COMMUNICATIONS

CHEMICAL COMPOSITION OF SUBRETINAL FLUID*

BY

H. HEATH AND THELMA C. BECK

Department of Chemical Pathology, University College Hospital Medical School, London

AND

W. S. FOULDS

Department of Ophthalmology, Addenbrooke's Hospital, Cambridge

THIS paper presents the results of a study of the chemical composition of subretinal fluid from cases of retinal detachment, with particular reference to the protein and ascorbic acid content of the fluid.

Many workers have studied the chemical composition of subretinal fluid obtained from patients undergoing surgery for retinal detachment. It is generally agreed that the subretinal fluid contains more protein than normal human vitreous: Magitot and Lenoir (1932) 0.135–6.0 per cent.; Arruga (1933) 0.09–9 per cent.; Magitot (1934) 0.135–15 per cent.; Franta (1937) 0.72–3.35 per cent.; Weve and Fischer (1940) 0.055–7.72 per cent.; Contino (1941) 0.37–3.85 per cent.; Santoni (1946) 0.6–2.64 per cent. These authors have shown that the protein concentration usually, but not always, increases with the duration of the detachment. This high protein content has been the major argument against the vitreal origin of the subretinal fluid. Recently, paper electrophoretic studies by Santoni (1954), Dorello (1955), Reichling (1955), Nakano (1958) and Smith and Douty (1960) have demonstrated the variable content of the albumin and globulin fractions in the subretinal fluid. The electrophoretic pattern of fluid with a high protein content resembles that obtained from human plasma, and the five components (albumin and α_1 , α_2 , β , and γ globulin) are all present. Santoni has suggested that, in cases of recent detachment, these proteins could arise from capillary bleeding and, in older detachments, from the choroid, by changes in its permeability. On the other hand, he found that the protein in subretinal fluid from three cases of recent detachment consisted almost entirely of albumin, which he thought to be indicative of a vitreal origin. Cagianut and Wunderly (1953) have shown that, in certain pathological conditions of the eye, albumin predominates in the vitreous, but there is as yet very little information available on the protein content of the vitreous body of eyes which have developed a retinal detachment, and normal human vitreous contains only approximately 0.05 per cent. protein. More recently, Manuel, Royer, Richard, and Creyssel (1960) have concluded from the results of immunoelectrophoresis that the subretinal fluid is derived from the blood plasma. This renders unlikely the view first proposed by Magitot (1934) that the

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protein in the subretinal fluid is derived from disintegration of the detached retina. The electrophoretic pattern of the proteins from the aqueous humour, which has been more fully studied, is also similar to that obtained from the plasma (Pirie and van Heyningen, 1956), and therefore the origin of the subretinal fluid cannot be established by protein and analyses alone.

The concentration of ascorbic acid in the aqueous humour of normal human eyes is approximately twenty times that of the plasma (Purcell, Lerner, and Kinsey, 1954) and so it was decided that the ascorbic acid as well as the protein content of the subretinal fluid should be determined, since a high ascorbic acid concentration might be evidence that the subretinal fluid was derived from the vitreous rather than from the choroid. At the same time information would be obtained about the ascorbic acid content of eyes which had suffered a retinal detachment and were undergoing surgery. The successful outcome of surgery in these cases depends upon the formation of a scar between the choroid and the retina, sufficiently strong to cause permanent adhesion and the means by which this scar is induced necessitate the production of localized areas of inflammation. It has been established that the tensile strength of a scar is related to the local concentration of ascorbic acid (Bourne, 1942; Bartley, Krebs, and O'Brien, 1953). There have been many reports in the literature that ascorbic acid levels in the body are reduced under conditions of stress (Meiklejohn, 1953), and it is generally assumed that intra-ocular inflammation reduces ascorbic acid levels within the eye. Duke-Elder and Goldsmith (1951) have stated that the composition of the aqueous approximates to that of the plasma when the eye is inflamed. In patients requiring more than one operation, analysis of the subretinal fluid taken at the first operation compared with that of fluid obtained at subsequent operations might show whether the inflammation caused by diathermy had led to any appreciable change in the intra-ocular ascorbic acid level.

Experiments

Collection of Specimens.—It was found that the specimens of subretinal fluid for analysis were best collected by aspiration with a specially-designed glass pipette some 50 mm. in length, with a bulb reservoir 15 mm. in diameter 10 mm. from the tip. Suction was obtained by a rubber bulb attached to the other end of the pipette. The subretinal fluid was withdrawn through a catholysis puncture in the sclera immediately after the application of diathermy had been completed. Care was taken to ensure that the pipette was dry before use to avoid dilution of the subretinal fluid with water, and wherever possible specimens were collected free from blood. When blood was present, however, the amount was determined by the method described below and the necessary corrections applied to the results. Venous blood was collected in oxalated tubes from the patients at approximately the same time as the subretinal fluid was being withdrawn. These patients had not received any dietary ascorbic acid during the preceding 18 hours. Seven patients (Table I, Cases 8, 14, 15b, 18a, 18b, 21, 24), received a supplement of 200 mg. ascorbic acid per day while in hospital, except for the 24 hours before

and after operation. The specimens were stored at 40° C. and analysed as soon as possible after collection. Sometimes the subretinal fluid was completely colourless and in five cases more than 1 ml. was collected. In one case, 1.6 ml. of a water-white specimen was obtained.

Determination of Total Ascorbic Acid.—This was determined on a weighed quantity of subretinal fluid (approximately 200 mg.) or in blood (2 ml.) by the method described by Heath, Beck, Rutter, and Greaves (1961), which was based on the dinitrophenylhydrazine method of Roe, Mills, Oesterling, and Damron (1948). The total ascorbic acid represents the sum of the ascorbic, dehydroascorbic, and diketogulonic acids present.

Determination of Protein.—Subretinal fluid was diluted $\times 100$ and blood $\times 1,000$ with water, and the protein content was determined by the method of Lowry, Rosebrough, Farr, and Randall (1951). Crystalline bovine serum albumin (Armour and Co., Eastbourne) was used as a standard.

Determination of Blood in Subretinal Fluid.—To a weighed quantity of subretinal fluid (approximately 100 mg.) was added 0.2 N sodium hydroxide (3 ml.) and A.R. pyridine (1 ml.), followed by sodium hydrosulphite (10 mg. approx.). The absorption of the pyridine-haemochromogen was measured at 557 m μ with a Unicam Spectrophotometer Model 500. The haemoglobin content of the patient's blood was determined at the same time, using 3 ml. of a $\times 500$ dilution in 0.2 N sodium hydroxide. This was based on the method of Rimington (1942).

Results

33 specimens of subretinal fluid were collected over a period of one year from 27 patients. Information about each case is given in Table I (overleaf). The detachments are classified as myopic when they occur in eyes exhibiting at least 3 D myopia; and as aphakic in eyes which have undergone a cataract extraction. The diagnosis of traumatic detachment is reserved for those cases in which there has been a direct injury to the eye itself. The three cystic detachments each showed a characteristic retinal cyst in the lower temporal periphery of the fundus with a superadded retinal separation for which surgical treatment was undertaken. The exact duration of the detachment in these cases could not be ascertained since the cysts had been present for an indefinite period of time (at least 6 years in Case 7) and the onset of the retinal separation was not marked by any definite change in symptoms. One detachment in a patient with severe aplastic anaemia (Case 27) was thought to be a secondary detachment and was classified as exudative. The remaining cases are listed as idiopathic. Operations were considered to be successful (+ +) when the retina was completely replaced. Partial re-attachments, giving the patient considerable improvement in vision, are classified as "improved" (+). Operations in which the retina was not re-attached are designated by the symbol (–).

The cases were operated upon by surgeons at three different hospitals. The series includes only those patients from whom an adequate sample of subretinal fluid could be obtained, and thus shows a large proportion of deep and total detachments which did not settle with pre-operative rest in bed.

TABLE I
DATA OF 27 CASES FROM WHOM 33 SPECIMENS OF SUBRETINAL FLUID WERE
OBTAINED FOR ANALYSIS

Patient No.*	Sex	Age (yrs)	Detachment		Retinal Hole Seen	Operation			Subretinal Fluid Protein (per cent.)
			Type	Duration (wks)		No.	Type	Result	
1	M	59	Myopic	3	no	1	Scleral resection	++	0.20
2	F	56	Myopic	1.5	yes	1	Scleral resection	++	0.20
3a	M	28	Cystic	—	no	1	Scleral resection	++	0.20
3b	M	28	Cystic	—	no	1	Diathermy	+	0.21
4	F	59	Idiopathic	2	yes	1	Scleral resection	++	0.24
5a	M	36	Myopic	2	yes	1	Schepens tube	—	0.25
6	F	57	Myopic, aphakic	1	yes	1	Schepens tube	++	0.27
7	F	60	Cystic	—	no	1	Scleral resection	++	0.29
8	M	36	Aphakic	1	no	2	Radial tube	—	0.44
9	F	56	Myopic	—	yes	1	Scleral resection	++	0.50
10	F	57	Idiopathic	2	yes	1	Scleral resection	++	0.59
11a	F	57	Idiopathic	2	yes	1	Scleral resection	—	0.79
12	M	59	Idiopathic	1	yes	1	Scleral resection	++	0.83
13	M	70	Idiopathic	1	no	1	Catholysis	..	0.85
14	F	51	Aphakic	24	yes	1	Scleral resection	—	1.17
15a	M	83	Aphakic	16	yes	1	Schepens tube	—	1.45
16	M	50	Myopic	1	yes	2	Scleral resection	++	1.56
17	F	75	Idiopathic	2	no	1	Scleral buckling	—	1.60
5b	M	36	Myopic	4	yes	2	Schepens tube	—	1.67
18a	M	69	Aphakic traumatic	2.5	yes	1	Scleral resection	—	1.88
19	M	50	Aphakic	8	yes	1	Scleral resection	—	1.92
20	M	10	Idiopathic	12+	no	1	Scleral resection	—	2.03
21	M	52	Myopic	8	yes	7	Radial tube	+	2.12
11b	F	57	Idiopathic	2	yes	2	Schepens tube	—	2.30
18b	M	69	Aphakic traumatic	2	yes	2	Scleral resection	+	2.33
22	M	10	Traumatic	16	no	1	Schepens tube	—	2.44
23	M	58	Myopic	3	no	3	Schepens tube	++	2.66
24	M	65	Myopic	100+	no	1	Scleral resection	—	2.94
25	M	52	Aphakic	150+	no	2	Radial tube	—	3.40
26	F	30	Traumatic	50+	yes	1	Scleral resection	++	3.83
15b	M	83	Aphakic	4	yes	2	Radial tube	—	4.53
5c	M	36	Myopic	26	yes	4	Schepens tube	+	8.8
27	M	63	Exudative, aphakic	8	no	1	Schepens tube	—	9.17

* There were 27 patients, but 33 specimens were taken, three from Case 5, two each from Cases 3, 11, 15, and 18, and one each from the rest.

Such cases carry a poor prognosis. The absence of more favourable cases from the series no doubt explains the overall low success rate.

When an analysis was made of the results of *all* cases operated on by one of us during the period of this investigation, including those from whom subretinal fluid was not obtained, it was found that 75 per cent. were successful.

In Table I the specimens have been arranged in ascending order of protein content of the subretinal fluid; when more than one specimen was taken from the same patient at different times, they are numbered a, b, c, etc. It can be seen that there is a higher incidence of successful re-attachments among the patients with low protein levels. This is seen more clearly in the Figure (p. 391), in which the percentage of successful operations at two different levels of protein concentration in the subretinal fluid has been represented. For levels below 1 per cent. surgical treatment resulted in 69 per cent. of cures, compared with only 19 per cent. for levels greater than 1 per cent.

In Table II (opposite) the protein content of the subretinal fluid from patients who had a successful first operation for a detachment other than traumatic or exudative is compared with that from patients undergoing unsuccessful

first operations; cases classified as "improved" are not included. The mean protein content from the successful cases (0.37 ± 0.07 per cent.) is significantly lower ($P < 0.01$) than that from the unsuccessful cases (1.44 ± 0.27 per cent.).

TABLE II

PROTEIN CONTENT OF THE SUBRETINAL FLUID FROM ALL EXCEPT TRAUMATIC AND EXUDATIVE DETACHMENTS, WHICH HAVE HAD SUCCESSFUL OR UNSUCCESSFUL FIRST OPERATIONS

Successful		Unsuccessful	
Patient No.	Subretinal Fluid Protein (per cent.)	Patient No.	Subretinal Fluid Protein (per cent.)
1	0.20	5a	0.25
2	0.20	11a	0.79
3a	0.20	13	0.85
4	0.24	14	1.17
6	0.27	15a	1.45
7	0.29	17	1.60
9	0.50	19	1.92
10	0.59	20	2.03
12	0.83	24	2.94
* Mean 0.37 ± 0.07		* Mean 1.44 ± 0.27	

* The difference between the means is significant ($P < 0.01$).

In four patients undergoing more than one operation on the same eye (Cases 5, 11, 15, 18), subretinal fluid was obtained at the first and subsequent operations, making it possible to determine the changes which had occurred in the protein and ascorbic acid levels since the first operation. These results are given in Table III.

TABLE III

PROTEIN AND ASCORBIC ACID CONTENT OF THE SUBRETINAL FLUID FROM EYES WHICH HAD MORE THAN ONE OPERATION

Patient No.		Operation No.	Period of Detachment (wks.)	Subretinal Fluid		Blood Ascorbic Acid (mg. per cent.)	Ratio Subretinal Fluid/Blood Ascorbic Acid
				Protein (per cent.)	Ascorbic Acid (mg. per cent.)		
5	<i>a</i>	1	2	0.25	5.54	0.43	12.8
	<i>b</i>	2	4	1.67	2.81	0.55	5.1
	<i>c</i>	4	26	8.8	0.37	0.39	0.9
11	<i>a</i>	1	2	0.79	2.86	0.61	4.7
	<i>b</i>	2	2	2.30	3.04	0.64	4.7
15	<i>a</i>	1	16	1.45	7.84	0.40	19.6
	<i>*b</i>	2	4	4.53	16.26	0.89	18.3
18	<i>*a</i>	1	2.5	1.88	2.43	0.73	3.3
	<i>*b</i>	2	2	2.33	5.64	0.87	6.5

* Indicates patients given a vitamin supplement on admission to hospital.

In all cases there was a marked rise in the protein content of the subretinal fluid after surgery. Although in Case 5 the ascorbic acid concentration decreased in the successive collections of subretinal fluid, this was not so in Case 11. Cases 15 and 18 were given supplementary ascorbic acid, and as can be seen from Table III, the concentration of ascorbic acid in the subretinal fluid was increased at the time of the second operation.

The ascorbic acid concentration was determined in all the subretinal fluid specimens obtained except Case 10; the results are arranged in ascending order in Table IV. Seven had been given supplementary ascorbic acid and this must be taken into consideration in assessing the results. When all the cases are considered it can be seen that surgery was successful in only 17 per cent. when the concentration of ascorbic acid in the subretinal fluid was less than 4 mg. per cent., whereas 56 per cent. were successful for ascorbic acid

TABLE IV
ANALYTICAL RESULTS OF 32 SPECIMENS (ALL EXCEPT CASE 10) ARRANGED
IN ASCENDING ORDER OF ASCORBIC ACID CONTENT OF SUBRETINAL FLUID

Patient No.†	Ascorbic Acid (mg. per cent.)		Subretinal Fluid/ Blood Ascorbic Acid Ratio	Result of Operation
	Subretinal Fluid	Blood		
27	0.00	0.20	0	-
5c	0.37	0.39	0.9	+
7	0.86	0.39	2.2	++
19	1.28	0.60	2.1	-
20	1.29	0.56	2.3	-
1	1.38	0.61	2.3	++
13	2.12	0.50	4.2	-
17	2.12	0.36	5.9	-
*18a	2.43	0.73	3.3	-
22	2.68	0.40	6.7	-
5b	2.81	0.55	5.1	-
11a	2.86	0.61	4.7	-
3b	2.96	0.77	3.8	+
11b	3.04	0.64	4.7	-
26	4.62	0.34	13.4	++
25	4.76	0.36	13.2	-
3a	5.10	0.84	6.1	++
9	5.13	0.40	12.8	++
16	5.40	0.56	9.6	++
5a	5.54	0.43	12.8	-
*18b	5.64	0.87	6.5	+
12	5.73	0.94	6.9	++
23	6.20	0.7	8.9	++
2	6.79	0.28	24.2	++
*24	7.62	0.70	10.9	-
15a	7.84	0.40	19.6	-
*21	8.30	1.04	8.0	+
*8	9.12	0.78	11.7	-
4	9.41	0.78	12.1	++
*14	11.20	1.04	10.7	-
*15b	16.26	0.89	18.3	-
6	17.93	1.10	16.3	++

† Case Nos. refers to those given in Table I.

* Indicates patients given a vitamin supplement on admission to hospital.

values greater than 4 mg. per cent. If the supplemented cases are excluded, *i.e.* an attempt is made to assess the vitamin content of the subretinal fluid which is formed naturally after detachment, then 18 per cent. were successful with ascorbic acid levels below 4 mg. per cent. and 75 per cent. were successful when the level was greater than 4 mg. per cent. These results are shown in the Figure. As the concentration of ascorbic acid in the aqueous humour has been shown by many workers to vary with the concentration in the plasma, the ratio of the ascorbic acid in the subretinal fluid to that in the blood is also given.

FIGURE.—Relationship between the outcome of surgery and the protein and ascorbic acid content of subretinal fluid.

The mean ascorbic acid concentration in the subretinal fluid from all successful operations was 6.23 ± 1.23 and that from the unsuccessful operations 3.03 ± 0.61 mg. per cent. If vitamin supplemented cases and those classified as "improved" are excluded, the difference between the means is significant ($P < 0.05$). There was no statistical significance if only first operations were considered because of the wide scatter of the results and the small number of cases.

In Table V the analyses of subretinal fluid obtained at first operations have been grouped according to the aetiology of the detachment. Owing to the small number of cases in each group the results cannot be compared statistically. It can, however, be seen that the traumatic cases had the highest protein level in the subretinal fluid apart from the exudative case, while the three samples from the cystic detachments (contrary to what is usually thought) showed a lower than average concentration of protein. In the only exudative detachment in the series the concentration of protein in the subretinal fluid was little different from that in the plasma. It is also worth noting that the mean concentration of ascorbic acid in the samples taken from aphakic eyes was not lower than that from other types of detachment.

TABLE V
PROTEIN AND ASCORBIC ACID CONTENT OF SUBRETINAL FLUID
IN DIFFERENT TYPES OF DETACHMENT OBTAINED AT FIRST OPERATION
FROM PATIENTS NOT GIVEN SUPPLEMENTARY ASCORBIC ACID

Type of Detachment	No. of Cases	Subretinal Fluid (Mean Values)		Mean Ratio Subretinal Fluid/Blood Ascorbic Acid
		Protein (per cent.)	Ascorbic Acid (mg. per cent.)	
Cystic	3	0.23	2.97	4.0
Myopic	5	0.28	7.35	13.7
Idiopathic	6	1.06	3.92	6.0
Aphakic	3	1.21	9.02	12.7
Traumatic	2	3.13	3.65	10.1
Exudative	1	9.17	0.00	0

Table VI (opposite) shows the relationship between the duration of the detachment and the protein content of the subretinal fluid in patients undergoing first operations. Traumatic and exudative detachments were excluded from this survey. While there is no close correlation between the protein content of the subretinal fluid and time, in all the detachments of less than 8 weeks' duration except one the protein level was below 1 per cent., while in all those of longer duration the level was above 1 per cent.

The cases were next grouped into those in which a retinal hole was clearly visible and those in which it was not. These results are shown in Table VII (opposite).

The mean protein levels in the subretinal fluid from eyes showing retinal holes, (1.93 ± 0.47 per cent.) and in that from those in which no retinal hole was seen (2.03 ± 0.68 per cent.) do not differ significantly. On the other hand there is a significant difference between the mean ascorbic acid content of the subretinal fluid and the subretinal fluid/blood ratio. The mean values were 6.45 ± 1.07 mg. and 3.55 ± 0.78 mg. per cent. ($P < 0.05$), and 10.1 ± 1.4 and 6.0 ± 1.1 ($P < 0.05$) respectively.

TABLE VI

RELATIONSHIP BETWEEN THE DURATION OF THE DETACHMENT AND THE PROTEIN CONTENT OF THE SUBRETINAL FLUID FROM PATIENTS UNDERGOING FIRST OPERATIONS, EXCLUDING TRAUMATIC AND EXUDATIVE CASES

Patient No.	Duration of Detachment (wks)	Subretinal Fluid Protein (per cent.)
6	1	0.27
12	1	0.83
13	1	0.85
2	1.5	0.20
4	2	0.24
5a	2	0.25
10	2	0.59
11a	2	0.79
17	2	1.60
1	3	0.20
19	8	1.92
20	12 +	2.03
15a	16	1.45
14	24	1.17
24	100 +	2.94

TABLE VII

MEAN PROTEIN AND ASCORBIC ACID CONTENT OF SUBRETINAL FLUID FROM EYES IN WHICH RETINAL HOLES COULD OR COULD NOT BE SEEN

Retinal Hole	Subretinal Fluid		Blood Ascorbic Acid (mg. per cent.)	Ratio Subretinal Fluid/ Blood Ascorbic Acid	No. of Samples
	Protein (per cent.)	Ascorbic Acid (mg. per cent.)			
Seen	1.93 ± 0.47	6.45 ± 1.07	0.66 ± 0.06	10.1 ± 1.4	19
Not Seen	2.03 ± 0.68	3.55 ± 0.78	0.55 ± 0.06	6.0 ± 1.1	13

The difference between the means of the ascorbic acid concentrations of the subretinal fluid and of the ratios between the subretinal fluid and blood were significant, $P < 0.05$ in both cases.

Discussion

The results of this investigation would indicate that the outcome of an operation for detachment of the retina is related to the concentration of protein in the subretinal fluid, low protein levels carrying a better prognosis than higher levels. It has also been shown that the concentration of protein in the subretinal fluid increases markedly after unsuccessful surgery and that the protein concentration in the subretinal fluid tends to be high when the detachment has been present for more than 8 weeks.

If the proteins in the subretinal fluid are derived from the blood circulating in the choroid, an increase in the capillary permeability of this structure would be indicated, for it is known that in health the capillaries of the

choroid are less permeable to protein than those of most other tissues (Duke-Elder, 1948). This postulated increase in choroidal capillary permeability could be an aetiological factor in the development of retinal detachment or might result from degenerative changes induced by the detachment. In either instance the concentration of protein in the subretinal fluid could be taken as a measure of the degree of choroidal dysfunction. Arruga (1933) has stated that reposition of the retina by surgery is dependent on a healthy choroid and the relationship of the protein content of subretinal fluid to the outcome of operation noted in Table II would support this view. The rise in protein content of the subretinal fluid after surgery with a consequently worsened prognosis is compatible with the clinical observation that second or subsequent operations have a poorer prognosis than first operations.

The only exudative detachment studied (Case 27) which had a concentration of 9.17 per cent. protein in the subretinal fluid could be regarded as an extreme case of choroidal malfunction related in this instance to a severe aplastic anaemia with a haemoglobin concentration of only 5 g. per cent. In this case the high protein content of the subretinal fluid approximating to that found in the plasma, the absence of ascorbic acid in the subretinal fluid, and the absence of a visible retinal hole, coupled with the presence of a severe aplastic anaemia, were taken as indications that the detachment was exudative. This view was supported by the further behaviour of the case; although the initial operation was unsuccessful spontaneous re-attachment of the retina occurred 3 months after a further release of subretinal fluid, and 4 months later the retina again became detached. That the presence of protein in the subretinal fluid is more likely to be the result rather than the cause of the detachment (except perhaps in exudative cases) is suggested by the fact that the concentration of protein in the subretinal fluid is much higher when the detachment is of over 8 weeks' duration than when it has been present for a shorter time.

At the beginning of this work it was thought that a concentration of ascorbic acid in the subretinal fluid, appreciably higher than that in the blood, would indicate the presence of a retinal hole, since it is well established that the high level of ascorbic acid in the aqueous and vitreous humours is derived from the ciliary body, so that a high level of this vitamin in the subretinal fluid might be taken as an indication that fluid from the anterior segment of the eye has passed into the subretinal space. de Vincentiis (1958) has also shown high levels of ascorbic acid in the subretinal fluid and has concluded that this is indicative of the vitreal origin of the fluid. Evidence in support of this is provided by the significant differences in the ascorbic acid level of subretinal fluid from eyes in which a retinal break was observed compared with that from those in which a hole could not be seen (Table VII), and by the fact that from Case 27, an exudative detachment, subretinal fluid was obtained which did not contain ascorbic acid. The concentration of ascorbic

acid in the guinea-pig retina (28.2 mg. per cent.) and choroid (31.2 mg. per cent.) is higher than that found in the vitreous (17.8 mg. per cent.) and aqueous (16.9 mg. per cent.). Thus high levels of ascorbic acid in the subretinal fluid do not necessarily indicate that this fluid has been derived from the vitreous. The difference between the ascorbic acid concentration in the retina and the vitreous of the rat is even more marked. Recent observations in our laboratory show that the rat retina contains 30.7 mg. per cent. ascorbic acid, whereas the vitreous contains 1.3 mg. per cent. and the lens 2.9 mg. per cent. In all cases except Case 27, there was a higher level of ascorbic acid in the subretinal fluid than in the plasma. The ratios of the blood to the subretinal fluid ascorbic acid showed wide variations, ranging from 0.9 to 24.2. It is interesting to note that two of the aphakic eyes undergoing first operations had ratios of 19.6 and 16.3, which are among the higher values. It has been shown previously (Heath and others, 1961) that in the aphakic guinea-pig there is a significantly lower level of ascorbic acid in the aqueous and vitreous humours but not in the retina as compared with the normal animal. It would appear that the human aphakic eye has the ability to accumulate ascorbic acid in the subretinal fluid at least as well as the human phakic eye.

Contrary to what might be expected, the concentration of ascorbic acid in the subretinal fluid was not markedly decreased after unsuccessful surgery and in cases receiving a dietary supplement of ascorbic acid its concentration actually increased. It has been shown that surgery is more likely to be successful where there is a high concentration of ascorbic acid in the subretinal fluid, but the artificial raising of the level of this vitamin at the time of surgery does not appear to have any beneficial effect.

While it is realized that factors other than those discussed may influence the results of surgery, care has been taken to ensure that comparisons have been made only between similar groups of patients.

Summary

(1) 33 specimens of subretinal fluid from 27 patients undergoing surgery for retinal detachments have been analysed for protein and ascorbic acid.

(2) The protein and ascorbic acid content of the subretinal fluid has been related to the outcome of surgery. The mean level of protein in the subretinal fluid from patients undergoing successful first operations was significantly lower than that from patients undergoing unsuccessful first operations.

(3) There was a significant difference between the mean ascorbic acid content of the subretinal fluid from eyes with a visible retinal hole and that from those in which a retinal hole was not seen.

(4) There was a marked increase in the protein content of the subretinal fluid obtained from eyes which had undergone more than one operation.

(5) The subretinal fluid/blood ascorbic acid ratios were often high in aphakic eyes. The possibility that the ascorbic acid in the subretinal fluid is derived from the retina or choroid has been discussed.

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