Case Report

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"Letter-Box" Conjunctival Flap in a Dog with Severe Corneal Edema after Phacoemulsification

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Abstract A two-year-old, spayed female, Bichon Frise, was referred for severe corneal edema and corneal ulcer in the left eye (OS). The cornea had gradually swelled over one week after phacoemulsification performed a month prior, and that was refractory to 5% sodium chloride eye drop instillation or temporary partial tarsorrhaphy. A complete ophthalmic examination was performed. Severe corneal edema with intrastromal bullae and moderate anterior chamber flare was found on slit-lamp biomicroscopy in the OS, which obstructed the fundus examination. Corneal thickness was measured using high-resolution ultrasound biomicroscopy. The thickness of the OS cornea was 2.74 mm. The "letter-box" conjunctival flap was planned. Dorsal and ventral superficial keratectomy followed by a hood conjunctival flap was performed. Topical and systemic antibiotics and 5% sodium chloride eye drops were prescribed. Decreased corneal thickness was observed at one week, two weeks, and two months postoperatively (1.53 mm, 1.32 mm, and 0.92 mm, respectively). There were no postoperative complications, such as ocular discomfort or recurrent corneal ulcers. The "letter-box" conjunctival flap, a type of superficial keratectomy and conjunctival advancement hood flap, effectively relieved the severe irreversible corneal edema. This could be a simple but effective surgical intervention for patients with endothelial cell damage especially after phacoemulsification.

Key words conjunctival flap, corneal edema, corneal thickness, letter-box technique, ultrasound biomicroscopy.

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Introduction

Corneal edema is a pathological change that results from the imbibition of fluid within the corneal stroma (4,11,17,19). This can lead to several corneal changes, such as loss of transparency, bullae formation, corneal ulcers, corneal perforation, and vision loss in dogs (11,17). As the corneal endothelium is a major contributor to the control of stromal dehydration, various diseases and traumatic damage that can cause endothelial cell loss or dysfunction, known as corneal endothelial degeneration (CED). Corneal endothelial cell loss after phacoemulsification has been reported, and the resulting corneal edema is known as a short-term and/or long-term complication following phacoemulsification (19).

Conventional treatment of corneal edema relies on the resolution of the underlying cause and symptomatic therapy with topical hyperosmotic agents (5% sodium chloride) (11,19). In veterinary ophthalmology, several surgical treatments, such as thermokeratoplasty (TKP) (11,14), superficial keratectomy and conjunctival advancement hood flap (SKCAHF) (7-9,18), corneal transplantation (5) have been attempted in the advanced stage of permanent corneal edema. In addition, as a fundamental treatment for canine CED patients, endothelial keratoplasty such as Descemet's Stripping Endothelial Keratoplasty (DSEK) (1,2) has been performed. The "letter-box" technique is a type of SKCAHF where a dorsal and ventral conjunctival hood flap is placed following superficial keratectomy while the central cornea is preserved (7). This procedure has been reported to show significant decrease in corneal thickness, relief of ocular pain, and vision preservation in canine patients with corneal endothelial decompensation (7).

This case report aimed to describe the application of a "letter-box" conjunctival flap in a dog with severe refractory corneal edema after phacoemulsification. Furthermore, clinical outcomes in terms of the corneal thickness measured using ultrasound biomicroscopy (UBM) have also been described.

Case Report

A two-year-old spayed female Bichon Frise presented to the Ilsan Animal Medical Center with severe corneal edema after phacoemulsification in the left eye (OS), which was performed a month prior by the referring veterinarian (rDVM). One week after the surgery, the cornea gradually swelled. Even with temporary tarsorrhaphy and 5% sodium chloride hyperosmotic ophthalmic solution (Muro 128®, Bausch&Lomb, USA) treatment by the rDVM, the corneal edema was not relieved.

A full ophthalmic examination, including neuro-ophthalmic examinations, was performed, but the Schirmer tear test was not performed because of severe blepharospasm OS. Menace response and dazzle reflex were positive in both eyes (OU), but the pupillary light reflex (PLR) of OS was negative because of posterior synechia. The intraocular pressure measured using rebound tonometry (Tonovet Plus®, Icare, Finland) was 21 mmHg the right eye (OD) and 9 mmHg OS. Fluorescein staining showed negative OD but was positive OS. Slit-lamp biomicroscopy (Model LS-6®, Chongqing SunKingdum Medical Instrument Co. Ltd., China) revealed no abnormalities in OD; however, conjunctival hyperemia, severe corneal edema with intrastromal bullae, corneal neovascularization, moderate aqueous flare, and pseudophakia were observed OS (Fig. 1A, B). Funduscopic examination using binocular indirect ophthalmoscopy (Heine Omega 180®, Heine, Germany) revealed a blurred tapetal reflex due to corneal edema. The third eyelid flap was placed on the first day of the visit, and topical instillation of 5% sodium chloride (5% NaCl) was maintained. To protect the cornea from the exposure damage, the third eyelid flap was placed on the first day of the visit, and topical instillation of 5% NaCl was maintained. There was an apparent improvement in the corneal edema two weeks later, but it returned to the previous status within a week after the third eyelid flap was undone. Surgical intervention using the "letter-box" procedure was planned to improve central corneal transparency by reducing corneal edema and treating corneal ulcers secondary to exposure of the bullous region.

High-resolution UBM (MD-320W®, MEDA Co., Ltd., China) was performed, and corneal thickness was measured using a software program built into the UBM equipment on the day of surgery. The thickest region of the cornea OS was 2.74 mm (Fig. 1C), and corneal thickness of OD was 0.56 mm (Fig. 1D). After pre-medication with cephazolin (22 mg/kg IV; Cefazoline®, Chongkundang Pharm, Republic of Korea), meloxicam (0.1 mg/kg IV; Metacam®, Boehringer Ingelheim, Spain), butorphanol (0.2 mg/kg IV; Butorphan®, Myungmoon Pharm., Korea), and midazolam (0.2 mg/kg IV; Midazolam®, Bukwang Pharm., Korea), general anesthesia was induced with propofol (6 mg/kg IV; Provive®, Myungmoon Pharm., Korea) and maintained with isoflurane (Ifran®, Hana Pharmaceutical Co., Ltd, Korea). A systemic neuromuscular blocking agent (Atracurium®, Aspen) was used for akinesia of the extraocular muscles to facilitate global positioning. The dog was positioned in a dorsal recumbent position. The periocular region was clipped and aseptically prepared using 0.5% diluted povidone-iodine. The conjunctival fornix was flushed twice with Ringer's solution (Hartman Solution®, JW

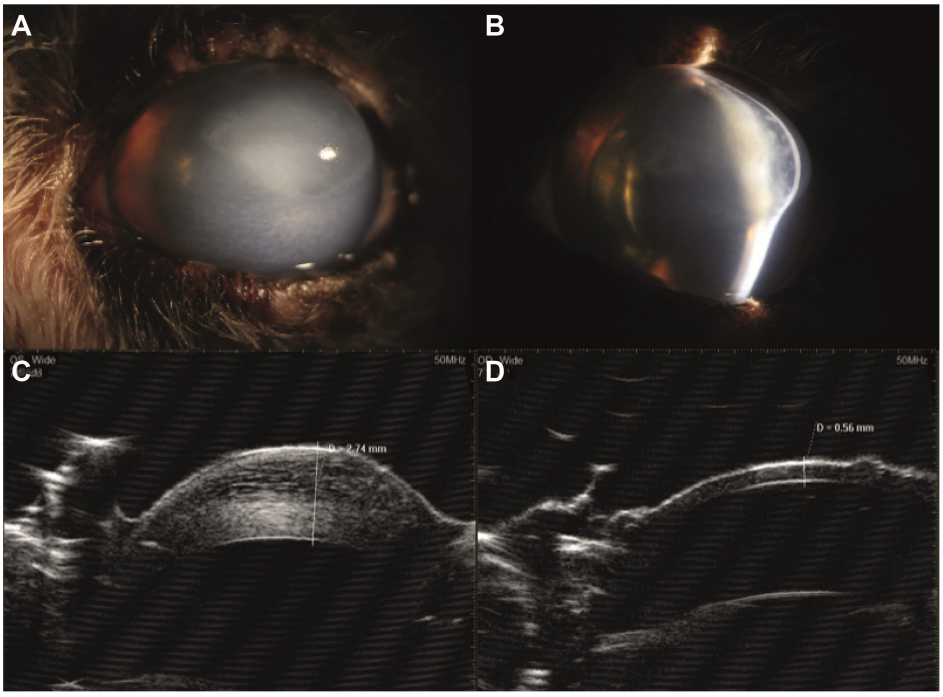


Fig. 1. Slit-lamp biomicroscopic photographs and ultrasound biomicroscopic (UBM) images showing preoperative appearances before the "letter-box" procedure. (A, B) Severe corneal edema with intrastromal bullae was observed. (C) The thickest region of the cornea was 2.74 mm in the UBM measurement. (D) The normal corneal thickness measured from OD was 0.56 mm.

Pharm., Korea) and 0.5% diluted povidone-iodine.

The "Letter-box" procedure was performed under an operating microscope. The vertical corneal length was measured using a Castroviejo caliper and divided equally into three parts, 5.3 mm each. Two horizontal incisions were made in the corneal OS with a 6400 Beaver blade onto the half the thickness of the swollen cornea. From the linear incision toward the corneal limbus, the cornea was dissected dorsally and ventrally using a disposable lamellar dissecting knife (Unique edge® microsurgical crescent knife 2.0 mm, Unique Technologies Inc., USA). Following superficial keratectomy, two conjunctival hood flaps were created using Steven's tenotomy scissors. Conjunctival flaps were sutured onto the region of the dorsal and ventral keratectomized cornea with 9-0 polyglycolic acid (Sinusorb® PGA, Peters Surgical, France), while the central cornea was preserved (Fig. 2). Partial temporary tarsorrhaphy was performed with two simple interrupted sutures using 6-0 nylon (Blue Nylon®, Ailee, Korea). Topical eye drops, including ofloxacin q 6 h (Ocuflox®, Samil Pharm., Korea), 1% tropicamide q 12 h (Mydriacyl®, Alcon, USA), and 0.3% hyaluronic acid artificial tear q6h (Hyalein®, Santen, Japan) was prescribed for two weeks. Additionally, 5% NaCl ophthalmic solution q 6 h (Muro 128®, Bausch&Lomb, USA) was administered for two months. Amoxicillin/clavulanic acid 12.5 mg/kg BID and firocoxib (Previcox®, Boehringer Ingelheim, Spain) 5 mg/kg SID were administered systemically for one week. An Elizabethan collar was applied

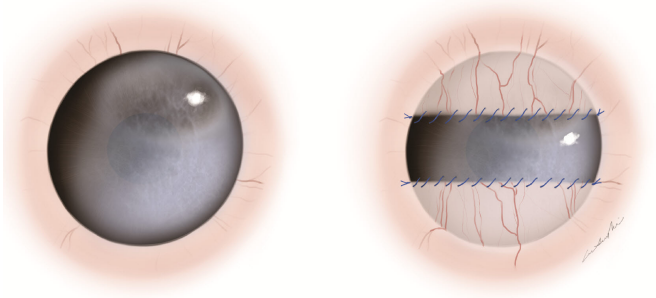


Fig. 2. Illustration of the surgical procedure for the "letter-box" conjunctival flap. The vertical corneal length was divided into three equal parts. The dorsal and ventral cornea were covered with conjunctival flaps after superficial keratectomy.

for two weeks.

On the seventh day, the partial temporary tarsorrhaphy was removed. The blepharospasm disappeared, and the corneal ulcer of the OS healed. The "letter-box" conjunctival flap was stable and corneal edema was reduced on slit-lamp biomicroscopy (Fig. 3A1, A2). Corneal thickness measured using UBM was 1.53 mm at the thickest part (Fig. 3A3). On the 14th day, an ophthalmic examination revealed a further reduction in the corneal edema (Fig. 3B1, B2), with a measured corneal thickness of 1.32 mm (Fig. 3B3). The aqueous flare due to phacoemulsification were reduced; however, the fundus was still not clearly visible. On the 53rd day, intrastromal bullae were not visible on the slit-lamp biomicroscopy, and

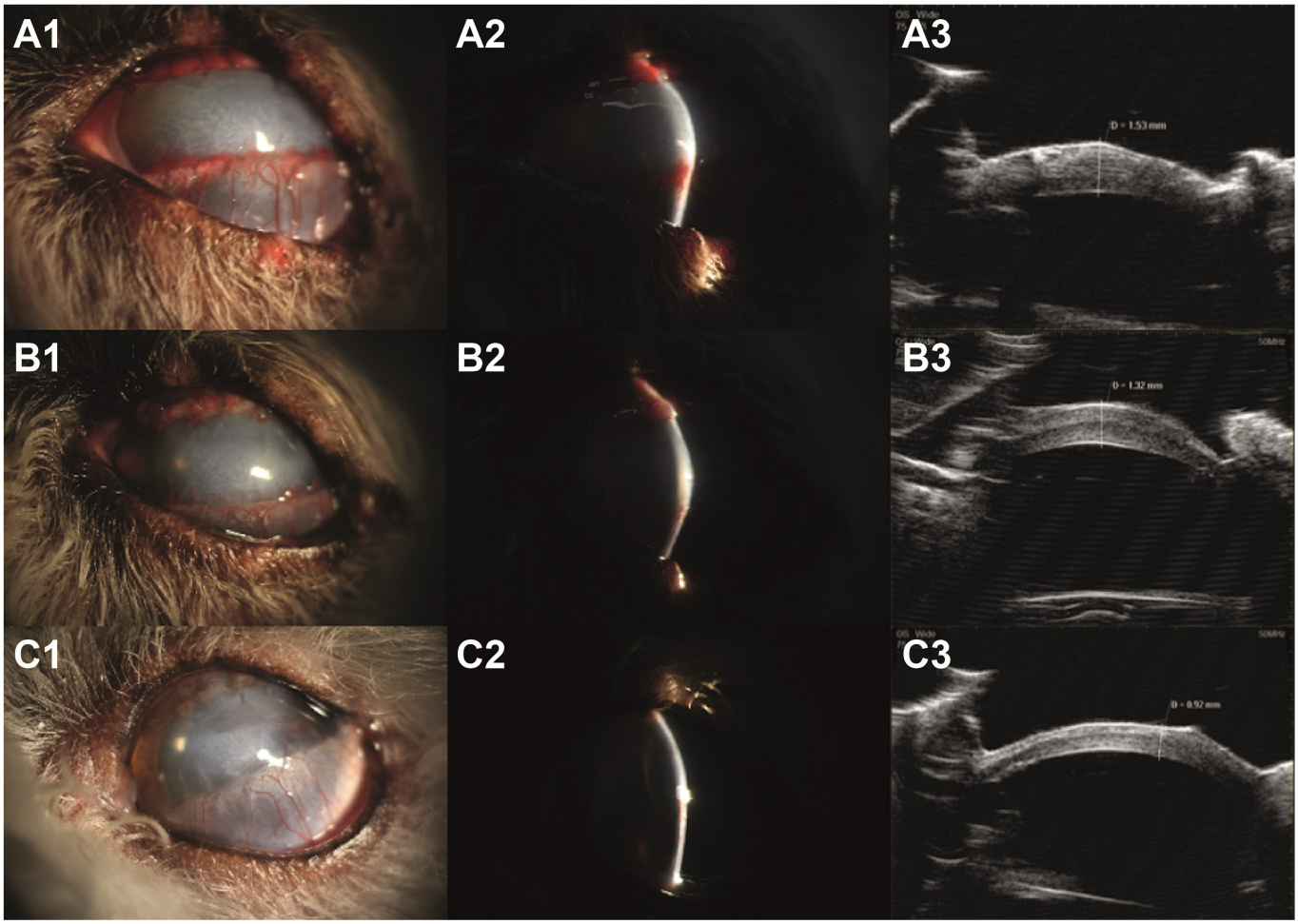


Fig. 3. Slit-lamp biomicroscopic photographs and an ultrasound biomicroscopic (UBM) image measuring corneal thickness on the seventh (A1-3), 14th (B1-3), and 53rd (C1-3) day after surgery. (A1, A2) Intrastromal bulla had disappeared, and corneal edema was reduced. (A3) The thickest region of the cornea was 1.53 mm in the UBM measurement. (B1, B2) Corneal edema was reduced. (B3) The thickest region of the cornea was 1.32 mm in the UBM measurement. (C1, C2) The central cornea without the conjunctival flap became clearer. (C3) The thickest region of the cornea was 0.92 mm in the UBM measurement.

corneal edema was further reduced with a corneal thickness of 0.92 mm on UBM (Fig. 3C3). The central cornea without conjunctival flaps was clearer than that from the last visit (Fig. 3C1, C2). The aqueous flare was negative, and the fundus was easily observed. The menace response was positive in all recheck examinations. Twelve months after the surgery, the owner confirmed over the phone that the condition of the cornea had been well maintained.

Discussion

Loss of the corneal endothelium can occur even in routine phacoemulsification surgery, of which the symptoms usually resolve over time (6). Generalized and permanent corneal edema induced by CED occurs infrequently after surgery (6). Longer irrigation time, older age, higher ultrasound power, and free radicals generated by ultrasound energy are the major risk factors for worsening endothelial cell loss associated with the surgery (5,6). Severe corneal edema associated with endothelial decompensation can lead to corneal exposure, recurrent corneal ulcers, ocular pain, and vision impairment (11,17).

Topical hyperosmotic agents can be used to reduce bulla formation in patients with CED (8). However, in patients with permanent and severe damage to the corneal endothelium, topical agents are not effective enough to improve stromal edema and transparency, as in this case (10). Moreover, the instillation of 5% NaCl eyedrop can induce ocular irritation related to drug dilution due to increased tear secretion (19). Other potential medical treatment option, Rho kinase (ROCK) inhibitors, in the field of corneal endothelial dysfunction has been suggested. Okumura et al. (15,16) showed ROCK inhibitor enhances wound healing in the corneal endothelium and

suppresses the incidence of bullous keratopathy especially in the patients with endothelial damage after cataract surgery. The use of ROCK inhibitor also reported in veterinary medicine in canine corneal endotheliitis (12).

TKP is a commonly performed surgical intervention in patients with advanced corneal edema. TKP prevents stromal fluid imbibition through thermal cauterization, which induces contraction and fibrosis of stromal collagen fibers (14,19). This could reduce bullae formation, corneal ulcers, and ocular pain but does not improve vision (14). However, SKCAHF has been reported to effectively reduce stromal edema through fluid drainage via implanted conjunctival vessels (8,9). The "letter-box" conjunctival flap, which is a modified technique of the SKCAHF, also has been reported to reduce central corneal thickness, improve corneal edema, and relieve ocular pain. Furthermore, the "letter-box" procedure specially emphasizes the conjunctival grafts not to be placed on the edematous central cornea to maintain a clearer visual axis (7,18).

Giannikaki et al. (7) performed a "letter-box" procedure in 72 eyes with progressive corneal edema. The mean central corneal thickness prior to surgery was 1.36 ± 0.25 mm, and it decreased to 1.29 ± 0.27 and 1.20 ± 0.15 mm at one and four months postoperatively, respectively (7). In the current case, the result of the "letter-box" conjunctival flap surgery could be different from that in the previous report because the corneal edema in this case was more severe, and the cause of the corneal edema was a surgical complication secondary to phacoemulsification, not endothelial degeneration or dystrophy. However, in this case, although the thickest region of the cornea measured prior to the "letter-box" procedure was 2.74 mm, it decreased to 0.92 mm two months after the procedure. Although edema was more severe prior to the procedure, more effective corneal thickness reduction was observed compared to that in the previous report. This might be related to the younger age of the patient in the current case (11,13). Also, the larger area of conjunctival flap coverage could be considered. Unlike the previous study, which uniformly conserved the central corneal width of 6 mm, the central cornea in this case was 5.3 mm, which was one-third of the vertical corneal length. Horikawa et al. (8) reported that the percentage of cornea covered by the conjunctival flap has a direct linear relationship with corneal thinning after SKCAHF surgery. For effective amelioration of corneal edema and a reduction in thickness, it might be advantageous to cover a sufficiently large dorsal and ventral corneal area. In the study by Giannikaki et al. (7), corneal thickness tended to increase or decrease over time in all eyes that underwent "letter-box" surgery. Corneal thickness increased one week postoperatively but continued to decrease from one month to two years postoperatively (7). In this case, an increase in corneal thickness was not observed, although it could be observed if follow-up examinations were more frequent. In addition, since this patient had severe corneal edema that progressed in a short term period due to the surgical trauma, rather than a general CED patient with chronic progression, the postoperative course may be different. Due to the limited equipment, it was not possible to measure the morphology or number of corneal endothelial cells in this case. Imaging the contralateral eye would have been helpful in evaluating the characteristics of the corneal endothelium before surgery. A previous clinical case report suggested that SKCAHF surgery could be performed as early as possible during the course of CED because there was no clear improvement in corneal transparency or poor vision recovery in patients with chronic CED (9).

In this study, UBM was used to measure the corneal thickness. Various technologies are available to measure in vivo corneal thickness, including optical pachymetry and ultrasound pachymetry (3). The optical pachymetry, using an oblique light source, can be limited in cases of corneal opacity such as corneal edema (3). However, by using UBM, corneal thickness could be measured regardless of the corneal opacity. Furthermore, for severely thick corneas, a UBM may be more useful than an ultrasound pachymeter for measuring corneal thickness (3).

Postoperatively, only 5% NaCl eyedrop was continued without topical corticosteroid in this case. During follow-up period, after the conjunctival graft is in position, it could be better to use topical corticosteroid to achieve corneal clearance by decreasing keratitis.

Conclusions

In this case, the "letter-box" conjunctival flap was applied to an eye with severe corneal edema following phacoemulsification. The apparent decrease in corneal thickness and improved corneal transparency was observed. There was no evidence of discomfort or recurrence of corneal ulcer during the six-month follow-up period. The "letter-box" procedure was effectively used for secondary refractory corneal edema after phacoemulsification and was showed a good prognosis, with the reduction of corneal edema and improvement of vision.

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Conflicts of Interest

The authors have no conflicting interests.

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