detached and re-inserted at the close of the operation should access not be sufficient without so doing. With the Schall machine the strength of current was so adjusted before the commencement of the operation that with the terminals of the apparatus short circuited, a reading of 1 ampère or slightly less was obtained on the meter. In the Weiss machine the milliampèremeter is a separate component and is connected in series with the active electrode, the current being so regulated as to give a reading of 60 ma. when the former is passing through the patient. In this apparatus the indifferent electrode is a perforated zinc plate which is applied to the forearm, perfect approximation being effected by the use of a special contact cream on the patient's skin. The active electrode is a silver-iridium wire, 25 mm. long, 0.66 mm. in diameter, and bent at an angle of $130^{\circ} 7$ mm. from its extremity. As in the Guist operation, absolute haemostasis is necessary, and the field of operation should be quite dry when it is desired to mark the sclera with the electrode, but, as previously mentioned, when actual cauterisation is being performed, it is of advantage to have the field kept moist with distilled water. The active electrode must be in contact with the sclera before the current is turned on; five seconds are allowed, and the current turned off before the electrode is removed. There was an immediate drying, flattening and apparent shrinkage of the sclera in the neighbourhood of the active electrode, and a greenish-brown ring appeared around it when cauterisation was effected by the old method, but with the moist technique there is little, if any, visible reaction on the surface of the sclera. Cauterisation is repeated over the required area, about 1.5 mm. interval being allowed between each application, the distribution necessarily depending upon the size and shape of the retinal hole which, with any thin areas of the retina that may have been discovered in relation thereto, must be adequately covered. The presence of the ciliary body must be remembered and cauterisation over this area avoided. The operation is completed by allowing the sub-retinal fluid to escape from the region in which the detachment was deepest, a free flow of this fluid is usually obtained, however, over the site of cauterisation showing that the former has not been coagulated by the strength of current used. This stage of the operation is usually carried out by trephining the sclera with a 1.5 mm. trephine, and perforating the choroid with a blunt instrument, or the electrode may be allowed to stay in contact with the

sclera at one spot until perforation occurs, whilst both Goulden and Doyne favour the thermo-cautery.

The results obtained with this type of operation are shown in the following table in which are included the ten cases operated upon previously by cautery puncture or the Guist operation :—

TABLE VI

Diathermy

	(60 cases) Holes present.			(12 cases) "Blind" operation		
	Cure	Improved	Failure	Cure	Improved	Failure
Emmetropia - - -	(21) 11 (52·4%)	1 (4·8%)	9 (42·8%)	(1) 1	0	0
Myopia (0-5 D.) - -	(21) 12 (57·2%)	5 (23·8%)	4 (19·0%)	(1) 1	0	0
Myopia (5-10 D.) - -	(7) 4 (57·1%)	1 (14·3%)	2 (28·6%)	(4) 0	0	4
Myopia (over 10 D.) -	(10) 4 (40·0%)	2 (20·0%)	4 (40·0%)	(3) 1	0	2
Aphakia - - - - -	(1) 0	0	1	(3) 0	1	2

Hence of all cases operated upon by diathermy 47·2 per cent. were cured and 13·9 per cent. improved. For those cases in which retinal defects were discovered the figures are 51·7 per cent. and 15·0 per cent. respectively, and for those in which no retinal holes were found prior to operation 25·0 per cent. were cured and 8·3 per cent. improved. Of five cases previously operated upon by Gonin's operation, two, both emmetropes, were subsequently cured by diathermy, and of four cases which had been operated upon unsuccessfully by the Guist method, one, again an emmetrope in whom no retinal defects had been discovered, was later cured by the Larsson operation. The case which had failed to respond to both a "blind" cautery puncture and a multiple trephining operation obtained no improvement from a subsequent diathermy.

Complications following this type of operative treatment have been notably small in number. In no case was there any marked increase of vitreous opacities attributable to the operation, nor was there any extensive vitreous haemorrhage though small sub-retinal and intra-choroidal extravasations of blood were occasionally seen. There were five, or 6·9 per cent., examples of secondary holes, two of a transient uveitis and one example of a localised choroidal infarct. Thrombosis of a vortex vein did not occur.

After Treatment

For all types of operative procedure, the after treatment has been conducted upon more or less similar lines. On completion of the operation both eyes are bandaged and the patient nursed in such a position that the retinal hole is situated in the most dependent part of the eye; the necessity for absolute rest is emphasised. From the first a drop of 1 per cent. atropine solution is instilled daily, and

a preliminary examination of the fundus made on the fourth day. On the eighth day the conjunctival sutures are removed and the fundus again examined. Should the detachment be as extensive as before operation with no sign of improvement, bandages are not re-applied and the patient is allowed up. On the other hand, if the detachment is less extensive or should the retina be in place, both eyes are again bandaged and absolute rest secured for a further seven days. At the end of this period, whatever the condition of the retina, the eyes are uncovered and a start made with getting the patient up. A few days later the operated eye is thoroughly examined in a dark room, and special note made of the site and size of the operation scars, their relation to the retinal rent, the extent of retinal detachment (if any), and the condition of the vitreous. If the retinal hole has been secluded and the retina is in place, the field of the eye is charted, and the patient discharged from hospital. In successful cases, particularly after diathermy, a considerable swelling of either coagulated choroid or a residuum of sub-retinal fluid, over which, of course, the retina is raised, is not uncommonly seen, and this appearance of a residual retinal detachment may remain for some weeks. All cases are kept on atropine for at least a month after discharge. More especially is this important in those cases in which the detachment has not been cured and a second operation contemplated, for a quiet plastic iritis is liable to develop at any time when the retina has become detached.

The Operative Procedures Compared

In the following table are shown the results obtained in all cases operated upon by cautery puncture, multiple trephining and diathermy together with the chief complications observed, all figures being expressed as percentages:—

TABLE VII

	Results		Chief complications			
	Cure	Improved	Secondary holes	Vitreous haemorrhage	Uveitis	Thrombosis vortex vein
CAUTERY PUNCTURE						
Holes present	- 29.9	10.3	17.6	7.2	4.5	0.45
"Blind" operation	0	11.8				
MULTIPLE TREPHINING						
Holes present	- - 26.3	14.2	11.4	7.6	2.5	2.5
"Blind" operation	22.7	18.2				
DIATHERMY						
Holes present	- - 51.7	15.0	6.9	0	2.8	0
"Blind" operation	25.0	8.3				

For cases with retinal dialysis the objective in each type of operation has been the same—to produce a barrage of scar tissue

immediately posterior to the tear, and in cases having localised holes behind the ora the zone of operative choroiditis has been so placed that when the sub-retinal fluid has escaped and the retina returned to its normal situation the hole may be in the centre of this zone and so become secluded. In cases having no visible holes the "blind" cautery puncture was performed in the old way over the most prominent portion of the detachment; with the Guist operation and with diathermy the procedure adopted was to cauterise at the periphery a quadrant of the retina corresponding to the initial field loss, on the assumption, of course, that a peripheral defect was present but not visible to ophthalmoscopy. Should the patient be unable to give material assistance, a zone immediately behind the ora throughout the extent of the detachment was cauterised, a complete circuit being made if the detachment was total. It is obvious that Gonin's operation has a limited application in such cases, in fact no success was obtained at Moorfields with a "blind" cautery puncture whereas with multiple trephining there were 22·7 per cent. of cures in "no hole" cases and with diathermy 25 per cent. Cautery puncture, moreover, is a drastic operation, necessarily traumatising the vitreous in cases where it is already only too frequently degenerate and producing a dense mass of scar tissue welding together all coats of the eye with the result that the incidence of secondary retinal rents is greater in this than in the other types of operation. Further, the cautery must "hit off" the retinal tear with absolute precision, which requires a very exact localisation of the hole, a procedure beset with difficulties, particularly when the hole is situated on a ballooned detachment and at some distance from the periphery; with large or multiple rents more than one cautery puncture becomes necessary, whereas with the other two methods no such accurate localisation of the rent and multiplicity of operations is required since an extensive, or more than one, area can be cauterised at a single operation. In both the Guist and Larsson methods the field of operation is essentially outside the vitreous chamber, a decided advantage when compared with that of Gonin in which a local coagulation, and at times a true loss of vitreous takes place.

The chief objections to the Guist-Lindner operation are that it is tedious to perform, and the technical difficulties of multiple trephining of the sclera, often at a considerable distance from the limbus, are great, for the risk of perforating the choroid is always present, after which completion of the operation becomes difficult and at times impossible. The Larsson operation would appear to possess all the advantages of that of multiple trephining without the attendant disadvantages, and in my opinion is the most satisfactory method yet devised for the treatment of simple detachment of the retina.

Visual Results

The field is apparently restored rapidly on the retina becoming replaced, for the great majority of cases in which the retina was *in situ* 10-14 days after operation have given a full field to a one or a half degree white object at a third of a metre, at the most there being only a small loss corresponding to the site of operation. A full field was obtained in a case successfully treated and having a history of two years' duration, but in one in which the detachment had been present for six and a half years and was cured by operation, no improvement in visual field resulted. The improvement in central vision has been variable. If the macula has not been involved in the detachment, visual acuity is unaltered by the operation unless, on account of vitreous opacity, a line or so less on Snellen's type may be read for a while, but, on the vitreous clearing, a process which varies with the amount of opacity and takes usually some two to three months, central vision returns to normal. If the macula has been involved in the detachment and the case has been successfully treated, central vision on the patient's discharge from hospital is usually 6/36 to 6/24 partly. In these cases there seems to be no question that a gradual improvement in central vision occasionally occurs over and above that merely dependent upon a clearing of the transparent media, for isolated examples have occurred in this series of a restoration of visual acuity to 6/9 and even 6/6 Snellen when there has been no doubt concerning the previous implication of the macula in the detachment.

With regard to the 79 cases in which no operative measures were employed, in 57 of these no retinal defects were discovered after prolonged and repeated searching; it is of interest to note that no less than 12, or 21 per cent., were aphakic subjects, and that 46 of these "no hole" unoperated cases occurred before the introduction of multiple trephining and diathermy, aptly demonstrating how greatly the latter procedures have enlarged the operative scope in detachment of the retina. Of the 22 cases in which retinal holes were found and no operation performed, in seven the rent was considered too large to merit operative interference; in five the rents were multiple, widely separated, and the retina atrophic; in three the hole was too far back and thought inaccessible for operation; in two the detachment was considered of too long standing; in two there was a concomitant uveitis; two of the subjects refused operative treatment, and in one the age of the patient militated against operation.

The objective of each of the operative methods mentioned in this paper has been to close the retinal defect, and I feel that ophthalmology, and indeed mankind in general, owes a debt of gratitude to Jules Gonin for having pointed out the importance of a retinal tear in the aetiology of simple detachment of the retina, and for having devised the pioneer operative means for secluding the retinal hole.

In conclusion I wish to express my thanks to all members of the Honorary Staff of Moorfields Eye Hospital, who have so kindly allowed me to utilise the case records of their patients, and to the almoners for assistance in the "follow-up" of this large series of cases.

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