8. Gehrcke —*Neurol. Centralbl.*, Vol. XL, p. 93, 1921.
9. Holmes, G.—*Trans. Ophthalm. Soc. U.K.*, Vol. LI, p. 209, 1931.
10. Lerperger.—*Klin. Monatsbl. f. Augenheilk.*, Vol. LIII, p. 241, 1914.
11. Markus, C.—*Trans. Ophthalm. Soc. U.K.*, Vol. XXVI, p. 50, 1906.
12. Mayer, W.—*Jl. of Psychol. u. Neurol.*, Vol. XXV, p. 170, 1919.
13. Moore, Foster.—*Trans. Ophthalm. Soc. U.K.*, Vol. XLIV, p. 38, 1924.
14. ——— *Idem.*, Vol. LI, p. 203, 1931.
15. Morgan, G. and Symonds, C. P.—*Guy's Hospital Reports*, Vol. LXXVII, p. 13, 1927.
16. ——— *Proc. Roy. Soc. of Med. (Neurol. Sect.)*, Vol. XXIV, p. 41, 1931.
17. Nonne, M.—*Neurol. Centralbl.*, Vol. XXI, p. 1,000, 1902.
18. Roemheld, L.—*Idem.*, Vol. XL, p. 100, 1921.
19. Saenger, A.—*Idem.*, Vol. XXI, p. 837, 1902.
20. Strasburger, I.—*Idem.*, Vol. XXI, p. 738, 1902.

CONTACT GLASSES

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RECENT interest in contact glasses would suggest that they are an innovation, but this applies only to the technical excellence of their manufacture for the conception of their clinical possibilities was perceived at least fifty years ago.

Historical

About the year 1879, Rähmann, concerned with the treatment of conical cornea, became dissatisfied with the crude lenses at that time in use and turned his attention to lenses having a hyperbolic curve. His improved results stimulated interest in the optical correction of conical cornea and in 1887 came the experimental work of Fick, which culminated in the production of the earliest contact glass.

Fick asked Professor Abbey, at that time a director of the Zeiss firm, if he could provide a contact glass having a corneal radius of 8 mm. and a scleral radius of 12 mm. by grinding. Four glasses were provided, but in 1889 Himmler pointed out that these glasses were not ground but had been skilfully manufactured by blowing.

Quite independently, in 1889, Müller, in his inaugural dissertation at Kiel, described his work with blown contact glasses which he had carried out in conjunction with Himmler.

Fick then obtained ground glasses with the corneal and scleral parts cemented together; the one piece glass appeared in 1892, manufactured by Benvist, Berthiot et Cie, and, almost at the same time, by Strubin of Basel. Müller himself had a myopia of 14 dioptries, which was reduced by contact glasses to 1.5 dioptries. He could not, however, wear them for longer than half an hour.

It was at this time recognized that the ideal combination of comfort and optical accuracy would be obtained by grinding a blown glass; many efforts were made, even to the breaking of 200 shells at one attempt, but these remained, and still remain unsuccessful.

The work of Sulzer on similar lines appeared in 1892. Thereafter, for the next ten years, further experiments were carried out, and in 1912 and 1913 appeared the work of Stock and v. Rohr.

A period of renewed interest followed productive of articles by Erggelet in 1913, with regard to the correction of aphakia, and by Siegrist in 1916 on the correction of conical cornea.

Both types of glasses were being used; in 1919 v. Hippel used the Müller type for conical cornea, and in 1922 Dohme described similar treatment by the Zeiss pattern. Deutsch extended the application to the treatment of irregular astigmatism in 1929.

From this time onwards, the clinical possibilities have been greatly amplified by Professor Heine, and the optical proofs thereof elaborated by Hartinger. In this country, the masterly writings of Rugg-Gunn have been extensively studied.

Physical Properties.—At the present time there are two types of contact glass in use, the blown type is an air-expanded capsule of glass which, although optically imperfect, is said to be more comfortable to wear. This was the type used in the early experiments.

The ground type, introduced in its present state in 1920 by Zeiss, is manufactured by cutting, grinding and polishing.

The Zeiss contact glass is described as consisting of two parts fused together, (a) a corneal segment, which is an arc of a sphere, having an inner radius varying from 5 to 11 mm. in 0.5 graduations, and (b) a scleral segment with a radius of 11 to 13 mm.

FIG. 1.

The Müller or blown type of contact glass.

FIG. 2.

The Zeiss type of ground contact glass.

It is generally agreed with Professor Heine, that these measurements are insufficient, and that the graduations should run in 0.25 mm. The diameter of the corneal rim is 12 mm. and the entire diameter of the glass is 20 mm. The weight depends on the optical correction, which may be worked on the anterior face of the glass; it is usually about 0.5 gr. Hard crown glass, with a refractive index of 1.516, is used, and the shoulder between the corneal and scleral segments is carefully bevelled off.

When it is remembered that this thin wafer of glass is worked to 0.5 mm. measurements, the technical skill of the Zeiss firm will be readily appreciated, for the product is an optical accomplishment of the very highest order.

Physiological Properties.—If for any reason, the even curvature of the normal cornea be distorted, as by the abnormal shape of a conical cornea, or the irregular curvature resulting from the scars of ulceration, incident rays of light, instead of passing evenly through the mis-shapen cornea and coming to a point focus on the retina, become dispersed in several directions on account of the irregular refraction of the abnormal media (cornea) through which they pass.

True, if this refraction is moderate and regular in amount, they may be re-directed to their focus by the use of ordinary spectacle lenses but this correction has a limit, and beyond this limit, refraction and distortion are so great that spectacle correction is unable to produce a clear image on the retina.

There remain two ways of counteracting such irregularly refracting surface (1) to adapt a lens curvature to the abnormal curvature of the cornea by hyperbolic glasses, as has been done with success by Kramer. (2) To abolish the refracting power of the abnormal cornea, this is the function of the contact glass. Refraction is the property of a transparent medium suspended between two media of unequal refractive index, whereby rays of light, passing from the medium of less density, such as air, into a medium of greater density, such as water, are deviated from the path which they were pursuing in air to one of a different direction which they continue to follow in water. The cornea acts as a refracting medium, whether regular or irregular, because it is interposed between the air and the aqueous; if the cornea were to have a fluid of equal refractive index on either side of it, then its power of refraction would be abolished.

The principle of the contact glass is to maintain, on the outer side of the abnormal cornea, a layer of fluid, equal in refractive index to that of the aqueous humour, and by so doing, to overcome the distortion. Such a fluid is usually normal saline.

Thus it is seen that the contact glass is in no sense a lens, for it is afocal, and merely acts as a supporting structure to the saline

FIG. 3.

This Diagram shows the Contact Glass in position over a Conical Cornea, a layer of Saline intervening.

meniscus. The term "contact lens" should be reserved for those cases in which a lens addition has been ground on the anterior face of the glass. Furthermore, it will be realized that the whole function of this combination depends on the presence of a fluid layer between the glass and the cornea. The entry of air in the form of an air bubble nullifies the effect of the glass, and maintains the irregular refraction, resulting in no improvement in vision.

The exclusion of this air bubble is one of the first difficulties which the patient, on inserting the glass, has to overcome.

The final result of correction of irregular astigmatism by contact glass is a much nearer approach to normal physiological conditions than can ever be obtained by a spectacle lens.

Optical Properties.—The principle of contact glass correction is to render coincident the focal point of the compound lens system, consisting of contact glass, irregular cornea and intervening fluid meniscus with the far point of the eye.

Astigmatism, apart from that small portion due to the lens, disappears.

The value of this compound lens system may be altered by varying the curvature of the corneal segment, or by working a lens correction on the face of it, for example, a 5 mm. radius, with an average corneal radius, has a value of about 65 D. This value varies inversely until a radius of 11 mm. is reached, when the dioptric value is 30 D.

Thus, refractive errors may be corrected extending from a hypermetropia of 15 D. to a myopia of 20 D., the normal corneal radius being taken as 7.5 mm.

So, also, in the aphakic eye having such a radius, distance

focus is obtained by a glass of 6 mm. radius, and reading focus at a distance of 20 cm. by a glass of 5 mm. corneal radius (Heine).

Optical defects inseparable from a lens system having a fixed and moveable component, such as exists when a spectacle lens is supported before the eye, are excluded. These defects are (1) astigmatism of oblique pencils of incident light, causing chromatic and spherical aberration. (2) Limitation of the field of vision. (3) Changes in external accommodation. (4) Differences in the angle of fixation of anisometropic eyes. Furthermore, in the case of myopes, there is the advantageous magnification of the retinal image which at 20 D. amounts to 50 per cent. similarly, in hypermetropes, there is a diminution of the image at 17 D. by 10 per cent. (Hartinger.) Optical proofs of these deductions are to be found in the papers of Heine, Hartinger and Rugg-Gunn.

Psychological Properties.—The greatest psychological factor of contact glasses is their invisibility, which in women is of great importance, especially as they replace the thicker and more unsightly type of spectacle lens.

Advantages and Disadvantages.—It is tempting to wax enthusiastic over such a clinical innovation as the contact glass, but increasing experience has tempered such enthusiasm and come to show that, although the contact glass has fixed and definite functions, it is not the ophthalmological panacea some would have us believe.

The disadvantages may be annotated as follows: (1) an easy method of insertion, suitable for all patients, has not yet been found. (2) Discomfort is invariably experienced at first which, if the glasses are not accurately fitted, often leads to their discontinuance. Some patients at once become accustomed to them whilst others are afraid to persevere, and soon give them up. A successful case should tolerate the glasses for at least six hours. (3) They are costly (about £4 each). (4) They may be a potential source of danger to the eye in case of injury, though no such case has yet been recorded. Rugg-Gunn holds the view that this possible danger is less than that of a broken spectacle lens. Bearing in mind these disadvantages, it will, therefore, be realized, that the rôle of contact glasses is in those cases for which ordinary spectacles are of no avail, and where the alternative is blindness. They do not pretend to replace even the higher values of lens correction, though they hold theoretical advantages over such.

The advantages from the optical and cosmetic point of view have already been discussed. Suffice it to say that they bring to the treatment of conical cornea a method, the results of which have not been approached by any other previously employed.

Causes of Failure.—(1) Discomfort. This has been a difficulty from the very early days.

It is not universally agreed as to whether the contact glass is more comfortable when fitting tightly, or when there is a slight laxity of correspondence in movements between the eye and the glass.

The bulk of opinion, however, agrees that a tight fit with regular circum-corneal pressure is the ideal. Stock, on the other hand, wore contact glasses for two years, with a duration time of four hours, and puts the discomfort after this time down to the perfect fitting and close adhesion which had been obtained.

The middle course is taken by Professor Lindner who modifies the fit of the glass to the comfort of the patient, at the expense of exact optical correction.

The cause of this discomfort is probably not pressure on the surface of the cornea, so much as irregular pressure on the vessels and nerves at the limbus. Erggelet points out that the glass may be reground at these pressure points. This writer has made a careful study of the causes of irritation; he found that quartz lenses were just as irritating as those composed of glass, and that corneal damage, in the form of wreaths of pearls, may actually be caused by the pressure of the glass on the cornea.

von Csapody endeavoured to attain a perfect fit by means of a paraffin mould which is poured on the cornea and subsequently treated with ice-cold paraffin. He claims that no great trouble or harm comes to the patient, but that the subsequent plaster and metal preparation is a difficult process. He finds it useful for complicated cases.

von Hippel and Dr. Clausen have experience of shells made from zellon, a form of celluloid. The latter is of opinion that the tighter these fit the cornea, the more uncomfortable they are to wear on account of the suction action, which they acquire after being worn for a short time.

Most people are agreed that the Müller glass is the more comfortable to wear, probably because the unit area of pressure is less than that of the Zeiss glass. The best optical correction, however, is undoubtedly procured by the latter.

In my small experience the cause of this discomfort is partly lid-pressure forcing the glass backwards against the eye, and partly a slight amount of movement in the glass which allows the shoulder to ride on to the corneal surface. Pain can be produced at once in this way, by moving a contact glass in position slightly laterally. To overcome this difficulty, precautions must be taken to avoid too small a corneal radius, and to employ the liberal use of holocaine.

(2) Psychology. There are a certain number of people who will not entertain the idea of wearing glasses in such close contact to their eyes. There are also many cases who will not persevere with

the use of the glasses when fitted. An inaccurate fit probably contributes to their discouragement.

Dohme postulates the following properties of the perfect contact glass. (1) Perfect corneal curvature. (2) Graduated to a definite scale. (3) An accurate fit with no displacement. (4) Resistant to chemical action and invisible. (5) It must be possible to grind additional correction on the anterior face.

Indications

The best indications for the use of contact glasses are (1) cases of advanced conical cornea where spectacle correction offers no improvement, and where there is no great opacity of the corneal apex. (2) Cases of old corneal irregular ulceration where the ensuing scars have no great density. (3) Cases of neuro-paralytic keratitis where corneal anaesthesia has hitherto called for a tarsorrhaphy to prevent external injury. (4) Selected cases of higher refractive errors.

Professor Heine gives the following additional indications for the application of ointment in *ulcus serpens* of the cornea: sclerotic keratitis, acne rosacea, vernal catarrh, pemphigus, xeroderma, hay-fever, kerato-iritis, dystrophia marginalis and keratitis e lagophthalmo.

He has found them valuable in many cases of iritis, as a splint after plastic operations, in nystagmus and colour-blindness, and, when tinted, for cosmetic and climatic purposes.

In his extensive experience he has never observed any disadvantages with properly fitting and optically suitable glasses, and he is of opinion that a true curative effect may be obtained by a diminution of intra-ocular pressure, by direct pressure on the cornea, as in myopia.

Clinical Methods.—Contact glasses are now supplied in three sets, consisting of 53 glasses in all, enclosed in a galalith case from which they may be easily removed without scratching. At present the only special tint available is the "umbral" tint, though I understand that it is possible for any tint to be incorporated in the glass.

Having determined by routine ophthalmological examination that a case is suitable for the employment of contact glasses, one proceeds with the trial of these.

The first thing to do is to anaesthetise the cornea and conjunctival sac with 2 per cent. holocaine; this may be continued permanently if desired, although some patients eventually come to insert the glasses without any anaesthetic at all. Cocaine should not be employed owing to its deleterious action on the corneal epithelium.

One of the difficulties associated with the trial of a number of contact glasses is to have an easy method of insertion so that many glasses may be rapidly changed.

Another difficulty is that the patient is usually apprehensive and unable to hold the contact glass steadily without spilling the saline, and allowing the entry of an air bubble.

Thus it comes about that several methods of insertion have been recommended. They are (1) the older method, in which the patient separates the lids with the thumb and finger of the ipsilateral hand, and applies the contact glass, adherent by suction to a rubber pipette, held in the other hand. (2) The method whereby the glass is inserted directly, the face being immersed in water. This is favoured by American authors and has obvious disadvantages. (3) The method of Affleck Greeves, which is to oppose the contact glass until it is almost touching the cornea. The field is then flooded by means of saline from an undine, carried by an assistant, and at the precise moment the contact glass is allowed to touch the cornea. This method is successful but, unfortunately, it entails the presence of one, if not two, surgeons. (4) The method of O'Rourke, by which the contact glass is held rigidly in the stopper of a wash bottle, to which the patient approached and from which the contact glass could be released by air pressure. The principle of the method is excellent but the apparatus is unnecessarily clumsy.

Messrs. Hamblin have constructed apparatus which has proved to be most useful, especially for the rapid interchange of glasses.

This apparatus is very simple and consists of a cup-shaped rubber sucker supported on an upright standard which is fixed into a base-block. A small glass tube of narrow bore is fitted into the lower end of the sucker; to the other end of the glass tube is attached a small pressure bulb. Halfway up the standard is fixed a plane mirror, which may be rotated to left or right.

The technique of examination proceeds as follows: the pressure bulb is slightly exhausted and the contact glass having previously been immersed in a bath of warm normal saline, is placed on the sucker with the corneal segment adherent to the rubber, and the whole glass filled with warm saline.

Pressure on the hand bulb is now released and the glass remains firmly fixed. The patient separates the lids with thumb and forefinger of the ipsilateral hand, and leans vertically towards the rubber sucker, watching the approach of the glass to the eye in the mirror as he does so. When the saline impinges on the cornea, gentle pressure is made on the hand bulb, the glass is released and the lids allowed to slide over it. In this way the saline is not prematurely spilt.

FIG. 4.
A Case of Contact Glasses (Zeiss).

FIG. 5.
Apparatus for Insertion of a Contact Glass.

The method of extraction is simple and is carried out by opposing the sucker with the pressure bulb exhausted to the contact glass, and at the same time turning the head and eyes in the opposite direction.

Originally it was recommended to insert an ivory peg like a toothpick under the outer rim of the glass. Professor Heine rightly points out, that not only is this liable to damage the cornea, but it may chip or roughen the rim of the glass. In my experience an important practical point is that both glass and saline should be well warmed before attempting insertion.

Contact glasses should be taken out every night, dried and kept in a special galalith case provided, care being taken not to confuse the right with the left.

Prescription of Contact Glasses.—This is essentially the duty of an ophthalmic surgeon, and may not be delegated to an optician.

Three factors must be ascertained (1) the scleral radius. This is obtained by trial of glasses with varying radii until a zone of complete adhesion is seen beyond the limbus, this may be by slit-lamp or by direct inspection alone. (2) The corneal radius. This may be ascertained by an ophthalmometer, after Heine, or by direct trial. When a suitable glass is found, the residual refraction is determined by objective methods, and by means of a graph the exact correcting radius, incorporating the additional correction, can be determined. It is found that an addition of over 6 D. when worked on the anterior surface makes the glass heavy and liable to easy displacement.

The curves of the correcting contact glasses with internal corneal radii of from 5-11 mm. are traced in a right-angled system of co-ordinates in which the abscissa represents the radius of corneal curvature and the ordinate the additional correction.

Rugg-Gunn has devised a very useful rule for measuring the distance between the spectacle lens giving the residual correction, and the apex of the contact glass. With an extra addition of 4 D. this measurement must be stated on the prescription, in addition to the scleral and corneal radii.

If the discomfort is extreme after the holocaine has worn off, a more shallow corneal radius may have to be substituted.

When the prescription has been made up the patient should be instructed to use holocaine freely (combined with adrenalin) and not to wear the glasses for more than two hours at a time. I have not seen any ill-effects from prolonged use of holocaine. It is better to correct both eyes at once, otherwise troublesome diplopia is apt to occur.

The more comfortable the insertion of the glasses is in the early stages, the more is the perseverance of the patient stimulated.

As time passes, the duration of use may be extended, until a daily

period of eight hours is reached, in about three months. Much longer times have been reported and one patient is said to have fallen asleep in them.

Results.—By far the best results, in the use of contact glasses, have been obtained in conical cornea, hitherto incurable. Some will say that the contact glass is not a cure, but merely alleviates the symptom of defective vision. The proof of this assertion will require the observation of a series of cases before a decision can be reached.

Successful cases of conical cornea have been reported by Siegrist, von Hippel, Dohme, Heine, Hartinger, Rugg-Gunn, von der Heydt, O'Rourke, Derby, Deutsche, and Katz. Beaumont has reported a very successful case of high astigmatism, treated by these means.

On the other hand, Mamoli, after extensive experience, stresses the limited application, and Wassemaer quotes four cases none of which was able to tolerate them for more than six months. Anderson states that his patient inserts the contact glass dry, and that the air bubble obtained causes no inconvenience. This is probably because tears percolate under the glass and gradually replace the air.

The following case is reported after having been under observation wearing contact glasses for nine months, and may thus be said to have reached a stage of conclusion.

Case Report

Four years ago, Miss T., aged 24 years, had four dioptries of astigmatism in each eye, which, when corrected, improved her vision to 6/18. Glasses were prescribed and she was kept under observation as a case of possible conical cornea.

In 1931 the vision with her glasses had sunk to 6/60 in both eyes, and the astigmatism had increased to about seven dioptries. Bilateral conical cornea without apical opacity was well established, and the patient was having the greatest difficulty in carrying on her work as a baker.

In August, 1931, contact glasses were fitted. The vision of the right eye was improved to 6/7.5 with a +1.0 sphere added, and that of the left eye to 6/7.5 (part) with a -1.0 sphere added. Her uncorrected vision was, R. E. 1/60 and L. E. counts fingers. Using both eyes together, fitted with contact glasses and no spectacle lens correction, her vision was normal.

At first she had some difficulty in avoiding the air bubble on insertion. This has been overcome and she is able to wear her glasses with comfort for eight hours, but she is being limited to six hours at the present stage of her treatment.

She is able to detect the presence of the air bubble by the diplopia which it produces.

Examined seven months after continuous use, her vision remains the same, and she is able to pursue her work in a normal fashion.

This case was made difficult by the fact that the patient was highly strung, and had been made desperate by the prospect of life-long blindness.

I wish to express my sincere thanks to Mr. Duke-Elder and Messrs. J. & A. Churchill (Publishers) for the use of the block for Fig. 1, and to Messrs. Theodore Hamblin for the courtesy and assistance which they have always been ready to extend in connection with this work.

BIBLIOGRAPHY

- Anderson.—*Med. Jl. Australia*, Vol. I, p. 216, 1930.
 Beaumont.—*Brit. Med. Jl.*, June 20, 1931.
 Clausen.—*Deutsch. Ophthal. Gesell. Heidelb.*, p. 252, 1920.
 Derby.—*New Eng. Ophthal. Trans.*, p. 223, p. 494.
 Deutsche.—*Klin. Monatsbl. f. Augenheilk.*, Vol. LXXXII, p. 295, 1929.
 Dohme.—*Zeitschr. f. Augenheilk.*, Vol. XLVIII, p. 106, 1922. *Deutsch. Med. Wochenschr.*, Vol. XLVIII, No. 33, p. 1,121, 1922.
 Dwyer-Joyce.—*Trans. Ophthal. Soc. U.K.*, p. 651, 1930.
 Erggelet.—*Zeitschr. f. Augenheilk.*, p. 33, 1913. *Klin. Monatsbl. f. Augenheilk.*, Vol. XVII, p. 241, 1914.
 Fick.—*Arch. f. Augenheilk.*, Vol. XVIII, p. 279, 1888. *Klin. Monatsbl. f. Augenheilk.*, Vol. XXXV, p. 129, 1897. *Münch. med. Wochenschr.*, Vol. LXXVII, p. 495, 1930.
 Greeves.—*Lancet*, p. 752, 1931.
 Hartinger.—*Klin. Monatsbl. f. Augenheilk.*, Vol. XLIX, p. 713, 1930. *Deutsch. Ophthal. Gesell.*, p. 216, 1930. *Zeitschr. f. Ophthal. Optik.*, Vol. XVII, Ed. 5 and 6, 1930.
 Heine.—*Münch. med. Wochenschr.*, Vol. I, p. 6, 1930. *Ibid.*, Vol. VII, p. 271. *Ber. XIII Concil. Ophthal.*, Amsterdam, Vol. I, p. 232, 1930. *Lancet*, Vol. I, p. 631, 1931.
 Katz.—*Trans. Chicago Ophthal. Soc.*, p. 835, 1931.
 Kramer.—*Zeitschr. f. Augenheilk.*, Vol. LI, pp. 235 and 371.
 Lindner.—*Klin. Monatsbl. f. Augenheilk.*, 1930.
 Mamdi.—*Lett. Oftal.*, February, 1931.
 Müller.—*Inaug. dissert.*, Kiel, 1889.
 O'Rourke.—*Trans. Amer. Acad. Ophthal. Oto. Gaz.*, 1928.
 Popoirci.—*Cluj. med.*, No. 9, 1929.
 Rählmann.—*Deutsch. Ophthal. Gesell. Heidelb.*, 1879.
 Rugg-Gunn.—*Brit. Jl. of Ophthal.*, p. 549, 1931. *Lancet*, Vol. II, p. 1067, 1930. *Trans. Ophthal. Soc. U.K.*, Vol. LI, p. 447.
 Siegrist.—*Klin. Monatsbl. f. Augenheilk.*, Vol. LVI, p. 400, 1916. *Deutsch. Ophthal. Gesell.*, p. 340, 1920.
 Sattler.—*Deutsch. med. Wochenschr.*, Vol. LVII, p. 312, 1931.
 Strebel.—*Schweig. med. Wochenschr.*, Vol. LXVI, p. 110, 1931.
 Stock.—*Deutsch. Ophthal. Gesell.*, p. 197, 1912.
 Sulzer.—*Bull. Soc. Ophthal. de France*, p. 306, 1892.
 Scheffels.—*Klin. Monatsbl. f. Augenheilk.*, Vol. LXXIV, p. 509, 1924.
 von Hippel.—*Klin. Monatsbl. f. Augenheilk.*, Vol. LX, p. 49, 1919.
 von der Heydt and Gradle.—*Amer. Jl. of Ophthal.*, Vol. XIII, p. 867, 1930.
 von Csapody.—*Klin. Monatsbl. f. Augenheilk.*, Vol. LXXXII, p. 818, 1929.
 von Rohr.—*Arch. f. Ophthal.*, Vol. LXXXIII, p. 189, 1912.
 Wassenaar.—*Jl. Med. Assoc., South Africa*, Vol. IV, p. 459, 1930.