ASSESSMENT OF CORNEAL SENSITIVITY*

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ACCURATE measurement of corneal sensitivity was first attempted by von Frey (1894), using as a criterion the length and bend of a horse hair through which pressure was applied and increased until the threshold of sensation was reached. The basic principle laid down by von Frey was generally accepted. Modifications were made by using different materials and adjustable plastic thread, which permitted the application of different pressures which could be measured on the same instrument in mg. of pressure (Boberg-Ans, 1955, 1956; Cochet and Bonnet, 1960; Schirmer and Mellor, 1961). The method depended on the idea that weight and surface were related in a rigid ratio. It was assumed that an increase of corneal contact had to be followed by a proportionate increase of weight to a hypothetical pressure index of 300 mg./sq. mm., which was universally regarded as mean average of corneal threshold sensitivity.

However, experiments have shown that this 300 mg./sq. mm. loading is not valid when varying areas of surface contact are employed. Furthermore, it has become apparent that an additional factor, that of friction, is involved and an instrument has therefore been devised able to measure and correlate all three factors—loading, contact area, and friction.

Method

The sensitivity of the corneal vertex of 220 persons with healthy eyes was assessed, using the specially designed Aesthesiometer† (Fig. 1, opposite).

Large surface contact is accomplished by the use of a plastic disc on the end of a wire connected to the spring mechanism of the instrument. When small corneal contact is the specific aim, the same instrument is fitted with a sharpened plastic wire in place of the disc.

The instrument is equipped with a scale from which readings may easily be converted to milligrams by reference to a graph (Fig. 2, opposite). The instrument settings inscribed on the handle may be used for varying the pressure levels (A, B, C).

* Received for publication December 13, 1962.

† The Aesthesiometer is manufactured by the Metropolitan Optical Company, 42 Burton Ave., Montreal, Canada, under the trade name "Corneal Sensitometer".

FIG. 1.—The Aesthesiometer, showing pressure disc on fine wire.

FIG. 2.—Graph for conversion of scale readings to milligrams.

For an actual test with this instrument the patient must be in a recumbent position (Fig. 3), similar to that required for Schiötz tonometry.

FIG. 3.—The instrument in use.

The following procedure was adopted for all tests under review: contact was made with the cornea and pressure applied. Pressure was increased until the stages “Point of Threshold” and “Limit of Tolerance” were reached. To induce friction the patient was requested to shift his gaze to a second point of fixation, resulting in a movement of the eye of 15° of arc. The appropriate scale readings were then translated and recorded.

Results

Table I represents the complete range of findings.

TABLE I
RANGE OF RESULTS (mg.)

Test	Measurement	Contact	
		Point	Large Surface
Pressure	Threshold	5-180	5-20
	Tolerance	5-500 and more	10-300
Friction	Threshold	Less than 5-7	Less than 5-10
	Tolerance	Less than 5-15	Less than 5-130

Table II (opposite) shows the mean result of all tests. From these Tables it can be seen that friction is more effective than pressure. It can also be observed that the threshold values for pressure decrease with the increase of surface contact.

TABLE II
MEAN RESULT OF ALL TESTS (mg.)

Test	Measurement (mg.)	Contact	
		Point	Large Surface
Pressure	Threshold	50	10
	Tolerance	150	90
Friction	Threshold	Less than 5	5
	Tolerance	10	60

In the assessment of sensitivity using the sharpened plastic wire an interesting phenomenon was observed. When pressure beyond the threshold was exerted, and before tolerance was reached, a range of lessened sensation was apparent.

The limit of tolerance can be equated as a sensation of pain which can be defined only by the patient.

Discussion

The figures set out in Tables I and II show that surface and weight do not progress proportionately. Therefore, a pressure index cannot be deduced. An explanation for the decrease in threshold values with the increase of surface contact area may lie in the summation of impulses as suggested by Rodger (1953).

In eliciting corneal sensation, friction is more effective than pressure. Among possible explanations are the cumulative on-and-off stimuli for sensory receptors, as suggested by Gray and Sato (1953). Another explanation is suggested by the anatomy of the corneal nerve endings, which pursue an essentially vertical course between the epithelial cells. If change and displacement of nerve endings are responsible for sensation, then tangentially-applied friction should be more effective in displacing corneal nerve endings than pressure.

It was interesting to note that, in covering the vertex area with several point pressure tests, the readings were of similar magnitude. This indicates that the high values obtained were not caused by measurements taken between so-called "pressure points". The low values previously reported in this type of procedure were possibly due to the inadvertently introduced friction.

An analysis of factors responsible for corneal sensation reveals the importance of friction and pressure on the involved area, and also the variable status of central nervous system excitation.

The threshold sensations observed in the majority of tests suggest that the tests did not cause discomfort. Pain was experienced mainly at the limit of tolerance. These findings are consistent with the view that the cornea is supplied with sensation for pain and touch. The result of the trigeminal tractotomy of Sjöqvist (1938) appears to support this theory. The cornea remains sensitive to touch, but not to pain (Rowbotham, 1939). However, taking into consideration the possibility of hyperaesthesia for pain (Cogan and Ginsberg, 1952) after tract injury, it seems possible that patients may mistake pain for touch.

Summary

A method for measuring corneal sensitivity is presented.

Pressure, friction, and area of corneal contact are the main variables affecting the threshold and tolerance levels of corneal sensitivity.

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