Two 6-month-old female domestic shorthair cats (cats 1 and 2) from the same litter were evaluated for bilateral eyelid agenesis while under the care of a local animal rescue organization. Both cats had tri-chiasis, blepharospasm, and ocular surface abnormalities associated with chronic exposure. The cats were otherwise healthy, as determined through physical examination and preoperative hematologic analysis.

The caretaker responsible for cat 2 requested enucleation of the left eye because of blindness caused by prior rupture. For the right eye of cat 2 and both eyes of cat 1, a blepharoplasty procedure was chosen. Cats were subsequently premedicated with buprenorphine hydrochloride (0.01 mg/kg [0.005 mg/lb]) and midazolam (0.1 mg/kg [0.045 mg/lb]) administered IV or IM approximately 2 hours before induction of anesthesia with propofol (5 mg/kg [2.3 mg/lb], IV). Cefazolin (20 mg/kg [9.1 mg/lb]) and dexamethasone (0.25 mg/kg [0.11 mg/lb], IV) were administered IV. Two percent lidocaine solution was topically applied to the arytenoids, and endotracheal intubation was performed. Cats were positioned in sternal recumbency, and anesthesia was maintained with isoflurane in oxygen. The periocular tissues were clipped of hair and aseptically prepared with alternating dilute 1:50 aqueous betadine solution and sterile saline (0.9% NaCl) solution before the surgical site was draped.

To plan the incisions for creation of the myocutaneous pedicle flap to be harvested from the lower eyelid, the surgeon used lighted head loupes with 2.5X magnification to measure the length and height of the colobomatous defect with calipers. A flap was then created by sharply incising the skin and orbicularis oculi muscle of the lower lid with a No. 15 blade. Specifically, 3 incisions were used to create the flap. The dorsal incision was made parallel to and 2 mm below the lower eyelid margin. The ventral incision was parallel to the dorsal incision with variable distance from it based on the height of the upper lid defect. Finally, the vertical incision that would form the distal margin of the flap.

ABBREVIATIONS

2OCA 2-octyl cyanoacrylate
PPM Persistent pupillary membrane
RBP Roberts-Bistner procedure

CASE DESCRIPTION

5 cats (9 eyes) were evaluated for surgical correction of bilateral eyelid agenesis.

CLINICAL FINDINGS

All eyes lacked > 25% of the temporal upper eyelid, and all cats had clinical signs attributable to chronic ocular exposure. Abnormalities were limited to the ocular surface in the 4 female cats, whereas the sole male cat had additional abnormalities consistent with anterior segment dysgenesis.

TREATMENT AND OUTCOME

A modified Roberts-Bistner procedure involving 2-octyl cyanoacrylate (2OCA) was performed on 9 eyes; 1 eye was enucleated. Surgical wounds in the initial 3 eyes were closed with 2OCA plus sutures, and flaps were lined with conjunctiva. The technique was optimized for remaining eyes by use of a single suture for flap apposition, no conjunctival lining of flaps, and 2OCA alone for wound closure. Median duration of surgery was 35 minutes/eye for the initial 3 eyes versus 16 minutes/eye for the subsequent 6 eyes treated with the optimized procedure. After surgery, all cats had complete palpebral reflexes and resolution of clinical signs of ocular irritation. Minor complications in the early postoperative period included eyelid swelling (n = 9), poor cosmesis (7), and persistent epiphora (3). By the second recheck examination, swelling had resolved and cosmesis was considered excellent. Two eyes with epiphora had been treated with the initial modified procedure and required cryoepilation for resolution of epiphora.

CLINICAL RELEVANCE

The modified Roberts-Bistner procedure for eyelid agenesis involving 2OCA for wound closure provided functional, cosmetic eyelids that improved comfort and provided protection of the ocular surface in affected cats. (J Am Vet Med Assoc 2018;252:215–221)
was made 0.5 to 1 mm medial to the edge of the upper colobomatous defect. In other words, the vertical incision was planned so that the myocutaneous flap would be 0.5 to 1 mm longer than the length of the upper eyelid defect to minimize tension at closure sites and account for minor contraction during healing. The base of this flap was made no longer than the tip because the width of a pedicle flap has no bearing on its survivable length owing to the existing blood supply. Increasing the width would only have resulted in redundant tissue, which may have increased the risk of postoperative entropion. The myocutaneous pedicle flap was therefore made to fill the height of the colobomatous defect as precisely as possible and to be 0.5 to 1.0 mm longer than the recipient site to allow for minor contraction during healing at the junction of the flap with intact upper eyelid tissue.

After the margins of the flap had been defined, the colobomatous recipient bed of the upper eyelid was prepared by sharp resection of the conjunctival edges of the defect with a surgical blade or tenotomy scissors on the basis of surgeon preference. Next, the incised myocutaneous flap was freed with a combination of blunt and sharp dissection by use of tenotomy scissors and rotated into the upper eyelid defect. The flap was secured into the recipient site with multiple absorbable sutures in a simple interrupted pattern. Regionally harvested conjunctiva (from the temporal fornix or nictitating membrane on the basis of surgeon preference) was secured to the bulbar surface of the flap with absorbable suture in a simple continuous manner.

Finally, the donor site was closed by application of either 2OCA alone or 2OCA with suture per surgeon selection. The 2OCA was applied directly from the container, which was opened immediately before application. Surgeons aimed to apply the smallest volume of 2OCA necessary to provide a thin layer of adhesive only over the incision to be closed. Median duration of surgery per eye, defined as the interval from initial incision to discontinuation of inhalant anesthesia, for the 2 cats was 35 minutes (range, 35 to 40 minutes).

Two 5-month-old domestic shorthair cat littermates (cats 3 [male] and 4 [female]) were also evaluated for bilateral eyelid agenesis and clinical signs secondary to trichiasis and chronic ocular exposure, including keratitis, conjunctivitis, ocular discharge, and blepharospasm. Cat 3 had the most severe clinical signs of all cats evaluated and was the only cat with intraocular abnormalities suggestive of anterior segment dysgenesis, with both eyes having multiple iris-to-cornea PPMs with resultant adherent leukoma, few iris-to-lens PPMs in both eyes, and an abnormally shaped lens (Figure 1). Both cats had been under the care of an animal rescue organization different from the organization for cats 1 and 2. Surgical treatment was recommended at their initial examination, when the cats were 5 months old, but was not performed until the cats were 1 year old because of the organization’s schedule. Clinical signs of both cats had worsened during the ensuing 8 months, but no new clinical abnormalities were detected on ophthalmic examination before surgery.

For the 4 eyes of cats 3 and 4, an updated modified RBP was used involving 2OCA and a few alterations intended to optimize the technique used for cats 1 and 2. Revisions included placement of

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**Figure 1**—Photographs of the right eye of a 5-month-old domestic shorthair cat (cat 3; 1 year old at the time of surgery) with eyelid agenesis before (A) and after (B) clipping of hair in preparation for a modified RBP involving 2OCA and at the conclusion of this procedure (C). A—Clinical signs of exposure keratitis are evident that were typical of all cats with eyelid agenesis in this report. These signs included a roughened corneal epithelial surface with diffuse neovascularization, conjunctival hyperemia, and dark brown serous-to-mucoid discharge that was rinsed away before surgery. B—This cat also had evidence of anterior segment dysgenesis, iris-to-cornea PPMs, adherent leukoma, and hypoplastic iris tissue, which can be seen in panel A as well. C—This postoperative photograph shows the flap incisions (black is dorsal, blue is ventral, and red is vertical) made during the procedure, the single interrupted apposition suture (green arrow), and excess 2OCA (white arrow). Although this may not be readily appreciable owing to the oblique angle of this image, it is important to remember that the base of the flap should not be wider than the tip because the width of a periocular pedicle flap has no bearing on its survivable length.
a single absorbable suture at the junction between the flap and recipient bed for apposition, closure of the surgical incisions with 2OCA only, and omission of the step involving lining of the bulbar surface of the transposed myocutaneous flaps with conjunctiva (Figure 1). These modifications were made with the goal of reducing the anesthetic period, minimizing the financial cost, and potentially avoiding postoperative entropion, which is a commonly reported complication associated with the traditional RBP.1,3,4 The surgical procedure mirrored that used for cats 1 and 2 to the point of flap fixation.

After the myocutaneous flap was rotated into upper eyelid defect, a single, simple interrupted, absorbable suture was placed at the distal tip of the transposed flap adjacent to the colobomatous recipient site (Figure 1). This suture was placed on the dermal surface to appose tissues during application of 2OCA for surgical wound closure. All incision sites were closed with 2OCA alone, which entailed holding tissues closed with digital pressure, tissue forceps, or both for at least 1 minute following administration to allow for adhesive polymerization.5,6 Median duration of surgery per eye for this technique was 16 minutes (range, 12.5 to 20.5 minutes).

A 4-month-old female domestic shorthair cat (cat 5) was also evaluated for bilateral eyelid agenesis while under the care of a third animal rescue organization. Compared with the other 4 cats, this cat had the mildest clinical signs of ocular irritation and the least gross ocular disease, possibly owing to its younger age at initial evaluation. The optimized modification to the RBP was recommended and performed on both eyes within the week. To further reduce the anesthetic period associated with this procedure, the cat was prepared and draped for bilateral ocular surgery so that only a single tube of 2OCA would be required for the procedure (Figure 2). All incisions were made bilaterally, and single sutures were placed in both eyes before the seal on the tube of 2OCA was broken. Duration of surgery was < 25 minutes for bilateral blepharoplasty.

No intraoperative complications were encountered for any of the 5 cats. After surgery, all 5 cats were treated systemically with a combination of amoxicillin trihydrate (11 mg/kg [5 mg/lb]) and clavulanic acid5 (2.75 mg/kg [1.25 mg/lb]) administered PO every 12 hours and with buprenorphine6 (0.02 mg/kg [0.009 mg/lb]), PO, q 8 to 12 h). Topical treatments included 3 doses/d of an ophthalmic antimicrobial solution,4 followed by an aqueous-based ocular lubricant5 5 minutes later. Cats were discharged from the hospital with a hard plastic Elizabethan collar, and caretakers were advised to keep this collar on the patient at all times until the first recheck examination.

All cats received a minimum of 2 recheck examinations, including at 2 and 6 weeks after surgery. All 9 eyes treated with the modified RBP retained vision and gained a functional palpebral reflex that was present at the first recheck visit and considered complete by the second recheck visit at the latest. Identified postoperative complications were considered minimal given their mild and transient nature.7 At 2 weeks after the nonoptimized modified RBP, cats 1 and 2 had eyelid swelling (3 eyes), marked to moderate periocular crusts (3 eyes), epiphora (3 eyes), and focal dehiscence (1 eye). At 6 weeks after the procedure, epiphora (3 eyes) and focal dehiscence (2) but no eyelid swelling or periocular crusts were noted. At 2 weeks after the optimized modified RBP, cats 3, 4, and 5 had eyelid swelling (6 eyes) and periocular crusts (4 eyes) but no epiphora or focal dehiscence, whereas at 6 weeks after the procedure, no complications were noted (Figure 3). Overall, all treated eyes had mild to moderate eyelid swelling, and most (n = 7) had fair to poor cosmesis in the early postoperative period owing to periocular crusts consisting of 2OCA and adherent environmental debris; the latter complication was more severe in cats with light-colored hair coats.

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**Figure 2**—Photographs of a 4-month-old female domestic shorthair cat (cat 5) before (A) and immediately after (B) performance of the optimized RBP as well as at recheck examinations performed 2 (C) and 6 (D) weeks after surgery. The young age of this cat may have accounted for the minimal gross corneal abnormalities visible in panels A and B.
Eyelid agenesis is a congenital colobomatous defect of the palpebra. The term coloboma denotes an abnormality characterized by missing tissue and in ophthalmology can be used to refer to the congenital absence of any ocular tissue. Most colobomas of the eye result embryologically from faulty or incomplete closure of the optic fissure; this is not believed to be true for colobomas of the eyelid. The etiology of eyelid agenesis is unknown, but the prevailing theories attribute the anomaly to a defect in the process of eyelid fusion or premature eyelid opening during gestation.

Eyelid agenesis has been reported for several veterinary species, most frequently for cats, sheep, and goats. A genetic predisposition has been suggested for Burmese cats and snow leopards (Uncia uncia) but has not been established. This condition is also commonly believed to be more prevalent in the feral cat versus owned cat population, which was the situation for the cats of the present report; however, this possibility also remains to be established. Eyelid agenesis generally affects cats bilaterally at the lateral aspect of the upper eyelids. As in humans, congenital upper eyelid coloboma can represent an isolated defect or it may be associated with other ocular abnormalities, such as PPMs, dermoid cysts, uveal and optic nerve colobomas, microphthalmia, cataracts, and retinal dysplasia.

Congenital upper eyelid coloboma is considered one of the few nontraumatic ocular emergencies in human medicine because normal eyelid function is essential for a complete palpebral reflex to protect ocular surface tissues. Left untreated, large eyelid defects can lead to painful and blinding sequelae secondary to chronic ocular exposure that manifests as corneal vascularization, fibrosis, pigmentation, epithelial hyperplasia, ulceration, and even globe rupture.

Owing to these potentially devastating outcomes, numerous treatments have been reported for eyelid colobomas in humans and other animals, including direct surgical closure for defects affecting < 25% of the eyelid margin, flap procedures, manual epilation or cryoepilation, excision of adjacent tissue, injection of collagen into adjacent tissues, frequent application of ocular lubricants, or no treatment if the cornea appears healthy.

Although eyelid agenesis may not warrant the status of ophthalmic emergency in veterinary patients, it is a painful, vision-threatening abnormality that is ideally treated by construction of a functional, cosmetic eyelid to protect the cornea and ocular surface tissues.

Reconstructive blepharoplasty best achieves these goals, but existing surgical procedures, including transposition flaps, are often perceived as technically difficult, prolonged surgeries associated with a greater expense and risk because of a longer anesthetic episode than is characteristic of nonreconstructive treatment options. Some portion of surgical cost directly relates to the duration of the procedure; however, the increased risk of postoperative complications associated with longer surgery periods has only recently been confirmed for plastic surgery. In addition, the congenital nature of eyelid agenesis often means that veterinary patients are quite young at the time of surgery, increasing their risk of complications from prolonged anesthesia.

Although veterinary ophthalmologists are trained in reconstructive blepharoplasty, referral to a specialist may not always be an option. With all of this in mind, we aimed to develop a novel modification of the classic RBP for the correction of eyelid agenesis in cats that may provide primary care veterinarians with a simple, quick surgical technique that has the potential to reduce cost and risk by decreasing the amount of time required for surgery and provides affected cats with functional, cosmetic eyelids to increase ocular comfort and promote corneal health.

The novel modification reported here is based on the classic technique for correction of eyelid agenesis in cats originally described by Roberts and Bistner in 1968 that involves use of a transposed pedicle flap harvested from the skin and orbicularis oculi muscle of the lower eyelid to fill the colobomatous defect of the upper eyelid. For the original RBP method, a simple interrupted suture pattern was recommended for closure of the entire lower eyelid defect and the dermal layer of the upper eyelid, in addition to placement of simple continuous sutures to close the deep layer of the upper eyelid defect. This recommendation was followed by the recommendation for fixation and closure of conjunctival tissue at both donor and recipient sites via a simple or continuous interrupted suture pattern.
Unfortunately, the rarity of eyelid agenesis has led to a paucity of data regarding the RBP, particularly in terms of the amount of time required for surgery. Although the time required to perform a given procedure will vary among surgeons, the traditional closure approach would undoubtedly take longer than placement of a single simple interrupted suture and application plus polymerization of 2OCA in the optimized technique reported here. Indeed, even for the cats of the present report, the time required to complete the modified RBP decreased further with optimization and surgeon experience, although additional research would be required to determine whether the optimized modified procedure is actually faster to perform than the original RBP.

In addition to the potential reduction in time associated with surgery, the modification of the RBP reported here achieved the goal of providing all cats with functional eyelids after surgery. Complications occurred only in the early postoperative period and were mild. The most common complications were poor cosmesis from periocular debris adherent to the 2OCA and eyelid swelling, which is a common outcome of reconstructive blepharoplasty. Postoperative swelling may be minimized by reduction of flap handling during surgery, application of limited pressure to the surgical site in the early recovery period, and use of anti-inflammatory medications as part of the postoperative treatment protocol. We would not recommend application of ice or any other treatment that could reduce local blood flow to the flap.

Although eyelid swelling contributed to the suboptimal cosmesis in the early postoperative period, debris adherent to 2OCA was the major contributor. The likelihood of this complication may be reduced by application of the minimum amount of 2OCA necessary to close the surgical wounds. The specific 2OCA container used made it difficult to control the rate or volume of 2OCA dispensed owing to its large dome-shaped applicator tip and rigid plastic vial that houses an internal glass ampule that must be crushed to release the adhesive. Similar difficulty has been reported in the human medical literature. Newer 2OCA products with a smaller-diameter application tip are now available and may reduce the likelihood of suboptimal cosmesis in the early postoperative period.

The use of 2OCA as part of the modified RBP was intended to make the surgery faster to perform and potentially reduce the associated cost, but 2OCA also provided several other benefits, including a tensile strength similar to 5-0 monofilament suture, good barrier capability, an antimicrobial effect, and a flexible nature that binds well in moist environments. In addition, cyanoacrylate tissue adhesives reportedly cause less pain during application and less irritation in situ than suture. Cyanoacrylate adhesives have been used for medical purposes since 1949 and 2OCA is one of the newest formulations that provides greater holding strength with less toxic effects to tissues than its predecessors. In the eyelids specifically, 2OCA induced less inflammation histologically than 7-0 nylon suture in rabbits with experimentally induced eyelid wounds. A few other features of this 2OCA product are worth noting. First, the crushing of the glass ampule required to release the adhesive also initiates the polymerization process, which achieves maximal bonding 2.5 minutes after application. This timing is important for surgical planning and makes this particular 2OCA product single use only. This means 2 containers of 2OCA would be needed for a bilateral procedure because of the rapid polymerization, even though the volume of adhesive within each container would be adequate for both eyes. We therefore recommend the protocol used for cat 5, which resulted in a shorter surgical period with no difference in complication rate: surgically prepare and drape the patient bilaterally, create all surgical incisions and prepare the recipient sites for both eyes, transpose and secure both myocutaneous flaps with the single anchor suture as described, and finally crush the internal ampule of the 2OCA container to release the product and apply the 2OCA bilaterally.

One final consideration of the rapid polymerization of 2OCA concerns postoperative treatment. Although maximal bonding of the product occurs 2.5 minutes after application, polymerization begins almost immediately. The manufacturer states that 2OCA may be wiped away within 10 seconds after application, but if 2OCA removal is necessary after that period, the affected area should be covered for 30 minutes with an antimicrobial ointment or petrolatum jelly to weaken the polymer bonds. This is crucial to remember when prescribing postoperative treatments; only topical ophthalmic solutions and aqueous-based ocular lubricants should be used in the first 2 weeks after surgery. The manufacturer also states that if malpositioned 2OCA cannot be easily removed by following these suggestions, 2OCA should be allowed to slough naturally, which can take up to 10 days. This is an important point to discuss with caretakers, given that environmental debris can bind to the 2OCA and appear unsightly in the early postoperative period. However, periocular crusts of debris embedded in 2OCA should not be manually removed because doing so can damage the surgical site and dehiscence. All applied 2OCA had sloughed from the cats of the present report by the second recheck examination (6 weeks after surgery), and cosmesis appeared optimal at that time, which may have been slower than with other traditional surgical closure techniques, although the timing of recheck examinations made this impossible to determine. This situation should be discussed with caretakers of rescue cats before surgery, given that it may affect when the rescue organization will deem the cat adoptable.

The other major modification to the classic RBP for cats 3, 4, and 5 of the present report was to eliminate conjunctival lining of transposed myocutaneous flaps. This was done out of concern that conjunctival tissue contraction may play a role in the commonly reported RBP-associated complication of trichiasis secondary to leading-edge entropion. The transposed conjunctiva may encourage inversion of the ventral margin of the flap with development of traction bands or asymmetric healing between the skin and conjunctival portions of the flap, although this...
possibility remains to be established. At the time of writing, none of the 6 eyes corrected with unlined myocutaneous flaps had developed entropion or trichiasis.

The likelihood of postoperative complications can also be minimized by meticulous apposition of the newly created eyelid margin. For most surgeries involving the eyelid margin, use of a figure-8 suture pattern is recommended to align the eyelid margin. The figure-8 pattern is a variety of vertical mattress pattern, which is particularly useful for closing skin incisions under considerable tension, and this should not be the situation between the colobomatous recipient site and the transposed myocutaneous flap. Additionally, the flap lacks normal eyelid margin structures and architecture, and use of a mattress suture pattern could apply uneven forces on the tissues, which could impair healing. As with earlier descriptions of flaps for reconstructive blepharoplasty, we recommend use of a simple interrupted pattern on the dermal surface at the juncture of the distal tip of the flap and the upper eyelid recipient site.

A novel modification of the RBP for correction of eyelid agenesis involving ZOCA provided successful outcomes for the cats of the present report. Following the procedure, all cats retained vision, had complete palpebral reflexes, appeared more comfortable with less ocular discharge, and had subjectively clearer corneas. Furthermore, use of ZOCA with our optimized technique, involving only a single absorbable appositional suture without harvested conjunctival lining of the transposed myocutaneous flap, was a quick process, requiring a median of 16 min/eye for the 3 cats treated with this procedure and < 25 minutes for both eyes in the fifth treated cat. Although additional cases are needed to verify the findings reported here, we suggest that these early results indicate that this modification of the RBP involving ZOCA provides a successful and time-efficient blepharoplasty option for correction of the most common congenital eyelid abnormality in cats.

Acknowledgments

The authors report that there were no conflicts of interest.

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Footnotes

a. Vicryl Rapide 4-0 suture, Ethicon, Somerville, NJ.
b. Dermabond mini topical skin adhesive, Ethicon, Somerville, NJ.
c. Amoxicillin trihydrate (50 mg/mL)—clavulanic acid (12.5 mg/mL) oral suspension, Zoetis, Kalamazoo, Mich.
d. Buprenorphine hydrochloride (0.3 mg/mL), Reckitt Benckiser, Hull, East Yorkshire, England.
e. Tobramycin 0.3% ophthalmic solution, Akorn Inc, Lake Forest, Ill.
f. GenTeal lubricant eye gel, Novartis Pharmaceuticals Corp, East Hanover, NJ.

References


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**From this month’s AJVR**

**Comparison of the percentage of the C3-C7 vertebral canal occupied by the spinal cord in small-breed dogs with that in Doberman Pinschers and Great Danes with and without cervical spondylomyelopathy**

Marília de A. Bonelli and Ronaldo C. da Costa

**OBJECTIVE**

To compare the percentage of the C3-C7 vertebral canal occupied by the spinal cord in small-breed dogs with that in Doberman Pinschers and Great Danes with and without cervical spondylomyelopathy (CSM).

**ANIMALS**

30 small-breed dogs (body weight, < 15 kg), 15 clinically normal Doberman Pinschers, 15 Doberman Pinschers with CSM, 15 clinically normal Great Danes, and 15 Great Danes with CSM.

**PROCEDURES**

In a retrospective study, sagittal and transverse T2-weighted MRI images of the cervical (C3 to C7) vertebral column obtained from dogs that met study criteria and were free of extensive abnormalities that could affect the spinal cord diameter between January 2005 and February 2015 were reviewed. The area and height of the vertebral column and spinal cord were measured at the cranial and caudal aspect of each vertebra from C3 to C7, and the percentage of the vertebral canal occupied by the spinal cord at each location was calculated and compared among groups of dogs.

**RESULTS**

Mean percentage of the vertebral canal occupied by the spinal cord was greatest for small-breed dogs and lowest for Great Danes, but did not differ between Doberman Pinschers and small-breed dogs at approximately half of the locations evaluated or between Doberman Pinschers with and without CSM or between Great Danes with and without CSM.

**CONCLUSIONS AND CLINICAL RELEVANCE**

Results suggested that the percentage of the vertebral canal occupied by the spinal cord, although expected to increase with vertebral canal stenosis, may not have a primary role in the pathogenesis of CSM. (Am J Vet Res 2018;79:83–89)