Fungal Infections Following Boston Type 1 Keratoprosthesis Implantation: Literature Review and In Vitro Antifungal Activity of Hypochlorous Acid

Abstract

Purpose

To review the current literature describing cases of fungal keratitis and endophthalmitis following Boston Keratoprosthesis (KPro) implantation, and characterize the antifungal activity of 0.01% hypochlorous acid against medically relevant fungi.

Methods

A literature review of fungal keratitis or endophthalmitis in KPro patients from January 2001 to April 2015, and an in vitro time kill assay characterizing the fungicidal activity of 0.01% hypochlorous acid against fungi causing ocular infections.

Results

Fifteen publications, predominantly retrospective case series, were identified. Infection rates following KPro implantation ranged from 0.009–0.02 fungal infections per patient-year of follow-up. The largest single surgeon series reported an incidence of 2.4% for fungal endophthalmitis during a 10-year period. Causative organisms included both yeasts and molds. Outcomes were favorable if infections were caught early and treated appropriately; less favorable outcomes were reported in developing countries where fungal species are endemic and resources limited.

0.01% hypochlorous acid is rapidly fungicidal, reducing the number of viable yeast cells or mold conidia by at least 99.99% within 60 seconds. The antifungal activity extended to all molds (*Acremonium kiliense, Aspergillus flavus, Aspergillus fumigatus, Fusarium solani, Mucor indicus*) and yeast species (*Candida albicans, Candida parapsilosis*) tested.

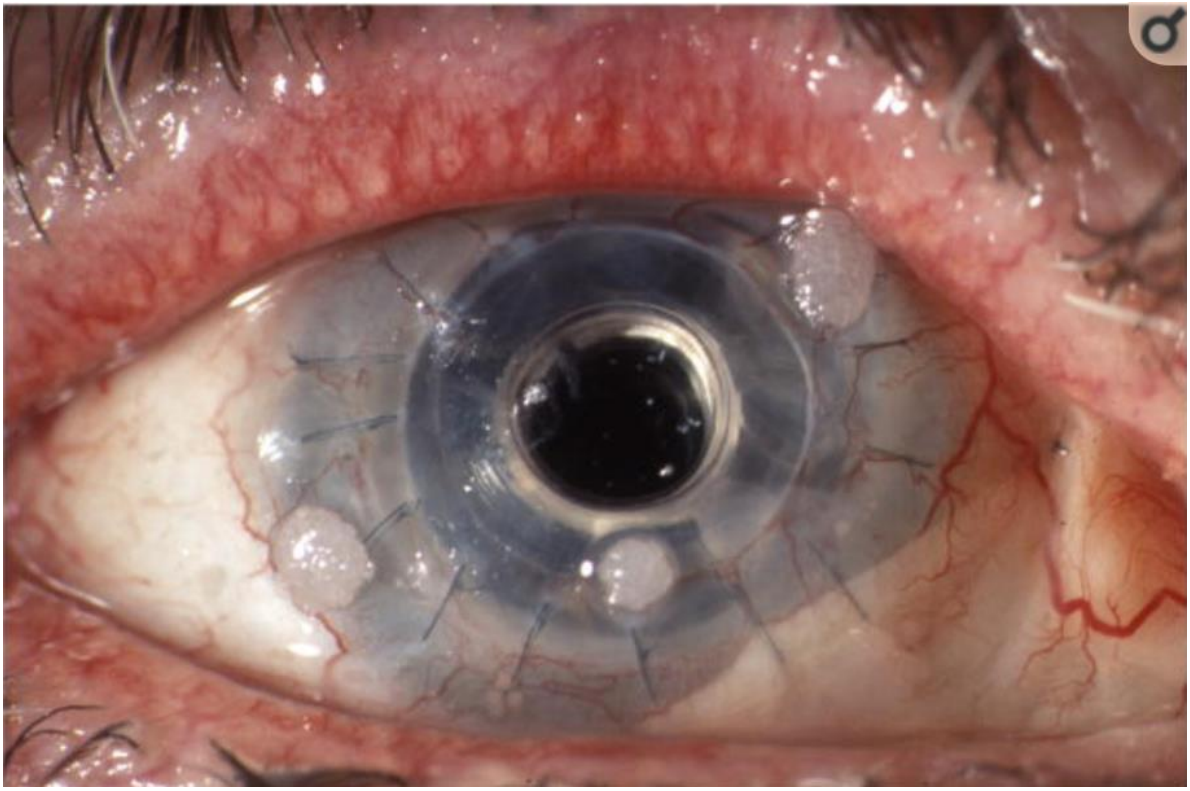
Conclusions

Fungal infections remain a lifelong concern in patients following KPro implantation. There is a growing need for a standard antifungal prophylaxis regimen, especially in the developing world. The rapid broad-spectrum in vitro fungicidal activity of 0.01% hypochlorous acid against all fungi tested makes it an attractive candidate as an antifungal prophylaxis in KPro patients.

Kill Rate after Exposure of Select Fungal Species to 0.01% Hypochlorous Acid for 1 Minute Using a 96-well Microtiter Time Kill Assay.

Fungal Species		Kill rate*
Acremonium kiliense	Mold	≥ 99.999%
Aspergillus flavus	Mold	≥ 99.99%
Aspergillus fumigatus	Mold	≥ 99.999%
Fusarium solani	Mold	≥ 99.99%
Mucor indicus	Mold	≥ 99.99%
Candida albicans	Yeast	≥ 99.999%
Candida parapsilosis	Yeast	≥ 99.99%

*A reduction in viable cells or conidia by four $\log_{10}$ units is reported as a 99.99% kill rate. Results represent the median value of three independent experiments.



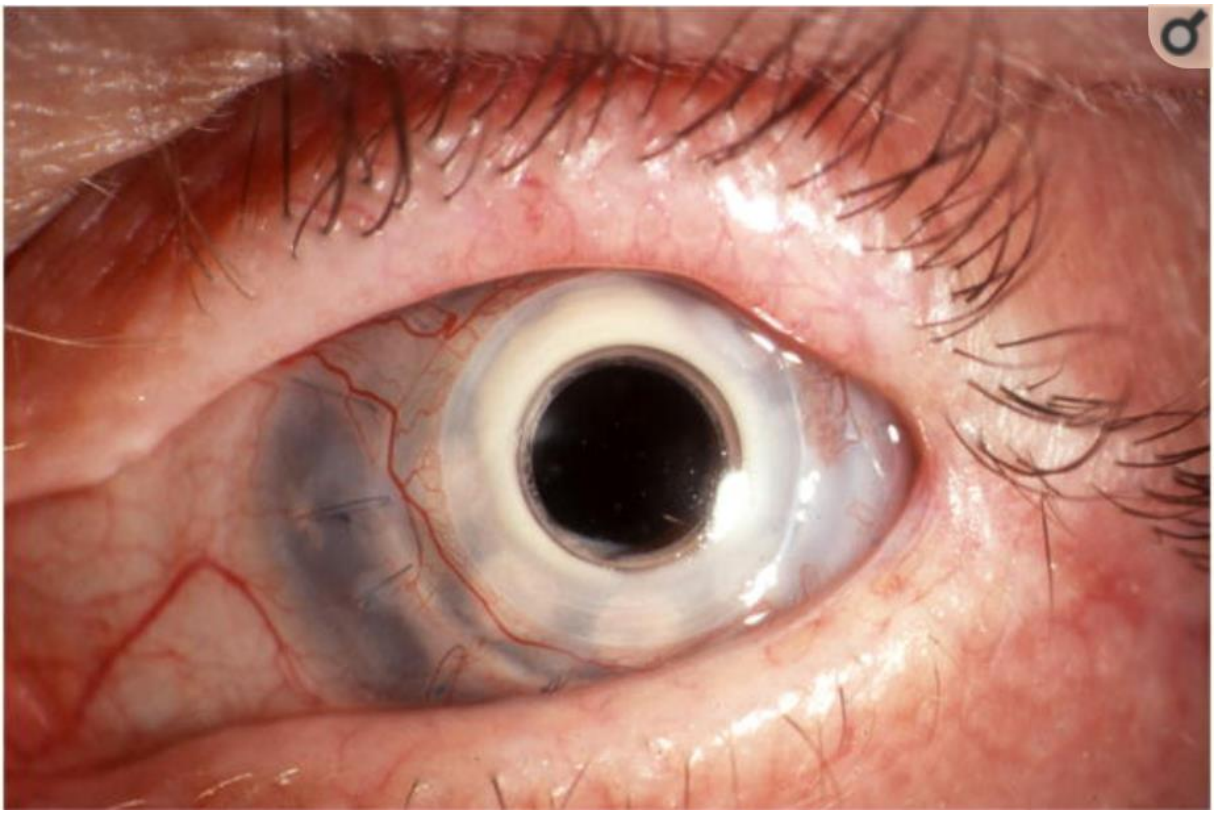


Figure 1

Figure 1A. Fungal colonization: white, mulberry shaped deposits on the soft contact lens.

Figure 1B. Active fungal keratitis: white sheen around the optic stem.