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Case Report

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# Nonsurgical treatment involving a contact lens and hyperosmotic solution for acute bullous keratopathy in a cat

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**Abstract:** A 4-year-old castrated male Korean domestic shorthair cat was referred with bilateral corneal edema. Focal and generalized acute bullous keratopathy in the oculus dexter and oculus sinister, respectively, were diagnosed by ophthalmologic examinations. Intensive topical treatment was administered to both eyes. A therapeutic soft contact lens was inserted in the oculus sinister as a corneal bandage instead of surgical treatment. The patient achieved complete recovery at 44 days after treatment. A therapeutic soft contact lens and an intensive regimen involving a topical hyperosmotic solution successfully treated acute bullous keratopathy in a feline patient.

**Key words:** Feline, bullous keratopathy, corneal hydrops, hyperosmolar solution, nonsurgical treatment, contact lens

## 1. Introduction

Feline acute bullous keratopathy (ABK), also known as feline acute corneal hydrops, is characterized by the development of subepithelial bullae in the cornea (1,2). A single bulla or multiple bullae may develop rapidly (within 24–48 h); multiple bullae can merge into a single large bulla, rupture, and cause eye loss (2–4). This condition initially appears unilaterally and later becomes bilateral (4). In addition, edema affects a corneal area ranging in diameter from a few millimeters to the entire cornea (1).

ABK is diagnosed according to the clinical presentation and ophthalmologic examination findings and must be differentiated from corneal melting ulcers, descemetoceles, corneal sequestra, trauma, and lacerations (4). Currently, the treatment of ABK involves procedures that deliver mechanical pressure to the bulla (1). The most common treatment protocol for ABK incorporates surgical treatment, such as superficial keratectomy, nictitating membrane flap, temporary tarsorrhaphy, conjunctival grafting, amniotic membrane transplantation, or perforating keratoplasty surgically, as well as medical treatment, such as topical antibiotic or hyperosmotic sodium chloride therapy (1,2,5).

More recently, physical devices such as therapeutic soft contact lenses (TSCLs) have been used as bandages to protect the cornea (6). In the fields of human and veterinary medicine, TSCLs have been used to provide pain relief, mechanical protection, and structural support while promoting epithelial healing, maintaining hydration, and delivering medication (5,6). A previous study of human medicine described the frequent use of TSCLs as bandages that could facilitate corneal reepithelialization (7). Before 1971, contact lenses had already been used to treat human patients with bullous keratopathy; in particular, these lenses provided pain relief by separating the bullae from the lids (5,8).

The endothelial and epithelial borders of the cornea form a barrier that controls the flow of water and maintains hydration homeostasis via an active pump mechanism (9). Many processes, such as inflammation, trauma, degenerative disease, toxins, or surgical procedures, can promote the loss of corneal transparency (10). Currently, topical hyperosmotic agents are frequently used to relieve corneal edema (6). A hyperosmotic 5% NaCl solution is most commonly used and has been reported to relieve symptoms effectively (10).

This case report describes successful use of a TSCL and intensive topical hyperosmotic solution (rather than surgical treatment such as tarsorrhaphy or keratectomy) to treat ABK in a cat.

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**2. Case history**

A 4-year-old castrated male Korean domestic shorthair cat with corneal edema was referred to the Yoolim Animal Clinic. The referring veterinarian had observed this corneal edema for 3 days and had first diagnosed corneal edema in the oculus sinister (OS), followed by the oculus dexter (OD). The cat had undergone tarsorrhaphy of the OS at the referring veterinary hospital 1 day earlier, and this procedure involved a ribbon-shaped knot that could be released temporarily to allow examination and medical treatment. The patient was placed in an Elizabethan collar to prevent self-injury.

Ophthalmologic and physical examinations of the OS were performed after the temporary release of the tarsorrhaphy knot. Despite photophobia, vision retention was confirmed through a visual test. The macroscopic examination revealed bilateral conjunctival hyperemia with focal corneal edema of the OD (Figure 1A) and generalized edema of the OS (Figure 1B). A slit lamp examination (SL-D7, Topcon Corp., Tokyo, Japan) identified bullae between the corneal epithelium and stroma (Figures 1C and D). The intraocular pressure (Icare TONOVET; Icare, Vantaa, Finland) in both eyes was 12 mmHg. Fluorescein staining revealed a corneal ulcer in the OS. Generalized corneal edema in the OS prevented additional ophthalmologic examination. No remarkable findings other than focal edema were observed in the OD. Accordingly, a diagnosis of bilateral ABK was made.

**3. Results and discussion**

The patient was calm and tolerated both the examination and medical therapy. The latter involved the application of topical ofloxacin (Ocuflox eye drops; Samil, Seoul, Korea), and 5% NaCl at a dose of 1 drop every 6 h to the OD; tarsorrhaphy of the OS was maintained except during examination and medication (initial treatment on day 0). Macroscopic and slit lamp examinations performed 1 day after treatment initiation revealed that the bulla in the OD

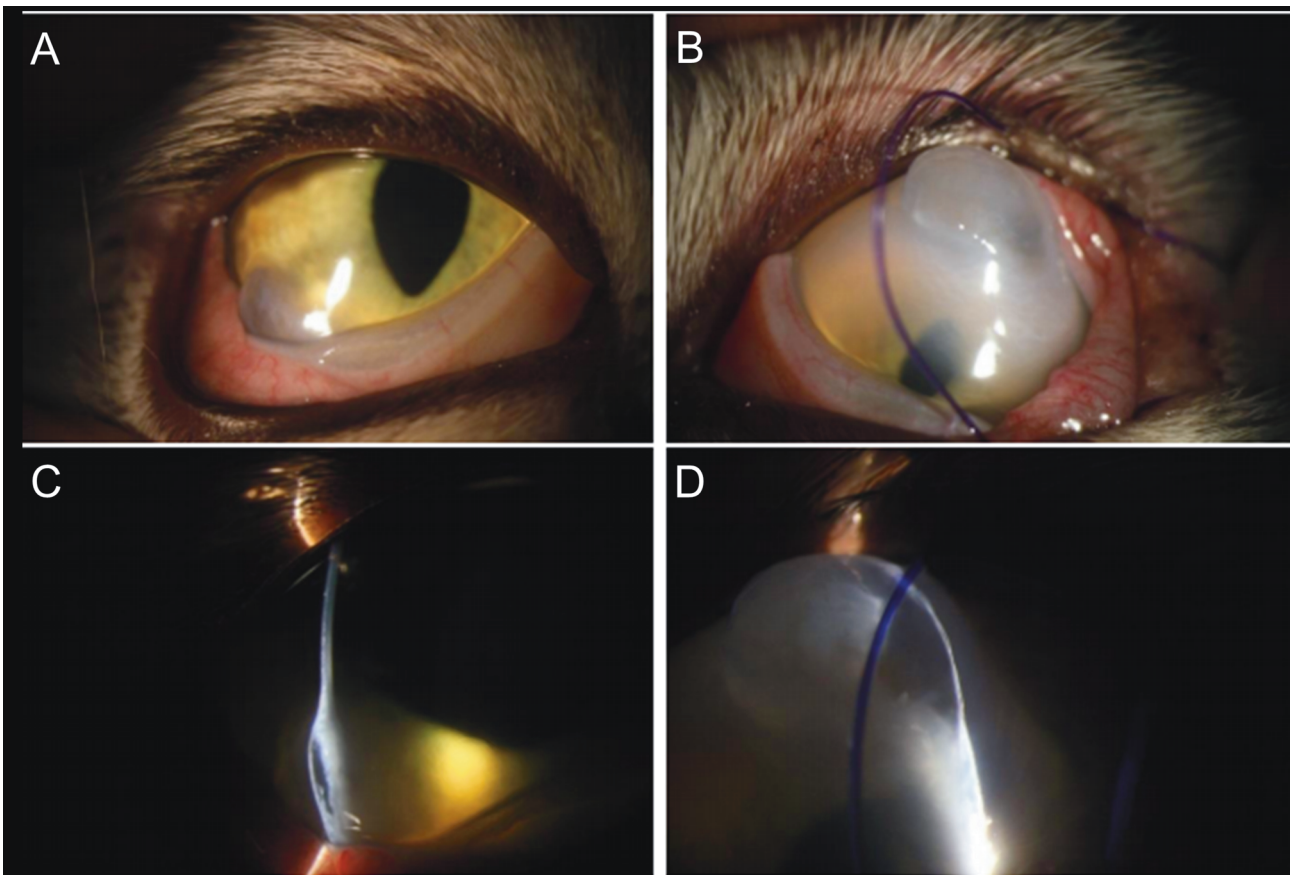


**Figure 1.** Appearance of bilateral acute bullous keratopathy in a 4-year-old castrated male Korean domestic shorthair cat at the initial presentation. (A) Macroscopic examination revealed focal edema and conjunctival hyperemia in the OD. (B) Macroscopic examination revealed generalized corneal edema and conjunctival hyperemia in the OS. The purple thread from the released tarsorrhaphy is visible. (C) Slit lamp examination revealed focal bullous edema between the corneal stroma in the OD. (D) Slit lamp examination revealed generalized bullous edema in the OS. Again, the tarsorrhaphy thread is visible.

had decreased (Figures 2A and 2C), whereas the bulla in the OS remained unchanged (Figures 2B and 2D). After removing the tarsorrhaphy, the TSCL margin (Acrivet Pat D1; Acrivet Inc., Berlin, Germany) was inserted into the deep conjunctiva of the OS to cover the whole bulla without artificial contouring, and intensive medical therapy comprising topical ofloxacin every 6 h and 5% NaCl (1 drop every 1 h) was administered. The TSCL was removed during each ophthalmologic examination and replaced after examination. At 2 days after the initial treatment, the topical treatment regimen for the OD was reduced to every 12 h following the observation of improvements; however, a slit lamp examination revealed that the bulla had not disappeared completely (Figures 3A and 3C). Improved photophobia was observed on the same day, and a fluorescein staining test failed to detect the corneal ulcer in the OS (Figures 3B and 3D).

Eleven days after treatment initiation, the topical treatments were terminated in the OD once a slit lamp examination confirmed resolution of the bulla (Figures 4A and 4C). The bulla in the OS, although still present, had diminished (Figures 4B and 4D), and topical treatments were tapered to every 6 h. Treatment of the OS was terminated 44 days after initiation because the bulla had disappeared completely (Figures 5A and 5B). The TSCL remained on the OS except during examinations and was removed simultaneously with the termination of topical treatment. No recurrence was observed during a 6-month follow-up.

Although there have been reports on the use of corneal lenses in feline, canine, and human ABK (5,11), occurrence of ABK is rare in feline species and progresses more rapidly in cats than in dogs (12). ABK in the feline cornea can be compared with keratoconus in the human cornea, a progressive and noninflammatory condition that causes the corneal surface to form a corn shape (2). The etiology of feline ABK is unknown, although clinical and histopathological findings suggest that the condition is associated with stromal and/or endothelial dystrophy (1,11–13). The corneal stromal fluid is mainly controlled

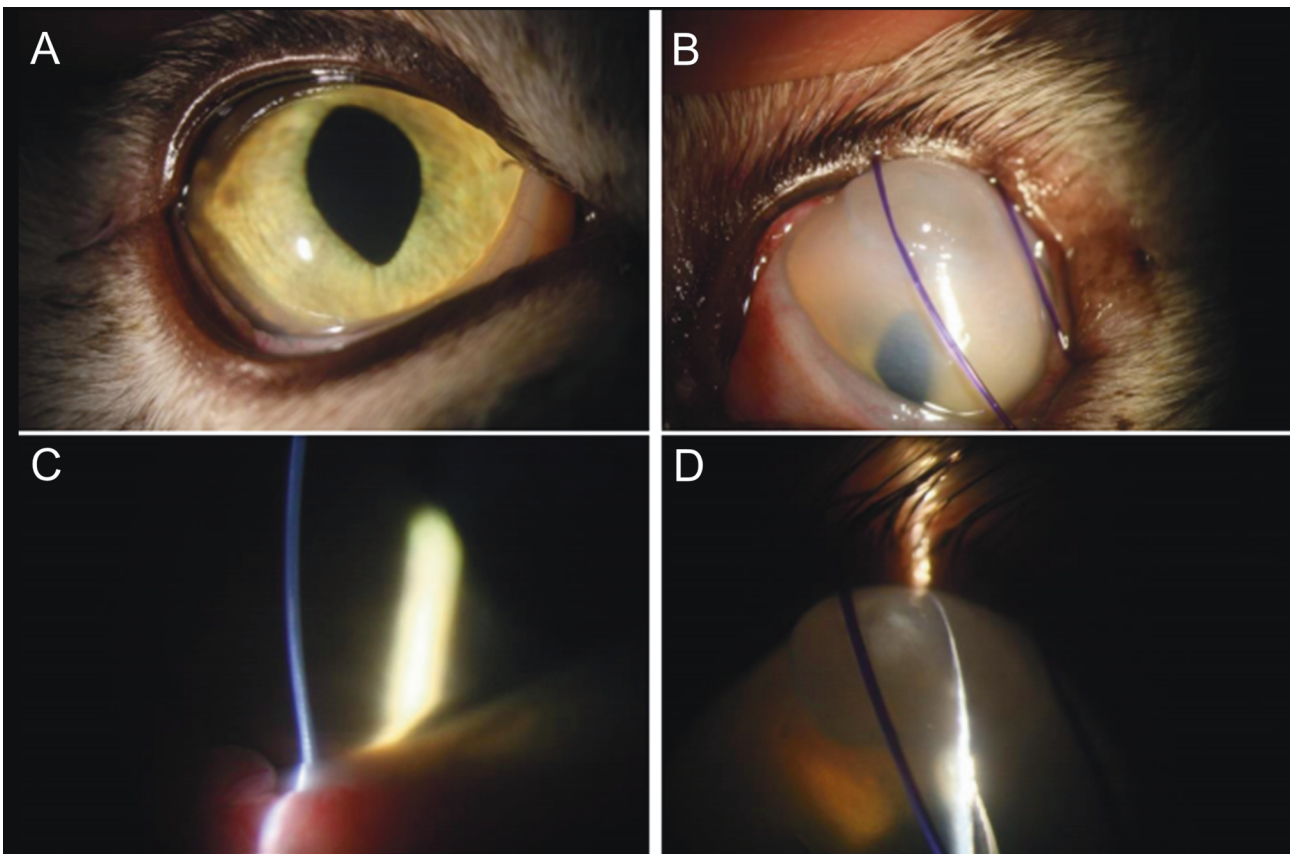


**Figure 2.** Appearance of the eyes at 1 day after the initial treatment. Bullous edema was diminished in the OD but unchanged in the OS. (A) Macroscopic examination revealed diminished focal edema in the OD. (B) Macroscopic examination revealed no change in the bulla in the OS. The purple thread from the released tarsorrhaphy is visible. (C) Slit lamp examination revealed edema in the OD. (D) Slit lamp examination revealed a generalized bulla in the OS. Again, the tarsorrhaphy thread is visible.

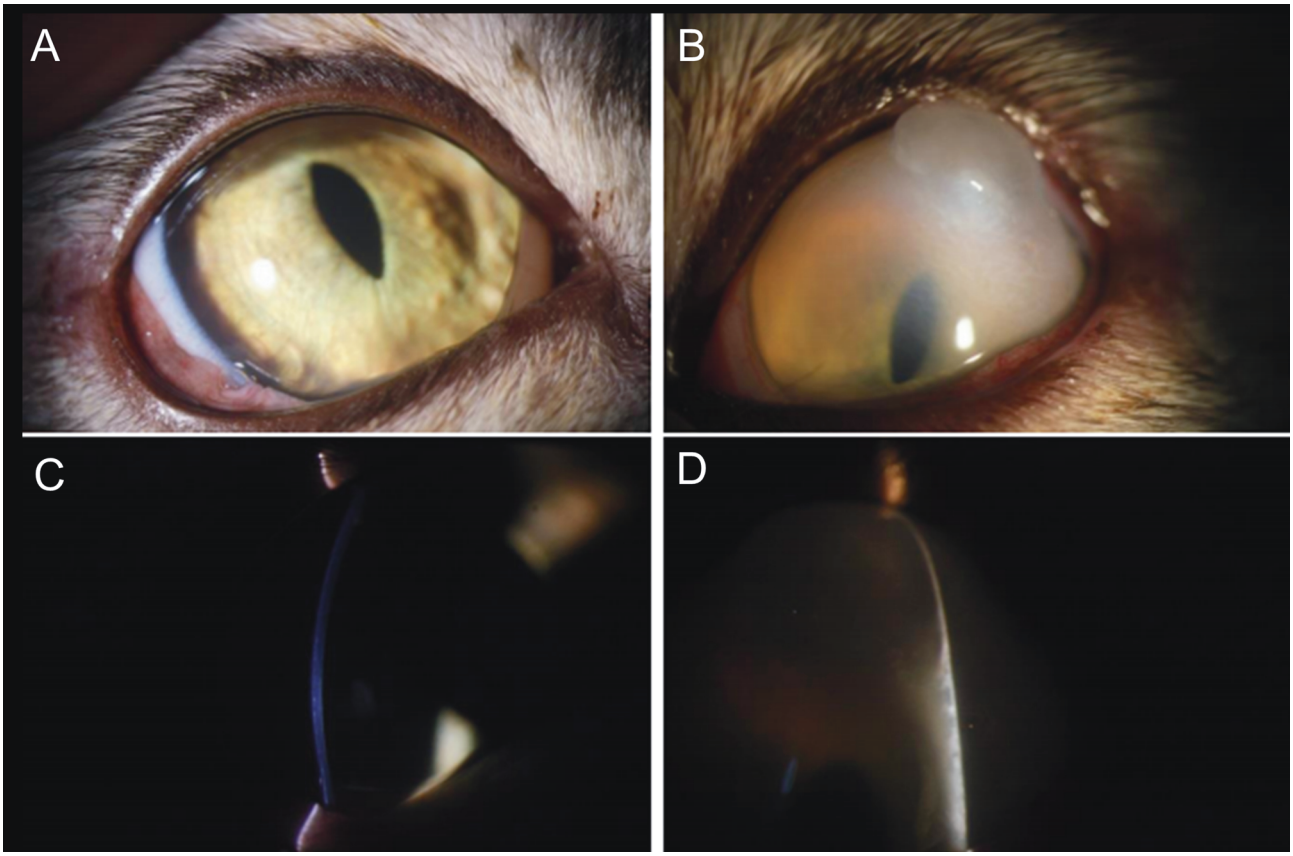


**Figure 3.** Appearance of the eyes at 2 days after the initial treatment. (A) Macroscopic examination did not detect edema in the OD. (B) Macroscopic examination did not observe a change in the size of the bulla in the OS. (C) Slit lamp examination revealed only a slight bulla in the cornea of the OD. (D) Slit lamp examination revealed no change in the bulla in the OS.

by the endothelium, which pumps solutes from the stroma to the aqueous humor; the epithelium plays a lesser role by pumping solutes from the stroma to the tears (6). The normal corneal stroma is maintained in a state of 78% hydration (9). In canine species, ABK has been attributed to corneal endothelium abnormalities that affect fluid and solute transport control and result in a dehydrated stroma. These phenomena are associated with various congenital and acquired diseases such as breed-related and age-related endothelial diseases, uveitis, glaucoma, toxic injuries, melting keratitis, trauma (self or other), collagenolytic ulceration, and hereditary dystrophy, as observed in Manx cats with induced corneal edema. Damage to endothelial cells because of phacoemulsification after cataract surgery has also been reported to cause ABK or pseudophakic BK in this context (2,7).

Generally, the treatments recommended for ABK involve administration of corneal pressure via temporary tarsorrhaphy, a conjunctival flap, or a nictitating membrane flap (1,2,6,11). Penetrating keratoplasty may be applied to replace dysfunctional endothelial cells and stromal layers; however, this procedure is not performed routinely because of costs, the risk of corneal allograft rejection, and the inconvenience of immunosuppressive medication regimens. Moreover, surgical expertise and specialized equipment are needed to apply penetrating keratoplasty (14). Various other therapies have also been described. For example, Hansen et al. described the application of frozen lamellar corneal grafts to two feline patients with ABK (4).

In human patients, TSCL application has been described as a treatment option prior to a conjunctival flap procedure or amniotic membrane transplantation (2,15). TSCLs have frequently been used alone or in combination with partial tarsorrhaphy to provide corneal protection (5,6,12). TSCLs also apply pressure to and thereby immobilize the corneal bulla, thus stabilizing corneal pain and protecting the bulla from conjunctival stimulation. Moreover, TSCLs have been reported to retain some topically applied drugs on the eyes, a phenomenon as known as the depot effect (6).

However, a TSCL treatment without concomitant therapy was not found to improve corneal edema (10). Topical broad-spectrum antibiotics and hyperosmotic solutions have been recommended for the medical

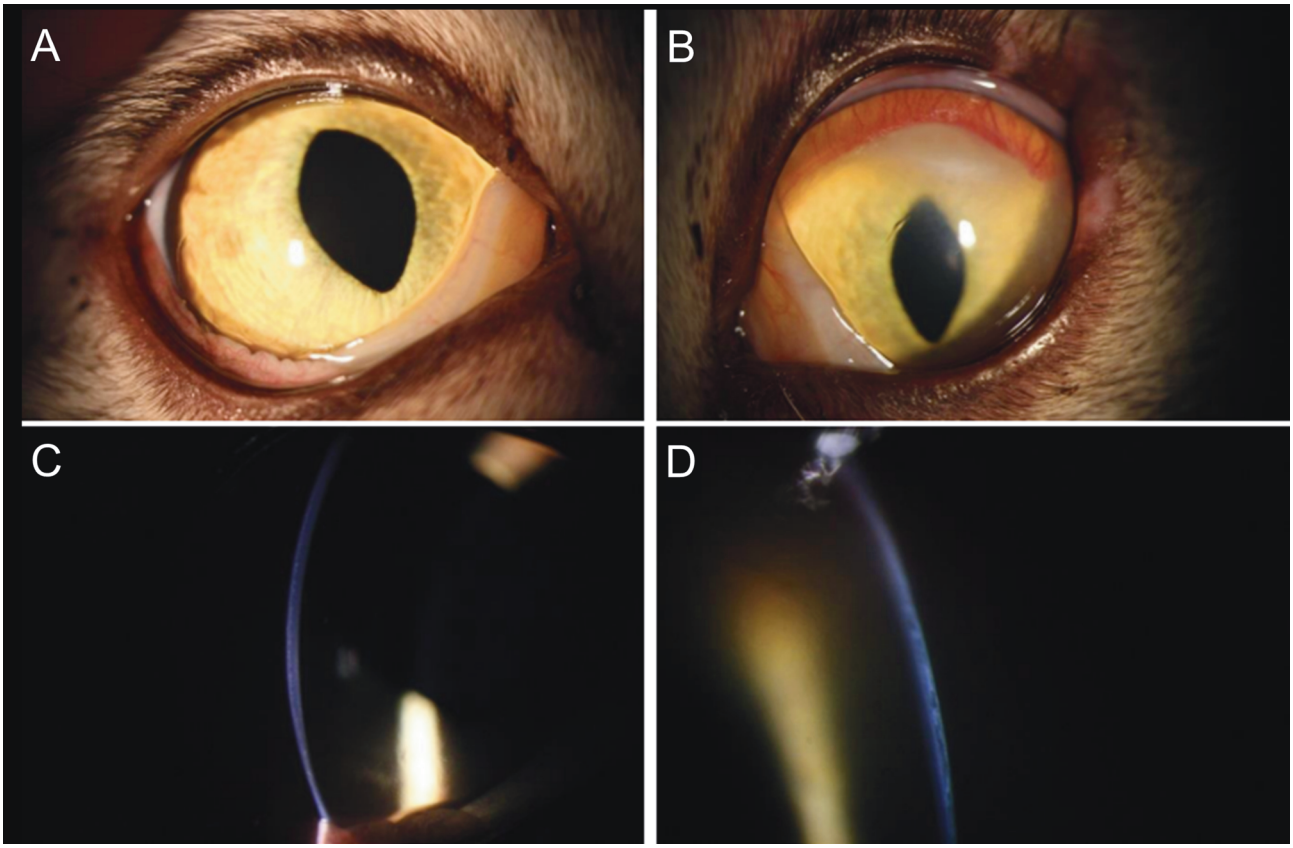


**Figure 4.** Appearance of the eyes at 11 days after the initial treatment. Bullous edema was not observed in the OD. (A) Macroscopic examination revealed no bulla in the OD. (B) Macroscopic examination revealed reduced edema in the OS. (C) Slit lamp examination of the OD revealed no bulla in the cornea. (D) Slit lamp examination detected remaining edema in the OS.

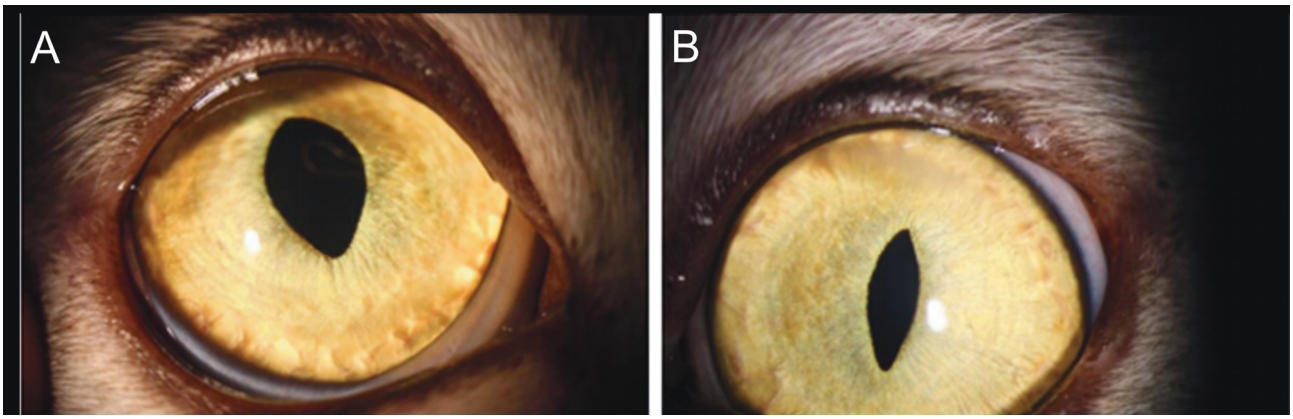


**Figure 5.** Appearance of the eyes at 44 days after the initial treatment. The bullous edema disappeared completely from OU. (A) OD, (B) OS.

treatment of ABK (1). The human medical literature describes the administration of hyperosmotic solutions as essential and reports that the application of a TSCL in the absence of hypertonic solutions failed to improve corneal edema. Although an optimal dose has not yet been established in human medicine, the recommended dose of a hypertonic solution is 1–2 drops given 4–6 times per day (10); in veterinary medicine, treatment is recommended at least 4 times daily because of the time required to affect the tear osmolality (6). The cornea comprises semipermeable

layers and thus exchanges fluid from the anterior chambers and tears. A 5% NaCl solution for corneal dehydration remained effective for more than 1 h, and to replenish the NaCl lost via the tears, the solution was applied at intervals of 1 h (9). Moreover, Knezović et al. reported that treatment with a 5% NaCl solution was significantly effective for early-stage ABK (10). Additionally, the use of topical corticosteroids remains controversial (7,14), and a recent report demonstrated that systemic cyclosporine administration could be a risk factor for ABK in felines (13).

In this case, we chose to use a TSCL as a corneal bandage for several reasons. Tarsorrhaphy did not appear to have reduced the bulla after 2 days and presented a barrier to intensive treatment with topical solutions. In addition, a TSCL might cause a sustained release effect, thus increasing the time of contact with topical solutions and thus the cornea-drug retention time. Moreover, to maintain the hyperosmotic solution concentration, we initially applied the solution every hour. Because the patient's vision was restricted during flap treatments or tarsorrhaphy of both eyes, intensive topical medications were administered only for focal edema in the OD and in association with a TSCL, which provided pressure, for general edema in the OS. The treatment duration was shorter than that associated with a conjunctival graft in a feline patient with ABK, and application of the TSCL during treatment not only allowed the patient to retain vision but also allowed convenient monitoring of the corneas by veterinarians.

ABK may cause pain related to an irritated or stretched corneal nerve, exposure of the corneal nerve ending, acute epithelial swelling, or disruption by edema (7,8). These types of pain are evidenced by symptoms such as epiphora, photophobia, and blepharospasm (5,8). Previous studies of therapeutic contact lenses mentioned their role as a precorneal protective layer that helps to protect the abnormal epithelium from external noxious stimuli; notably, patients with bullous keratopathy tend to experience near-immediate pain relief following TSCL application (8). In the present case, we believe that the patient experienced pain relief, as the observed photophobia disappeared along with the corneal ulcer within 1 day of TSCL application.

In conclusion, intensive application of a topical hyperosmotic solution together with a TSCL was used to treat ABK successfully in a feline patient; accordingly, the patient did not require concurrent or subsequent surgical treatment. To investigate the effect of intensive hyperosmotic medication with a TSCL, further cases and research are needed.

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