INTRODUCTION

In veterinary ophthalmology, ulceration is one of the most common corneal diseases in companion animals. Superficial and uncomplicated ulcers heal rapidly, with minimal scar formation. In most cases, only medical therapy is required, consisting of topical antibiotics, hyaluronic acid, and cycloplegic agents. Ulcerative keratitis that extends...
more deeply into the corneal stroma usually involves a secondary microbial infection which initiates stromal destruction. Both matrix metalloproteinases and dysregulated endogenous proteinases can lead to the degradation of the corneal stroma, causing corneal melting. In these cases, aggressive medical therapy consisting of topical and systemic antibacterial medication, topical, or systemic matrix metalloproteinase inhibitors, and cycloplegics are indicated, unless the integrity of the globe is at risk. In a significant number of cases, despite medical treatment, corneal melting leads to progressive ulceration and even perforation.

The successful use of cross-linking of corneal collagen (CXL) as an adjunctive therapy for corneal melting keratitis was recently described in veterinary medicine. This procedure increases the corneal resistance to enzymatic and mechanical constraints by creating new covalent links, and it reduces the microbial burden. 8,9

In the management of corneal ulcers, to prevent possible vision loss, surgery is indicated where there is a risk of corneal perforation. Severe ulcerative corneal lesions can be surgically treated using several materials which can be divided in four groups: homologous tissue, heterologous tissue, acellular biomaterial, and synthetic material. A combination of different techniques has also been described.

Some of these materials require specialized instrumentation, are expensive, and are difficult to obtain or store. Moreover, some can only be used for small, superficial corneal defects and others prevent corneal evaluation during the follow-up period.

The autologous buccal mucosa is an abundant tissue, which is relatively easy to harvest, can be used fresh, and is always available and thus has no need for storage. The buccal mucous membrane has been used in veterinary ophthalmology for eyelid defect reconstruction, third eyelid replacement or reconstruction, keratoconjunctivitis sicca treatment and in one case of corneal perforation. In the case of deep or penetrating corneal lesions, with or without iris prolapse, an autologous buccal mucosa can be used as a tectonic graft.

The purpose of this retrospective case series study was to evaluate the efficacy, outcomes, and complications of an autologous buccal mucous membrane graft (ABMMGS) applied to the cornea of dogs and cats affected by descemetocele, deep, and perforated corneal ulcers.

2 | MATERIALS AND METHODS

For this retrospective case series study, the medical records of dogs and cats referred for corneal ulcers and that had undergone surgery during a nine-year period were reviewed. The criteria for inclusion were as follows: presentation with descemetocele, deep stromal ulcers, or perforated corneal ulcers, with or without iris prolapse; surgical treatment of lesions with ABMMG; and at least two follow-up visits in the 30 days following surgery.

Data collected from each animal patient included breed, age, gender, affected eye, depth of the corneal defect, concurrent ocular and/or systemic diseases, type of surgery performed, postoperative treatments, visual function, and fundus oculi evaluation prior to surgery and at the last follow-up.

Preoperatively all animal patients underwent ophthalmic examination in the affected eye consisting of neuro-ophthalmic assessment (palpebral and corneal reflex, menace response, direct and indirect pupillary light reflexes and dazzle reflex), and slit-lamp biomicroscopy (Kowa SL-15, Kowa Company). Schirmer tear test I (STT I) (Schirmer tear test, Eickemeyer), applanation (Tono-pen Vet, Ametek Inc and Reichert Inc) or rebound tonometry (Tono-vet, Icare) and indirect ophthalmoscopic examination (Omega 500, Heine Optotechnik) were performed, when practicable. A fluorescein test (Ochrex, Dioptrix) was always performed except when evident corneal perforations were observed. In cases of suspected perforation, a Seidel test was performed to detect the leakage of aqueous humor through the cornea. In the fellow eye, a complete ophthalmological examination was always performed.

Visual impairment was assessed by complete neuro-ophthalmic examination. On the basis of the results, visual function was classified as absent, uncertain, or present.

2.1 | Surgical procedure

Different premedication drugs were injected intramuscularly (IM) or intravenously (IV) prior to anesthesia induction by IV administration of propofol (Propovet, Zoetis Italia; 2–3 mg/kg) and maintenance with inhaled 2% isoflurane (Isoflo, Zoetis Italia) and 100% oxygen, following endotracheal intubation. In all cases, surgery was performed with the aid of an operating microscope (Shin-Nippon OP-2, Rexam). The corneal surface and conjunctival sac were washed with 1:50 povidone iodine solution and sterile 0.9% saline. In cases of corneal perforation, only sterile saline was used. Any necrotic corneal tissue was resected with corneal scissors, and fibrin protruding through the perforation site was trimmed.

A viscoelastic solution (D-Rhexx, Dioptrix) was used to re-inflate the anterior chamber if it had collapsed or the iris had prolapsed in the perforation site. The diameter of the corneal lesion was measured with a Castroviejo caliper. The buccal graft was harvested by a second operator from the unpigmented labial mucosa using a basic surgical set (Figure 1B). The area was prepared using a 1:10 solution of iodine povidone, and the graft was taken using a dermal biopsy punch with a 4–10 mm caliber. The labial wound was not sutured and was left to heal by second intention. Using an ophthalmic surgery set, the buccal graft was then applied...
over the cornea with the epithelial side up (inlay technique) to enable the epithelial cells to migrate over the graft. The graft was then sutured to the healthy tissue with 9–0 polyglycolic acid (Surgicryl, SMI, Belgium; Figure 1C).

Four cardinal sutures were placed followed by simple interrupted or continuous sutures. In 24/27 treated eyes, an overlying conjunctival pedicle graft was also performed in order to increase and improve the blood supply, using the same suture material (Figure 1D). In all the animals, a temporary nictitating membrane flap was placed using a 3-0/5-0 nylon suture (Daclon, SMI) depending on the animal's size. In the one case presenting bilateral corneal ulcers, the nictitating membrane fixation was performed only in the most affected eye.

2.2 | Medical treatments

Postoperative treatments consisted of 10 mg/kg doxycycline (Ronaxan, Merial Italia) administered orally once daily for 7–14 days, 4 mg/kg carprofen (Rimadyl, Zoetis Italia) orally once daily for 7 days. All animals were discharged wearing an Elizabethan collar. At the moment of third eyelid flap removal, tobramycin ophthalmic drops (Stilbiotic, Trebifarma srl) were administered twice daily to eyes in which there were postoperative complications.

2.3 | Follow-up

The nictitating membrane flap was removed 1 week after surgery in all cases. The conjunctival pedicle graft, when present, was reshaped 10–20 days after surgery based on the type of initial corneal lesion and the engraftment of the graft of each clinical case (Figure 1E).

Follow-up time ranged from 14 to 2691 days. Follow-up examination consisted of STT 1, neuro-ophthalmic evaluation, slit-lamp biomicroscopy, IOP measurement, and indirect ophthalmoscopy examination.

As in the preoperative ophthalmological evaluation, visual function was assessed and classified as absent, uncertain, or present.

In cases with long-term follow-up (more than 6 months), a modified clinical score by 27 was used to classify residual corneal opacities (Table 3).

3 | RESULTS

3.1 | Animal patients

The study population consisted of 27 eyes from 14 dogs and 12 cats. Twenty-five animals showed unilateral corneal injuries, while only one cat presented with bilateral lesions.
### Table 1: Data collected for canine patients

| Case | Breed       | Gender | Age (years) | Eye   | Primary Lesion                          | Ulceration position and extension | Cause                          | Concurrent ocular abnormalities                                                                 |
|------|-------------|--------|-------------|-------|----------------------------------------|-----------------------------------|--------------------------------|---------------------------------------------------------------------------------------------|
| 1    | Shih-tzu    | F      | 4           | OS    | Corneal perforation with iris prolapse | Lateral paracentral <25%          | Unknown                      | Euryblepharon, medial corneal pigmentation, trichiasis, distichiasis                        |
| 2    | Shih-tzu    | M      | 4           | OS    | Corneal perforation with iris prolapse | Central 25%–50%                   | Unknown                      | Euryblepharon, trichiasis                                                                  |
| 3    | Yorkshire Terrier | M  | 13         | OD    | Descemetocoele                        | Central 25%–50%                   | Unknown                      | Trichiasis                                                                                |
| 4    | Pekingese   | M      | 2           | OS    | Corneal perforation, melting          | Central <25%                      | Unknown                      | Euryblepharon, trichiasis                                                                  |
| 5    | Shih-tzu    | M      | 2.5         | OS    | Descemetocoele, melting, hyphema      | Central 25%–50%                   | Unknown                      | Euryblepharon, medial corneal pigmentation, trichiasis                                      |
| 6    | Shih-tzu    | M      | 3           | OD    | Corneal perforation with iris prolapse | Medial paracentral <25%           | Unknown                      | Euryblepharon, trichiasis, distichiasis                                                |
| 7    | Beagle      | F      | 5.5         | OS    | Deep stromal ulceration, melting      | Central <25%                      | Suture notch                  | Bilateral KCS                                                                            |
| 8    | Shih-tzu    | M      | 5           | OD    | Corneal perforation with iris prolapse | Central 25%–50%                   | Unknown                      | Euryblepharon, medial corneal pigmentation, trichiasis                                      |
| 9    | English Bulldog | M  | 6.5         | OS    | Corneal perforation with iris prolapse | Central 25%–50%                   | Unknown                      | Bilateral KCS, distichiasis                                                               |
| 10   | Shih-tzu    | M      | 2           | OS    | Corneal perforation with iris prolapse | Central 50%–75%                   | Unknown                      | Euryblepharon, medial corneal pigmentation, trichiasis                                      |
| 11   | Shih-tzu    | M      | 2           | OD    | Corneal perforation with iris prolapse | Medial paracentral 25%–50%        | Unknown                      | Euryblepharon, medial corneal pigmentation, trichiasis                                      |
| 12   | Shih-tzu    | FS     | 13          | OS    | Corneal perforation with iris prolapse | Central 25%–50%                   | Unknown                      | Euryblepharon, medial corneal pigmentation, trichiasis                                      |
| 13   | Shih-tzu    | M      | 10          | OD    | Corneal perforation, melting         | Central 50%–75%                   | Unknown                      | Bilateral KCS, euryblepharon, trichiasis                                                |
| 14   | English Setter | M  | 11          | OD    | Corneal perforation with iris prolapse | Central 50%–75%                   | Foreign body injury           | None                                        |

Abbreviations: ABMMG, autologous buccal mucous membrane graft; CPG, conjunctival pedicle graft; F, female; FS, sterilized female; KCS, keratoconjunctivitis sicca; M, male; NA, not applicable; OD, oculus dexter; OS, oculus sinister; PO, pre-operative; TEF, third eyelid flap.

**Table 1** for dogs and **Table 2** for cats report the signalment, as well as the affected eyes, depth, extension and position of the corneal defect, concurrent ocular, and/or systemic diseases, type of surgery performed, visual impairment, and possibility of fundus oculi evaluation prior to surgery and at the last follow-up visit.

### 3.2 Preoperative ophthalmological findings

Corneal perforation was present in 22 eyes (11 dogs and 11 cats) of which 16 also showed iris prolapse (10 dogs and 6 cats), two dogs showed descemetocoele and one a deep stromal wound; concurrent corneal melting was present in 13 eyes.
(9 dogs and 4 cats). The cat with the bilateral corneal lesions showed bullous keratopathy with perforation of the left eye.

On the basis of the visual assessment results, only 4 eyes (3 cats and 1 dog) showed the unequivocal presence of visual function prior to surgery. In 23 eyes, visual function was judged to be uncertain because the menace response was negative (21/23 eyes; 91.3%) or uncertain (2/23 eyes; 8.7%), while dazzle reflex in the affected eye and consensual pupillary reflex in the fellow eye were present.

Indirect opthalmoscopical examination of the affected eyes was only possible in three cases (two cats and one dog), and no fundus abnormalities were observed.

| Systemic diseases | Surgery          | PO visual function | PO fundus evaluation | Follow-up (days) | Visual function at last check | Fundus evaluation at last check | Long term complications                                    |
|-------------------|------------------|--------------------|----------------------|------------------|------------------------------|-------------------------------|-----------------------------------------------------------|
| None              | ABMMG +CPG + TEF | Uncertain          | Impossible           | 330              | Present                      | Possible                      | Lipidic keratopathy, minimal corneal opacity              |
| None              | ABMMG +CPG + TEF | Uncertain          | Impossible           | 2539             | Present                      | Possible                      | Moderate corneal opacity                                  |
| Heart murmure     | ABMMG +CPG + TEF | Present            | Possible             | 499              | Present                      | Partially possible            | Moderate corneal opacity                                  |
| None              | ABMMG +CPG + TEF | Uncertain          | Impossible           | 65               | Present                      | Possible                      | NA                                                        |
| None              | ABMMG +CPG + TEF | Uncertain          | Impossible           | 812              | Present                      | Possible                      | Moderate corneal opacity                                  |
| None              | ABMMG +CPG + TEF | Uncertain          | Impossible           | 777              | Present                      | Possible                      | Mild lipidic keratopathy, moderate corneal opacity        |
| None              | ABMMG +CPG + TEF | Uncertain          | Impossible           | 1055             | Present                      | Possible                      | Moderate corneal opacity                                  |
| None              | ABMMG +CPG + TEF | Uncertain          | Impossible           | 1730             | Present                      | Possible                      | Severe corneal opacity                                   |
| None              | ABMMG +CPG + TEF | Uncertain          | Impossible           | 199              | Absent                       | Impossible                    | Endophthalmitis, phthisis bulbi, severe corneal opacity   |
| None              | ABMMG +CPG + TEF | Uncertain          | Impossible           | 668              | Absent                       | Impossible                    | Glaucoma, enucleation                                    |
| Chronic dermatitis| ABMMG +CPG + TEF | Uncertain          | Impossible           | 22               | Present                      | Partially possible            | NA                                                        |
| None              | ABMMG +TEF       | Uncertain          | Impossible           | 187              | Absent                       | Impossible                    | Graft rejection, endophthalmitis, enucleation             |
| Hearth murmure    | ABMMG +CPG + TEF | Uncertain          | Impossible           | 386              | Present                      | Possible                      | Moderate corneal opacity                                  |
| None              | ABMMG +CPG + TEF | Uncertain          | Impossible           | 116              | Present                      | Possible                      | NA                                                        |
3.3 | Short-term follow-up: postoperative clinical findings up to 30 days

All surgeries were performed without complications. At the first follow-up visit, 5–7 days after surgery, the third eyelid flap was removed in all animal patients and no complications were observed in any of the subjects.

The conjunctival pedicle graft, performed in 24/27 eyes (88.9%), was reshaped 10–20 days after surgery, depending on the complexity of the clinical case, with topical anaesthesia except for two cats in which an aggressive temperament required sedation.

One dog, an English Bulldog (case 9), developed a severe endophthalmitis 23 days after surgery which led to secondary phthisis bulbi (Figure 3B). All other animal patients showed no complications at the short-term follow-up.

3.4 | Long-term follow-up: postoperative clinical findings

Sixteen animals (17 eyes) had follow-ups for approximately six months post-surgery, 11 of which (11 eyes) were reassessed after more than 1 year.

At the last ophthalmic follow-up visit (ranging from 187 to 2691 days), 11/17 eyes (64.8%) showed visual function, in 3/17 eyes (17.6%) visual function was judged as absent, and in 3/17 eyes (17.6%) visual impairment was considered uncertain. The fundus was completely observable in 10/17 eyes (58.9%), while in 3/17 eyes (17.6%), fundoscopy was only partially possible. Due to the degree of corneal opacity and intraocular post-surgical sequelae, no part of the fundus was observable via ophthalmoscopy in 4/17 eyes (23.5%). Minimal opacity (grade 1; Figure 2A) was observed in 1/17 eyes.
### Table 2

Data collected for feline patients

| Case | Breed | Gender | Age (years) | Eye | Primary Lesion | Concurrent ocular abnormalities | Systemic diseases | Surgery | PO visual function | PO fundus evaluation | Follow-up (days) | Visual function at last check | Fundus evaluation at last check | Complication |
|------|-------|--------|-------------|-----|----------------|---------------------------------|-------------------|---------|-------------------|-------------------|-----------------|-----------------------------|-----------------------------|-------------|
| 1    | DSH   | FS     | 10          | OS  | Corneal perforation | Central 25%–50% | Unknown | Herpetic stromal keratitis | None | ABMMG + TEF | Impossible | 790 | Present | Impossible | None | Impossible | Severe corneal opacity |
| 2    | DSH   | FS     | 16          | OS  | Corneal perforation, melting | Central 50%–75% | Unknown | Bilateral entropion | None | ABMMG +CPG + TEF | Uncertain | 23 | Present | Possible | NA | NA |
| 3    | Persian | MC     | 13          | OU  | OS: bullous keratopathy, perforation. OD: bullous keratopathy | Central 25%–50% | Nigrum spontaneous extrusion | Fundus degeneration | None | OS: ABMMG +CPG + TEF; OD: ABMMG | Uncertain | 309 | OS Absent; OD Present | OU possible | OS severe corneal opacity OD moderate corneal opacity |
| 4    | Persian | M      | 0,33        | OD  | Corneal perforation with iris prolapse, hyphema, hypopyon | Dorsonasal <25% | Cat scratch | None | None | ABMMG +CPG + TEF | Present | Impossible | Possible | NA | NA |
| 5    | DSH   | FS     | 0,46        | OS  | Corneal perforation, melting | Lateral paracentral <25% | Cat scratch | None | None | ABMMG +CPG + TEF | Present | Possible | 225 | Partially possible | Graft rejection, moderate corneal opacity |
| 6    | DSH   | MC     | 16          | OS  | Corneal perforation, melting | Central >75% | Topical corticosteroid | None | Kidney failure | ABMMG +CPG + TEF | Uncertain | Impossible | Possible | NA | NA |
| 7    | DSH   | FS     | 7           | OS  | Corneal perforation | Central 25%–50% | Cat scratch | None | None | ABMMG +CPG + TEF | Uncertain | Impossible | Present | Possible | NA |
| 8    | DSH   | MC     | 5           | OD  | Corneal perforation with iris prolapse, hyphema | Dorsotemporal <25% | Cat scratch | None | None | ABMMG +CPG + TEF | Present | Possible | 44 | Present | Possible | NA |
| 9    | Persian | MC     | 6           | OS  | Corneal perforation with iris prolapse | Central 50–75% | Nigrum spontaneous extrusion | Bilateral inferomedial entropion | None | ABMMG +CPG + TEF | Uncertain | 2691 | Present | Partially possible | Severe corneal opacity |
| 10   | DSH   | M      | 1,5         | OS  | Corneal perforation with iris prolapse, melting | Central 25%–50% | Cat scratch, CPG rejected | None | Retinal detachment | None | ABMMG +TEF | Uncertain | Impossible | Absent | Possible | NA |
| 11   | DSH   | MC     | 0,5         | OD  | Corneal perforation with iris prolapse, hyphema | Central <25% | Cat scratch | None | None | ABMMG +CPG + TEF | Uncertain | Impossible | Present | Possible | NA |
| 12   | DSH   | FS     | 15          | OS  | Corneal perforation | Central <25% | Cat scratch | None | None | ABMMG +CPG + TEF | Uncertain | Impossible | 622 | Present | Possible | Moderate corneal opacity |

**FIGURE 2** Residual corneal opacity classified as: (A) Minimal: clear visualization of the anterior chamber and posterior segment through the graft is possible. (B) Moderate: visualization of the anterior chamber and posterior segment through the graft is possible, but difficult. (C) Severe: anterior chamber and posterior segment cannot be visualized through the graft.
eyes (5.9%), moderate opacity (grade 2; Figure 2B) in 9/17 eyes (52.9%), and severe opacity (grade 3; Figure 2C) in 7/17 eyes (41.2%; Table 3).

In two cases, one dog (case 12) and one cat (case 5), graft rejection was observed after 85 days and 70 days post-surgery, respectively. The cat underwent a second operation, and a pedicle flap was performed with a positive outcome. The dog developed an endophthalmitis which was not controllable with medical drugs, and thus, the eye was enucleated.

One Shih-tzu (case 10) developed glaucoma secondary to an extensive anterior synechia 10 months after surgery. The pharmacological control of IOP was impossible, and the eye was thus enucleated.

Two Shih-tzus, case 1 (Figure 3A) and case 6, developed lipidic keratopathy which was evident at days 52 and 118 of the follow-up examinations, respectively. The lipidic keratopathy was treated with a keratectomy 10 months after graft surgery in the most severe case (case 1).

| Grade | Classification | Description | Number of dogs | Number of cats |
|-------|----------------|-------------|----------------|---------------|
| Grade 1 | Minimal | Minimal stromal opacity and/or pigmentation and/or vascularization. Clear visualization of the anterior chamber and posterior segment through the graft is possible (Figure 2A) | 1 | 0 |
| Grade 2 | Moderate | Moderate stromal opacity and/or pigmentation and/or vascularization. Visualization of the anterior chamber and posterior segment through the graft is possible, but difficult (Figure 2B) | 6 | 3 |
| Grade 3 | Severe | Severe stromal opacity and/or pigmentation and/or vascularization. Anterior chamber and posterior segment cannot be visualized through the graft (Figure 2C) | 4 | 3 |

FIGURE 3 Long-term complications (A) Canine case number 1: diffuse lipidic keratopathy (B) Canine case number 9: subconjunctival hemorrhages, endophthalmitis, phthisis bulbi, and severe corneal opacity

4 | DISCUSSION

Deep corneal ulcers, corneal perforations, and descemetoceles are frequently presented in veterinary ophthalmology practice, and their prompt treatment is required to prevent vision loss and ensure the anatomical preservation of the globe.10

Brachycephalic breeds are most commonly affected by corneal ulceration, both in cats and dogs, due to various morphological characteristics such as: corneal exposure, increased eyelid fissure, reduction in corneal sensitivity, multiple palpebral abnormalities, and nasal folds.43

In our study, brachycephalic canine breeds were over-represented (11/14). In most cases, it was not possible to determine the primary cause of corneal injury, based on medical history or on ophthalmic examination. The only exceptions were the Beagle, which showed a notch suture behind the third eyelid due to a previous pocket surgery, and the English Setter in which a foreign body trauma, which occurred during a hunting incident, was reported by the owner. However, in all the other animals, there were concomitant ocular abnormalities which potentially predisposed them to corneal ulceration.

In our feline population, domestic shorthair cats were the most represented breed (9/12). In these cases, ulcerations were mostly secondary to traumatic injuries (cat scratch 6/9), while in the three Persian cats, the most common cause of presentation was the spontaneous extrusion of a corneal sequestrum (2/3).

Many different techniques have been described for deep corneal ulceration, corneal perforation, and descemetocele treatment, both in dogs and cats. These procedures can be classified into four groups of surgical techniques involving:
a. homologous tissue (conjunctival graft and conjunctival island, corneo-scleral or corneo-conjunctival transposition, autologous corneal grafts, lamellar, and penetrating transplants using fresh or frozen corneal tissue);

b. heterologous tissue (lamellar and penetrating transplants using fresh or frozen corneal tissue, equine amniotic membrane, equine pericardium, porcine amniotic membrane, equine renal capsule, bovine amniotic membrane, and human amniotic membrane);

c. acellular biomaterial (porcine small intestinal submucosa, porcine urinary bladder, bovine pericardium, human amniotic membrane, and acellular corneal stroma);

d. synthetic material (expanded polytetrafluoroethylene and cyanoacrylate tissue adhesive).

The conjunctival graft is the most common technique used for the surgical resolution of corneal ulcers. Several modifications of the technique were initially described in 1950, which differed above all in terms of the location and modifications of the technique were initially described for the surgical resolution of corneal ulcers. Several kinds of acellular biomaterials are now on the market which are easy to acquire and store. In addition, their acellularity is associated with a lower immune response and therefore limited graft rejection, and there is a good final transparency of the cornea. However, their use alone is not recommended in the case of a perforation or very deep ulceration, and some authors suggest that their collagenous nature could be potentially used as a substrate for the action of collagenases.

In our study, most cases presented severe lesions such as descemetocytes or corneal perforation with or without iris prolapse (25/27 eyes), and concomitant corneal melting was present in 13/27 eyes. These features prevented the use of some of the above-mentioned techniques and, in other cases, limited finances led to less expensive procedures and with a low risk of rejection to prevent further surgery.

The advantages of the buccal mucosa are a complete and readily available tissue. It is also easy to obtain and use, and as it is a homologous tissue, it has a poor immune response with low rejection rates. In addition, the labial mucosal graft provides a strong tectonic support and thus worked better in corneal lesions with a bulging ulceration bed as in the majority of our cases presented. Based on our previous experience (unpublished data), the conjunctival pedicle graft performed alone does not work with this kind of corneal ulceration.

Although 85.1% of eyes showed moderate-to-severe corneal scarring, a fundus evaluation was only possible in 14.8% of cases at the final check-up. Moreover, at the first...
presentation, an indirect ophthalmoscopy evaluation was not possible in 88.2% of eyes. Only 18.5% of patients showed a negative menace response at the final check-up against 74.1% at the first presentation.

The limitations of this study include the retrospective design and the lack of a comparative group. Incomplete data collection especially regarding the long-term follow-up which was only available in 16/26 animal patients.

We believe that ABMMGs represent a possible alternative to other surgical techniques in large ulcerative corneal lesions with perforation, where a strong tectonic support is required. The technique restores the globe and, despite secondary corneal fibrosis, visual function seems to be maintained in most cases. Finally, ABMMGs are cheaper than other techniques and represent the best choice when the owner does not have large financial resources.

ACKNOWLEDGEMENT
Open Access Funding provided by Universita degli Studi di Pisa within the CRUI-CARE Agreement. [Correction added on 31 May 2022, after first online publication: CRUI funding statement has been added.]

ORCID
Samanta Nardi https://orcid.org/0000-0003-4394-5082

REFERENCES
1. Wilkie DA, Whittaker C. Surgery of the cornea. Vet Clin North Am Small Anim Pract. 1997;27(5):1067-1107.
2. Ledbetter E, Gilger B. Diseases and surgery of the canine cornea and sclera. In: Gelatt K, Gilger B, Kern T, eds. Veterinary Ophthalmology. 5th ed. Chichester, UK: John Wiley & Sons; 2013:976-1049.
3. Ollivier FJ, Gilger BC, Barrie KP, et al. Proteinases of the cornea and precorneal tear film. Vet Ophthalmol. 2007;10(4):199-206.
4. Guyonnet A, Desquillet L, Faure J, et al. Outcome of medical therapy for keratomalacia in dogs. J Small Anim Pract. 2020;61(4):253-258.
5. Pot SA, Gallhöfer NS, Matheis FL, et al. Corneal collagen cross-linking as treatment for infectious and noninfectious corneal melting in cats and dogs: results of a prospective, nonrandomized, controlled trial. Vet Ophthalmol. 2014;17:250-260.
6. Famose F. Evaluation of accelerated collagen cross-linking for the treatment of melting keratitis in ten cats. Vet Ophthalmol. 2015;18:95-104.
7. Hellander-Edman A, Makkouni K, Mortensen J, et al. Corneal cross-linking in 9 horses with ulcerative keratitis. BMC Vet Res. 2013;9:128.
8. Zamani M, Panahi-Bazaz M, Assadi M. Corneal collagen cross-linking for treatment of non-healing corneal ulcers. J Ophthalmic Vis Res. 2015;10:16-20.
9. Wollensak G, Spoerl E, Seiler T. Riboflavin/ultraviolet-a-induced collagen crosslinking for the treatment of keratoconus. Am J Ophthalmol. 2003;135:620-627.
10. Gelatt KN, Brooks DE. Surgery of the cornea and sclera. In: Gelatt KN, Gelatt JP, eds. Textbook of Veterinary Ophthalmic Surgery. Gainesville, FL: Elsevier; 2011:191-236.
11. Kuhns EL. Conjunctival patch grafts for treatment of corneal lesions in dogs. Mod Vet Pract. 1979;60:301-304.
12. Hakanson NE, Merideth RE. Conjunctival pedicle grafting in the treatment of ulcers in dog and cat. J Am Anim Hosp Assoc. 1987;23(6):641-648.
13. Pumphrey SA, Pizzirani S, Pirie CG. 360-degree conjunctival grafting for management of diffuse keratolamacia in a dog. Vet Ophthalmol. 2011;14:209-213.
14. Parshall CJ. Lamellar corneal-scleral transposition. J Am Anim Hosp Assoc. 1973;9:270-277.
15. Cebrian P, Escanilla N, Lowe RC, et al. Corneo-limbo-conjunctival transposition to treat deep and perforating corneal ulcers in dogs: a review of 418 eyes and corneal clarity scoring in 111 eyes. Vet Ophthalmol. 2020;24(4):48-58. Online ahead of print.
16. Gogova S, Leiva M, Ortillés A, et al. Corneonconjunctival transposition for the treatment of deep stromal to full-thickness corneal defects in dogs: A multicentric retrospective study of 100 cases (2012-2018). Vet Ophthalmol. 2020;23:450-459.
17. Laguna F, Leiva M, Costa D, et al. Corneal grafting for the treatment of feline corneal sequestrum: a retrospective study of 18 eyes (13 cats). Vet Ophthalmol. 2015;18:291-296.
18. Lacerda RP, Peña Gimenez MT, Laguna F, Costa D, Ríos J, Leiva M. Corneal grafting for the treatment of full-thickness corneal defects in dogs: a review of 50 cases. Vet Ophthalmol. 2017;20(3):222-231.
19. Jaksz M, Fischer M-C, Fenollosa-Romo E, Busse C. Autologous corneal graft for the treatment of deep corneal defects in dogs: 15 cases (2014-2017). J Small Anim Pract. 2020 Online ahead of print.62(2):123-130.
20. Barros PSM, Safatie AMV, Malerba TA, et al. The surgical repair of the cornea of the dog using pericardium as a keratoprosthesis. Braz J Vet Res Anim Sci. 1995;32:251-255.
21. Barachetti L, Giudice C, Mortellaro CM. Amniotic membrane transplantation for the treatment of feline corneal sequestrum: pilot study. Vet Ophthalmol. 2010;13:326-330.
22. Costa D, Leiva M, Sanz F, et al. A multicenter retrospective study on cryopreserved amniotic membrane transplantation for the treatment of complicated corneal ulcers in the dog. Vet Ophthalmol. 2019;22:695-702.
23. Tsuzuki K, Yamashita K, Izmisawa Y, et al. Microstructure and glycosaminoglycan ratio of canine cornea after reconstructive transplantation with glycerin-preser porcine amniotic membranes. Vet Ophthalmol. 2008;11:222-227.
24. Andrade AL, Laus JL, Figueiredo F, et al. The use of preserved equine renal capsule to repair lamellar corneal lesions in normal dogs. Vet Ophthalmol. 1999;2:79-82.
25. Dulaurent T, Azoulay T, Gouille F, et al. Use of bovine pericardium (Tutopatch®) graft for surgical repair of deep melting corneal ulcers in dogs and corneal sequestra in cats. Vet Ophthalmol. 2014;17:91-99.
26. Ballard O, Poinssard AS, Famose F, et al. Use of a porcine urinary bladder acellular matrix for corneal reconstruction in dogs and cats. Vet Ophthalmol. 2016;19(6):454-463.
27. Chow DWY, Westermeyer HD. Retrospective evaluation of corneal reconstruction using ACell Vet™ alone in dogs and cats: 82 cases. Vet Ophthalmol. 2016;19(5):357-366.
28. Vanore M, Chahory S, Payen G, Clerc B. Surgical repair of deep melting ulcers with porcine small intestinal submucosa (SIS) graft in dogs and cats. Vet Ophthalmol. 2007;10(2):93-99.
29. Gouille F. Use of porcine small intestinal submucosa for corneal reconstruction in dogs and cats: 106 cases. J Small Anim Pract. 2012;53(1):34-43.
30. Lin XC, Hui YN, Wang YS, et al. Lamellar keratoplasty with a graft of lyophilized acellular porcine corneal stroma in the rabbit. *Vet Ophthalmol*. 2008;11:61-66.
31. Watté CM, Elks R, Moore DL, et al. Clinical experience with butyl-2-cyanoacrylate adhesive in the management of canine and feline corneal disease. *Vet Ophthalmol*. 2004;7:319-326.
32. Pumphrey SA, Desai SJ, Pizzirani S. Use of cyanoacrylate adhesive in the surgical management of feline corneal sequestrum: 16 cases (2011–2018). *Vet Ophthalmol*. 2019;22:859-863.
33. Wilkie DA, Wolf ED. Treatment of epibulbar melanocytoma in a dog, using full-thickness eyeball resection and synthetic graft. *J Am Vet Med Assoc*. 1991;198:1019-1022.
34. Featherstone HJ, Sansom J. Feline corneal sequestra: a review of 64 cases (80 eyes) from 1993 to 2000. *Vet Ophthalmol*. 2004;7:213-227.
35. Dorbandt DM, Moore PA, Myrna KE. Outcome of conjunctival flap repair for corneal defects with and without an acellular submucosa implant in 73 canine eyes. *Vet Ophthalmol*. 2015;18(2):116-122.
36. Keenan AV, Boveland SD, Rodriguez Galarza R, et al. Corneoconjunctival transposition with and without Acell for deep corneal ulcer repair in 18 dogs. *Vet Ophthalmol*. 2020;23:884-891.
37. Peña TM, Garcia FA. Reconstruction of the eyelids of a dog using grafts of oral mucosa. *Vet Rec*. 1999;144:413-415.
38. Warren C, Grozdanic S, Reinstein S. Use of free oral mucosal graft for treatment of feline eyelid agenesis in seven patients. *Vet Ophthalmol*. 2020;23:659-667.
39. Kuhns EL. Replacement of canine membrana nictitans with a lip graft. *Mod Vet Pract*. 1981;62:773-776.
40. Kuhns EL. Reconstruction of canine membrane nictitans with an autograft. *Mod Vet Pract*. 1981;62:697-700.
41. Cherry RL, Smith JD, Ben-Shlomo G. Canine oral mucosa evaluation as a potential autograft tissue for the treatment of unresponsive keratoconjunctivitis sicca. *Vet Ophthalmol*. 2018;21:48-51.
42. Penazzi C, Pizzirani S. Utilizzo di un innesto di mucosa orale libera per il trattamento di una perforazione corneale cronica in un cane. Cremona, Italy: Proceedings of the Italian Society of Veterinary Ophthalmology; 2004 November 20 to 21.
43. Packer RM, Hendricks A, Burn CC. Impact of facial conformation on canine health: corneal ulceration. *PLoS One*. 2015;10:e0123827.
44. Stern AI. Conjunctival flap operation. *J Am Vet Med Assoc*. 1950;116:44-45.
45. Yang VY, Labelle AL, Breaux CB. A bidirectional corneoconjunctival transposition for the treatment of feline corneal sequestrum. *Vet Ophthalmol*. 2019;22(2):192-195.

**How to cite this article:** Mezzadri V, Crotti A, Nardi S, Barsotti G. Surgical treatment of canine and feline descemetoceles, deep and perforated corneal ulcers with autologous buccal mucous membrane grafts. *Vet Ophthalmol*. 2021;24:599–609. [https://doi.org/10.1111/vop.12907](https://doi.org/10.1111/vop.12907)