Thesis
on
Errors of Refraction
by
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I have chosen my Thesis on the basis of Refraction because I believe the prescription of glasses is little understood by the general practitioners and yet a large number of people require glasses and there is a big gap between the patient who can afford to consult an ophthalmic surgeon and the person who should be treated at an infirmary. It is difficult to say why the general practitioners should avoid this part of his profession. I have met many medical men who have had little experience in abdominal surgery who would undertake an operation like a case of Chlamydia rather than call in a consulting surgeon and yet when they have a patient who complains of bad vision they advise him to see a non-medical optician. I believe the reason is that accuracy in refraction can only be obtained after long practice and to correct a case of astigmatism is usually tedious and in many cases the patient goes little better.

In many cases of myopia, hypermetropia or astigmatism, it is easy to frame the correct glass, but these are the cases that the practitioners seldom see as the blunder as a rule go first of all to an optician. In turning up the last 100 cases that
that I have had in practice I find that I have had Myopia 5, Hypermetropia 4, Presbyopia 13, Hypermetropic Astigmatism 32, Myopic Astigmatism 28 and Mixed Astigmatism 18, therefore 78 have eye cases of astigmatism. Possibly a reason is that some ophthalmicians themselves send all their cases of astigmatism to medical men.

Books I find tend to avoid difficulties and even when you do realize them it is not always easy to advise a patient for the best.

A boy of say 9 is brought to you with defective vision. After taking a retinoscopy under atropine you find +3, what advice would you give? When you try on the glasses you possibly find that he can see you better and that spherical glasses do not improve his vision, if after a lot of trouble you give him a carefully washed out cylinder, in six months time you may see the boy with the frames bent and the cylinder quite out of its place and yet I think that it is important that cases of astigmatism should be corrected as soon as possible. Children a little older also present difficulties to a conscientious worker as they are slow in abbreviating impairment of vision.
otherwise and frequently make wrong answers. Nor are children the only people who present difficulties. I have sometimes been told when attending a patient about 40 that his sight has never been good but that he has never worn glasses, after taking a retinoscopy I find that he has say 4 D of astigmatism, should I give the full correction? The patient has become so accustomed to using certain parts of the retina that a full correction is actually harmful. Were this always the case the remedy would be simple but one patient is delighted with the full correction and the next will not stand it. Again we may have to do with a case of +2.0 in one eye and -2.0 in the other a correction that few helpless would stand, am to prescribe +1.0 in one eye and -1.0 in the other or +2.0 and a bluer glass or a bluer glass and -2.0 or will the person stand a difference of 2 D between the two eyes? There is also a tendency for patients at least the class that come to a general practitioner to get cheap frames and I have on several occasions been told that the glasses I ordered suited very well at first but that after six months
Months they caused headaches and on examination I have found that on account of weak frames the cylinders in one or in both eyes is quite out of its place.

Sometimes we are "let down" by the optician.

I recently ordered glasses for a case of myopic astigmatism.

Rt. -4.50 and with -3.5 glass 30º.

Lft. -3.00 and with -3.5 glass 160º.

The glasses when in the trial frame suited very well but in a week I had the patient back to say that my glasses were most unsuitable.

I found that the glasses had been put on upside down which made the cylinders almost ohhohute. When correcting the glass that the optician has made it is important to see that the centralisation is correct, many a patient has cast a pair of glasses as unsuitable when the fault was due to a badly cut glass.

Headaches, although frequently due to faults of refraction, even in a astigmatic person may be due to other causes, but if a practitioner corrects the astigmatism and the headaches persist he is apt to be blamed for not finding out faults that he was not
not consulted about. A lady called upon me and said that she had been advised to have her eyes examined as she suffered very much from headaches. On examination I found that there was 1.0 of astigmatism in each eye which I corrected. I saw her again in ten days time and was told that the headaches were as bad as ever, and I advised her to use the glasses a little bit longer. Accidentally meeting her six months afterwards I asked after her headaches and was told that she had seen a consulting physician who informed her that she had "Bright's Juxari".

In another similar case where the patient, a woman about 30 had consulted me about her eyes, I found by retinoscopy

\[ \begin{align*}
\text{Right eye:} & \quad -1 \\
\text{Left eye:} & \quad \times
\end{align*} \]

\[\begin{align*}
\text{Sph.} & \quad +1.75 \\
\text{Cyl.} & \quad +1.25
\end{align*} \]

I prescribed Right eye -1.50 sph with 1.50 cyl axis horizontal

Left eye +.50 cyl axis 135/

The patient returned complaining that her headaches were as troublesome as before.

On reexamining the left eye she again chose the same cylinders and the same axis.
further investigation I found that the headaches were most severe in the morning and as the urine was normal and the nasal cavity appeared to be healthy I gave her Mists Bhiu which relieved her symptoms.

In testing for glasses it is important after obtaining the best results with each eye separately to try the eyes together.

A lady age about 55 consulted me about reading glasses, she had a little astigmatism which however had never caused her inconvenience.

Right eye $\frac{1}{4} + 5$ Dcyl axis $50^\circ = \frac{1}{6}$ +30 $\delta$hh added = Jaeger 1.

Left eye $\frac{1}{4} + 25$ Dcyl axis $125^\circ = \frac{1}{6}$ +3 $\delta$hh added = Jaeger 1.

When I tried both eyes together however she saw double for both distance and near, a condition which was not present for either if I left out the cylinder and the double vision disappeared with the cylinder if I added a prism of 4° base upwards in the right eye or base downwards in the left. I advised her to see W.M.A. Tickle who confirmed my observations and we proceeded +3 D $\delta$hh for reading which proved quite satisfactory for the patient.
Where glasses are required for both near work and for distance in a person using a cylinder although we may have to alter the spherical glass the cylinder should remain the same in strength and position. I had one patient to whom this rule did not apply however. She had a well marked conical cornea in her right eye and vision was only \( \frac{5}{24} \) corneal (6).

In the left eye, the condition was not so well marked and with \(-0.5 \text{ sph} +1.25 \text{ cyc} \angle 75^\circ = \frac{6^2}{12}\)

new vision = corneal (4) if blown the axis was attuned to 50/ she could read Corneal (24) almost corneal (2).

**Refractometry.**

I do not prefer going into the details of refractometry as it would make the paper too long. In practice I strongly recommend the plane mirror. I can truly do so as I was taught with the concave.

Swarup's Woes in Diseases of the Eye advise the student to work at 4 metres. I think this distance is quite unnecessary except in more eminent, of course if we work at a foot we must remember that we are not working at the patient for want of
if we deduct +1.0 from our finding the 
retinoscopy should be correct.
In most cases it is advisable to use a 
mydriatic, Atropine Sulphate 1 per cent. dropped 
into the eyes three times daily for three days 
before the examination in preschool under 16 years. 
From 16 to 30 a with care to 35 a 40
Homatropine Hydrobromate 1 per cent can be used and 
the examination made an hour afterwards.
In older patients I use Cyclopentolate Hydrobromate 
5 per cent.
I think it is much better to take the retinoscopy 
on the macula as I have frequently found 
that it has differed from that taken on the 
disc particularly in myopic feeble.
Sometimes it is difficult to get a reflex 
at all and if we are free from choroid in 
cornea or lens there is probably a big error 
of refraction and a strong + glass a strong- 
should not once be tried.
As we reach the correction it is difficult to 
say how the shadow moves.
Sometimes we find a shadow that moves in 
both directions (oscillation action), in these cases we 
can only approximately estimate the refraction and
and we should note when the scissor action began and when it left off, say the action began at +1.50 and ceased at +2.50 the correct refraction would be about +2.0.

At times we get a change at the hockbery with a different glass than at the centre, the centre should be taken as the correct one.

Students learning retinoscopy seem to have more trouble with the vertical shadow due I believe to the eyelids and eyelashes, tilting the head backwards a little gets over this trouble.

In cases of astigmatism it is important to note the axis in which the shadow moves but it is important to remember that a wrong impression is produced in many cases owing to the head of the patient being held on one side a condition not always easy to note in a dark room.

After the retinoscopy has been taken we should examine the fundus and then the cama with oblique (focal) light, as small choracias are sometimes found.

We should next try distant vision when the eyes are still under the mydriatic.
If atropine has been used the patient should return in two weeks time when we shall try both the distant and the near vision, in some cases however I have found that the atropine had not worn off and I had to postpone the final examination.

If homatropine or cyclopleginic have been used, the final examination may be made in two days time.

**Hyphamatropia**

The focal length of the refracting media is greater than the length of the eyeball in hyphematropia. A hyphematropic eye with relaxed accommodation sees all things indistinctly as all rays are divergent.

**Causes:**

1. The corneo-ocular diameter is too short, this is by far the most common cause and is congenital.
2. A flattened condition of cornea, due frequently to ulceration when we get astigmatism as well in many cases.
3. Absence of lens
4. Detachment of retina from occlusion behind it or from a tumour
5. A diminution in the index of refraction of the aqueous, lens or vitreous

Generally...
Generally hypermetropia is a congenital defect, the eye is small, the lens and iris are more forward, the anterior chamber is shallow, the pupil small, often there is an aberration of divergence due to the large angle, the ciliary muscles are large due to excessive use. Convergence is often in excess, producing internal strabismus.

In high degrees the optic nerve is often small and visual acuteness is below normal.

Occasionally in high hypermetropia the margin of the disc is indistinct, resembling somewhat the margin that is seen in chiasmal anomalies.

Symptoms. Distant vision is often good and near vision is often clear at first, but after reading for a short time, particularly if the person is tired, the print becomes indistinct and accommodation cannot be kept up and eye ache (accommodative asthenopia) is produced. The eye looks waxy and the conjunctiva becomes hyperaemic.

The total hypermetropia consists of manifest hypermetropia and latent hypermetropia.

The strongest convex glass that gives the patient the best vision equal the amount of manifest hypermetropia.
by hemihypertrophia, by lost vision I mean lost distant vision, the rest of the hemihypertrophia is called latent.

Sham of the ciliary muscle often simulates myopia in a person who is by hemihypertrophia.

Treatment. There is a difference of opinion as to the amount of hemihypertrophia that should be corrected. Some doctors correct the manifest hemihypertrophia only, others, after finding the total amount correct the manifest and \( \frac{1}{3} \) of the latent, others again correct the total amount less +1.0.

A safe rule is to correct the manifest and \( \frac{1}{3} \) of the latent, thus in a child with +6.0 total hemihypertrophia and +2.0 of it manifest we might order +3.0 and if there is any inconvenience let him start the glasses when the eyes are under atropine.

At 20 years in the above case +4 would be manifest and we might order +4.5D and at 40 years we might order +5.0.

If strabismus is present correct +1.0 less than the total hemihypertrophia and start the glasses when he is under atropine.

Nigeria
Myopia

Myopia is the obstructive condition to hypermetropia. The refractive power of the eye is too great. Although a myopic eye cannot see things clearly at a distance, his eye is well adapted for near vision. Parallel rays are focused in front of the retina in a myopic eye.

A myopic eye is able to see at infinity with the concave glass whose focal length is equal to the distance of his far point to the eye. If his far point is situated at 20 centimeters from his eye, he will see at infinity with -5 D. If his far point is at 50 centimeters, he will require -2 D.

Cause: (1) The refractive power of the eye may be abnormally great. The cause of this increased refractive power may lie in the cornea or in the lens.

In the cornea it is increased curvature that leads to myopia in which case we generally find accommodation as well.

In the lens it may have either increased curvature or increased density.

(2) In relaxation the lens takes on an increased curvature because the tension exerted by the zonules...
is removed. In evisceration into the anterior chamber the nodal point of the whole
diabetic system is shifted forward.
(b) The curvature of the lens may be increased
by degree of accommodation.
(c) Increased density of lens, seen in the
beginning of a senile cataract.
2. The refractive power of the eye may be normal
but the retina is too far back, due to an
elongation of the axis of the eye.
The elongation of the eye is due to stretching
of the sclera either in its anterior or posterior
divisions but by far the most frequent site of
the distortion is in the posterior division of the
sclera.

A myopic person can see well for near things
but his distant vision is indistinct.
In working at a close range less accommodation
is required and presbyopia comes on late in life
or if the myopic person is -4.50, as his near point
is at 12 centimetres, he should never require
convergent glasses.
In low degrees of myopia the indistinct distant
vision is often of little inconvenience and
as his near vision is good and presbyopia
Later
Later in abducing the patient is well off.

In high degrees of myopia, owing to the short distance of his fix point from his eyes increased convergence is required which often gives rise to muscular asthenopia, and the convergence is more difficult owing to the absence of accommodation, a divergent strabismus may be set up.

Muscaric volitantes are often a source of annoyance to myopic people.

The eyes are prominent, pupils large. The small angle a gives an appearance of convergence, the circular muscles are small particularly the circular muscles. There are crescent shaped hatches of atrocity at the outer side of the disc and encasing the disc, sometimes we have a complete ring or we may have an irregular hitch extending outwards, the broadest hick between the disc and the macula.

The disc sometimes abhers avoid due to the ch flute runners looking forwards and outwards instead of forwards.

In progressive myopia we are able to get sectocata from retinal atrophy, diminished field of vision, retinal haemorrhages and detachment.
of retina, patches of choroiditis, degeneration of vitreous with floating cataracts, and the nutrition of the lens may be interfered with and cataracts develop particularly at posterior pole.

Treatment: recent strong convergence & focusing.

Avoid reading in a train, do not read too long, do not read in a bed or unsteady light, no small print. The wash should be at least 14 inches from the face.

If there is irritation with increasing myopia insist on rest of the eyes, atropine 1% to 2% will do this.

In slight degrees of myopia in young habits we should correct fully and advise the person to use the glasses always, this rule might apply to all cases under -3.0.

In higher cases of myopia where we have the acuteness of vision diminished a weaker glass than full correction would be required as concave glasses diminish the size of things.

In high myopia the full correction is often harmful when used for near work and a weaker glass is more comfortable.

If muscular asthenopia is present a known base onwards often relieves it.
Sandelt and the French authorities say that the action of the ciliary muscles increase myopia and therefore they give no glass for reading in low myopia and make glasses for near work in higher forms of myopia.

Each case must be treated on its merits.

**Astigmatism**

In myopia and hypermetropia, the cornea plays little part in the production, in astigmatism, the fault is chiefly in the cornea.

Parallel rays falling on an astigmatic eye are not brought to a common focus at any point. The refractive meridians are unequal.

Usually the fault is congenital but it may be acquired.

There are two varieties Regular & Irregular

In Irregular Astigmatism, there is a different refraction in the different parts of the same meridian.

It is due to (a). Changes or dislocation of the lens.

(b). Ulcers or nebulae of cornea or corneal curvatures.

Little can be done for these conditions, however, steepening spectacles may improve the vision.

Regular Astigmatism. The greatest difference...
in the meridians are at right angles to each other. When the greatest curvature is vertical, the astigmatism is said to be "with the rule" if horizontal "against the rule." Often the greatest meridian is oblique.

Symptoms. The vision is not clear but in testing a case of astigmatism we find that some letters are easier to make out than others and that the patient may see some letters only in say 1/16 Snell and some in 1/2.

Separate radii are seen with different distinctness. Small objects are said to be elliptical.

The patient suffers from headaches which may be frontal or occipital.

Binocular vision, particularly in the oblique cases, is often much better than single vision.

Fechts in Text Book on Ophthalmology says,"As long as this difference remains below 1/10 the astigmatism may be regarded as physiological, since most eyes are affected with a slight error of curvature of this sort." This is not my experience.

Duane in Fuchs Text Book on Ophthalmology says,"We correct the total amount of astigmatism found under a cycloplegic. The only exception is when the astigmatism is very high 5.0 or more in which case a partial correction is less annoying.
than a complete correction that gives better vision.
With properly adjusted glasses, however, even very
strong glasses will be worn with comfort and
advantage. Although I quite agree with these
remarks, I think great care should be used before
ordering cylindrical glasses of 40 or 450.
Cases of low astigmatism do not require correcting
unless there are eye symptoms, but I have
frequently met with cases of vision that has
been normal except for +.250 of astigmatism in
which the patient had some headaches which
were relieved when the small cylinder was
prescribed.
Diame corrects slight cases of astigmatism.
1. When glasses have to be ordered in any case.
2. If the patient requires to use the eyes a
   great deal for near work.
3. Symptoms of eye strain present such as
   headaches, asthenopia, blepharitis, or conjunctival
   irritation.

Anisometropia

One eye has a different refraction from the other.
This is usually congenital, but it may be
acquired.
We met three varieties.
1) Binocular vision may be present.
2) The eyes may be used alternately.
3) Only one eye may be used.

In the first case the difference is not great. When we have the second variety we often find that one eye is emmetropic or hypermetropic and is used for distant vision and the other is myopic and is used for near work.

Treatment. If the difference is only 1.0 or 1.5 D we may fully correct both eyes. Where the difference is greater if we fully correct the eyes the patient is apt to suffer from headaches or eyestrain. Possibly the cause of this is that convex glasses make objects larger and concave glasses make them smaller and thus the two images do not fuse in the brain.

Possibly the reason is due to the prismatic action of glasses.

Where only one eye is being used I think the sound eye should occasionally be fastened so as to retain the function of the bad eye.
Presbyopia

With advancing age the acuteness of vision becomes less owing partly to a loss of transparency in the media and partly to a diminution in the focussing and conduction powers of the retina and optic nerve.

At the age of 40 a person with normal vision can see \( \frac{1}{6} \) at 6 metres, at 50 his vision is still \( \frac{1}{6} \), after this it diminishes and at 80 he may only have \( \frac{1}{12} \) vision.

The eye becomes more hypermetropic and the myopic eye less myopic.

At 55 the refraction has diminished 1.25D at 65, 1.50D, and at 80 as much as 2.50D, thus an emmetropic eye has acquired 2.50D of hypermetropia.

In addition from birth the near point recedes due to decreasing elasticity of the lens.

Presbyopia may be arbitrarily stated to exist when the binocular near point has receded to 22 cm and this usually occurs in an emmetropic eye at forty-five.

As it is not convenient for people to have all their accommodation at 45 an emmetropic eye requires +1.0 D for near work.
At the age of 50 the eye possesses 2.5 D of accommodation and as 4.5 D is required to see at 22 cm we must add +2.0 and at 55 when the eye possesses 1.5 D accommodation +3 D is needed.

Symptoms. The distant vision is clear but the patient cannot maintain clear vision for near work, he has a feeling of weariness in the eyes after near work, things are held further away and he often places a strong light between his eyes and the book he is reading thus causing the pupils to contract and so lessens the circles of diffusion.

Treatment. A good reading distance for a person with normal eyes is 30 to 40 cm. Most emmetropes will require a convex glass soon after 45 and we may add +1.0 for every 5 years until +3.5 D has been given. An emmetrope when sixty or seventy will not require a stronger glass than +3.5 D.

If a person is -2.0 hypermetropia at 45 he would require +3.0 or if he has 2.0 of myopia at 55 he would require +1.0 only.

In testing glasses we must find out at what distance the patient wants to read.
also why he wishes to have glasses.
Although I have always tried to make patients understand this sometimes they have stated that they only wanted glasses for their work after they have chosen glasses for reading. If we find rapidly increasing presbyopia look out for glaucoma.
If presbyopia is not increasing we sometimes find an interesting counter although it may hasten presbyopia.
Sometimes after ordering glasses for reading we have asthenopia which is relieved by ordering prisms 2° base inwards or by having the lenses decentred as the prisms are heavy.
A lens of 1 D must be decentred 8.7 mm to produce a prismatic effect of 1°.
To find the amount a lens should be decentred to give a certain prismatic effect, multiply the number of the prism by 8.7 and divide the result by the number of the lens.
Thus with a +4.0 lens we wish a prismatic effect of 2°,

\[
\frac{8.7 \times 2}{4} = \frac{17.4}{4} = 4.35 \text{ mm}
\]
Asthenopia

Asthenopia is a term to designate a group of symptoms caused by fatigue or strain of some part of the eye or its muscles.

It often accompanies hypermetropia, myopia, or astigmatism.

When no ametropia exists, it may be due to overfatigue or diminished power of the ciliary muscles, weakness of internal recti or exhaustion of an over-sensitive retina.

The patient is unable to sustain long and continuous near work.

Asthenopia is accompanied by pain, either in the eyes or around the orbit which increases if the eyes are used for near work and in may get photophobia & lachrymation and the conjunctiva becomes red and irritated.

Headaches are often a prominent symptom; they may occur in the frontal or occipital regions, more apt to occur in the evening.

Asthenopia may be divided into

Accomodative

Muscular

Retinal
Accomodative Asthenopia is very common and is due to fatigue of the ciliary muscle.
It may be caused from (a) A weak condition of the ciliary muscle,
(b) From excessive use
(c) Unequal demand as in astigmatism
(d) Unequal demand in the two eyes as in Amotropia.
(e) Diminished elasticity of lens as in presbyopia.
Accomodative asthenopia is chiefly due to the constant excessive action of the ciliary muscles but also to abnormal relations of the two functions accomodation and convergence, hypermetropes who squint seldom have asthenopia

Treatment: Correct the refractive error.
In some cases a prism 2° base inwards or to decant the lenses will relieve the asthenopia.

Muscular Asthenopia is due to fatigue of some of the external muscles of the eyeball.
Heterophoria is a term used to express a disturbance of equilibrium of the muscles of the eyeball and may be divided into
1. Exophoria
2. Esophoria
3. Hyperphoria
4. Insufficiency of the oblique muscles
   a. Hypertropia
   b. Hypertropia

Exophoria: One eye tends to turn outwards and is prevented by muscular action of internal rectus. This condition is often seen in amblyopia. The internal rectus cannot keep up the strain, the patient becomes double, often there is a sensation of the eye turning outwards.

Esophoria is an insufficiency of the external rectus and is seldom seen as it merges into an internal strabismus, as a rule there is excessive action of the internal recti.

Hyperphoria: one eye tends to elevate upward. Usually it is associated with esophoria but may occur alone.

Insufficiency of the obliques are very seldom seen.

To test the amount of latent elevation, place a Maddox rod in test frame horizontally for exophoria and esophoria and ask the patient to look at a light 6 metres off.
a scale immediately behind the light for measuring the amount of divergence.

If the red line appears to right of the flame homonymous diplopia is present and we have convergence, if the red line is to the left of the light crossed diplopia is present and we have divergence.

For near test we use Maddox line at 1 metre, place a prism 12° in front of base upwards and read line bent below the line, if the eyes are normal we see one arrow above the other in one line, if the lower arrow is to the right of the upper arrow there is convergence, if lower arrow is to left we have divergence.

Treatment: In myopia correct it and if asthenopia is still present a weak prism base inwards often gives relief or the concave glass may be decentered outwards.

When exotropia occurs here, we may have to advance the external rectus with or without division of the external recti.

Retinal Asthenopia: In some cases where there is no cataract we find intense discomfort and inability to read or do near
near work for any length of time. These cases are chiefly seen in weakly visual
chubby young girls who have long hours
of near work.
Treatment. Rest if possible and tonics
with plenty of outdoor exercise.

Conclusion

Hypermétropia. If \( \frac{1}{3} \) can be read with each
eye no glasses are required for distance
For reading correct the manifest hypermetropia
and \( \frac{1}{3} \) of the latent.
If there is internal strabismus correct
all the latent hypermetropia except about +1.0
and start using the glasses when under
strabismus.

Myopia. If the degree is low and near
work can be seen at 30 cm give folders
for distance and no glass for near.
In moderate cases either correct fully
and wear for distance and near a
allow the patient to have a little weaker
pair of spectacles for reading.
In high cases we may correct for
distance but for near order the glass
that the patient finds best for near work.
at about 30 cm.

Asthigmatism. Correct fully unless the astigmatism is very great, and wear the glasses constantly. See that the patient gets strong frames and that the glasses are centred properly.

Achromatic glasses are not convenient if they are stronger than 3° or 4°. Anisometropia. Few people can stand more than 1.5D or 2D of difference between the glasses.

Spectroscopic glasses although very useful to some people should be ordered with great care as owing probably to the difficulty of centreless, such near and farsighted objects cannot be worn with comfort.