**Pseudomonas aeruginosa Corneal Ulcer Related to Overnight Orthokeratology**

Ching-Hsi Hsiao, MD; Lung-Kun Yeh, MD; An-Ning Chao, MD; Yeong-Fong Chen, MD; Ken-Kuo Lin, MD

**Background:** Overnight orthokeratology was thought to be a safe and non-invasive alternative for low-grade myopia and astigmatism correction. We assessed histories, clinical courses, and visual outcomes of the patients with pseudomonal keratitis related to overnight orthokeratology.

**Methods:** The records of six patients with pseudomonal keratitis related to overnight orthokeratology were reviewed from January 2001 through December 2002.

**Results:** The average age of the patients was 13 years. The average period between the time that the patient started the overnight orthokeratology program and the onset of infectious keratitis was 17 months. All patients presented with painful red eyes. The area of the corneal ulcer was central in three, and para-central in three eyes. The corneal infiltrate was small in one eye, and medium in five eyes. The corneal scrapings from these six patients revealed *Pseudomonas aeruginosa*. All patients responded well to topical antibiotic treatment. Two of six eyes had a final visual acuity within two lines of the pre-infection vision at the last follow-up. Four of the eyes examined lost their best-corrected visual acuity due to central corneal scar or irregular astigmatism.

**Conclusions:** Overnight orthokeratology contact lens wear has the potential complication of pseudomonal keratitis and may cause significant visual impairment. *(Chang Gung Med 2004;27:182-7)*

**Key words:** corneal ulcer, *Pseudomonas aeruginosa*, overnight orthokeratology.
reducing myopia.\textsuperscript{(7)} Nichols and his coworkers also reported satisfactory results from the use of overnight orthokeratology.\textsuperscript{(8)} The theory underlying overnight orthokeratology is that as the RGP lenses are worn, the cornea is reshaped and the level of myopia is reduced as the patient sleeps. The lenses are removed upon waking and good vision is maintained without correction throughout the day. A cautionary note to overnight orthokeratology, as in all contact lens use, is for overnight wear there is a risk of developing infectious keratitis which is a serious and vision-threatening complication.\textsuperscript{(9-11)} Previous case reports have specifically documented the occurrence of this rare complication of overnight orthokeratology.\textsuperscript{(12-16)}

In this study, we report six cases of pseudomonal keratitis related to overnight orthokeratology in order to investigate patient histories, clinical courses, and visual outcomes.

**METHODS**

We retrospectively reviewed the medical records of six inpatients and outpatients who developed pseudomonal keratitis related to overnight orthokeratology in our hospital from January 1, 2001 through December 2002. Smears and cultures from corneal scrapings for bacteria, mycobacteria, and fungi were performed for all patients. Using standard microbiological culture techniques, the scrapings were inoculated in blood, chocolate, and modified Sabouraud agars, Lowenstein-Jensen agar slant and into thioglycolate broth. Culture results revealed growth of \textit{Pseudomonas aeruginosa}. All patients were initially treated empirically with topical cefazolin sodium (25 mg/cc) plus amikacin (25 mg/cc), cycloplegics, as well as with systemic analgesics until the specific microbiological diagnoses were made.

**RESULTS**

Summaries of the results are presented in Table 1. The average age of the patients was 13 years (range, 9 to 17 years). There were three females and three males. The mean follow-up time was 7.3 months (range, 3 to 10 months). Four ulcers developed in the right eyes, and two ulcers developed in the left eyes. Patient 1 had bilateral ulcerations, but two ulcers developed in the right eye. Patient 1 had bilateral ulcerations, but two ulcers developed in the left eyes. Patient 1 had bilateral ulcerations, but two ulcers developed in the left eyes. Patient 1 had bilateral ulcerations, but two ulcers developed in the left eyes. Patient 1 had bilateral ulcerations, but two ulcers developed in the left eyes. Patient 1 had bilateral ulcerations, but two ulcers developed in the left eyes.

The corneal scrapings from these six patients revealed \textit{P. aeruginosa}, which was sensitive to amikacin. Thus, amikacin was administered alone during the subsequent period. All patients responded well to medical therapy and no one required surgical intervention. Two of six eyes had a final visual acuity within two lines of the pre-infection vision (i.e. better or equivalent to 20/25) at the last follow-up.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age/Gender/Eye</th>
<th>Overnight orthokeratology history</th>
<th>Organism</th>
<th>Location and size (mm)</th>
<th>Final VA</th>
<th>Follow-up (month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17/F/R</td>
<td>4.5 y</td>
<td>-</td>
<td>PC, 0.4 x 0.4</td>
<td>20/20</td>
<td>8</td>
</tr>
<tr>
<td>2</td>
<td>17/F/L</td>
<td>1m</td>
<td>\textit{P. aeruginosa}</td>
<td>PC, 1 x 1</td>
<td>20/20</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>15/M/L</td>
<td>3m</td>
<td>\textit{P. aeruginosa}</td>
<td>PC, 2 x 2</td>
<td>20/20</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>9/F/R</td>
<td>1.5 y</td>
<td>\textit{P. aeruginosa}</td>
<td>C, 3.0 x 2.6</td>
<td>20/50</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>10/F/R</td>
<td>1.5 y</td>
<td>\textit{P. aeruginosa}</td>
<td>C, 4 x 2.4</td>
<td>20/100</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>10/M/R</td>
<td>6m</td>
<td>\textit{P. aeruginosa}</td>
<td>C, 5 x 5</td>
<td>20/200</td>
<td>9</td>
</tr>
</tbody>
</table>

Abbreviations: M: male; F: female; R: right; L: left; y: year; m: month; C: central; PC: paracentral; P: peripheral; VA: visual acuity.
examination. Four of the eyes examined lost their best-corrected visual acuity due to central corneal scarring or irregular astigmatism.

Case reports

Case 1 (Patient No. 1)

A 17-year-old female developed ocular pain in both eyes for 1 day. She had undergone overnight orthokeratology treatment for the correction of myopia -4.0D in both eyes for 4.5 years.

Upon examination at our hospital, her best-corrected visual acuity was 20/25 and 20/40 in the right and left eyes, respectively. Slit-lamp examination showed conjunctival congestion and a 0.4×0.4 mm corneal infiltrates in the right eye (Fig. 1A) and a 1×1 mm corneal infiltrate in the left eye (Fig. 1B). The scraped tissue and the contact lens solution were cultured for bacteria, mycobacteria and fungi.

Fig. 1 Slit-lamp examination showed conjunctival congestion and a 0.4×0.4 mm corneal infiltrate in the right eye (A, arrow) and a 1×1 mm corneal infiltrate in the left eye (B, arrow).

Topical cefazolin sodium (25 mg/cc) and amikacin (25 mg/cc) were given hourly. Cultures of the corneal scrapings and contact lens solution grew *P. aeruginosa* sensitive to amikacin, but those from the right cornea yielded nothing. The infection resolved soon thereafter with the treatment of topical amikacin. Eight months after treatment, her vision had returned to 20/20.

Case 2 (Patient No. 4)

A 9-year-old girl experienced a red, painful right eye for 1 day. She had received overnight orthokeratology treatment for 1.5 years for the correction of myopia -3.0 D in both eyes at a local eye clinic. She claimed to have followed the instructed cleaning procedure strictly using standard commercial RGP lens care solutions.

Upon examination, her visual acuity in the right eye was the discernment of hand motion at 50 cm. Under slit-lamp examination, a 3.0×2.6 mm corneal infiltrate with a surrounding immune ring and peripheral corneal edema was noted (Fig. 2). A small hypopyon and conjunctiva congestion were also present. Corneal scrapings were cultured for bacteria and fungi. Topical cefazolin sodium (25 mg/cc) and amikacin (25 mg/cc) were given hourly initially. Amikacin was administered alone when the culture and antibiotic susceptibility results were positive for amikacin-sensitive *P. aeruginosa*. The ulcer started to heal and the patient was discharged after 5 days of hospitalization. Ten months later, a central
scar was left. Best-corrected visual acuity in the right eye was 20/50 with a refraction of -1.50/-6.00 x 35 degrees.

DISCUSSION

Overnight orthokeratology is gaining increased popularity for the treatment of myopia in children because good vision can result without the aid of glasses or contact lens during the daytime. Although the risk of infection from contact lens use in general and with overnight orthokeratology specifically is rare, this complication can be devastating.\(^{12-16}\) Furthermore, it is likely that many cases of infection are not reported, or some mild cases may have been encountered and treated in local clinics. Thus, the reported number of infections is likely to be underestimated. Infectious keratitis is the most devastating complication for contact lens wearers. This infection can produce permanent loss of vision.\(^{10,11}\) Overnight wear is a principal risk factor for infectious keratitis among all types of contact lens users.\(^9,10\) The new generation of RGP lenses are reported to have high oxygen transmissibility, which could minimize and perhaps eliminate hypoxic stress and corneal edema when worn on an overnight basis.\(^8\) However, several studies have shown that overnight contact lens wear, including wear of the high oxygen transmissibility RGP lenses, produces corneal swelling, decreases epithelial cell desquamation, increases surface cell size, and increases the permeability of the corneal epithelium, with the effects of impairing the barrier imposed by the epithelial cells.\(^{17-19}\) Furthermore, overnight, closed eye contact lens wear can render the eye more susceptible to bacterial infection, particularly with \textit{P. aeruginosa}, due to the reduced oxygen transmission through contact lens, lack of eye movements that helps disrupt the bacterial glycocalyx, and the absence of blinking that acts to spread lysozyme over the corneal surface.\(^{18,20}\)

Orthokeratology lenses intentionally fit flatter on the corneal surface than the normal contact lenses.\(^{7,8}\) Such a fit could compromise, even damage, the central corneal epithelium, and so may render the corneal surface more susceptible to bacterial adhesions and infection.

Lens hygiene is important in contact lens wear, and so would be expected to play a role in the infection related to orthokeratology. Most of our patients claimed they cleaned the lens properly. Indeed, the fact that three patients had worn RGP lenses for more than one year attests to the diligence of their cleaning regimen and handling of the lenses. However, sampling of contact lens solution of Patient 1 produced positive culture results. Similar results have been published.\(^{12-15}\) Instilling in young children who are enrolled in an orthokeratology program the importance of proper lens hygiene and their habitual use the standard cleaning procedure is thus very important. The parents, especially of the younger children, should help their children clean the lenses and check the ocular condition daily.

Concerning the bacterial infections observed in the present study, the scientific literature contains several case reports of infectious keratitis occurring after overnight orthokeratology.\(^{12-14,16}\) Of these six cases reported, four were due to \textit{P. aeruginosa}, one was due to \textit{Serratia marcescens} and one was due to \textit{Acanthamoeba}. A case of filtering bleb infection after traditional orthokeratology was reported, but the culture results were not available.\(^{21}\) One case series from China of infection after orthokeratology reported seven cases of corneal ulcers due to pseudomonads, eight cases of acanthamoeba keratitis and one case of mycotic keratitis.\(^{15}\) Taken together with our series, it is clear that \textit{P. aeruginosa} is the most frequently isolated pathogen. This is not surprising since the bacterium is also the most common pathogen of contact lens related corneal ulcers.\(^{9,11}\) Adherence of \textit{P. aeruginosa} to RGP lenses and exfoliated epithelial cells has been studied.\(^{8,20}\)

Infectious keratitis is an uncommon but serious complication of overnight orthokeratology. As overnight orthokeratology increases in popularity, the incidence of related infections will also likely increase. The long-term safety of overnight orthokeratology should be evaluated thoroughly. Eye care practitioners who perform overnight orthokeratology have an obligation to warn their patients of this potential vision-threatening complication. Part of this obligation entails educating patients to the importance of strict adherence to proper contact lens hygiene. Patients must be informed to seek prompt medical attention when they experience signs or symptoms of infectious keratitis. Once an infection develops, the ophthalmologist needs to be aggressive in culturing and identifying the type of organism that is responsible. Prompt and aggressive management
of this potentially vision-threatening complication can result in the preservation useful vision.

REFERENCES

過夜型角膜塑型術所引發的綠膿桿菌角膜炎

蕭靜熹 葉龍坤 趙安年 陳永豐 林耕國

背 景：評估過夜型角膜塑型術所引發的綠膿桿菌角膜炎病人的病史，臨床表現及視力預後。

方 法：從2001年1月到2002年12月，共有6位病人因過夜型角膜塑型術引發綠膿桿菌角膜炎。

結 果：病人的平均年齡為13歲，自配戴過夜型角膜塑型術到產生角膜潰瘍的平均時間為17個月，6位病人皆以急 性眼紅、疼痛前來求治。角膜潰瘍位置位於中心者有3位，中心偏旁者亦有3位。有1位微小潰瘍，其餘5位為中等大小的潰瘍。6位經適當的抗生素治療潰瘍皆癒合，6位中有4位因中央角膜結疤或不規則散光造成最終最佳視力喪失兩行以上。

結 論：過夜型角膜塑型術可引發角膜潰瘍嚴重的併發症，並可能導致視力喪失。

(長庚醫誌 2004;27:182-7)

關鍵字：角膜潰瘍，綠膿桿菌，過夜型角膜塑型術。