Descemet’s membrane detachment in horses; case series and literature review

Márian Matas Riera,* David Donaldson† and Simon Lawrence Priestnall‡

*Ophthalmology Service, Royal Veterinary College, Hawkshead Lane North Mymms, AL97TA London, UK; †Unit of Comparative Ophthalmology, Animal Health Trust, Lanwades Park, Newmarket CB87UU, UK; and ‡Dept of Pathology and Pathogen Biology, Royal Veterinary College, Hawkshead Lane, North Mymms, AL97TA London, UK

Address communications to:
Márian Matas Riera
Tel.: 44 (0) 1707 666366
Fax: 44 (0) 1707 649384
e-mail: mmatasriera@rvc.ac.uk

Abstract

The aim of this article was to describe Descemet’s membrane detachment (DMD) following phacoemulsification in five equine eyes and to review the human literature on this topic. In the last decade, there has been increased reporting of DMD in the human literature, in particular following cataract surgery. The natural history of DMD remains unknown and although various medical and surgical treatments have been advocated there is no recognized ‘gold standard’ treatment for DMD. This case series reports the diagnosis of DMD in four horses (5 eyes) in association with phacoemulsification surgery. The diagnosis of DMD in these patients was made intra-operatively, postoperatively or on subsequent histopathological examination. The surgical reports, photographic or video recordings, and ultrasound data were evaluated and possible factors associated with the pathophysiology of DMD are discussed. This is the first description of DMD in the veterinary literature, and the authors believe that DMD might hitherto have been overlooked in veterinary ophthalmology due to a lack of awareness of the condition. The possible causes, clinical signs, and treatment of DMD as described in the human literature are also reviewed.

Key Words: cataract surgery, corneal edema, descemetopexy, descemet’s membrane detachment, phacoemulsification, surgical complication

INTRODUCTION AND LITERATURE REVIEW

This report aims to review the available human ophthalmology literature concerning Descemet’s membrane detachment (DMD) and introduce the veterinary counterpart of this condition.

DMD is a disinsertion of Descemet’s membrane (DM) and the attached corneal endothelium from the corneal stroma.1 We first described a detachment of DM.1 A year later, Samuels published a systematic description of DMD including drawings of several ocular lesions linked to the condition, including sarcoma of the ciliary body, postiridectomy, and penetrating corneal wounds.2 DMD was not described again for 50 years; however, in recent years, numerous reports have associated DMD with a wide range of conditions including penetrating keratoplasty, intraocular surgery, chemical injury to the eye or blunt trauma; use of obstetric forceps, and airbag deployment.1—22

Descemet’s membrane detachment is generally diagnosed via slit-lamp biomicroscopy or gonioscopy.23 In recent reports, the use of ultrasound biomicroscopy (UBM), in vivo confocal microscopy (IVCM), or anterior segment optical coherence tomography (OCT) have facilitated the diagnosis and surgical repair of DMD.24,25 The percentage of clinically apparent DMD reported in human medicine is 2.6% and 0.5% for extracapsular and phacoemulsification surgery, respectively.26 In contrast, up to 43% of human patients have subclinical DMD after cataract surgery.23,27

There are three different classifications used to describe types of DMD.28,29 Mackool and Holtz separated the detachments into planar; when the DMs detached from the stroma by <1 mm, and nonplanar; when this separation is larger than 1 mm.28 Assia et al. made the distinction between DMD which is scrolled; when DM exhibits a rolled edge, and nonscrollled; when there is no rolled edge.30—32 The third classification is peripheral, when the visual axis is not involved, or central with axial involvement.30 DMD classification is important because it can influence its management and the prognosis given.30 It appears that planar DMD has a better prognosis.
than nonplanar DMD, and un-scrolled DMD a better prognosis than scrolled DMD\textsuperscript{28,32} Table 1.

Although DMD is a well-known complication of intraocular surgery in humans, its natural history is controversial.\textsuperscript{14} Shallower anterior chambers are reported to have a higher incidence of DMD, although the reasons for this have not been elucidated.\textsuperscript{33} It is thought that mechanical forces applied to the cornea during surgery cause the DM to separate from the stroma.\textsuperscript{30} The detachment occurs at the incision site and can progress toward the central cornea.\textsuperscript{30} Mahmood \textit{et al.} 1998 suggested that a pre-operative diagnosis of glaucoma with a recent episode of corneal edema may increase the risk of DMD.\textsuperscript{34} Other risk factors proposed, but not of proven clinical significance, include globe hypotony, previous intraocular surgery, pre-existing corneal scarring, the use of blunt instruments and incorrect technique during intraocular surgery.\textsuperscript{30,35} The possibility that some human patients might be anatomically predisposed to DMD due to an abnormality in the fibrillar stromal attachment to the DM, has also been proposed.\textsuperscript{3,13,21,36–38}

Marcon \textit{et al.} 2002, suggest that this increased incidence of DMD in tertiary referrals might be due to the increase of clear corneal incisions used for cataract surgery.\textsuperscript{31} Anderson 1993 evaluated the internal appearance of the corneal wound after no-stitch cataract surgery via gonioscopy and reported 5% of patients with DMD that could not be identified by slit-lamp biomicroscopy and in which, the diagnosis was reached via gonioscopy, the DMDs were <2 mm long in three patients and more than 2 mm in one patient.\textsuperscript{23} The width of the detachments was 1 mm or less, and they did not lead to clinically significant sequela such as filtration blebs or persistent corneal edema.\textsuperscript{23}

In 1995, Mulhern & Barry listed several factors that could help minimize the risk of DMD: gentle and minimal use of instrumentation, avoiding reusable blunt keratomes, and incisions of the inner cornea should be equal to or slightly greater than the incision in the outer aspect to prevent undue trauma.\textsuperscript{22} Olson also reports general rules for avoiding anterior DM tears: avoidance of a very tight wound, insertion of phacoemulsification instruments parallel to the wound plane, pushing slightly posteriorly as entering the wound to try and avoid putting pressure on the anterior cut edge of DM and, if a small tear is seen, enlarge the wound opposite to the tear to avoid pressure on the area where the tear has formed.\textsuperscript{35} Most authors highlight the importance of prevention and early intra-operative identification of DMD to avoid rapid progression.\textsuperscript{35}

Management of DMD may be medical or surgical, the latter being called descemetopexy. Spontaneous resolution has also been described in the literature \textsuperscript{10,24} and this is the likely reason why some authors recommend a period of observation before attempting descemetopexy.\textsuperscript{3,5,35} Generally, planar DMDs have a much better prognosis than nonplanar detachments, with or without descemetopexy.\textsuperscript{28}

Medical management is generally reserved for planar, nonscrolled and peripheral DMDs and involves use of topical steroids and hyperosmotic agents that are believed to reduce the corneal edema.\textsuperscript{30,31} For nonplanar or scrolled DMD surgical intervention is recommended.\textsuperscript{39} When surgical intervention is elected, the least possible use of instrumentation is advised.\textsuperscript{28} Multiple surgical interventions have been described to treat DMD including suturing the edge of the detached membrane to the scleral edge with nylon 10/0, intracameral injection of gas (14% C3F8, 20% SF3 or 100% air), and anterior chamber injection of an ophthalmic viscosurgical device (OVD).\textsuperscript{19,22,30,40,41} In a retrospective study over 8 years of managing tertiary ophthalmologic referrals, 12 patients were identified with large DMD.\textsuperscript{34} Most of these patients were treated with SF6 20% gas with or without corneal sutures.\textsuperscript{24} Other authors suggest that early intervention is warranted as DM folds persist months after the initial DMD and these might interfere with reattachment.\textsuperscript{42} A retrospective case series from 2013, which evaluated anatomic and visual outcomes of descemetopexy for DMD after cataract surgery, found eyes in which air was used for descemetopexy had significantly better final visual outcomes compared with those where isoexpansile C3F8 was used.\textsuperscript{33} In this same study, pupillary block was observed in 11.66% of patients, and this was only seen in patients in whom C3F8 was used and was not seen with air.\textsuperscript{43} In contrast, other authors suggest that descemetopexy using air may not be effective because of its early reabsorption.\textsuperscript{3} With the current data and lack of randomized control studies, a gold standard for treatment of human DMD does not exist.

Following DMD, human patients can develop corneal haze, corneal edema and DM folds and, as a result of these changes, a reduction in visual acuity.\textsuperscript{10,31,44} With the use of advanced imaging DM folds can be observed to cause mild fibrosis in many patients.\textsuperscript{42} In some patients, the corneal fibrosis can be so severe that penetrating keratoplasty or endothelial keratoplasty may be required to restore vision.\textsuperscript{31,34}

**Table 1.** Classifications of Descemet’s membrane detachments in the human literature

<table>
<thead>
<tr>
<th>1. DMD separation</th>
<th>Planar: &lt;1 mm separation DM from stroma Nonplanar: more than 1 mm separation DM from stroma</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. DMD conformation</td>
<td>Scrolled: rolled edge Nonscrolled: edge not rolled</td>
</tr>
<tr>
<td>3. Area of DMD</td>
<td>Peripheral Peripheral with axial involvement</td>
</tr>
</tbody>
</table>

Adapted from Potter \textit{et al.} 2005.

**MATERIAL AND METHODS**

A retrospective search of the Clinical Data Base at the Animal Health Trust, Newmarket, UK (AHT) was
performed for equine cases that underwent any intraocular surgery between 2008 and 2012. Five eyes (four equine patients) were identified with DMD in association with phacoemulsification surgery, either intra-operatively, postoperatively or at postmortem examination. The surgical reports, photographic or video recordings, and ultrasound data for these cases were evaluated. Information recorded included age, gender, breed, gross or histopathological lesions, surgeon, surgical details (one or two handed/IOL insertion), type of corneal incision (1 step, 2 step or 3 step-i.e. trilaminar), presence of corneal edema postoperatively, and the appearance of the corneal incision/peri-incisional area at the last follow-up.

RESULTS
A total of 16 horses (17 eyes) were identified as having intraocular surgery between 2008 and 2012. Of these, DMD was identified in 4 horses (5 eyes). The data collected concerning signalment, surgical details, and outcomes are summarized in Table 2. Specific details of individual cases are summarized below. All patients received routine postoperative medication including topical dexamethasone (Maxidex® 0.1% w/v dexamethasone eye drops, Alcon Laboratories limited, UK), topical chloramphenicol (Chloramphenicol 0.5% w/v, Midoptic, UK), oral flunixin meglumine (Finadyne®, 5% w/w flunixin meglumine, oral paste, MSD Animal Health, UK), and oral trimethoprim sulfadiazine (Norodine® Granules, Norbrook Laboratories, UK). One of the patients developed a superficial corneal ulcer in which case the topical steroids were discontinued and topical ketorolac (Acular 0.5% Allergan Pharmaceuticals, Ireland) instigated.

Case 1
A 24-year-old Appaloosa gelding presented with an immature cataract in the left eye and an incipient cataract in the right eye. Bimanual phacoemulsification was performed in the left eye. An artificial intraocular lens could not be placed due to an iatrogenic disruption of the posterior lens capsule. The corneal incision was a two-stepped clear corneal incision. In this case, the DMD was observed at the start of the surgery, with 30% of DM detached. Surgery was then routinely performed ensuring that no instruments or OVDs entered the space between DM and the corneal stroma. The corneal edema was severe enough to preclude ophthalmoscopic examination. The globe was normotensive on routine postoperative checks. An 8 MHz ocular ultrasound was performed; horizontal scanning revealed an echogenic line continuous with and extending from the inner corneal surface into the anterior chamber. This ultrasonographic finding was consistent with DMD (Fig. 1). This DMD was...
classified as nonplanar and peripheral. The edema resolved after several weeks. Mild diffuse corneal fibrosis was evident in the region of prior corneal edema. No membrane could be seen in the anterior chamber after the corneal edema had resolved.

**Case 2**

A 14-year-old Thoroughbred mare presented with immature cataracts in both eyes. The patient underwent bilateral one-handed phacoemulsification surgery under the same anesthetic. The corneal incision was a trilaminar clear corneal incision (3-stepped) in both eyes. Artificial foldable intraocular lenses were placed in both eyes. Both surgeries were routinely performed. In this patient, DMD was visualized intra-operatively in both eyes and was classified as small and planar. Postoperatively, peri-incisional corneal edema was evident in both eyes. In the left eye, a superficial ulcer developed in the region of the corneal edema. In the right eye, the corneal sutures broke down 2 days postoperatively, and the corneal incisions were resutured. The right eye was eventually enucleated 4 weeks postoperatively due to severe chronic inflammation, poor response to treatment, and a guarded prognosis. Postoperative visualization of the detached membrane was difficult due to the corneal edema overlying the detachment. However, oblique visualization with a portable slit lamp (Kowa SL-14, Kowa company Ltd, London, UK) revealed separation of DM from the remaining edematous stroma. One month, postoperatively, the area of corneal edema within the left eye appeared to be fibrotic.

**Case 3**

A 15-year-old Welsh Cob gelding presented with an immature cataract in the left eye. One-handed phacoemulsification was performed through a trilaminar clear corneal incision. A small DMD was identified at the beginning of the surgery adjacent to the main temporal corneal incision. ‘Video’ Mild corneal edema was noticed during the first few days postoperatively. Long-term follow-up was limited to photographic records provided by the referring veterinary surgeon. These revealed a small area of peri-incisional fibrosis temporal to the corneal incision.

**Case 4**

A 15-year-old French Warmblood stallion presented with end-stage equine recurrent uveitis (ERU) in the left eye. The right eye had a complete hypermature cataract and signs of chronic ERU. Phacoemulsification surgery was performed using a one-handed technique and a trilaminar corneal incision. On recovery from anesthesia, total hyphema and marked corneal edema affecting the middle and dorsal cornea was apparent (Fig. 2). The horse was euthanized for reasons not associated with ophthalmic disease. The globe was retrieved for histopathological examination which revealed a centrally detached, ruptured and ‘scrolled up’ DM along the posterior margin of the cornea. The portion of exposed corneal stroma was edematous and covered by a thick retrocorneal fibrovascular membrane which was contiguous with a similar membrane arising from the anterior aspect of the iris (pre-iridal fibrovascular membrane, PIFM) causing peripheral anterior synechiae and also posterior synechiae with attachment to the lens capsule. The exposed corneal stroma was markedly thickened at each free end of the detached membrane by a proliferation of spindloid mesenchymal cells that bridged the space between the membrane and the corneal stroma. The ciliary body was expanded by abundant pale eosinophilic hyaline extracellular material with apple green birefringence with Congo red staining—amyloid, consistent with a diagnosis of ERU (Fig. 3). Retrospectively,
intra-operative pictures were evaluated and found changes compatible with the intra-operative DMD (Fig. 4).

DISCUSSION

This report describes DMD occurring as a complication of phacoemulsification surgery in 4 horses (5 eyes) performed by three different surgeons, two being experienced in cataract surgery and a third year resident. Although the number of cases is too small to draw any epidemiological conclusions, this report raises awareness of DMD within veterinary ophthalmology. It may be that DMD is not an uncommon complication associated with equine intraocular surgery with 4 of 16 horses (25%) being affected in this review. In a retrospective study, evaluating complications after equine cataract surgery, corneal edema was reported as the most common complication of equine cataract surgery; however, DMD was not described nor the localization of the corneal edema. It is plausible that DMD may have been associated with, or even the precursor of, the corneal edema in some of these cases. In human ophthalmology, the presence of diffuse corneal edema raises the concern for the presence of DMD which is listed as a differential diagnosis for postoperative corneal edema.

Although DMD is not reported in other veterinary species, the authors are aware of small detachments adjacent to the corneal or corneal–limbal incision in dogs undergoing phacoemulsification surgery; these small detachments do not typically progress but may be associated with a degree of peri-incisional edema and eventually fibrosis.

Of the 5 eyes reported here, cases 2 and 3 showed small, planar and peripheral detachments that did not progress further. Case 1 showed a nonplanar, peripheral with central involvement detachment with reattachment of DM within weeks after the onset, despite no specific treatment. Case 4 showed a scrolled, nonplanar, peripheral DMD with central involvement detachment identified postoperatively. The type of DMD in case 4 is considered to have the worst prognosis. Histopathological examination of the scrolled areas of DM suggests that an early descemetopexy would have been required to restore this type of DMD. The proliferating spindle cells which bridged the space between the detached and ruptured membrane, and the exposed posterior corneal stroma likely reflected either reactive corneal stromal elements, or more likely, metaplasia of the corneal endothelium over the 4 weeks between surgery and enucleation.

The pathophysiology of DMD has not been fully elucidated but certain extrapolations from the human literature may help explain the apparently high incidence of this complication in equine patients. Samuels 1928 postulated that the development of DMD may increase with a shallower anterior chamber and a greater radius of curvature of the cornea. Given this, the authors in this manuscript suggest that DMD, and its progression, may occur more frequently in horses due to their greater corneal radius of curvature (i.e. flatter corneas) compared with dogs or humans. Furthermore, the relatively shallow anterior chamber of the equine eye may predispose to development of DMD during intraocular surgery and, once detached, may contribute to its clinical progression.

REFERENCES


**SUPPORTING INFORMATION**

Additional Supporting Information may be found in the online version of this article:

**Video S1.** Intraoperative video of the beginning of one handed phacoemulsification in case 3. If the corneal wound is closely evaluated, a diffusely stained Descemet’s membrane can be seen appearing and disappearing as the probe is introduced in the anterior chamber. Note that this video was aimed to record the cataract surgery but has been edited to show the corneal wound and the DMD.