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Surgical Management of Mature Cataract by Placement of Capsular Tension Ring (CTR) in Association with Hydrophobic Acrylic Foldable Intraocular Lens (IOL) Following Phacoemulsification in Cataractous Dogs

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A B S T R A C T

Cataract is the leading cause of reversible blindness and visual impairment in both humans and canines. The only treatment of choice for cataract is surgical intervention. Phacoemulsification along with implantation of artificial intraocular lens (IOL) is considered as the gold standard surgical technique for the management of cataract throughout the world. By following the superior surgical technique as well as using high quality IOL also, there could be a chance of formation of posterior capsular opacification (PCO) from months to years' post-surgery. Many of the trial and errors have been carried out to prevent or arrest the PCO. Placement of capsular tension ring (CTR) in the lens capsule has been considered one among them.

Introduction

A cataract is the clouding of an otherwise clear ocular lens, with disturbance in the passage of light (Davson, 1980). This can make vision hazy. The lens has a protein concentration of 33% of its total weight; and most of these proteins are transparent and water-soluble (Shahzad *et al.*, 2012). The only treatment for cataract is surgical removal of the lens and replacement with a permanent artificial intraocular lens (IOL). Successful cataract surgery universally improves vision and quality of life (Song *et al.*, 2014). Even

though the phacoemulsification and intraocular lens (IOL) implantation are routinely performed for the management of cataract, the most common complication following phacoemulsification and IOL implantation in human and canine eyes is posterior capsular opacification (PCO), as PCO has been shown to occur in 100 per cent of canine eyes following cataract surgery (Bras *et al.,* 2006). Posterior capsular opacification is due to epithelial-mesenchymal transformation, proliferation and migration of residual lens epithelial cells (LECs) and can result in impaired vision and IOL decentration (Wilkie and Colitz, 2013). There is an evidence to suggest that in addition to the design of the IOL, use of a capsular tension ring (CTR) may decrease PCO (Kim *et al.,* 2005). In veterinary medicine, the development of a foldable intraocular lens (IOL) has made small-incision cataract surgery possible (Gaiddon *et al.,* 2000). Hara *et al.,* (1991) described CTR for first time as to maintain a circular capsular contour after cataract surgery in humans. Maintaining a circular equatorial contour and a transparent capsular bag as well as creating an anterior capsulectomy site that does not affect overall capsule structure were three goals mandatory for secure IOL fixation. Conserving the capsule contour prevents post-operative capsule shrinkage, deformity and possible IOL decentration. An additional finding with the CTR was that LECs were mechanically inhibited from undergoing posterior lens capsule migration.

Materials and Methods

In the present study, six clinical cases, irrespective of breed (Labrador Retriever – 2; Pomeranian – 2 and Nondescript – 2 dogs), age (3 – 13 yrs) and sex (Female – 5 and Male – 1) of mature cataract, presented to the Veterinary College Hospital, Hebbal, Bangalore were included. All the dogs were subjected to detailed ophthalmic examination by gross examination of the eye, direct ophthalmoscopic examination and the visual function tests which included; menace reflex test, obstacle test, palpebral reflex test, pupillary light reflex test, tracking reflex test, Schirmer's tear test, fluorescein dye test and measuring intraocular pressure using Schiotz tonometer. They were subjected for clinical examination and haematobiochemical assays to assess their fitness for the surgery and those animals whose test results were within normal range were selected for the surgery. Selection criteria for good surgical patients were as follows: Bilateral or unilateral, mature cataract, negative menace response, positive dazzle reflex, positive direct and consensual pupillary light reflexes (PLR), failed obstacle test in scotopic and photopic conditions, normal intraocular pressure (IOP), no pre-existing systemic disorders, well-mannered (controllable) dog with owner's cooperation.

All the dogs were restricted solid food for 12 hours and water for 6 hours before the surgery. For aseptic precaution, the cataractous eye to be treated was instilled topically with Ofloxacin ophthalmic solution and Flurbiprofen sodium ophthalmic solution @ 2- 3 drops thrice daily for a period of 72 hours prior to surgery to reduce existing subclinical infection and inflammation and 2 per cent homatropine hydrobromide eye drop @ 2-3 drops twice daily for three days prior to surgery to achieve mydriasis.

All the dogs of both the groups were pre-medicated with Inj. Atropine sulphate @ 0.045 mg/kg body weight subcutaneously and Inj. Xylazine hydrochloride @ 1 mg/kg body weight intramuscularly. After 15 - 20 minutes, general anaesthesia was induced with Inj. Thiopentone sodium @ 12.5 mg/kg body weight intravenously and maintained by Isoflurane using inhalant anaesthetic machine. Induction of anaesthesia was smooth and

uneventful. No intraoperative anaesthetic complications were noticed in any of the cases.

Surgical site was prepared for aseptic surgery by flushing the eyelids, globe and conjunctival sac with normal saline and swabbing the same with 1:40 dilution povidone iodine solution using sterile cotton. The dog was positioned on its lateral recumbency on the ophthalmic operating table with the operating eye facing up and the head was secured in between two weighted patient positioning sand bags. The dog's eye was draped with sterile surgical ophthalmic disposable drapes which has got a small aperture through which only the operating eye was exposed. Fixing of the eyeball was achieved by applying stay sutures to the bulbar conjunctiva at 4 sites at an equal distance between each suture using non absorbable monofilament suture material polyamide No. 0 and fixed to the drapes with artery forceps to fix the eyeball in position.

An incision about 3.8 mm was made at the limbus at 10 O'clock position by using disposable double bevel keratome blade (Fig. 1). One ml of Adrenaline was infused to constrict the iris so as to dilate the pupil (Fig. 2). One ml of viscoelastic material, *i.e*., hydroxypropyl methylcellulose ophthalmic solution, was infused from the incision using a blunt bent syringe needle into the eye to create a space as well as to protect the corneal endothelium during operation (Fig. 3). Another side port was made at 2 O'clock position using disposable MVR blades. One ml of trypan blue ophthalmic solution was then infused to stain the anterior capsule bag of the lens (Fig. 4). Capsulorrhexis was done by using a 23G bent tip hypodermic needle in a semi-circular fashion (Fig. 5). Hydro dissection was done by infusing Ringer's lactate to separate the lens from its capsular bag (Fig. 6). The capsular tension ring (CTR) was placed inside the capsular bag with the help of CTR injector, after filling the bag with adequate viscomet material (Fig. 7). Phacoemulsification hand piece was then introduced inside the anterior chamber and irrigation, emulsification and aspiration of the lens material was done (Fig. 8 and 9). The Hydrophobic aspheric 360° square edge foldable IOL piece was inserted behind the iris in front of the posterior capsular bag of the lens (Fig. 10). One ml pilocarpine nitrate was infused in the anterior chamber; this was to relax the iris so as to constrict the pupil. The anterior chamber was then properly irrigated and reformed with Ringer's lactate solution taking care not to leave the viscomet material inside the chamber. The incision site was then sutured by one or two interrupted sutures using No. 6/0 polyglactin 910 (Fig. 11). A combination of 5 mg of Inj. Prednisolone and 5 mg of Inj. Gentamicin was injected sub conjunctively immediately after the surgical intervention (Fig. 12).

Results and Discussion

Cataractous eye was fixed by placing stay sutures in the bulbar conjunctiva using polyamide No. 0 was adequate for positioning and fixing the eye for surgery (Suresh, 2018). A double bevel keratome blade 2.8 mm was found to be adequate for performing a limbal incision at 10 O'clock in precise to enter the anterior chamber (Nelms *et al.,* 1994). Whereas, Ramani *et al.,* (2011) made an incision at 3 O' clock position. A 20 G MVR blade was found to be adequate for making a side port at 2 O'clock, this is for performing a modified bimanual phacoemulsification technique; in which one hand controls the phacoemulsification hand piece and the other holds the stabilization forceps (Ali *et al.,* 2007 and Raghuvanshi and Maiti, 2013). The anterior chamber was entered through a limbal incision, an incision at the limbus has the advantage of lesser astigmatism (Nelms *et al.,* 1994), whereas Joy *et al.,* (2011) stated that

when comparing limbal against corneal incision, limbal incision increased the incidence of iris bulging. In the present study, limbal incision was found to be adequate for entering the anterior chamber without any damage to the iris. Irrigation of one ml adrenaline into the anterior chamber results in efficient pupillary dilatation for adequate exposure of the lens (Suresh, 2018). Viscoelastic material, *i.e.*, hydroxypropyl methylcellulose ophthalmic solution was found to be adequate for maintaining the stability and integrity of the anterior chamber, coat and to protect the corneal endothelium, intraocular tissues (Glover and Constantinescu, 1997). A 23-gauge hypodermic needle bent at an angle of 45 degrees along with bent tip was found to be satisfactory for making a curvilinear capsulorrhexis to open the anterior capsule of the lens (Olesan *et al.*, 1980 and Ramani *et al.*, 2011).

The capsular tension ring (CTR) is a specially designed ring that was developed by Nishi and coauthors in 1998. Made from polymethyl methacrylate (PMMA) material, the capsular tension 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 (Nishi *et al.,* 1998). The CTR was PMMA open-ring device with blunt tipped eyelets at both ends and which was designed to be implanted into the capsular bag and left permanently in place (Bayraktar *et al.,* 2001). CTR has got square cross-section, sharp-edge design and might mechanically compress the capsule, reduce the distance between IOL and capsular bag, inhibit LECs migration and reduce the development of PCO (Wilkie *et al.,* 2014). The Capsular tension ring (CTR) was placed inside the capsular bag after filling the capsular bag with adequate viscoelastic material (Das *et al.,* 2009). Then the CTR was inserted with the help of CTR injector but before phacoemulsification (Chee and Jap, 2011). However, Ahmed *et al.,* (2005) implanted CTR after cortical aspiration and before IOL implantation. All eyes of dogs have an intact capsular bag (Hasanee and Ahmed, 2006). In this study placement of CTR inside the capsular bag stabilized the bag contour and which would have helped for performing phacoemulsification as well as IOL implantation (Jacob *et al.,* 2003). CTR was placed in our study in such a way that both the eyelets just overlapped each other (Goldman and Karp, 2007). In the present study, placement of CTR was done before phacoemulsification made placement of the CTR easier and noticed less capture of lens and cortex material between the bag and the ring and there were no major complications encountered.

Phacoemulsification performed was found to be satisfactory for emulsifying and aspirating the cataractous lens material (Beteg *et al.,* 2010). The technique used in this study, *i.e.*, bimanual phacoemulsification or two-handed technique was found to be adequate, 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 are in the eye (Ali *et al.,* 2007).

Hydrophobic foldable acrylic intraocular lens, +41D was used and was found to be satisfactory for the study. The acrylic IOL has got sharp optic edged biophysical property which is associated with lower incidence of PCO (Gift *et al.,* 2009).

Fig.1 Photograph showing limbal incision

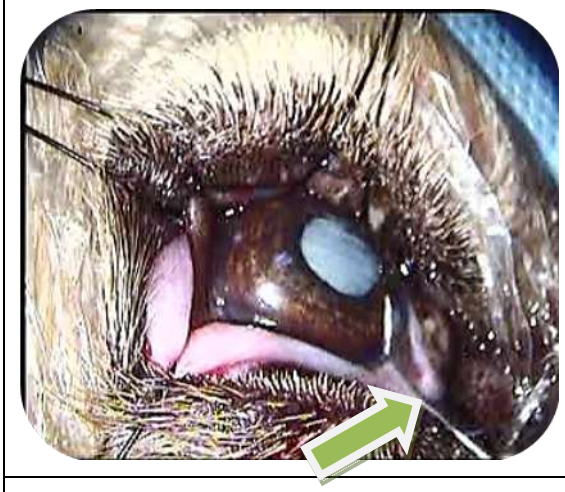


Fig.2 Photograph showing administration of adrenaline

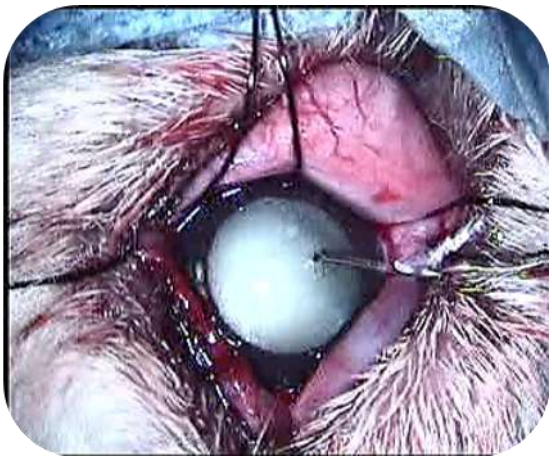


Fig.3 Photograph showing administration of viscoelastic material using a blunt bent syringe needle

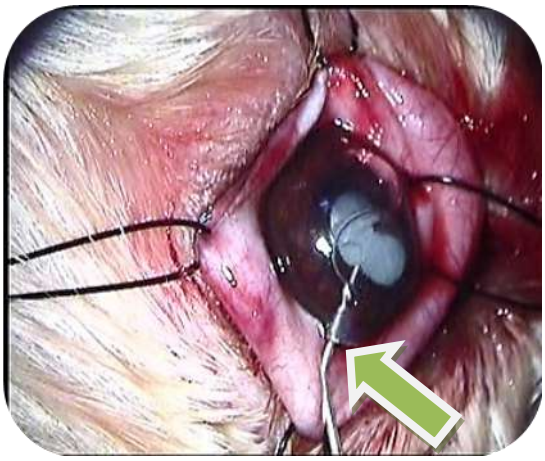


Fig.4 Photograph showing staining of anterior capsule with Trypan blue dye

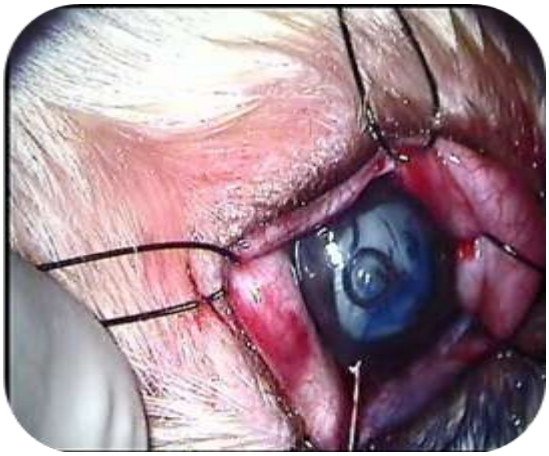


Fig.5 Photograph showing capsulorrhexis

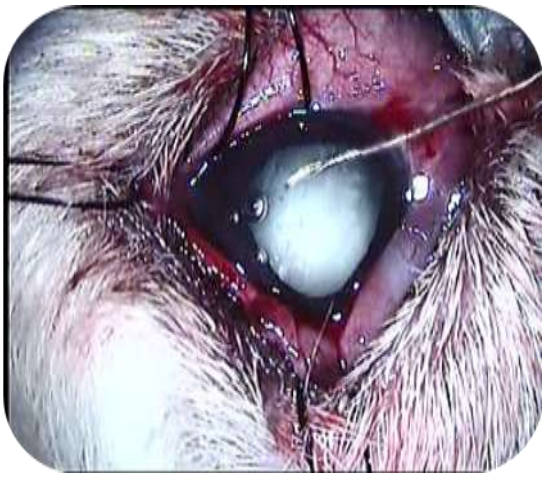


Fig.6 Photograph showinghydro dissection

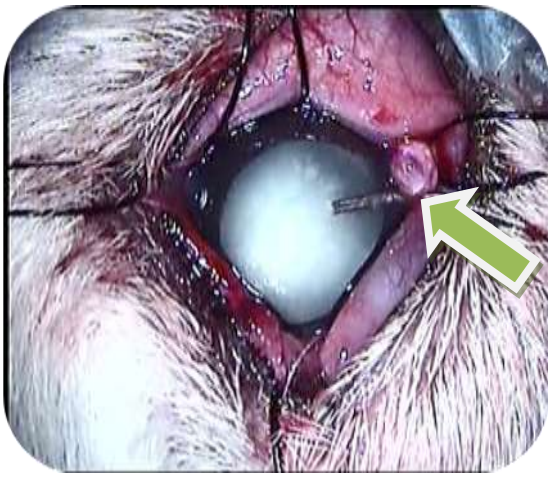


Fig.7 Photograph showing CTR Placement	**Fig.8** Photograph showing phacoemulsification

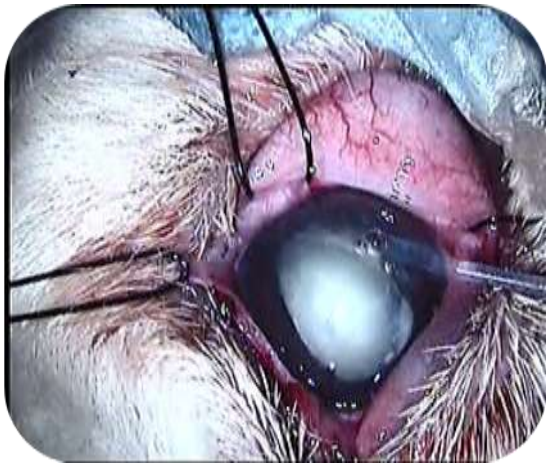
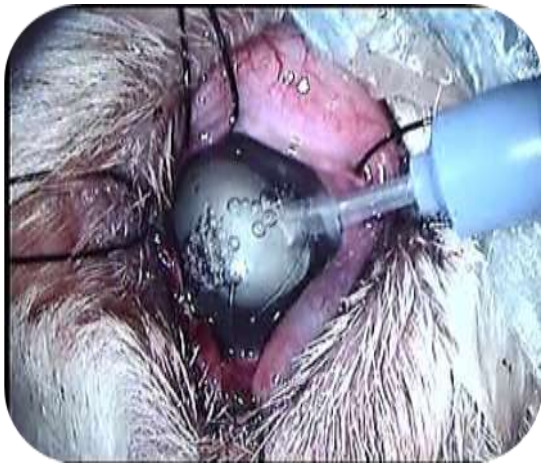
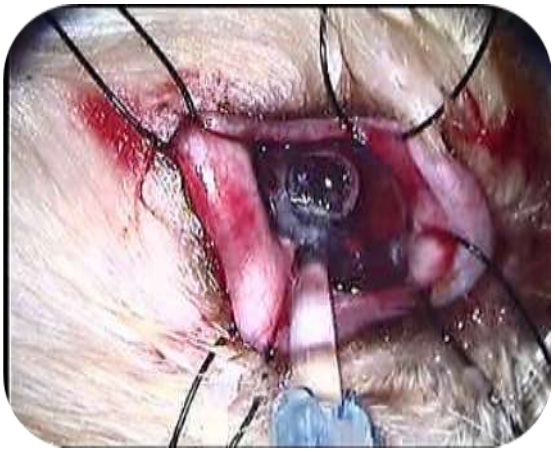
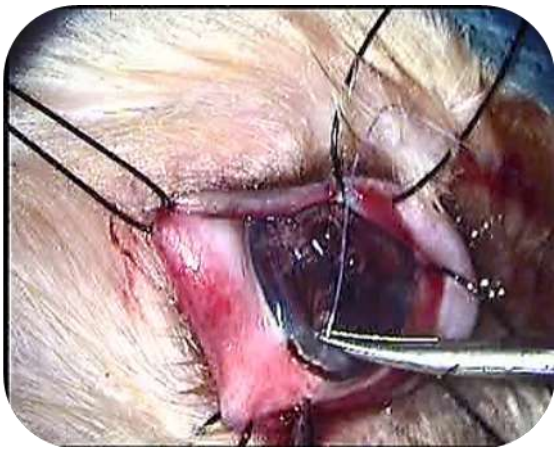

	

Fig.9 Photograph showing aspiration of cortical remnants	**Fig.10** Photograph showing insertion of IOL
	
Fig.11 Photograph showing suturing of limbal incision	**Fig.12** Photograph showing subconjunctival injection
	

Among six dogs, 66.67 % of the dogs' regained vision by the end of study period (Suresh, 2018). The lens material used was acrylic, which is associated with lower incidence of posterior capsular opacity as compared to other lens materials (Gift *et al.,* 2009). It is foldable synthetic lens having a +41D, 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 (Patil *et al.,* 2014). The +41D power used for the present study was found to be adequate for restoring the vision to dogs (Yi *et al.,* 2006). However, Hayashi and Hayashi (2005) reported an acrylic optic IOL had significantly lower PCO than a PMMA optic IOL (Hollick *et al.,* 1999). Immediately at the end of surgical intervention, 5 mg of Inj. Prednisolone acetate and 5 mg of Inj. Gentamicin mixed in an insulin syringe was administered sub conjunctively to prevent local inflammation and infection (Honsho *et al.,* 2007).

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