ORIGINAL ARTICLE

An 8-year Retrospective Review of Microbial Keratitis in A Secondary Referral Centre in Malaysia.

Nazri Omar[1,2], Maimunah Abdul Muna'aim[1,2], Rafidah Md. Saleh[1,2], Zaidah Mohd. Kasim[2], Muhammad Mohd. Isa[1,2]

[1] Ophthalmology Department, Faculty of Medicine & Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor.
[2] Ophthalmology Department, Hospital Serdang, Lebuhraya Kajang-Puchong, 43000 Kajang, Selangor.

ABSTRACT

Introduction: Microbial keratitis (MK) is an important cause for corneal blindness and understanding its risk factors enable us to improve management and minimise its complications. **Methods**: In this retrospective case review, medical records of all patients treated for MK from 2006 to 2013 was analysed to know the socio-demography, preceding risk factors, clinical characteristics, causative organisms and final visual outcome. **Results**: A total of 174 patients (180 eyes) were included in this study. Identifiable ocular risk factors included contact lens (CL) usage (85, 47.2%), ocular trauma (50, 27.8%), ocular surface disease (21, 11.6%), steroid use (6, 3.3%) and immuno-compromy (19, 10.5%). Association factors for presenting uncorrected visual acuity (UCVA) were age group (p=0.013), size (p<0.001), location (p<0.001) and hypopyon (p<0.001). The predictors for final best spectacle-corrected visual acuity (BSCVA) were age group (p<0.001), nationality (p=0.020), occupation (p<0.001), CL use (p<0.001), ocular surface disease (p=0.048), size (p<0.001) and location (p<0.044), hospitalisation duration (p=0.002) and presenting UCVA (p<0.001). **Conclusions**: Contact lens was the most frequent predisposing risk factor for microbial keratitis, followed by ocular trauma. Understanding the association factors for presenting vision and predictors for final vision may help in the patients' management and improve eventual outcome of microbial keratitis.

Keywords: Microbial keratitis, Corneal ulcer, Contact lens, *Pseudomonas aeruginosa,* Visual outcome

Corresponding Author:
Dr. Nazri Omar
Tel: +603-89472445
Fax: +603-89414631
E-mail: naz@upm.edu.my

INTRODUCTION

Microbial keratitis (MK) is defined as the infective inflammation of the corneal stroma by non-viral pathogens which include bacteria, protists (e.g. Acanthamoeba) and fungi (yeasts, moulds and microsporidia). It is characterised by an acute or sub-acute onset of pain, conjunctival injection and corneal ulceration with a stromal inflammatory infiltrate. Upon healing, the resultant corneal scar may limit vision. Without aggressive and effective treatment, severe corneal scarring, corneal thinning leading to perforation and endopthalmitis can complicate MK, hence aggressive treatment is indicated in this case.

Different predisposing factors and causative organisms of MK were identified across the world and the patients responded to different forms of treatment (1). In New Zealand, prior ocular surgery was the most frequent risk factor and coagulase-negative *Staphylococcus* was the commonest organism isolated (2). On the other hand, corneal injury was the most frequent risk factor and fungus was the commonest causative organism reported in a study in India (3). Based on these instances of geographical, social and risk variations, it is important to obtain data for local population as this will define the disease characteristic and thus help in the disease management.

To date, the prevalence of the MK in Malaysia has been reported in several reviews of different populations and sample sizes (4-8). A study with larger sample and over a longer duration will increase our knowledge on the MK in Malaysia and the surrounding regions. Hospital Serdang was inaugurated for ophthalmology services in 2006, and as a secondary referral centre, has offered general ophthalmology and oculoplasty services since then. For MK cases, the patients were managed by the general ophthalmologists and complicated cases were referred to cornea services in nearby tertiary referral centres. The objective of this study was to determine socio-demography, risk factors, clinical features, causative organism and the visual outcome of MK cases in a secondary referral hospital of a developing country.

PATIENTS AND METHODS

This study was approved by the Malaysian National Institute of Health and was registered in the National Medical Research Registry (NMRR-14-1200-19622). In a retrospective case review, the medical records of all patients clinically diagnosed and treated for MK in Hospital Serdang over an eight-year period from January 2006 to December 2013 were analysed. Cases with missing medical records or irretrievable data were excluded. Data on patients' demography, clinical findings of the MK, bacteriological work-up and visual outcome of the patients were collected.

Presentation interval, in day, was the time from onset of the symptom to first examination by the eye doctor. The size of the keratitis and its location were obtained from the description or diagram in the patients' medical record. Hypopyon was described as either present or absent.

The bacteriological work-up data such as corneal scrapings, CL and the CL solution, whenever available, for gram staining and culture and sensitivity tests, were also retrieved from the medical record. A diagnosis of *Acanthamoeba* keratitis was made if the MK was associated with severe pain, photophobia and tearing, and it responded to a combination of anti-amoebic agents including biguanides such as polyhexamethylene biguanide (PHMB) and chlorhexidine, aromatic diamidines such as propamidine isethionate, dibromopropamidine, and neomycin or when *Acanthamoeba* spp was grown in the *Escherichia coli*-laden non-nutrient agar and visualised using the calcofluor stain under fluorescein microscope (9, 10).
The hospitalisation duration, in day, was calculated from the admission until the patient was discharged from the ward. Hospitalisation longer than seven days was considered as prolonged. The patients were then reviewed as outpatient at appropriate interval until they completely recovered from the infection. Refractions were performed at the completion of treatment and at 3-month following the disease onset. Follow-up duration, in week, was calculated from the discharge until the last outpatient visit. The patients' final status was also recorded.

The presenting and final visions were recorded in Snellen acuity system and converted to corresponding log minimal angle resolution (logMAR) for data analysis (11). They were categorised as good (6/6 -6/12), moderate (6/15 to 3/60) and blind (worse than 3/60).

The data was analysed using SPSS 21.0 for descriptive analysis and indicating any significance in difference, whenever applicable. Independent t-test was used to compare means of continuous variables while paired-sample t-test was used to compare means from a similar group. Pearson's chi-square or Fisher's exact tests was used to determine association between two categorical data. All significant association factors were subjected to multivariable analysis using multinominal logistic regression test to eliminate potential inter-variable confounding effect. A *p* value of less than 0.05 indicated statistical significance.

RESULTS

There were 174 patients managed as MK in Hospital Serdang from January 2006 to December 2013. Unilateral involvement was recorded in majority of patients (n=168, 96.6%) while bilateral involvement was noted in six (3.4%) patients. Five of them had simultaneous disease and another patient had sequential involvement. As such, there were 180 eyes eligible for analysis in this study. The complete data on the socio-demography of the cases is shown in **Table 1**. The age distribution of cases in this study showed two peaks with the higher peak at twenties and a lower peak at sixties age groups (**Figure 1).**

Predisposing ocular risk factors
Twelve (6.7%) cases had no identifiable predisposing factor while 168 (93.3%) cases recorded at least a predisposing factor. The identifiable risk factors included CL in 85 (47.2 %) cases, ocular trauma in 50 (27.8%) cases, topical steroid in six cases (3.3%), ocular surface diseases in 20 (11.1%) cases, ocular surgery in one (0.6%) case, immuno-compromy in 19 cases (10.6%) and other risks in 10 (5.6%) cases. Fourteen (7.8%) cases had a combination of two risks, two (1.1%) had three risks and one (0.5%) case had four risk factors.

Clinical characteristics
There were 89 cases (53.6%) who presented within up to 3 days and 151 cases (91.0%) presented within up to 7 days following the onset of the symptoms. The presenting uncorrected visual acuity (UCVA) was recorded in 176 cases. The average UCVA logMAR was 1.85 (SD 1.39), which was approximately equivalent to Snellen acuity of 1/60. The presenting UCVA was further sub-classified into good (6/6 to 6/12), moderate (6/15 to 3/60) and blind (worse than 3/60). Good presenting UCVA was recorded in 22 (15.5%) cases, moderate in 71 (40.3%) and blind in 83 (47.2%) cases. Complete data on the clinical characteristics of the cases is shown in **Table 1**. Factors associated with the presenting UCVA were investigated. Age group (p=0.013), size (p<0.001), location (p<0.001) and hypopyon (p<0.001) were significantly associated with presenting UCVA (**Table 2**). After performing the multinomial logistic regression modelling, age group (χ^2=13.652, df=6, p<0.034), location (χ^2=24.472, df=4, p<0.001) and hypopyon (χ^2=16.020, df=2, p<0.0010 were found to be significantly associated with presenting UCVA.

Table 1. Socio-demography and clinical characteristics of microbial keratitis cases in Hospital Serdang.

	n	Mean	SD
*Age	174	35.2	16.9
Presenting interval, days	166	4.67	4.43
Presenting UCVA logMAR	176	1.85	1.39
Size (largest diameter), mm	156	3.59	2.92
*Hospitalisation duration, days	167	9.87	8.64
*Out-patient follow-up duration, weeks	173	4.89	6.55
Socio-demographic factors	**n (%)**		
*Gender (n=174)			
Male	95 (54.6)		
Female	79 (45.4)		
*Nationality (n=174)			
Malaysia	141 (81.0)		
Non-Malaysia	33 (19.0)		
*Ethnicity, among Malaysian (n=141)			
Malay	99 (70.2)		
Chinese	27 (19.1)		
Indian	11 (7.8)		
Others	4 (2.8)		
*Occupation (n=106)			
Manual worker	22 (20.8)		
Office worker	8 (7.5)		
Student	22 (20.8)		
Unemployed	25 (23.5)		
Others	29 (27.3)		
*Source of referral (n=88)			
Health clinic or general practitioner	27 (30.7)		
Other ophthalmologist	14 (15.9)		
Other specialty	33 (37.5)		
Other source	14 (15.9)		
Clinical characterisation			
Presentation interval (n=166)			
3 days or less	89 (53.6)		
More than 3 days	77 (46.4)		

Laterality (n=180)	
Right eye	88 (49.2)
Left eye	92 (50.8)
Size, largest diameter (n=156)	
2 mm or less	61 (39.1)
More than 2 to 4 mm	49 (31.4)
More than 4 mm	46 (29.5)
Location (n=178)	
Peripheral	27 (14.7)
Paracentral	63 (35.6)
Central	88 (49.7)
Hypopyon (n=180)	
Present	60 (33.3)
Absent	120 (66.7)
Hospitalisation duration (n=167)	
7 days or less	87 (52.1)
More than 7 days	80 (47.9)
Bacteriology (n=75)	
Pseudomonas spp	50 (31.6)
Staphylococcus aureus	9 (5.7)
Staphylococcus epidermidis	2 (1.3)
Fungus	2 (1.3)
Mixed growth	2 (1.3)
Others	10 (5.6)
Presenting UCVA (n=176)	
Good : 6/6 - 6/12	22 (12.5)
Moderate: 6/15 - 3/60	71 (40.3)
Severe loss : worse than 3/60	83 (47.2)
Final BSCVA (n=73)	
Good : 6/6 - 6/12	41 (56.2)
Moderate: 6/15 - 3/60	16 (21.9)
Severe loss : worse than 3/60	16 (21.9)

*Calculated based on the number of patients; SD, standard deviation; UCVA, uncorrected visual acuity; BSCVA, best spectacle-corrected visual acuity.

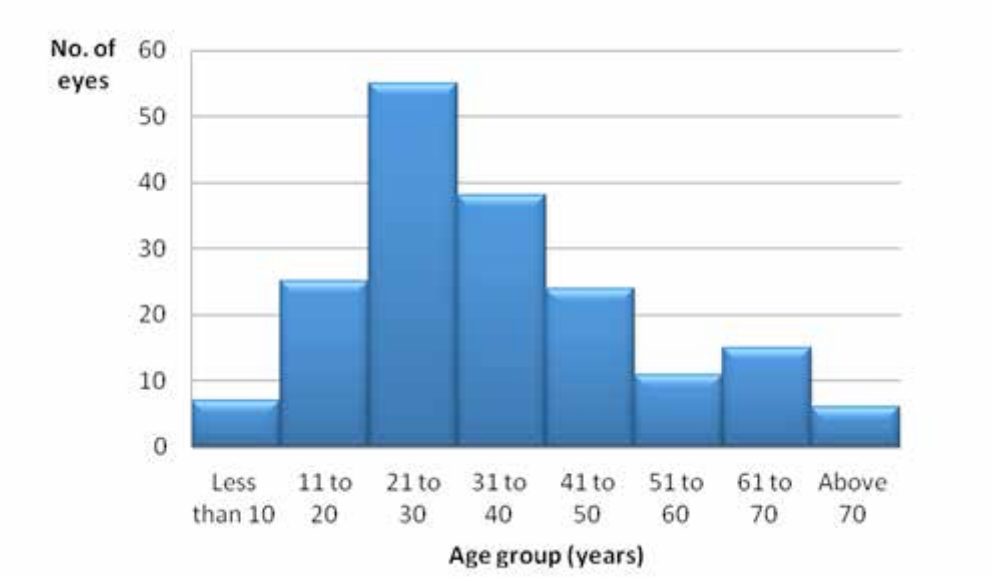

Fig. 1. Distribution of microbial keratitis cases in Hospital Serdang according to the age group

Bacteriology

Gram stain from corneal scraping was performed in 157 (86.7%) cases. Organisms were detected in 42 (26.8%) of the samples, of which 38 (90.2%) cases were bacteria and four (9.8%) were fungi. Seven (18.9%) of the bacteria were gram positive and 31 (81.1%) were gram negative. Culture and sensitivity test from corneal scraping were performed in 158 (87.3%) cases. Positive result was seen in 75 (47.5%) cases. Distribution of cases according to the cultured organisms is shown in **Table 1**.

Hospitalisation and final diagnosis

Seven patients were treated on outpatient bases. The remaining 167 patients were hospitalised for intensive antibiotic treatment and further management of the keratitis. The number of days spent in the ward ranged from one to 46 days. Eighty-seven (52.1%) patients were hospitalised up to 7 days and another 80 (47.9%) patients stayed longer than a week. Bacterial keratitis was the diagnosis in 140 (77.8%), fungal keratitis in 14 (7.8%), Acanthamoeba in one case (0.6%), mix infection in 17 (9.4%) cases and undetermined in another eight (4.4%) cases.

Ending of treatment

In the course of the disease, 43 (23.9%) of cases were referred to corneal service centres. Another 11 (6.1%) cases requested for discharge against medical advice or transferred to other hospitals. Sixty-six (36.7%) of the cases defaulted their treatment and follow-ups while 60 (33.3%) cases completed treatment and were finally discharged. The overall mean duration of outpatient follow-up was 9.2 weeks (SD 5.3 weeks).

We also investigated the visual outcome among the cases. Final visual outcome, defined as the best spectacle-corrected visual acuity (BSCVA) at discharge, or after at least 4 weeks of outpatient follow-up, was analysed. The mean BSCVA logMAR was 0.93 (SD 1.46), which was equivalent to approximately 6/60 Snellen acuity. Paired-sample t-test was performed to compare the presenting and the final vision following recovery from the MK in eligible cases (n=72). There was a statistically significant improvement between the presenting UCVA and the final vision with a mean difference (MD) logMAR of 0.98 (SD1.15) (95% confidence interval, CI = 0.71, 1.252, t=7.236, df=71, p<0.001).

Final BSCVA was categorised as good in 41 (56.2%), moderate in 16 (21.9%) and blind in 16 (21.9%) of cases. The predictors for poor BSCVA were age group (p<0.001), nationality (p=0.020), occupation (p<0.001), CL use (p<0.001), ocular surface disease (p=0.048), size (p<0.001) and location (p<0.044), hospitalisation duration (p=0.002) and presenting UCVA (p<0.001) (**Table 3**). Following multinomial logistic regression modelling for the above predictors, it was found that CL use (χ^2=11.637, df=2, p=0.003) and size (χ^2=13.657, df=4, p=0.008) were significant predictors for final BSCVA.

DISCUSSION

MK prevails as one of the leading causes of preventable blindness worldwide. It could be difficult and costly to treat (12) and more importantly visual outcome following MK can be potentially devastating. The socio-demography and precedent ocular risk factors for MK were noted to be variable in different populations, climates and geographic locations (13, 14). As time passes, these factors and the microbial profile may

Table 3. Association factors for the final BSCVA for microbial keratitis cases in Hospital Serdang.

	Visual acuity			χ^2	df	p
	Good	Moderate	Blind			
	n (%)					
Age group (n=73)						
Pre-adult	11 (73.3)	3 (20.0)	1 (6.7)	28.925	6	**<0.001**
Young adult	23 (67.6)	9 (26.5)	2 (5.9)			
Middle age	6 (50.0)	2 (16.7)	4 (33.3)			
Elderly	1 (8.3)	2 (16.7)	16 (75.0)			
Gender (n=73)				3.108	2	0.211
Male	16 (45.7)	10 (28.6)	9 (25.7)			
Female	25 (65.8)	6 (15.8)	7 (18.4)			
Nationality (n=73)				7.871	2	**0.020**
Malaysian	40 (59.7)	12 (17.9)	15 (22.4)			
Non-Malaysian	1 (16.7)	4 (66.7)	1 (16.7)			
Ethnicity (Malaysian) (n=67)				12.420	6	0.053
Malay	33 (70.2)	6 (12.8)	8 (10.5)			
Chinese	4 (36.4)	3 (27.3)	4 (36.4)			
Indian	2 (33.3)	1 (1.0)	3 (50.0)			
Others	1 (33.3)	2 (66.7)	0 (0)			
Occupation (n=43)				28.324	8	**<0.001**
Manual worker	0 (0)	3(75.0)	1 (25.0)			
Office worker	3 (50.0)	1 (16.7)	2 (33.3)			
Students	5 (71.4)	2 (28.6)	0 (0)			
Unemployed	1 (7.7)	2 (15.4)	10 (76.9)			
Others	10 (76.9)	2 (15.4)	1 (7.7)			
Presenting interval (n=66)				0.857	2	0.652
3 days or less	25 (65.8)	8 (21.1)	5 (13.2)			
More than 3 days	16 (57.1)	6 (21.4)	6 (21.4)			
Source of referral (n=34)				9.722	6	0.137
Health clinic or general practitioner	4 (40.0)	1 (10.0)	5 (50.0)			
Other ophthalmologist	0 (0)	1 (25.0)	3 (75.0)			
Other specialty	9 (75.0)	2 (16.7)	1 (8.3)			
Other sources	3 (37.5)	2 (25.0)	3 (37.5)			
Laterality (n=73)				2.578	2	0.276
Right eye	16 (48.5)	7 (21.2)	10 (30.3)			
Left eye	25 (62.5)	9 (22.5)	6 (15.0)			

Contact lens use (n=73)				17.977	2	**<0.001**
Yes	28 (77.8)	7 (19.4)	1 (2.8)			
No	13 (35.1)	9 (24.3)	15 (40.5)			
Ocular surface disease (n=73)				6.065	2	**0.048**
Yes	4 (30.8)	3 (23.1)	6 (46.2)			
	37 (61.7)	13 (21.7)	10 (16.7)			
Size (n=66)				29.951	4	**<0.001**
2 mm or less	18 (75.0)	5 (20.8)	1 (4.2)			
More than 2 to 4 mm	16 (59.3)	8 (29.6)	3 (11.1)			
More than 4 mm	2 (13.3)	2 (13.3)	11 (73.3)			
Location (n=72)				9.817	4	**0.044**
Peripheral	9 (81.1)	2 (18.2)	0 (0)			
Paracentral	16 (66.7)	5 (20.8)	3 (12.5)			
Central	16 (40.5)	9 (24.3)	13 (35.1)			
Hypopyon (n=73)				5.608	2	0.061
Present	8 (36.4)	6 (27.3)	8 (36.4)			
Absent	33 (64.7)	10 (19.6)	8 (15.7)			
Hospitalisation duration (n=66)				12.876	2	**0.002**
7 days or less	22 (81.5)	4 (14.8)	1 (3.7)			
More than 7 days	15 (38.5)	12 (30.8)	12 (30.8)			
Presenting UCVA (n=72)				21.042	4	**<0.000**
Good : 6/6 - 6/12	8 (100)	0 (0)	0 (0)			
Moderate: 6/15 - 6/60	21 (72.4)	7 (24.1)	1 (3.4)			
Blind : worse than 3/60	12 (34.3)	9 (25.7)	14 (40.0)			

SD, standard deviation; UCVA, uncorrected visual acuity; BSCVA, best spectacle-corrected visual acuity.

Table 4. Table of published microbial keratitis case reviews in Malaysia.

Author	**Year**	**N**	**Aspect studied**
Hooi *et al*	2005	101	Culture-proven bacterial keratitis
Norina *et al*	2008	42	Microbial keratitis
Kadir AJ *et al*	2008	87	Corneal ulcers
Kursiah *et al*	2008	28	Corneal ulcers
Reddy *et al*	2008	56	CLRMK
Wajin *et al*	2008	20	CLRMK

CLRMK, contact lens related microbial keratitis

change too. It was reported in Hong Kong that the risk factors change from ocular surface disease to CL use after a lapse of 15 years. They also reported however, consistency in the microbial pattern for contact lens related microbial keratitis (CLRMK) where *Pseudomonas* was followed by coagulase-negative *Staphylococcus* as important causative agents. It is therefore important to study and track these changes so that updated and precise strategy could be adopted and lead to lower incidence of, and better outcome following MK.

To the best of our knowledge, after searching the published online reports in the internet on this subject matter, this study is currently the largest single-centre study on MK in Malaysia to date. We included 180 eyes from 174 patients who were diagnosed with MK over a period of eight years in this review. Among other studies that were reported in Malaysia are listed in **Table 4**.

Our study was comparable in the age, which ranged from 2 to 83 years, to other studies. However, our cases were relatively younger with a mean age of 35.2 years compared to 46.2 to 54.1 years that were reported in those studies (2, 12, 15, 16). There seemed to be biphasic distribution of MK according to age. The taller first peak was in the third decade of life whereas the smaller second peak was in the seventh decade. Although not statistically significant, this observation can be attributed to a seemingly existed trend between certain risk factors and age group, where trauma and CL use were more commonly found among the young and ocular surface disease and impaired immunity in elderly patients. In term of gender, most studies including ours, reported male preponderance of between 51.5% and 66.2% of their cases, although not statistically significant. This was more likely so in populations where trauma was an important risk factors for the MK (17-19).

The influence of occupation has been widely studied in MK reports (19, 20). We found that many of our cases were not occupation-related and thus explained the small number of cases with their occupation recorded. Because of this, despite observing a significant association between occupation and the presenting UCVA, we suggest that this observable difference be taken cautiously, and a more focused attention and emphasise be paid upon this aspect in future MK studies.

Precedent ocular risk factor

At least a single identifiable risk factor was found in 93.3% of our cases, which was comparable with 72.6% to 92.0% rates reported in other studies (2, 6, 17, 19). In nearly half of the cases (85, 47.2%) in our study, CL was reported as the predisposing risk factor for MK. Other risk factors, in order of descending frequency, included trauma (50 cases, 27.6%), ocular surface diseases (21 cases, 11.6%), ocular surgery (1 case, 0.6%) and immuno-compromy (19 cases, 10.5%) and steroid use (6 cases, 3.3%). While non-surgical trauma is the major risk factors for MK in developing countries (3, 21), CL use and ocular surface diseases are the major risk factors found in developed country (2, 15, 16). In Malaysia, trauma was the leading predisposing factors in sub-urban region (5, 8) and CL in the more urbanized population (7). In our study, CL was the most frequent predisposing risk factor. This could be due to the fact that the population served by our centre was inhomogeneous with predominance of urban population. CL users should be educated of proper use and care of different types of CL available in the market as well as the potential harms arising from its use including the MK. The presence of manufacturing and construction industries in nearby areas formed the bases which explained trauma as the next most frequent risk factor after CL. Soft daily wear contact lens was the most frequent type of contact lens associated with MK (43%) (22) and the several risky behaviours for CLRMK which included suboptimum lens care practice (23, 24). Overnight use and full time extended wear increase risk for MK by between 2 and 5-fold, compared to daily wear (25).

Most cases were either referred by the general medical practitioner clinic and community health clinic (HCC) or by other subspecialty such as the Accident and Emergency Department (AED). This underlined the importance of medical officers to be aware of this condition to diagnose and refer MK cases for further management by ophthalmologist. More than half (53.3%) of the cases had presented within 3 days from the onset of the symptoms. The mean presenting time of 4.67 days in this study was similar to that reported in an earlier local study (6). However, it was shorter compared to presenting time of 8.9 and 11.7 days reported by Wong *et al* (2) and Yilmaz *et al* (19), respectively. Majority of our cases (n=151, 90.0%) presented within not more than a week from the start of their symptoms. Tananuvat *et al* and Yilmaz *et al* reported that 55.4% and 24.2% of their cases presented after one week of symptoms (17, 19). This was attributed to limited access to healthcare facility especially ophthalmology clinic, or due to the patients seeking treatment elsewhere before presenting to the ophthalmology clinic. Our centre was readily accessible by locals and legal foreigners and this could have contributed to high proportion of cases presented within a week of the starting of symptoms.

The average largest dimension of the infiltrate was 3.59 mm (SD 0.23 mm). About 40% of our cases were 2 mm or less in their largest diameter, and about 30% between more than 2 to 4 mm while another 30% were more than 4 mm in their largest diameter. Kadir *et al* reported 24.1% of their cases had up to 2 mm, 43.6% had from 2 to up to 4 mm, and 32.2% had more than 4 mm in size (7). Hooi *et al* reported approximately 50% of their cases had keratitis larger than 4 mm in largest dimension (6). The relatively smaller proportion of large keratitis in our series compared to those of other studies could be due to the shorter presenting interval.

In this study, the peripheral, paracental and central cornea were involved in 14.7%, 35.6% and 49.7%, respectively while hypopyon was recorded in approximately a third of the cases. A local study had reported a higher proportion of central keratitis of 69% (5). In a study conducted in Thailand, peripheral keratitis were reported in 7%, paracentral in 49.54% and central ulcer in 43.46% of their cases with 32.24% of cases presented with hypopyon (17). We found that hypopyon were significantly associated with large ($p<0.001$) and centrally located ($p<0.001$) keratitis, which was consistent with a previous local study (6).

Bacteriological work-up was performed in the majority of eyes which included corneal scrapings for gram stain (157, 86.7%) and for culture and sensitivity test (158, 87.3%). Our rate of gram stain-positive result was slightly above a quarter (26.8%) of the cases. This was lower compared to other studies. Hooi *et al* reported bacteria were found in gram staining of 39.6% cases (6). Tananuwat reviewed MK in northern Thailand and found approximately a third (33.86%) of cases were positive for smears. In contrast to our result, they found bacteria in 42 out of 64 (65.6%) positive cases. Fifty percent of the bacteria were gram-positive cocci (26).

Our rate of culture positivity (47.5%) was higher compared to those in Thailand (25.6 to 30.16%) (17, 18) and Turkey (36.3%) (19) but lower compared to other studies in developing country such as India (20) and developed countries such as New Zealand (71%) (2) and the USA (63-82%) (27). This variation could be due to the scraping technique, culture methods and the types of involved organisms. Positive cultures enable sensitivity test and increase the opportunity to successfully control the infection.

It was observed in this study that the age group was associated with the presenting UCVA. Elderly patients were more likely to present with poorer UCVA than a younger patient. This could be attributed to the possibly higher prevalence of ocular surface disease and delayed treatment as they were dependant on their caretakers to seek treatment. No precedent ocular risk factors including CL use, trauma, ocular surface disease, ocular surgery, steroid use and immune-suppression was associated with presenting UCVA. Despite the relatively early presentation, only 12.5% of our cases had UCVA of 6/12 or better while nearly half (n=83, 47.2%) of our cases presented with visions worse than 3/60. Categorically, the latter group met the criteria of blind eye, as defined by the WHO. This alarming fact stemmed to the findings of high proportion of large, central severe keratitis reported in our series. We demonstrated that severity parameters such as the size, location and hypopyon were all associated with the poor presenting UCVA. A large lesion is more likely to affect the visual axis compared to small lesions, thus explained the poorer UCVA in this case. Likewise, a centrally located lesion directly blocked the visual axis leading to poorer UCVA than in the peripherally located lesion. Age group, location and hypopyon were found to be significant association factors after ruling out confounding effects through multivariable analysis.

Although majority (n=41, 56.2%) of our cases attained good BSCVA following recovery from MK, a sizable proportion of them (n=16, 21.9%) had vision worse than 3/60, or blind. Elderly patients had higher risk for poor final BSCVA compared to young patients. This could be attributable to the poorer UCVA and higher ocular surface conditions they presented with, and poorer healing capability. Most Malaysian cases (59.7%) had good final BSCVA compared to foreigners who on the other hand, mostly (66.7%) had moderate final BSCVA. More emphasised should be placed to educate the foreigners on the importance of prevention, treatment and visual rehabilitation should they contracted microbial keratitis. Although occupation was significantly associated with final BSCVA, this findings warrant further investigation in preferably larger prospective study as the relatively small sample size with occupation data had resulted in unreliable statistical test.

It is interesting to note that CLRMK had higher proportion of good final BSCVA compared to the non-users. Only one case (2.8%) had blind final BSCVA compared to 40.5% among non-users. This findings was in agreement with that reported locally (6). Ocular surface disease predisposes the cornea for infection and renders the cornea less able to regenerate new epithelium, and often occurs in dry eyes, trichiasis and lagophthalmous. This increased the proportion of poor final vision among the cases with compared to those without ocular surface diseases.

We found that size and location but not hypopyon predicted poorer BSCVA which is was in agreement with another report (7). In our study, multivariate analysis showed CL use and size of keratitis were predictors after excluding the confounding effect of age group, nationality, ocular surface disease, location, hospitalisation duration and presenting UCVA.

This study was not spared from the disadvantages of a retrospective study design whereby some data were missing. This could be attributable to defaulted cases, especially among the foreigners. Nevertheless, data from the included samples had enabled associations to be determined from this study. It is only appropriate to proposed that a standardised practice and record system for MK cases across all participating centres be organised to allow larger prospective multicentre researches be conducted and yield collective data for stronger and more precise conclusions to eventually improve the management and outcome of cases in the future.

CONCLUSIONS

Although recovered from the microbial keratitis, a proportion of the patients had poor visual outcome. Contact lens was the most frequent risk factor for microbial keratitis, followed by ocular trauma. Association factors for presenting vision were age group, location of keratitis and presence of hypopyon. Predictors for final visual outcome were contact lens use and size of keratitis.

ACKNOWLEDGEMENTS

We would like to thank the Director General of Health Malaysia for giving the permission to publish this article and the Research Management Centre (RMC), Universiti Putra Malaysia for their kind assistance. The authors claim to have no financial interest in the commercial products in this study.

REFERENCES

1. Lam DS, Houang E, Fan DS, Lyon D, Seal D, Wong E. Incidence and risk factors for microbial keratitis in Hong Kong: comparison with Europe and North America. Eye (Lond). 2002 Sep;16(5):608-18.
2. Wong T, Ormonde S, Gamble G, McGhee CNJ. Severe infective keratitis leading to hospital admission in New Zealand. Br J Ophthalmol. 2003 September 1, 2003;87(9):1103-8.
3. Bharathi MJ, Ramakrishnan R, Meenakshi R, Padmavathy S, Shivakumar C, Srinivasan M. Microbial keratitis in South India: influence of risk factors, climate, and geographical variation. Ophthalmic Epidemiol. 2007;14(2):61-9.
4. Goh PP, Shamala R, Chandamalar S, Tai XY. Contact lens--related corneal ulcer: a two-year review. Med J Malaysia. 2010 Jun;65 Suppl A:120-3.
5. Norina TJ, Raihan S, Bakiah S, Ezanee M, Liza-Sharmini AT, Wan Hazzabah WH. Microbial keratitis: aetiological diagnosis and clinical features in patients admitted to Hospital Universiti Sains Malaysia. Singapore Med J. 2008 Jan;49(1):67-71.
6. Hooi SH, Hooi ST. Culture-proven bacterial keratitis in a Malaysian general hospital. Med J Malaysia. 2005 Dec;60(5):614-23.
7. Kadir AJ, Samsudin A, Fauzi A, Abidin ZZ. Review of corneal ulcers at University Malaya Medical Centre. International Journal of Ophthalmology. 2008;8(12):2376-80.
8. Kursiah MR, Sharif FM, Balaravi P. Retrospective review of corneal ulcers in Ipoh Hospital. Med J Malaysia. 2008 Dec;63(5):391-4.
9. Lorenzo-Morales J, Khan NA, Walochnik J. An update on Acanthamoeba keratitis: diagnosis, pathogenesis and treatment. Parasite. 2015;22:10.
10. Lorenzo-Morales J, Martín-Navarro CM, López-Arencibia A, Arnalich-Montiel F, Piñero JE, Valladares B. Acanthamoeba keratitis: an emerging disease gathering importance worldwide? Trends in Parasitology. 2013;29(4):181-7.
11. Holladay JT. Visual acuity measurements. J Cataract Refract Surg. 2004;30(2):287-90.
12. Kampitak K, Patrasuwan S, Kongsomboon K. Cost evaluation of corneal ulcer treatment. J Med Assoc Thai. 2013;96(4):456-9.
13. Houang E, Lam D, Fan D, Seal D. Microbial keratitis in Hong Kong: relationship to climate, environment and contact-lens disinfection. Trans R Soc Trop Med Hyg. 2001;95(4):361-7.
14. Shah A, Sachdev A, Coggon D, Hossain P. Geographic variations in microbial keratitis: an analysis of the peer-reviewed literature. Br J Ophthalmol.2011 Jun;95(6):762-7. doi(2011 Apr 8):10.1136/bjo.2009.169607.
15. Fong C-F, Tseng C-H, Hu F-R, Wang IJ, Chen W-L, Hou Y-C. Clinical characteristics of microbial keratitis in a university hospital in Taiwan. Am J Ophthalmol. 2004;137(2):329-36.
16. Ng AL-K, To KK-W, Yuen LH, Yim S-M, Chan KS-K, Lai JS-M, et al. Predisposing Factors, Microbial Characteristics, and Clinical Outcome of Microbial Keratitis in a Tertiary Centre in Hong Kong: A 10-Year Experience. Journal of Ophthalmology. 2015;2015.
17. Tananuvat N, Sienglew S, Ausayakhun S. Microbial keratitis leading to admission at Maharaj Nakorn Chiang Mai Hospital. Chiang Mai Med J. 2004;43(3):93-103.
18. Tananuvat N, Punyakhum O, Ausayakhun S, Chaidaroon W. Etiology and clinical outcomes of microbial keratitis at a tertiary eye-care center in Northern Thailand. J Med Assoc Thai. 2012 Apr;95 Suppl 4:S8-17.
19. Yilmaz S, Ozturk I, Maden A. Microbial keratitis in West Anatolia, Turkey: a retrospective review. Int Ophthalmol. 2007 Aug;27(4):261-8.
20. Gopinathan U, Sharma S, Garg P, Rao GN. Review of epidemiological features, microbiological diagnosis and treatment outcome of microbial keratitis: experience of over a decade. Indian J Ophthalmol. (10):2009 Jul-Aug;57(4):273-9.
21. Sethi S, Sethi MJ, Iqbal R. Causes of microbial keratitis in patients attending an eye clinic at Peshawar. Gomal Journal of Medical Sciences. 2010;8(1).
22. Mah-Sadorra JH, Yavuz SGA, Najjar DM, Laibson PR, Rapuano CJ, Cohen EJ. Trends in Contact Lens–Related Corneal Ulcers. Cornea. 2005;24(1):51-8.
23. Lili I, Lekhraj R, Hejar AR, Nazri O, Habshah M, Azrin EA. Non-compliance to lens care procedures in patients with contact lens related microbial keratitis. SEGi Review. 2012;5(1):14-20.
24. Lili I, Lekhraj R, Hejar AR, Nazri O, Habshah M, Azrin EA. Risk factors associated with contact lens

related microbial keratitis. Malaysian J Med Health Sci. [original article]. 2016;12(1):3-10.
25. Keay L, Stapleton F. Development and evaluation of evidence-based guidelines on contact lens-related microbial keratitis. Cont Lens Anterior Eye. (2007 Nov 26):2008 Feb;31(1):3-12.
26. Tananuvat N, Salakthuantee K, Vanittanakom N, Pongpom M, Ausayakhun S. Prospective comparison between conventional microbial work-up vs PCR in the diagnosis of fungal keratitis. Eye. 2012 10//print;26(10):1337-43.
27. Sand D, She R, Shulman IA, Chen DS, Schur M, Hsu HY. Microbial keratitis in Los Angeles: The Doheny Eye Institute and the Los Angeles County Hospital experience. Ophthalmology. 2015 May;122(5):918-24.