THE LABILITY TEST*

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THE lability test was described by Bloomfield and Lambert (1945). As with other provocative tests it is used for the detection of glaucoma in eyes with a normal pressure.

Methods

The test is a combined one. One hand is put into ice-cold water and at the same time constriction is applied to the neck in order to increase the venous pressure in the head. The latter is done by means of an ordinary sphygmo-manometer with the blood pressure cuff round the neck. We have only used a pressure of 40 mm. Hg. in the cuff. Bloomfield (1947) and Bloomfield and Keltzman (1947) use a pressure up to 60 mm. Hg., but many patients complain when such a high pressure is used and we have therefore reduced it. The test lasts only one minute and the ocular tension is measured with a Schiötz X-tonometer after half a minute, and after one minute. The rise in tension is recorded.

In some cases we have done the ice-water test and the neck compression test (the "cuff" test) separately, and then the combined lability test. In order to find out what really happens in the eye during the test, we have, in addition to measuring the ocular tension, also observed the aqueous veins and measured the pressure in an episcleral vein. This venous pressure is measured with a water manometer previously used by one of us and a fuller description of the method has been given by Thomassen (1947a). The water in the manometer is connected by rubber tubing to a transparent chamber, one side of which is composed of thin cellophane. This side is placed over the vein, which can be clearly seen through the transparent chamber, and the pressure required to collapse the vein is then read on the manometer.

We have examined normal eyes, and eyes suffering from simple glaucoma. In all, 52 normal persons have been examined. The ice-water test has been applied separately to thirteen of them. This test did not alter the pressure in the episcleral veins in any case, nor did the appearance of the aqueous veins change except in one case, in which a definite increase in the outflow of clear liquid was seen in the aqueous vein. This patient was the only one who had a definite increase in ocular tension during the test. This means that the increased intra-ocular pressure was combined with

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an increased outflow of aqueous humour and must therefore have belonged to that group of pressure changes which are compensated by the safety valve action of Schlemm's canal (Thomassen, 1949). This suggests that the rise in bulbar pressure was due to an increased amount of intrabulbar blood.

The "cuff" test produced a remarkable change in the aqueous veins in all thirteen cases observed. Both the blood veins and the aqueous veins increased in diameter, and the aqueous veins by degrees filled with blood. In some cases the flow in the aqueous veins remained in the same direction all the time while the contents altered; in other cases, however, the current was reversed and blood entered and filled the aqueous vein from the previous collecting vein. The amount of clear liquid usually decreased, but sometimes it increased considerably at first. This increased amount of clear liquid may depend on a pushing backwards of the clear liquid already present further along the vessels, but is more likely to depend on an increased outflow of aqueous humour. As mentioned before, such a rise in intra-ocular pressure combined with an increased outflow of aqueous is most probably due to an increase in the volume of intra-bulbar blood. This increase must therefore occur soon after the cuff is blown up and before changes in the episcleral veins are observed. The explanation may be that the venous obstruction affects the outflow in the vortex veins before the episcleral veins.

The pressure in the episcleral veins is preferably measured at or near the point where an aqueous vein joins a blood vein. We have found that the lateral pressure in these veins usually increases 20 to 30 mm. Hg. when the cuff is blown up to 40 mm. Hg. In a few cases we have found a smaller increase—the lowest was 12 mm. Hg.—and in a few cases a greater increase—up to 40 mm. Hg. These differences may perhaps depend on how the cuff is placed round the neck or on the varying degree of rigidity of the tissues and vessels in the neck.

In the combined ice-water and cuff test the same changes in the aqueous veins are seen as in the cuff test alone. The increase in venous pressure is also usually found to be similar, although in a few cases pressures slightly higher or lower were obtained with the lability test.

Results

As mentioned before, the ice-water test alone increased the bulbar pressure only in one case. In the other twelve the bulbar pressure was either unchanged or, as in a few, showed a slight drop. The cuff test usually produced about the same increase in bulbar pressure as the full lability test. Sometimes, however, a remarkable difference was observed, the higher pressure being produced as often by the cuff test alone as by the lability test.

The full lability test produced in 52 normal persons an increase in bulbar pressure of 0 to 8 mm. Hg., the average being 2.7 mm. Hg. Age was not found to influence the results of the test, the persons tested being from 12 to 75 years old.

How does the lability test produce the rise in bulbar pressure?

It is obvious that the increased venous pressure will hamper the outflow of aqueous humour. The fact is, however, that we have found no correlation, either in normal or glaucomatous eyes, between the rise of pressure in the episcleral veins and the rise in the bulbar pressure. In our opinion, therefore, it is the increased blood volume in the eye which plays the most important part. The venous congestion produced by the cuff increases the blood volume in the eye, as in all probability does the ice-water test. It has also been shown (Bloomfield and Lambert, 1945), that the ice-water often increases the general blood pressure, which may account for its influence on the eye.

One phenomenon particularly shows that an increased blood volume is the most important factor—the fact that the pressure in the eye rises very rapidly during the test. After half to one minute it has reached its maximum and in a similar period after the test it has fallen to the pre-test value. Such a rapid change in the pressure can hardly be explained by an alteration in the amount of aqueous humour, especially in cases of glaucoma when the rise may be as high as 20 mm. Hg. or more.

Now an increased venous pressure in the episcleral veins must, of course, hamper the outflow through the aqueous veins. In order to investigate the effect of this acting in isolation on the bulbar pressure, we chose two normal persons who had no rise in the bulbar pressure during the cuff test. After a rest the cuff was blown up again in each case, but now only to 20 mm. Hg. The experiment lasted 20 minutes and the bulbar pressure was found to rise gradually and to reach a new level after about 15 minutes. In one case the bulbar pressure increased 8 mm. Hg., in the other 10 mm. Hg. When the cuff was first blown up the aqueous veins filled with blood, but after about 10 minutes aqueous was again visible, and finally, a new equilibrium seemed to be established between the venous pressure and the pressure in the aqueous veins. It was, however, impossible to determine whether the amount of clear liquid leaving the eye was the same as before the experiment started, as the veins now appeared considerably broader.

This shows that the effect of the increased venous pressure on the aqueous outflow does not make itself felt very much over periods as short as one minute. We have therefore come to the conclusion that it is mainly an increase in the intra-ocular blood volume that produces the rise in the bulbar pressure during the lability test.

The Lability Test in Glaucomatous Eyes

The lability test, like all provocative tests, has the disadvantage that a normal result by no means excludes glaucomatous disease. The question therefore arises—what is the cause of the abnormal reaction in glaucomatous eyes, and why is the test sometimes normal and sometimes abnormal in these eyes?

In most cases of simple glaucoma the pressure changes from hour to hour during the day and night. In our opinion therefore all research work on the ocular pressure in glaucomatous eyes must take into account whether the pressure is increasing, decreasing, or remaining level during the experiment. One of us has already shown that the venous pressure in the eye changes, and the appearance of the aqueous veins alters in a characteristic way when the ocular pressure is increasing or decreasing, Thomassen (1947a, b). It has also been found that another provocative test, the bulbar compression test, always gives an abnormal reaction when the bulbar pressure is increasing and a negative reaction when it is decreasing, Thomassen (1946).

We have therefore measured the ocular tension at half-hourly intervals during a large part of the day and repeated the lability test in the same eye many times. In this way it is often possible to estimate the phase of the ocular pressure during the tests. One has, however, to be very careful in deciding whether the pressure is increasing or decreasing at any particular moment. This difficulty has been mentioned before, Thomassen (1947a; 1946), but as it does not seem to have been fully understood, will be explained again.

Observation of the ocular tension cannot be continuous, and we can therefore never know with certainty how the pressure has changed between measurements. If, however, the following rules are obeyed the estimation can, in our opinion, be fairly accurate.

It is necessary to take at least three measurements—the first about half an hour before the experiment begins, the second at the start, and the third about half an hour after the experiment has finished. If these measurements show the same pressure, the experiment has been done while the intra-ocular pressure remained on the same level. If each succeeding measurement shows a rise, the experiment has been performed during an increasing phase; if each succeeding measurement shows a fall, the experiment has been performed during a decreasing phase. If the three measurements do not show such regularity, it is impossible to be sure in what phase the experiment has been performed. Thus many experiments will be performed in vain, since the readings of the ocular tension will often show no such regularity.

We have investigated fifteen patients suffering from bilateral simple glaucoma. Most of them were observed over many days, the ocular tension being measured every half hour. Five of the patients had a normal tension the whole time and showed no remarkable change. They had either been operated on or were being treated successfully with miotics. In these eyes the lability test always produced a rise in pressure within the limits found in normal eyes. In the other ten patients the ocular pressure changed during the time of observation. Curves 1, 2, and 3 show that the result of the test depends on whether the bulbar pressure is in an increasing or decreasing phase during the experiment.

Curves 1, 2, and 3 show the pressure of three different glaucomatous eyes during one day. The continuous line presents the bulbar pressure. L. means Lability Test. P. means that pilocarpine 2 per cent. is instilled into the conjunctival sac. The dotted vertical lines show the rise in pressure during the respective lability tests. Where no such dotted line is given below the test, it means that the test has not produced any rise in pressure.

Curve 1 shows the results of a test performed while the ocular pressure was increasing. A rise of 11 mm. Hg. was produced. Two hours later the test was repeated, but now the pressure was decreasing and no rise was produced by the test.

In Curve 2 the same phenomenon can be seen. It should be noted that both tests were performed while the bulbar pressure was below 30 mm. Hg. Nevertheless, the first test, performed in an increasing phase, was positive, whereas the second which was performed in a decreasing phase was negative.

Curve 3 again shows a positive result in an increasing pressure phase. It is, however, impossible to be sure in which phase the second test was performed. As can be seen, the control measurements half an hour before and half an hour after the test show a higher pressure than that recorded at the starting point. Abiding by the previously mentioned rules, it is impossible to tell whether the pressure was in the increasing or decreasing phase

during the test. The third lability test in Curve 3 produced no rise in pressure. This test was done in a decreasing phase after the instillation of pilocarpine. The effect of pilocarpine on the lability test will be discussed later.

In all, the test was performed eight times during a definite increasing phase, and produced rises varying from 10 to 20 mm. Hg. and averaging 13.5 mm. Hg. The test was performed eleven times in the decreasing phase and on no occasion was a rise of pressure produced.

From these experiments we conclude that the lability test will be positive when the ocular pressure is in an increasing phase and negative when the ocular pressure is decreasing. In this connection the absolute height of the pressure seems to be of no importance to the result of the test.

Pilocarpine in itself seems to have no effect on the test. If the pressure is decreasing the test will be negative whether the fall is spontaneous or induced by pilocarpine. On the other hand, if pilocarpine is instilled into the eye and no drop in pressure is produced, the test will behave as if no pilocarpine had been used.

The test was performed four times while the bulbar pressure was increased but remaining on the same level. In all these cases the test was positive.

On many occasions, however, the test was performed when the pressure remained level and at a normal height. In these cases the test was sometimes positive and sometimes negative. When the pressure was studied in greater detail over many days it was found that all the eyes which showed a negative test were very well stabilized at a normal pressure. Five of our patients, as mentioned before, belonged to this group and no abnormalities were ever found in their pressures.

On the other hand in five cases showing a positive test, although with level pressures within normal limits, investigation showed that the ocular pressure in these cases was very unstable. In four of them the pressure had been increased a few hours earlier, and in the fifth case the pressure had been increased the day before the test.

From our findings we can make the following summary. The lability test will be positive if the ocular pressure is increasing, negative if it is decreasing, positive if it is increased and remaining on the same level, negative or positive if the pressure is normal and remaining on the same level.

If in the latter case it is positive, the bulbar pressure is probably unstable. This explains why the test is of such limited value, and we agree with Sugar (1948) when he emphasizes that repeated measurements of the pressure will be at least as valuable as the test.

It is of some interest that our findings on the lability test in glaucomatous eyes are the same in detail as one of us has found using another provocative test, namely the bulbar compression test, Thomassen (1946).

It has already been emphasized in this paper, that the rise in the ocular pressure produced by the lability test must be one mainly to an increased blood volume in the eye. In cases of simple glaucoma we have seen that the same eye may respond very differently to the tests applied. That is to say that sometimes the vessels of the eye dilate considerably to accommodate the increased blood volume and sometimes they are able to resist the stress and do not dilate at all. The explanation must be that the reactions of the vessels vary. Normally they will be in a state when they dilate a little. In the increasing phase in glaucoma they cannot withstand the stress as they normally do and they dilate considerably more. In the decreasing phase they are better able to withstand the stress and do not dilate at all.

With our present knowledge we are ignorant of the nature of these vascular changes, but it is possible that they represent the actual cause of the glaucomatous disease. It is certainly probable that they cause the variations in the venous pressure which have been described previously, Thomassen (1947a).

Summary

It is found that the lability test in normal eyes raises the ocular pressure from 0 to 8 mm. Hg. The rise must mainly be caused by an increased blood volume in the eye.

In eyes suffering from simple glaucoma the test will be positive if the ocular pressure is in an increasing phase and negative if it is in a decreasing phase. The test will be positive if the pressure is high and remains on the same level, but it can be positive or negative if the pressure is normal and remains on the same level. If the test is positive under the last mentioned circumstances, the bulbar pressure is presumed to be unstable.

The lability test can therefore change from positive to negative or *vice versa* in the same glaucomatous eye within a short interval. The cause must be that the conditions in the ocular vessels change. The nature of such changes is unknown, but it is possible that they represent the actual cause of the glaucomatous disease.

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