# Effects of artificial deposits on adhesiveness of *Pseudomonas aeruginosa* onto orthokeratology lens

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【 Financial disclosure 】
TS, CS, RS and MI are full-time employees of Menicon Co.,Ltd.

## Introduction

Compared with conventional rigid gas permeable contact lenses, deposits onto orthokeratology contact lenses (OK) are typically difficult to remove, particularly along the reverse curve, due to its inner complex designs. It is suggested that this design promotes an increase in OK lens deposition at the reverse curve area which may help increase bacterial retention[1]. Although there have been reports of infections with OK lens wear, with *Pseudomonas aeruginosa* (*PA*) being the most common causative organism[2),3)], to the authors knowledge there have been no studies that evaluated the relationship between deposits and *PA* adhesion onto OK lens *in vitro*.

## Purpose

To evaluate the effect of artificial deposits on adhesiveness of *PA* onto OK lens and the effects of two cleaning regimens *in vitro*.

## Methods

1. Unworn OK lenses (αOrtho-K; alpha corporation) were soaked in an artificial solution that included mucin, lecithin, and lysozyme in saline for 7 hours at 80 °C (Fig 1).
2. Deposited and unworn OK lenses were incubated with *Pseudomonas aeruginosa* ATCC9027 in suspension ($1\times10^5$ CFU/mL) for 3 or 6 hours at 37 °C. The number of *PA* organisms adhered to deposited and unworn OK lenses was assessed by scanning electron microscopy (SEM) and real-time PCR and compared between deposited and unworn OK lenses.
3. 4 types of lenses were prepared.
   Group 1: deposited OK lens without cleaning, Group 2: deposited OK lens soaked in Progent® intensive cleaner (Menicon Co.,Ltd.) for 30 min,
   Group 3: deposited OK lens cleaned with $O_2$ care® (daily cleaner, Menicon Co.,Ltd.) for 4 hours, Group 4: unworn OK lens
   Each group lenses (N=3) were incubated with *PA* in suspension ($1\times10^5$ CFU/mL) for 3 hours at 37 °C. Then, the number of *PA* organisms adhered to each type of OK lens was compared by SEM and real-time PCR.

## Results

**Figure 1.** SEM images of unworn (left) and deposited (right) OK lens

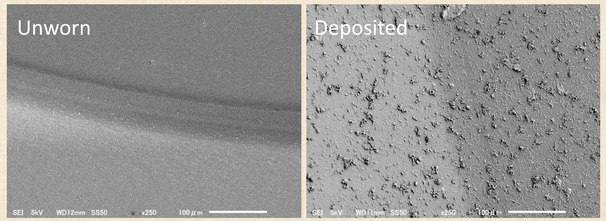



**Figure 2.** SEM images of unworn (left) and deposited (right) OK lens following 3hr incubation in *PA*

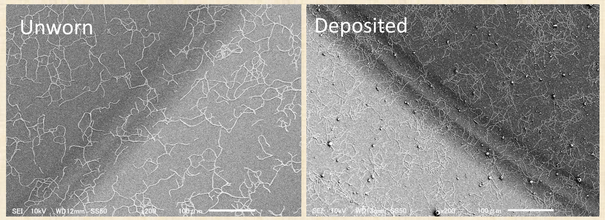
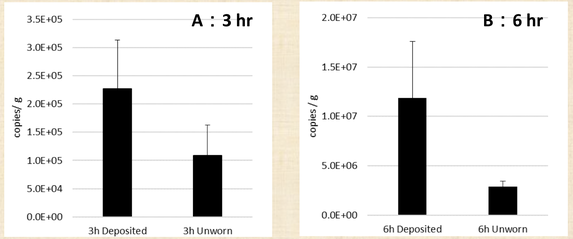



**Figure 3.** Real-time PCR estimations of the number of *PA* adhered to deposited and unworn OK lenses.




No deposits were observed in unworn lenses, but considerable amounts of deposition on the surface of deposited OK lenses were observed in SEM images (Fig 1). Furthermore, SEM images also revealed an evenly attachment of *PA* to both unworn and deposited OK lenses (Fig. 2), although the number of *PA* adhered to deposited OK lenses, assessed using real-time PCR, were 2- and 4-fold higher at 3 and 6 hours, respectively in comparison with unworn OK lenses (both $p < 0.05$) (Fig 3).

**Figure 4.** SEM images of adhered *PA* onto 1) deposited OK lens; deposited OK lenses following 2) Progent® and 3) $O_2$ Care® cleaning; and 4) unworn OK lens

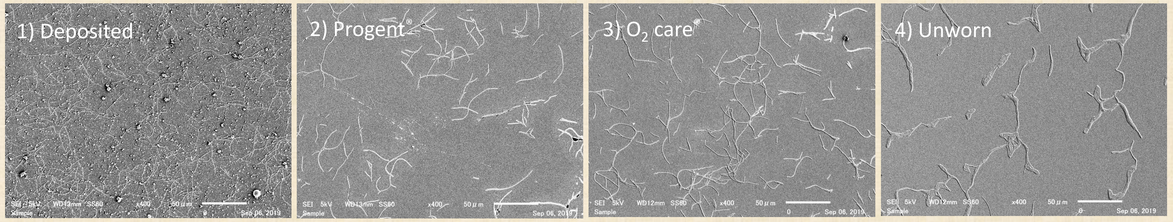
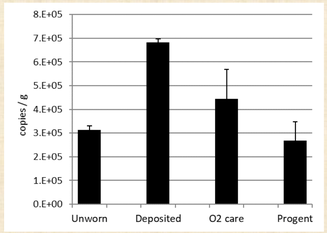



**Figure 5.** Real-time PCR estimations




Inspection of SEM images revealed that both care systems (i.e., $O_2$ care® and Progent®) were able to remove artificial deposits from the surface of OK lenses (data not shown).

More interestingly, the number of *PA* adhered to the deposited OK lens treated with the Progent® intensive cleaner for 30 min was apparently similar to that of the unworn OK lens as shown in SEM images (Fig 4).

Moreover, real-time PCR estimation showed that the number of *PA* adhered to the deposited OK lens is 2-fold higher than that found on the unworn OK lens, whereas the number adhered to the OK lens treated with Progent® intensive cleaner was quantitively equal to the unworn OK lens (Fig 5).

## Discussion

This study demonstrates that deposits on OK lenses increase the level of *PA* adhesion to the lens surface *in vitro*, which could ultimately lead to an increased risk of OK-related infectious keratitis.

As deposits on OK lenses were effectively removed by $O_2$ Care® daily cleaner with a rubbing step and were further cleaned with Progent® intensive cleaner, the results of this study indicate that removal of such deposits from OK lenses decreases *PA* adhesion from the lens surface, ultimately minimizing the risk of potential ocular infections.

As such, OK lens wearers should be recommended effective lens care systems for enhanced and safe contact lens wear.

## Conclusions

- Our results indicate that deposits on OK lens increase adhesion of *PA* onto the lens surface *in vitro.*
- Intensive lens cleaning removed deposits and decreased *PA* adhesion from the surface of OK lenses.
- This work highlights the importance of using an effective lens care regimen, including the use of an lens intensive cleaner, to remove deposits and reduce adhesion of *PA* from the surface of OK lens for safe and effective contact lens wear.

## References

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3) Kam KW, Yung W, Li GKH, Chen LJ, Young AL. Infectious keratitis and orthokeratology lens use: a systematic review. Infection. 2017;45(6):727-35