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FUNCTIONAL EXPLORATION IN REFRACTIVE KERATOPLASTY

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Before Attempting Surgical correction of an ametropia you must know the physiological and optical parameters that determine the characteristics of the eye. This knowledge is essential not only to correct the ametropia but in deciding on type of surgical action and amount of correction necessary.

The sequence presented here will enumerate step by step the tests and considerations, established by clinical histories, and are applicable for various refractive errors.

Tests to be considered

The tests to be considered include:

1.—*Subjective Refraction*

This test is made with a Green's phoropter at 12 mm. corneal vertex distance and under cycloplegia.

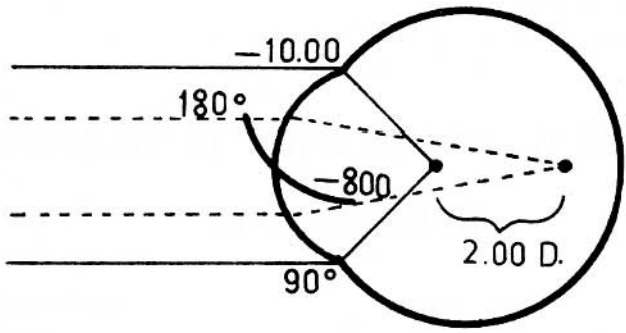


Fig. 1

Example Nº 1. -8.00 (-2.00 x 180.)

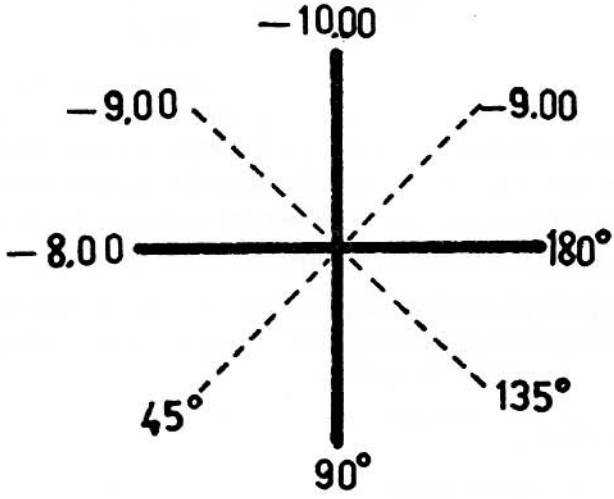


Fig. 2

This lens is a combination of a sphere and a cylinder. The optical cross represents a spherical lens of -8.00 diopters combined with a cylindrical lens of -2.00 x 180.

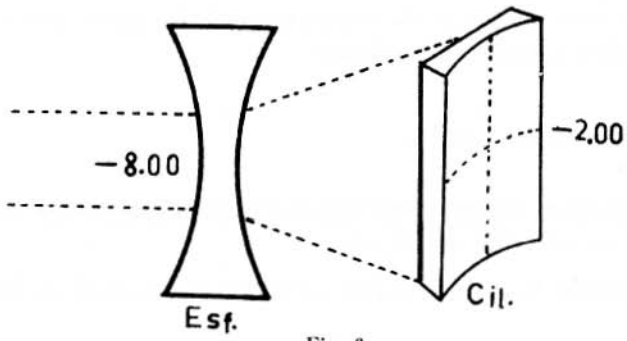


Fig. 3

The diagrammatic effect of those lenses on a schematic eye produces an induced emmetropia.

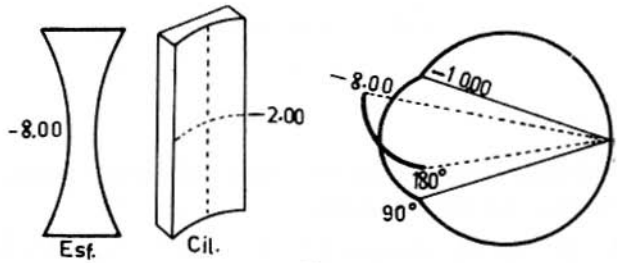


Fig. 4

2.—*The Spherical Equivalent*

The spherical equivalent, which is the first basic value to be corrected in keratomileusis (spherical), is represented in this case by a -9.00 dioptric

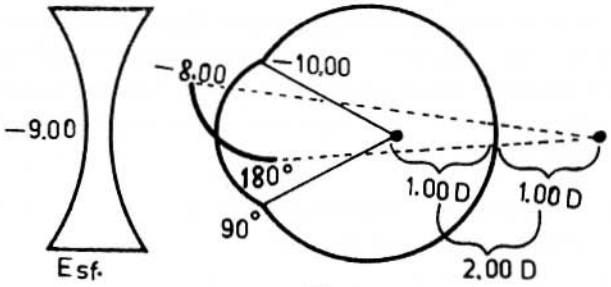


Fig. 5

The effect of the -9.00 diopter lens in the vertical meridian is an under correction of 1.00 diopter; in the horizontal meridian, it is an over correction of 1.00 diopter. Mathematically, the spherical equivalent of a cylin-

drical correction is equal to the combination of the sphere power, with half of the cylindrical value. (Combination).

3.—*Vertex Distance Considerations*

Effective power of the corrective lens at zero vertex must be calculated since the refraction was done at 12 mm.

The mathemaical formula of vertex refraction is expressed as follows:

FE — New dioptric power

F — Known power

D — Corneal distance at the vertex of the lens, expressed in meters.

$$FE = \frac{F}{1 - DF}$$

Several lens calculators can be used for simply and quickly finding the effective power of a lens at a given distance.

In the sample case, the effective power in the corneal plane of a lens of -9.00 diopters lens is of -8.12 d.

4.—*Static Objetive Refraction*

This information is acquired by the use of two instruments, the streak retinoscope and the Rodenstock refractometer. These instruments have great value due to the high incidence of absolute and relative amblyopia because eyes with considerable anisometropia are prime candidates for surgery of refraction. Objective tests are especially important if the patients are young. The tests should be conducted under comp'ete cycloplegia.

The Dynamic, Retinoscopy information has some value in some of these cases if cycloplegies have not been used.

Fixation

5.—Direct ophthalmoscopy is used, employing two instruments, the Oculus Ophthalmoscope using the green filter with a transparent circle in the cen-

ter, (Bangerter system), and a Cuppers Visuscope. In some cases of unilateral high myopia despite foveal fixation it is found that it is impossible to obtain an acuity over 20/100 with correcting spectacles and/or pinhole. These cases should not be considered hopeless if they have good vision (20/30 or better) at very short distances between the test types and the eye.

This phenomenon could be explained by an induced magnification. It has been observed in amblyopia myopic eyes with low acuity for long distance (when corrected optically), bus with good acuity without correction at short distance there is a tendency towards recuperation after surgery, or by means of Pleoptics using the Pleoptophor after surgical treatment.

The classification of fixation follows:

a. Foveal (stable or unstable)

b. Para-Foveal (stable or unstable)

c. Macular (stable or unstable)

d. Para-Macular (stable or unstable)

e. Eccentric (stable or unstable)

f. Lack of fixation

6.—Keratometry or Ophthalmometry of the Anterior Surface of Cornea. A. We use in our clinic two instruments on each patient, the *Micrometric C. I.* Ophthalmometer, made by the American Optical Company, gauged for refraction index of 1.3375, and the Zeiss Ophthalmometer constructed for a refraction index of 1.332, with a chord of 4.00 mm. for large radius, and 2.5 mm. for smaller ones.

Another excellent instrument is the Obrig Cornealometer which permits a topographic study. It is scaled for an index of 1.376, the same used in calculating the radius for the latheing of the cornea. This instrument measures a cornel area of an approximate diameter of 1/10th of the radius to be measured. This is 0.6 mm. diameter for 6.00 mm. of radius and 1.1 mm. of diameter for 11.00 mm. of radius.

When the ophthalmometric exploration is made with instruments with an index of 1.3375 or 1.332, a dioptric table equivalent to radius of curvature in millimeters is used in accordance with the index adopted by the manufacturer.

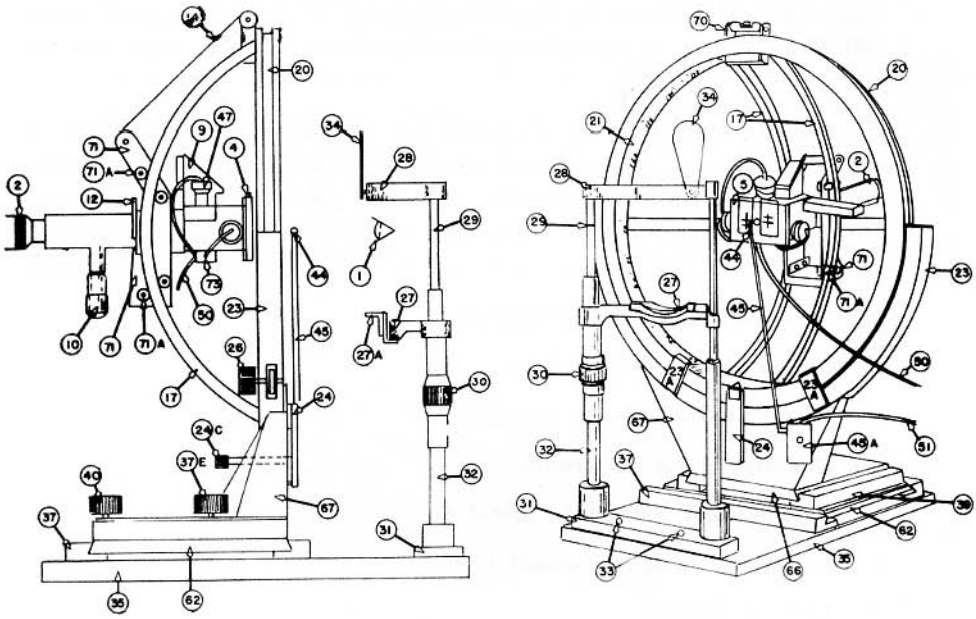


Fig. 6

7.—*Keratometric or Ophthalmometric Average* (Example: (43:00 x 180)
(45:00 x 90)

Following the figure Nº 7, the dioptric middle point, or ophthalmometric spherical equivalent is found at the 45 degrees and 135 degrees with a dioptric value of 44.00 diopters.

8.—*Posterior Face or Surface in Ophthalmometry*

To determine the total dioptric value of the cornea, it is necessary to know the curvature of both surfaces of cornea.

This knowledge is also helpful in knowing whether the postoperative change is due to a regeneration of the corneal thickness (small optic zone) or to other extracorneal factors. The radius of the posterior surface of the

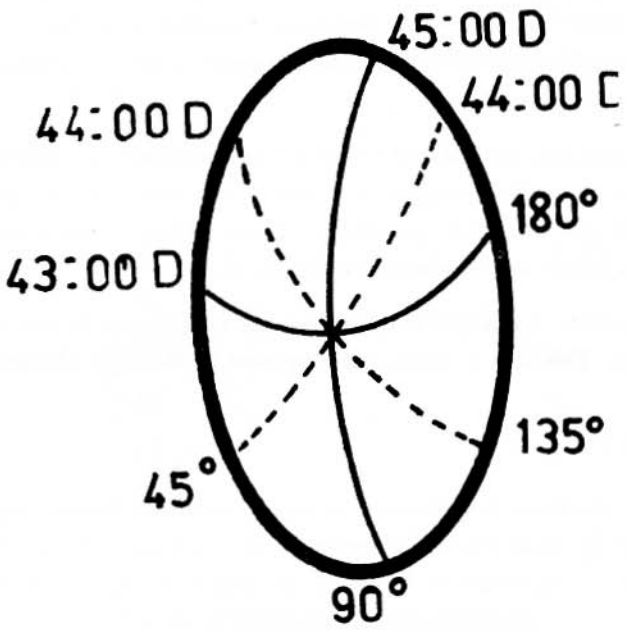


Fig. 7

cornea is measured with the Zeiss ophthalmometer; the meir reflections on the posterior corneal surface are smaller than those of the anterior. This makes the image easily visible. The information given by the ophthalmometer does not correspond, in one to one ratio, although it is recorded on the case history sheet. The real radius value is obtained by complicated formula.

9.—*Corneal Diameter*

This information is generally determined by the use of a Zeiss or Titmus pupilometer, which consists of a tube with a reticular scale which is superimposed on the corneal plane and simply by marking a line in the network

of lines, over the two extremes of the limbus, the corneal diameter can be read in millimeters. A second method; an adjusting eyepiece with a graduated scale in millimeters has been attached to a Zeiss slit lamp, with 10-X magnification and a direct measurement of the maximum and minimum diameters can be made.

In all cases, the vertical and horizontal measurements are taken. The vertical diameter generally averages 0.5 mm., less than the horizontal. This is probably due to a large percentage of eyes having a small amount of astigmatism, which is considered physiological.

To generalize, the major corneal diameter corresponds to the flattest corneal meridian. This fact is particularly evident in the high oblique astigmatism.

10.—*Corneal Thickness*

Corneal thickness is measured in vertex, with the Jaeger apparatus manufactured by Haag-Streit. It indicates the thickness of the resection to be used and is important in following the post-operative course of the patient.

11.—*Corneal Transparency*

The cornea inspection is preferred under the slit lamp and with fluorescein. In cases where minute leucomas are noted, their density and relation in the pupillary area are observed. Major changes in transparency are a contraindication for refractive surgery.

12.—*Corneal Sensitivity*

The Cochet-Bonnet esthesiomether is assembled within and empty metallic spindle with a rack so that only one hand is required to easily slide out the plastic filament. The measurements begin with the filament set at a length of 60 mm. A scale is incorporated on the stem for easy measurement and close control of the thread extension done with a gear arrangement.

The equivalent scale between the thread extension and the weight in mg. are as follows:

Length in mm.	*Weight in mg.*
60	11
55	12
50	13
45	16
40	20
35	27
30	35
25	53
20	75
15	100
10	140
5	200

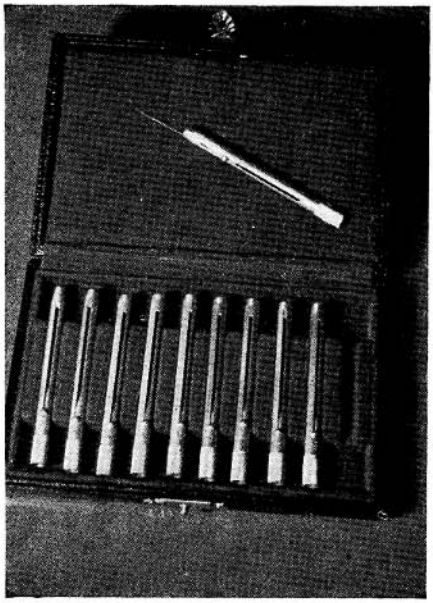


Fig. 8

Before proceeding with the test, the patient is informed that it is a painless procedure. The contact of the nylon filament with the cornea, is made and must be kept perpendicular until the flexion of the filament is observed and when the contact is reported by the patient. The maximum extension (60) should always be used to start, decreasing the lenght until the patient fee!s it. The cornea area utilized is the "apical" area, or the central 3 or 4 mms. of cornea. The optical zones for surgery in keratomileusis ranges between 5.5 and 6.5 mm.

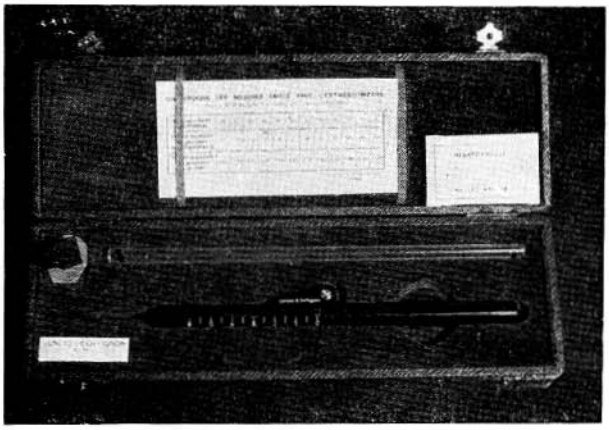


Fig. 9

The Esthesiometric pre-operative study, in addition to establishing the normal sensitivity of the cornea for surgery, gives information essential for post-operative follow-ups to investigate the reinervation of the operated cornea.

13.—*Anterior Chamber Depth*

Measured with the Jaeger device, manufactured by Haag-Streit, the total lenght of the globe is learned (Gernet Method), to discover whether post-operative modifications have taken place.

14.—*Anterior-Posterior Globe Length*

To determine the measure of the anterior-posterior ocular globe, the Gernet method is used. The optical ultrasonic method establishes the eye refraction when a cataract is evident. Also the volume of the ocular globe for predetermining the increase of tensile stress with the pneumatic rings and, lastly, whether a post-operative increase in axial myopia has taken place. The Echo-Ophthalmomograph of Siemens is used.

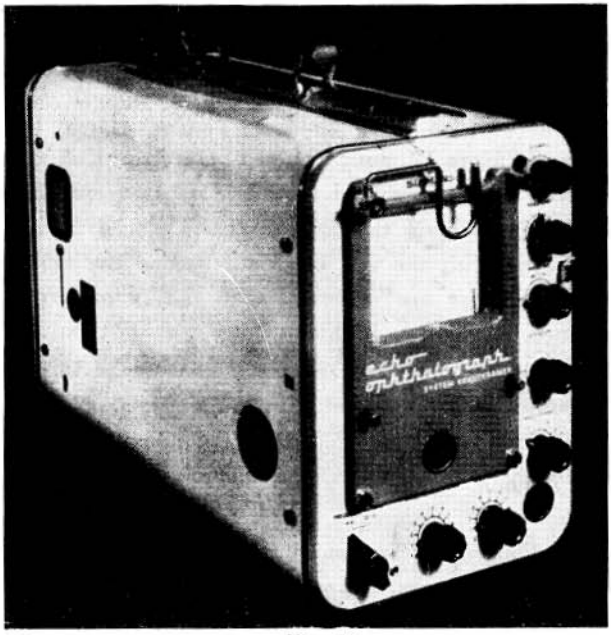
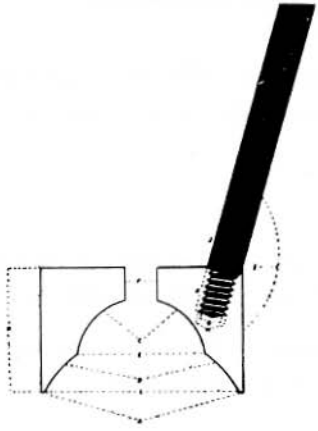


Fig. 10

15.—*Determination of the Scleral Radius*

The purpose of determining the scleral radius as part of the examination prior to keratomileusis surgery is to determine the proper radius of the pneumatic fixation ring, which will be applied to the sclera.



ESCLEROMETER

Fig. 11

Five test lenses (sclerometers), with a 13 mm. wide central area designed to clear the cornea are used. They are made of transparent plastic material and are a centimeter high. Convex surfaces are parallel or identical in radius to concave surface to allow observation.

The test lenses measure 12 mm., 12.5 mm., 13 mm., 13.5 mm. and 14 mm. in radii. These radii correspond to the more frequent scleral curvatures. After instilling anaesthesia the Sclerometer is placed on the anterior segment of the eye. With the aid of a microscope the compressing of the conjunctival capillaries are observed. The radius of scleral curvature is thus determined. Moreover, in many cases, the instillation of fluorescein helps the observation of scleral steepness or flatness thereby determining the scleral radius, as well as the presence of scleral astigmatism.

16.—*Intra-Ocular Tension*

Mackay-Marg Electronic Tonometer is used, which quickly and exactly gives the required information on intra-ocular tensión. With this instrument, the normal ranges are from 16 mm. to 20 mm. without anaesthesia, and from 18 to 22 mm. with local 2% novocain.

17.—*Ocular Fundus*

Any pre-operative abnormality is observed with ophthalmoscope and given careful consideration, both before and after surgery.

18.—An aniseikonic study being carried out within this exploration is exepcted to solve many of the problems associated with strabismus.

Conclusion

From the study of this data and the refraction of the eye on which surgery is contemplated, the amount and kind of surgical modification is determined.

The appraisal of the data, the calculation of the correction, and the evaluation of the post-operative results will be in a subsequent paper.

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