STUDY ON THE MECHANISM OF DELAYED ABSORPTION OF THE SUBRETINAL FLUID

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ABSTRACT

In retinal detachment, the subretinal fluid is absorbed by the choroid when all retinal holes are closed by surgery. It usually takes 16 to 48 hours, but in a few cases it prolongs weeks to months depending on the function of the choroid. There has been few reports on cases whose subretinal fluid persisted for over four months and the mechanism of such a long delay in absorption has never been elucidated.

The hospital charts of 130 surgically treated retinal detachment patients at the Keio University Hospital during the period of August, 1973 to July, 1975 were looked through to pick out cases whose postoperative courses were complicated by the prolonged presence of subretinal fluid for over 4 months in spite of adequate closure of all retinal holes. The out-patient clinic charts of these patients were carefully analysed at the same time to categorize these patients and to find out the mechanism of delay in absorption of subretinal fluid.

The patients were usually young. The retinal detachments were usually shallow with small round holes and involved one or two quadrants. Most of them received a relatively minor procedure without drainage of the subretinal fluid. All had good visual acuity both pre- and postoperatively. Slitlamp examination of the detached retina in these cases indicated that the retina was too short to settle down to the choroidal surface and this seemed to be the mechanism of delay in absorption.

Since these cases eventually reattached and recovered, it was recommended to follow these cases conservatively. The importance of recognizing these cases were emphasized and "Tented retina syndrome" was suggested to indicate this state of retina after retinal detachment surgery.

To eliminate the subretinal fluid is an essential prerequisite to a successful treatment of retinal detachment. It is either drained by surgery or absorbed by the choroid. The modified Custodis procedure, which is now widely practiced all over the world, has its main advantage in not draining subretinal fluid. Con-
sequently, the procedure depends entirely upon natural absorption of the subretinal fluid. In this procedure, it has been generally observed that the subretinal fluid disappeared within 16 to 48 hours after surgery in the majority of cases.

However, a few cases take longer time before the subretinal fluid is completely absorbed. Lincoff\(^1\) said that some might take weeks to months, and attributed this absorption delay to a poorly functioning choroid. O'Connor\(^2\) described 23 cases whose subretinal fluid persisted up to three months, and listed as causes of delay, 1) senile choroidopathy, 2) radial fold, 3) retinoschisis, 4) anterior fold, 5) choroidal detachment, and 6) uveitis. I have seen a few cases whose retinal holes were adequately closed by surgery but the subretinal fluid persisted for nearly one year. These patients were usually young and the choroidal pattern was healthy not only in the fellow eyes but in the affected eyes. Aforementioned reasons were unlikely to explain these cases.

This study was undertaken, 1) to establish the presence of these cases whose subretinal fluid persists for over 4 months in spite of the closure of all holes, 2) to find the mechanism of delay in these cases, and 3) to find the proper treatment of these cases.

MATERIALS AND METHODS

The hospital charts of 130 retinal detachment patients who were surgically treated at the Keio University Hospital during the period of two years from August, 1973 to July, 1975 were looked through to find cases whose postoperative courses were complicated with delayed absorption of subretinal fluid for over four months. Four months was chosen because it was generally accepted that the residual fluid was absorbed by this time. There were six such cases. These cases were followed in the retina clinic periodically. All eyes were dilated with 0.5% tropicamide and 10% phenylephrine drops and examined by slitlamp with three mirror lens and binocular indirect ophthalmoscope.

RESULTS

Brief summary of six patients appears in Table 1. All patients are young except one 57 years old patient. Visual acuity both pre- and postoperative are exceptionally good for retinal detachment in all cases. Relatively minor procedures were performed in all cases. Subretinal tap was done in only one case. The subretinal fluid persisted for 4 to 12 months. The brief description of pre- and postoperative courses of each patient is as follows.

Case 1: 57-year-old man noticed haziness in the lower field of vision in the
### Table 1: Summary of patient data

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Sex</th>
<th>Age</th>
<th>Duration of detachment</th>
<th>Type of detachment</th>
<th>Retinal holes</th>
<th>Refractive error</th>
<th>Type of surgery</th>
<th>Duration of residual fluid</th>
<th>Visual acuity Preop.</th>
<th>Visual acuity Postop.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>57</td>
<td>3 W</td>
<td>Superior temporal</td>
<td>One round</td>
<td>+1.00</td>
<td>Segmental sponge</td>
<td>6 M.</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>25</td>
<td>2 W</td>
<td>Temporal</td>
<td>One round</td>
<td>-4.50</td>
<td>Gyropeyx, No drainage</td>
<td>12 M.</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>30</td>
<td>1 M.?</td>
<td>Inferior</td>
<td>One round</td>
<td>-5.50</td>
<td>Same as above</td>
<td>5 M.</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>4</td>
<td>M</td>
<td>23</td>
<td>2 W.</td>
<td>Superior temporal</td>
<td>One round</td>
<td>-7.00</td>
<td>Same as above</td>
<td>8 M.</td>
<td>1.0</td>
<td>1.2</td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>20</td>
<td>10 D.</td>
<td>Inferior</td>
<td>One round</td>
<td>-5.00</td>
<td>Same as above</td>
<td>4 M.</td>
<td>1.2</td>
<td>1.4</td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>21</td>
<td>2 W.?</td>
<td>Inferior</td>
<td>Three round</td>
<td>-5.00</td>
<td>Segmental sponge</td>
<td>6 M.</td>
<td>0.7</td>
<td>1.0</td>
</tr>
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</table>
right eye about three weeks prior to his visit at the Eye Clinic on 11/22/73. He had a round ballooning detachment of the retina limited to the upper temporal quadrant. There was a small round hole at 10:30 meridian in the mid-peripheral retina. The patient was admitted to the hospital and the modified Custodis procedure was performed on 11/30/73 without subretinal drainage. Postoperatively, the hole was on the buckle and in contact with the choroid. The subretinal fluid reduced but persisted. (Fig. 1) Two xenon photocoagulations were done on the buckle surrounding the hole but the fluid persisted. The second operation was done on 12/14/73, when a small 2.5 mm sponge was replaced with a large 4 mm diameter sponge without draining the fluid. Again postoperatively, the fluid persisted posterior to the buckle. It was concluded that the hole was sealed well, there was no other detectable hole, and the fluid looked stationary and not increasing. By slitlamp examination, the detached retina looked tight making a straight slope from the top of the buckle to the border of detachment. The patient was discharged and followed in the out-patient clinic. The fluid persisted through January next year. A questionable area of pin-point holes near the original hole was found and decided to treat this area. The patient was readmitted and a longer episcleral sponge was used to cover both original and a new questionable area. The fluid again persisted. On 5/6/74 the fluid appeared to be decreasing but still noticable. The detached retina now looked more transparent and thinner. The surface became more concave and looked like a roof of a tent. The patient was lost for follow up until November, 1975, when the retina was completely flat with slitlamp examination. The fluid persisted at least 6 months in this case.

Case 2: 25-year-old woman first noticed distorted vision in the right eye on 12/25/73. The fundus examination revealed a shallow detachment of the retina extending clockwise from 6 O'clock to 10 O'clock with a small round hole at 9:30 meridian in the mid-peripheral retina. The boundary of the detachment split the fovea vertically. On 1/8/74 the modified Custodis procedure was done with a 2.5 mm diameter sponge over the hole. Postoperatively, the fluid reduced but persisted in the inferior temporal quadrant. (Fig. 1) The hole was on the buckle and almost invisible. The patient was discharged to be followed in the out-patient clinic. Four months after the operation, the fluid was still observed with slitlamp. The patient was brought back to the hospital and two rows of cryopexy was done over the area between the buckle and the fluid in the hope that the peripheral trough could be sealed off. The fluid persisted in spite of this procedure. On 12/26/74 the fluid was still present though remarkably diminished. On 6/26/75 there was no fluid and a complete reattachment was obtained. The fluid persisted for about one year in this case.
Case 3: A 30-year-old woman first noticed that things looked darker in the left eye in the middle of January of 1975. An inferior detachment with several intra-retinal white lines and a small round hole at 5 O'clock meridian in the peripheral retina was found in the left eye. The presence of white lines in the retina indicated the detachment to be long-standing even though the patient noticed visual disturbances not long time before. A 3 mm diameter silicone sponge about 10 mm long was placed over the sclera after the area was treated with cryopexy. No fluid was drained. One day postoperatively the hole was well tamponaded by the buckle but the fluid persisted posterior to the buckle. The fluid decreased steadily during the next two weeks leaving a semicircular area of fluid pocket attached to the buckle. (Fig. 1) On 7/15/75 the fluid was still present although shallower and the retinal surface became more concave to the inside. When she returned for the fourth time on 11/15/75, the retina was completely flat. The fluid persisted over 5 months in this case.

Case 4: A 23-year-old man was referred to us with a diagnosis of retinal detachment in the left eye. He noticed metamorphopsia for about two weeks before he was operated in our hospital. He had a superior temporal shallow detachment with a very small round hole at 12 O'clock near ora serrata. The hole was treated with cryopexy and a 4 mm diameter sponge by 10 mm is securely placed over the hole with two 5–0 Dacron mattress sutures. The fluid was not drained. Next day we thought the fluid was completely disappeared. He was discharged on 8th postoperative day. When he returned in one month, the slit-lamp examination revealed a small area of fluid inferiorly with the same boundary nasally from the previous detachment. (Fig. 1) This fluid was followed for about 8 months. With slitlamp there were two parallel optical surfaces, one at the pigment epithelium and the other at the overlying retina. The retina was thin and transparent. This fluid disappeared when examined on 11/21/75.

Case 5: A 20-year-old man noticed a nasal visual field defect in his right eye five days prior to admission to the hospital on 2/25/74. The retinal detachment was limited to the temporal peripheral retina from 8 O'clock to 11 O'clock meridian with a small round hole at 10 O'clock. There was an unrelated small hole at 12 O'clock in this eye. He had moderate lattice degeneration in all four quadrants in each eye. There were several round holes in the lattice in the left eye. A 3 mm diameter, 10 mm long sponge was placed for this detachment in the right eye. A hole at 12 O'clock was simply treated with cryopexy. A lattice degeneration in the superior temporal quadrant in the left eye was treated with transconjunctival cryopexy. The subretinal fluid in the right eye was completely absorbed within 24 hours. The patient was discharged 9th postoperative day to be followed in the clinic. The patient noticed flashes of light in his left eye and returned to
the hospital on 3/25/75. There was an inferior detachment from 4 to 7 O'clock with a small round hole at 5 O'clock in the lattice. This detachment was treated with 3 mm diameter sponge, 15 mm long. The hole was on the buckle at the anterior slope and attached to the underlying choroid. The fluid, although localized and limited only around the 5 O'clock meridian, persisted for four months before it is completely absorbed. (Fig. 1)

Case 6: 21-year-old woman noticed narrowing of the nasal visual field in the right eye for about one week, when she was examined and an inferior temporal detachment from 3:30 to 9 O'clock was discovered. There were three small

Fig. 1 Schematic drawing of the cases. Broken lines indicate original detached retina, stippled areas; residual fluid, shaded areas; buckles, and solid black areas indicate holes.
round holes in the lattice degeneration located in the inferior temporal quadrant. There were subretinal or intraretinal organization with several fixed folds. We thought this detachment was long-standing and 3 mm sponge was placed from 3 O’clock to 10 O’clock inferiorly and a sclerotomy was made to drain the fluid. Only a small amount of fluid was obtained. Postoperatively, most of the fluid in the equatorial area between the buckle and the posterior pole. (Fig. 1) The patient was discharged from the hospital on 7/9/74. This fluid was lastly observed on 1/7/75. The fluid persisted over 6 months in this case.

**DISCUSSION**

It is not a rare occurrence to find a small pocket of fluid in retinal detachment patients long after surgery. If we follow this fluid for long time, it disappears and a complete reattachment occurs, provided the fluid was not rhegmatogenous in origin. Six patients that I described here belong to this group, that is, all patients attained complete recovery without further operative intervention. It seems unequivocal that these patients do exist.

A question arises what the mechanism of this late absorption is. The biochemical analysis of the subretinal fluid revealed a high hyaluronic acid content and proved its origin from the vitreous fluid. Rosengren explained the general hemodynamics of absorption of subretinal fluid from the choroid. It has been shown that the older the subretinal fluid becomes, the more the protein content of the fluid increases. Gortz thought that the subretinal fluid was removed from underneath the retina into the choroidal circulation by passive oncotic pressure gradient, and when the oncotic pressure exceeded that of the serum, the fluid would not be absorbed and surgical drainage became necessary. Lincoff challenged this idea and after extensive experience with clinical cases, proposed that the only indications for the subretinal drainage were 1) giant tear, 2) massive preretinal retraction, 3) uncertain localization, 4) glaucoma, and 5) staphylomatous sclera, and omitted a long-standing, old, viscid fluid as an indication. With his 1000 consecutive cases, he proved the correctness of his theory. Chignell, O’Connor, and Francois followed him and reassured its high rate of success and low incidence of complication.

O’Connor analyzed his 100 cases of modified Custodis procedure and found that 23% did not flatten completely during the first one week postoperative period. Out of 23%, 8% took anywhere from one week to three months before the subretinal fluid was completely absorbed without further treatment. He attributed these cases to the senile choroidopathy. 7% developed radial fold which were either treated by photocoagulation or flattened by itself. 3% were from the pres-
ence of anterior fold. He treated these cases with further operative procedures such as, by drainage, radial sponge or intravitreal air injection. The remaining 5% were divided into retinoschisis, choroidal detachment and missed holes as reasons for delayed absorption. Among the reasons he pointed out, radial fold, anterior fold, retinoschisis and missed holes are reasons for failures of closing the holes and the fluid was actually rhegmatogenous. Ichihashi reported 6 cases in which the subretinal fluid persisted for more than 6 months before it was completely absorbed. The description of the clinical courses is quite similar to that of my cases and I think they belong to the same category, but he failed to comment specifically on the mechanism of this prolonged absorption.

The appearance of the retina overlying the fluid in my cases clearly indicated that the retina was too short to cover the surface of the underlying choroid. When the retina is too short, the retina can not settle even though all retinal holes are closed completely. (Fig. 2) Naturally the retina takes a concave surface toward the vitreous due to a constant subretinal negative pressure. The shortness of the retina may be caused by degenerative cystoid spaces in the retina or proliferative organization as is shown by Machemer in the experimental detachment of the retina. This process is probably augmented by time and also by immobility of the detached retina. If the retina is swayed back and forth with the movement of the vitreous, the floating retina suffers a certain pulling pressure which may keep the retina from shortening. The immobility of the retina tends to occur in young individuals whose vitreous is not extensively liquefied or detached. I think cases 2, 3, 4 and 6 are examples of this degenerative shortness of the retina. The tightness or shortness of the retina can occur at the time of surgery when

Fig. 2 Left drawing shows “tented retina” from disorganization of the detached retina, right drawing shows surgically produced “tented retina”.
the buckle is produced under the detached retina. When the inflammatory exudate functionally closes the hole, the inflammed choroid over the buckle may attach the retina in the wrong place making one side of the buckle redundant and the other side too short to settle down. (Fig. 2) Cases 1 and 5 probably represent this mechanism of shortness.

Once in a while we are amazed with a dramatic change in the appearance of the fundus of an old detached retina. I have seen in a young patient whose retina was off for at least two years and then surgically reattached, even a twisted and collapsed fold was flattened and almost completely disappeared after years' of convalescence. I see a tremendous reconstructive potential of the retina according to the physical or physiological requirement of its environment. In this case the tight retina lengthens as time elapses and finally reattaches. I think this process will take time certainly more than the hydrodynamic process of a viscid fluid and a sclerotic choroid. Since this is not a very rare instance of recovery period of retinal detachment surgery, I suggest to call this state of detached retina “Tented retina syndrome”. It is probably best to treat these cases conservatively because a good prognosis has been the rule in spite of prolonged convalescence.

SUMMARY

The subretinal fluid persisted for unusually long time after successful retinal detachment surgery in 6 cases. The mechanism of delay is thought to be the tightness of the detached retina. It was recommended to treat these cases conservatively rather than resorting to another surgical procedure. The importance of recognizing these cases are emphasized and “Tented retina syndrome” was suggested to indicate this state of retina after retinal detachment surgery.

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REFERENCES