Malaysian Journal of Medicine and Health Sciences (ISSN 1675-8544); Vol 12 (2) June 2016

Original Article

Visual Status following Contact Lens Related Microbial Keratitis

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ABSTRACT

Introduction: A hospital based case control study was conducted in government hospitals on contact lens patients diagnosed with microbial keratitis. **Methods:** The objective of this study is to determine the visual outcomes of contact lens related microbial keratitis. The visual outcomes which comprised of visual acuity, keratometry readings, corneal topography findings and contrast sensitivity examinations was determined after three months from the first presentation at the hospitals. **Results:** The mean LogMAR visual acuity during presentation was 0.96 ± 0.73 or a Snellen equivalent 6/60 (n=76) and mean LogMAR visual acuity after three months was 0.10 ± 0.48 or a Snellen equivalent 6/7.5 (n=76) with a significant difference (t=11.22, df=78, p=0.001). Best fit curve for the cases had a regression coefficient, r=0.350 ± 0.063 (95% CI = 0.224, 0.447, df=78, p=0.001. The visual acuity in cases and controls was 0.10 ± 0.48 and -0.10 ± 0.14 respectively (t= -3.61, df=154 p=0.001) after three months which showed improvement. There was a reduction in the corneal uniformity index and corneal asphericity in the cases. The Corneal Uniformity Index (CU index) in cases was 63.03 ± 26.38 (n=76) and in controls, 80.13 ± 11.30 (n=77), (t= -5.22, df=151, p=0.001). There was also a reduction in the contrast sensitivity function at all spatial frequencies in the cases which was significantly different. **Conclusion:** Microbial keratitis reduced the vision, corneal uniformity index, asphericity and contrast sensitivity after three months in eyes of patients diagnosed with the condition.

Keywords: Contact lens, Visual status, Microbial keratitis

INTRODUCTION

A contact lens is a lens placed on the corneal surface for several reasons including for refractive errors, cosmetic or therapeutic reasons. In 2004, it was estimated that 125 million people (2%) used contact lenses worldwide, including 28 to 38 million in the United States (1). A more recent survey of contact lens wearers worldwide found the total contact lens wearers globally have been estimated at about 140 million (2). As high as two thirds of the wearers were female with overall average age of 31 years old (3).

Corneal contact lenses have been in the market for the past 50 years. In the beginning, contact lens was made of polymethyl methacrylate (PMMA). PMMA lenses gained popularity through the 1960s, as lens designs became more sophisticated with improving manufacturing technology. However, PMMA has the disadvantage of very low gas permeability, putting a limit to its usage. By the end of the 1970s, lenses made of oxygen permeable but rigid materials (polymers), referred to as rigid gas permeable lenses (RGP) were developed to overcome this problem. The hydrogel soft which further improved gas permeability was introduced in the 1960s and obtained Food and Drug Administration (FDA) approval in 1971 (4). In 1972, disposable contact lens was introduced, initially monthly disposable. Daily disposable soft contact lens appeared in the market in the middle of 1990s (5). In 1980, cosmetic contact lens use for extended wear was approved by the FDA allowing use of the lenses up to 30 days of continuous wear.

Microbial keratitis presents as infective corneal stromal infiltration with or without an overlying epithelial defect. In severe cases, it may be associated with visual loss due to corneal scarring and perforation. Contact lens wear was among the major risk factors for microbial keratitis (MK) in developed countries, which also included non-surgical corneal trauma (6, 7).

The most alarming rate for MK was observed during the era of extended wear using conventional soft lenses which had relatively low oxygen permeability. Corneal hypoxia had increased the risk for contact lens related microbial keratitis

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(CLRMK) and in 1989, extended wear lenses was shown to be a risk factor for CLRMK. The annual incidence of CLRMK was found to be 20.9 per 10,000 (8). The relative risk of CLRMK in extended wear was 4.21 (CI 2.35, 6.48) when compared to daily wear (9). Since then, efforts have been made to improve the contact lens material. In 1998, the first silicone hydrogels was launched into the market and subsequently approved by the FDA in 2001. Silicone hydrogel lenses enable extended wear for 30 continuous days. They allow as much as four times the amount of oxygen as conventional hydrogel contact lenses to pass through the lens even during sleep (10). Silicone hydrogel lenses combined the benefits of silicone which has extremely high oxygen permeability with the comfort and clinical performance of the conventional hydrogels which had been used for the previous 30 years. These lenses were initially advocated primarily for extended (overnight) wear although in more recent years, daily (no overnight) wear silicone hydrogels have been launched.

Compared to the RGP, the relative risk for CLRMK was 4.76 (95% CI 1.52, 14.87) in extended wear lenses and 3.51 (95% CI 1.6,7.66) in daily wear soft lenses (11). In Netherlands, the annual incidences for CLRMK were 3.5 per 10,000 soft lens users among daily wear and 20 per 10,000 among extended wear soft lens users (12). A study in Hong Kong found the incidence of CLRMK in daily wear and extended wear to be 3.1 per 10,000 and 9.3 per 10,000, respectively (13).

Not much different from the rest of the world, contact lens has also gained popularity in Malaysia especially recently.

Although there were various reports on microbial keratitis in Malaysia (14,15), very little data could be found on the visual outcome following successful treatment of microbial keratitis. Not many studies have been conducted in CLRMK in case-control design. This study highlights the limitations in patients' vision following recovery from CLRMK.

MATERIALS AND METHODS

A multicentre prospective case-control study involving several hospitals was performed. All patients who attended the ophthalmology clinic for treatment of CLRMK during the study period were included. The sampling population were patients who attended the ophthalmology clinic and the sampling frame was the list of patients who were treated with CLRMK. The sampling unit for cases were the patients with treatment of CLRMK. All patients attending the ophthalmology clinic who were contact lens users without microbial keratitis were included as controls. The controls were selected from a list of contact lens users without CLRMK attending the clinics. The sampling frame was assembled from a registry recording all contact lens users that attended the clinic during the study period. The sampling unit for controls was the contact lens user without microbial keratitis.

Upon presentation to the ophthalmological unit, the patients were attended to by the ophthalmologist. An interview with the patients was requested and once they agreed, an informed consent was obtained from the patients before enrolling them. Data was collected using validated questionnaires, medical records and clinical measurements. Thorough history was taken and complete examination was conducted. Bacteriological investigation based on the corneal scraping was performed before the commencement of treatment. All patients including cases and controls were interviewed by the researcher using a questionnaire which includes detailed demographic data (age, gender, ethnicity, income level, education level) lens type, lens usage schedule and lens hygiene.

The cases were interviewed during their first visit or reviewed within a few days. For cases that were admitted to the ward, they were interviewed there. The researcher contacted the controls and they were interviewed during the contact lens appointment clinics. Following discharge from the ward, the patients were reviewed as out-patients in the eye clinic. Visual acuity test, refraction and several tests including keratometry, contrast sensitivity and corneal topography were performed at three months visit following the onset of CLRMK. Visual acuity was measured using the LogMAR chart. Contrast sensitivity was performed using the Functional Acuity Contrast Test (FACT) chart. The corneal topography was performed using the Eye Sys Corneal Topography (EyeSys Vision, Houston Texas, USA). Parameters captured were corneal uniformity index (CU index), asphericity, and regular and irregular astigmatisms indices.

Inclusion criteria in cases were all patients aged between 18 to 60 years old with CLRMK. Inclusion criteria in controls were patients aged between 18 to 60 years old who wore contact lens without microbial keratitis. Exclusion criteria in cases were patients with a medical indication for contact lens wear who required bandage lens (dry eyes, bullous keratopathy, post corneal transplant, corneal laceration/trauma, corneal perforation, post cataract operation). The exclusion criteria in controls were patients with a medical indication for contact lens wear who required bandage lens or had a past history of microbial keratitis.

Data analysis

Data analysis was done using SPSS 16.0. Mean and standard deviation was determined for the demographics data for both cases and controls. Comparison of LogMAR visual acuity among cases at presentation and after 3 months follow-up was done. A regression analysis was done for vision at presentation and three months follow-up. Comparison of the visual outcomes in keratometry values, corneal topography values and contrast sensitivity values was done among the respondents at three months after presentation. Correlations was also done between LogMAR and both CU index and Contrast Sensitivity.

Table 1: Patients' demography.

	N (%)
Age (years)	
18-29	61 (64.9)
30-39	24 (25.5)
40-49	6 (6.4)
50-59	3 (3.2)
Gender	
Male	21 (22.34)
Female	73 (77.66)
Ethnicity	
Malay	70 (74.47)
Chinese	13(13.83)
Indian	6 (6.38)
Others	5 (5.32)
Education level	
Primary	4 (4.26)
Secondary	33 (35.11)
Diploma/Cert	26 (27.63)
Degree	30 (31.94)
Master/PhD	1 (1.06)
Income level	
< RM1000	19 (22.21)
RM1000-1999	21 (22.34)
RM2000-2999	28(29.79)
RM3000-3999	11 (11.70)
RM4000-4999	7(7.45)
>RM5000	8 (8.51)

Table 2: Comparison of LogMAR visual acuity among cases at presentation and after 3 months.

Visual Acuity	LogMAR	t	p
During presentation	0.96 ± 0.73	11.22	0.001*
After 3 months from presentation	0.10 ± 0.48		

* Significant at the 0.001 level

Table 3: Comparison of keratometry values among respondents 3 months after presentation.

Keratometry (D)	(Mean±SD)		t	p
	CLRMK	Controls		
Vertical, K1	43.60 ± 5.43	44.60 ± 1.59	-1.56	0.121
Horizontal , K2	42.55 ± 5.26	43.40 ± 1.41	-1.37	0.171
Astigmatism	1.12 ± 0.98	1.36 ± 0.85	1.65	0.101

Table 4: Comparison of mean corneal topography values among respondents 3 months after presentation.

	(Mean ± SD)		t	p
	Cases (n=76)	Controls (n=77)		
CU index	63.03 ± 26.38	80.13 ± 11.30	-5.22	0.001*
Aspheric Q	-0.06 ± 0.29	-0.16 ± 0.18	2.38	0.001*
Corneal astigmatism (D)	1.42 ± 1.36	1.37 ± 0.73	-0.29	0.771
Irregular astigmatism (D)	0.50 ± 2.5	0.19 ± 0.19	1.12	0.261

* Significant at the 0.001 level

Table 5: Comparison of mean contrast sensitivity values among respondents three months after presentation.

Spatial frequency, SF (c/deg)	Contrast sensitivity (Mean ± SD)		t	p
	Cases (n=73)	Controls (n=77)		
1.5	48.26 ± 19.67	57.68 ± 19.65	2.93	0.001*
3	75.19 ± 32.32	89.13 ± 30.05	2.74	0.011*
6	82.97 ± 45.03	100.44 ± 38.95	2.55	0.011*
12	41.25 ± 22.60	58.61 ± 28.06	4.16	0.001*
18	19.08 ±13.71	27.27 ± 16.33	3.32	0.001*
Global score	29.74 ± 8.47	34.06 ± 5.59	3.71	0.001*

* Significant at the 0.05 level

RESULTS

Patients' demography

There were 100 CLRMK cases identified during the study period. Six cases refused to participate leaving 94 cases included in this study. The mean age was 28.5 ± 8.0 years. There were 21 (22.34%) males and 73 (77.66%) females. They comprised of 70 Malays (74.47%), 13 Chinese (13.83%), six Indians (6.38%) and five from other ethnic groups (5.32%). Table 1 summarises the demography of the subjects in this study.

Visual acuity

Vision assessment data was available for 79 (84.04%) cases that came back for follow-up. A regression analysis was done for vision at presentation and at follow-up. Best fit curve for the cases had a regression coefficient, r=0.350 ± 0.063 (95% CI = 0.224, 0.447, df=78, p=0.001) and is shown in Figure 1. The mean pre-treatment logMAR was 0.96 ± 0.73 compared to the follow-up logMAR best spectacle-corrected visual acuity (BSCVA) which was 0.10 ± 0.48 (paired t-test, t=11.22, df=78,p=0.010) as shown in Table 2. The visual acuity in Snellen notation according to severity at three months follow-up among cases was also recorded. A total of 61 cases achieved visual acuity better than 6/18, twelve cases obtained visual acuity between 6/18 and 6/36 and six cases had poor visual acuity of worse than 6/36. Therapeutic keratoplasty was performed for five eyes which did not respond to medical treatment. Another patient had synecheolysis surgery. Two eyes developed endophthalmitis for which one eye had to be enucleated.

Keratometric reading

Table 3 shows the horizontal and vertical keratometry readings in cases and controls. There were no significant differences in keratometry readings between cases and controls in the horizontal and vertical keratometry.

Corneal astigmatism, which was defined as the difference between horizontal and vertical keratometric readings, was calculated and compared. There was no statistically significant difference in corneal astigmatism between cases and controls.

Corneal topography

The topographical features of the CLRMK and controls are shown in Table 4. There was a significance difference between cases and controls for the CU index (t= -5.22, df=151, p=0.001) and for corneal asphericity (t=-2.38, df=151 p=0.001). Corneal uniformity index measures the uniformity or the distortion of the corneal surface within the 3 mm pupil in percentage and measures corneal abnormality. Asphericity or Q value measures the level of asphericity of a cornea.

Irregular astigmatism is defined as the difference between the effective refractive power and the average simulated keratometry (16). In this study, the difference was not statistically significant (t = 1.12, p = 0.261). It can be concluded that CLRMK did not cause significant irregular astigmatism in our study cohort.

Contrast sensitivity

Table 5 shows the contrast sensitivity at various spatial frequencies. There were statistically significant differences in contrast sensitivity between CLRMK cases and controls for all spatial frequencies and contrast global score (t=3.71, df=151, p=0.001).

Figure 2 shows the difference in log contrast sensitivity between cases and controls for five different spatial frequencies. The cases have a higher value of log contrast sensitivity compared to controls. This corresponds to the lower mean contrast sensitivity found in the cases. Contact lens related microbial keratitis caused a significant reduction in contrast sensitivity at three months following infection.

The correlation between different parameters in cases was investigated. There was a positive correlation between CU index and global score in cases (r=0.478, df=78, p=0.001). However, a negative correlation was found between the visual acuity post MK (LogMar) with CU Index (r = -0.649, df=78, p=0.001). A negative correlation was also obtained between visual acuity following MK and global score (r = -0.525, df=78, p = 0.001) respectively.

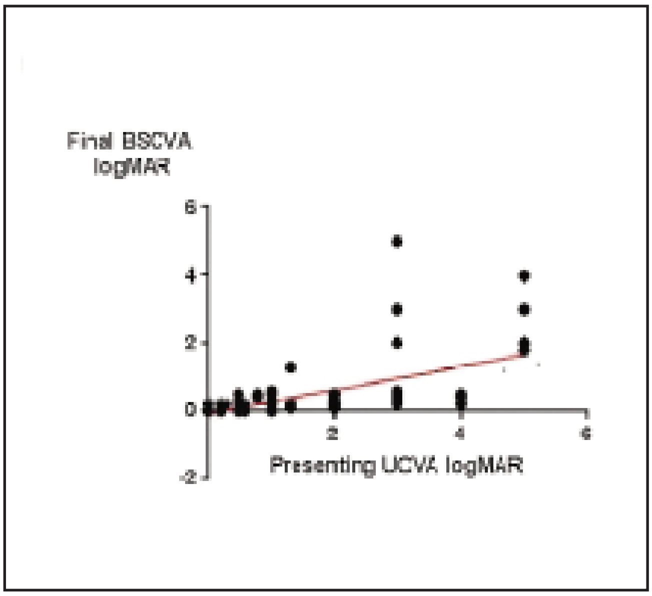

Figure 1: Scatter plot comparing the presenting UCVA logMAR and the final BSCVA logMAR in CLRMK cases. Best fit curve for the cases had a regression coefficient, r=0.350 ± 0.063 (95% CI = 0.224 to 0.447, df=78, p<0.001). (CLRMK, contact lens related microbial keratitis; UCVA, uncorrected visual acuity; BSCVA, best spectacle-corrected visual acuity).

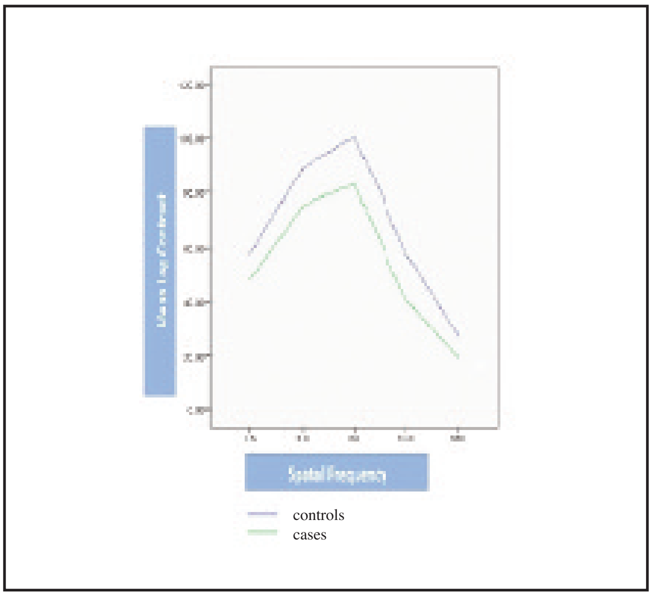

Figure 2: Comparison of mean log contrast sensitivity and spatial frequency in contrast sensitivity function among cases and controls.

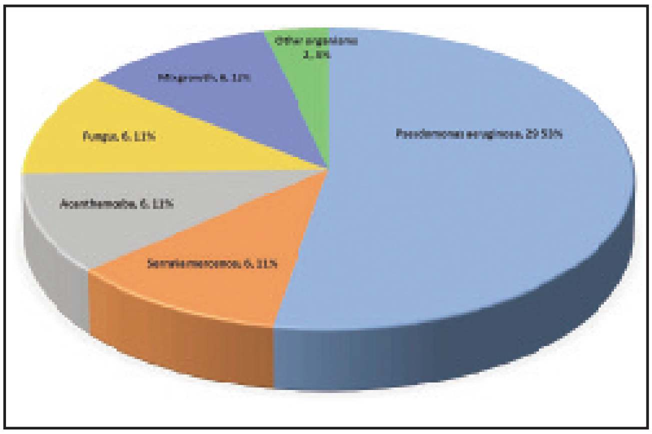

Figure 3: Organisms isolated in the culture-positive cases.

Bacteriology
Bacteriological work-up was performed from the corneal scraping specimen in 72 (76.59%) cases. Culture was positive for organisms in 55 (76.38%) of these cases. Among the culture positive cases, Pseudomonas was detected in 29 (52.73%), Serratia marcesens in six (10.9%), Acanthamoeba sp in six (10.9%) cases, fungus in six (10.9%) cases, mix growth in six (10.9%) cases and other organism in another two (3.6%) cases. The complete culture positive result is depicted in Figure 3.

DISCUSSION
Soft contact lens is popular among contact lens users as they are more tolerable and cheaper. However the users may be not very meticulous in the care of the contact lens therefore are predisposed to the bacterial infection. Invasion of the cornea by pathogens lead to infiltration of the corneal stroma by immune cells in order to contain the infection. This leads to the rapid loss of vision in cases where the visual axis is affected. Fibroblast will repair the damage tissue and form a scar. The corneal scar prevents passage and normal refraction of light visual loss and irregular corneal astigmatism.

The proportions of microbial keratitis related to contact lens in Malaysia were between 18 to 26% (17-19) . A study in Thailand reported that 81 out of 435 (18.6%) cases were contact lens related. Thirty four percent of patients did not practice proper contact lens care and 67% wore contact lenses overnight (19). In another study in Thailand, the use of contact lens beyond the replacement date was the highest risk factor for developing microbial keratitis (OR = 9.1; 95% CI 1.8,45.4, p = 0.005). Overnight wear of lenses (OR = 2.9, 95% CI 1.3,6.2, p = 0.012) and poor lens hygiene (OR = 2.3, 95% CI 1.0,5.1, p = 0.007) significantly increased the risk of microbial keratitis, respectively (20).

Although in general, the visual acuity improved significantly, a sizeable proportion of cases irreversibly lost vision by a few lines. In addition, approximately 10% of cases become blind. The poor vision rate in our patients was 9.6%. These were in agreement with other studies (21, 22) although several other studies (23, 24), reported lower or higher rates.

In this study, the contrast sensitivity after recovery was markedly reduced. The decrease is due to reduction in the CU index in cases. Corneal uniformity index measures the uniformity of the corneal surface. Contrast sensitivity is a useful indicator for the clinical loss of visual function because it tests over a range of spatial frequencies. What this reduction in sensitivity does to the patient is interesting. A vision related Quality of Life questionnaire would probably resolve this issue. How this reduction affect the patient's life is of interest.

Determination of changes in the K reading following the recovery of MK was challenging. This was partly due to the fact that these eyes had pre-existing astigmatism prior to the onset of MK. Hence, it was not surprising to find the astigmatism was not obvious.

Corneal topography is a method that provides early detection and diagnosis of corneal pathology and the optical characteristics of the anterior corneal surface (25). In the present study, corneal topography measurements taken with the Eye Sys corneal topography (16) were Corneal Uniformity Index (CU) and Corneal Asphericity (Q). The mean CU index in the cases was 63.03 ± 26.38 and in the controls 80.13 ± 11.30. The mean CU index for the controls was higher than the cases and this was statistically different from the controls ($t=-5.22$, $df=151$, $p=0.001$).

Corneal uniformity index measures the uniformity or the distortion of the corneal surface within the 3mm pupil in percentage and is useful for measuring any corneal abnormality (16). Corneal uniformity index in the cases is significantly lower than the controls; this indicates that the corneal uniformity in the cases is lower than the controls. The value of the CU index in the controls is almost the same as the normal corneal uniformity value which is taken to be 80% (16).

For the measurements of Q, the cases had a mean reading of -0.061 ± 0.290 and the controls had a mean reading of -0.16 ± 0.18. These findings were significantly different ($t=2.38$, $df=151$, $p=0.001$). A negative Q value indicates that the corneal surfaces have flattened toward the periphery while positive Q values indicate aspheric surfaces that steepened towards the periphery over a 4.5mm pupil (16). A lower Q value, which almost equals the asphericity of a sphere, or zero, is noted in the cases and this value is significantly different from the control group's Q value. The value of Q in the cases means that the aspheric corneal surfaces steepens more towards the periphery compared to controls, and this results in corneal distortion and spherical aberrations (16).

Correlations were done between LogMAR and both CU index and contrast sensitivity (CS) respectively. Although, visual acuity (VA) improves post keratitis in cases, there was a reduction in CU index ($r= -0.649$, $df=78$, $p=0.001$). With improvement in VA, a reduction in global scores (CS) was observed ($r = -0.525$, $df=78$, $p=0.001$). This means that the cornea is affected via CU index or the uniformity of the cornea is reduced due to the healing process. The global scores indicate that the contrast sensitivity is reduced, and suggests some reduction in corneal sensitivity due to corneal distortion and opacity post keratitis.

Our culture-positivity rate was 74% and similar to Reddy et al (26) and Wajin et al (85%) but higher compared to another study which reported 49.5% positivity rate (27). In all these studies, the most frequently isolated organism was invariably Pseudomonas but at variable rates. We found a rate of 29.5% which was relatively low compared to those found by Goh et al (84.6%) (27) , Wajin et al (65%) (28) and Reddy et al (26). Wajin reported 15 out of 20 (75%) cases had surrendered their contact lens and solution, 30% of which grew Pseudomonas and 60% had mixed growth.

CONCLUSION

Microbial keratitis is a serious complication of contact lens wear. Although majority of patients responded well to treatment, short term vision can be affected. At three months after presentation, although the visual acuity dramatically improved, corneal uniformity index, corneal asphericity and contrast sensitivity reduced significantly in the healed eyes. *Pseudomonas aeruginosa* is the most frequent organism implicated in CLRMK.

ACKNOWLEDGMENTS

The authors would like to thank colleagues in the Ministry of Health who have contributed to the study. Data accumulation was carried out in the Ministry of Health hospitals situated in Klang Valley, Malaysia and conforms with all national, federal or state laws. Informed consent was obtained and the study was in adherence to the tenets of the Declaration of Helsinki.

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