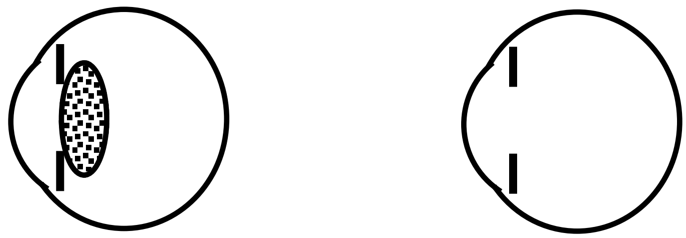
Aphakia and Pseudophakia

Definition



phakic eye aphakic eye

Surgical treatment of cataract by removal of the crystalline lens of the eye results in an aphakic eye which has very different optical properties from the normal or phakic eye.

Aphakic Refraction

In particular, after the removal of the crystalline lens which accounts for about two-thirds of the eye's optical power, the patient requires a spectacle lens about +10.00D stronger than has previous spectacle correction. Thus it is very important to establish the exact vertex distance at which an aphakic refraction is done. This can be done with a distometer, a mechanical device which measures the distance between the back surface of the phoroptor lens and the patient's closed eyelid, with the Essilor pupillometer, or simply with a PD rule.

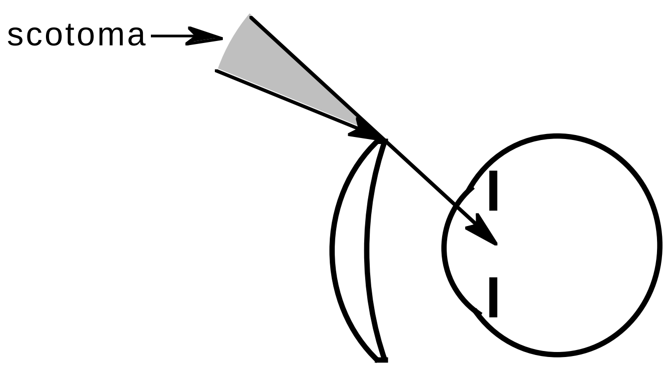
If the patient already has a pair of glasses, the whole vertex distance problem can be avoided by doing an over-refraction. Eschewing the phoroptor, perform the refraction through lenses held before the patient's habitual prescription with a pair of trial clips. When the refraction is completed, read the resulting prescription by placing the habitual glasses with trial lenses in the lensometer.

If the patient has completely recovered, the actual refraction goes about like an ordinary refraction. One difference--since the main source of internal astigmatism is gone, the keratometric cylinder should be about the same as the refractive cylinder.

Aphakic Spectacles

Aphakic spectacle corrections require powers of +8.00 to +15.00diopters. Such high powered corrections produce a number of difficulties. Among them

- ☞ Spectacle magnification of about 35%
- ☞ Decreased field of view with ring scotoma
- ☞ Aberrations and swimming of objects in field of view
- ☞ "Popeye" appearance of patients
- ☞ Sensitivity to exact position of the lens
- ☞ Lens weight and thickness



The patient can't see objects within the scotoma add the edge of a high powered plus lens.

Various design approaches have been taken to cataract lenses, some paralleling the philosophies used in developing corrected curve series, some not. There are two main approaches the "foveal philosopy" and the "peripheral philosophy". Both, as we'll see, make use of aspheric curves, but each with a different reason.

Foveal Philosophy

This philosophy parallels the standard lens design philosophy, namely trying to give the patient the largest possible dynamic field of view. As indicated by Tscherning ellipses, this cannot be done for high plus lenses with spherical curves. Instead aspheric curves are used. In order to cut down on weight, lenticular designs are often employed.

Peripheral Philosophy

This assumes aphakics are head--not eye--turners. It uses front surface curves of diminishing power away from center as in the Welsh Four Drop or Signet Hyperaspheric. These diminish the lens thickness and lower its weight.

When these came out they were accompanied by much fitting information and, especially useful, nice looking frames.

Contact Lenses

Optically, contact lenses are the best correction for aphakia since they leave the retinal image almost the same size as before cataract surgery. Image sizes with spectacles and contact lenses turns out to be just the ratio of the powers of the two corrections once vertex effects have been taken into account. In equation form,

$$M = \frac{\text{image size with spectacles}}{\text{image size with contact lenses}} = F_c/F_g.$$

Example: Compare the size of the retinal image with spectacle and contact lens correction for an aphakic patient with a +12.00DS spectacle correction for spectacles of 14mm vertex distance.

Solution: The power of the appropriate contact lens is, from the vertex correction formula

$$F_{cl}=+12.00/[1-(0.014)(+12)]=+14.42D.$$

The ratio of the image size with spectacles to that with contact lenses is then

$$M=(+14.42)/(+12.00)=1.20X,$$

or 20% larger with spectacles.

Incidentally, sometimes a low vision patient is **better** corrected with spectacles because the larger image gives better acuity.

Problem: If the patient in the previous problem had 20/60 acuity with his best spectacle correction, what would his acuity have been with his contact lens correction?

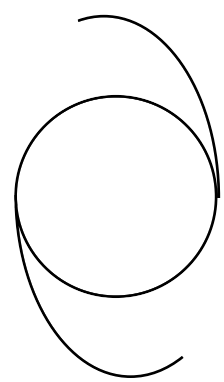
Solution: The image with spectacles is 1.20X as large as the image with contact lenses. If the patient's Snellen acuity with contact lenses is 20/*x*, then $x=(1.2)(60)=72$ so the patient would have 20/72≅20/70 acuity with contacts. Thus the patient loses about one line on the acuity chart.

Fitting a contact lens to an aphakic is not a simple proposition. The high powered lenses are thick, behave rather differently from conventional lenses mechanically, and impede oxygen exchange, as well as being quite expensive. Fortunately, most aphakics will be wearing bifocals over their contacts anyway, so it is feasible to correct any residual cylinder in the spectacle lenses.

Pseudophakia

True aphakia is increasingly rare nowadays due to the advent of the ocular implant. These small plastic lenses are routinely inserted in the eye to replace the patient's own crystalline lens. A patient wearing an implant is termed a pseudophakic.

Ophthalmologists have experimented with intraocular lens implants (IOL's) for over thirty years, but they have become popular only in the last decade. Initial experiments used "iris clip" lenses which were mechanically attached to the iris and sat in the anterior chamber. Since those earliest efforts virtually every conceivable design has been tried. Now surgeons almost universally employ posterior chamber lenses inserted in the lens capsule after an extracapsular cataract extraction (an extraction which removes the cataractous material while leaving the capsule intact). The commonest lenses are made of polymethylmethacrylate (PMMA) fitted with a couple of "J" loops.



typical posterior chamber implant

Since the crystalline lens is responsible for most of the UV light absorption in the eye, UV blocking filters are now incorporated in the PMMA prior to lens fabrication.

The choice of lens powers prior to surgery is based on keratometry and on the A-scan measurement of the axial length of the eye. These numbers are run through formulas based on schematic eye calculations modified with statistical fudge factors. The most popular of these equations is the 'SRK' formula used in dedicated calculator and computer programs. The latest version is the SRK II formula which looks something like this:

power of implant in eye
=118.7-2.5[axial length(mm)]-0.9[average keratometer reading (D)].

Usually this formula is programmed into a calculator or microcomputer to prevent calculation errors.

There has been some experimentation with bifocal IOL's. These are based on one or another of the "simultaneous focus" systems used in bifocal soft contact lenses. They can be expected to be about as successful as those contacts.

Pseudophakic Refraction

Refraction of the pseudophakic patient procedes exactly as it does for any other absolute presbyope.

