Original Research

Comparison of Intraocular Lens (IOL) Implantation with and without Capsular Tension Ring (CTR) Placement in Cataractous Dogs

H. K. Santosh[1*], L. Ranganath[2], B. N. Nagaraja[1], M. L. Satyanarayana[3]and M. Narayanaswamy[4]

[1]Department of Veterinary Surgery and Radiology, Veterinary College, KVAFSU, Bengaluru - 560 024, Karnataka, INDIA
[2]Veterinary College, KVAFSU, Hassan - 573 202, Karnataka, INDIA
[3]Department of Veterinary Pathology, Veterinary College, KVAFSU, Bengaluru - 560 024, Karnataka, INDIA
[4]Department of Veterinary Physiology, Veterinary College, KVAFSU, Bengaluru - 560 024, Karnataka, INDIA

***Corresponding author:** surgeonhk@gmail.com

Rec. Date:	May 14, 2019 17:09
Accept Date:	Jun 19, 2019 13:08
DOI	10.5455/ijlr.20190514050945

Abstract

The objective of the present study was to compare the implantation of intraocular lens (IOL) with and without Capsular Tension Ring (CTR) placement and its efficacy in decreasing the occurrence of posterior capsule opacification (PCO) after phacoemulsification in cataractous dogs. Twelve client-owned dogs with mature cataracts were divided into IOL alone and CTR/IOL groups comprising six dogs in each group. The eyes were randomly selected to receive IOL alone or in association with the CTR. Clinical evaluations were conducted on day 0, 1st, 3rd, 7th, 14th, 21st, 30th, 60th, 90th, 120th, 150th, 180th and 210th day. IOL group recorded 50% PCO as compared to CTR/IOL group, where it was recorded as 16.67% at the end of the study period. These results suggest CTR could be useful in the prevention of the post-operative capsule opacities, with minor complications.

Key words: Cataract, CTR, Dogs, IOL, Phacoemulsification

How to cite: Santosh, H. K., Ranganath, L., Nagaraja, B. N., Satyanarayana, M. L., & Narayanaswamy, M. (2019). Comparison of Intraocular Lens (IOL) Implantation with and without Capsular Tension Ring (CTR) Placement in Cataractous Dogs. International Journal of Livestock Research, 9(7), 65-76. doi: 10.5455/ijlr.20190514050945

Introduction

Cataract is the main cause of vision impairment both in humans and dogs. Phacoemulsification with intraocular lens (IOL) implantation is the best method for restoring vision. The most common long-term post-operative complication in both humans and dogs is posterior capsule opacification (PCO) (Gift *et al*., 2009), which is due to epithelial–mesenchymal transformation, proliferation and migration of residual lens

epithelial cells (LECs) which can result in impaired vision and IOL decentration (Wilkie and Colitz, 2013). Prevention of posterior capsule opacification is important for dogs, which present high PCO rates, about 69 to 100% up to one-year post surgery (Bras *et al*., 2006). The severity of PCO in dogs is also greater and may be related to the differences in inflammatory and fibrous response (Gerardi *et al*., 1999). The current treatment of PCO in humans, using Nd:YAG laser, is expensive and not free from complications (Hazra *et al*., 2012). Laser capsulotomy is less successful in dogs due to the presence of dense capsular plaques, residual lens material and thick inflammatory membranes requiring greater energy to achieve a capsular hole (Nasisse and Davidson, 1988). Although lens implantation is considered as one of the main choice in the prevention of PCO in dogs, it is not sufficient to effectively prevent the opacities. Studies in dogs using different types of lenses demonstrate only partial control of PCO months after the surgery (Yi *et al*., 2006). Many trials have been performed to test the IOL materials and shapes in dogs (Kugelberg *et al*., 2008). The theory that the shape of the square edge is more important than the IOL materials has gained popularity and the IOLs have been modified in an attempt to effectively reduce PCO formation. Some studies have reported that a sharp posterior optic edge is the main factor in preventing PCO (Kohnen *et al*., 2008) due to the "barrier effect" against lens epithelial cell migration (Apple *et al*., 2001).

It has also been shown that the use of the endocapsular tension ring can reduce secondary lens epithelial cell proliferation (LEC) (Nishi *et al*., 2001). Capsular tension rings were first reported to be used to maintain the shape of the capsular bag after the insertion of IOLs (Hara *et al*., 1991). It has also been used to reinforce the zonule in cases of zonular dehiscence or to facilitate the phacoemulsification in traumatic cataracts (Marques *et al*., 2007). It was then observed that the secondary cataract was significantly lower in those eyes that have received the ring implantation (Kim *et al*., 2005), while some authors have proposed to modify its shape to improve PCO prevention (Nishi *et al*., 2001). The data shown that the lens implantation alone is not sufficient to prevent PCO as expected. Nevertheless, the real need is to prevent PCO formation after canine cataract surgery and few studies about it have been carried out. This study aims to investigate the role of the CTR with IOL implantation in the control of PCO in dogs after phacoemulsification.

Materials and Methods

Animals and study area, a total of 12 client-owned dogs of various breeds, ageing between three and 13 years, with mature cataracts, were included in the present study. The dogs were randomly divided into two groups *viz.*, Group A (Phacoemulsification followed by hydrophobic acrylic foldable intraocular lens (IOL) implantation) and Group B (Phacoemulsification followed by hydrophobic acrylic foldable IOL implantation with CTR placement), comprising six in each group. All the dogs underwent a complete ophthalmic and physical examination in order to exclude any coexisting ophthalmic or systemic diseases.

 DOI 10.5455/ijlr.20190514050945

All the dogs were withheld 12 hours for food and 6 hours for water before the surgery. As a pre-operative antibiotic, the cataractous eye was instilled topically with Ofloxacin ophthalmic solution and Flurbiprofen sodium ophthalmic solution @ 2-3 drops t.i.d for 3 days prior to surgery to reduce existing subclinical inflammation and 2% homatropine hydrobromide eye drop @ 2-3 drops b.i.d for 3 days prior to surgery to achieve mydriasis. All the dogs in both the groups were premedicated with Inj. Atropine sulphate @ 0.045 mg/kg BW, S/C and Inj. Xylazine hydrochloride @ 1 mg/kg BW, I/M. After 15 - 20 minutes, general anaesthesia was induced with Inj. Thiopentone sodium @ of 12.5 mg/kg BW, I/V and maintained by Isoflurane using Surgivet® inhalant anaesthetic apparatus.

A 3.8 mm incision was made at the limbus at 10 O'clock position by using disposable double bevel keratome blade (Fig.1). One ml of Inj. Adrenaline was infused to dilate the pupil (Fig. 2). Trypan blue was then infused to stain the anterior capsule of the lens. Capsulorrhexis was done by using a 23G bent tip hypodermic needle in a semi-circular fashion and intracamerally infused viscoelastic material, i.e. hydroxypropyl methylcellulose ophthalmic solution through the incision using a blunt bent syringe needle to create a space as well as to protect the corneal endothelium during operation (Fig. 3).

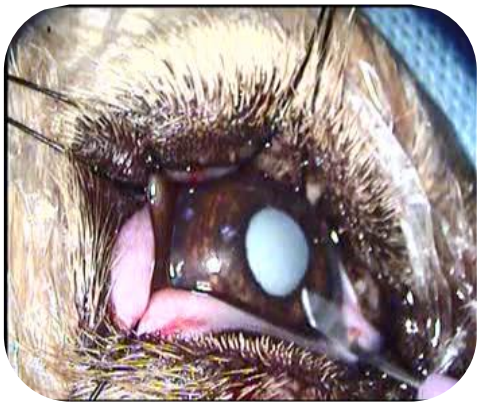

Fig. 1: Limbal incision using disposable keratome blade

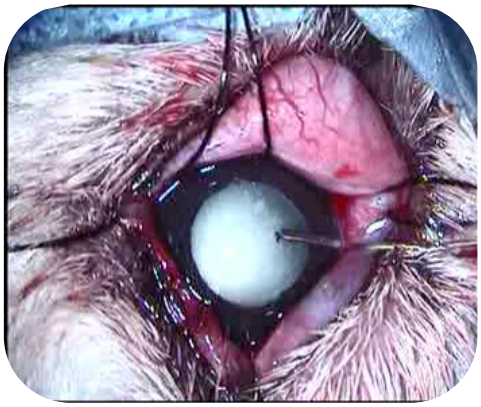

Fig. 2: Infusion of adrenaline into the anterior chamber to dilate the pupil

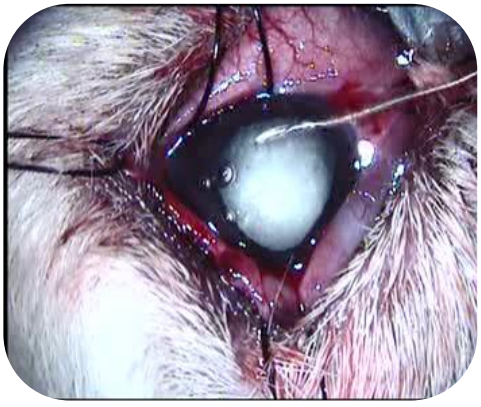

Fig. 3: Capsulorrhexis using blunt tipped 23 G hypodermic needle

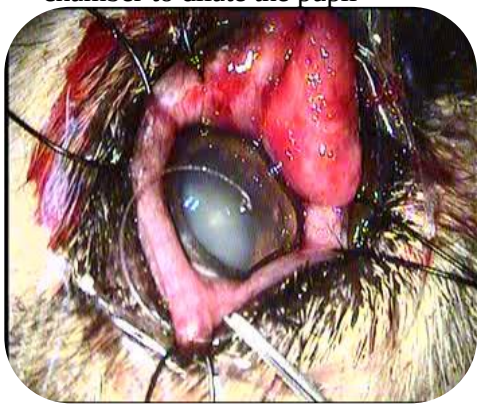

Fig. 4: CTR placement inside the capsular bag

DOI 10.5455/ijlr.20190514050945

Hydro dissection was also performed on all eyes. Group B dogs received Capsular tension ring (CTR) (PMMA CTR Ring*, PMMA Single piece capsular tension ring with two eyelets, Model: TCR 1311, Normal size: 13.00 mm and compressed size: 11.00 mm; Model: TCR 1210, Normal size: 12.00 mm and compressed size: 10.00 mm, Truviz Ophthalmic, Dharmapuri – 636 706, Tamilnadu, India) inside the capsular bag with the help of appropriate CTR injector (Tension ring injector, Wipak medical, Madhu instruments Pvt. Ltd, New Delhi – 110 020, India) (Fig. 4), after filling the capsular bag with sufficient viscomet material.

Surgery was carried out using a Galaxy Pro phacoemulsification machine (Appasamy Associates Pvt. Ltd, Chennai). All the dogs received hydrophobic aspheric 360° square edge foldable intraocular lens (IOL) (Truviz Phobic*, Hydrophobic aspheric 360° square edge foldable Intraocular Lens, Model: THF 613, Power: +41.00 D, Optic Size: 6.00mm, Overall Size: 13.00mm, Truviz Ophthalmic, Dharmapuri – 636 706, Tamilnadu, India) piece was inserted behind the iris in front of the posterior capsular bag of the lens (Fig. 5). Anterior chambers of all dogs were infused with one ml pilocarpine nitrate 0.5% w/v to relax the iris so as to constrict the pupil. The anterior chambers of all the dogs were properly irrigated and reformed with ringer's lactate solution taking care not to leave the viscomet material inside the chamber. The limbal incision site was then sutured by one or two interrupted sutures using No. 6/0 polyglactin 910 (Fig. 6). A combination of 5mg of Inj. prednisolone and 5mg of Inj. gentamicin was injected sub conjunctively after completion of the procedure (Fig. 6).

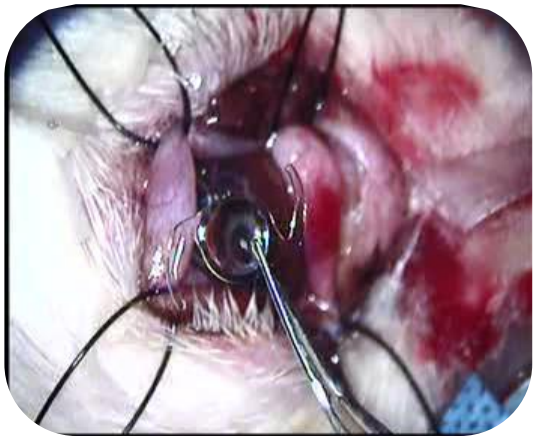

Fig. 5: Hydrophobic acrylic foldable intraocular lens (IOL) implantation

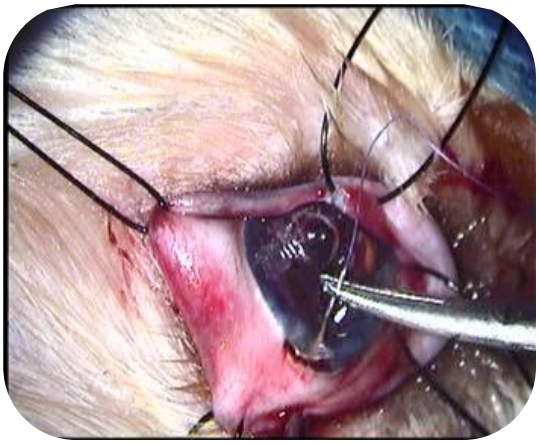

Fig. 6: Suturing of limbal incision using 6/0 vicryl suture

Systemic antibiotic Amoxycillin and Clavulanic acid @ 20 mg/kg BW, orally, b.i.d was administered for 7 days and prednisolone dispersible tablets @ 0.5mg/kg BW b.i.d orally for 2 weeks, followed by 0.5mg/kg BW s.i.d for next one week and 0.25 mg/kg BW s.i.d orally for another week. Post-operatively advised instillation of Ofloxacin ophthalmic solution @ 3 drops hourly for the 1st week followed by two hours interval for 2nd week, 3 hours interval for the 3rd week and 4 hours interval for the 4th week. Flurbiprofen

 DOI 10.5455/ijlr.20190514050945

sodium ophthalmic solution @ 3 drops hourly for the 1st week followed by two hours interval for 2nd week, 3 hours interval for the 3rd week and 4 hours interval for the 4th week. Instillation of prednisolone acetate ophthalmic suspension @ 3 drops hourly for the 1st week followed by two hours interval for 2nd week, 3 hours interval for the 3rd week and 4 hours interval for the 4th week. Application of sodium chloride ophthalmic ointment 6% w/w b.i.d for 4 weeks and instillation of operated eye twice daily with sodium chloride ophthalmic solution for 4 weeks. Application of Elizabethan collar of suitable size in all the cases for 21 days was advised to prevent self-mutilation.

The dogs in both the study groups were evaluated pre-operatively for signs of ophthalmic as well as systemic illness. Ophthalmic examinations and neurological tests for vision evaluation including visual function tests *viz.* menace response, palpebral reflex, pupillary light reflex (PLR), tracking reflex test, obstacle test, cotton ball test, dazzle light reflex, consensual reflexes were evaluated pre-operatively on day 0 and on 1st, 3rd, 7th, 14th, 21st, 30th, 60th, 90th, 120th, 150th, 180th and 210th day post-surgery in both the groups, and clinical examination of the eye was done by naked eye examination, catoptric test, direct ophthalmoscopy, tonometry and Schirmer tear tests were performed on the above mentioned follow-up period. These tests were conducted in order to determine the visual status of the animal as well as to evaluate fundus visibility, persistency of transparency of the capsular membrane and the intactness of neurologic pathways of the cranial nerves pre-operatively and thus enable the detection of changes if any that may occur post-operatively.

Post-operative Follow-up

Complete ophthalmic evaluations were conducted on 1st, 3rd, 7th, 14th, 21st, 30th, 60th, 90th, 120th, 150th, 180th and 210th post-operative days. Gross changes in the eye prior and post-surgery in Group A and B were graded from "-" to "++++" ("-" for Nil; "+" for mild; "++" for Moderate; "+++" for Severe; "++++" for Extensive) as mentioned in the Table 2. PCO was recorded by examination via direct ophthalmoscopy (Heine, USA). Fundus photographs were also taken at the 1st, 3rd, 7th, 14th, 21st, 30th, 60th, 90th, 120th, 150th, 180th and 210th post-operative days using Canon IXUS, 12X optical zoom camera. The PCO was graded as mentioned in the Table 1.

Table 1: Grading of Posterior Capsule Opacification (PCO) based on fundus visibility

PCO Severity	Grading of PCO	Description
(Nil)	-	Visibility of Fundus was clear with clear-cut appearance of optic nerve head, blood vessels, tapetal part and non-tapetal part
+ (Mild)	Grade I	Visibility of Fundus was clear with mild blurred appearance of optic nerve head, blood vessels, tapetal part and non-tapetal part
++ (Moderate)	Grade II	Visibility of Fundus was not clear with moderate blurred appearance of optic nerve head, retinal vessels, tapetal part and non-tapetal part
+++ (Severe)	Grade III	Visibility of Fundus was not clear with lack of appearance of margins of optic nerve head, hazy appearance of retinal vessels, tapetal part and non-tapetal part

DOI 10.5455/ijlr.20190514050945

Table 2: Gross changes in the eyes prior and post-surgery of Group A and B dogs

Group	Case No.	Day 0 (Before Surgery)	Day 0 (After Surgery)	Day 1	Day 3	Day 7	Day 14	Day 21	Day 30	Day 60	Day 90	Day 120	Day 150	Day 180	Day 210
A	1	-	Bl^{+}, P^{++}, C^{+++}	Bl^{+}, P^{++}, C^{++}, CO^{+}, OD^{+++}	C^{++}, CO^{+}, OD^{++}, CP^{+}	CO^{+}, OD^{+}, CP^{++}, E^{+}, C^{++}	C^{++}, CP^{++}, E^{+}	C^{+}, E^{+}, CP^{++}	CP^{+}	CP^{+}	-	-	-	-	-
	2	-	Bl^{++}, C^{++}, P^{++}, H^{++}	Bl^{+}, P^{+}, C^{++}, OD^{++}, H^{+}	CP^{+}, C^{+}, H^{+}, OD^{+}	CP^{+}, C^{+}, H^{+}, OD^{+}	CP^{+}, H^{+}, E^{+}, Af^{+}	CP^{+}, H^{+}, E^{+}, Af^{+}	CP^{+}, Af^{+}	Af^{+}	Af^{+}	Af^{+}	PCO^{+}	PC O^{+}	PC O^{+}
	3	-	Bl^{+}, C^{++}, P^{++}	Bl^{+}, C^{+}, P^{+}, OD^{++}, CO^{++}	OD^{+}, CO^{++}, E^{+++}, Af^{+}	CO^{+}, E^{+++}, Af^{+}	CO^{+}, E^{++}, Af^{+}	CP^{+++}, Af^{+}, E^{++}	CP^{+++}, E^{++}	CP^{+++}, E^{++}	CP^{++}, E^{+}	CP^{+}, E^{+}, PCO^{+}	CP^{+}, PCO^{+}	PC O^{+}	PC O^{+}
	4	-	Bl^{+}, C^{++}, P^{+++}	Bl^{+}, C^{++}, P^{++}, OD^{+}, CO^{+}	C^{++}, P^{+}, OD^{+}, CO^{+}, E^{+}	CO^{+}, OD^{+}, E^{+}, C^{++}	C^{++}, CO^{+}, E^{+}	C^{+}, E^{+}, Af^{+}	CP^{++}, E^{+}, Af^{+}, PCO^{+}	CP^{+}, E^{+}, Af^{+}	CP^{+}, Af^{+}	CP^{+}	-	-	-
	5	-	Bl^{+}, C^{++}, P^{++++}	Bl^{+}, C^{++}, P^{++}, OD^{++}, CO^{+++}	C^{+}, P^{+}, CO^{+}, H^{+}, E^{+}	E^{+}, H^{+}	E^{+}, H^{+}	E^{++}, Af^{+}	E^{++}, CP^{+}, Af^{+}	CP^{+}, Af^{+}	CP^{+}	CP^{+}	CP^{+}	CP^{+}	-
	6	-	Bl^{+}, C^{++}, P^{+++}	Bl^{+}, C^{++}, P^{+++}, OD^{++}, CO^{++}, H^{++}	C^{+}, P^{++}, CO^{+}, OD^{++}, H^{++}, E^{+}	E^{++}, H^{+}, Af^{+}	E^{+}, H^{+}, Af^{+}	E^{+}, H^{+}, Af^{+}	CP^{++}, H^{+}, Af^{+}	CP^{++}	CP^{++}, PCO^{+}	CP^{+}, PCO^{+}	PCO^{+}	PC O^{++}	PC O^{++}
B	1	-	Bl^{++}, C^{++}, P^{++++}	Bl^{++}, C^{++}, P^{++}, OD^{++}, H^{+++}, CO^{+++}	CP^{++}, P^{+}, OD^{+++}, H^{+++}, CO^{++}, E^{+}	C^{+}, OD^{+++}, CP^{+}	OD^{+}, CP^{++}	E^{++}, CP^{++}	E^{++}, CP^{+++}	E^{+}, CP^{++}	CP^{++}	CP^{++}	-	PC O^{+}	PC O^{+}
	2	-	Bl^{++}, C^{+++}, P^{+++}	Bl^{++}, C^{++}, P^{++}, OD^{++}, H^{+}, CO^{++}	C^{+}, E^{+}, P^{+}, OD^{+}, H^{+}, CO^{+}, Af^{+}, CP^{+}	C^{+}, E^{+}, H^{+}, CO^{+}, Af^{+}, CP^{+}	E^{+}, CP^{++}, H^{+}, Af^{+}	E^{++}, CP^{+++}, H^{+}, PS^{+}	CP^{+++}, E^{+++}, H^{+}, PS^{+}	CP^{+++}, PS^{+}, E^{++}	CP^{++}, PS^{+}, E^{+}	CP^{++}, E^{+} PS^{+}	CP^{++}, E^{+}, PS^{+}	CP^{+} , PS^{+}	CP^{+}, PS^{+}
	3	-	Bl^{+}, C^{++}, P^{++}	Bl^{+}, C^{++}, CO^{++}, OD^{+}, P^{+}	C^{+}, E^{+}, CO^{+}, OD^{+}, CP^{+}, Bl^{+}, P^{+}	Bl^{+}, P^{+}, OD^{+}, CP^{++}, E^{+}	CP^{+++}, E^{+}, G^{++}	CP^{+++}, E^{+}, G^{++}	CP^{++}, E^{+}, Af^{+}, G^{++}	CP^{++}, Af^{+}, G^{++}	CP^{+}, G^{++}	CP^{+}, G^{++}	CP^{+}, G^{++}	CP^{+} , G^{++}	G^{++}
	4	-	Bl^{++}, C^{++}, P^{++}	Bl^{+}, C^{++}, P^{+}, CO^{++}, OD^{++}	CO^{+}, OD^{++}, E^{+}, C^{++}	CO^{+}, OD^{++}, C^{++}, E^{+}	C^{+}, E^{+}	CP^{+}, E^{+}	CP^{+++}, E^{++}, G^{+}	CP^{+++}, E^{+}, G^{+}	CP^{++}, G^{+}	CP^{+}, G^{+}	G^{+}	-	-
	5	-	Bl^{++}, C^{+}, P^{+}	Bl^{+}, C^{+}, P^{+}, CO^{+}, OD^{+++}, H^{+++}, E^{+++}	C^{+}, CO^{+}, OD^{++}, H^{++}, E^{++}	CO^{+}, OD^{+}, E^{+}	OD^{+}, E^{+}	CP^{+}, OD^{++}, E^{++}, PS^{+}	OD^{+}, E^{+}, PS^{+}	E^{+}, PS^{+}	PS^{+}	PS^{+}	PS^{+}	PS^{+}	PS^{+}
	6	-	Bl^{+}, C^{+}, P^{+++}	Bl^{+}, C^{+++}, P^{+}, CP^{+}, OD^{+++}, CO^{++}, H^{++}	E^{++}, CP^{+}, OD^{+}, H^{+}, P^{+}	CP^{+}, E^{+}	CP^{+}	CP^{+}	CP^{+}	-	-	-	-	-	-

Bl - Blepharospasm; C-Chemosis; CP - Corneal opacity; CO –Corneal Oedema; E -Episcleral congestion; OD - Ocular Discharge ; PCO-Posterior Capsular Opacity; P-Photophobia; H – Hyphaema ; PS – Posterior Synechiae; Af-Aqueous flare; G-Glaucoma
+ Mild; ++ Moderate; +++ Severe; ++++ Extensive; - Nil

DOI 10.5455/ijlr.20190514050945

Imaging of Fundus

In order to evaluate the PCO formation, the images were viewed at different intervals by direct ophthalmoscope (Heine, USA) and then evaluated by two different examiners.

Statistical Analysis

Mean values and standard deviations were calculated and the data were subjected to unpaired t-test, using computer based statistical programme Graph pad prism and interpreted as per the procedure described by Snedecor and Cochran (1996) to arrive at conclusion.

Results and Discussion

Return of vision was recorded in four dogs of each group. In CTR/IOL group, posterior synechiae was observed in eyes of two dogs by 21st post-operative day which persisted as mild form till the end of study period. Glaucoma was observed in eyes of two dogs by 14th and 30th post-operative days which persisted in moderate form till the end of study period. Inflammatory conditions like episcleral congestion, hyphaema, photophobia, corneal opacity, corneal edema, ocular discharge, chemosis and blepharospasm were observed in almost all the eyes of both groups but the episcleral congestion, hyphaema, photophobia and corneal opacity were comparatively more in CTR / IOL (Group B).

Although clinical inflammation seemed to be more evident in the eyes of CTR/IOL group, there were no statistical differences between increase in inflammatory parameters like intraocular pressure (IOP) as well as Schirmer tear test (STT) values. The pre-operative Mean ± SE IOP for Group A and B were 17.22 ± 0.28 and 17.13 ± 0.28 respectively; the post-operative Mean ± SE IOP values ranged for Group A and B were 13.80 ± 0.29 to 17.64 ± 0.34 and 14.34 ± 0.51 to 19.58 ± 1.82 respectively. The pre-operative Mean ± SE STT values for IOL alone and CTR/IOL groups were 19.83 ± 1.25 and 17.92 ± 1.05 respectively; the post-operative Mean ± SE STT values ranged from 18.00 ± 1.25 to 22.42 ± 1.35 and 18.08 ± 0.86 to 22.25 ± 1.52 respectively. Three dogs of group A, have developed posterior capsule opacification (PCO), by 90th, 120th and 150th post-operative day. The severity of opacification had increased in one dog, while it was static in other 2 dogs. Whereas in group B, only one dog developed PCO by 180th post-operative day which was static till the end of the study period (Table 3).

Results of this study indicate that within 210 days post-implantation, eyes those received CTR plus IOL implantation showed less PCO than the IOL group. Results of vision function tests were evaluated on different post-operative follow-up periods (Martin, 2001; Ofri, 2008 and La Croix, 2010). The decrease in IOP value might be due to widening of the drainage angles initially after operation. A similar observation was made by Turk *et al.* (2013). The tear production increased apparently in all the six dogs of both the groups; however, the values were within the normal range and statistically non-significant (P>0.05).

 DOI 10.5455/ijlr.20190514050945

Table 3: Development of Posterior Capsular Opacification (PCO), its position and Fundus Visibility during different observation time period of eyes in Group A and Group B dogs

Group	Animal No.	0 Day (Before)	0 Day (After)	Day 1	Day 3	Day 7	Day 14	Day 21	Day 30	Day 60	Day 90	Day 120	Day 150	Day 180	Day 210
A	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	2	-	-	-	-	-	-	-	-	-	-	-	PCO^{+} (N) (Grade I)	PCO^{+} (N) (Grade I)	PCO^{+} (N) (Grade I)
	3	-	-	-	-	-	-	-	-	-	-	PCO^{+} (C) (Grade I)	PCO^{+} (C) (Grade I)	PCO^{+} (C) (Grade I)	PCO^{+} (C) (Grade I)
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6	-	-	-	-	-	-	-	-	-	PCO^{+} (T) (Grade I)	PCO^{+} (T) (Grade I)	PCO^{++} (T) (Grade II)	PCO^{++} (T) (Grade II)	PCO^{++} (T) (Grade II)
B	1	-	-	-	-	-	-	-	-	-	-	-	-	PCO^{+} (N) (Grade I)	PCO^{+} (N) (Grade I)
	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-

+ Mild (Grade I); ++ Moderate (Grade II); +++ Severe (Grade III); - Nil

- Nil: Visibility of Fundus was very clear with clearcut appearance of optic nerve head, blood vessels, tapetal part and non-tapetal part.

Grade I PCO: Visibility of Fundus was clear with mild blurred appearance of optic nerve head, blood vessels, tapetal part and non-tapetal part.

Grade II PCO: Visibility of Fundus was not clear with moderate blurred appearance of optic nerve head, retinal vessels, tapetal part and non-tapetal part.

Grade III PCO: Visibility of Fundus was not clear with lack of appearance of margins of optic nerve head, hazy appearance of retinal vessels, tapetal part and non-tapetal part.

N: Nasal in position; C: Central in position: T: Temporal in position

DOI 10.5455/ijlr.20190514050945

As the values were below 30 mm, it might be concluded that the surgery did not cause severe irritation nor pain, in agreement with La Croix (2010) as he stated that canine tear production that exceeds 30 mm/min could be a sign of ocular irritation caused by ectopic cilia, corneal ulceration or the presence of a foreign body.

Episcleral congestion, corneal edema, hyphaema, corneal opacity, ocular discharge and photophobia were observed in almost every eye of both groups; episcleral congestion persists as mild form till the end of the study period in eyes received CTR/IOL. Formation of posterior synechia and glaucoma were recorded in the eyes that received CTR and IOL together; they persists as mild form and moderate form, respectively, till the end of the study period owing to the greater manipulation while placement of CTR inside the capsule (Morales *et al*., 2015). PCO occurred in 3/6 (50%) of the eyes with IOL group observed from 90th day onwards, it persists in two eyes (Grade I) and it had increasing tendency to moderate opacity in one eye (Grade II) from 150th post-operative day onwards on the other hand. A mild (Grade I) degree of opacification was observed in only one eye (16.67%) with the CTR plus IOL group from 180th post-operative day onwards. These findings are in agreement with Prajna *et al.* (2000).

Posterior capsular opacification (PCO) was observed in three eyes i.e., 50% of IOL alone group that too in nasal, central and temporal position in each eye and one of the eyes i.e., 16.67% from CTR/IOL group, which was observed in nasal position. These findings are in agreement with Gift *et al*. (2009) and Hara *et al*. (2011). Morales *et al*. (2015) also reported PCO only in 1/10 (10%) of the eyes with CTR/IOL group on 180th post-operative day in their study. What is noteworthy in this study is that, almost absence of PCO formation in CTR/IOL group, even after 7 months post-surgery. Implantation of CTR inside the capsular bag significantly decreased the PCO, but it could not able to prevent it completely. These findings are in accordance with Halili *et al.* (2014).

The capsular tension ring (CTR) is a specially designed device that was developed by Nishi *et al*. (1998), made from polymethylmet hacrylate (PMMA) material, the capsular bending ring is an open band-shaped ring that measures 0.2 mm in thickness, 0.7 mm in width, and 11.0 mm in diameter with pretension and 13.0 mm in diameter when open. CTR has blunt tipped eyelets at both the ends and designed to be implanted into the capsular bag and left permanently in place (Bayraktar *et al*., 2001). CTR is square in cross section, sharp-edge design and might mechanically compress the capsule, reduce the distance between IOL and capsular bag, inhibit LECs migrations and reduce the development of PCO (Wilkie *et al.*, 2014). The Capsular tension ring (CTR) was placed inside the capsular bag after filling the bag with adequate viscoelastic material as followed by Riedel and Samuelson (2014). Then the CTR was inserted with the help of CTR injector but before phacoemulsification as followed by Riedel and Samuelson (2014). However, Ahmed *et al*. (2005) implanted CTR after cortical aspiration and before IOL implantation in eyes with intact capsular bag. In this study, placement of CTR inside the capsular bag stabilized the bag contour

 DOI 10.5455/ijlr.20190514050945

and helps for performing phacoemulsification as well as IOL implantation, as reported by Jacob *et al.* (2003). CTR was placed in our study in such a way that both the eyelets just overlapped each other, as indicated by Goldman and Karp (2007). In our study, placement of CTR was done before phacoemulsification made placement of the CTR easier and produce less capture of lens as well as cortex material between the bag and the ring and there were no complications encountered.

The technique used in this study, i.e., bimanual phacoemulsification or two- handed technique was found to be suitable as all cases in the present study were of mature cataracts. The principle advantage is a greater flexibility in lens manipulation afforded by having two instruments in the eye. This technique results in quicker and safer surgery because the lens can be cracked, without the need for sculpting near the posterior capsule and the lens can be fed to the phaco tip. A major disadvantage of this technique is that it is technically more demanding, because two separate instruments have to be accommodated in the eye; which was also opined by Brikshavana (2007) and Suresh (2018). Hydrophobic foldable acrylic intraocular lens, 41D was used and found to be satisfactory for the study. In both the groups 4 out of 6 dogs regained vision by the end of observation period and these results are in agreement with Ofri (2008), Raghuvanshi and Maiti (2013) and Hmar (2014). The lens material used was acrylic, which has a lower incidence of posterior capsular opacity as compared to other lens materials, is in agreement with Kecova and Necas (2004). Since it is foldable it could be injected through a smaller rent less than 3 mm, it results in minimal or no induced astigmatism, smaller scar accompanied by greater corneal transparency, provides much more rapid visual and physical recovery, prompt refractive stability and promote better coaptation of the surgical incision, is in agreement with Pandey *et al*. (2004). The power 41D used for the present study was found to be adequate for restoring the vision to dogs. Similar findings were also reported by Gaiddon *et al*. (1991), Yi *et al.* (2006) and Hmar (2014).

Conclusion

Placement of CTR reduces the occurrence of PCO significantly but it could not arrest completely. Its use also associated with few minor complications like uveitis, episcleral congestion, posterior synechiae etc; due to these the benefit of CTR devices in dogs should be evaluated. But in the present study, it is possible to admit that the use of CTR can play an important role in the prevention of PCO, without major complications. Although in the present study the period of evaluation stopped at the 210th post-operative day and more PCO can be formed during the following months or years after the surgery, it is a critical period for PCO to begin. The results of this study are promising. However, a long-term follow-up will be needed because PCO may develop several years after cataract surgery.

 DOI 10.5455/ijlr.20190514050945

References

1. Ahmed, I.K., Cionni, R.J., Kranemann, C., & Crandall, A.S. (2005). Optimal timing of capsular tension ring implantation: Miyake-Apple video analysis. *Journal of Cataract and Refractive Surgery*. 31: 1809-1813.
2. Apple, D.J., Peng, Q., Visessook, N., Werner, L., Pandey, S.K., Escobar-Gomez, M., Ram, J., & Auffarth, G.U. (2001). Eradication of posterior capsule opacification: Documentation of a marked decrease in Nd:YAG laser posterior capsulotomy rates noted in an analysis of 5416 pseudophakic human eyes obtained postmortem, *Ophthalmology*, 108(3): 505-518.
3. Bayraktar, S., Altan, T., Kucuksumer, Y., & Yilmaz, O.F. (2001). Capsular tension ring implantation after capsulorhexis in phacoemulsification of cataracts associated with pseudoexfoliation syndrome. *Journal of Cataract and Refractive Surgery*, 27: 1620-1628.
4. Bras, I.D., Colitz, C.M., Saville, W.J., Gemensky-Metzler, A.J., & Wilkie, D.A. (2006) Posterior capsular opacification in diabetic and nondiabetic canine patients following cataract surgery. *Veterinary Ophthalmology*, 9: 317-327.
5. Brikshavana, P. (2007). Success rate and postoperative complications of phacoemulsification in 25 cataractous eyes: a retrospective study in 20 dogs (2003-2005). *Thailand Journal of Veterinary Medicine*, 37(2): 53-60.
6. Gaiddon, J., Rosolen, S.G., Crozafon, P., Steru, L., Cook, C.S., & Peiffer, R. Jr. (1991). Use of biometry and keratometry for determining optimal power for intraocular lens implants in dogs. *American Journal of Veterinary Research*, 52(5): 781-783.
7. Gerardi, J.G., Colitz, C., Dubielzig, R., & Davidson, M.G. (1999). Immunohistochemical analysis of lens epithelial-derived membranes following cataract extraction in the dog. *Veterinary Ophthalmology*, 2(3): 163-168.
8. Gift, B.W., English, R.V., Nadelstein, B., Weigt, A.K., & Gilger, B.C. (2009). Comparison of capsular opacification and refractive status after placement of three different intraocular lens implants following phacoemulsification and aspiration of cataracts in dogs. *Veterinary Ophthalmology*, 12 (1): 13-21.
9. Goldman, J.M., & Karp, C.L. (2007). Adjunct devices for managing challenging cases in cataract surgery: pupil expansion and stabilization of the capsular bag. *Current Opinions in Ophthalmology*. 18(1): 44-51.
10. Halili, I., Mutlu, F.M., Erdurman, F.C., Gundağon, F.C., & Kiliç, S. (2014). Influence of capsular tension ring on posterior capsule opacification in myopic eyes, *Indian Journal of Ophthalmology*, 62(3): 311-315
11. Hara, T., Hara, T., Narita, M., Hashimoto, T., Motoyama, Y., & Hara, T. (2011). Long-term Study of Posterior Capsular Opacification Prevention with Endocapsular Equator Rings in Humans. *Archives of Ophthalmology*, 129(7): 855-863
12. Hara, T., Hara, T., & Yamada, Y. (1991). "Equator ring" for maintenance of the completely circular contour of the capsular bag equator after cataract removal, *Ophthalmic Surgery.*, 22: 358-359.
13. Hazra, S., Palui, H., & Vemuganti, G.K. (2012). Comparison of design of intraocular lens versus the material for PCO prevention. *International Journal of Ophthalmology*, 5(1): 59-63.
14. Hmar. (2014). Comparison of phacoemulsification with and without intra ocular lens implantation for management of cataract in dogs. MVSc. Thesis, Karnataka Veterinary Animal and Fisheries Sciences University, Bidar, India.
15. Jacob, S., Agarwal, A., Agarwal, A., Agarwal, S., Patel, N., & Lal, V. (2003). Efficacy of capsular tension ring for phacoemulsification in eyes with zonular dialysis. *Journal of Cataract and Refractive Surgery*, 29: 315-321.
16. Kecova, H., & Necas, A. (2004). Phacoemulsification and Intraocular lens implantation: Recent Trends in Cataract Surgery. *Acta Veterinary Brno*, 73: 85-92.
17. Kim JH, Kim H and Joo CK (2005). The effect of capsular tension ring on posterior capsular opacity in cataract surgery, Korean *Journal of Ophthalmology*, 19(1): 23-28.

DOI 10.5455/ijlr.20190514050945

18. Kohnen, T., Fabian, E., Gerl, R., Hunold, W., Hutz, W., Strobel, J., Hoyer, H., & Mester, U. (2008). Optic Edge Design as Long-term Factor for Posterior Capsular Opacification Rates. *Ophthalmology*, 115(8): 1308-1314.
19. Kugelberg, M., Wejde, G., Jayaram, H., & Zetterström, C. (2008). Two-year follow-up of posterior capsule opacification after implantation of a hydrophilic or hydrophobic acrylic intraocular lens. *Acta Ophthalmologica.*, 86(5): 533-536.
20. La Croix, N. (2010). The Schirmer Tear Test: Veterinary Medical Center of Long Island. http://www.vmcli.com/veterinary-articles-schirmer-tear-test.html.
21. Marques, D.M., Marques, F.F., Cionni, R.J., Osher, R.H., & Freitas, L.L. (2007). Avaliação do uso do anel endocapsular modificado em casos de subluxação traumática do cristalino. *Arquivos Brasileiros de Oftalmologia.*, 70(5): 746-751.
22. Martin, C.L. (2001). Evaluation of patients with decreased vision or blindness. *Clinical Techniques in Small Animal Practice*, 16(1): 62-70.
23. Morales, A., Costa, P.F., Conceicao, L.F., Andrade, A.L., Pauda, I.R.M., Marinho, F.A., Brito, F.L.C., & Laus, J.L. (2015). Capsular tension ring alone and associated with acrylic foldable intraocular lens in posterior capsular opacification after phacoemulsification in dogs. *Ciência Rural*, 45(3): 540-545.
24. Nasisse, M.P., & Davidson, M.G. (1988). Laser therapy in veterinary ophthalmology: perspective and potential. *Seminars in Veterinary Medicine and Surgery (Small Animal)*, 3(1): 52-61.
25. Nishi, O., Nishi, K., Mano, C., Ichihara, M., & Honda, T. (1998). The inhibition of lens epithelial cell migration by a discontinuous capsular bend created by a band-shaped circular loop or a capsule-bending ring. Ophthalmic Surgery and Lasers, 29(2): 119-125.
26. Nishi, O., Nishi, K., Menapace, R., & Akura, J. (2001). Capsular bending ring to prevent posterior capsule opacification: 2-year follow-up. *Journal of Cataract and Refractive Surgery*, 27(9): 1359-1365.
27. Ofri, R. (2008). Lens. In: Slatter's Fundamentals of Veterinary Ophthalmology (DH Slatter, Eds.) (4th Edn.), *W. B. Saunders Co, Philadelphia*, 261-272.
28. Pandey, S.K., Werner, L., & Escobar-Gomez, M. (2004). Phacoemulsification. *Journal of Cataract and Refractive Surgery*, 30: 2046-2049.
29. Prajna, N.V., Ellwein, L.B., & Selvaraj, S. (2000). The Madurai intraocular lens study IV: posterior capsule opacification. *American Journal of Ophthalmology*, 130: 304-309.
30. Raghuvanshi, P.D.S., & Matiti, S.K. (2013). Canine cataract and its management: An overview. *Journal of Animal Research*, 3(1): 17-26.
31. Riedel, P.J., & Samuelson, T.W. (2014). *In*: Chapter 14, Capsular Tension Rings. *pp*: 115-121., https://pdfs.semanticsscholar.org/b301/a7bad75971e1dlac34dbfdaab0860d208d21.pdf
32. Snedecor, G.W., & Cochran, W.B. (1996). Statistical methods. *Oxford and IBH Pub, New Delhi*, 138-169.
33. Suresh, L. (2018) Comparative studies on different types of intraocular lens implantation following phacoemulsification in cataractous dogs. Ph.D. Thesis, Karnataka Veterinary Animal and Fisheries Sciences University, Bidar, India.
34. Turk, A., Mollamehmetoglu, S., Imamoglu, H.I., Kola, M., Erdol, H., & Akyol, N. (2013). Effects of phacoemulsification surgery on ocular hemodynamics. *International Journal of Ophthalmology*, 6(4): 537-541.
35. Wilkie, D.A., & Colitz, C.M. (2013). Surgery of the lens. In: Veterinary Ophthalmology (KN Gelatt, Eds.) (5th Edn.), *Blackwell Publishing, Ames, IA*, 1234-1286.
36. Wilkie, D.A., Hoy, S.S., Gemensky-Metzler, A., & Colitz, C.M.H. (2014). Safety study of capsular tension ring use in canine phacoemulsification and IOL implantation. *Veterinary Ophthalmology*, 1-7.
37. Yi, N.Y., Park, S.H., Jeong, M.B., Kim, W.T., Kim, S.E., Chae, J.M., & Seo, K.M. (2006). Phacoemulsification and acryl foldable intraocular lens implantation in dogs: 32 cases. *Journal of Veterinary Science*, 7(3): 281-285.

DOI 10.5455/ijlr.20190514050945