Management of spontaneous chronic corneal epithelial defects (SCCEDs) in dogs with diamond burr debridement and placement of a bandage contact lens

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Objective To describe the outcome of canine spontaneous chronic corneal epithelial defects (SCCED) treated with diamond burr debridement (DBD) and bandage contact lens placement (BCL).

Animal studied Forty eyes of 36 dogs presenting to a single private practice.

Procedures A retrospective review of medical records was performed. Cases were eligible for inclusion if they were newly diagnosed with SCCED by a veterinary ophthalmologist and treated with DBD/BCL. All patients received a complete ocular examination followed by DBD using a battery-powered, handheld motorized burr (Algerbrush®, Alger Equipment Company, Lago Vista, TX, USA). A BCL was placed post-debridement in all patients. Data were analyzed for sex, age, breed, duration of clinical signs prior to DBD; number of debridements required before healing was achieved; contact lens retention, complications attributed to DBD, and additional surgical interventions were required to achieve healing.

Results The median time to first recheck examination was 7 days (IQR 7–9 days) with 28/40 (70%) of cases healed at this examination. The mean time to second recheck examination was 15.5 ± 5.5 days with 37/40 (92.5%) healed by this examination. The median time to final recheck examination was 19 days (IQR 18–35.5 days) with a range of 18–52 days. All cases resolved by the third and final recheck examination. A second DBD/BCL was performed in 5/40 (12.5%) of cases. The BCL retention rate was 95% over all examination time points. No case required a keratectomy or other surgical intervention to achieve healing. The only complication observed was one case of suspected bacterial keratitis post-DBD/BCL.

Conclusions Results suggest that DBD/BCL is safe and effective for treatment of canine SCCED.

Key Words: bandage contact lens, cornea, diamond burr debridement, erosion, indolent ulcer, spontaneous chronic corneal epithelial defects

INTRODUCTION

Spontaneous chronic corneal epithelial defects (SCCEDs) have been well described in the dog, including a recent review.1–5 Clinical hallmarks include superficial corneal erosion with redundant, nonadherent epithelial margins associated with variable corneal vascularization and ocular pain.4 Classic histopathologic features include nonadherent, dysplastic epithelium adjacent to the ulcerated region, loss of epithelial basement membrane, presence of a hyalinized, acellular zone in the superficial stroma, and an abnormal nerve plexus in the anterior stroma surrounding the erosion.6 Affected dogs are typically middle aged and free of concurrent ocular disease, and Boxers have been demonstrated to be overrepresented in multiple studies.1–3,5,7,8 A variety of medical and surgical treatments have been reported. Medical therapies have included administration of topical epidermal growth factor, polysulfated glycosaminoglycans, apoprotinin, substance P, insulin-like growth factor-1, and tetracycline.3,8–11 Reported surgical therapies include debridement, anterior stromal puncture techniques (grid keratotomy, multiple punctate keratotomy), third eyelid flaps, temporary tarsorrhaphy, application of cyanoacrylate tissue adhesives, thermal cautery, and superficial

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keratectomy. A preliminary report of the use of handheld device for mechanized debridement of the cornea has piqued interest in the technique of diamond burr debridement (DBD). This report of 100 cases showed a low rate of complications and a significantly shorter healing time when compared to the more conventional technique of grid keratotomy. A subsequent report evaluating the histologic effect of DBD in normal and experimental corneal erosions demonstrated that DBD was safe and not associated with removal of corneal stroma beyond the epithelial basement membrane. This study suggested that further evaluation of DBD in clinical cases of SCCEDs was warranted.

The purpose of this study is to document the clinical outcomes of 40 canine cases of SCCED treated with a combination of DBD and placement of a bandage contact lens (BCL).

MATERIALS AND METHODS

Medical records of canine patients presenting to the Ophthalmology Department at WestVet Animal Emergency and Specialty Center between January 2010 and May 2011 were retrospectively evaluated. Criteria for a diagnosis of SCCED included presence of superficial corneal ulcer with no loss of underlying stroma, presence of redundant, nonadherent epithelium at the margins of ulcer, duration of ulceration of \( \geq 1 \) week prior to diagnosis of SCCED, and no identifiable causes for corneal ulceration (i.e., entropion, neuroparalytic keratitis, keratoconjunctivitis sicca (KCS), eyelid margin defects). Cases were eligible for inclusion if they received a complete ophthalmic examination and were diagnosed by a board-certified veterinary ophthalmologist with SCCED, were subsequently treated with DBD/BCL, had no significant co-morbid ocular conditions (i.e., uveitis, glaucoma, endothelial degeneration), and follow-up information was available regarding case outcome.

In all cases, the DBD/BCL was performed similarly. The DBD was completed using a battery-operated, handheld diamond burr unit (Algerbrush; Alger Equipment Company, Lago Vista, TX, USA) with a 2.5 or 3.5-mm burr in either a fine or medium grit. The removable burr tip was sterilized in a steam autoclave between each use. The ocular surface was prepared using a dilute 1:50 povidone iodine solution (Poviderm Solution; Butler Animal Health, Dublin, OH, USA). Topical anesthetic solution (proparacaine hydrochloride 0.5% ophthalmic solution USP; Falcon Pharmaceuticals Ltd., Fort Worth, TX, USA) was administered prior to the DBD. The patient was gently manually restrained to prevent movement of the head during the procedure. Twelve patients required sedation with intravenous dexmedetomidine (375 mcg/kg, Dextdomitor; Pfizer Animal Health, New York, NY, USA) and intravenous butorphanol (0.1 mg/kg, Butorphanol tartrate 10 mg/mL; Pfizer Animal Health). The burr was passed over the ulcer bed in multiple even circular passes, removing nonadherent epithelial tissue until stable epithelium was encountered (Figs 1–3). When no additional epithelial tissue could be removed with the burr, corneal curvature and diameter were assessed using a handheld, commercially supplied ruler (Acrivet, Henningsdorf, Germany). Each patient was then fitted with a 18-mm diameter/9.6-mm curvature BCL (Acrivet Pat D1; Acrivet) or 18.0-mm diameter/9.8-mm curvature BCL (Acrivet Pat D2; Acrivet, Veterinary Division of S&V Technologies AG).

Data harvested from each medical record included age, sex, breed, duration of clinical signs prior to evaluation by a veterinary ophthalmologist, ophthalmic examination findings, treatment performed, post-DBD/BCL topical/systemic medical therapy, number of days to achieve healing of the SCCED, post-DBD/BCL complications, and additional therapeutic interventions. A SCCED was considered resolved after ophthalmic examination by a single veterinary
ophthalmologist revealed a fluorescein-negative, stable epithelial surface with no evidence of ocular discomfort as evidenced by blepharospasm or ocular discharge. Continuous data were analyzed for normality, and descriptive statistics were performed (IBM SPSS Statistics 19; IBM Corporation, Armonk, NY, USA). Nonparametric data were compared using a Mann–Whitney U-test.

RESULTS

A total of 36 dogs (40 SCCEDs) were included in the study. Mixed-breed dogs were most commonly represented (n = 8), followed by Labrador Retrievers (n = 4), Boxers (n = 4), and Golden Retrievers (n = 4). Other breeds included English Bulldog (n = 3), Welsh Corgi (n = 3), Boston terrier (n = 2), and one Bassett Hound, Boykin Spaniel, German Shorthair Pointer, Siberian Husky, Jack Russell Terrier, Toy Poodle, Weimaraner, and West Highland White Terrier. The population included 18 female spayed dogs, three intact male dogs, and 15 neutered male dogs. The mean age was 8.9 years (SD ±2.4 years) and range of 3–13 years. A total of 25 SCCEDs were diagnosed in the right eye and 15 in the left eye.

Prior to specialist referral, the median duration of clinical signs was 3.7 weeks (interquartile range (IQR) 2.0–6.5 weeks) with a range of 1–15 weeks. The most common presenting clinical sign was blepharospasm in 29/40 cases (72%), followed by conjunctival hyperemia in 27/40 cases (68%), enophthalmos in 14/40 cases (35%), corneal vascularization in 12/40 cases (30%), corneal edema in 10/40 cases (24%), epiphora in 9/40 cases (23%), miosis in 9/40 cases (10%), and corneal fibrosis in 2/40 cases (5%). All patients were treated with DBD/BCL as described previously. A single dose of atropine ophthalmic solution (Atropine sulfate ophthalmic solution USP 1%; Bausch and Lomb, Tampa, FL, USA) was administered immediately post-DBD/BCL in 35/40 (88%) cases. Post-DBD/BCL medical therapy varied among patients. Neomycin–polymixin–gramicidin ophthalmic solution (one drop q8h, neomycin and polymixin B sulfates and gramicidin ophthalmic solution USP, Bausch and Lomb) was prescribed in 22/40 (55%) of the patients, whereas the remaining cases were continued on the topical antibiotic initiated by their primary care veterinarian. Oral tramadol (2–4 mg/kg PO q8h, tramadol hydrochloride tablets USP 50 mg; Amneal Pharmaceuticals, Hauppauge, NY, USA) was prescribed to be used at owner discretion for analgesia in 34/40 cases (85%). The oral NSAID carprofen (2.2 mg/kg PO q12h, Rimadyl; Pfizer) was only prescribed in 4/40 cases (10%). Two cases were continued on a topical NSAID previously prescribed by their referring veterinarian.

The median time to first recheck examination was 7 days (IQR 7–9 days) after initial presentation with a range of 2–15 days. A total of 28/40 (70%) of cases were resolved at the first recheck examination. The mean time to second recheck examination was 15.5 ± 5.5 days after initial presentation with a range of 7–22 days. A total of nine additional cases were resolved at this time, bringing the total number of resolved cases to 37/40 (92.5%). The median time to final recheck examination for the remaining three cases was 19 days (IQR 18–35.5 days) with a range of 18–52 days. At the time of the first recheck examination, five of the 12 unresolved cases were treated with a second DBD/BCL. The decision to repeat the procedure was made based on clinical evidence of poor response to initial treatment, including the presence of redundant epithelial tissue at the erosion margins. The procedure was not repeated when convincing evidence of clinical improvement, including decrease in the area of fluorescein retention, absence of nondherent epithelial margins, and absence of fluorescein wicking beneath the epithelial margins was present. Of these five cases, four were resolved at the second recheck examination. One case was not completely resolved, but received no further intervention, and was healed at the final recheck examination. The proportion of cases requiring a second DBD/BCL was 5/40 (12.5%). The proportion of cases that healed with only one DBD/BCL was 35/40 (87.5%). No case required more than 2 DBD/BCL to achieve healing, nor was superficial keratectomy required in any case. The median time to first recheck examination of the five cases that required a second DBD/BCL was 9 days (IQR 7–13 days) with a range of 7–15 days. There was no statistically significant difference between the median number of days to first recheck examination in cases that resolved with a single DBD/BCL and cases that required a second DBD/BCL (P = 0.881).

The contact lens retention rate was 38/40 (95%) at the first recheck examination. The contact lens retention rate was 11/12 (92%) at the second recheck examination. The overall retention rate for all dogs and all visits was 52/55 (95%). One patient developed marked blepharospasm and serous ocular discharge 1 day after BCL placement, which resolved within 24 h of removing the BCL.
Clinical signs present at the date of last recheck examination included mild corneal edema in 24/40 cases (60%), vascularization in 16/40 cases (40%), conjunctival hyperemia in 14/40 cases (35%), corneal haze in 9/23 cases (23%), and mild chemosis in 3/40 cases (8%). Vision was present in all eyes at the date of last recheck examination.

The only significant complication encountered in this case series was the development of suspect bacterial keratitis at the first recheck exam. A 6-year-old FS Boxer developed stromal infiltrate and loss of stroma (approximately 25% of the corneal thickness). Culture of the ocular surface for microorganisms was declined by the owner. Medical therapy successfully resolved the bacterial keratitis after several weeks of treatment, and the SCCED healed with no additional intervention.

**DISCUSSION**

This study represents the first published report of the use of diamond burr debridement in conjunction with placement of a bandage contact lens for treatment of canine SCCED. It is well established that surgical intervention produces the highest success rates for resolution of SCCED.$^2,5,7–9,12,15,15$ A meta-analysis of previous reports found that the resolution rate with a single treatment of corneal debridement alone is approximately 50%, while performing anterior stromal puncture (either multiple punctate keratotomy or grid keratotomy) increases healing rates to approximately 80%.$^3$ The highest success rates are found in cases that receive a superficial keratectomy, where the overall success rate approaches 100%.$^4$ The disadvantages of superficial keratectomy, despite its high success rate, includes the need for general anesthesia, increased postoperative scarring with resultant corneal opacity, and increased expense.$^5,7$ The ideal treatment for SCCED would be inexpensive, minimally invasive, produce rapid and complete healing, and not require general anesthesia, expensive equipment, or specialized facilities to perform.

Diamond burr debridement was first reported for treatment of corneal erosions in humans in 1983.$^{18}$ Subsequent experimental evaluation of the DBD technique in laboratory rabbits demonstrated that DBD was effective in removing epithelium and in partial removal of the underlying basement membrane and that wounds created by DBD healed more quickly than those created using lamellar keratectomy utilizing a scalpel blade.$^{19}$ Since that time, a number of studies have evaluated DBD for the treatment of superficial corneal erosions and dystrophic epithelial irregularities.$^{20–27}$ A meta-analysis of four studies revealed an overall success rate of 94%.$^{21}$ A recent prospective study demonstrated a decreased rate of recurrence of corneal erosions utilizing DBD when compared to manual debridement with a cellulose sponge.$^{20}$ When compared to phototherapeutic keratectomy, DBD has a decreased rate of recurrence and a slight decrease in post-treatment corneal haze.$^{27}$ DBD is now widely advocated in the treatment of recurrent erosions in humans.$^{28}$

Purported advantages of DBD include decreased expense, no requirement for specialized equipment or advanced surgical training, minimal scar formation, removal of abnormal basement membrane, low recurrence rate, simplicity of performing the procedure, and minimal influence on refractive error.$^{25}$ The exact mechanism by which DBD influences the healing of corneal erosions is unknown. Previous authors have suggested that DBD creates micro-erosions of the basement membrane that contribute to an alteration of corneal topography which in turn affects the assembly of epithelial cell adhesion complexes and that physical ‘polishing’ of the basement membrane improves the adhesion of new epithelial cells. They also theorized that DBD induces expression of proteins by regional extracellular matrix that may subsequently contribute to fibrosis and improved epithelial adhesion strength or that the exposure of normal basement membrane peripheral to the erosion positively influences epithelial adhesion.$^{17}$ The reported complications of DBD are few, with recurrence of corneal erosion and post-treatment subepithelial haze representing the most common complications.$^{21}$ A recent report of significant astigmatism post-DBD in a woman with antecedent forme fruste keratoconus suggests that DBD should be avoided in patients with keratoconus and that corneal topographic analysis be considered prior to DBD.$^{26}$

The sole clinical report of DBD in veterinary medicine compared 100 canine SCCED eyes treated with DBD with grid keratotomy utilizing a #64 beaver blade (43 eyes) or a 25-g needle (52 eyes).$^{16}$ In this study, eyes treated with DBD were significantly more likely to be healed at 1–3 weeks post-treatment than those treated with either grid keratotomy techniques. The only reported complication was the development of keratomalacia in three dogs at 1 week post-treatment. All cases responded to appropriate medical management.

The results of this study suggest that DBD/BCL is an effective treatment for canine SCCED. The overall healing after a single treatment was 92.5%, and no case enrolled in this study required more than 2 DBD/BCL procedures. The true time to healing in these cases is unknown, as patients were not rechecked daily after the DBD/BCL. Number of days to each recheck examination and proportion of cases healed at each recheck examination were chosen as outcome measures in this study to accurately report the observed healing rates, despite the variability in individual patient’s recheck examination schedules. A prospective study with daily serial examinations would be required to more precisely determine the true time to healing after DBD/BCL.

One advantage of DBD is the ease with which it can be repeated and that repeat procedures contribute minimally to post-treatment scarring.$^{25}$ General anesthesia was not required to perform DBD/BCL in this study, although short-acting sedation was utilized in fractious patients. Post-treatment scarring was not objectively quantified. The post-treatment examination findings of
The use of a BCL has been previously reported in veterinary medicine, although it does not appear to be a widely utilized adjunctive therapy for the treatment of SCCED in clinical practice. While use of a BCL alone does not appear to generate healing rates comparable with surgical intervention, it has been suggested that use of a BCL significantly improves healing rates when combined with an anterior stromal puncture technique. Rigorous controlled studies comparing use of a BCL after anterior stromal puncture for treatment of SCCED are lacking. The design of this study did not allow for a comparison in patient comfort with and without use of BCL; however, future studies investigating the use of BCL on healing of canine SCCED are warranted. Experimental use in rabbits has shown use of a BCL speeds wound healing in experimental corneal ulceration. The use of a BCL has been demonstrated to support resolution of a variety of corneal diseases in man, including chronic erosions. The bandage contact lens may shield the migrating epithelial cells from the disruptive mechanical action of the eyelids, supporting rapid cellular migration. The contact lens may also provide a temporary exogenous substrate, providing a matrix against which migrating epithelial cells can grow. While the exact mechanism by which a SCCED may benefit from a BCL is unknown, multiple studies in humans have demonstrated a significant relief of discomfort with their use. The use of a BCL is not without risk of complications, most notably infectious keratitis. Diligent monitoring for deterioration of corneal disease is warranted when utilizing a BCL.

CONCLUSION

The results of this study suggest that the use of DBD/BCL is safe and effective for treatment of SCCED in the dog. Further studies comparing DBD/BCL to anterior stromal puncture techniques are necessary to determine the most effective treatment for SCCED. Future studies are also warranted to evaluate the role of the BCL in the treatment of SCCED.

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