Penetrating eye injury in a dog: a case report

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ABSTRACT: A four-year-old, male German Shepherd dog with severe pain in the left eye following a corneal perforation with a foreign body was examined. An ophthalmic examination revealed conjunctival hyperaemia and pancorneal dense oedema, preventing a diagnosis of deeper structures of the eye and lowered IOP. Vision testing was missing or impossible to detect. Ultrasonography showed a solid hyperechoic line protruding through the iris and lens into the vitreous and minor posterior lens displacement. The dog qualified for immediate surgical treatment. Intraoperative ophthalmic examination revealed a rupture of the anterior hyaloid membrane with vitreous herniation, posterior lens subluxation, lens capsule rupture and a torn iris. Partial iridectomy and intracapsular lens extraction (ICLE) was conducted. Slit-lamp biomicroscopy revealed iridodonesis and a gradual reduction of the corneal oedema, leading to complete transparency in the bottom two-thirds of the area on Day 12 after surgery. Direct and consensual PLR was sluggish and the dazzle reflex was positive. An electroretinographic examination confirmed normal activity of the retina.

Keywords: acute ocular trauma; intraocular foreign body; dog

Penetrating eye injuries, including corneal wounds and corneal and lens lacerations, are common in small animal ophthalmology practice, resulting from the cornea being scratched by a cat claw (Spiess et al. 1996; Paulsen and Kass 2012), a foreign body such as grass awn (Bussanich and Rootman 1981; Cullen and Grahn 2005), rose thorns (Dean 2004), fragments of plant material (Gelatt 1974; Crispin 1986; Gionfriddo and Chen 2011), porcupine quills (Williams and Wilcock 1988; Grahn et al. 1995; Sandmeyer et al. 2007), lead or air gun pellets (Slatter and Bryan 1972; Schmidt et al. 1975; Sansom and Labruiere 2012) and sticks (Martin 2010a). Perforating wounds require immediate treatment (Gelatt and Gelatt 2001a; Hendrix 2007) due both to quite severe pain as a result of abundant sensory innervation (Barrett et al. 1991; Marfurt et al. 2001) and to a number of potential complications, such as secondary bacterial (Malar and Dubielzig 1995; Klatte et al. 2012; Bell et al. 2013) and fungal infections (Andrew 2003; Chew et al. 2010), as well as due to traumatic lens capsule rupture (Wilcock and Peiffer 1987; Davidson et al. 1991). The release of previously sequestered lens protein to the anterior chamber activates the dynamic development of immune response, leading to phacoclastic anterior uveitis or even panuveitis (Bussanich and Rootman 1981; Davidson et al. 1991). Immediate treatment is important also in order to avoid the so called Septic Implantation Syndrome. Bell et al. (2013) pointed to an essential role of the inoculation of bacteria into the lens cortex resulting in secondary development of septic endophthalmitis often within no more than one week.

Complications are also associated with perilenticular inflammation, lens epithelial proliferation, pupillary occlusion and subsequent secondary glaucoma, which often results in a complete loss of vision (Bussanich and Rootman 1981; Wilcock and Peiffer 1987). In extreme cases, the consequences of corneal injuries may lead to the loss of the eyeball (Williams and Wilcock 1988; Gelatt and Gelatt 2001a). The time between an injury and initiation of surgical treatment affects the severity of complications (Davidson et al. 1991; Spiess et al. 1996). Comprehensive retrospective studies by Paulsen and Kass (2012) suggest that half of the traumatic corneal laceration cases with associated lens capsule disruption result in blindness.
This case report describes the clinical presentation, electroretinographic findings as well as surgical treatment in a German Shepherd dog with perforating corneal injury with traumatic lens rupture and vitreous hernia. To the best knowledge of the authors, no case of vision retention after such a multiple eye injury has ever been reported.

Case description

A four-year-old, male German Shepherd dog was referred to the ophthalmologic division of our clinic with severe pain in the left eye. The owners reported that the injury had occurred six to seven hours before. A clinical examination of the left eye (OS) revealed blepharospasm, epiphora, prolapse of the third eyelid and the presence of a foreign body (thorn) stuck in the medial part of the cornea (Figure 1). Digital slit-lamp biomicroscopy OS (Hawk Eye, Dioptrix, France) revealed moderate conjunctival hyperaemia and pancorneal dense oedema, preventing an examination of deeper structures of the eye, including the fundus. An ophthalmologic examination of the right eye (OD) performed with slit-lamp biomicroscopy, a portable indirect ophthalmoscope (Omega 500, Heine Instruments, Germany) with a 20 D power lens (Volk Optical, USA) and direct ophthalmoscopy (Beta 200S, Heine Instruments, Germany) revealed no anterior segment abnormalities. Vision testing, including menace response, dazzle reflex, direct and consensual pupillary light reflexes (PLR), were normal for the OD and missing or impossible to detect in the OS. Further examination was performed under local anaesthesia induced with proxymetacaine hydrochloride (Alcaine, Alcon-Couvreur, Belgium) administered at a dose of two drops at 5-min intervals. Intraocular pressure (IOP) measured with an applanation tonometer (TonoPen XL, Reichert Technologies, USA) did not reveal any recording in the OS indicating a valve under 5 mmHg, which was below the measuring capacity of the device. IOP OD reached 22 mmHg. Fluorescein staining for corneal uptake was positive in the OS – around the foreign body – and negative in the OD. Ultrasoundography (USG) was performed under premedication due to eye pain and severe blepharospasm. Atropine sulphate was administered (Atropinum sulfuricum WZF, Polfa, Poland) at a dose of 0.04 mg/kg of body weight (b.w.) s.c., butorphanol (Dolorex, Intervet International B.V., Holland) at a dose of 0.2 mg/kg b.w. i.m. and medetomidine hydrochloride (Domitor, Orion Pharma Animal Health, Finland) at a dose of 20 µg/kg b.w. i.m. B-mode USG of the orbital and ocular structures was performed with a 10 MHz transducer (Ultrascan Imaging System, Alcon, USA). All scans were performed with a probe under general anaesthesia.

Figure 1. Foreign body (thorn) in the medial part of the cornea OS, moderate conjunctival hyperaemia and pan-corneal dense oedema

Figure 2. A vitreous displacement into the anterior chamber, leakage of lens material from the damaged lens capsule, bleeding from the iridial vessels, aqueous humour outflow and the subsequent collapse of the anterior chamber
placed directly on the sclera and partially on the cornea, coated with 1.5% hypromellose (Goniovisc, HUB Pharmaceuticals, USA) as a coupling gel. An ophthalmic ultrasound OS showed a solid hyper-echoic line protruding through the iris and lens into the vitreous and a minor posterior lens displacement. The USG in the OD was unremarkable. The dog qualified for immediate surgical treatment. The total blood count and serum biochemical profile were within normal limits.

**Surgical management.** Before the surgery, the dog was anesthetised with propofol at a dose of 5 mg/kg b.w. i.v. (Scanofol, ScanVet, Poland). General anaesthesia was maintained with isoflurane (Aerrane, Baxter Polska, Poland) at a concentration of 1–1.5%. The left periocular skin and conjunctiva were flushed with povidone–iodine diluted in saline in a 1 : 50 ratio. After a blepharostat was put in place, the cornea and conjunctiva were cleansed with sterile buffered-saline solution (BSS) to remove foreign material residues (AquaCrom, Croma-Pharma, Poland). The foreign body was removed with a vertical rotational movement with Bonn forceps. It was a thorn of 20 mm in length (Figures 2 and 3). The removal of the foreign body resulted in an opening in the structures that had been ruptured, including the anterior hyaloid membrane, posterior and anterior lens capsule, iris and the corneal wound. This resulted in a vitreous displacement into the anterior chamber, leakage of lens material from the damaged lens capsule, bleeding from the iridial vessels, aqueous humour outflow and the subsequent collapse of the anterior chamber (Figure 2). Anterior chamber perilimbal paracentesis was performed at 12 o’clock with a 3.2 mm slit-angled ophthalmic blade (Mani, Yamanashi, Japan). The accumulated tissue material originating from the torn iris and lens as well as hyphaema from the damaged iridial vessels were then flushed from the anterior and posterior chamber with a sterile BSS solution using an I/A cannula, Venturi pump system (Megatron S3 VIP, Geuder, Germany). High dispersive visceoclastics were used to restore the physiological depth of the anterior chamber (Eyefill HD, Croma-Pharma, Poland).

The restoration of partial transparency of the optical system in the anterior segment of the eyeball allowed for a more accurate evaluation of intraocular injuries. These injuries included: a rupture of the anterior hyaloid membrane with Wieger’s ligament and herniation of the vitreous through the pupil into the anterior chamber, posterior cataractous lens subluxation with a typical aphakic crescent secondary to more than two-thirds zonular damage, posterior and anterior lens capsule rupture, traumatic iris tear at the pupillary margin and a puncture wound of the cornea. Partial iridectomy of the pupillary margin, which included a part of the torn iris, was performed (Figure 3). Bleeding from the iridial vessels was stopped with high-frequency bipolar wet-field coagulation (Megatron S3 VIP, Geuder, Germany). Lack of sufficient visibility due to corneal oedema prevented a removal of the lens by phacoemulsification. It was decided to extend the incision of the cornea to approximately 150 degrees and perform intracapsular lens extraction (ICLE) (Figure 3).

![Figure 3. Removed thorn of 20 mm in length, a part of the torn iris and the lens material after ICLE](image1)

![Figure 4. A gradual reduction of corneal oedema leading to complete transparency in the bottom two-thirds of the area on Day 12 after the surgery](image2)
After lifting the cornea up with a viscoelastic and restoration of the anterior chamber, a paralimbal incision was closed with a single 9-0 nylon interrupted suture (Mani, Yamanashi, Japan), leaving a 2-mm opening. The next step was to remove the herniated vitreous from the pupil and the anterior chamber. A vitrectomy was performed with a Magnetic High-Speed drive combined with a double-bladed cutting head with the capacity of up to 4,000 cuts/min (Megatron S3 VIP, Geuder, Germany). After flushing the viscoelastics from the anterior chamber with an I/A cannula – Venturi pump system (Megatron S3 VIP, Geuder, Germany), the opening was sealed. The corneal wound was then closed with two single, interrupted sutures using 9-0 nylon.

**Post-surgical management.** Analgesic treatment was conducted with tramadol hydrochloride (Tramal 100, Polpharma S.A., Poland) at a dose of 4 mg/kg of b.w. i.m. for two days following the surgery. Topical ophthalmologic treatment was administered according to the following procedure: tobramycin 0.3% and dexamethasone 0.1% (Tobradex, Alcon-Couvreur, Belgium) q3h to both eyes (OU), phenylephrine hydrochloride 10% (Neo-Synephrine, Sanofi-Winthrop, USA) q12h OS, atropinum sulfuricum 1% (Polfa, Poland) q12h OS, dorzolamide hydrochloride (Trusopt, Merck Sharp&Dohme, France) q12h OS and dexpanthenol (Corneregel, Bausch and Lomb, Germany) q3h OS. The treatment procedure described above was continued for 14 days. Systemic treatment included a broad-spectrum antibiotic, i.e. amoxicillin (Betamox L.A., ScanVet, Poland), administered for 12 days and carprofen (Rimadyl, Pfizer Trading Polska, Poland) administered for three weeks. The measurements of IOP on Days 2, 5 and 12 after the surgery were 11, 8 and 7 mmHg OS and 18, 21 and 20 mmHg OD, respectively. Slit-lamp biomicroscopy OS (Hawk Eye, Dioptrix, France) revealed iridodonesis and a gradual reduction of corneal oedema leading to complete transparency in the bottom two-thirds of the area on Day 12 after the surgery. Mild oedema was still found in the upper one-third of the corneal surface and showed a progressive reduction (Figure 4). The results of slit-lamp biomicroscopy in the OD remained unchanged. Indirect ophthalmoscopy without a 20 D power lens and direct ophthalmoscopy in the OS did not reveal any lesions of the fundus. Single vitreous floaters/opacities were detected. The OD ophthalmoscopy results remained unchanged. A gonioscopic examination in the OS with a Koeppe lens with a 160° visual angle and 18 mm-diameter (Ocular Instruments, USA) revealed a deep anterior chamber and a wide iridocorneal angle. The OD was unremarkable. Direct and consensual PLR measured on Day 12 after the surgery was sluggish in the OS and normal in the OD. The dazzle reflex was positive in the OU. The menace response was

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**Figure 5.** ERGs from the discussed case (four-year-old, male German Shepherd dog), obtained during the dynamic process of dark adaptation following low-intensity flash stimulation (0.03 cd s/m²), six times every 4 min at 0, 4, 8, 12, 16 and 20, respectively, from bottom to top – a selective rod response. Each red and blue trace indicates OD and OS responses, respectively (Figures 5, 6, 7, 8)

**Figure 6.** The dark-adapted, high-intensity (3 cd s/m²) flash stimulated ERGs – a mixed rod-cone response. Normal baseline values of the implicit times and amplitudes in a control group of German Shepherd dogs with indicating the median (black, dotted trace) and limits of normality using the 5th and 95th percentiles (green traces) according to the protocol recommended by Ekesten et al. (2013). Calibration bars are denoted separately for each type of ERG response. Markers indicate the onset of the light stimulus (Figures 6, 7, 8)
Corneal translucency is possible due to the coexistence of protective mechanisms against its overhydration. The corneal epithelium protects the cornea against absorption of the aqueous humour via an active route through sodium-potassium ATPase pumps and passively by the tightness of cellular junctions called occluding junctions (Waring et al. 1982). In contrast to the well-regenerating epithelial cells, the regenerative capacity of the endothelial cells disappears with age (Gilger et al. 2007). In an adult dog, the mitotic activity of the endothelial cells is minimal and the replenishing of defects is achieved by enhancing the volume of cells and their migration (Befanis et al. 1981). Corneal epithelium mechanical injuries, which exceed the repair capacity of endothelial cells result in permanent translucency defects. Perforation of the corneal stroma causes a release of hydrophilic glycosaminoglycans (GAG) which bind water both from the outside, such as in the lacrimal film, and from the inside originating from the aqueous humour, causing corneal swelling (Gilger et al. 2007). In the present case, the damage to all protective mechanisms of the cornea caused by the thorn resulted in overhydration and pancorneal dense
Nasisse and Glover 1997). As discussed in this case, quite severe pain (Curtis et al. 1983; Bedford 1988; of the aqueous outflow, a rapid IOP increase and 2006). These complications may cause a blockage at the trabecular meshwork level (Manning et al. Curtis et al. 1983; Bedford 1988). Vitreous dis placement may additionally provoke obstruction the iris base and a narrowing of the ciliary cleft as well as anterior hyaloid face damage. A pro extended vitreous as well as a subluxated lens may ocular hypertension may occur as a complica tion of phacoclastic uveitis and lens subluxation secondary to an auto-immune reaction and also and is located in the anterior and axial part of the lens (Wilcock and Peiffer 1987; Davidson et al. 1991; Davidson and Nelms 1999).

In the discussed case, uveitis could have been secondary to an auto-immune reaction and also a mechanical irritation caused by a posterior lens luxation (Curtis 1990). Secondary glaucoma and ocular hypertension may occur as a complica tion of phacoclastic uveitis and lens subluxation as well as anterior hyaloid face damage. A pro truded vitreous as well as a subluxated lens may cause a pupillary block, anterior displacement of the iris base and a narrowing of the ciliary cleft (Curtis et al. 1983; Bedford 1988). Vitreous dis placement may additionally provoke obstruction at the trabecular meshwork level (Manning et al. 2006). These complications may cause a blockage of the aqueous outflow, a rapid IOP increase and quite severe pain (Curtis et al. 1983; Bedford 1988; Nasisse and Glover 1997). As discussed in this case, posterior lens subluxation could have also caused retinal damage (Curtis et al. 1983; Bedford 1988). For these reasons, rapid removal of a displacement lens is commonly recommended (Glover et al. 1995; Pizzirani 1998).

The removal of a subluxated lens by phacoemulsification (Curtis 1990; Santoro et al. 2003; Manning et al. 2006; Paulsen and Kass 2012) is less invasive than by ICLE (Glover et al. 1995; Nasisse and Glover 1997; Saroglu et al. 2007). In studies by Manning et al. (2006), long-term effects related to vision were better after lensectomy carried out with the phaco technique than after ICLE. In the present case, due to corneal oedema and a lack of sufficient visibility, it was decided to remove the subluxated lens by ICLE. A wide, 150-degree opening of the anterior chamber allowed for direct and precise visualisation of the surgical area.

In the case of perforating eye injuries, sudden decompression is the cause of uveal or iris prolapse that, together with fibrin, seal a defect (Hendrix 2007; Martin 2010a). In the present case, the thorn acted like a stopper that maintained relative sealing in the anterior chamber, lens and anterior vitre ous face, which delayed and alleviated the induc tion of an auto-immune response. This thorn also prevented a prolapse of the vitreous to the ante rior chamber and reduced the risk of secondary retinal detachment. The removal of the foreign body resulted in the formation of a canal joining the vitreous with the external environment. The accumulation in the anterior chamber of a mass consisting of the vitreous, lens material and blood from the damaged iris, is suggestive of a poor prog noticis (Hendrix 2007). The immediate flushing of the mass from the anterior chamber minimised the probability of all the above-mentioned complica tions.

In cases of perforation of the eye with metallic foreign bodies (Slatter and Bryan 1972; Schmidt et al. 1975; Sansom and Labruyere 2012; Martin 2010a), the risk of infection is substantially lower than with foreign bodies of an organic origin (Bussanich and Rootman 1981; Williams and Wilcock 1988; Paulsen and Kass 2012). Hence, postsurgical medical management included a systemic and topical broad-spectrum antibiotic, steroidal and non-steroidal anti-inflammatory medication and mydriatic treatment (Hendrix 2007; Martin 2010a; Paulsen and Kass 2012). In studies by Paulsen and Kass (2012) on traumatic corneal lac-
In the reported case, an early surgical intervention allowed us not only to reconstruct the correct anatomical architecture inside the injured eye,
but also to restore the transparency of the optical system. The accompanying conservative treatment helped to reduce inflammatory processes, minimise complications in the retina and led to the preservation of vision.

REFERENCES


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