INTRODUCTION

The third eyelid, or nictitating membrane, is an extension of the conjunctiva that is supported by a T-shaped piece of cartilage. The cartilage maintains the third eyelid’s shape as it passively sweeps across the ocular surface when the globe is retracted. At the base of the T-shaped cartilage is the nictitans gland, which produces approximately 30% of the aqueous portion of the tear film in dogs. 1 The third eyelid is crucial for the maintenance and distribution of the tear film, debris removal, and corneal protection. 2–4 Experimental removal of the third eyelid and its gland has been shown to result in significant decreases in STT, increased tear pH, and shortened tear film break-up time. 3 The cornea also developed punctate fluorescein staining and diffuse interstitial Rose Bengal staining after third eyelid removal identifying trauma to the corneal surface. Without the third eyelid’s protection, the cornea’s epithelium was degraded and necrosed. 2 Consequently, the third eyelid should never be removed unless trauma or neoplasia precludes its retention.

Third eyelid cartilage scrolling occurs when the stem of the cartilage bends, evert ing the leading edge of the T-shaped cartilage. Less frequently, the stem may bend toward the globe resulting in inversion. Third eyelid cartilage scrolling is often observed in large and giant breed dogs less than a year old, but it can also occur in cats. 3–5 Third eyelid cartilage scrolling has not been previously described in other species. 3,5–7 The scrolled cartilage shape prevents the third eyelid from conforming to the globe and can lead to keratoconjunctivitis by exposure or irritational mechanisms. 5 The condition is easily diagnosed by observing the everted cartilage at the medial canthus. Third eyelid cartilage scrolling can accompany third eyelid gland prolapse. Third eyelid gland prolapse can worsen the keratoconjunctivitis caused by cartilage eversion and can lead to keratoconjunctivitis sicca development when left untreated. Surgical correction for both conditions can be performed within the same procedure if the conditions occur concurrently. 7–10

The definitive cause of the condition is unknown, but numerous theories have been proposed. In a case of feline scrolled cartilage, the excised scrolled cartilage straightened when fixed in formalin. 6 This suggested that the cartilage deformation was not due to inherent anomalies of the cartilage but was instead due to tension on the cartilage resulting in eversion. 6 However, this contradicts other proposed theories. A genetic cause has been proposed by

CASE REPORT

Surgical correction of third eyelid cartilage eversion in an Anglo-Nubian goat: A case report

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Abstract

This case of everted third eyelid cartilage in a goat demonstrates that everted cartilage occurs in animals other than domestic dogs and cats. Everted cartilage in the goat can be treated successfully with surgical excision of the abnormally bent cartilage.

KEYWORDS
cartilage, cat, dog, goat, ophthalmology, scroll, surgery, third eyelid, veterinary
Martin in German shorthair pointers. Albert et al. suggested that breakdown of the fascia between the cartilage and the orbit results in the scrolling.

Among all species studied, the third eyelid cartilage shape is a variation on a T-shape. Dogs have a triangular-shaped junction and curved, blunt edges of the crossbar. Cats have fine tapered edges to their reverse S-shaped crossbar. Small ruminants have a similar shaped cartilage to dogs but have tapered ends of the crossbar akin to the cat and lack the triangular-shaped junction. In most species, including small ruminants and dogs, the third eyelid cartilage is composed of hyaline cartilage. However, in horses and cats, elastic fibers are distributed throughout the cartilage.

To the authors’ knowledge, third eyelid eversion has not been reported in a species outside of dogs and cats. The purpose of this case report is to describe a case of everted scrolled cartilage in a young Anglo-Nubian goat.

2 | CASE REPORT

At the time of disbudding, the Cornell University Ambulatory Service noted that a 10-day-old female intact Anglo-Nubian goat had an anomaly of the left third eyelid cartilage and referred the goat to the Cornell University Hospital for Animals Ophthalmology Service. Upon presentation to the Ophthalmology service at 2 months of age, persistent eversion of the left third eyelid cartilage was diagnosed (Figure 1). A full ophthalmic and physical examination was performed, including slit-lamp biomicroscopy, indirect ophthalmoscopy, Schirmer tear tests, fluorescein staining, and applanation tonometry, with no other abnormalities noted. Schirmer tear test results were unremarkable (12 OD and 20 OS [mm/min]), and no clinical evidence of discomfort or epiphora was noted. Attempts to manually straighten the third eyelid cartilage with cotton-tipped swabs and forceps after the application of topical anesthetic were unsuccessful. Prior to surgery, a complete blood count and chemistry panel revealed no significant abnormalities.

The patient was premedicated with intravenous morphine (90 μg/kg; morphine sulfate injection, West Ward) and midazolam (90 μg/kg; midazolam, Almajet). General anesthesia was induced with an intravenous injection of ketamine (3 mg/kg; ketamine hydrochloride, Covetrus) and propofol (9 mg/kg; propofol, Sagent Pharmaceuticals). The patient was intubated, and anesthesia was maintained by inhalation of isoflurane (isoflurane solution, Covetrus). The goat was placed in sternal recumbency and clipped, prepped, and draped in a standard aseptic manner. The eyelids were retracted using a Castroviejo eyelid speculum. The third eyelid was exteriorized and everted using two Elschnig O’Connor forceps placed at the lateral and medial aspects of the leading margin. A linear conjunctival incision parallel with the vertical aspect of the third eyelid T-cartilage was performed with a #64 Beaver blade on the bulbar aspect of the third eyelid. Blunt dissection with iris and Steven’s tenotomy scissors was performed. Subjectively, the conjunctiva was adhered more firmly to the cartilage than what is typically encountered by the authors in dogs and cats. After continued blunt dissection, the abnormal scrolled cartilage segment was isolated and excised. The cartilage was repaired with simple interrupted 7–0 polyglactin 910 sutures placed across the cut edges to firmly oppose the cartilage surfaces. The conjunctival incision was closed with 6–0 polyglactin 910 sutures in a continuous pattern. The suture knots were placed on the palpebral surface of the eyelid, and the bulbar surface was closely examined for exposed suture. After excision, the third eyelid resumed a normal anatomic position and shape. The patient recovered uneventfully from anesthesia and was discharged with erythromycin ophthalmic ointment to be placed onto the left eye three times daily for 14 days.

The excised cartilage was submitted for histopathological evaluation. The histology was considered normal for hyaline cartilage. The cartilaginous matrix was embedded with chondrocytes within clear central lacunae and showed no evidence of cellular atypia, inflammation, or neoplastic process. Therefore, there was no evidence of pathology or abnormal development within the cartilage (Figure 2).
No further complications were noted in either eye and the left third eyelid remained morphologically normal by phone and photographic evaluation for the next 6 months.

3 | DISCUSSION

The normal histologic appearance of the excised, scrolled cartilage supports the gross and histopathological findings of the scrolled cartilage described by William et al. and Martin. However, as this is an isolated case within a goat, it does not rule out cartilage dystrophy as the cause in dogs or cats. However, when considering the histopathology of both cartilages from this case and that described by William et al. and Martin, it is possible that the scrolling is a result of uneven tension exerted by the third eyelid conjunctiva. This theory has also been suggested by Michel et al. in which both control dogs with normal cartilage and dogs with scrolled cartilages and nictitans gland prolapse had fibrous attachments between glandular tissue and the cartilage. It was proposed that scrolling occurred with tension across the third eyelid as the gland prolapsed and broke its fibrous attachments. The etiopathogenesis of everted third cartilage remains unknown, but the normal histology findings within this case suggest it is not directly due to cartilage anomalies that can be detected by histopathology.

Prior to this case, everted third eyelid cartilage had only been documented in dogs and, less frequently, cats. However, this case exemplifies that everted third eyelid cartilages may be present in other species as well. When presented with third eyelid pathology of any species, differentials for disease should include scrolled third eyelid cartilage, hypertrophy of the nictitans gland, trauma, Horner’s syndrome, prolapsed nictitans gland, conjunctivitis, and neoplasia.

There are many surgical options for the correction of third eyelid cartilage scrolling. The cartilage can be approached from the bulbar or palpebral conjunctiva. Approaching from the bulbar aspect often results in easier blunt dissection of the conjunctiva and isolation of the cartilage. However, the palpebral approach may be preferred because it decreases the risk of postoperative corneal trauma due to suture placement. Excision of the bent cartilage portion is often routinely done but can lead to complications including shortening of the third eyelid, convergence of cut edges, loss of tension of the third eyelid, and inflammatory reactions/necrosis at the edge of the cut cartilage. The cut edges of the cartilage can heal by second intention or may be sutured into apposition. Surgical preference usually drives this decision. The author routinely apposes the cartilage edges when correcting everted cartilage in dogs and cats. In the author’s opinion, surgical apposition leads to improved surgical outcomes, shorter healing times, and improved comfort. Careful placement of the sutures to avoid penetration through the conjunctiva mitigates the risk of corneal irritation from the suture knots.

Homotransplantation of cartilage to replace the excised scrolled cartilage has also been proposed. This technique is more time and resource intensive but can result in successful reconstruction of the third eyelid cartilage.
and ensure that the third eyelid conforms closely to the globe.\textsuperscript{14} Thermal cautery can also be used to correct scrolled cartilage.\textsuperscript{7} At the bulbar conjunctiva, the convex curve of cartilage is identified, and electrocautery is applied to contract the conjunctiva and soften and remodel the cartilage. The process can also be repeated at the free edges of the cartilage if the edges curl. This procedure is quick and has low risk of hemorrhage but does risk thermal damage to the nictitans gland and further eversion of the third eyelid cartilage if excess heat is applied.\textsuperscript{7} Other techniques include removal of the entire third eyelid cartilage with the nictitans gland, but are less frequently done and not recommended due to the adverse effects seen with removal of the nictitans gland.\textsuperscript{2,3,7} The best surgical technique is dependent on the size of the bent cartilage portion, resource availability, and surgical skill.

**AUTHOR CONTRIBUTIONS**
Laura Donohue involved in surgical assistant, literature review, and initially wrote the draft. Zoe Mack involved in preparation, creation, and interpretation of histopathology images. Eric Ledbetter involved in logistical organization, surgical correction, revised the manuscript, and approved the final version.

**ACKNOWLEDGMENTS**
None.

**CONFLICT OF INTEREST**
None.

**DATA AVAILABILITY STATEMENT**
Data sharing not applicable to this article as no datasets were generated or analysed during the current study.

**CONSENT**
Written informed consent was obtained from the client to publish this report in accordance with the journal’s patient consent.

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**How to cite this article**: Donohue LK, Mack ZE, Ledbetter EC. Surgical correction of third eyelid cartilage eversion in an Anglo-Nubian goat: A case report. *Clin Case Rep*. 2022;10:e06208. doi: [10.1002/ccr3.6208](https://doi.org/10.1002/ccr3.6208)