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Case report

PHACOEMULSIFICATION FOR CATARACT SECONDARY TO PERSISTENT HYPERPLASTIC *TUNICA VASCULOSA LENTIS* AND PERISTENT HYPERPLASTIC PRIMARY VITREOUS IN A WELSH CORGI

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A 7-month-old Cardigan Welsh Corgi was presented with rapid cataract formation. Slit lamp biomicroscopy revealed mature cataract in the left eye. Ultrasonography revealed a microphakic lens and the presence of a cord-like structure extending from the posterior lens to the optic disc. On the basis of ophthalmological examinations, a diagnosis of cataract secondary to persistent hyperplastic tunica vasculosa lentis and persistent hyperplastic primary vitreous was made. Routine phacoemulsification with a capsular tension ring and intraocular lens implantation were performed. Although a blood-filled vasculature with focal hemorrhage was observed during surgery, we did not fenestrate the posterior capsule or cut the hyaloid artery. We only polished the posterior capsule carefully for 2 min. At 22 days after surgery, Doppler ultrasonography did not detect blood flow within the cord-like structure, and the implanted intraocular lens appeared clear without fibrin formation or posterior capsule opacification. The findings from this case suggest that routine cataract surgery is an optimal surgical treatment for persistent hyperplastic tunica vasculosa lentis and persistent hyperplastic primary vitreous. To the best of our knowledge, this is the first case report of phacoemulsification with intraocular lens implantation for persistent hyperplastic tunica vasculosa lentis and persistent hyperplastic primary vitreous in a Welsh Corgi.

Key words: cataract, dogs, lens implantation, phacoemulsification, PHTVL/PHPV

INTRODUCTION

Persistent hyperplastic tunica vasculosa lentis and persistent hyperplastic primary vitreous (PHTVL/PHPV) is a congenital ocular anomaly characterized by the persistence of the hyaloid–tunica vasculosa lentis system due to failure of regression and fibroblastic proliferation [1]. Real-time color-flow Doppler ultrasonography is a useful modality for the diagnosis of PHTVL/PHPV and can identify the vascular

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characteristics of this tissue [2]. Most lesions are associated with various anomalies, including lenticular, capsular, and retinal anomalies. Among these, secondary cataract with visual impairment is the primary reason for presentation [1,3]. To our knowledge, only a few reports have described surgical treatments such as lens extraction or phacoemulsification followed by intraocular lens (IOL) implantation for PHTVL/PHPV with visual impairment caused by cataract in dogs [1,4]. Here we present a case involving a 7-month-old Welsh Corgi with secondary cataract caused by PHTVL/PHPV that was successfully treated by phacoemulsification with IOL implantation.

CASE PRESENTATION

A 7-month-old male Cardigan Welsh Corgi presented at the Veterinary Medical Teaching Hospital (VMTH), Konkuk University with a history of leukocoria in the left eye. The owner observed rapid progression of the leukocoria over a week. Ophthalmologic examinations revealed a positive menace response and dazzle reflex in the left eye. Mydriasis was detected because atropine eyedrops had been administered at a local animal hospital. Slit-lamp biomicroscopy revealed an immature posterior lens cortex with generally increased opacity. Ultrasonography revealed a posterior lenticonus, a dense echogenic area involving the posterior lens capsule and the immediate retrolental region, and a cord-shaped structure extending from the optic disc to the posterior capsule of the lens (Fig. 1). Intraocular pressure (IOP) in the left eye was 14 mmHg. The retinal function was normal according to the results of electroretinography (ERG). On the basis of these findings, a diagnosis of cataract secondary to PHTVL/PHPV was made.

Routine phacoemulsification was performed on the affected eye. From 2 h before surgery, atropine (Isopto Atropine, Alcon NV, Belgium), tropicamide with phenylephrine (Mydrin P, Santen Pharmaceutical Co. Ltd, Japan), prednisolone acetate (Pred forte, Allergan, USA), flubiprofen sodium (Flubiprofen sodium, Bausch & Lomb, Tampa, USA), and ofloxacin (Tarivid, Santen Pharmaceutical Co. Ltd, Japan) eyedrops were administered every 30 min. Then, cefazolin (Cefozol, Hankook Korus Pharm. Co., Ltd, Korea) was administered as a prophylactic antibiotic, followed by the induction of anesthesia with intravenous propofol (6 mg/kg; Provive 1%, Myungmoon Pharm. Co., Ltd, Korea). Normal saline (0.9%) was used for intraoperative fluid therapy. Atracurium besilate (Atra, Hana Pharm Co. Ltd., Korea), a neuromuscular blocking agent, was intravenously injected to facilitate the globe positioning and reducing external forces from extraocular muscles. The dog was placed in dorsal recumbency and the surgical site was prepared using 0.2% povidone–iodine solution for sterilization.

A 3-mm clear corneal incision was placed, followed by Trypan Blue staining for the anterior lens capsule to aid visualization prior to capsulectomy. After capsulectomy, a capsular tension ring (CTR) (an-CTR-13, an-vision Inc., Utah, USA) was inserted using a CTR injector for safe cataract extraction with a stable IOL position within the capsular bag. Then, a second 1-mm incision was placed at 70° from the first incision

for two-handed phacoemulsification. Following lens removal, all residual cortical materials were eliminated using an irrigation/aspiration handpiece. At the end of the cataract extraction procedure, a persistent blood-filled vasculature and a focal vascular capillary network were observed on the posterior lens capsule, without defects (Fig. 2). We did not fenestrate the posterior capsule or cut the hyaloid artery for removal of the blood-filled vasculature; rather, we carefully performed capsular polishing in the capsular regions of PHPV for 2 min. Then, the adjacent posterior lens capsule became transparent and allowed visualization of the fundus. The capsular bag was carefully filled with viscoelastic material (Healon GV®, Abbott Medical Optics Inc. CA, USA) because of the small capsular bag capacity (Fig. 1). Considering the deformity of the posterior lens and capsular regions, a specific IOL (Loki 13, Cristalens Industrie, Lannion, France) with a posterior haptic angulation and a posteriorly bulging surface was implanted to maximize the barrier effect on lens epithelial cell migration at the posterior optic edge by pushing IOL toward the posterior capsule after filling the anterior chamber and capsular bag with the viscoelastic agent. The incisions were closed with a 9-0 polyglactin 910 suture (Vicryl*, Ethicon LLC, New Jersey, USA). A drop of dorzolamide and timolol (Cosopt®, Merck Sharp & Dohme Corp, USA) was applied at the end of the surgery to decrease the possibility of postoperative ocular

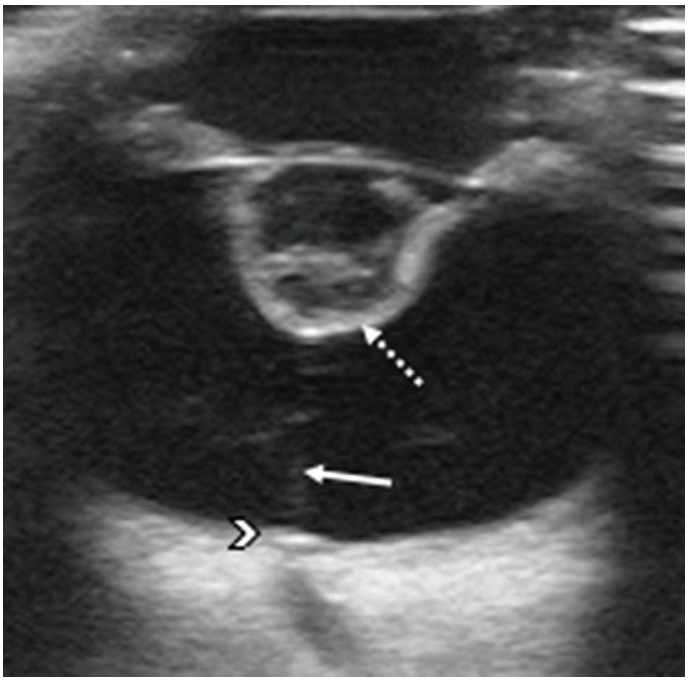

Figure 1. Transverse sonography of the left eye of a Welsh Corgi with cataract secondary to persistent hyperplastic tunica vasculosa lentis and persistent hyperplastic primary vitreous in the left eye. A prominent cord-like structure (white arrow) can be seen coursing from the optic disc to the posterior lens capsule. The optic disc is bulging inward at the site of insertion of the persistent hyaloid artery (arrowhead), while the posterior lens surface is protruding backward (dashed arrow).

hypertension. IOP was evaluated at 30-min intervals during the first 4 h after surgery and was maintained within the normal range (15–25 mmHg). For 10 days after surgery, tropicamide with phenylephrine (Mydrin P, Santen Pharmaceutical Co. Ltd, Japan), prednisolone acetate, flubiprofen sodium, and ofloxacin were applied four times a day. The frequency of application was gradually decreased over 2 months.

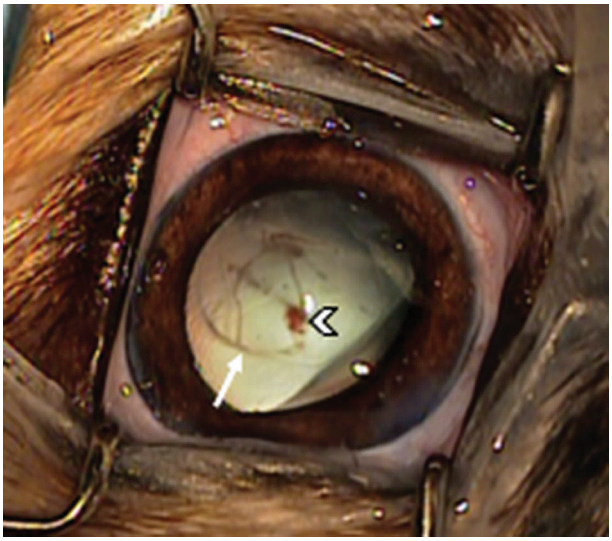

Figure 2. Intraoperative view of the posterior capsule after the removal of lens material during phacoemulsification in a Welsh Corgi with cataract secondary to persistent hyperplastic tunica vasculosa lentis and persistent hyperplastic primary vitreous in the left eye.
A patent vasculature (white arrow) and a focal vascular capillary network (arrowhead) can be observed on the posterior capsule.

No active Doppler signal and the disappearance of the blood-red vasculature on the posterior capsule on doppler ultrasonography and slit lamp biomicroscopy indicated that blood flow in the remanence of the vasculature might be regressed (Fig. 3). The dog maintained clear vision with a positive menace response, and there was no evidence of ocular complications such as intraocular fibrin formation, posterior capsule opacification, inflammation, glaucoma, retinal detachment, and IOL decentration/luxation until the 180-day follow-up visit.

PHTVL/PHPV is a congenital anomaly characterized by abnormal regression of the primary vitreous body and hyaloid vasculature system [5]. The primary vitreous, which is the embryonic vasculature of the eye, supplies nutrients to the developing lens and retina during early gestation [5,6]. It is composed of the main hyaloid artery (extending from the region of the optic disc toward the lens through the center of the vitreous), the vasa hyaloidea propria (capillary branches that course throughout the vitreous), and the tunica vasculosa lentis (terminal branches of the hyaloid artery) [7,8]. Normally, the hyaloid vascular system in dogs begins to atrophy by day 45 of gestation, although a normal tunica vasculosa lentis is observed until 14 days after

birth [7]. As the vascular structures regress, they are gradually replaced by the avascular or secondary vitreous [2,5,7]. By 2–4 weeks after birth, the posterior part of the globe, which is mainly composed of the secondary vitreous, and the remains of the primary vitreous are reduced to a small central structure known as Cloquet's canal, which runs from the optic disc to the posterior surface of the lens [8].

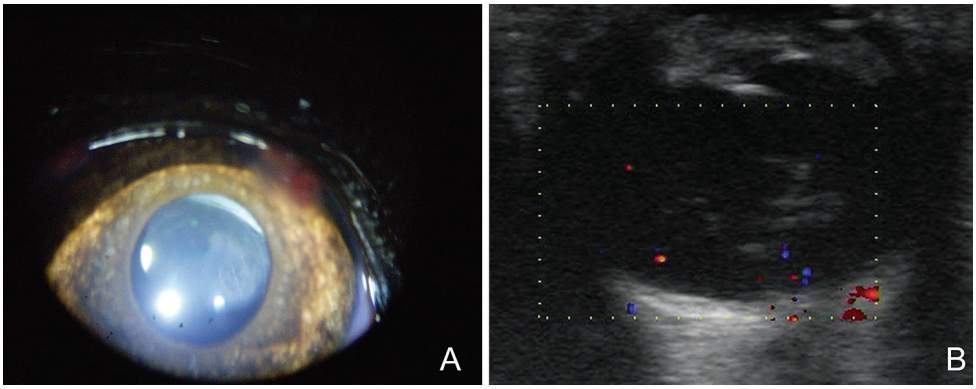

Figure 3. Slit lamp biomicroscopy **(A)** and transverse real-time color-flow Dopper ultrasonography **(B)** findings at 22 days after phacoemulsification with intraocular lens implantation in the left eye of a Welsh Corgi with cataract secondary to persistent hyperplastic tunica vasculosa lentis and persistent hyperplastic primary vitreous.
The blood flow present before surgery has regressed.

PHTVL/PHPV in dogs is commonly bilateral and associated with other ocular anomalies, including posterior lenticonus/lentiglobus, intralenticular hemorrhage, lens colobomata, secondary cataract, glaucoma, microphthalmos, retinal dysplasia, and microphakia [3, 5, 9]. During the natural course of PHTVL/PHPV in dogs, the loss of an eye to secondary glaucoma or global shrinkage is uncommon [5,10,11].

Diagnosis of PHTVL/PHPV in dogs should be based on the history, clinical signs, and appearance of the anomaly and take into account all conditions resulting in leukocoria [3,5]. These include retinal detachment/dysplasia, cataract, intraocular hemorrhage, intraocular tumor, and endophthalmitis [5]. PHPV can be differentiated from these diseases, as it is congenital and opacification usually occurs on the posterior lens surface, with vascularization. Ultrasonography, slit-lamp biomicroscopy, and ERG are useful tools for diagnosis and evaluation of the prognosis.

The main clinical relevance of this condition is its relationship with vision-impairing cataract formation. If vision is severely restricted by lens opacification, lens removal surgery is recommended [1]. Surgical treatment including cataract surgery, fenestration of the posterior capsule, cutting of the hyaloid artery, and anterior vitrectomy may be indicated. To the best of our knowledge, only a few studies have described surgical treatments for PHTVL/PHPV in dogs. Stades et al. (1983) reported lens extraction combined with removal of the center of the posterior capsule, anterior vitrectomy, and cutting of the hyaloid artery [1]. This surgical procedure diminishes the possibility

of retinal detachment by reducing tension on the hyaloid and vascular remnants [1]. However, there is a risk of posterior lens capsule rupture and anterior vitreous disturbances, which may result in vitreous migration into the lens capsule and anterior chamber, and consequently pull on the retina. Around 15 percent of dogs with posterior capsular fenestration showed retinal detachment suspected to be secondary to the anterior vitreous migration [11]. Therefore, in the present study, we decided not to fenestrate the posterior capsule or cut the hyaloid artery and we simply polished the posterior capsule carefully for 2 min. This can remove all lens materials and completely cut the hyaloid artery from the lens. After surgery, the blood in the vascular structure was considered to have regressed on its own. Only one report has documented canine phacoemulsification with IOL implantation, which was performed in a Siberian Husky [4]. When other lenticular anomalies present with cataract formation, the design of IOL and the usage of a capsular tension ring should be considered before surgery. In particular, patients exhibiting cataract with lenticonus, such as that observed in the present case, require the implantation of a specific IOL with a posteriorly angulated and bulging lens [1,10]. This characteristic shape maximizes the barrier effect and minimizes the space between the posterior capsule and lens cortex, which can be otherwise invaded by fibrin, lens epithelial cells, and other components [10,11]. Moreover, this shape stabilizes the posterior capsule by pushing the capsule backward while stretching it. The capsular tension ring was inserted to stabilize the abnormal lens capsule for safe cataract extraction and a stable IOL position within the capsular bag. This stabilization diminishes the possibility of complications, such as posterior lens capsule rupture, anterior vitreous migration, and retinal detachment. The surgical prognosis for severe PHPV is poor, with a complication rate higher than that reported after routine cataract surgery [1]. In particular, when a persistent hyaloid artery is patent or extensive vitrectomy is indicated, the prognosis is less favorable because retinal detachment, intra- or postoperative hemorrhage, and formation of a traction band can occur.

In conclusion, we reported successful a outcome of lens removal with phacoemulsification followed by IOL implantation in a dog with PHTVL/PHPV. Although no other surgical procedures were performed for the removal or regression of vascular structures, the blood present in those vessels regressed on its own without any complications. Although the reason is uncertain, discontinuation of the anatomical/vascular correlation between the lens and the persistent primary vitreous may have attributed to this regression. Moreover, usage of a capsular tension ring and IOL with a specific design that fits into the posterior capsule with dysplasia can prevent lens capsule instability and opacification after surgery. The findings from our case suggest that routine cataract surgery is an optimal surgical treatment for PHTVL/PHPV in dogs. Further clinical studies will be necessary to define the relationship between phacoemulsification and vascular regression.

Authors' contributions

MYK and JYK contributed to the case description. JYK and HYY conducted the literature review. All authors participated in the drafting of the manuscript and have read and approved the final manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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FAKOEMULZIFIKACIJA SEKUNDARNE KATARAKTE U ODNOSU NA PERZISTENTNU HIPERPLAZIJU *TUNICA VASCULOSA* SOČIVA I PERZISTENTNU HIPERPLAZIJU STAKLASTOG TELA KOD PSA RASE WELSH CORGI

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Pregledan je pas rase Welsh Corgi, star 7 meseci pri čemu je uočeno ubrzano formiranje katarakte. Biomikroskopskim pregledom Slit-lampom, uočena je već formirana katarakta na levom oku. Ultrazvučnim pregledom je uočena promena sočiva kao i prisustvo hrapave strukture u predelu posteriornog segmenta sočiva ka optičkom disku. Na osnovu oftalmološkog pregleda, postavljena je dijagnoza: katarakta sekundarna u odnosu na perzistentnu hiperplastičnu *T. vasculosa lentis* kao i perzistentna primarna hiperplazija vitreus-a. Obavljen je tretman u vidu rutinske fakoemulzifikacije sa kapsularnim prstenom i intraokularne implantacije sočiva. Uprkos tome što su tokom operacije uočene fokalne hemoragije kao i kongestija vaskularnog sistema, tokom same procedure nije probijena posteriorna kapsula niti je napravljen rez na arteriji. Tokom procedure, obavljeno je pažljivo poliranje posteriorne kapsule, u trajanju od 2 minuta. Dvadeset i dva dana posle operacije, upotrebom Doppler ultrazvučnog aparata, nije uočen protok krvi u okviru hrapave strukture koja je ličila na uže. Istovremeno, intraokularni implantati sočiva su bili čisti i prozirni, bez formiranja fibrinskih naslaga niti je uočeno zamućenje posteriorne kapsule. Rezultati koji su dobijeni na osnovu ovog slučaja, ukazuju da rutinska hirurška obrada katarakte predstavlja optimalni tretman perzistentne hiperplastične *T. vasculosa* sočiva i perzistentnog hiperplastičnog staklastog tela. Prema našim saznanjima, ovo je prvi slučaj opisivanja fakoemulzifikacije sa intraokularnom implantacijom sočiva kod pacijenata sa hiperplastičnom *T. vasculosa* sočiva kao i sa perzistentnim hiperplastičnim primarnim staklastim telom kod psa rase Welsh Corgi.