

Late Bacterial Keratitis After Intracorneal Ring Segments (Ferrara Ring) Insertion for Keratoconus

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Purpose: To report a case of late bacterial keratitis after intrastromal corneal ring segments (ICRSs; Ferrara ring; Ferrara Ophthalmics, Belo Horizonte, Brazil).

Methods: Review the clinical findings in a 42-year-old woman with bilateral keratoconus who underwent implantation of Ferrara ring segments in her left eye and 4 months later presented with corneal infiltrates and hypopyon. Bacterial staining, culture, and antibiotic sensitivities were done. Medical treatment and rings explantation were performed.

Results: The cultures revealed growth of vancomycin-oxacillin sensible coagulase-positive *Staphylococcus aureus*. Treatment with topical moxifloxacin, topical imipenem, and systemic intravenous and topical vancomycin was kept for two weeks. Corneal inflammation and hypopyon resolved, leaving a minimal residual leucoma.

Conclusions: Infectious keratitis is an uncommon complication of ICRS and it may be late in presentation, even months after implantation. Importance of patient education about alarm symptoms and the need for long-term close postoperative follow-up cannot be underestimated. If a change in surgical technique, i.e., suturing the incision, has an influence in this complication's incidence, it will require further studies.

Key Words: bacterial keratitis, intrastromal corneal ring segments, Ferrara ring, keratoconus

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Intrastromal corneal ring segments (ICRSs) that use 2 different types of polymethyl methacrylate devices, have the shape of sections of circumference, and are inserted in semicircular channels between the stromal lamellae (Intacs; Addition Technology, Fremont, CA; and Ferrara rings, Ferrara

Ophthalmics, Belo Horizonte, Brazil), constitute a new, promising, and reversible refractive technique for keratoconus management.^{1–5} They achieve a refractive correction by regularization of the central cornea, flattening the meridian near the tip of the rings, and steepening the flattest meridian in relation with the ring body. They spare the central cornea and preserve corneal tissue, unlike subtraction techniques, such as Excimer laser refractive surgery, which in these weak corneas has a high risk of triggering or worsening the ectasia.^{6–8} The corneal ring segment technique follows the Barraquer thickness law, which states that central corneal flattening is achieved by adding tissue to the corneal periphery,⁹ but the action mechanism of the Ferrara rings seems to be flattening of both the central and peripheral cornea, shortening of the anterior-chamber depth, and displacing the corneal apex closer to its physiologic position in front of the pupillary area.² In fact, because of this effect and according to the so-called Ferrara law, sometimes the shift in refraction does not occur toward hyperopia, as expected secondary to flattening, but toward myopia, secondary to the centration of the steeper keratoconus apex (P. Ferrara, unpublished data). ICRSs have intraoperative associated complications such as anterior-chamber perforation or late complications such as extrusion or displacement of the segments¹⁰ and infection.^{11–13} Although it has been infrequently reported, this last complication may be serious and sight threatening when it occurs. Because Intacs are implanted more frequently, because they were also used to correct low myopia, infection cases have been reported more commonly with them.^{14,15}

We present a patient who developed culture-proven bacterial keratitis 4 months after ICRS (Ferrara ring; Ferrara Ophthalmics) implantation for keratoconus in her left eye.

CASE REPORT

A 42-year-old woman with bilateral keratoconus had implantation of Ferrara ring segments in her left eye. She had been a gas-permeable rigid contact lens user for >35 years, and she had blepharoplasty in both eyes 4 years before, with secondary lagophthalmos and dry eyes. The preoperative uncorrected visual acuity was count fingers at 3 m, and refraction was $-6.00/-4.00 \times 140^\circ$. Spectacle best-corrected visual acuity (BCVA) was 20/100.

The patient underwent uneventful free-handed Ferrara ring implantation by using 1 superotemporal incision at 66° , the steepest corneal meridian, at our institution (surgeon V.G.) in October 2005. Two segments of rings of 160° (superior: 200 μm ; inferior: 300 μm) were implanted at 400 μm corneal depth. No sutures were placed at the end of the procedure. The patient was treated with topical antibiotics and steroid eye drops for 2 weeks.

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The third day after surgery, her refraction was $-2.50/-1.75 \times 150^\circ$, and BCVA was 20/80+.

The patient remained stable and asymptomatic until 4 months after surgery, when she reported photophobia and pain in her left eye, beginning 6 hours previously. At slit-lamp examination, there was mild limbal injection but not keratitis. Loteprednol eye drops were initiated, but 24 hours later the slit-lamp biomicroscopy found a dense white infiltrate around the superotemporal incision, inside both intracorneal channels, and around the ring segments, hypopyon of $\sim 15\%$ of the anterior-chamber volume, cellular reaction in the anterior chamber, a pupillary membrane, chemosis, and corneal and palpebral edema (Fig. 1). Intraocular pressure (IOP) was 26 mm Hg.

Diagnosis of infectious keratitis was made. Samples were taken for Gram stain and cultures for bacteria and fungi. Vancomycin (50 mg/mL), imipenem (25 mg/mL), amphotericin B 0.15% and moxifloxacin 0.5% 1 drop hourly, and atropine 1 drop every 12 hours were started. Gram stain reported Gram-positive cocci. The patient was hospitalized, and besides the topical medication, systemic intravenous vancomycin and imipenem were started 4 times a day in conjunction with systemic fluconazole orally 2 times a day.

On the second day of hospitalization, both rings were removed easily with a Sinsky hook under topical anesthesia. The channels were irrigated with balanced saline solution and vancomycin (50 mg/mL). Implants were sent for Gram staining and cultures for bacteria and fungi. Microbiological culture was reported as vancomycin-oxacillin sensitive coagulase-positive *Staphylococcus aureus*. For that reason, antifungal systemic and topical drugs and systemic intravenous imipenem were stopped. The treatment with topical moxifloxacin every 2 hours, topical imipenem every 6 hours, and systemic intravenous and topical vancomycin was kept for 14 days. Corneal inflammation, hypopyon, and pain resolved, leaving a minimal residual leucoma.

Three months after ring removal, the patient's postoperative refractive error was $-5.00/-5.25 \times 5^\circ$, with a BCVA of 20/60. Slit-lamp examination showed a superotemporal leucoma in an otherwise quiet eye (Fig. 2).

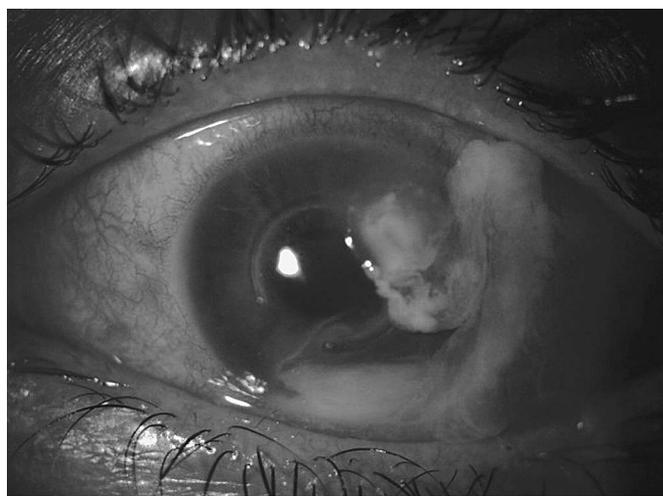


FIGURE 1. Late postoperative keratitis. Infiltrate can be seen around both segments, with pronounced stromal infiltration at the superotemporal incision, where a corneal ulcer with overlying purulent discharge is seen. Hypopyon of 15% is present. Courtesy of Dr. Virgilio Galvis.

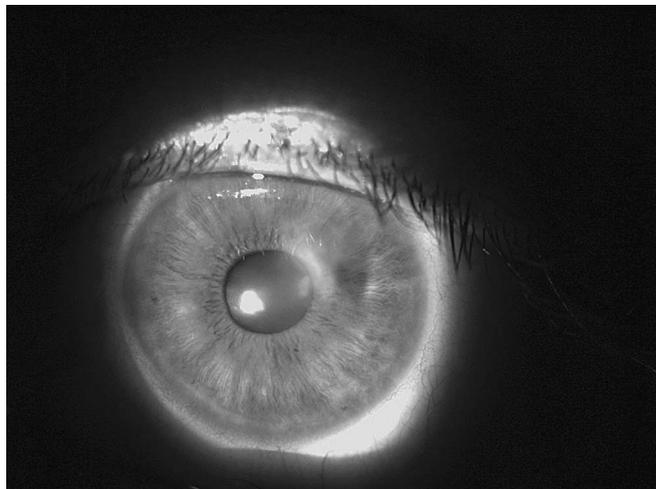


FIGURE 2. Eight weeks after explantation and after receiving antimicrobial treatment. The slit-lamp examination showed a superotemporal leucoma in an otherwise quiet eye. Courtesy of Dr. Virgilio Galvis.

DISCUSSION

Infection is an uncommon complication of ICRS, but it has been described with both Intacs and Ferrara rings,^{11,14,15} and its consequences may be serious (in 1 series, 2 patients required penetrating keratoplasty).¹¹ Although most of the infections have occurred in the early postoperative period, there have been cases described up to 22 months after implantation.^{11,13} In 1 series of 8 cases of infection after ICRS, *S. aureus* (as in the case presented here), *Klebsiella* sp., and *Paecylomices* sp. were isolated in the 3 cases that presented with infections 2 months or more after surgery. Risk factors were identified in 1 of these 3 patients (contact lens use) but not in the remaining 2 (28 and 32 years old).¹¹ In a case of another late infection, 3 months after Intacs implantation for myopic correction, a polymicrobial culture was found, growing *Clostridium perfringens* and *Staphylococcus epidermidis*. This 32-year-old patient had laser epithelial keratomileusis previously, and no other risk factor was identified.¹³

In this case, the patient presented with a mild lagophthalmos with disturbance of the tear film after a previous eyelid surgery, but she did not show evident epithelial defects after the ring segment implantation. Our hypothesis, which is in accordance with other authors, is that there may be several factors influencing the risk of late infections in these cases. First, the perpendicular keratotomy made before creating the intrastromal channels, which was not sutured, may pose a risk. There have been several series of late infectious keratitis after radial and astigmatic keratotomies, up to 3 years after surgery.¹⁶⁻¹⁸ Histopathologic analyses of corneal specimens after radial keratotomy have shown findings of delayed corneal wound healing and that epithelial pseudocysts are common.¹⁹ These epithelial pseudocysts within incisions have been linked as possible risk factors for keratitis.^{17,20} In vivo confocal microscopy of epithelial inclusions in gaped incisions after astigmatic keratotomy has also shown clusters of epithelial inclusions corresponding to the pearlike pseudocystic lesions



FIGURE 3. In another patient, it is evident that there is a gap with an epithelial plug in the incision site, 3 months after surgery. Courtesy of Dr. Virgilio Galvis.

observed clinically.²¹ Moreover, light and transmission electron microscopy of corneas after radial keratotomy has shown that epithelial plugs are invariably present, and because the epithelial cells have a limited life span, cells originating in the plug may die before reaching the surface of the cornea, which may lead to loss of integrity of the epithelium, and this breach may become the site of entry for pathogens.²²

Because during the implantation of Ferrara rings a perpendicular keratotomy is performed, and instrumentation through this incision is done to create the intrastromal channels and insert the ring segments, these maneuvers stretch the corneal lamella in the incision and may lead to the formation of a gap and the apparition of pseudocysts. In the standard technique of implantation, this incision is usually not sutured. In other patients, there is a gap with an epithelial plug in this incision, as in the case shown in Figure 3, 3 months after surgery. The second factor is that the tips of the ring segments are close to the incision, and there is a direct communication with it, so once inside the incision, microorganisms may easily enter the adjacent intrastromal channels.

Our case reiterates the risk of microbial keratitis even months after ICRS implantation. It highlights the importance of patient education about alarm symptoms and the need for long-term close postoperative follow-up. On the other hand, it provides evidence of the reversibility of the procedure even after an infectious complication and that the original surgical technique may warrant a reevaluation in regard with the necessity of suturing the incision during the procedure. We had a good result, without visual sequelae, by using an aggressive

approach with triconjugated antibiotic therapy and explantation of ICRS.

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