straying into that of mere surmise. So much has been written and is still being written on the ductless glands that it comes as something of a shock to realize how little we really know, and how much of what we sometimes consider knowledge is in reality nothing more than ingenious speculation. We know something of the influence of the thyroid on growth; less of the pituitary; and still less of the adrenal glands. We know that the interstitial tissue of the sexual glands, the testes and the ovaries, is of great importance for normal development. We believe that the parathyroid and the thymus have an intimate relationship with certain disorders. And we are just now apparently on the edge of conquest of a new sphere of control, in the isolation of the active principle of the internal secretion of the pancreas. I do not wish to enlarge on these topics. I want to turn your attention in a slightly different direction.

We have seen, in considering the subject of vitamins, that if you supply sufficient quantity and quality of food the young animal will grow in a normal fashion. But he will only do so if the glands which control growth are working naturally and in harmony with each other. If there is, for instance, a defect of the thyroid secretion growth will be abnormal; the creature will not cease to grow, but the increasing tissues will be distributed in the body in an abnormal way—the skeleton will develop abnormally; the fatty tissue will be excessive and curiously localized; and the mental powers will be defective. It is as if you had presented an architect with the richest material in proper proportion and asked him to build a shrine, and though he has used the material he has built a deformed and unsightly hovel. So it is also with a defect of the pituitary secretion, and with the victims of a defect of the interstitial tissue of the sexual glands. In the one case the failure of the pituitary architect may produce a "Fat Boy of *Pickwick*"; in the other the failure of the interstitial architect may produce the deformity of the body which we call the "eunuchoid" type. In the case of the cretin we have to a certain extent mastered the secret and can by addition of thyroid extract procure a more or less normal growth; in the hypo-pituitary abnormality we are only tentatively feeling our way; in the "eunuchoid" type there is, so far as I know, as yet no real success.

I want to digress for a moment to speak of the hypo-pituitary type. There is a group of children who exhibit a tendency to become very fat and at the same time to develop the fat especially in the hips, thighs, and abdomen; in addition their genital organs retain the infantile type, and towards puberty they exhibit none of the secondary sexual characteristics. Fröhlich was, I believe, the first to point out that this abnormality was sometimes associated with a tumour of the anterior portion of the pituitary gland, and it is often known as "Fröhlich's syndrome." What is perhaps not so well appreciated is that such a syndrome is often only a temporary phenomenon, and that after a time normal growth is resumed. The presumption is that there is a functional disorder which for a time diminishes the available amount of the necessary internal secretion. I have had some success in treating such children with extracts of the whole pituitary gland. One boy in particular was brought because he could not keep awake either in school or even at his meals. In this, as in his general appearance, he recalled Dickens's description of the Fat Boy. He had no sign of a pituitary tumour, but when placed on extract of the whole gland he became almost normal. He was discharged, but after an interval his father appeared asking for more of the tablets as the only means of keeping him awake. More often, however, therapeutic efforts fail: we do not know enough of the conditions.

In such forms of abnormal growth there is an inherent defect in the functions of the glands of internal secretion, but there are other conditions in which we have reason to suppose that the alteration of the secretion is brought about by factors over which we may learn to gain a degree of control. For example, it is a notorious fact that after some infectious diseases growth may take place with unusual rapidity. After an attack of typhoid fever, for instance, the adolescent may suddenly increase several inches in height; while the adult may become alarmingly stout. On the other hand, there are two diseases of childhood which in my own experience exert the opposite effect. Both diphtheria and tuberculous peritonitis may for a time completely stop growth in height and weight, and I think it is usually a matter of a couple of years before growth is resumed, so that either of these diseases may leave a permanent mark. In these instances I think we are obliged to look for an explanation to some functional disorder of the glands of internal secretion, and I am at present trying the effect of increasing doses of thyroid on one such case, with the result that he has put on a pound a month since he began the drug, whereas for the previous year the total increase had been less than two pounds.

Somewhat in the same category I should feel inclined to place the celebrated case recorded by Byrom Bramwell, in which the addition of pancreatic extract transformed in a year or two a real dwarf into a small but fairly normal individual.

Lastly there is a group which is much less hopeful but which is, from our present standpoint, of great interest—the group of "renal" dwarfs. They were recognized and described by Morley Fletcher in adolescents some years ago and have been written about a good deal since. But quite lately my colleague Donald Paterson has shown that there is a similar group with characteristic lesions in the skeleton recognizable by *x*-ray examination, occurring in the infant; and I have recently had in my charge a child of 7 years who seems to me to represent another type of the same abnormality. Whether their dwarfism is due to an internal secretion of the kidney, or can more justly be referred to a poisoning of the sources of growth, is a matter which must be left for later research.

There is, of course, much more that could be said on such a subject, but I hope that I have succeeded in sketching the intimate relationships which appear to exist between the materials and the architects: that the architects cannot work without the proper materials, and that improper material may impair the powers of the architect for a short time or even permanently; and that with architects of inferior powers or out of harmony with each other good material may be built into monstrosities.

The Middlemore Lecture, 1922,

ON

REFRACTION.

DELIVERED AT THE BIRMINGHAM EYE HOSPITAL

BY

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(*Abridged.*)

DR. RICHARD MIDDLEMORE founded this lecture in order that it might year by year afford the medical men of the Midlands an opportunity to hear the latest views upon an ophthalmic subject of general interest. I therefore do not apologize for selecting refraction as my subject.

The field for refraction is unlimited, and it is quite impossible for ophthalmic surgeons to handle the whole. At the present time the majority of the cases are dealt with either in hospitals or by men who do not possess a medical training. There is no reason why much of this work should not be undertaken by the general practitioner to the advantage of himself and his patient. If he decide to take up refraction he must adopt modern methods and learn retinoscopy.

Refraction cannot be learnt from books, and retinoscopy demands considerable practice. Probably the average man will require three months' constant work in an eye clinic before he attains the necessary accuracy. This period will not be wasted, for both from the standpoint of diagnosis and treatment a working knowledge of ophthalmology, not excluding refraction, is indispensable to the up-to-date physician.

THE OBJECTS OF REFRACTION.

The object of refraction is to make the patient comfortable, not the solution of a problem in optics. Glasses are prescribed to enable an individual to see clearly, and to relieve symptoms caused by errors of refraction and of muscle balance. It does not follow that spectacles which

accurately correct an error will be comfortable; on the contrary, a man may prefer indifferent vision to wearing glasses which he dislikes. In cases of this kind we must temper our desire for optical perfection with common sense. If our patient is quite satisfied with his moderate acuity, and does not suffer from the symptoms of an error of refraction, then he may, if an adult, choose for himself when he will wear his spectacles. We prescribe the glasses to be worn when he wishes for clear vision, and we attain our object, which is to make him physically and psychically comfortable. In the case of a child the conditions are different, and we allow no such latitude. An infant with poor acuity will grow up with unsocial habits and will not develop the habit of observation. He must wear his spectacles constantly.

Symptoms Caused by Errors of Refraction.

The chief and obvious symptom is failure to attain to the normal standard of acuity. Using the ordinary Snellen's test types with the standard illumination this must be taken not as 6/6 but as 6/4.5. In actual practice for all ordinary work 6/12 is sufficient, so if the acuity is 6/12 or better, glasses are not called for in the absence of symptoms due to an error of refraction.

Headache is the next commonest symptom. In every case of headache the eyes should be examined both for refraction error and for disturbance of the normal muscle balance. It does not follow that a refractive error is the cause of the headache nor that its correction will cure the headache. If the spectacles have no favourable influence upon the pain, and if the acuity be good without them, then there is no necessity to wear them. I wish to emphasize the fact that many men and most women object to wearing glasses, and if they are of no use there is no valid reason for employing them. Headache may be due to migraine, to nasal sinusitis, and to many other causes, which may coincide with an error of refraction which is not responsible for the pain.

The degree of error is not proportional to the trouble it causes. In one individual a considerable amount of astigmatism may cause no symptoms, whereas another may suffer agonies from a minimal defect. There are some who possess an abnormal visual acuity—they may be able to read all the letters in the 6/3 line; such are very prone to be inconvenienced by a trivial refractional error. Others, with a highly excitable nervous system, may be relieved from life-long misery by a 0.25 cylinder. We must not, however, allow exceptional cases of this kind to pervert our judgement; in young persons slight astigmatism with the so-called rule, and in the aged against it, is so common that it may be taken as normal, and in most cases causes no symptoms.

Pain in and about the eyes is, after headache, the most frequent complaint. This may be, and in fact often is, due to an abnormality in refraction or muscle balance, but it can be a pure neuralgia. Countless women complain of ocular neuralgia, often associated with pain elsewhere; intercostal neuralgia, rachialgia, coccygodynia, sciatica, and dysmenorrhoea—such are not in the main relieved by glasses; the pain must be treated along ordinary medical lines generally with scant success.

Vertigo, in my own experience, is one of the rare symptoms. It may be caused by muscle imbalance, especially by a high degree of hyperphoria, but the large majority of those who have come to me complaining of giddiness have, if young, been suffering from an aural trouble, and if aged, from circulatory disturbances in the brain.

The essential symptoms of an error of refraction or of muscle balance are: poor acuity, headache, asthenopia, and very occasionally vertigo; but a host of others have been associated with these defects; in fact our American colleagues have given a long list of nervous and even of more general affections which they have treated by correcting errors of refraction. In this connexion we must steer a middle course and not allow enthusiasm to blind common sense. It is doubtless true that an individual of highly neuropathic habit may suffer in various ways from the constant strain of an uncorrected error of refraction, and it is a fact that such may derive benefit from wearing spectacles, at any rate for a time—in some cases from relief of strain, in others from pure suggestion; but, on the other hand, the extravagant lengths reached by some regarding the effects of eyestrain have given rise to much confusion of thought and to not a little frank charlatanism. Every specialty tends to run to extremes and may even approach quackery. The term "eyestrain" has been so much abused in the commercial sense that I prefer to avoid it. There is no doubt that eyestrain exists, but it is not nearly so common as some would have us believe, nor are its effects in the main so baleful as is commonly supposed.

Methods of Determining Errors of Refraction.

The only satisfactory objective method of determining an error of refraction is by retinoscopy; it is the Alpha and Omega of refraction, and a man who is incapable of accurate retinoscopy will never achieve much success in refraction. Accuracy can be attained only by long and constant practice, but much may be done by attention to detail.

The apparatus necessary is of the simplest character: we require an adequate box of accurate trial lenses, a good trial frame, test types correctly illuminated, and a flat retinoscopy mirror. We must work in a room which is at least 20 feet across the diagonal, and we require a small but bright source of light.

Probably few to-day use the concave mirror; it has nothing to recommend it, and in my hands has never yielded accurate results. In many mirrors the hole is too large; I find that 3 mm. gives the best effect, and of all patterns I prefer that designed by Priestley Smith.

The source of illumination should be about the size of a shilling, and having cut down the size we must compensate by using a brilliant light. I think that the best illuminant is paraffin—a lamp with a round wick half an inch in diameter—but electric light is more convenient. I employ a 40 candle-power frosted globe in a Thorington's chimney with an iris diaphragm. This limits the general illumination of the room, and a shaded reading lamp will be convenient to light the box of lenses and the notes. The room should not be completely dark; objects at the end should be visible, otherwise, working without a cycloplegic, it will be impossible to secure full relaxation of accommodation. The old-fashioned dark room is an anachronism; it is better to work in a room with curtains sufficiently thick to obscure but not entirely exclude the light.

The retinoscopist must learn to use both eyes with equal facility, otherwise when a cycloplegic is not employed he cannot refract near the macula, because his head will prevent the patient from fixing an object immediately behind him, and the retinoscopy will be inaccurate. It is essential that the surgeon have good personal acuity, that he may appreciate the tenuous central shadows which alone determine the point of reversal.

In difficult cases it is wise to use cylinders as well as spheres. When the astigmatism has been approximately determined place the appropriate cylinder in the trial frame and alter it till a sphere corrects both meridians simultaneously. This method is very sensitive and is especially valuable when working without a cycloplegic.

Errors in retinoscopy depend almost entirely upon failure to work near the macula. In many eyes the posterior pole is not truly spherical and slight eccentricity in the retinoscopy may introduce an error of a dioptre or more. Generally speaking, retinoscopy should be accurate to within a quarter of a dioptre, but there are cases with scissor shadows and other manifestations of irregular astigmatism in which the limit value is far higher. Corneal nebulae render retinoscopy difficult and often impossible.

If a cycloplegic be used incomplete paralysis of accommodation is a fertile source of error, in fact it may be far greater than we are likely to get without the use of a drug. This has been forced upon my notice in school clinic work, and I have concluded that to obtain certain paralysis of the ciliary muscle in children atropine must be used, and it must be instilled over a period of twenty-four hours. The majority are ready for the test after three instillations spread over two hours, but there are frequent exceptions.

In all cases, except infants who cannot read, the final adjustment will be made with the trial lenses and test types. Intelligent children over 5 years old will give valuable information during the subjective test, in fact they are often more helpful and sensible than some adults. There is a tendency to underrate the intelligence of the child.

When each eye has been examined separately it will often happen that together they will take a stronger convex lens, a fact that has been emphasized by Priestley Smith.

The Use of Cycloplegics.

There is still a wide difference of opinion to what extent we should use cycloplegics in refraction. My own views upon the subject will be found in a paper which I read to the Congress of the Ophthalmological Society in 1922.[1] My practice is to use atropine for young children, but to refract the majority of my patients without cycloplegia.

Cycloplegics are necessary in infants who have not sufficient concentration to fix a distant object, and in cases of spasm of accommodation. Hirschberg tells us that this is one of the rarest of ocular abnormalities, and most ophthalmologists will agree with him. I can only recollect half a dozen cases, and in each the spasm was obvious and detection easy; I am sure that spasm is a bogy. We meet with the ready and powerful accommodation of the young and the irritable action of the ciliary muscle in neurotic persons. Such may not easily accept the full correction of their hypermetropia, but I find that a properly conducted retinoscopy will rarely fail to show the full amount. If the patient will not accept the total correction of hypermetropia as shown by the shadow test, then it is wise to check the result with a cycloplegic. Generally the final result is the same.

Although it is permissible for the experienced to work largely without cycloplegics, the beginner will use them frequently; with increasing practice he will gain confidence and that instinct for spotting the "wrong 'un" which comes from constant association with patients, and he will use drugs less and less. I find that homatropine is not a reliable cycloplegic, and that it frequently gives less hypermetropia than one gets without it. I have found this anomaly after instilling a 2 per cent. solution three times during an hour or more.

In any case, assuming that an occasional error is made by working without a cycloplegic and that no errors accompany its use—a very large assumption—even then I prefer this infrequent lack of accuracy to submitting a large number of my patients to the discomforts of cycloplegia.

Varieties of Errors of Refraction.

Myopia.

Myopia is the most interesting and important error of refraction—interesting because of the uncertainty of its genesis, and important because it so frequently ends in grave loss of sight and even blindness.

There are two types of short-sight; one we may call overgrowth myopia, the other progressive myopia. The first is a developmental anomaly, the second a disease.

Emmetropia is the result of a correct balance between the strength of the dioptric system of the eye and its distance from the retina. The young eye is hypermetropic and attains its final refraction when its growth is complete. In most cases the eye finishes with a more or less correct balance between axial length and lens strength, but there are units above and below the base line. On the one side we have cases in which the eye is short in proportion to lens power (the hypermetropes), and on the other those eyes which are too long in proportion to dioptric strength (the myopes). These myopes are not diseased, and the error, which rarely exceeds 3 dioptres, does not as a rule alter.

Progressive myopia is entirely different; here we have an eye in which the posterior segment gradually elongates. In time, if the stretching passes a definite limit, the sclera expands faster than the inner tunics of the eye, and there is developed first a myopic crescent, and eventually a posterior staphyloma. At the same time low-grade inflammatory changes take place in the choroid, and the retina begins to suffer, more especially at the macula. Haemorrhages may appear at the fovea, and large areas of the retina and choroid disappear, leaving extensive white plaques of bare sclera at the posterior pole.

These destructive changes are accompanied by serious loss of acuity. In some cases the retina refuses to stretch any further and becomes detached. I think that this tragedy is more frequent in cases which do not show the extensive destruction of the choroid that I have mentioned, but it may take place in any case of progressive myopia even when of comparatively low degree.

Causes of Myopia.

For many years there has been much discussion about the cause of myopia. A generation has passed since Cohn and his supporters coined the objectionable term "school myopia," and put forward the theory that advancing short-sight was due to the effect of close work. The upholders of this view showed that the degree and incidence of myopia increased in proportion to the age of the scholars, and that myopia was more common in those who used their eyes for near work than in others who led an open-air life. The first statement is true, and it is equally valid for the length of nose or leg in the same children. The second is but partially true. Statistics of thousands of cases of myopia are available, drawn from German, British, and other sources. They bring out the curious fact that examples of progressive myopia of the worst type with fundus degeneration are more common in agricultural than in urban districts. Moderate myopia is commonest in towns, advanced in the country. The most recent and conclusive figures were published by Ernest Thomson. He found that severe myopia was commonest in mining districts, less so in agricultural areas, and still less in towns. My own feeling is that in the Midlands myopia is commonest among miners, but I have no exact figures to go upon.

The reason is clear: in a mining village it is almost a social crime to marry out of the community. In most villages there are few surnames and the whole population is related. In towns the conditions are different. The result is that the miner is the product of close in-breeding, an agriculturist of in-breeding, the urban dweller of cross-breeding. These facts point to the real cause of myopia—heredity. Myopia is also a racial disease. It is said that it is commonest in the Roman Campagna, because for centuries this area has been the recruiting ground for the constant wars of the past; the myope was rejected for military service and lived to perpetuate his kind. Short-sight is notoriously prevalent in Germany—decimated by the thirty years' war—and among the Jews. Myopia is rare in Britain, a country that has been spared the annihilating wars of the Continent.

The objections to the theory that myopia is due to close work *per se* are to my mind conclusive. The suggestion is that during the act of accommodation and convergence the intraocular pressure rises and gradually distends the organ. It has not been proved that such a rise of tension actually takes place, and even if such were the case the conditions found in the myopic eye are not those which are present in an eye which has been subjected to real well defined high tension. In glaucoma the hypertony is associated with cupping of the optic disc, whereas in myopia the stretching is more evident further forward. It is by no means uncommon to find myopia in infants, who have not used the eyes for near work, and cases are common with high myopia in one eye alone. These facts are all against the theory that close work causes myopia. We must seek another cause, and we find it in heredity.

I have dealt with the genesis of myopia at some length because there is a danger that false theory may be followed by worse practice. There is to-day a tendency for educational authorities to deprive myopes of the benefit of a liberal education. It is suggested that a child with more than three dioptres of myopia shall not be allowed to hold a scholarship, and young children with short-sight are herded into special myope schools. Special schools are necessary for children whose sight is so bad that they cannot be educated in an ordinary establishment, but if the child has sufficient sight to benefit by the general school he should not be condemned to an inferior system unless it has been proved that work under these conditions will be detrimental to his sight. It seems to me that it is not even probable that this is the case. It is true that confinement in a badly ventilated, indifferently lighted school will affect the general body tone, and that the resistance of the sclera will be lowered with the general deterioration of tissue nourishment. This consideration has great weight in the management of cases of myopia. Such must have as much fresh air as possible with sufficient exercise and

plenty of good food. In my private practice I allow myopes to continue their education, but I forbid music and novel reading. The child must read outside school work in the vacation, and if he take up music seriously he must not think of examination training. After an illness the myope needs a long rest, for it has been noted that an increase in myopia synchronizes with debilitating disease. The myope must be examined once a year and he must wear his full correction constantly.

It was once the custom to order special reading glasses for myopia. It was supposed from anatomical considerations that the ciliary muscle was weak and accommodative power defective. In the majority of cases, and especially in the young, this is bad practice. The myope has ample accommodative power, and he becomes presbyopic at the same age and to the same degree as the emmetrope. If, however, an adult myope has never worn a correction, he has not trained his accommodation, and for a time he will find it difficult to read with a full correction. If his myopia be under three dioptres the average man will wear his glasses for far sight only.

No rules can be laid down for the correction of very high myopia, nor for the strongest lens that can be worn with comfort. I furnish my patient with the lens which gives him the maximum acuity even if he cannot wear it constantly. The rule is to give our patients the best acuity possible with due regard to comfort.

Hypermetropia.

A high degree of hypermetropia will call for a constant correction, but it is unnecessary to order spectacles for moderate long-sight which is causing no symptoms. All depends upon the individual: some must wear their glasses always, others for near work only, while a third category can read and sew comfortably without optical aid. The young eye has an immense reserve of accommodative power and can utilize it without detriment as long as the general health is good.

Astigmatism.

The greatest care is necessary to obtain an accurate measure of the angle and degree of the astigmatism of an eye. Retinoscopy will give the approximate figure within about half a dioptre, especially if a cylinder is used for the final determination, but the ultimate choice depends upon the patient himself. Some of the astigmatic clocks are useful, but I depend upon a good set of test types with standard illumination, and I make the last adjustment with the aid of Jackson's crossed cylinders. A very few patients, and those mostly with an acuity of 6/3, are able to appreciate a difference of one-eighth dioptre, and they must be refracted within this limit, for they may be uncomfortable if the cylinder be not accurate to an eighth of a dioptre.

If the examiner is not a skilled retinoscopist he will have to fall back upon the astigmometer. This is a very expensive instrument, and, as it measures the corneal curvatures only, it cannot be accurate in the presence of any lental astigmatism.

A full correction should be ordered for astigmatism except when it is extreme; in such a case it is wise to undercorrect the astigmatism at first and proceed to the full correction when the patient has become accustomed to the first glasses. In any case we warn our patients with high astigmatism that they may at first suffer from some distortion when the error is corrected. Very high cylinders can be worn with comfort. I have a patient who gets excellent acuity with a 14 dioptre cylinder and complains of no discomfort.

Presbyopia.

The correction of presbyopia is not difficult if we use common sense; we must curb our desire for scientific accuracy, for few of our patients will appreciate the work of Donders. Generally speaking it is safest to undercorrect presbyopia. After 50 it is better not to add more than 2.5 dioptres to the distance correction. Even if the smallest print cannot be read and the work has to be held at a greater distance, the under-correction allows for work at a middle distance, and is more convenient for writing. In many cases we order three pairs of glasses—one for far, the second for near, and the third for music. A low myope over 50 years of age will often be well suited with a pair of lenses one dioptre under the full correction. These will give him an acuity of about 6/12, which is ample for everyday requirements; they will afford full acuity for middle distance, and with them he can read large print.

SPECTACLES.

It is important that the lenses shall be correctly placed before the eyes, for all the work of a careful surgeon may be stultified by a careless and ignorant optician. For most purposes spectacles are better than pince-nez, but there are types of pince-nez which are perfectly satisfactory. The form which has a horizontal split bar and a coiled spring must be avoided, for it does not maintain a fixed distance between the optical centres and soon loses its rigidity.

Meniscus lenses and torics are best avoided for the following reasons: the optical advantages are largely theoretical, they are fragile and expensive, and they are disfiguring. No woman should wear torics. A pair of flat lenses with a delicate central mount is almost invisible, and gives a glint of light in but few positions. The toric reflects light in every position and gives the wearer a glazed appearance, hiding the eyes. Except for special occupations there is little or no advantage in Crookes's glass, which is expensive and absorbs much useful light. The combination of toric lenses and Crookes's glass is a fruitful source of financial loss to the poorer classes of society. In general the public will choose its own fitting, and we should avoid any interference with individual preference, merely indicating what we consider to be best or essential.

CHANGES IN REFRACTION.

The refraction of an eye cannot be regarded as final and unchanging. During the growth of the eye, in adult life, and in old age, alterations occur—some regular and progressive, others irregular, and a few oscillatory in nature. I have not time to enter fully into this interesting aspect of the subject here, but I will briefly summarize a paper which I read to the Oxford Ophthalmological Congress in July, 1922. It is to be found in the *Transactions of the Ophthalmological Society*, vol. xlii, p. 293. I came to the conclusions that:

(1) The growing eye, examined from time to time, may show considerable alteration as regards sphere and cylinder. The astigmatism may alter both in amount and direction.

(2) In most cases equilibrium is reached when growth ceases, and the refraction is stabilized till old age, when the eye tends to alter in the direction of more hypermetropia. This change is by no means constant, in fact it is probably as often absent as present.

(3) In other adults progressive changes take place, chiefly in the amount and angle of the astigmatism, and in the main they are such that they tend to replace astigmatism with the rule by that against the rule—that is to say, that in the young a convex cylinder is more frequently vertical than horizontal, whereas in the old the reverse is found. This alteration is effected in two ways: there may be a gradual swing of the angle from the vertical towards the horizontal, or the astigmatism with the rule may diminish, disappear, and reappear against the rule. Such being the case it is advisable to examine our patients about every five years.

In addition to these alterations, which probably depend upon variation in the shape of the cornea, and perhaps upon lens changes, there are others caused by disease. Thus diabetes not infrequently gives rise to myopia which is due to an increase in the refractive power of the lens. Occasionally the reverse change may be noted. Cataract, again, may have a similar action. When a man who all his life has had good sight becomes in later years short-sighted, diabetes should be suspected.

ERRORS OF MUSCLE BALANCE.

Heterophoria is theoretically a difficult subject, but, fortunately, for all practical purposes its detection, measurement, and correction can be carried out along simple lines.

If means are taken to abolish fusion the visual axes of the two eyes should remain approximately parallel. This state is called euphoria or orthophoria. If one axis rises or falls with reference to the other the condition is called hyperphoria or hypophoria. Diverging axes are named exophoria, and crossed axes esophoria. There is

in heterophoria a tendency for the visual axes to depart from parallelism, and the necessary co-ordination is effected by excessive use of the fusion faculty. When the muscles are fatigued this state of suppressed squint may become actual strabismus, and diplopia may be complained of.

It is obvious that heterophoria disturbs the co-ordination between accommodation and convergence, and that increased nervous energy is used up in each act of combined vision. In consequence fatigue will develop and cause asthenopia and headache. It is therefore essential that the error shall be corrected. I shall not here go into the details of the examination. We use the Maddox rod and tangent scale for testing the muscle balance at infinity, and the Maddox wing test for measuring the error at reading distance.

Hyperphoria causes most trouble, but is not common. The most frequent defect is weakness of converging power, and this causes difficulty in reading and needlework. It is corrected by adding prisms base in to the near glasses, and such an addition is greatly appreciated by those who have convergence insufficiency.

REFERENCE.

[1] *Transactions of the Ophthalmological Society of the United Kingdom*, vol. xlii, p. 127.

THE INFLUENCE OF INSULIN UPON ACIDOSIS AND LIPAEMIA IN DIABETES.

(A Preliminary Communication.)

BY

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THE effect of insulin in reducing the blood sugar of animals and of man has now been well established. Its similar action in an enhanced degree has also been found in cases of diabetes mellitus. In addition to reducing the high level of blood sugar in diabetes insulin has been shown to have the power of increasing the utilization of ingested carbohydrate. It is these facts which make the introduction of insulin of such importance in the treatment of moderately severe cases of diabetes.

In severe cases, however, other and more alarming disturbances are found. Lipaemia, increase of the ketone bodies in the blood, reduction of the bicarbonate reserve, together with hyperpnoea and mental disturbances, are all symptoms of great importance and frequently are forerunners of disastrous results. It seemed of importance, therefore, to ascertain how far insulin might remedy or prevent the occurrence of these conditions.

Methods.

The blood sugar, bicarbonate reserve of the whole blood, and the percentage of total ketone bodies in the blood were estimated, and where possible the hourly metabolism and respiratory quotient were determined. The blood sugar was estimated by the method of Folin and Wu,[1] the bicarbonate reserve was estimated by determining the carbon dioxide combining power of the blood at 40 mm. of mercury pressure of carbon dioxide, the amount found being expressed as a percentage of the normal (Haldane[2]). The ketone bodies were estimated by the method of Van Slyke and Fitz,[3] while the respiratory quotient and hourly metabolism were determined by the Douglas bag method. The lipaemia was determined comparatively by centrifuging the specimens of blood and noting roughly the degree of lipaemia of the plasma. Four stages were recognized: +++ where there was a definite layer of creamy fat above the plasma, ++ where there was marked opacity of the plasma, + where there was moderate opacity, and ± for a slight cloudiness.

The following cases are examples of those which have so far been investigated. It was considered advisable to make observations upon cases with a moderate degree of diminished bicarbonate reserve in order to have a comparison between normal people and diabetics without any such reduction, and those cases showing evidence of impending coma.

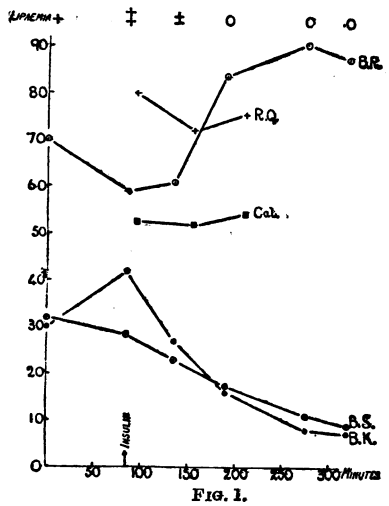

FIG. 1.

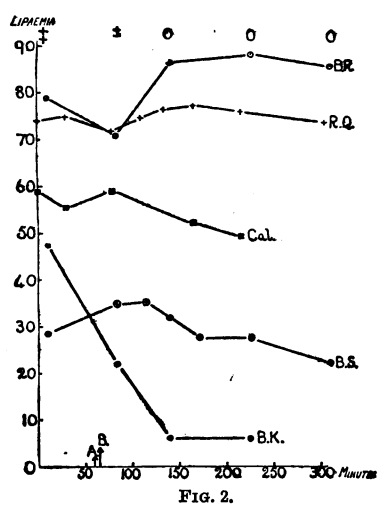

FIG. 2.

FIG. 1 (Case I).—B.R. = Bicarbonate reserve percentage (normal 100 per cent.). R.Q. = Respiratory quotient. Cal. = Calories per hour calculated from respiratory exchange. B.S. = Blood sugar percentage. B.K. = Blood ketone bodies in milligrams per cent. The respiratory quotient and the blood sugar percentage have been multiplied by one hundred in order to show them by means of the same scale of ordinates. Abscissae = time in minutes from commencement of observation. Patient fasting; weight 32.3 kilos. Insulin 10 units at point shown. FIG. 2: Patient fasting; weight 32 kilos. Insulin 4 units at A. Glucose 16 grams at B.

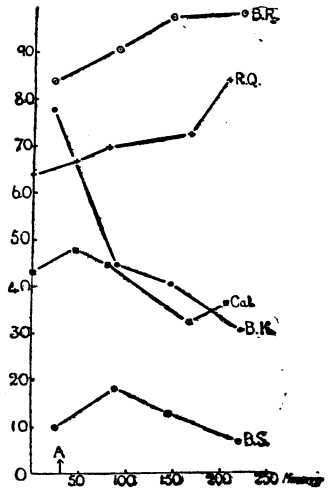

FIG. 3 (Case II).—Letters and conventional signs as in Figs. 1 and 2. Patient fasting; weight 31.1 kilos. Insulin 10 units and glucose 20 grams at A. There was no lipaemia in this observation.

CASE I.

F. H., a woman aged 24, was a case of severe diabetes that had been under observation from time to time for two years, giving a history of diabetic symptoms for three years. Her diabetic condition had progressed over numerous periods of exacerbation and remission, her carbohydrate tolerance diminishing from 67 grams a day to her present condition, in which 10 grams a day produce glycosuria. Observations were begun at 9 a.m. after sixteen hours' fasting, and were carried out under basal conditions as far as possible. The blood sugar before insulin was given was 320 mg. per cent., while the bicarbonate reserve was between 60 and 70 per cent. of normal (Fig. 1). Ten units of insulin were given and frequent examinations of the blood were made during the subsequent three hours. It will be noted that there was a steady decline of the blood sugar until it reached the level of 90 mg. per cent. Coincidently there was an increase of the bicarbonate reserve from 59 per cent. to 91 per cent., and a decrease of the ketone bodies from 42 mg. per cent. to 8 mg. per cent. During this period the hourly metabolism varied but little, although the respiratory quotient showed a considerable change. The lipaemia rapidly disappeared. At the end of the observation the urine was free from sugar and ketone bodies.