LEARNING DOMAINS

CLINICAL PRACTICE

PROFESSIONAL GROUPS

Dispensing opticians — CPD PROVIDER — General Optical Council

Optometrists — CPD PROVIDER — General Optical Council

CPD CODE: C-108872

MCQs AVAILABLE ONLINE:
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This CPD session is open to all FBDO members and associate member optometrists. Successful completion of this CPD session will provide you with a certificate of completion of one non-interactive CPD point. The multiple-choice questions (MCQs) are available online from Monday 1 July 2024. Visit **abdo.org.uk**. After member login, scroll down and you will find CPD Online within your personalised dashboard. Six questions will be presented in a random order. Please ensure that your email address and GOC number are up-to-date. The pass mark is 60 per cent.

CPD CODE: C-108872

A review of spectacle lens dispensing measurements

By Cheryl Hill FBDO SMC (Tech) CertEd

In this CPD article, we will look at the measurements required to be taken to accurately dispense a variety of lenses into a frame for a successful visual outcome for the patient. The article will serve as a refresher for registrants, and as a guide to review your current practices. Consider driving: once you pass your test you can legally drive, but how many of us drive as we were taught to?

This article will only consider the measurements required when dispensing to adult patients. Paediatric patients require additional considerations and, therefore, will not be included in the scope of this article. The relevant British Standards will be referred to throughout when discussing spectacle lens and frame measurements.

A 2021 systematic review with meta-analysis of spectacle non-tolerance by Bist *et al* found an overall pooled non-tolerance level of 2.1 per cent, of some 4,000 patients[1]. Of those, 47.4 per cent reported an error in refraction and 13.5 per cent were due to a dispensing problem. Any negative outcome can have a lasting effect on the patient's confidence in their spectacles, but also on the practitioner and/or practice that dispensed them.

Firstly, it is important to ensure that the frame is fully fitted to the patient before embarking on lens centration measurements – so that the measurements are accurate in the as-worn position. For practices that order a new frame for every patient, or that have a complete package glazing arrangement with their lab, the fitted frame measurements should be noted on the patient's file so that accurate frame set-up can be carried out prior to collection.

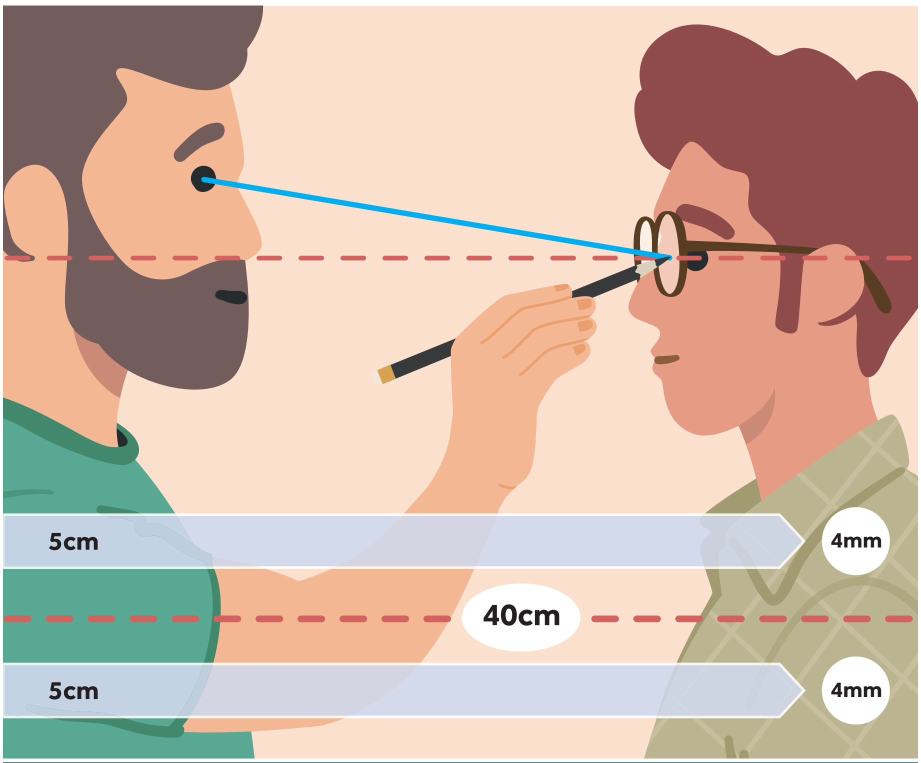

FIGURE 1: Vertical measurement error

Correct frame fitting and adjustment is beyond the scope of this article, but specific consideration needs to be given to a good fit at the nose and ear points – as well as head and temple width and pantoscopic angle.

Once the frame is fitted, the next step is to ensure that as the practitioner you can align yourself correctly with the patient. The patient's eyes need to be at the same height and directly in front of you. Any variation from this set-up will cause an error in measurements. Mathematically, for every 5cm difference in height of the two sets of eyes there can be almost 4mm of error in measurement. Similarly, if you are displaced laterally from your patient, any horizontal measurements will be affected (**Figure 1**). A height-adjustable chair for the practitioner can help to overcome this problem.

SINGLE VISION

Interpupillary distance (IPD) or pupillary distance (PD) is measured for both distance and for near and the method used is different for both. Dispensing opticians and optometrists are all taught to take manual measurements using a ruler (Viktorin method) during their training.

When taking the distance PD of a patient, it is vital to ensure that there is no parallax. That is to say, that the eye being measured is situated in its primary position. This is done by measuring each eye in turn, and asking the patient to look into the practitioner's opposite eye to ensure the correct alignment (**Figure 2**). The PD dictates where the optical centres (OCs) of the lenses will be placed when glazed, taking into consideration any decentration if required.

Many complex single vision surfaces and multifocal lens designs call for monocular centration to be provided. Whilst it may seem acceptable to divide a binocular measurement by two, this will not consider any asymmetry in the patient and can lead to inaccurate centration measurements being provided to the lab for glazing purposes.

The use of a mono-PD ruler makes the accurate measurement of monocular centration simple, effective and easy to undertake routinely. The two measurements can then be added together should you wish to record the binocular PD also (**Figure 3**).

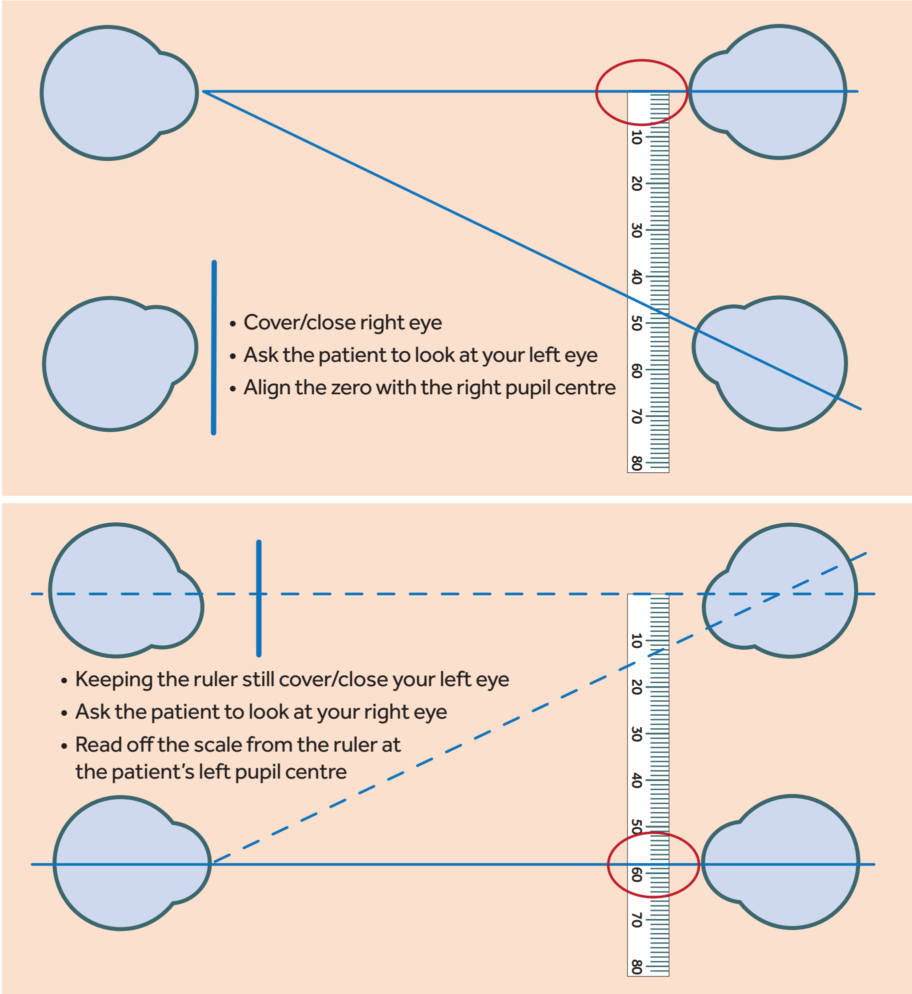

FIGURE 2: Avoiding parallax errors

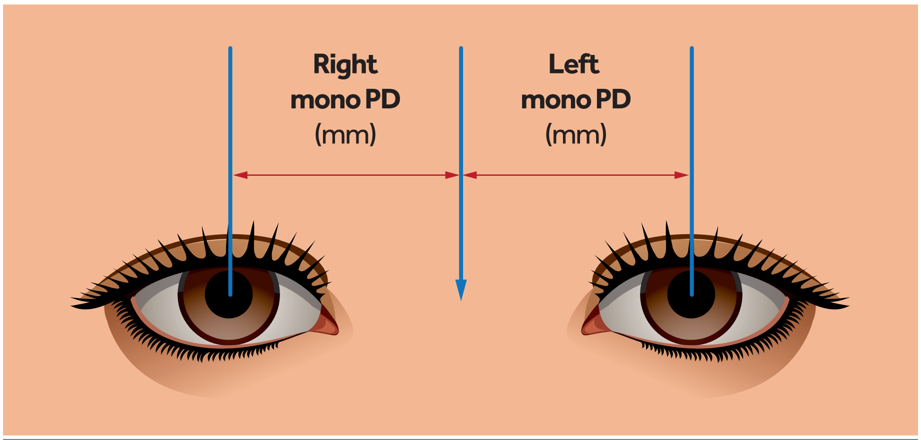

FIGURE 3: Monocular centration

When taking the near PD, this must be done with the chosen spectacle frame in situ. This is because the eyes will converge towards the object and, therefore, the monocular distance between the eyes at the spectacle plane will be smaller than that at the cornea[2] (**Figure 4**). Again, it is recommended to take this measurement monocularly and add the two figures together should you wish to record the binocular amount too, as opposed to the other way around for accuracy.

Much of the time, PDs will be taken for orthophoric patients, that is where no binocular vision issues are present. There is also a need to take accurate measurements for patients who may present with a phoria. Here, the eye of the patient not being measured needs to be occluded, to allow the measured eye to take up its primary gaze position (**Figure 5**).

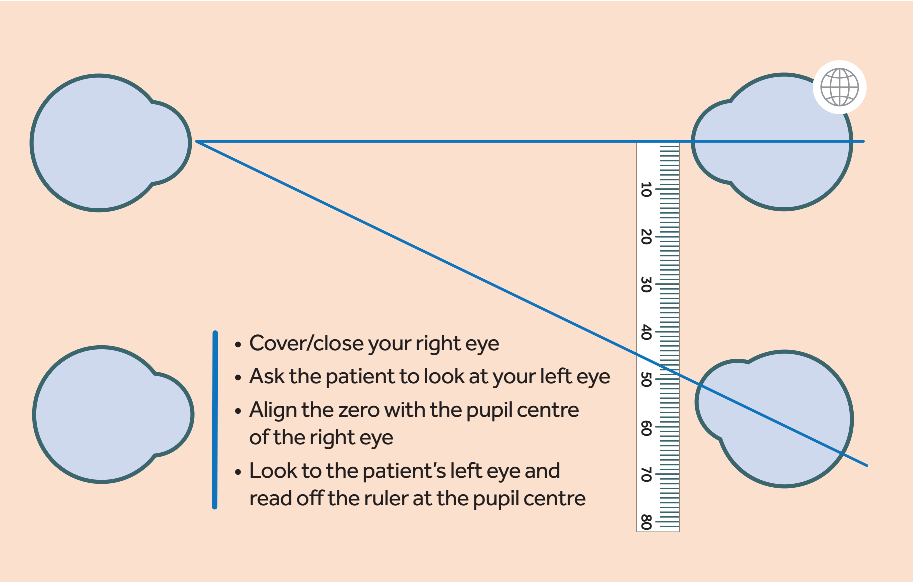

FIGURE 4: Near centration

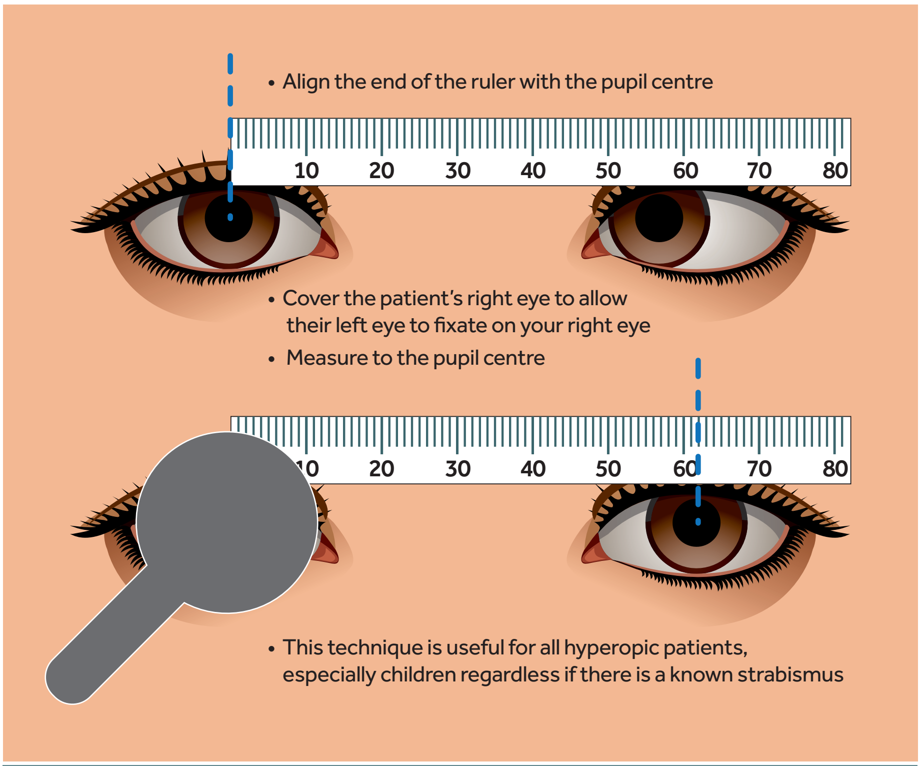

FIGURE 5: Centration measurement for a patient with a phoria

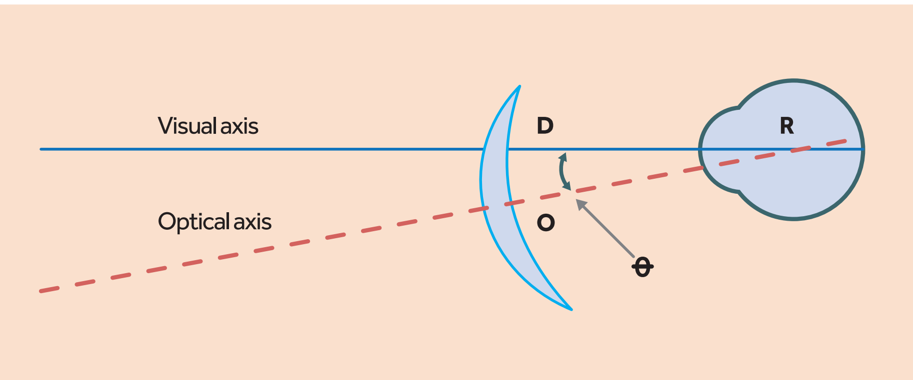

FIGURE 6: Relationship between OC and tilt

Once accurate PD measurements have been taken, the practitioner can be confident that the patient will be looking through the OC of the lens in the horizontal meridian, and no unwanted prismatic effect will be induced.

When dispensing single vision lenses, consideration needs to be given to locating the vertical position of the OC to ensure that in this meridian too, the patient is looking through the OC of the lens. Whilst incorrect vertical centration would not induce unwanted prismatic effect (unless anisometropia was present), any amount of prism will move the image on the retina. If the amount of prism is the same and the vertical direction of the base is the same, double vision will not be the issue. However, the image will fall away from the fovea and can lead to unclear images being seen by the patient.

Yoked prisms are used in behavioural optometry to alter the relationship between eye and head movements and can influence posture by making the eyes or head move entirely. They are also used in some low vision cases to move the image onto a more functional area of the retina in an attempt to improve visual acuity[3]. For example, a patient suffering with age-related macular degeneration or diabetic retinopathy, who cannot easily use eccentric viewing, if fundus and optical coherence tomography images can be used to locate an area of less damaged, or undamaged retina, prisms can be used to re-direct the image to fall on this part.

When dispensing aspheric designed lens surfaces, it is important to consider the relationship between the OC and the pantoscopic tilt. To ensure the optical and the visual axes coincide, an adjustment to the vertical position needs to be made. As a rule, we reduce the vertical centration point 0.5mm for every one degree of pantoscopic tilt[4] (**Figure 6**). This is especially true for aspheric design lenses, which are more sensitive to tilt and decentration errors than spherics[4]. The proof of this rule lies in the equation DO=s tan q, where 'DO' is the amount of height reduction required, 's' is the distance from the back vertex of the lens to the eye's rotational centre, and 'q' is the pantoscopic angle[5].

BIFOCALS

When measuring bifocals, the position of the segment in relation to the eye is required. The segment needs to be positioned so that the lens provides adequate fields for both the distance and the near requirements.

Several methods are commonly used to position the segment as this can be measured as the segment drop, the segment top to the lowest tangent of the lens, or the segment top relative to the horizontal centre line (HCL). As a reference point to begin the measurement, the top edge of the lower point of the lid can be used. Some practitioners measure from the segment top to the lower limbus. However, depending on the patient's facial anatomy, the limbus can lie below the lid margin and not always be seen. Therefore, it would not be the recommended approach to take.

Commonly, it is seen in practice that bifocals are measured from the lower lid to the bottom of the frame at the OC to place the segment top position. This method of measurement relies on accurate horizontal centration and frame-fit first. If the horizontal centration and/or the frame-fit is inaccurate, the final position of the segment will be incorrect and can cause problems for the patient in using the segment.

According to British Standards, the segment height is defined as the vertical distance of the segment top above the horizontal tangent to the lens periphery at its lowest point[6]. As can be seen from **Figure 7**, this measurement can be different to the commonly used measurement to the bottom of the lens at the OC – and can lead to inaccuracies when transferring this into a glazed pair of bifocals.

According to British Standards, segment drop is the vertical height of the distance OC above the segment top[6]. If a single lens replacement is being ordered it would, however, be prudent to measure the segment drop to ensure the final pair of lenses match to avoid unwanted future complications.

Professional examinations for both dispensing opticians and optometrists require the students to measure the segment top position relative to HCL as this is a standardised measurement and accurate to replicate. It is good to check segment top positioning in comparison to any current pairs, but also to consider the occupation/hobbies of the patient as the top position can then be tailored to suit their specific needs.

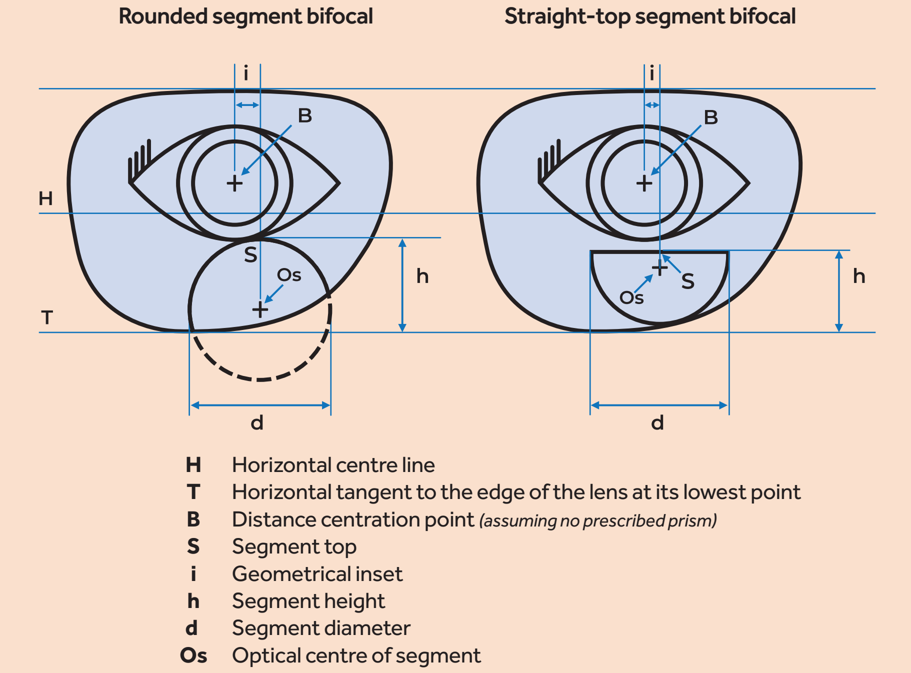

FIGURE 7: Bifocal measurements

The geometrical inset of a bifocal is the horizontal difference between the OC for the distance and the mid-point of the segment diameter[7]. It tells us how much the eyes converge when the patient views a near distance object. As previously stated, it is important that both the distance and near PDs are taken monocularly to ensure the inset is an accurate representation of the eye's actions.

It is possible to manipulate the centration to aid with dispensing. If the dispense was for a jeweller, for example, the centration for near can be reduced, and if required reduced further to induce an amount of base in prism to aid with convergence. If dispensing bifocals for occupational use, then the centration can also be reduced as there will be less difference between the intermediate and near centration distances (CDs).

VARIFOCALS

Progressive powered lenses (PPLs) have been around since 1959 when the Varilux 1 was introduced by Essel, now EssilorLuxottica[4]. In the UK, they are commonly known as varifocals owing to the power progression to accommodate a reading prescription. As a minimum requirement, all varifocals need to be ordered using monocular PDs and vertical heights to pupil centre. The British Standards tolerance when checking varifocals is that the vertical position of the fitting point, or the fitting point height, shall be within 1mm, as is the horizontal fitting point position in relation to the monocular CD[7]. So, as previously stated, it is not an acceptable method to take a binocular PD and simply divide it by two.

The vertical position of the fitting cross should be measured from the centre of the pupil and relative to the HCL. This measurement should be taken for both right and left eyes independently. Commonly in practice, the measurement is taken from the pupil centre to the lower edge of the frame at the OC.

As stated previously, this is not a method accepted at professional examinations as it can be an ambiguous point to measure and relies upon accurate horizontal measurements first. In an asymmetric frame style, such as the aviator, the margin for error is increased owing to the shape.

Depending on the type of lens being dispensed, it may be required to specify the corridor length. This measurement will determine how far up the lens the reading area will reach its maximum power, and how this will affect the design of the lens.

The shorter the corridor length, the harder the design becomes, and so peripheral errors such as surface astigmatism can be more noticeable to the patient, where they would perceive a narrower intermediate area. This is owing to the increase in the rate at which the progression changes, and reducing the width of the near area of the lens. If there is an increase to the reading addition power, this can also affect the design of the lens, making the reading area narrower as the power increases.

With the advancement of freeform and digital surfacing techniques, bespoke varifocals often now also require further measurements which are described below. These extra measurements allow the lens designers to cater each lens to the specific requirements of the patient. Using the data provided, they are able to design a lens which is softer or firmer, depending on how the frame fits the patient and what activities they are doing whilst wearing their spectacles. Therefore, it is paramount for bespoke lenses that the frame is fully fitted prior to measurements being taken and supplied to the lens manufacturer.

When dispensing bespoke freeform single vision and PPLs, more measurements are now required to be taken so that the manufacturer can tailor the lens design to not only the chosen frame parameters, but also the specific visual needs of your patient. These shall be discussed in more detail below.

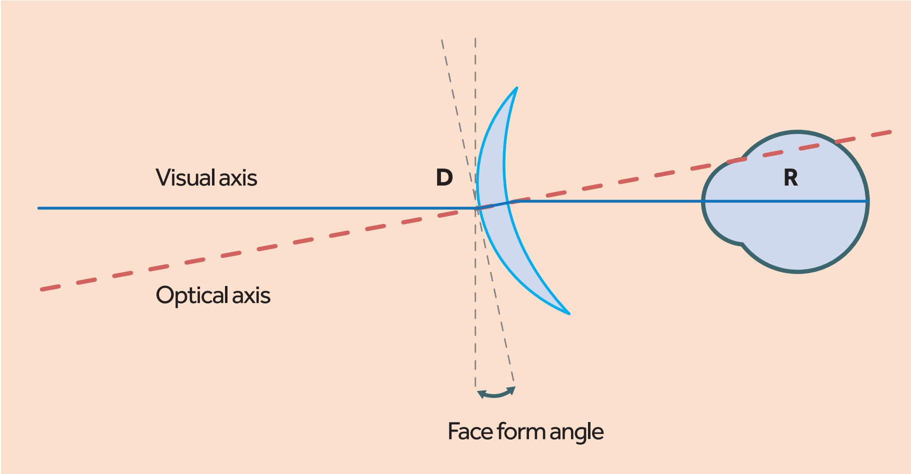

FIGURE 8: Face form angle

OCCUPATIONAL LENSES

Time spent on digital screens has significantly increased over the years and increased further during the COVID-19 pandemic. Adults reported a 51 per cent increase in digital screen time, including both work and personal devices[8]. Occupational lens dispensing is, therefore, on the increase, and there is a vast array of lens designs to choose from.

Occupational varifocals, sometimes referred to as room distance lenses, were traditionally designed for the office and can be modified to suit the wearer's needs. Consideration needs to be given to the focal range which the patient requires.

Most designs have a maximum viewing distance of 4m, 2m or 1.2m. Other designs work by increasing the distance prescription by +0.50 and taking -0.50 from the reading prescription. This reduces the viewing distance to two metres (f=1000/0.50=2) and the extra plus given in the distance aids the plus required for near vison tasks. For many of these lenses, the manufacturer requires distance monocular PD and vertical heights to pupil centre for a standard varifocal. However, some variation does occur – and it is always recommended to check with the lens manufacturer prior to ordering.

Degressive design lenses work slightly differently in that the power reduces from the near to the intermediate portion and, therefore, only has one primary power reference point unlike the occupational and varifocal designs which have two. They are generally ordered by supplying the near prescription with a negative dioptric degression such as -0.75 or -1.50. For centration purposes, they can be ordered either to pupil centre, or in some cases they are fitted as a bifocal lens. Again, consultation with lens manufacturer information is required to ensure the correct method is used for the chosen design.

The main benefit of a degressive design over an occupational design is that the change in power is relatively low and so reduces surface astigmatism. This can provide longer and wider areas of clear vision for the patient within the limits of the lens power range chosen.

FURTHER MEASUREMENTS

Vertex distance is measured from the apex of the cornea to the back surface of the spectacle lens. Whenever a prescription is issued that is more than +/-5.00D then a tested vertex distance must be provided by the prescriber[9]. If a prescription is received for dispensing without this measurement, then it must be referred to the prescriber for correction before the dispense can be completed. This is so that the effective power can be calculated using $F= \frac{F}{1-dF}$ to ensure the correct prescription in the final spectacle lenses. Calculation by the change in focal length can also be used if preferred. Most bespoke spectacle lenses also require a vertex distance measurement to be provided, as they are used in the complex lens surface calculations.

It is generally assumed that the pantoscopic tilt is a positive value, and it is when the lower edge of the frame is tilted towards the patient's cheek. However there are occasions, such as in dispensing specific snooker spectacle frames, when the tilt is reversed to create a negative retroscopic tilt to account for the wearer's unique positioning.

Pantoscopic angle is an as-worn frame measurement and is the angle between the optical axis of a lens and the visual axis of the eye in the primary position, usually taken to be the horizontal. This should not be confused with the US 'pantoscopic frame angle', which is the British equivalent to angle of side which is a stand-alone frame measurement[10].

As discussed earlier, the vertical centration position is altered when dispensing aspheric single vision lenses, particularly those aspheric in design. It is important when dispensing progressive power lenses that we remember the lens designer will have already taken this measurement into account, generally assuming 10-15˚ depending on the manufacturer. In bespoke lens design, the measurement you provide when ordering is used to design the lens specifically for your patient's requirements. There are several tools available to help take this measurement in practice.

Face form angle is the angle between the plane of the spectacle front and the right (or left) plane of the lens shape[11] (**Figure 8**). It is more widely known as the frame bow, dihedral angle, or wrap. However, the correct terminology as per British Standards is face form. Again, gauges have been provided by manufacturers to aid in taking this measurement.

Standard frames usually have a face form angle of around four degrees either side, so a total measurement of eight degrees, but it is common to find that rimless style frames are much flatter. The opposite is then true for sports frames as they are designed on anything from a 6D base to follow the curve of the face, which can give face form measurements over approximately 30˚.

If there is a difference in the face form angle between refraction and dispensing, this can influence the final prescription. For example, if a +10.00DS spherical lens is prescribed using a phoropter where the face form angle is zero, and this in turn is dispensed into a frame with a face form angle of 12˚, the overall lens power will effectively be +10.25/+0.46 x 90.

To calculate this, the formula $Fs = F\,(1 + \frac{\text{Sin}^2 q}{2n})$ can be used on a spherical prescription, or $F_c = F_s \tan^2 q$ for a cylindrical component. Remember: the axis will parallel to the axis of rotation[6]. It should also be remembered that any frame with a significant face form angle will also need this calculation to achieve the correct prismatic effect at the eye.

SUMMARY

This article does not contain an exhaustive list of measurements required when dispensing spectacles. As technologies emerge and improve, manufacturers are frequently requesting more information to be provided – including eye dominance, near vision behaviour, working distance and patient height. One lens design required the practitioner to confirm if the patient was male or female.

Technology has evolved, as has the machinery available to take these measurements. From the traditional marker pen and ruler, to pupillometers and now access to clips to use with a tablet, tower units to measure frame and lens centration, eye rotational centre and a multitude of other parameters which earlier were not possible. Whilst many of these devices have accuracy claims to the mm, and in some cases to the 0.1mm, it should be remembered that they still require human input to be obtained. For example, the positioning of the device or the patient, which may introduce error not in place in the manufacturer's testing.

A study into a pupillometer found a standard deviation in measurements to be ø =+/-0.63mm[12]. It is important to note that electronic devices such as pupilometers use infra-red light and detect corneal reflex to take the measurement. If the patient has a sufficiently abnormal corneal shape, this will affect the measurement taken. A 2009 study by Walsh and Pearce found a standard deviation of ø =+/-1.54mm when using a ruler to measure PD[13]. It should be noted this value is outside the usual 1mm tolerance for a PPL[7].

A more recent study into measuring IPD stated that there was no clinical significance in the mean difference found between Viktorin (manual) and reflex pupillometer measurements and stated both methods were found to offer good inter-session repeatability[14].

As a final note, it is important to appreciate the relationship between the frame/lens parameters we have discussed, and how they correspond and align with the facial measurements we were trained to take. For example, being able to use the frame's boxed CD alongside the patient's IPD to reduce the lens blank size required to improve the overall cosmetic look. Recognising the impact that the final frame fit will have on the accurate lens centration measurements you have taken when considering things such as face form angle, vertex distance and pantoscopic angle will aid in initial frame selection.

Understanding the relationship between the frame and the patient's face is paramount to a successful dispense, which enhances the patient's visual outcome. Whilst this article has discussed the measurements we need to take, taking time to assess other factors, such as posture and working distance, and understanding how your patient will be using the appliance you provide, will inevitably lead to a positive outcome.

REFERENCES

References can be found when completing this CPD module. For a PDF of this article with references, email abdocpd@abdo.org.uk

CHERYL HILL qualified from ABDO College and registered as a dispensing optician (DO) in 2006. Cheryl has worked in both independent and multiple optical practice at management level. She previously lectured in ophthalmic dispensing at Bradford College before moving to currently lecture in ophthalmic lenses and dispensing at the University of Bradford, School of Optometry and Vision Science. Cheryl also works part-time for the ABDO CPD Department developing professional education for DOs and optometrists. She is a member of the advisory panel for All About Vision UK, and a UK and overseas practical and theory examiner for ABDO. Cheryl is an experienced face-to-face and online presenter and facilitator of CPD, for both DOs and optometrists.

LEARNING OUTCOMES FOR THIS CPD ARTICLE

DOMAIN: Clinical Practice

5.3: *Be aware of current good practice in relation to spectacle dispensing measurements and the current relevant standards these are required to conform to.*

7.5: *Provide effective spectacle dispensing by adhering to appropriate measurement taking and accuracy based on current good practice.*

CLINICAL PRACTICE

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