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Back to basics in dispensing

Part 8 – Anisometropia

Paul McCarthy looks at ways of predicting problems due to anisometropia and how best to avoid them. C7205, one standard CET point, suitable for optometrists and dispensing opticians

When presented with an anisometropic prescription there are many issues that must be considered by the dispensing optician to ensure that patient non-tolerance is avoided. These issues have been broadly grouped under three main headings:

- Recognition of anisometropia
- Likely impact on the patient
- Choice of lens.

Recognition of anisometropia

A significant difference in refractive error between the two eyes of more than 1.00D in any meridian is often given as a definition of anisometropia.[1] It is also generally accepted that many subjects cannot tolerate more than about 1Δ of differential prismatic effect for a prolonged period, especially in the vertical meridian.[2] From Prentice's rule (P=cF) it should be apparent that when a subject with a 1.00D refractive error difference looks through corresponding points 1cm away from the optical centres of their lenses, 1Δ of differential prismatic effect will be encountered.

A prescription of R +1.00DS, L +3.00DS will induce a differential prismatic effect of 2Δ (base up in the left or down in the right) at 10mm below the optical centres. Not so obvious at first glance is the effect at the same visual point with a prescription R +2.00/-1.75x180, L +2.75/-1.00x 35. Figure 1 shows that for the right eye the vertical power is just +0.25D. For the left eye the cylinder exerts only -0.50D in the vertical direction, giving a total power of +2.25D. The differential prismatic effect is again 2Δ (base up in the left or down in the right) at 10mm below the optical centres.

The above examples show the importance of considering the effect of the cylindrical element on the meridional anisometropia and its impact on the differential prismatic effect, especially in the more critical vertical direction.

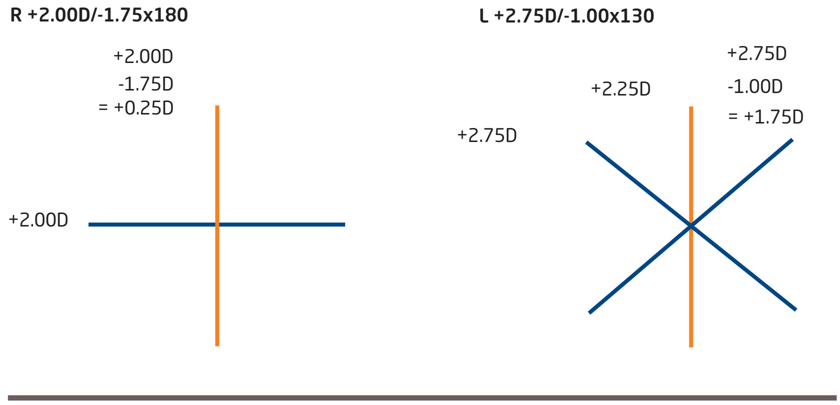

Figure 1

Induced anisometropia

In the earlier days of intraocular implants, cases of meridional anisometropia often resulted from the astigmatism induced during the operation. This frequently led to a notable change from the patient's original prescription.

The following example is given where a patient, after many years of wearing bifocals, was unable to tolerate the same lens type after undergoing a cataract removal from the left eye.

Rx before cataract removal from the left eye:
R +3.00/-1.00x10 VA 6/6-1 add +2.50.
L +2.75/-1.00x45 VA 6/36 add +2.50

Rx following left lens implant:
R +3.25/-1.00x10 VA 6/6-1 add +2.75
L +2.25/-2.25x175 VA 6/6-1 add +2.75

Assuming a near visual point (NVP) of 10mm below the optical centre, with the old lenses the subject would have encountered a difference of only 0.25Δ base down in the right, which would not have caused any problems of diplopia although, of course, vision in the left eye would have been poor. With the new prescription the spherical element of both prescriptions has not greatly altered, but the new cylinder power and axis direction in the operated eye has resulted in a differential prismatic effect of about 2.25Δ base down in the left lens at the same NVP. Despite good VAs in both eyes the patient in this case experienced diplopia at near and was unable to tolerate the new lenses.

It is useful to remember that the differential prism at near will always be base down in the more negative eye.

Likely impact on the patient

In the earlier examples, both with a differential prism with base up in the left, this eye would need to rotate downwards in relation to the right. It is likely that fusion of the right and left images would not be sustained, resulting in the object being seen double.

We have seen that a differential prismatic effect will only occur when both eyes look through corresponding points away from the optical centre of lenses of different powers. Usually it is the multifocal or progressive lens wearer who is required to look through such points on the lens. Consideration is usually focused on the differential prismatic effect at the NVP where the subject lowers the eyes to read. However, it should not be overlooked that the distance visual point or fitting cross position on a progressive power lens can be as much as 6mm above the prism reference point. Anisometropia of just 1.67D would induce a differential prismatic effect of 1Δ at a point on the lens that will likely be used for prolonged distance vision.

While the single-vision lens wearer is mostly able to move the head to ensure the eyes view objects through the optical centre, there may be circumstances such as prolonged or constant use for close up work, where visual difficulties may be encountered.

Visual acuities

Amblyopia, where the VA in one eye is reduced compared to the other,

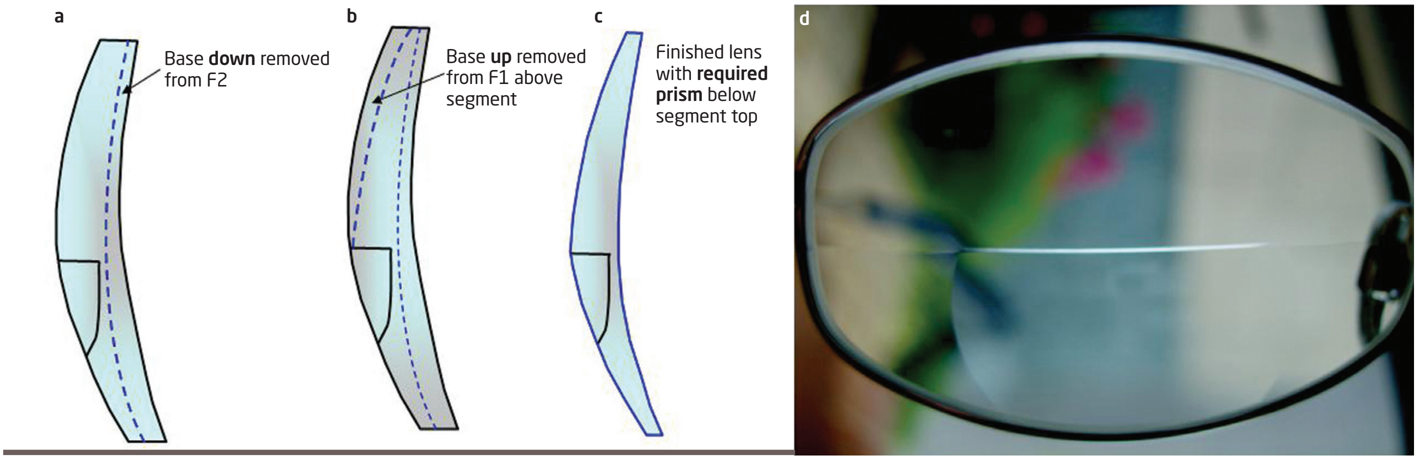

Figure 2

commonly results from anisometropia especially with hypermetropic subjects who, if uncorrected, only tend through accommodation, to focus with the eye requiring the lower Rx – given this requires less accommodative effort. This will commonly lead to poorer VAs in the more hypermetropic eye due to blur-monocular deprivation.[3] Early correction is essential in these cases if amblyopia is to be avoided.

With myopes having the far points in front of the eyes, both are able to be stimulated and so amblyopia is less common. A subject with R -0.25D, L -3.00D could use the right eye for more distance viewing and the left for distances of 33.3cms or less. Where VAs are significantly different, there is the likelihood of suppression of the poorer image. If the eye with the worse VA is accompanied by a significantly higher Rx, as is usually the case, the expected diplopia with off-centre viewing may not manifest itself to the wearer. It is likely that little advantage would be gained to the patient in providing any solution to the anisometropia in these cases. Even if the myope above had good VAs, they may suffer poor binocular vision, which would require investigation prior to any lens recommendation.

Assessing patient tolerance

From the earlier discussions it could be supposed that a subject with a significant difference in their right and left prescriptions would require a compensating prism at the off-centre visual point of their lenses, which is usually at the NVP. Some anisometropic subjects, however, are able to adapt to the differential prism and exhibit no symptoms. Some will just suppress, especially at higher levels. Others, at lower levels, may have good fusional reserves and tolerate the differential prism. Subjects with marked anisometropic amblyopia benefit from prism compensation even though vision is monocular. In most cases, deciding whether a subject will be tolerant of the differential prismatic effect resulting from an anisometropic Rx should not present any difficulties to the dispensing optician.

The subject must be instructed to look through the NVP of their single-vision reading or distance lenses, depending upon whether they are first-time presbyopes or not, while observing print close to their resolution limit, making any problems more obvious. This would normally require the subject to lower the eyes about 10mm below the optical centre. The required compensating prism is placed before the corresponding eye and, if a 'better' response is given, prism compensation would be beneficial.[4]

It is usual for anisometropic subjects, whose existing lenses have not been prism compensated, to be dispensed with the same lens type. It is simple to employ the method above to determine whether a solution to the anisometropia would give any added benefit to the wearer. Providing any change in lens design is minimal, there should be no additional problems with regard to aniseikonia if the subject is currently wearing spectacles and has no symptoms as he will have adapted to different right and left cortical image sizes. When dispensing an anisometrope with first-time spectacles, the issue of aniseikonia may need to be addressed, especially if both eyes have good VAs.

Choice of lens

Having identified the presence of anisometropia and its likely effects, we need to consider how this can be optically corrected to avoid patient non-tolerance through the diplopia that the dispensing of just standard lenses would create. Eliminating or reducing the differential prism responsible for the diplopia when viewing through the NVP of the lenses can be done through the following methods:

- Slab-off
- Different round bifocal segment sizes
- Franklin split
- Prism controlled bifocals
- Cemented or bonded bifocal segments.

Slab-off

This technique may be carried out on single-vision or multifocal lenses to remove or neutralise unwanted vertical prismatic effect in the near vision zone only. With progressive power lenses this may also be extended to removing the prism at the distance vision zone. More commonly the technique is performed on bifocal lenses where the horizontal line, showing the apex of the slabbed-off prism, is made to coincide with the segment top (Figure 2d). When performed on an executive bifocal the line becomes indistinguishable with the segment top. However, as the OC of the segment will not be on the dividing line, the lens will no longer fulfil the no-jump requirement.

Figure 2 shows the procedure carried out on the less plus (or more minus) glass fused bifocal; this being the lens exhibiting the more base-down prismatic effect at the NVP. In Figure 2a the whole of F2 is surfaced to remove the required amount of base-down prism. The same amount of base-up prism is removed from the portion of the lens above the segment top in Figure 2b, neutralising the prism introduced in 2a in this part of the lens. This leaves the required amount of prism just in the reading zone of the lens.

The process is more challenging with plastic lenses, where the protruding segment on the front surface of plastics lenses requires the entire slab-off process to be performed on the concave rear surface only.[5] The slab-off technique for PPLs involves removing the differential prism at the distance reference point by working prism over

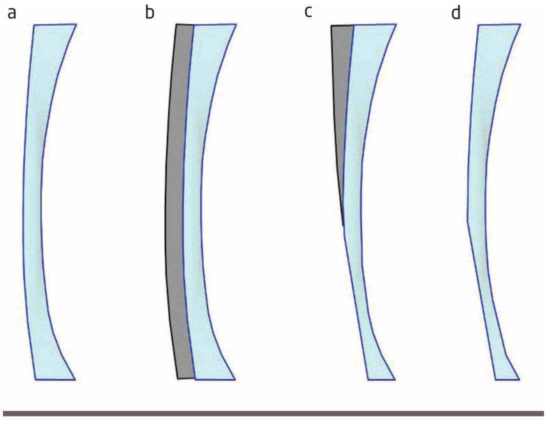

Figure 3

Figure 4 Bi-centric lens

the whole prescription surface and then removing the required base-down prism again from the lower part of the weaker plus (or higher minus) lens. Vision will, however, be restricted at the height of the prism measuring point due to the slab-off edge.[6]

When slab-off is performed on a single-vision lens, a bi-centric lens is created having a separate optical centre in the near portion that may be positioned to eliminate any differential prism at the NVPs. As stated previously, most single-vision wearers can lower the head to look through the optical centres of their lenses, especially if the OCs are glazed well below the pupil centres. However, bi-centric lenses should not be overlooked if they are appropriate to the patient's needs and likely to provide better optical comfort.

A bi-centric lens is made by cementing a cover onto the lens (Figure 3b) and then the required amount of prism is removed by grinding the lens at the correct angle (Figure 3c). This is continued until the lower edge of the lens is at a pre-calculated thickness, placing the dividing line at the required distance below the optical centre of the distance zone of the lens (Figure 4).

Different bifocal round segment sizes

Although not cosmetically attractive, careful choice of round segment sizes can reduce, if not always eliminate, the differential prismatic effect at the NVPs to a level the wearer may tolerate. Round segments exert base-down prism at the NVP; the amount dependent upon the reading add and the distance between the NVP and the optical centre of the segment (OS).

From the geometry of the lenses in Figure 5 we can calculate that the round 38mm segment in the left eye will exert 0.7Δ base down more per 1.00D of reading add at the NVP than the round 24mm segment in the right eye.

Left eye: OS $\rightarrow$ NVP = 13mm (1.3x1.00D) = 1.3Δ base down
Right eye: OS $\rightarrow$ NVP = 6mm (0.6x1.00D) = 0.6Δ base down
Differential prism per dioptre of add at the NVP = 0.7 base down

(Alternatively; the product of the difference in segment radii and 1.00D gives us 0.7Δ).

In this example the distance Rxs will induce a differential prismatic effect of 2Δ (base up in left) at the NVP. With a +3.00D reading add the different segment sizes will produce 2.1Δ (0.7Δx3) base down in the left at the NVP, resulting in just 0.1Δ of differential prism which will be easily tolerated by the wearer.

If the difference in segment diameters is required, the formula:

$$\frac{2c \times \delta F}{\text{Add}}$$

can be used where c is the distance from the OC to the NVP (in mm) and δF is the difference in lens powers.

Franklin split

There cannot be many 250-year-old inventions that are still being offered as a solution to a current-day problem. It is often the first solution given by examination candidates where differences between the distance and near Rxs cannot be overcome by the use of conventional multifocal lenses. Although it is indeed a very versatile option, the lens is somewhat cosmetically unattractive (Figure 6) and whether the recommendations in practice reflect its choice as an examination answer is doubtful.

The Franklin split was created in the 1760s as just two lenses cut in half and cemented together. These would most certainly have been distance and near vision lenses – although with Benjamin Franklin being closely associated with the first two presidents of the Royal Academy of Arts, Sir Joshua Reynolds and Benjamin West, it is not beyond doubt that to help them with their work, intermediate and near lenses could have been combined, thus creating the first occupational lens. Franklin would probably not have considered the potential of his invention where the optical centres of each separate lens could be positioned to create a desired

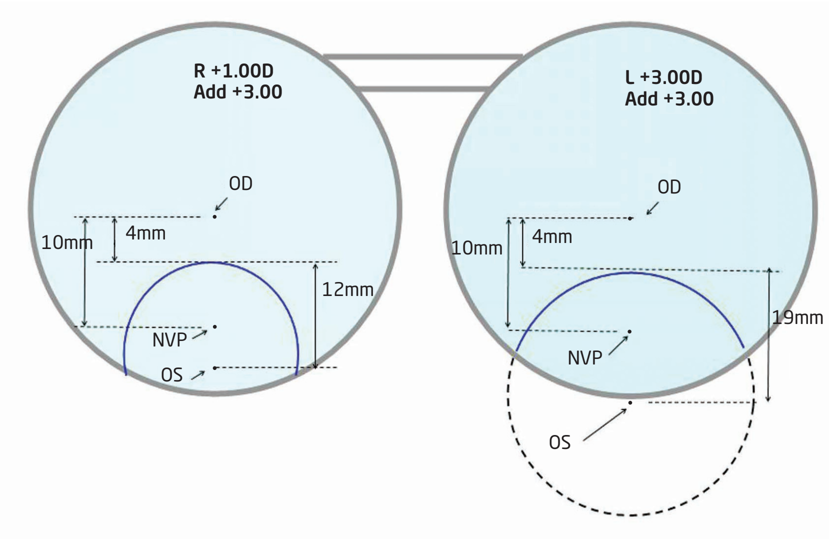

Figure 5 Different segment sizes

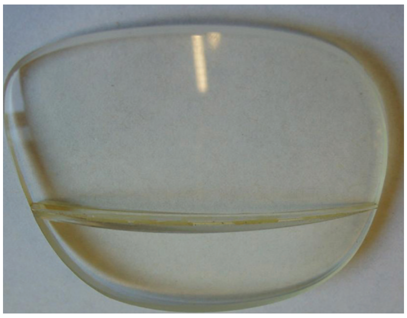

Figure 6 Franklin split

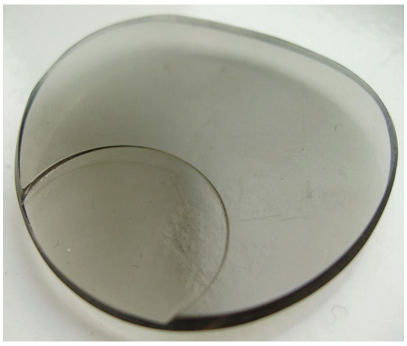

Figure 7 Prism controlled solid bifocal

MULTIPLE-CHOICE QUESTIONS

1 Which Rx would give the greatest degree of anisometropia in the vertical meridian?
A R +2.50DS L +3.50/-1.00x180
B R -6.25/+1.00x90 L -7.50/+2.00x45
C R -5.50/+1.00x180 L -6.25DS
D R +1.50/+2.00x180 L +3.50/-0.25x70

2 How much differential prismatic effect is present 8mm below the optical centres of the lenses; R +1.25/-0.75 x 180 L +3.50/ -1.00 x 180?
A 1.6 Δ base up in the left
B 1.6 Δ base up in the right
C 1.8Δ base down in the left
D 1.8Δ base down in the right

3 Anisometropic myopes are more likely to benefit from compensated prism at near because:
A The eye with the poorer VA will show improvement
B It changes the far point of the prism-compensated eye
C Both eyes can be stimulated so both VAs are likely to be good
D The right and left retinal image sizes will become equal

4 What is the best combination of segment sizes for the Rx. R +0.75DS L +2.25/+1.00x90, Add 2.00D, to remove the differential prismatic effect at the NVP at 10mm below the OC?
A R round 24mm, L round 30mm
B R round 24mm, L round 45mm
C R round 28mm, L round 38mm
D R round 24mm, L round 38mm

5 What is the disadvantage of performing a slab-off on an executive bifocal?
A The slab-off line is coincident with the segment top
B Some diplopia will remain
C The no-jump condition is removed
D Differential prism cannot be eliminated

6 Which one of the solutions to anisometropia removes the issues of both differential prism and aniseikonia?
A Slab-off
B Separate distance and near spectacles
C Contact lenses
D Franklin split

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prismatic effect. The correct positioning of the OCs of the reading lens portions can be used to eliminate differential prism arising from anisometropia.

Prism controlled solid bifocal

Another extremely versatile lens is the glass 30mm round segment prism-controlled bifocal, which has been available for many years. It can produce prisms within the segment up to 6Δ in any direction although for the control of anisometropia-induced differential prism we are only concerned with vertical compensation. For cosmetic reasons the normal procedure would be to split the differential prism compensation between the two lenses. Where 3Δ base down in the left needs to be compensated for example, the right segment would incorporate 1½Δ base down with the left having 1½Δ base up. If one lens only were to be used for prism compensation, then all of the 3Δ base up would be incorporated in the left lens to avoid the ridge at the dividing line (Figure 7). The right eye would be matched with a standard solid R30 bifocal lens.

Bonded segments

As with the Franklin split, when one lens is bonded onto another, its OC can be positioned to provide a desired prismatic effect at a given point. When removing differential prism the reading segment, with its compensating prism, is bonded onto the main lens at the near vision zone.

It is preferential to use this prism compensation on the main lens that requires base down to prevent a thick ridge at its upper edge.

Other options

A Fresnel prism is not a permanent option because of the poor cosmetics and durability and the reduction in visual acuity. Its use is to assess the wearer's acceptance of the compensating prism before a more permanent solution is decided upon.

Single-vision distance and reading spectacles remove the need for the eyes to look away from the OCs. However the benefits of avoiding the issues of anisometropia are offset by the inconvenience of needing to change spectacles for different viewing distances.

Contact lenses offer the most natural vision. As well as creating very little difference in retinal image size, the problems of differential prism obviously do not arise regardless of direction of gaze.

Summary

This article has considered the fundamental aspects of identifying the presence of anisometropia when presented with a prescription and the likely effects on the patient if the resultant differential prismatic effects are not compensated for.

The solutions to these issues are still available and so offer the dispensing optician the means of providing their anisometropic patients with the best possible vision.

References

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● **Paul McCarthy** is a dispensing optician and a senior lecturer in dispensing optics at the Anglia Ruskin University. He is also an examiner for the Association of British Dispensing Opticians