CLINICAL AND EXPERIMENTAL
OPTOMETRY

A clinical comparison of the Johnson & Johnson Acuvue, the Barnes-Hind Calendar and the Bausch & Lomb Medalist disposable contact lenses

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We compared the clinical performance of three brands of disposable contact lenses available in Australia by refitting 82 Johnson & Johnson Acuvue wearers with either Barnes-Hind Calendar or Bausch & Lomb Medalist lenses. Subjective lens assessments were analysed with regard to patient factors. Many of these factors were not significant for predicting the success of a lens but overall lens preference and preference on the basis of comfort, handling and quality of vision were predictable from a history of keratitis, wearing mode or lens power. However, high individual variations did occur. Fitting success is improved by following some simple guidelines but is maximised only by trialing more than one lens type.
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Key words: contact lens comfort, disposable contact lens, contact lens preference, quality of vision

The first commercially available disposable lens in Australia was the Johnson & Johnson (J & J) Acuvue in 1988. There is now a considerable array from which the contact lens practitioner can choose but little clinical data on which to base the choice of the best lens for a patient. Unfortunately, most published research on disposable lenses, such as that on lens edge defects or tear film debris, fails to bridge the gap between statistical significance and clinical significance.[1,2] Practitioners are forced to rely on manufacturers' claims, their own experience, which may be limited to a few cases, or to extrapolate from this non-clinical research to determine the choice of lens for a patient.

To address this shortfall in clinical data for lens selection, we compare three lenses: the J & J Acuvue, the Barnes-Hind (B-H) Calendar and the Bausch & Lomb (B & L) Medalist. Table 1 compares the features of these lenses. In their promotional literature, all manufacturers claim that their lenses provide certain clinical advantages. These are summarised in Table 2.

The large number of differences between lenses suggests that they should perform differently for different patients, especially in view of the variations possible in patient factors, such as corneal curvature, lens power, patient age and wearing pattern. We questioned whether it was possible to assess such patient factors and predict preference for a lens type based on this assessment.

Since disposability was first mooted as a management for giant papillary conjunctivitis (GPC), much of the manufacturers' advertising has centred around protein up-take and GPC. In addition to the claims set out in Table 2, B & L's promotional material presents research claiming that their low water content non-ionic material takes up 100 times less protein than their competitor's ionic lens. They state that such protein deposits cause discomfort, a decrease in visual acuity and, possibly, inflammatory conditions, thus implying that their lens is a better choice due to reduced protein deposits.

Others have also praised virtues in lens design. Ghormley[3] suggested three advantages of the B & L lens material: stable vision, decreased dryness and decreased lens deposits, which is important for GPC patients.

These claims of lens superiority led us to question whether, in a large group of patients, consistent patient preference differences existed between lens types, in particular, whether:

1. the small Dk/L differences between lenses affect patient assessment of performance,
2. edge defects are relevant to patient comfort,
3. claims of superior handling qualities are justified,
3. the type of lens material is relevant for the GPC patient.

	Acuvue[a]	Calendar[b]	Medalist[c]
water content	58%	74%	38.6%
Dk ($x10^{-11}cm^2mlO_2$/ sec ml mm Hg)	18[d]	43	9[d]
centre thickness at -3.00 (cm)	0.07	0.14	0.035
Dk/L ($10^{-9}cm^2mlO_2$/ sec ml mm Hg)	26	31	26
diameter (mm)	14.0	14.4	14.0
material	ionic	non-ionic	non-ionic
manufacture	moulded	moulded	spun/lathe

Table 1. Lens design comparison.
Source:
a Johnson & Johnson Acuvue promotional literature
b Barnes-Hind Calendar promotional literature
c Bausch & Lomb Medalist promotional literature
d Weissman BA, Schwartz SD, Gottschalk-Katsev N, Lee DA. Oxygen permeability of diposable soft contact lenses, *Am J Ophthalmology* 1990; 110: 269-273

	Acuvue	Calendar	Medalist
Oxygen transmissibility	high Dk/L, physiology good (implies better for EW)	high water content high Dk (implies better for EW)	high Dk/L (implies better for EW)
Comfort	thin lens better comfort	surface and edge quality, better comfort	surface and edge profile, better comfort
Vision	moulding process good optics	moulding process improved visual acuity	spun-cast lens crisp optics
Handling		thicker is easier	more rigid material, spun-cast better
GPC management	2 week exchange (implies better for GPC)	non-ionic material reduced deposits (implies better for GPC)	low water content non-ionic material (implies better for GPC)

Table 2. Manufacturers' claims of benefits for their disposable lens product.

We attempt to address these issues and to determine which of the patient factors reliably predict preference for a particular lens.

METHOD

We approached the entire population of successful Acuvue wearers from an Adelaide suburban private practice: 82 agreed to participate, 21 declined and four were lost to follow-up. Ages varied from 15 to 70 years (mean 35 years). All were wearing the 8.80 base curve lens and disposing of it fortnightly. Of the 25 male and 57 female patients, 38 wore the lenses on a daily wear basis and 44 on an extended wear basis. A variety of lens care systems were used. Lens powers varied from -8.00 Dioptres (D) to +6.00 D (mean -2.90 D), with 70 myopes and 12 hypermetropes. Ten patients had a history of keratitis and 17 had a history of GPC. We randomly assigned the patients either the B-H Calendar (N = 42) or the B & L Medalist (N = 40) lens to trial for a period of one month.

At the end of the month, we asked these patients to fill out a questionnaire comparing the different lenses. Seven criteria were selected for patient comparison, namely, comfort, quality of vision, stability of vision, handling, eye redness, eye dryness and overall preference. Comparison was made on an analog scale, where zero to four represent a relative inferiority of the trialed lens, five represents equality of the two lenses and six to 10 represent a relative superiority of the trial lens to the J & J Acuvue lens.

We also recorded data on nine different patient factors: sex, age, wearing pattern, mean corneal power, corneal cylinder, GPC history, monovision, lens power and a history of keratitis. Keratitis was defined to include red eye reactions, solution toxicities, sterile ulcers, bacterial ulcers, superior epithelial arcuate lesions and similar conditions. The results of the comparisons for the seven criteria were subjected to multivariant analysis of variance, taking into account the nine variables and all their possible combinations.

RESULTS

Non-significant factors

Six of the nine patient factors were found to be not statistically significant in providing predictive information about the relative merits of different lenses. These variables were sex, age, mean corneal power, corneal cylinder, GPC history and monovision. Lens power was not significant for the hypermetropic population, which may be due in part to the small numbers involved (N = 12). Similarly, none of the three lenses provided a statistically significant advantage for three of the seven clinical performance criteria. These were stability of vision, eye redness and eye dryness.

Significant factors

COMFORT

There was a considerable spread of responses. The Calendar lens rated superior in comfort to the Acuvue at low minus powers, but the Acuvue lens was preferred ($p = 0.007$) for powers above -2.50 D (Figure 1). The Medalist lens was preferred by eight patients, the Acuvue by 20, but this was not statistically significant ($p = 0.07$) (12 patients found the lenses equivalent).

HANDLING

Both groups found the Acuvue lens inferior for handling, validating the manufacturers' claims. Calendar was superior over the full range of minus powers, with the difference being greatest at lower powers ($p = 0.005$) (Figure 2). The difference was also greater for daily wear rather than extended wear ($p = 0.009$) (Figure 3). Medalist was also superior over the full range of minus powers, but the difference was greater at higher powers ($p = 0.01$) (Figure 4).

QUALITY OF VISION

The result of quality of vision comparison is shown in Figure 5. Despite a spread of responses, most patients found the Calendar lens to be superior to the Acuvue lens ($p = 0.03$). Similarly, the Acuvue lens was superior to the Medalist lens ($p = 0.03$).

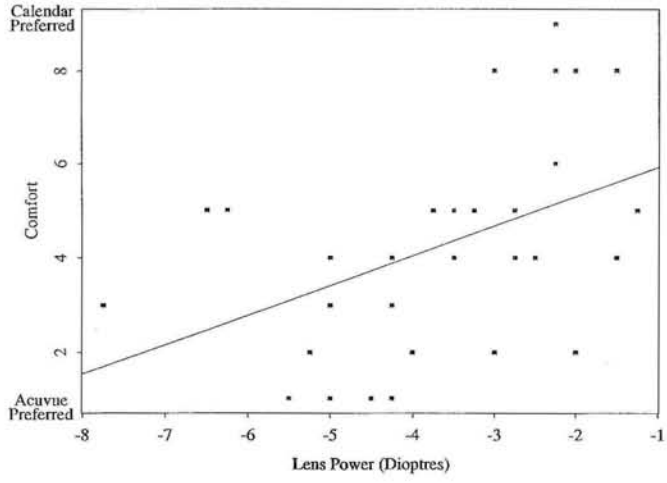

Figure 1. Patient preference for comfort in the Calendar versus Acuvue group varies with lens power (D). The regression line shows the lenses are equivalent for comfort at -2.50 D, the Calendar lens is preferred at powers less than -2.50 D and the Acuvue is preferred for powers greater than -2.50 D.

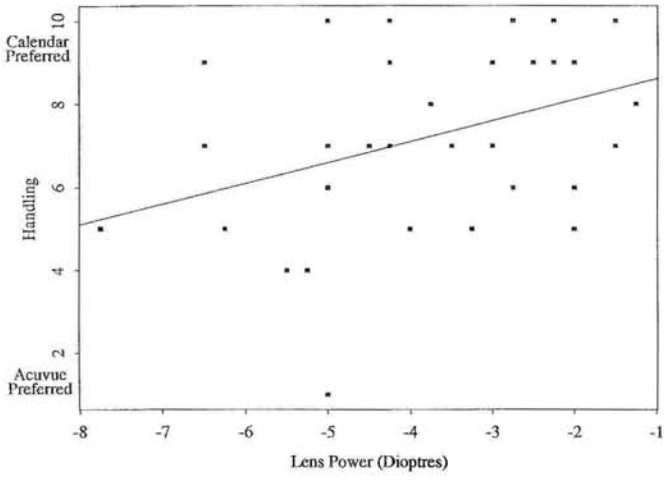

Figure 2. Patient preference for handling in the Calendar versus Acuvue group varies with lens power (D). The Calendar lens is superior to the Acuvue for handling over the whole range of minus powers but particularly for lower powers.

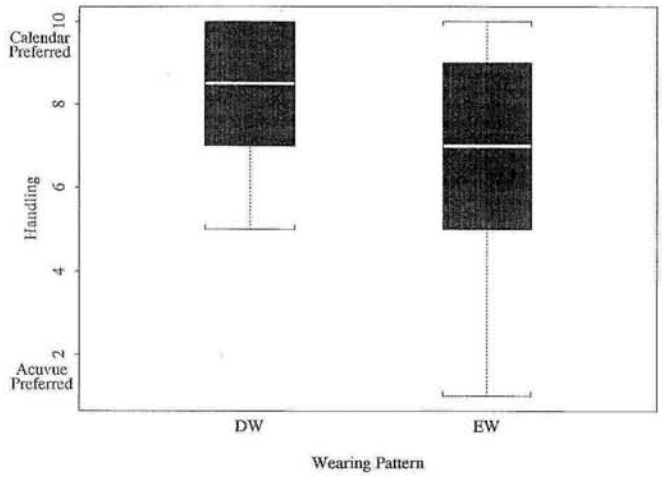

Figure 3. Patient preference for handling in the Calendar group varies with mode of wear. The shaded block represents the interquartile range which contains the middle half of the ranked data. The white line represents the median and 1.5 times the interquartile range is depicted by the dotted line. Handling superiority for the Calendar lens was more marked in the daily wear (DW) group.

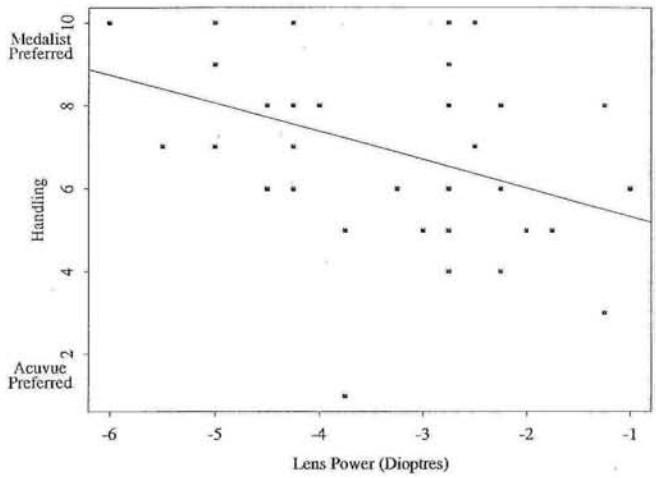

Figure 4. Patient preference for handling in the Medalist group varies with lens power (D). The Medalist lens is superior to the Acuvue for handling for all powers but particularly at higher powers.

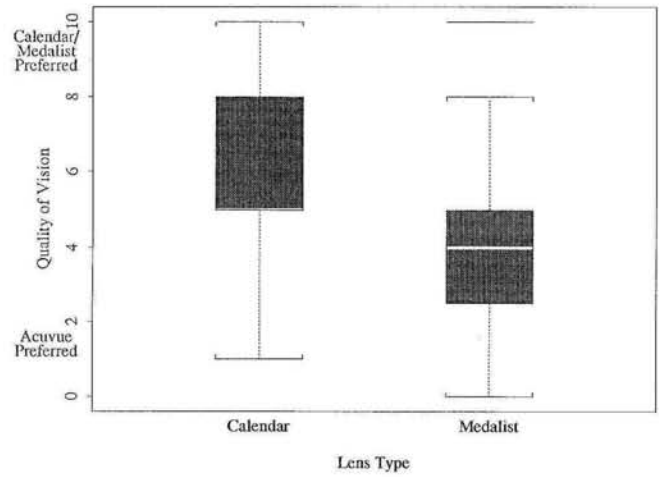

Figure 5. Quality of vision comparison for Calendar to Acuvue and Medalist to Acuvue. The shaded block represents the interquartile range which contains the middle half of the ranked data. The white line represents the median and 1.5 times the interquartile range is depicted by the dotted line. Although there is a spread of responses, the Calendar group reports vision superior to Acuvue, but the Medalist group reports vision inferior to Acuvue.

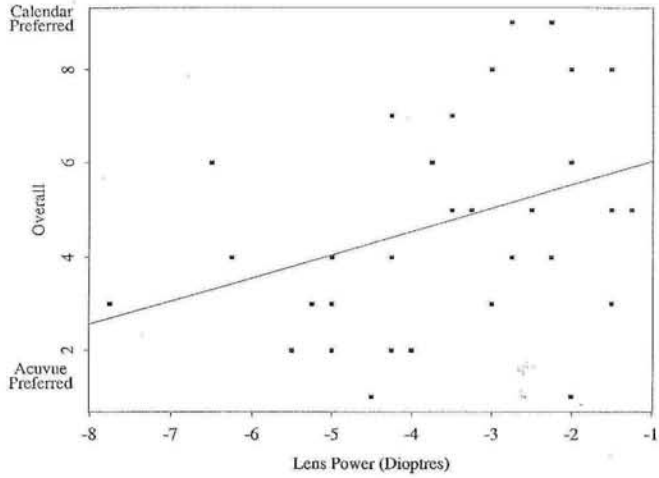

Figure 6. Overall preference varies with lens power (Dioptres) for the Calendar versus Acuvue group. The regression line shows that overall preference is equal at -3.00 D. At powers of less than -3.00 D Calendar was preferred, but at higher powers Acuvue was preferred.

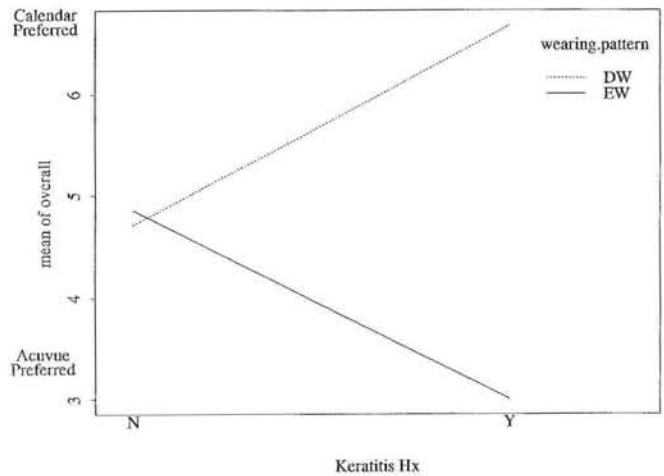

Figure 7. In the Calendar versus Acuvue group, a negative history of keratitis has no influence on overall preference. However, those patients with a history of keratitis who were on daily wear (DW) preferred Calendar, but those patients who were on extended wear (EW) preferred Acuvue.

OVERALL PREFERENCE

The assessment of overall preference for the Acuvue patients who trialed the Calendar lens showed that Calendar was preferred at low minus lens powers (Figure 6). However, the balance shifted to Acuvue as powers rose above -3.00 D ($p = 0.02$).

The Medalist lens was preferred by nine patients, the Acuvue by 26, but this was not statistically significant ($p = 0.07$) (five patients found the lenses equivalent).

OVERALL PREFERENCE WITH A HISTORY OF KERATITIS

This was significant only in the Calendar versus Acuvue group. Those patients with a history of keratitis who follow a daily wear regime preferred the Calendar lens, while those on an extended wear routine preferred the Acuvue lens ($p = 0.04$) (Figure 7).

DISCUSSION

Non-significant factors

KERATOMETRY

The patient-related factors that were not significant for lens preference were surprising. Patient comfort, stability of vision and overall preference were not dependent on corneal power or corneal cylinder. All patients were previously wearing the Acuvue lens, which in every case fitted well. Hence, if the 8.80 Acuvue lens fits, keratometry provides no predictive information about whether another lens will or will not fit. However, this does not allow for those patients for whom the 8.80 Acuvue lens does not fit adequately, and who may be better served by another lens. Unfortunately, our study does not address this issue.

GIANT PAPILLARY CONJUNCTIVITIS

For the 17 patients with a history of GPC, there was no statistically significant preference for any lens. This was interesting because disposable lenses are becoming the first choice for GPC patient management and all manufacturers are keen to promote their lenses as superior in this regard. All the data on the high protein uptake of the ionic Acuvue lens appear irrelevant in the clinical setting, provided lenses are disposed of every fortnight.[4,5] The non-ionic lenses provide no advantage for the management of GPC. However, all of these patients were able to wear the Acuvue lens. It is possible that some GPC patients are unable to be rehabilitated with the Acuvue lens. Our private practice has had two such patients in the last four years. Both were trialed with non-ionic lenses as well and these were equally unsuccessful. Although this is a small sample, it appears that no lens type has an advantage for the management of GPC. It is notable that a number of subjects did not like Calendar because they felt the thicker lens irritated the upper lid. However, one GPC patient preferred Calendar to the extent that she switched from Acuvue to Calendar. Many subjects expressed concern about using the same lens for one month. We can only conclude that GPC is a very individual problem.

SEX, AGE, MONOVISION AND DRYNESS

Sex, age and monovision were not significant predictors of success for any of the seven criteria. Either our monovision patient base was too small ($N = 13$) or there is genuinely no advantage for any lens for this patient group. We were surprised that age was not significant as we felt dryness or comfort differences might have shown a statistical trend. The fact that dryness was not significant was also surprising as it contradicted the findings of Burnett Hodd[6] who found Acuvue gave less dryness than B & L's Seequence lens, which has a design similar to that of the Medalist. However, our findings confirm those of Ruston and Burnett Hodd,[7] who found no difference between Acuvue and Calendar lenses for dryness. We were surprised that Calendar was not found to be better for dryness because of its increased thickness, a well-established problem-solver for dryness. Possibly the increase in water content and porosity counters any advantage of thickness.

STABILITY OF VISION AND EYE REDNESS

Stability of vision and eye redness were the other two criteria for which no lens was shown to have an advantage. Therefore, if a patient is wearing the Acuvue lens, but the aim is to reduce their eye redness or improve the stability of vision, neither of the other lenses can be predicted to perform better. Ridder and Tomlinson[8] also found no statistically significant difference in stability of vision for several types of disposable contact lenses.

WEARING MODE

We found no patient preference for any lens of the extended wear group, except in the presence of a history of keratitis. This indicates that whatever the differences in Dk/L between these lenses, they are not perceptible to the EW patient. This does not include minor differences in slit-lamp findings, which were not assessed as part of this study. The subjective irrelevance of Dk/L differences supports the findings of Mishima, Fujisaki and Williams,[9] who found no difference in overnight corneal swelling between the Ciba Newvue disposable lens and the Acuvue lens.

Significant factors

COMFORT

The importance of lens edge defects has been controversial in recent years. If lens edge defects are clinically significant, it is reasonable to assume that comfort should be poorer with the defective lenses. A higher incidence of lens edge defects is well-established in Acuvue lenses compared to B & L lenses.[1,6,10,11] However, Medalist and Acuvue did not differ significantly for comfort in this study, although we did not examine the lenses for the presence of defects. Our findings also compare favourably with the findings of previous authors who found the J & J lenses to be equal or superior for comfort or overall preference.[5-7,12,13]

The results for the Calendar group were a little more complicated (Figure 1). The preference for the Acuvue lens at powers of greater than -2.50 D probably relates to the increased thickness of the Calendar lens being unacceptable for an eye accustomed to an Acuvue lens. The preference for Calendar at lower powers may also relate to thickness, with the thicker Calendar lens holding its shape better on the eye, or to edge or surface quality. Interestingly, Ruston and Burnett Hodd[7] in 1993 found that Acuvue's thicker stable-mate, Surevue, was more comfortable than Calendar.

HANDLING

Calendar's superiority for handling (Figure 2) probably relates to its greater lens thickness and confirms the findings of Ruston and Burnett Hodd[7] who found Calendar to be better than Acuvue's thicker stable-mate, Surevue. The Acuvue lens is half the thickness of the Calendar lens and its mid-peripheral thickness is particularly thin for low powers. An important component of lens handling is the degree to which the lens holds its form and the ease of determining whether it is inside out. Figures 8a and 8b show an Acuvue lens placed both correctly and inside out, demonstrating the difficulty in determining the difference. Figures 9a and 9b show a Calendar lens of the same power which demonstrates that it is much easier to assess. This disparity at lower powers may be made worse by the presence of recent onset myopes, who may not have developed the same contact lens manipulative skills as myopes of greater degree. The daily-wear group may have found handling to be more important, simply because they handle their lenses more often (Figure 3).

The Medalist lens provides better handling than the Acuvue, due to its tint, its more rigid 38 per cent water content material and the fact that it holds its shape well as a virtue of the spin casting process (Figure 4). Interestingly, many patients thought that the Medalist lens was thicker than the Acuvue.

Shape comparisons between the Acuvue and Medalist lenses (Figures 8a and 8b and 10a and 10b) demonstrate that the Medalist lens can be more easily identified as inside-out. The preference for Medalist lenses at higher powers probably relates to the lens tint. Unlike low myopes, high myopes have poor vision at a working distance for lens manipulation. Many commented that the tint helps with visibility.

QUALITY OF VISION

Our finding of superior subjective vision with the Acuvue lens over the B & L lens confirms the finding of many previous studies.[5,12,14,15] Interestingly, such results occur despite radiuscopic findings suggesting B & L lenses possess superior optics compared to the J & J lens.[16] The superior performance of the B-H lens compared with the J & J lens also confirms the finding of Ruston and Burnett Hodd[7] who found a similar subjective difference but could not establish a measurable difference in acuity. Contact lens quality of vision is principally due to two factors, namely, optical quality and lens fit. It is difficult to draw conclusions about the reasons for vision being superior with a particular lens, since lens fit, in particular, is influenced by so many factors, including lens thickness, edge thickness, edge profile, lens diameter, base curve and peripheral curve design. Hence, although the Medalist lens may have better radiuscopic optics than the Acuvue, other aspects of the lens design influence fitting in such a way that its on-eye performance is inferior. Similarly, the moulded Calendar lens is better visually than the moulded Acuvue lens, but we cannot confirm whether this is due to better optics or better fitting.

OVERALL PREFERENCE

In the Calendar trial group, close inspection of Figures 1, 2 and 6 reveals that overall preference is largely the sum of comfort and handling results. The preference for Acuvue with powers above -3.00 D chiefly reflects the findings of greater comfort and less difference in handling. The preference for Calendar for powers below -3.00 is probably mostly due to handling, with comfort and quality of vision also important.

Overall preference for the Acuvue wearers who trialled medalist did not provide a statistically significant result. The population distributions for comfort and overall preference are very similar which implies that comfort is the most important determinant of overall preference. However, superior vision would also have worked in favour of Acuvue and superior handling would have worked in favour of Medalist.

OVERALL PREFERENCE WITH A HISTORY OF KERATITIS

Patient comments suggest that the difference in overall preference for patients with a history of keratitis may be an arte-

Figure 8a. Acuvue lens of power -1.00 D. Correct orientation.

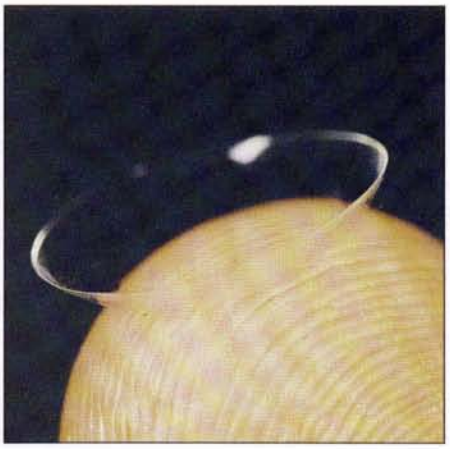

Figure 8b. Acuvue lens of power -1.00 D. Inside out. This difference is difficult to assess.

Figure 9a. Calendar lens of power -1.00 D. Correct orientation.

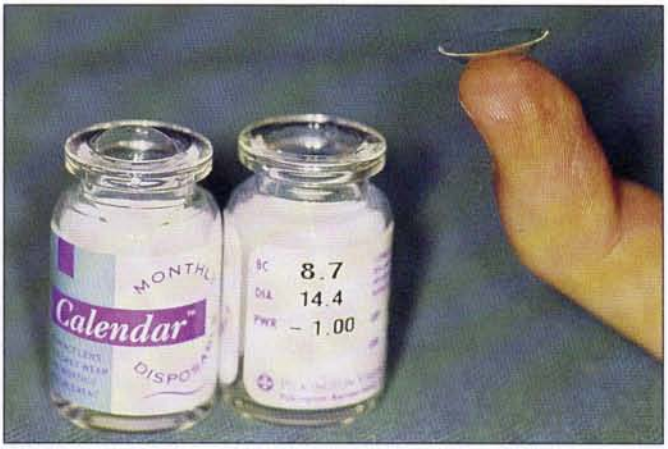

Figure 9b. Calendar lens of power -1.00 D. Inside out. This difference is much more obvious than with the Acuvue lens.

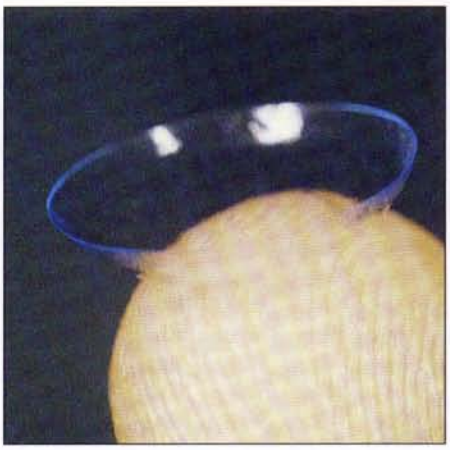

Figure 10a. Medalist lens of power -1.00D. Correct orientation.

Figure 10b. Medalist lens of power -1.00D. Inside out. This difference is much more obvious than with the Acuvue lens. The lens is tinted which would also help handling.

Criterion	Finding	Predicting factor
Comfort	Acuvue better than Calendar	• Lens power -2.50 to -9.00
	Calendar better than Acuvue	• Lens power plano to -2.50
	Acuvue equal to Medalist	
Handling	Medalist better than Acuvue	• Especially for high myopia
	Calendar better than Acuvue	• Especially for low myopia
		• Especially for daily wear
Quality of vision	Calendar better than Acuvue	
	Acuvue better than Medalist	
Overall	Acuvue equal to Medalist	
	Acuvue better than Calendar	• Lens power -3.00 to -9.00
		• Extended wear and a history of keratitis
	Calendar better than Acuvue	• Lens power plano to -3.00
		• Daily wear and a history of keratitis

Table 3. Summary of findings of patient preference.

fact of patient education or low patient numbers. Those with a history of keratitis who were on EW (N = 2) preferred a fortnightly rather than a monthly regime, as they accepted that EW represents an increased risk of occurrence or recurrence of complications and they have been taught that fortnightly replacement is a healthy and important step in preventing such recurrence. However, those patients with a history of keratitis, who are mostly low myopes on DW (N = 6), preferred the Calendar lens for other reasons, such as handling (see Figure 7).

CONCLUSION

Patient lens preference seems to be based chiefly on comfort and handling, with differences in quality of vision also being perceptible. Knowledge of a patient's lens power is of the greatest benefit when selecting a lens but mode of wear and a history of keratitis are also of predictive value. Patient comparisons of these lenses support only some of manufacturers' claims for their products.

Finding the preferred disposable lens for each patient can be achieved by following a few simple rules, summarised in Table 3. The great variations between individual patients ensure that any guidelines which arise from this or any other contact lens study may not be applicable to any specific patient. Therefore, echoing the sentiments of Ruston and Burnett Hodd[7] in 1992, we recommend that more than one disposable lens system be used clinically to maximise fitting success.

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REFERENCES

1. Efron N, Veys J. Defects in disposable lenses can compromise ocular integrity. *ICLC* 1992; 19: 8-18.
2. Cohen LD. Reducing risk factors in dispensing disposables. *Contact Lens Spectrum* 1992; 7: 27.
3. Ghormley NR. Seequence 2 and Medalist—a new planned replacement system. *ICLC* 1992; 19: 53-54.
4. Lin ST, Mandell RB, Leahy CD, Newell JO. Protein accumulation on disposable extended wear lenses. *CLAO J* 1991; 17: 44-50.
5. Jones L, Horne A, Franklin V, Tighe B. The comparative surface spoilation and clinical performance of two disposable lens systems. *Optom Vis Sci* 1992; 69 (Supp): 23.
6. Burnett Hodd NF. Clinical and practical aspects of planned replacement systems. *Trans BCLA* 1989; 46: 12.
7. Ruston DF, Burnett Hodd NF. A clinical comparison of 2 daily wear monthly disposable contact lens systems. *Optom Today* 1993; 33: 15-19.
8. Ridder WH III, Tomlinson A. Blink-induced temporal variations in contrast sensitivity. *ICLC* 1991; 18: 231-237.
9. Mushima TD, Fujisaki JC, Williams MA. Overnight corneal swelling responses: a comparison of Newvues and Acuvue plus. *Contact Lens Spectrum* 1992; 7: 41-43.
10. Lowther GE. Evaluation of disposable lens edges. *Contact Lens Spectrum* 1991; 6: 41-43.
11. Wodis M, Hodur N, Jurkus J. Disposable lens safety: the reproducibility factor. *ICLC* 1990; 17: 96-101.
12. Guillon M, Guillon JP, Shah D. Visual performance stability of disposable contact lenses. *ICLC* 1993; 20: 7-17.
13. Quinn G. Clinical experience of two disposable lenses for daily wear. *Optician* 1991; 202(5308): 22-28.
14. Guillon M, Shoek SE. Soft contact lens visual performance. A multicentre study. *Optom Vis Sci* 1991; 68: 96-103.
15. Watanabe RK, Ridder WH, Tomlinson A. Visual performance of three disposable soft contact lenses. *ICLC* 1993; 20: 106-112.
16. Burnett Hodd NF. Disposables in routine practice. *J BCLA* 1991; 14: 45-48.

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