The Effect of Hydrogen Peroxide Neutralisation on the Fitting Characteristic of Group IV Disposable Contact Lenses.

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Abstract

Twenty subjects took part in a single-masked, randomised, cross-over study to investigate the fitting characteristic and comfort encountered after disinfecting ionic disposable contact lenses with a two-step hydrogen peroxide (H_2O_2) disinfection system, whilst using both overnight disinfection and overnight neutralisation. Lenses inserted after 20 minutes neutralisation resulted in a statiscally significant reduction in comfort on insertion compard with overnight neutralisation ($p=0.0005$). After 10 minutes there was no difference in comfort between the two groups. There was a wide scatter in the comfort scores for the 20 minute neutralisation droup, indicating significant inter-subject variation, with ~70% (±20%) of subjects grading comfort as ~7/10 or better.Lenses neutralised for 20 minutes were generally immobile on insertion, requiring almost 10 minutes to commence movement. After 60 minutes there was no difference in movement between the two neutralisation systems. The study indicates that if H_2O_2 is to be used to disinfect group IV lenses then a small percentage of subjects may complain of lens discomfort on insertion if the lenses are only neutralised for 20 minutes. The results also show that such lenses show an acceptable clinical fit within 60 minutes of insertion, whichever neutralisation method is utilised.

Key Words: Hydrogen peroxide, desinfection, neutralisation, Acuvue, disposable contact lens.

Introduction

As soon as a contact lens is placed on the eye it becomes contaminated with a biofilm consisting of both tear contaminants and bacteria. On removal, contact lenses must be both cleaned and disinfected in order to minimise the risk of infective conditions such as microbial keratitis. In an attempt to reduce the complications and incovenience associated with soft contact lenses, increasing numbers of practitioners are using planned replacement and disposable lenses. Where used on a daily-wear basis such lenses require a suitable care regimen. In many countries simplistic systems such as «Optifree» and «ReNu» are used for the routine maintenance of daily wear disposables. These products are corruntly not available in the UK due to licensing complications, which has led to many practitioners recommending the use of one-step chlorine release systems. A number of recent publications have questioned the use of chlorine systems, questioning their efficacy, particulary in the presence of residual cleaner or organic material. These publications, in combination with two papers describing cases of corneal ulceration in subjects using daily-wear disposable lenses with a chlorine-system as the method of disinfection, has resulted in practitioners considering alternatives to chlorine for the desinfection of disposable lenses. One of the most effective methods of disinfecting soft contact lenses is via the use of disinfectants based on 3% hydrogen peroxide. Although the causative factors of ocular infections in contact lens wearers are not clearly understood, they have been closely linked to exposure to contaminated lenses, lens cases and solutions. Using this assumption, the efficient kill-rate of peroxide-based systems should provide subjects with a potencially larger margin of error and increased safety in cases of poor compliance, which has been variously estimated as being between 40% and 74% of all contact lens subjects. However, the use of peroxide-based systems with soft lenses, particularly Group IV materials, has been noted to result in parameter changes, which could be expected to affect the fit of such lenses following disinfection and subsequent neutralisation. The purpose of this study was to examine the in-vivo parameter changes associated with differing disinfection and neutralisation times. The hydrogen peroxide system chosen was Allergan «Oxysept», which has the most rapid neutralisation phase of all currently available peroxide systems in the UK.

Materials and Methods

Twenty myopic subjects took part in th study, all of whom wore Acuvue disposable lenses on a daily-wear basis with Alcon «Pliagel» and «Softab» (a free-chlorine based disinfectant) as their normal system of cleaning and disinfection. None of the subjects had used hydrogen peroxide disinfection systems with Group IV materials or hydrogen peroxide based solutions for a period of one year prior to the study. The subjects details are outlined in (Table 1).

	Mean	SD	MIN	MAX
AGE	29.70	7.66	19.50	45.00
MEAN R BVP	-2.78	0.91	-1.25	-4.50
MEAN L BVP	-2.76	0.89	-1.25	-4.50
MONTHS OF ACUVUE WEAR	19.10	8.64	3	31
R Horiz K (mm)	7.81	0.29	7.30	8.20
R Vert K (mm)	7.75	0.32	7.10	8.20
L Horiz K (mm)	7.82	0.31	7.20	8.25
L Vert K (mm)	7.72	0.31	7.10	8.10

The subjects were issued with Allergan «Oxysept». This utilises 3% hydrogen peroxide as a disinfecting agent, which is subsequently neutralised by a unit-dose catalase neutraliser before lens insertion takes place. The subjects were instructed to rub the lens for 5 seconds following lens removal with a small amount of the disinfecting agent («Oxisept 1») and then carry out one of the following two regimens:

A). The lenses were placed in «Oxysept 1» overnight (for a minimum of 6 hours) and then neutralised with «Oxysept 2» in the morning for exactly 20 minutes.

B). The lenses were placed in «Oxysept 1» for exactly 20 minutes and then neutralised with «Oxysept 2» overnigt (for a minimum of 6 hours).

Each subject attended for two visits, one whilst using overnight peroxide disinfection and once whilst using overnigt neutralisation. The appointments were organised such that the solution regimen being used by the subject at the time of the consultation was unknown to the observer taking the measurements. The appointments were organised such that the numbers of subjects using each system at their first appointment was equal and randomised. Each subject began wearing a new pair of Acuvue lenses on the day before attending for each of the two appointments, ie the lens was taken from the blister pack the previous day, inserted in the subjects' eye and then disinfected with Oxysept that evening. On the morning of the appointment the subjects attended the practice not wearing lenses, 30 minutes before their allotted appointment time. Those subjects who had been assigned to overnight peroxide were then instructed to neutralise their lenses for exactly 20 minutes. The subjects then inserted their lenses (without any saline rinsing) and recorded the lens comfort. After an interval of one minute (to allow the lenses to settle) the lens fit was assessed and recorded. This was then repeated at intervals of 10, 20, 30 and 60 minutes. Comfort was graded by the subjects on a 10 point scale, where «1» represented «unwearable» and «10» an «inability to feel the lens». Primary gaze movement was recorded utilising an eye-piece graticule. Lens tightness was assessed by using a vertical push-up test, where 100% represented no movement and 0% represented a lens which decentred off the cornea without lid tension. Lens centration was recorded in mm via a «grid system», where superior and nasal positions were recorded as positive values and inferior and temporal decentrations negative values.

Data Analysis

Summary statistics were calculated for all variables. Eyes were not considered to be independent for comfort ratings and so the mean value of the two eyes were calculated. The comfort scores, being interval measurements, were considered to be non-normal data. All other data was tested for normality of distribution. Wilcoxon signed rank test was used to compare sets of nonparametric data Students paired t-Test was used for normally distributed data. Percentages are given with their 95% confidence intervals.

A «p» value of < 0.05 was taken as being statistically significant.

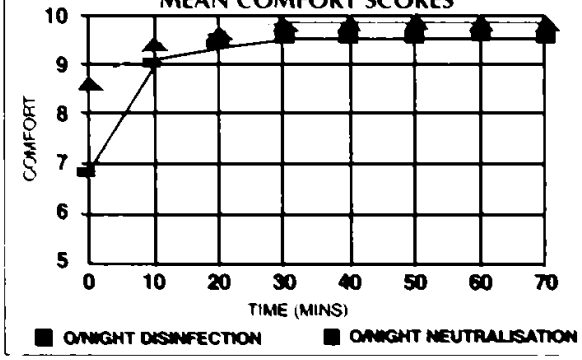
Results

Comfort

The mean comfort scores are given in (figure 1) and (Table2).

The results show that there is a mean reduction in comfort on initial insertion with lenses neutralised for only 20 minutes. The difference between

FIGURE 1
MEAN COMFORT SCORES



TIME			
1 MIN	6.80 ± 2.29	8.75 ± 0.89	P = 0.0005
10 MIN	9.00 ± 1.14	9.45±.63	P = 0.05
20 MIN	9.33 ± 0.98	9.90 ± 0.20	P = 0.004
30 MIN	9.50 ± 0.76	9.88 ± 0.22	P = 0.04
60 MIN	9.53 ± 0.75	9.95 ± 0.22	P = 0.01

:he two neutralisation systems rapidly diminishes. Whilst the difference continues to be statistically significant throughout the hour's wearing time, it s unlikely that this difference is clinically significant, with a maximun difference in comfort score ıfter the first 10 minutes of only half a grade. The reduced comfort would appear to be significantly subject dependent, with a greater standard deviation found after overnight peroxide disinfection. Seventy percent (+- 20%) of subjects using 20 minuts neutralisation had a comfort score of >- 7 on nitial insertion, whilst 20% (+- 18%) of patients ıad comfort scores of <-4.

Vertical Centration

These results are presented in(Table 3). The lenses tended to centre slightly superiorly (approximately 0.05 mm), but all lenses provided full corneal coverage at all times. There was no statistically significant difference found with either system, or between each eye, over the period of the trial.

Horizontal Centration

The results are given in (Table 4). The lenses tended to centre very well. The left lens had a tendency to sit more nasally at the end of the wearing period in those lenses neutralised for only 20 mins (p=0.01). However, with a difference of approximately 0.12 mm after 60 minutes of wear, this finding is not thought to be clinically significant.

TIME	OVERNIGHT PEROXIDE		OVERNIGHT NEUTRALISATION	
	RE	LE	RE	LE
1 MIN	0.03±0.08	O.O3±0.10	0.02±0.36	0.008±0.36
10 MIN	0.03±0.10	0.06±0.15	0.12±0.23	0.11±0.30
20 MIN	0.02±0.19	0.04±0.16	0.06±0.23	0.08±0.34
30 MIN	-0.03±0.13	0.01±0.12	0.04±0.33	0.06±0.33
60 MIN	0.09±0.15	0.12±0.18	0.09±0.29	0.08±0.30

TIME	OVERNIGHT PEROXIDE		OVERNIGHT NEUTRALISATION	
	RE	LE	RE	LE
1 MIN	0.06+-0.24	0.14+-0.20	-0.04+-0.27	0.06+-0.31
10 MIN	0.15+-0.20	0.11+-0.24	0.02+-0.30	0.06+-0.36
20 MIN	0.07+-0.31	0.04+-0.37	0.00+-0.34	0.03+-0.39
30 MIN	0.00+-0.31	0.14+-0.29	-0.01+-0.25	0.06+-0.35
60 MIN	0.00+-0.32	0.12+-0.36	0.02+-0.31	0.03±0.35

Vertical Movement

Initial paired t-Testing indicated no difference in movemenet between R and L eyes and so analysis of mean vertical movement was undertaken. The results are presented in (Figure 2) and (Table 5). There was a significant difference in lens movement on initial insertion with either system. It took approximately 10 minutes for a lens to show any movement if only neutralised for 20 mins. After 60 minutes there was no significant difference in movement.

Percentage Tightness

As with movement, mean data for each point in time was taken.The results are given in (Figure 3) and (Table 6). These results support those found with lens movement.

Discussion

The standard deviations of the comfort scores indicate that certain subjects are likely to experience marked discomfort after inserting lenses which have been neutralised for only 20 minutes, but these differences become clinically insignifi-

FIGURE 2

MEAN VERTICAL MOVEMENT

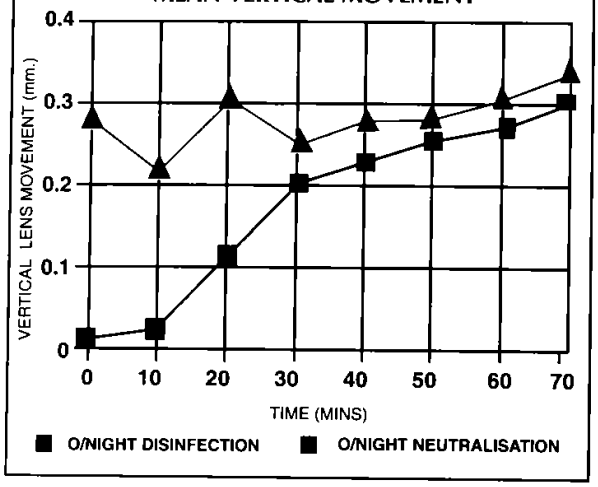


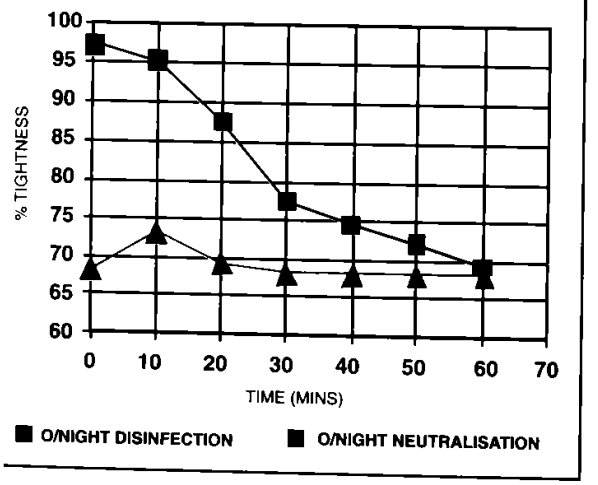
Table 5

Mean Vertical Movement (mm)

TIME	OVERNIGHT PEROXIDE	OVERRNIGHT NEUTRALISATION	STUDENTS t-TEST
1 MIN	0.004±0.01	0.27±0.21	P = 0.0000
10 MIN	0.01±0.02	0.21±0.14	P = 0.0000
20 MIN	0.11±0.10	0.30±0.18	P = 0.0005
30 MIN	0.20±0.12	0.27±0.13	P = 0.0077
60 MIN	0.29±0.14	0.31±0.09	P = NS

FIGURE 3

MEAN % TIGHTNESS



TIME	OVERNIGHT PEROXIDE	OVERNIGHT NEUTRALISATION	STUDENTS t-TEST
1 MIN	99.00±2.00	68.00±15.00	P = 0.0000
10 MIN	97.00±3.00	73.00±8.00	P = 0.0000
20 MIN	87.00±7.00	69.00±8.00	P = 0.0000
30 MIN	76.00±10.00	68.00±4.00	P = 0.0013
60 MIN	69.00±6.00	67.00±3.00	P = NS

cant after 10 minutes. The reason for this discomfort is unlikely to be due to residual peroxide remaining attached to the lenses. Gyulai et al have shown that the catalase neutralisation system employed in the «Oxysept» system is the most effective of all the forms of neutralisation currently available, resulting in the carry-over of <1 ppm hydrogen peroxide after 10 minutes neutralisation. It has been estimated that ocular tissues are able to withstand between 100ppm and approximately 250ppm, with no adverse effects on corneal funtion. Of potentially greater significance is the pH of the final solution, which has been postulated in several studies to bee the cause of the likely discomfort following insertion of soft lenses after hydrogen peroxide disinfection. Human tear pH is a highly individualized function, showing both inter- and intra-subject variability, but with an average value of 7.45. The objective of the neutralization phase is to both eliminate all traces of hydrogen peroxide and to return the contact lenses and soaking solution to the physiological pH of 7.45, although the threshold pH for ocular awarencess has been found to be between 6.6 to 7.8 pH units. Harris et al measured the pH «Oxysept 1» to be approximately 3.5, with a final pH after neutralisation of approximately 6.9. This pH will be on the slightly acidic side for some subjects, and could explain why certain subjects experience discomfort upon initial insertion with lenses neutralised with such two-step peroxide solutions. If pH is involved in producing discomfort, then advising subjects who experience discomfort to utilise copious buffereed saline rinsing may alleviate the problem. However, further work is

necessary to determine whether pH is the causative factor, particularly with reference to localised differences in pH at the lens surface and within the lens matrix after different periods of neutralisation, in lenses of varying chemical composition, water content and water binding properties. The large intersubject difference found in this study has also been reported in other studies, indicating that tear film differences may be a causative factor. This also requires further investigation. The lens movement results indicate that lenses disinfected overnight took approximately 40 minutes to move as much as those which underwent overnight neutrali-sation, with the final movement found being consistent with that found in similar studies with Group IV disposable lenses. Whilst the initial difference in movement is marked between the two systems, the short period over which the difference is found would intuitively seem unlikely to have any clinical significance.

The likely reason for the differences in lens tightness is that of dehydration of the lens material following hydrogen peroxide desinfection. Disinfection of hydrogel lenses for long periods in hydrogen peroxide solutions has been shown to result in a marked steepening of the base-curve and decrease in diameter, both of which will tighten the lens fit, due to a reduction in water content. Several studies have indicated that hydrogel lenses, particularly Group IV materials, are prone to both dehydration and parameter changes, especially when disinfected with hydrogeen peroxide-based solutions. McCarey and Wilson found that Group IV materials experienced >20% reduction in water content when the pH of the surrounding medium was reduced from 7.40 to 5.00. The reason for this is that when the pH is lowered the sodium salt of the carboxylate group (the carboxylate anion) is converted to the much less dissociated carboxyl group, altering the water structuring and electrostatic forces present within the gel. This reduces the repulsive electrostatic charges and the number of water binding sites within the polymer network and causes the molecular structure to contract, resulting in a decrease of the physical volume of the material.

These findings have been verified in-vitro. McKenney found Group IV materials experienced a 1-2mm reduction in diameter and 0.3-0.5mm steepending in base curve after an extended soaking in hydrogen peroxide, which took approximately 60 minutes to recover to initial values, a similar result to that found by Janoff. Harris et al indicated a dramatic difference in dehydration and end-point water content of Acuvue lenses when overnight neutralisation was compared with overnight peroxide. They measured a 19% dehydration following six-hours of pereoxide, compared with a 2% increase in water content if soaked for only 20 minutes. After neutralisation the end-point dehydrations were 6% and 3% for «overnight peroxide» and «overnight neutralisation» respectively, a statistically significant difference. Such results could be expected to reproduce differences in lens movement when the lenses were inserted into the eye. Such differences have been observed by McKenny, who noted that Group IV lenses neutralised for only short periods were immobile on lens insertion for a period of 40-60 minutes, a finding corroborated by our study. The «edgee-fluting» of lenses alluded to by McKenney was also noted by all the subjects in this study following overnight peroxide soaking, although no «fluting» was seen in those lenses neutralised for longer periods. The final question to consider is whether subjects be encouraged to utilise overnight peroxide or overnight neutralisation with Group IV lenses. Penley et al suggest that a minimal soaking time of 45 minutes is necessary to guarantee elimination of certain species of fungi. Long soaking times are similarly necessary to eliminate Acanthamoeba. Subject compliance with a 45 minute soaking procedure followed by overnight neutralisation is likely to be low, with subjects possibly tempted to «cut corners» and disinfect for significantly less time before neutralisation. In view of these factors, overnight peroxide is the preferred form of disinfection.

Conclusions

In view of the increased efficacy and simplicity associated with the use of overnight disinfection with peroxide-based system, it is recommended that subjects who use such systems to desinfect group IV disposable lenses should disinfect their lenses in this way, with a minimum neutralisation time of 20-30 minutes in the morning.

Used this way, approximately 20% of subjects may experience stinging on lens insertion. Such subjects should be advised to either neutralise for a longer period in the morning, switch to overnight neutralisation or switch to a different care regimen. In subjects who neutralise for only a short time, no lens movement for at least 10 minutes should be expected, with normal lens movement resuming after 40-50 minutes.

The time dependent effectt of Hydrogen peroxide neutralisation on the fitting characteristics of Group IV disposable contact Lenses.