

Original Article

Risk Factors Associated with Contact Lens Related Microbial Keratitis

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ABSTRACT

Introduction: Microbial keratitis is one of the most challenging complications of contact lens (CL) wear. Proper CL practice plays an important role to reduce the risk for contact lens related microbial keratitis (CLRMK). **Methods:** This multi-centre case-control study was conducted from January 2008 until June 2009 to determine the risk factors associated with CLRMK. Cases were defined as respondents who were treated for CLRMK, whilst controls were respondents who were contact lens wearers without microbial keratitis. Ninety four cases were compared to 94 controls to determine the risk factors for CLRMK. **Results:** The predictors for CLRMK were: Not washing hands with soap before handling CL (aOR 2.979, CI 1.020, 8.701 p=0.046), not performing rubbing technique whilst cleaning the CL (aOR 3.006, CI 1.198, 7.538 p=0.019) and, not cleaning the lens case with multipurpose solution daily (aOR 3.242 CI 1.463, 7.186 p=0.004). Sleeping overnight with the CL in the eye (aOR 2.864, CI 0.978, 8.386 p=0.049) and overall non-compliance with lens care procedures (aOR 2.590, CI 1.003, 6.689 p=0.049) contributed significantly to CLRMK. **Conclusion:** Health education and promotion in contact lens care are important and should be conducted by eye care practitioners to reduce the occurrence of CLRMK.

Key words: Contact lenses, Microbial Keratitis, Risk factors

INTRODUCTION

Contact lenses (CL) are widely used for refractive visual correction and are worn by approximately 140 million people around the globe (1). Microbial keratitis is an infection of the cornea due to bacteria, fungi or parasites (2). It may be associated with ulceration of the corneal epithelium with inflammation of the underlying stroma (3). It can also be related to ocular trauma, ocular surgery, ocular surface disease, bullous keratopathy, corneal anaesthesia, corneal exposure cases and dry eyes (4). Although microbial keratitis is rare³, it can cause significant ocular morbidity and thus requires prompt diagnosis and treatment to prevent devastating outcomes (5).

Before the popular usage of contact lens for the correction of ametropia, microbial keratitis was rare in normal eyes because of the eye's natural resistance to infection, and occur only in association with therapeutic and aphakic contact lens wearers (6,7). Non-compliance to lens care procedure and unhygienic contact lenses and their storage cases have been associated with microbial keratitis (8). It has been widely reported that CLRMK is often caused by *Pseudomonas aeruginosa* which can lead to significant morbidity (9). Contact lens related microbial keratitis is an important public health issue because of the large number of wearers who are at risk for the disease with the majority of them who are in their prime working years (2).

Overnight use of contact lenses, poor storage case hygiene, smoking, internet purchase of contact lenses, usage of less than 6 months and higher socio-economic status are some of the risk factors for CLRMK (10). Compliance to the prescribed regime is indeed important, and practitioners should ensure users wear their lenses according to wear schedule, are properly instructed in lens handling, lens case hygiene and replacement. They should be made aware of

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the importance of good hand hygiene and increased risk of CLRMK associated with overnight use of contact lenses (11). Studies done in Malaysia found that the factors associated to CLRMK were mainly behavioral and were related to lens care procedures and practices (12). Cases-control studies on CLRMK has not been reported in Malaysia and this has motivated us to embark on the present study. The objectives of this study are to determine the socio-demographic characteristics of patients, the proportion of CLRMK by the types of contact lens and the risk factors associated with CLRMK in Klang Valley, Malaysia.

MATERIALS AND METHODS

This case-control study was carried out in the eye clinics of seven hospitals throughout the Klang Valley in Malaysia. Approval was obtained from the Ethics Committee of the Medical Faculty, University Putra Malaysia and Ethics Committee from the National Medical Research Registrar, Ministry of Health Malaysia. Informed consent was obtained from the respondents before participation in the study. All respondents with CLRMK were included as cases and controls were contact lens users without CLRMK who attended the eye clinics for reasons other than anterior eye pathology. Patients with keratoconus, bandage lenses and aphakia were excluded from this study.

Methods

A self-administered questionnaire in *Bahasa Malaysia* was used. The questionnaire was aimed to determine the following risk factors for CLRMK: Hand washing with soap while handling the contact lenses, rubbing of the lenses when cleaning them, re-disinfecting the contact lenses before resuming wear, daily cleaning of lenses with multipurpose solution, sleeping overnight with lenses in the eye, and overall non-compliance with lens care procedures defined as the inability to fully adhere to the recommended lens care procedures.

Sample size determination

The sample size was calculated using a formula that is derived from Schlesselman (1982) specifically for case control study. Equal number of cases and controls was selected for sample size in each group (n per group) as above. With an estimated proportion rate among the controls (p_0) being 71% and OR for soft disposable lens being 3.51 (Radford, 1998a), the sample size was 94 per group for cases and controls. The symbol p_0 is the Estimated exposure rate (proportion exposed) in controls and R is the Relative risk corresponding to the smallest decrease or increase in risk of interest.

Data collection

Data collected included demographic data, contact lens characteristics and personal contact lens handling and care. Microbial investigations were done using culture and sensitivity technique by the hospital laboratory service.

Data Analysis

Crude ratios were calculated for each of the aforementioned factors using logistic regression. Adjusted odds ratios were done for adjustment of confounders using multiple logistic regression test. All data were analysed using SPSS 16 which included chi-square test and multiple logistic regression.

RESULTS

Out of the 100 incident cases, a total of 94 cases agreed to participate giving a response rate of 94%. Out of a total of 110 controls, a total of 94 controls agreed to participate giving a response rate of 85%. A total of 188 respondents which comprised of 94 cases and 94 controls were recruited.

Sociodemographic features

Average age of the subjects was 27 ± 7 years ($n = 188$). Majority of cases and controls were in the younger age group (18-29 years) being 65% and 82% respectively. Female was predominant in this study with 78% females in cases and 68% in controls. Malays made the majority for cases (75%) and controls (43%). The demographic data of the respondents is shown in Table 1.

Contact lens characteristics

Of all the cases, majority ($n=84$, 89.36%) were using monthly disposable lenses. Others used yearly conventional lenses ($n=6$, 6.38%), bi-weekly disposable lenses ($n=2$, 2.13%) and daily disposable lenses ($n=2$, 2.13%). Among

the controls, 48% were conventional RGP wearers. Contact lens characteristics, wearing mode and lens replacement schedule are shown in Table 2.

Lens Care Practices

The risk factors in relation to lens care procedures were the following: Not washing hands with soap (OR 6.415, CI 2.66, 15.47, $p=0.001$), not performing rubbing technique to clean lenses (OR 5.693, CI 2.829, 11.454 $p=0.001$), not re-disinfecting lenses after lenses were left longer than indicated (OR 4.085, CI 2.078, 8.030 $p=0.001$) and, not using multipurpose solution containing enzymatic cleaning agent weekly or not carrying out enzymatic cleaning at least once a week (OR 2.718, CI 1.353, 5.461 $p=0.005$). Sleeping overnight with lens in the eye (OR 4.427, CI 1.965, 9.976) and overall non-compliance with lens care procedure (OR 3.238, CI 1.592, 6.565) increased the risk for CLRMK (Table 3). Multiple logistic regression analysis was performed to obtain the adjusted odds ratio (aOR). The significant results were found for Not washing hands with soap before handling lenses (aOR 2.979, CI 1.020, 8.701 $p=0.046$), not performing rubbing technique (aOR 3.006, CI 1.198, 7.538 $p=0.019$) and, not cleaning lens case with multipurpose daily (aOR 3.242 CI 1.463, 7.186 $p=0.004$). Sleeping overnight with lenses in the eye contributed to an increased risk of almost three times (aOR 2.864, CI 0.978, 8.386 $p=0.049$) and non-compliance with lens care procedures had an increment in the risk of up to 2.6 times (aOR 2.590, CI 1.003, 6.689 $p=0.049$) (Table 4).

Table 1. Demographic characteristics data and the association between contact lens related microbial keratitis

	Case n=94	Control n=94	X ² †	df	p
Total					
Age (years)					
18-29	61 (64.9)	77 (81.9)	8.69	3	0.034*
30-39	24 (25.5)	13 (13.8)			
40-49	6 (6.4)	1 (1.1)			
50-59	3 (3.2)	3 (3.2)			
Gender					
Male	21 (22.34)	30 (32)	2.18	1	0.140
Female	73 (77.66)	64 (68)			
Ethnicity					
Malay	70 (74.47)	40 (42.55)	23.7	3	0.001*
Chinese	13 (13.83)	30 (31.91)			
Indian	6 (6.38)	21 (22.34)			
Others	5 (5.32)	3 (3.20)			
Education level					
Primary	4 (4.26)	2 (2.13)	9.4	4	0.049*
Secondary	33 (35.11)	51 (54.26)			
Diploma/Cert	26 (27.63)	15 (15.96)			
Degree	30 (31.94)	23 (24.46)			
Master/PhD	1 (1.06)	3 (3.19)			
Income level					
< RM1000	19 (22.21)	10 (10.64)	17.02	5	0.004*
RM1000-1999	21 (22.34)	16 (17.02)			
RM2000-2999	28 (29.79)	18 (19.15)			
RM3000-3999	11 (11.70)	21 (22.34)			
RM4000-4999	7 (7.45)	8 (8.51)			
>RM5000	8 (8.51)	21 (22.34)			

* Significant at $p < 0.05$

† Chi square bivariate analysis

Table 2. The association between contact lens related microbial keratitis (CLRMK) and contact lens characteristics

	Case n (%)	Control n (%)	χ^2 †	p
Lens type				
Disposable Soft	88(93.62)	46(48.94)	59.16	0.001*
Conventional Soft	6(6.38)	3(3.20)		
Conventional RGP	0(0)	45(47.86)		
Wearing mode				
Daily wear (\leq 12 hours)	65(69.15)	76 (80.85)	3.46	0.181
Daily wear (13-24 hours)	27(28.72)	17 (18.09)		
Extended wear (\geq 24 hours)	2 (2.13)	1 (1.06)		
Replacement schedule				
Daily	2 (2.13)	7 (7.45)	53.12	0.001*
Two weeks	2 (2.13)	1 (1.06)		
Monthly	84 (89.36)	38 (40.43)		
Yearly	6 (6.38)	48 (51.06)		

* Significant at $p < 0.05$

† Chi square bivariate analysis

Table 3. The risk factors for CLRMK related to lens care

Risk factor	Crude Odds ratio	95% confidence interval, CI		p
		lower	upper †	
Not washing hands with soap	6.415	2.660	15.470	0.001*
No rubbing technique	5.693	2.829	11.454	0.001*
No re-disinfecting lenses	4.085	2.078	8.030	0.001*
Not cleaning case daily with MPS	4.086	2.191	7.617	0.001*
Sleeping overnight with lens in the eye	4.427	1.965	9.976	0.001*
Overall non- compliance to lens care procedure	3.238	1.592	6.565	0.001*

* Significant at $p < 0.05$

† 95% Confidence intervals lower and upper value

Table 4. The predictors for contact lens related microbial keratitis

Predictor	Adjusted odds ratio	95% confidence interval, CI		p
		lower	upper †	
Ethnicity				
Chinese	0.126	0.045	0.355	0.001*
Indian	0.295	0.088	0.989	0.048*
Other	0.414	0.066	2.611	0.348
Not washing hands	2.979	1.020	8.701	0.046*
Not performing rubbing	3.006	1.198	7.538	0.019*
Not cleaning lens case daily with MPS	3.242	1.463	7.186	0.004*
Sleeping overnight with lens	2.864	0.978	8.386	0.049*
Overall non compliance to lens care procedures	2.590	1.003	6.689	0.049*
Constant	0.001			0.001

* Significant at $p < 0.05$

† 95% Confidence intervals lower and upper value

DISCUSSION

A compliant CL user is a person who washes his hands before handling contact lenses, uses an FDA (Food and Drug Administration) approved care system and in agreement with the published guidelines of the manufacturer and good hygiene while adhering to the recommended wear schedule (13). Non-compliance with contact lens care procedures is defined as failure to adhere to the proper technique of contact lens maintenance. There have been relatively few studies conducted on the predisposing factors leading to CLRMK in Malaysia. This is the first local multi-centre case control study on the risk factors for CLRMK. The present study showed that the predictors for CLRMK were: Not washing hands with soap before handling lenses (aOR 2.979, CI 1.020, 8.701 $p=0.046$), Not performing rubbing technique (aOR 3.006, CI 1.198, 7.538 $p=0.019$) and Not cleaning lens case with multipurpose daily (aOR 3.242 CI 1.463, 7.186 $p=0.004$). In addition, it was discovered that sleeping overnight with the lens in the eye (aOR 2.864, CI 0.978, 8.386 $p=0.049$) and overall non-compliance with lens care procedures (aOR 2.590, CI 1.003, 6.689 $p=0.049$), were predictors for CLRMK.

Not washing hands before handling lenses

Omitting hand washing increased risk for CLRMK by 3 folds (aOR 2.979, CI 1.020-8.701, $p=0.046$). Previous compliance studies have revealed that 16-50% of subjects did not pay proper attention to hand washing prior to lens insertion (13). By diligently adhering to the cleaning guidelines such as washing hands with soap, most if not all organisms will be removed from the hands and fingernails, thus preventing contamination of the lens (14). Previous studies have found patients practiced poor hand washing or incomplete rinsing of hands, did not clean lens case regularly, did not replace lens case regularly, did not observe cleanliness with bottle caps, kept contact lens solution bottle caps open and kept lens cases open, did not rinse lenses after taking them out of the cases and topping off solution in the lens cases (15).

Not performing the rubbing technique

In this study, after adjusting for confounders, not performing the rubbing technique was found to increase in the risk for CLRMK by three folds (aOR 3.006, CI 1.198, 7.538 $p=0.019$). Cleaning and rinsing contact lenses immediately after lens removal with the cleaner/multipurpose solution and saline is more effective than cleaning before inserting

the lens in the eye (16). This is because all the tear deposits, contaminants and microorganism will be removed from the lens before they are placed in the lens case. Physical cleaning of lenses and lens case is helpful in reducing microorganisms before chemical disinfection (17). Complacency to lens hygiene and the emphasis of convenience which has been encouraged by the availability of no-rub solutions may have contributed to this behaviour. Performing the rubbing technique improves the effectiveness of lens cleaning and failure to perform this technique increases the risk of CLRMK (18). If the lens rubbing is not performed properly, deposits will accumulate at the midperiphery area of the lens, which will subsequently lead to an allergic response caused by the friction between the lens and the palpebral aperture when the eye blinks (19).

Not cleaning lens case daily with multipurpose solution

Cleaning the lens case daily with a multipurpose solution and disinfecting the lens case weekly are recommended hygiene practices (20). Non-compliance with care of lens case has been associated with contamination of the case and infection in contact lens wearers (21) and increase risk for microbial keratitis including *Acanthamoeba* (5,9,22). Contact lens users risk up to 50-fold increase in the risk of *Acanthamoeba* keratitis, largely attributable to repeated wear of lenses, irregular or lack of disinfection and use of saline and chlorine-based solutions (16).

Overnight wear of contact lens

Overnight wear of lens is known to be a major risk factor for microbial keratitis (23). In an eye with contact lenses, there are greater levels of hypoxia and hypercapnia compared to open eye. Coupled with tear stagnation beneath the lenses in a closed lid environment it can lead to epithelial compromise, oedema and superficial punctate keratitis (SPK) (24-26). In this study, overnight wear of contact lens increased the risk of CLRMK by 3 folds (aOR 2.86, CI 0.978-8.386, p=0.049). The results supported other studies which reported an increased risk of CLRMK when contact lenses were worn overnight : (OR 3.95, CI 1.02, 15.26) for daily wear soft contact lens (27).

Non-compliance with lens care procedures

Non-compliance with lens care procedures, and contaminated lenses and lens cases were associated with an increased risk for microbial keratitis (8). A study in Hong Kong found non-compliance with contact lens care procedures to be a risk factor for CLRMK (OR 11.04, CI 1.87, 135.56, p=0.003) (28). The specific areas of non compliance that are frequently discussed are: Lack of hand hygiene, lack of case hygiene, prolonged contact lens use, inadequate use of lens care maintenance systems and infrequent follow-up visits (29). In this study, overall non-compliance was a risk factor for CLRMK and contributed to an increased risk of 2.59 (aOR 2.59, CI 1.003-6.689, p=0.049). Thus, it is important to improve patient compliance with contact lens care procedures as it has been shown in our study that non-compliance increased the risk for CLRMK. Our study also supports studies conducted elsewhere which found *Pseudomonas aeruginosa* as the most common microorganism in CLRMK in developing worlds. It was also in agreement with the findings that *Pseudomonas* was the most frequent pathogen found in corneal ulcers of soft contact lens wearers (30,31,32,33).

Limitations

Although this was the first case-control study on the risk factors for CLRMK to be conducted in Malaysia to the knowledge of the authors, there were unavoidable limitations. Among the limitations was not using matching in the design stage of the study. The reasons were due to inability to find suitable hospital matched controls in our setting. The use of multiple logistic regression in the analytical part of the study seemed more appropriate for the case control study design besides controlling for confounders. In addition, by using hospital based controls, it only provided internal validity to the study. The fact that a high proportion of hospitals based controls were RGP users may not actually reflect the real situation in the community. In view of that, the authors proposed that future case control studies be conducted using population based controls.

CONCLUSION

Health promotion and education should be conducted by eye care practitioners, doctors and optometrists for the public specifically for the contact lens users. With improved public health promotion, this will increase awareness on the risks for CLRMK and minimize the occurrence of CLRMK.

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