Daily disposable soft lens diameters

Dr Graeme Young looks at the diameter of modern soft contact lenses, whether they meet their specifications and how they change with temperature

All of the currently marketed daily disposable soft lenses are only available in a single diameter. However, diameter is an important parameter in relation to optimising lens fit. Lenses which are too small fail to give complete corneal coverage and result in discomfort and peripheral corneal staining. However, lenses which are too large exert more pressure at the periphery – due to greater bending forces – which can lead to discomfort and indentation of the bulbar conjunctiva.

In a typical population, corneal diameters vary by about 1.5mm,[1] whereas the range of diameters on offer with daily disposable lenses is relatively narrow – 13.8 to 14.3mm. In fact, all but a few designs are labelled as 14.2mm. However, previous work has shown that measured diameter does not always correspond to labelled diameter because of the effects of pH, osmolarity and temperature. In particular, raising the temperature of the lens from room to eye temperature can have a significant effect.[2-3]

It has been suggested that daily disposable lenses are 'commodity products' and readily interchangeable. At least one internet supplier of daily disposable lenses encourages the switching of patients from their existing soft lenses to an alternative daily disposable lens without the need for a contact lens check.[4] For this to be feasible there would need to be close consistency of on-eye diameter between the two products to ensure the same corneal coverage.

The purpose of this study was to evaluate the actual diameter of currently available daily disposable lenses and their change in diameter when raised to eye temperature.

METHODS

The diameters of 13 daily disposable lens brands currently available in the UK (Table 1) were measured at two different temperatures: room temperature and eye temperature.[5] Eighteen of each type of lens were measured: six lenses in three powers (-1.00, -3.00 and -6.00D). The measurements were taken using a temperature-controlled Chiltern Lens Analyser (Optimec, Malvern, UK). Two sets of measurements were recorded: at room temperature (20°C) and at eye temperature (34°C). Buffered unpreserved saline was circulated in the measurement cell. In both cases the temperature of the cell was regularly checked and appropriate action taken to avoid taking measurements outside of a narrow range of temperature (±1°C).

Prior to measurement, the lenses were allowed to settle in the wet cell for approximately two minutes. After the settling period, a diameter measurement was taken, the lens was then agitated, allowed to resettle and the measurement repeated. The diameter measurements were taken at the two and eight o'clock positions and an average of these two reading taken. The instrument incorporates a graduated display in steps of 0.1mm. However, it was possible to carry out measurements to the nearest 0.05mm. All measurements were repeated three times and the mean calculated.

RESULTS

Eight of the 13 lenses in this study had a labelled diameter of 14.2mm; one lens (New Day) was labelled larger and four smaller than this. All of the lens diameters measured at room temperature were within 0.2mm of labelled diame-

TABLE 1 Study lenses

Lens brand	Manufacturer	Material	Water content (%)	Labelled BOZR (mm)	Labelled diameter (mm)
SofLens one day	Bausch & Lomb	hilafilcon A	70	8.60	14.2
Clear 1-day	ClearLab	hioxifilcon	58	8.70	14.2
Dailies Aquacomfort Plus	CIBA Vision	nelfilcon A	69	8.70	14.0
Dailies All Day Comfort	CIBA Vision	nelfilcon A	69	8.60	13.8
Focus Dailies	CIBA Vision	nelfilcon A	69	8.60	13.8
BioMedics 1 Day	CooperVision	ocufilcon B	52	8.70	14.2
Proclear 1 day	CooperVision	omafilcon A	60	8.70	14.2
Daysoft UV 58	Provis	filcon II 1	58	8.60	14.2
Daysoft UV 72	Provis	filcon II 2	72	8.60	14.2
New Day	Sauflon	methafilcon A	58	8.70	14.3
Bioclear	Sauflon	filcon IV 1	56	8.60	14.1
1 Day Acuvue	Vistakon	etafilcon A	58	8.50	14.2
1 Day Acuvue Moist	Vistakon	etafilcon A	58	8.50	14.2

TABLE 2
Diameter measurement results arranged by

Lens Type	Daysoft 72	Daysoft 58	
Labelled (mm)	14.2	14.2	
Mean (mm)	14.37	14.13	
SD	0.06	0.04	
Min	14.30	14.10	
Median	14.40	14.10	
Max	14.45	14.20	
Range	0.15	0.10	
Mean(mm)	13.54	13.57	
SD	0.05	0.08	
Min.	13.50	13.50	
Median	13.50	13.55	
Max.	13.60	13.70	
Range	0.10	0.20	
Difference 25 34°C(mm)	0.83	0.57	

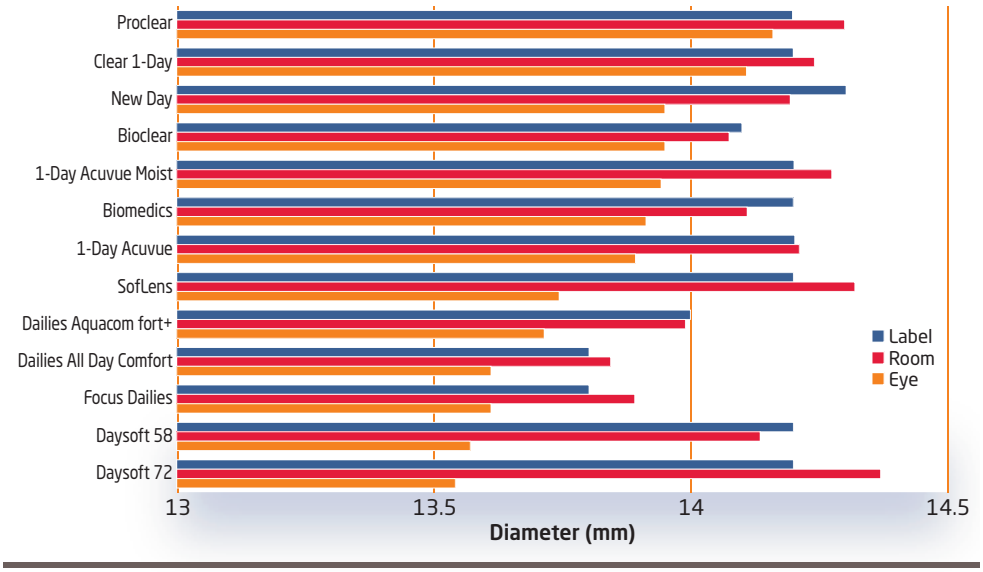

Figure 1 Summary of labelled and measured lens diameters

ter, ie within ISO tolerance 6 (Table 1). The range of measurements at room temperature for a given lens varied from the labelled diameter by 0.05mm with Focus Dailies to 0.20mm for New Day. When re-measured at eye temperature, each of the lenses showed a mean reduction in overall diameter (Fig 1). This shrinkage ranged from 0.12mm with Clearlab 1Day to 0.83mm with Daysoft 72.

DISCUSSION

The results confirm that comparing labelled diameters is unhelpful, and in some cases misleading, for predicting the on-eye performance of current daily disposable soft lenses. This is highlighted by the fact that lenses labelled 14.2mm ranged in diameter from 13.5mm to 14.1mm when measured at eye temperature. Paradoxically, the lens that showed the largest diameter at room temperature (Daysoft 72) was the smallest lens at eye temperature (14.4 vs 13.5mm). Soft lens diameter is arguably a more critical parameter than BOZR since typical variations in the latter have little effect on lens fit.[7] This lack of clarity in the parameter of lens diameter is therefore particularly regrettable.

When comparing the lenses in this study, the eye temperature diameters fall roughly into three categories which can be described as 'small' (13.5-13.7mm), 'medium' (13.9mm) and 'large' (14.1-14.2 mm). It is helpful for practitioners to be aware of this categorisation, particularly when selecting lenses for corneas at either end of the size range. Given that the actual cornea is approximately 1.3mm larger than the visible iris diameter, small diameter lenses are rarely suitable for larger corneas.[1] A cornea with horizontal visible diameter of 12.0 mm, therefore, might be expected to have an actual diameter of about 13.3mm which is close to the diameter of the smallest lens measured here, thus, leaving little scope for lens movement.

The three lenses showing the greatest shrinkage when raised to eye temperature were all FDA Group 4 lenses (SofLens, Daysoft 58 & 72). This is consistent with previous work inves-

eye temperature diameter, from smallest to largest (left to right)

	Focus Dailies	Dailies All Day Comfort	Dailies Aquacomfort Plus	SofLens	1 Day Acuvue	Biomedics	1 Day AcuvueMoist	Bioclear	New Day	Clear 1-Day	Proclear
	13.8	13.8	14.0	14.2	14.2	14.2	14.2	14.1	14.3	14.2	14.2
			Measurements @ 20°C								
	13.89	13.84	13.99	14.32	14.21	14.11	14.27	14.07	14.19	14.24	14.30
	0.02	0.05	0.04	0.04	0.04	0.03	0.05	0.05	0.07	0.05	0.01
	13.85	13.80	13.95	14.25	14.15	14.05	14.20	14.00	14.10	14.20	14.25
	13.90	13.83	14.00	14.35	14.20	14.10	14.30	14.10	14.20	14.20	14.30
	13.90	13.90	14.05	14.35	14.30	14.20	14.30	14.15	14.30	14.30	14.30
	0.05	0.10	0.10	0.10	0.15	0.15	0.10	0.15	0.20	0.10	0.05
			Measurements @ 34°C								
	13.61	13.61	13.71	13.74	13.89	13.91	13.94	13.95	13.95	14.11	14.16
	0.03	0.03	0.05	0.06	0.06	0.02	0.07	0.06	0.06	0.05	0.03
	13.60	13.60	13.65	13.70	13.80	13.90	13.80	13.85	13.90	14.05	14.10
	13.60	13.60	13.70	13.70	13.90	13.90	13.90	13.98	13.93	14.10	14.15
	13.70	13.70	13.80	13.85	14.00	13.95	14.05	14.00	14.05	14.20	14.20
	0.10	0.10	0.15	0.15	0.20	0.05	0.25	0.15	0.15	0.15	0.10
	0.28	0.23	0.28	0.58	0.32	0.20	0.33	0.12	0.24	0.13	0.14
	Small				Medium					Large	

tigating the temperature sensitivity of non-ionic lenses.[8-10]

The three lens types showing the least shrinkage (Bioclear, Clear 1-day and Proclear) use materials which are claimed to be biomimetic and, as a result, dehydration resistant. The differences in shrinkage between materials can be explained by differences in the fraction of bound (or non-freezing) water. Those materials, such as omafilcon A, with relatively strong interaction with water have a relatively high fraction of bound water.

Two of the lenses in this study (Daysoft 58 and 72) are marketed direct to the public and are claimed to be interchangeable with most other disposable lenses without recourse to refitting. However, the fact that, at eye temperature, these are significantly smaller than several of the other lenses casts some doubt on this claim. For example, only a limited number of large corneas successfully fitted with Proclear (14.2mm) are likely to achieve full corneal coverage with Daysoft 72 (13.5mm). Clearly, other variables such as lens design and material modulus also affect lens fit and further complicate the interchangability of lenses.

Two lens brands (Dailies, 1 Day Acuvue) are available with and without wetting agents. In both cases, the amount of shrinkage was similar between lenses with and without the wetting agents.

Conventionally, soft lens diameter is measured at room temperature (20°C) during manufacture, as it is easier to maintain wet cells at this rather than eye temperature. A preferable approach with total diameter might be for manufacturers to specify soft lens diameter based on eye temperature as this is more easily related to the on-eye performance. This would not prevent routine checking at room temperature as a simple conversion factor could be used between the two measurements. However, as with oxygen permeability, it would be necessary to indicate the measurement temperature so as to avoid confusion.

This evaluation did not take into account differences between lenses with respect to sagittal depth which can vary widely in lenses of similar diameter. Burki noted a difference in sagittal depth of nearly 1.0mm for lenses of similar labelled diameter and BOZR.[11] Due to lens wrapping, these differences are a potential further source of variation in on-eye diameter.[12] Further work in this area would be useful in relating clinical performance more closely to soft lens parameters. Similar information on other categories of lens would also be useful (eg silicone hydrogels) and this will be the subject of future reports.

In conclusion, total diameter is an important parameter in relation to successful soft lens fit. However, because of temperature induced changes, on-eye diameter is not easily predictable from the labelled diameter. More information is needed to help practitioners select the appropriate lens type.

Acknowledgements

This study was funded by Visioncare Research which has, at various times, received sponsorship from: Bausch & Lomb, CIBA, Clearlab, Johnson & Johnson Visioncare, and Sauflon. I am grateful to Shaun Peters for undertaking the measurements.

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● **Dr Graeme Young** is managing director of Visioncare research, an independent clinical research organisation specialising in eye care research