Mooren's ulcer in Uganda: A prospective observational case series

Kavuma D[1], Arunga S[2,3], Onyango J[2], Leck A[3], Hoffman JJ[3], Hu VH[3], Burton M[3,4]

[1]Faculty of Medicine, Kabale University, Uganda
[2]Department of Ophthalmology, Mbarara University of Science and Technology, Uganda
[3]International Centre for Eye Health, London School of Hygiene & Tropical Medicine, UK
[4]Moorfields Eye Hospital, London, UK

Corresponding author: Dr Denise Kavuma, Faculty of Medicine, Kabale University, Kabale, Uganda.
Email: dkavuma@kab.ac.ug

ABSTRACT

Background: Mooren's ulcer is a progressive, chronic, and painful peripheral ulceration of the cornea, commonly seen in adult men. In our set up, it has been observed to be aggressive and difficult to treat, often resulting in poor visual outcomes. There is limited published evidence on its management.
Objective: Our aim was to describe the presentation, treatment and outcomes of patients presenting with Mooren's ulcer in Mbarara, Uganda over a defined time period.
Methods: A prospective case series conducted over 3 months from August 2017 to November 2017, with scheduled reviews up to 3 months. Participants' history, presentation, management and clinical course were captured. Laboratory investigations for underlying systemic diseases were performed, in addition to corneal microbiology testing.
Results: A total of eight patients (6 males and 2 females) were enrolled. The median age was 26 years (IQR 22-27.5, full range 16-32). A history of trauma was present in 3 (38%) of cases. The earliest presenting time was one month after start of symptoms. At presentation, 2 (25%) patients had normal vision, 3 (38%) had moderate vision impairment (VI), 1 (12%) had severe VI, and 2 (25%) were blind. There was no systemic disease diagnosed on investigation, but corneal microbiology revealed 3 (38%) ulcers had fungal co-infections. At 3 months, 4 (50%) patients had normal vision, 1 (12%) had moderate VI, and 3 (38%) were blind. No patients required evisceration or enucleation.
Conclusion: Most patients were below 30 years and presented late to the hospital, with advanced ulcers, leading to outcomes ranging from good to poor. Mooren's ulcer is difficult to treat and further studies to assess risk factors would be beneficial in providing evidence for better management of this condition, particularly in resource limited settings.

Key words: Moorens ulcer, Peripheral keratitis, Marginal keratitis, Peripheral ulcerative Keratitis

INTRODUCTION

Mooren's ulcer is an idiopathic, chronic inflammation of the corneal periphery that progresses centrally, centrifugally, and posteriorly, with eventual corneal thinning. The ulcer may involve the full thickness of the cornea, leading to perforation[1]. While the aetiology is unknown, Mooren's ulcer is considered to be an autoimmune disease. It is a rare disease that is hard to manage and can lead to blindness. The median age of onset varies depending on geographical location. Studies from Africa have shown the mean age of onset to be between 20 to 30 years, while those from Asia reveal the onset to be between the 6th and 8th decades[2]. It is often seen in healthy adult men with no evidence of systemic disease[3].

On presentation, patients often complain of photophobia, tearing, severe pain and red, inflamed eyes. Some studies show that clinical presentation and demographic characteristics may differ in children[4]. Examination on the slit-lamp typically shows a crescent-shaped corneal ulcer on the periphery with an undermined central edge. A linear epithelial defect may also develop. Stromal melting can follow, with the ulcer progressing both circumferentially and centrally. This leads to corneal thinning, perforation, severe astigmatism and conjunctival or episcleral inflammation. Complications including iritis, astigmatism and central corneal scarring lead to decreased visual acuity[2].

Mooren's ulcer is a diagnosis of exclusion; other potential causes of peripheral ulcerative keratopathy, including those associated with underlying systemic disease, must be considered and ruled out with appropriate investigations[5]. Treatment is challenging, often with poor clinical outcome. Therapeutic options include steroid therapy (topical and/or systemic), conjunctival resection, conjunctival cryotherapy, immunosuppressive therapy, and surgical intervention[6]. Evidence for Moreen's ulcer treatment is scanty: no randomized control trial has been done to show which treatment modality is the most effective.

A retrospective audit on Mooren's ulcer from Southwestern Uganda found limited evidence to guide clinical practice[7]. In order to address this, this study was undertaken, to provide more data on this rare but potentially blinding disease.

MATERIALS AND METHODS

This study was approved by the regional Research Ethics Committee and conformed to the tenets of the Declaration of Helsinki. The total study duration was six months: patients recruitment for three months, who were followed up for a subsequent six months.

Study participants

All patients attending the recruitment centres clinically diagnosed with Mooren's ulcer between 15th August 2017 to 15th November 2017 were enrolled. Data on history, clinical examinations, treatment, and follow up were recorded. The definitions used were:

(i) *Early case of Mooren's ulcer*: This was defined as a unilateral active crescent-shaped peripheral ulcer manifesting with stromal ulceration and an undermined central edge, typical of Mooren's ulcer. No perforation and no impending perforations, with less than 50% stromal thinning , and normal anterior chamber and iris; or anterior chamber inflammation but with normal iris[8].

(ii) *Advanced Mooren's ulcer*: Active peripheral ulceration with more than 50% stromal melting showing impending perforations or already perforated corneas. Bilateral disease and anterior chamber inflammation, or iris were also included in this category[8,9].

Assessment

The demographic details and history from each patient were recorded according to the agreed protocol. Snellen vision assessment was done in a well-lit room, at 6 meters, using the World Health Organization classification of vision system[10]. All participants were assessed on a slit-lamp, following the structured protocol with details on assessment of eyelids, ocular surface features, corneal ulcer details (site, perforation, size, infiltrate status), and anterior chamber and iris inflammation. The bulbar conjunctival hyperaemia was graded using the Efron Grading Scales, which assigns 5 grades, from grade zero to grade four[11]. The anterior chamber inflammation was graded using the SUN Working Group Scheme[12]. A senior ophthalmology resident and consultant ophthalmologist assessed the patients on each review, filling the protocol form independently and discussing any varied findings until a consensus was reached. After a clinical diagnosis, all the study participants had the following investigations performed: Complete Blood Count (CBC), Rheumatoid Factor (RF), Routine Counselling and HIV Test (RCT), Random Blood Sugar (RBS), Erythrocyte Sedimentation Rate (ESR), VDRL, stool analysis for parasites, and Chest X-Ray (CXR). All the patients also had corneal tissue specimens collected for microbiology. The corneal scrape samples were processed at the a microbiology laboratory using Gram stain, Potassium Hydroxide (KOH) wet preparation, calcofluor white stain, lactophenol cotton blue stain, culture on blood agar, chocolate agar, potato dextrose agar and in brain heart infusion broth.

Treatment and follow-up

Each patient was initially treated empirically with prednisolone 1% eye drops (locally formulated) 2-hourly and ofloxacin 3% eye drops (Biomedica Remedies, India) 2-hourly, until microbiology results were available. After review of the microbiology results, patients with no evidence of infection stopped using the antibiotic eye drops and continued receiving the same prednisolone that was initially given.

Patients with fungal co-infection were treated with natamycin 5% eye drops (Zonat Sunways, India) hourly and topical steroid treatment was halted and restarted at the clinician's discretion during follow-up. The prednisolone eye-drops were tapered at the clinician's discretion, depending on the response of the inflammation to medication, and eventually replaced with prednisolone 0.5% eye drops (locally formulated)[13,14]. Every patient was also treated with atropine 1% eye drops (locally formulated). Increased intraocular pressure was treated with timolol 0.5% eye drops (locally formulated). Patients with Mooren's ulcers that were perforated or had impending perforations, also received prednisolone tablets starting with 60mg once daily, which was slowly tapered over the course of the reviews by 5mg decrements every week[15]. All locally made drugs were formulated. The consultant ophthalmologist and senior ophthalmology resident discussed treatment decisions on each review. Each patient was followed up for 3 months, at intervals of 1 week, 3 weeks and at 3 months. The treatment was adjusted accordingly on each review, depending on the response. Clinical photographs were taken after each assessment and review, using a Nikon SLR D7000 camera with a 105mm macro lens.

Each case is reported individually, presented with their clinical photographs. The main outcome measures were best corrected visual acuity on the final day of follow-up at 3 months, and inflammation status of the eye on slit-lamp examination, progression of ulceration. A good outcome is defined as cessation of inflammation with normal vision, no active ulceration, and no pain, or normal vision with minimal inflammation, which is defined as grade 2 or lower conjunctival injection and grade 1 or lower anterior chamber cells, with early active ulceration. A moderate outcome was defined as cessation of inflammation with poor vision, or continuing inflammation with poor vision but with preservation of the eye. A poor outcome was one in which the eye was removed, or advanced active ulceration and inflammation with poor vision.

RESULTS

A total of eight patients were enrolled over 3 months. Two of the participants were female, giving a male to female ratio of 4:1. The median age was 26 years, (IQR 22.0-27.5), with a range of 16-32 years. A summary of the demographic characteristics can be found in Table 1, together with clinical features at presentation and final review.

Table 1: Patient characteristics at presentation and visual outcome

Case	Age (Years)	Sex	History of Trauma	TEM Use	Duration of symptoms before presenting to hospital (Months)	Presenting Vision (Snellen)	Perforation on presentation	Co-infection	Final Vision (Snellen)	Status on day 90	Final outcome
1	27	M	Yes	Yes	10	1/60	Yes	Fungal	PL	360-degree ulceration	Moderate
2	23	M	No	Yes	2	3/60	Yes	Fungal	HM	Total corneal involvement	Poor
3	16	M	No	Yes	2	6/12	No	None	6/7.5	Reactivation after healing and default from treatment	Good
4	28	F	Yes	Yes	1	HM	Yes	None	1/60	Reactivation after default from treatment	Moderate
5	25	M	No	Yes	1	6/6	No	None	6/6	Reactivation after healing	Good
6	32	M	No	Yes	1	6/24	No	Fungal	6/12	Healed	Good
7	21	F	No	Yes	2	6/48	No	None	6/48	Active inflammation with associated corneal fungal infiltrates after default from treatment	Moderate
8	27	M	Yes	Yes	2	6/24	No	None	6/18	Healed	Good

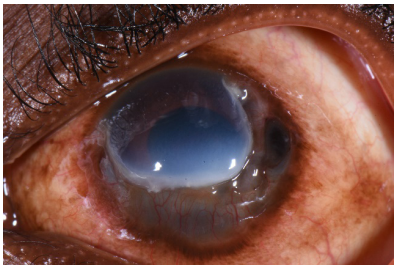
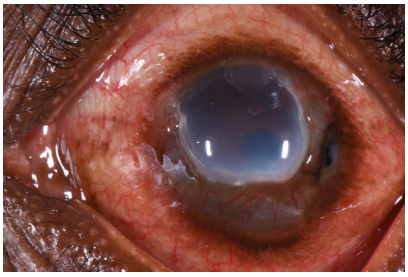
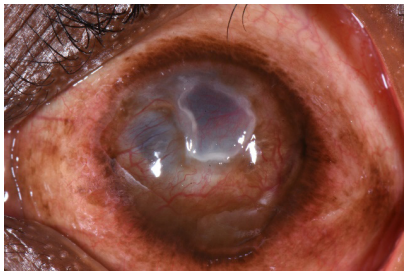
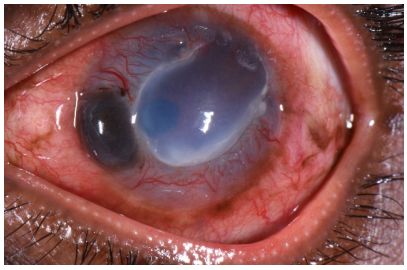
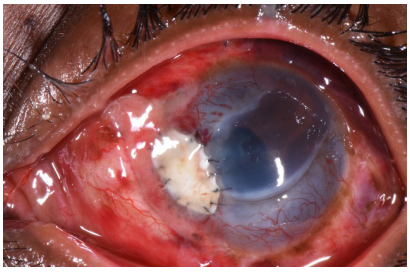
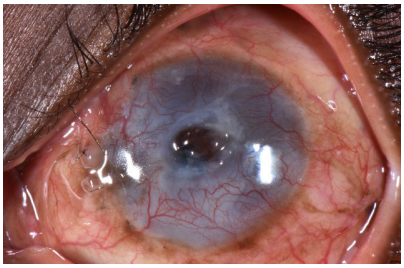
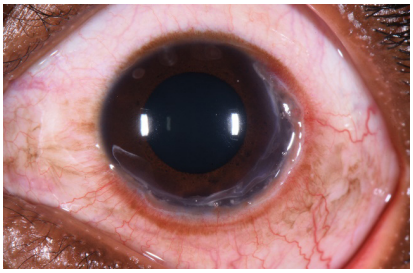
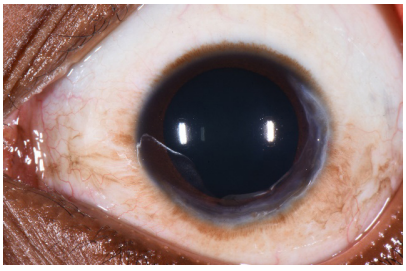
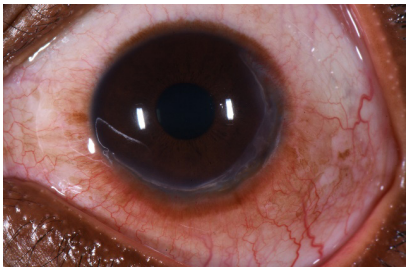
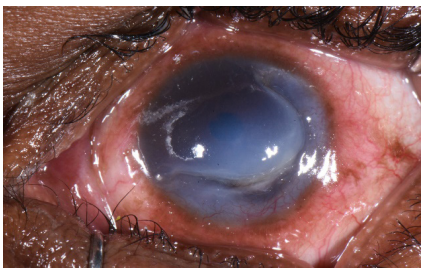
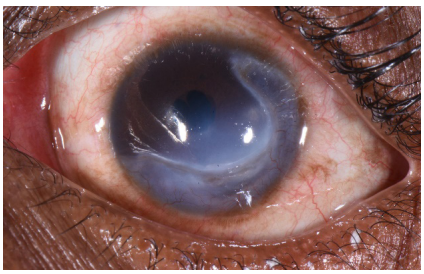
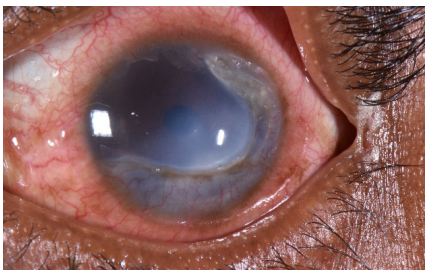
Legend: TEM: Traditional Eye Medicine; PL: Perception of Light; HM: Hand Motion

All the patients presented with a history of pain and redness for at least one month before coming to the hospital, and all the patients had used Traditional Eye Medication (TEM) before presenting to hospital. Three patients (38%) reported a history of non-penetrating trauma. Two of the causes of trauma were from sticks and one was from an insect. Three patients (38%) already had perforations at the time of presentation. No patient presented with bilateral disease. At presentation, 2 (25%) patients had normal vision, 3 (38%) had moderate Vision Impairment (VI), 2 (25%) had severe VI, and 1 (12%) was blind. No patient presented with bilateral disease.

Of the systemic investigations done at presentation, only one of the patients had a positive VDRL. This patient did not receive any syphilis treatment and did not attend at the intermediate visits, returning only on the 90th day treatment. On repetition of the test on day 90, the results were negative.

The patient had no symptoms or signs of syphilis from history and examination and the initial test was subsequently reported as a false-positive result. The rest of the systemic tests, for each patient, were normal. Microbiology samples revealed 3 (38%) of the patients had fungal co-infection: calcofluor white preparations were positive; two of whom had also presented with perforated ulcers. Culture results were negative, for all patients. There were no cases of bacterial co-infection.

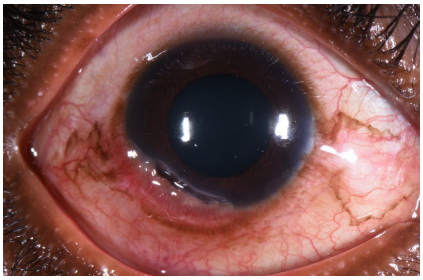
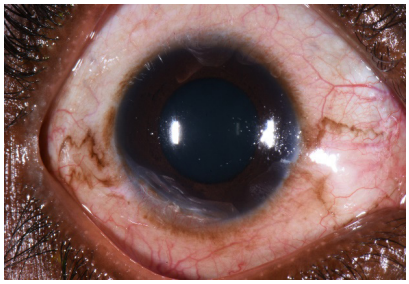
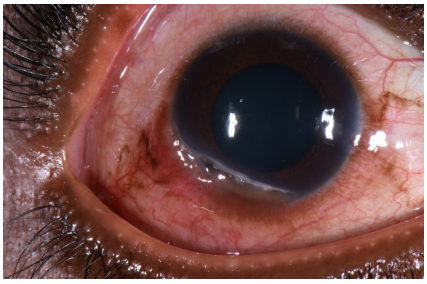
Three of the patients missed at least one review, however all the patients were reviewed on day 90. None of the patients developed any new perforations after presentation. At 3 months, 4 (50%) patients had normal vision, 1 (12%) had moderate VI, 1 (12%) had severe VI, and 2 (25%) were blind. Four patients (50%) had a good outcome, three (38%) had a moderate outcome, and 1 (12%) had a poor outcome. The images and details of follow-up can be found in Figure 1.

Presentation	Interim follow-up	Final follow-up
Case 1: Advanced Mooren's ulcer with a perforated ulcer spanning 8 clock hours, with fungal co-infection. Vision 1/60. The patient was initially started on prednisolone 1% eyedrops, which were stopped after microbiology results showed fungal co-infection. He was then started on natamycin 5% eyedrops and prednisolone tablets	Day 21: The ulcer had extended to span 9 clock hours, with increased inflammation. The same treatment was continued	Day 90: A 360 degree spread of ulcer with no pain and highly vascularized. This was a moderate outcome. Vision PL
		
Case 2. An advanced perforated ulcer spanning 10 clock hours, with fungal co-infection. Vision 3/60. The patient was initially started on prednisolone 1% eyedrops, which were stopped after microbiology results showed fungal co-infection. He was then started on natamycin 5% eyedrops and prednisolone tablets	Day 7: Scleral graft done over the perforation. The same treatment was continued	Day 90: poor outcome with failed scleral graft, central perforation and total corneal involvement. Vision HM
		
Case 3: Early Mooren's ulcer spanning 7 clock hours. Vision 6/12. The patient was started on prednisolone 1% eyedrops	Day 21: A healed ulcer with scar. All treatment was stopped.	Day 90: There was reactivation of ulceration. Vision 6/7.5
		
Case 4: Advanced ulcer with perforation spanning 8 clock hours. Vision HM. The patient was started on prednisolone 1% eyedrops and prednisolone tablets	Day 21: Healing ulcer with reduced inflammation. The same treatment was continued	Day 90: Patient had gone off treatment for a month and there was reactivation of inflammation. Vision 1/60.
		

Case 5: Early Mooren's ulcer spanning 3 clock hours. Vision 6/6. The patient was started on prednisolone 1% eyedrops

Day 21: Healing ulcer. The prednisolone 1% eyedrops were tapered slowly

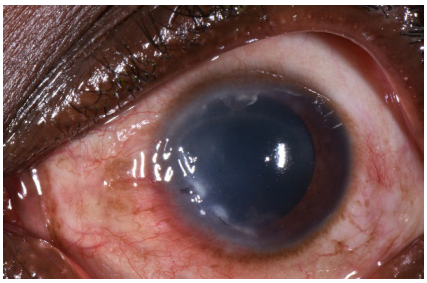
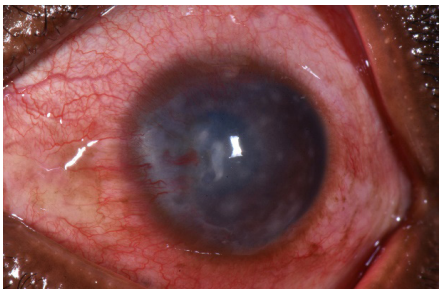
Day 90: Reactivation of the ulcer after healing. Vision still 6/6

Case 6: Early Mooren's ulcer spanning 7 clock hours, with fungal co-infection. Vision 6/24. The patient was initially started on prednisolone 1% eyedrops and prednisolone tablets

Patient did not attend interim reviews and steroid treatment could not be changed after the microbiology results were available

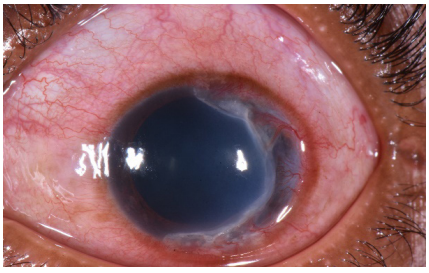
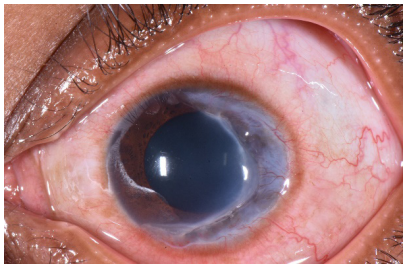
Day 90: Patient returned on the last day with active inflammation and corneal infiltrates. He had been on and off treatment. Poor treatment compliance. Vision 6/12

Case 7: Early ulceration spanning 7 clock hours, with increased intraocular pressure. Vision 6/48. The patient was started on prednisolone 1% and timolol eyedrops

Day 21: Patient did not attend regularly with poor treatment adherence. Whilst on medication, the ulcer was healing. Timolol eye drops were stopped and prednisolone eyedrops were tapered

Day 90: On day 90 of follow-up, the patient had seen no reason to return to hospital and was assessed at her home. She had no complaints of pain, vision in the left eye was 6/48. Microscopic examination could not be performed at this time. All treatment was tapered. No clinical photographs were available.

Case 8: Healing Mooren's ulcer spanning 5 clock hours. Vision 6/24. The patient was started on prednisolone 1% eyedrops

Patient did not attend interim reviews

Day 90: Despite not attending, patient had been compliant with treatment. He returned with a healed ulcer. Vision 6/18

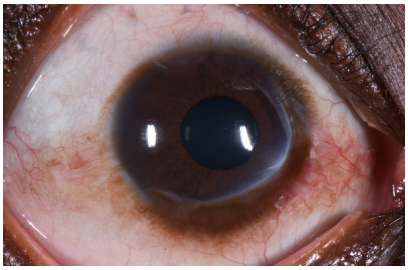
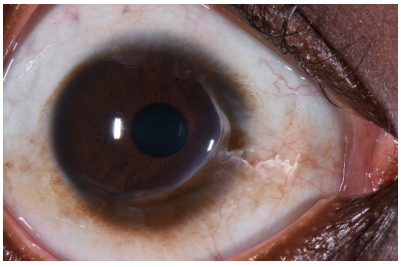



Figure 1: Clinical images of participants' corneas at presentation and follow-up

DISCUSSION

Mooren's ulcer is a relatively rare disease. In keeping with this, 8 patients were enrolled over the course of 3 months. This is in line with a retrospective audit done in Uganda, showing a near doubling of Mooren's ulcer cases over the course of three years, from 14 cases in 2013, to 24 cases in 2015[7]. The participants had a male to female ratio of 4:1. This is comparable to other studies done in Africa with Uganda having a ratio of 8:1, and ratios of 3.6:1 and 4:1 found in different studies in Nigeria[7,16,17]. This value is much higher than the ratio found in Caucasians (1.6:1) and in China (1.35:1), even though the evidence still shows that males are at a higher risk than females[18,19]. The difference between men and women may be attributed to increased risk factors in men, for example, men having more ocular trauma than women but this may differ in various regions[19]. In this study, two of the three patients with a history of trauma were male.

The median age of study participants at 26 years is comparable to other studies on Mooren's ulcer done in Africa[7,16,17,20–22]. This is in contrast to studies from Asia, Europe and North America, where the median age is higher (48 years in China and 65 in India) [9,18,23,24]. Many of the patients presented with an advanced form of Mooren's ulcer; this is similar to a study from Nigeria[22]. This could be attributed to the late presentation of the patients as all of them reported to the hospital after experiencing the symptoms for at least one month and after trying various medications. None of our patients presented with bilateral ulcerations during the follow-up period, which is different from studies done previously, even in Africa, where bilateral ulcerations made up to 30% of all cases[16,20]. Three patients presented with perforated ulcers and these were the ones who had more than half of the cornea involved, with the lesion spanning 6 or more clock hours.

It was interesting to note that three patients had fungal co-infection. It is plausible that this could be attributed to use of Traditional Eye Medication (TEM) to treat the ulceration in the eye. This might not be a reliable indicator because not all patients who used TEM had co-infection. Microscopy should be performed in patients with Moreen's ulcer to rule out co-infection. Where microbiology testing is not possible, antifungal, and antibiotic prophylaxis may need to be guided by local disease patterns. In Uganda, fungal keratitis is the leading cause of microbial keratitis and therefore treatment with a readily available antifungal eyedrop is important[25].

This autoimmune ulceration is often a diagnosis of exclusion[5]. The association of Mooren's ulcer to helminthiasis has been discussed before but there was no such parasitic infestation in our patients on stool examination[26-28]. Additionally, all the tests carried out on the study participants were either negative or normal. One patient tested positive on the VDRL test but had no signs or symptoms of syphilis on history and investigation. A repeat VDRL test after 3 months was negative despite the patient receiving no treatment for syphilis. This likely indicates a false positive test and has no bearing on the Mooren's ulcer diagnosis[29]. This finding can justify the clinical diagnosis of Mooren's ulcer without need for extensive investigations in resource limited settings, where many of the tests are expensive. However, systemic investigations still have a role to play and should be done whenever possible.

The outcomes ranged from good, with the ulceration healed and the vision normal, to poor, with the inflammation still active and the vision poor. Most patients who had moderate or poor outcomes presented with advanced and perforated ulcers. Despite this, there was no eye removal. The poor outcome could be attributed to the severity of the ulceration on presentation.

Additionally, more aggressive forms of Mooren's ulcer have been reported in younger patients, as compared to older ones and this could also contribute to poorer outcomes since our oldest participant was 32 years old. Follow-up of patients in this rural setting can be difficult and some of the patients discontinued their medication, only to return later with worse symptoms and progression of the ulceration. Three of the patients also had reactivation of the ulcer after healing and poor compliance in maintenance of treatment. It is worth considering that patients with Mooren's ulcer need to be on a long course of treatment, for better outcomes.

STUDY LIMITATIONS

Unfortunately, due to resource limitations, a more intensive and regular follow-up schedule, which our patients would have benefited from, was not possible. Additionally, this is a relatively small case series and therefore the evidence provided needs to be interpreted with this in mind. As Mooren's ulcer is a rare disorder, prospective studies are challenging particularly if limited to a single geographical area. A multi-national, prospective study would be highly beneficial, and would provide more generalizable data to ophthalmologists globally.

CONCLUSIONS

(i) There were more males than females in this study, most of them below 30 years of age. The use of Traditional Eye Medicine (TEM) was common.
(ii) The participants of this study presented late to the hospital and so often presented with advanced forms of ulceration.
(iii) Systemic investigations were negative or normal except for one VDRL false positive.
(iv) Some participants presented with fungal co-infected ulcers.

(v) The treatment of Mooren's ulcer is difficult particularly in a resource limited setting where long-term and intensive follow-up is key, and topical steroid therapy may need to be used long-term to prevent reactivation of the ulcer.

(vi) All good outcomes were observed in participants who presented earlier to the hospital, with mild to moderate visual impairment.

RECOMMENDATIONS

(i) The use of Traditional Eye Medication (TEM) is a public health concern and extensive health education needs to be carried out to reduce the frequency. Additionally, adequate yet simplified education on the identification and referral of Mooren's ulcer patients should be emphasized for medical personnel within the country, so there is a reduction in the late presentation of these patients to an eye hospital.

(ii) Clinical diagnosis of Mooren's ulcer would be adequate in low resource settings where extensive systemic investigations are difficult to get

(iii) Further studies to assess the risk factors and efficacy of the medication for Mooren's ulcer would be beneficial.

ACKNOWLEDGMENT

We would like to appreciate Mr Gilbert Arinda and Ms. Pauline Boonabaana for tirelessly filling out the forms of these patients.

Funding: DK was supported by a research funding from Sightsavers. SA was supported by a Research Fellowship from the Commonwealth Eye Health Consortium, funded by The Queen Elizabeth Diamond Jubilee Trust. MJB is supported by the Wellcome Trust (207472/Z/17/Z). The funding organisations were not involved in the design, collection, analysis and review of this manuscript.

Consent for publication: Not applicable. All data were anonymized after extraction from clinical notes.

Availability of data and materials: The data and materials used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests: The authors declare that they have no competing interests.

REFERENCES

1. Foster CS, Kenyon KR, Greiner J, Greineder DK, Friedland B, Allansmith MR. The immunopathology of Mooren's ulcer [Internet]. *Amer J Ophthalmol*. 1979; **88**(2): 149-159. Date of Publication: 1979.; Available from: http://ovidsp.ovid.com/ovidweb.cgi ? T= JS&CSC = Y& NEWS = N&PAGE = fulltext&D = emcl2&AN = 0979211707.
2. Hwang FS, Sirajeldin A, Padhan P. Mooren's ulcer [Internet]. Ophthalmology AA of, editor. Vol. 2016. *Indian J Rheumatol*. 2015;**10**(4): 248. Date of Publication: 01 Dec 2015. Available from: http://ovidsp.ovid.com/ovidweb. cgi?T = JS&CSC = Y&NEWS = N&PAGE = fulltext&D = emed13&AN = 2015113415.
3. Sangwan VS, Zafirakis P, Foster CS. Mooren's ulcer: Current concepts in management [Internet]. *Indian J Ophthalmol*. 1997; **45**(1): 7-17. Date of Publication: 1997; Available from: http: // ovidsp.ovid.com / ovidweb. cgi ? T = JS&CSC = Y&NEWS = N&PAGE =fulltext&D=emed4&AN=1997273497.
4. Mathur A, Ashar J, Sangwan V. Mooren's ulcer in children [Internet]. *Br J Ophthalmol*. 2012; **96**(6):796-800. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T = JS&CSC = Y&NEWS = N&PAGE = fulltext&D = emed 10&AN = 2012294742.
5. Nguyen QD. Mooren's ulcer. Nguyen QD. Moorens ulcer. *Ocul Immunol Uveitis.* [Internet]. 1997 [cited 2017 Jun 11];2(12). Available from: https://uveitis.org/wp-content/uploads/2017/05/moorens_ulcer_diagnosis_management.pdf.
6. Abah ER, Akinwande AO, Pam VA. Mooren's corneal ulceration in a pseudophakic eye: A case report and literature review. *Ann Niger Med.* 2012; **6**(1):50.
7. Kavuma D, Arunga S. The clinical presentation and outcome of Mooren's ulcer at Ruharo Eye Centre, Southwestern Uganda; a hospital based retrospective study. *JOECSA*. 2016; **20**(2): 65-68.
8. Wood TO, Kaufman HE. Mooren's ulcer [Internet]. *Amer J Ophthalmol.* 1971; **71**(1-2): 417-422. Date of Publication: 1971. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T = JS&CSC = Y&NEWS = N&PAGE = fulltext&D = emcl1&AN = 0008604681.
9. Srinivasan M, Zegans ME, Zelefsky JR, Kundu A, Lietman T, Whitcher JP, *et al.* Clinical characteristics of Mooren's ulcer in South India [Internet]. *Br J Ophthalmol*. 2007; **91**(5):570-575. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T = JS&CSC = Y&NEWS = N&PAGE = fulltext&D = med5&AN = 17035269.

10. ICD-11. ICD-11 - Mortality and Morbidity Statistics [Internet]. Vol. 04/2019, World Health Organization. 2019. p. 9D90. Available from: https://icd.who.int/browse11/l-m/en#/http%3A%2F%2Fid.who.int%2Ficd%2Fentity%2F1041487064.
11. Efron N. Efron grading scales for contact lens complications (Millennium Edition), Butterworth-Heinemann. 2000.
12. Jabs DA, Nussenblatt RB, Rosenbaum JT, Atmaca LS, Becker MD, Brezin AP, *et al*. Standardization of uveitis nomenclature for reporting clinical data. Results of the first international workshop. *Am J Ophthalmol*. 2005; **140**(3):509–516.
13. Topical Steroids 101 [Internet]. [cited 2020 Jun 3]. Available from: https://www.reviewofoptometry.com/article/topical-steroids-101.
14. Savvy Steroid Use - American Academy of Ophthalmology [Internet]. [cited 2020 Jun 3]. Available from: https://www.aao.org/eyenet/article/savvy-steroid-use.
15. Liu D, Ahmet A, Ward L, Krishnamoorthy P, Mandelcorn ED, Leigh R, *et al*. A practical guide to the monitoring and management of the complications of systemic corticosteroid therapy. *Allergy, Asthma Clin Immunol*. BioMed Central; 2013; **9**: 1–25.
16. Fasina O, Ogundipe AO, Ezichi EI. Mooren'S ulcer in ibadan, southwest Nigeria. *J West African Coll Surg* [Internet]. 2013; **3**(3):102–119. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T = JS&CSC = Y&NEWS = N&PAGE = fulltext&D = prem&AN = 25717466.
17. Majekodunmi AA. Ecology of Mooren's ulcer in Nigeria [Internet]. *Documenta Ophthalmologica*. 1980; **49**(2): 211-219. Date of Publication: 1980. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T = JS&CSC = Y&NEWS = N&PAGE = fulltext&D = emed1ab&AN = 1981067564.
18. Chen J, Xie H, Gong X, Feng C, Chen L, Wang Z, *et al*. A clinical analysis of Mooren's corneal ulcer. [Chinese] [Internet]. [Zhonghua yan ke za zhi] *Chinese J Ophthalmol.* 1999; **35**(2): 125-128. Date of Publication: Mar 1999. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T = JS&CSC = Y&NEWS = N&PAGE = fulltext&D = emed4&AN = 11835791.
19. Lewallen S, Courtright P. Problems with current concepts of the epidemiology of Mooren's corneal ulcer [Internet]. *Annals Ophthalmol.* 1990; **22**(2): 52-55. Date of Publication: Feb 1990. Available from: http: // ovidsp.ovid.com / ovidweb. cgi? T = JS&CSC = Y&NEWS = N&PAGE = fulltext&D = med3&AN = 2316951.
20. van der Gaag R, Abdillahi H, Stilma JS, Vetter JCM. Circulating antibodies against corneal epithelium and hookworm in patients with Mooren's ulcer from Sierra Leone. *Br J Ophthalmol* [Internet]. 1983; **67**(9):623–628. Available from: http: // ovidsp.ovid.com/ovidweb.cgi? T = JS &CSC = Y&NEWS = N&PAGE = fulltext&D = cagh1&AN = 19840814451.
21. Stilma JS. Conjunctival excision or lamellar scleral autograft in 38 Mooren's ulcers from Sierra Leone. *Br J Ophthalmol* [Internet]. 1983; **67**(7):475–478. Available from: http: // www.ncbi.nlm.nih.gov / pmc/articles/PMC1040097/.
22. Kietzman B. Mooren's ulcer in Nigeria. *Am J Ophthalmol* [Internet]. 1968; **65**(5):679–685. Available from: http://www.sciencedirect.com/science/article/pii/000293946894381X.
23. Kinoshita S, Ohashi Y, Ohji M, Manabe R. Long-term results of keratoepithelioplasty in Mooren's ulcer. *Ophthalmology* [Internet]. 1991; **98**(4):438–445. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T = JS&CSC = Y&NEWS = N&PAGE = fulltext&D = med3&AN = 2052297.
24. Schallenberg M, Westekemper H, Steuhl K-P, Meller D. Amniotic membrane transplantation ineffective as additional therapy in patients with aggressive Mooren's ulcer. *BMC Ophthalmol* [Internet]. 2013; **13**:81. Available from: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3878411/.
25. Arunga S, Kintoki GM, Mwesigye J, Ayebazibwe B, Onyango J, Bazira J, *et al.* Epidemiology of microbial keratitis in Uganda: A cohort study. *Ophthalmic Epidemiol* [Internet]. [cited 2020 Jun 10]; 2020; **27**(2):121–131. Available from: https://www.tandfonline.com/doi/full/10.1080/09286586.2019.1700533.
26. Agarwal P, Singh D, Sinha G, Sharma N, Titiyal JS. Bilateral Mooren's ulcer in a child secondary to helminthic infestation of the gastrointestinal tract [Internet]. *Intern Ophthalmol.* 2012; **32**(5): 463-466. Date of Publication: October 2012. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T = JS&CSC = Y&NEWS = N&PAGE = fulltext&D = emed10b&AN = 2012620552.
27. Zelefsky JR, Srinivasan M, Cunningham ET. Mooren's ulcer [Internet]. *Expert Review Ophthalmol*. 2011; **6**(4): 461-467. Date of Publication: August 2011. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T = JS&CSC = Y&NEWS = N&PAGE = fulltext&D = emed10&AN = 2011469186.
28. Zelefsky JR, Muthaiah S, Arunava K, Lietman T, Whitcher JP, Wang K, *et al.* Hookworm infestation as a risk factor for Mooren's ulcer in South India. *Ophthalmology* [Internet]. 2007; **114**(3):450–453. Available from: http://ovidsp.ovid.com/ovidweb.cgi?T = JS&CSC = Y&NEWS = N&PAGE = fulltext&D = med5&AN = 17123614.
29. Nayak S, Acharjya B. VDRL test and its interpretation. *Indian J Dermatol*. 2012; **57**(1):3–8.