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Neuro-ophthalmic Tests for Assessment of Vision Before and After Phacoemulsification in Cataractous Dogs

Babita Das[1], Apra Shahi[1], Shobha Jawre[1], Randhir Singh[1], Apoorva Mishra[1]

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ABSTRACT

Background: The aim of current study was to assess pre and post-operative vision status through neuro-ophthalmic examination of 24 canine eyes after phacoemulsification with implantation of different acrylic intra ocular lenses.

Methods: The study was conducted on 24 canine eyes. Preoperatively, detailed neuro-ophthalmic tests *viz*. Menace response, Pupillary light reflex (PLR), Obstacle Course and Moving object (cotton ball) were conducted for assessment of vision due to cataract and to exclude other ocular pathologies. Dogs were divided in four groups with 6 eyes in each group and subjected to phacoemulsification procedure for removal of cataractous lens and implanted with square edge or round edge, hydrophilic or hydrophobic intra ocular lenses (IOL). Post operatively, aforementioned neuro-ophthalmic tests were conducted on 3, 7 and 15 days and scores were given and comparatively analysed for vision acuity.

Result: Preoperatively, neuro-opthalmic tests indicated poor and absent vision in eyes affected with various stages of cataract. Post operatively, the visual outcome in dogs of all treatment groups were assessed from the scores obtained in various neuro-ophthalmic tests. Neuro-ophthalmic evaluation revealed restoration of vision in 50% dogs in group I, II, IV and in 66.66% dogs of group III on day 15 after phacoemulsification and intraocular lens (IOL) implantation. It was concluded that neuro-ophthalmic tests are useful and mandatory protocols for pre and post-operative vision assessment in dogs with cataract.

Key words: Cataract, Dogs, Neuro-ophthalmic tests, Phacoemulsification.

INTRODUCTION

A thorough and systematic ophthalmic examination is essential to reach a diagnosis. The assessment through a systematic neuro-ophthalmological examination is important for the precise anatomical localization of the lesion and the final diagnosis (Rucker *et al*., 2011).

The neuro-ophthalmic examination is a tool that localizes a defect to the nervous system or the eye. The neuro-ophthalmic examination has a number of components including general observations, neurologic evaluation, assessment of the pupils, pupillary size and light reflexes, ocular position, ocular motility and movement, eyelid position and movement, lacrimation and ocular sensation.

Gelatt and Plummer (2022) noted that the vision can be assessed by the menace response, tracking reflex (cotton ball test), visual placing reflex (for small animals) and maze test (in photopic and scotopic conditions).

Earlier workers (Arican *et al*., 2014; Plummer, 2016) suggested a complete ophthalmic examination for diagnosis of cataract including systemic and ophthalmic examinations such as assessment of vision (menace test and obstacle course test) and reflex test (pupillary light reflex and corneal reflex).

Cullen *et al.* (2009) concluded cortical blindness on the basis of the history of listlessness and lethargy, bumping into objects and moving tentatively, abnormality in the menace response, appropriately sized pupils, normal direct and indirect PLR's in both eyes, presence of a dazzle reflex from each eye. Their study illustrated the importance of a thorough neurologic examination, including neuro-ophthalmic examination, in localizing blindness-associated lesions.

[1]Department of Veterinary Surgery and Radiology, Nanaji Deshmukh Veterinary University, Jabalpur-482 001, Madhya Pradesh, India.

Corresponding Author: Babita Das, Department of Veterinary Surgery and Radiology, Nanaji Deshmukh Veterinary University, Jabalpur-482 001, Madhya Pradesh, India.
Email: bob_surg21@yahoo.com

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La Croix (2018) noted that a menace response tests the continuity of a neurologic pathway initiating at the medial retina (optic nerve); continuing through the contralateral geniculate nucleus, motor cortex and pontine nucleus; to the cerebellum and terminating at both facial nerves.

Spatola *et al.* (2015) stated that presence of a PLR, which is a subcortical reflex, prior to surgery, was not associated with a higher likelihood of visual return and PLR may be retained long after functional vision is gone and is a poor indicator of potential for return of vision in patients with giant retinal tears.

Gemensky-Metzler (2013) noted that if the menace response is absent, the ability to blink should be tested using the palpebral reflex and vision loss should confirmed by another method such as cotton ball tracking or maze testing. If the menace response is absent and the PLR and dazzle responses are abnormal or absent, then the lesion involves the retina, optic nerve, optic chiasm, or optic tracts. If the PLR and dazzle responses are normal despite the presence of vision loss, then central blindness is most likely. Central blindness results from one or more lesions of the lateral geniculate nucleus, optic radiations or visual cortex of the cerebrum.

Present study was conducted on 24 dogs presented to Veterinary Clinical Complex, Jabalpur and State Veterinary Hospital, Bhopal with indication of cataract. For assessment of vision, neuro-ophthalmic tests were conducted preoperatively as suggested by earlier workers (Ofri, 2007). After phacoemulsification procedure, IOL implantations were done and on postoperative day 3, 7 and 15, neuro-opthalmic tests were conducted and scores were recorded for ascertaining vision acuity.

MATERIALS AND METHODS

Clinical cases of dogs presented with the history and symptoms suggestive of cataract were subjected to physical and hemato-biochemical tests to rule out underlying systemic diseases. Detailed ophthalmological, neuro-ophthalmic and ultrasonography examination were conducted to confirm the diagnosis and to ascertain the stage of cataract. These 24 dogs were then divided randomly into four groups consisting of six dogs each and only one eye of each dog was subjected to phacoemulsification procedure under general anaesthesia. Phacoemulsification with a modification of the "divide and conquer" method was performed through a 3 mm corneal-scleral incision in all the groups. After removal of cataractous lens, each group was implanted with round or square edged hydrophobic/ hydrophilic acrylic lens. Owner consent was taken for cooperation and compliance of an uncompromised postoperative follow up to 90 days.

Below mentioned tests were performed pre and post operatively to ascertain visual acuity and scores were given according to response obtained.

Menace response (MR)

A sudden threatening gesture was made in order to elicit a blink response. Rapid hand movements about each eye and small ball of cotton were thrown at the animal.

Pupillary light reflex (PLR)

A penlight or torch was moved back and forth between both the pupils (Swinging flashlight test) to create dynamic contraction of pupil (anisocoria). The pupil under the direct light stimulation was slightly smaller than the opposite consensual pupil size. This was considered as a normal or satisfactory pupillary reflex.

Obstacle course test

The photopic and scotopic obstacle course tests were done by evaluating animal's movement through makeshift obstacles in the examination room and the level of illumination was intermittently changed. The animals with significant visual deficit that failed in the obstacle test demonstrated an altered or accentuated gait or simply refused to move.

Moving object/cotton ball test/reflex

A cotton ball was tossed in front of the animal's eye after patching one eye to see the animal's reaction.

These tests were conducted on 0 day preoperative and postoperative day 3, 7 and 15.

RESULTS AND DISCUSSION

Palpebral stimulation, to initiate blink reflex, was done in all dogs and gave positive results, this observation established integrity of facial nerve. In group-I menace test response was absent in all the dogs at preoperative examination.

Eyes with mature and hyper mature cataract failed completely to elicit menace response as evident in group-I. However, sluggish menace response was observed in dogs with immature cataract (D1, D6 of group-II, D3, D6 of group-III and D2 of group-IV). Sooryadas (2010) also found negative menace response in dogs with mature cataract. Similar findings of negative preoperative menace response in all the dogs studied were also reported by Ahmad (2016). Mitchell (2011) suggested that a negative menace response usually indicates blindness, although animals with cerebellar lesions and normal vision also have a negative menace response.

Postoperatively, sluggish menace response was observed in D2, D5 and D6 dogs in Group-I on day 3, out of which D6 exhibited strong menace response on day 7. These dogs continued to exhibit positive menace response on all subsequent days of observation. The score of menace response was also increased gradually and non-significantly from 0.00±0.00 to 1.33±0.61 from day 0 to day 15, respectively.

D1, D4 and D6 dogs of group-II exhibited positive menace response on day 3 postoperative observations, which continues upto day 15 postoperatively. Statistical analysis of scores also showed gradual increase from 0.67±0.42 to 1.50±0.67 from day 0 to 15, respectively.

In group-III, sluggish menace response was observed in D1, D3, D4 and D6 on day 3 observation. On day 7, D3, D4 and D6 dogs showed strong positive menace response, whereas D1 showed a sluggish response. On day 15, all the four dogs (n=4/6) showed a strong positive menace response. Rest of two dogs did not show menace response. The scores ranged from 0.67±0.42 on day 0 to 2.00±1.55 on day 15 and differed non-significantly.

Group-IV observation of day 3 revealed sluggish menace response in D2, D3 and D6 dogs, which improved on day 7 in D2 and D3 dogs showed a strong menace response, whereas, D6 continued to show a sluggish response. On day 15, all the dogs (n=3/6) showed a strong positive menace response with mean score as 1.50±0.67 compared to 0.33±0.33 on day 0.

Statistical analysis of post-operative menace response scores (Table 1) between various groups revealed non-significant difference. Results of the current study were in concurrence with Sooryadas (2010), who reported positive menace response on day 1 as well as on day 7 postoperatively. The positive menace response may be due to post-surgical clearance of opaque lens and normal functioning of visual pathways as suggested by La Croix (2018) and Amitha (2015). However, it was observed that, eyes affected with hyper mature and mature cataract with negative preoperative menace response fail to achieve vision post operatively, which might possibly be due to underlying pathologies as suggested by Mitchell (2011), who noted that animals with cerebellar lesions and normal vision also have a negative menace response.

Preoperatively, positive PLR scores have been obtained for dogs having mature and immature cataract (D1, D2, D4, D5 of group-I, D1, D2, D5, D6 of group-II, D1, D3, D4, D6 of group-III and D1, D2, D3, D4, D6 of group-IV) and only those dogs that have hypermature cataract showed negative PLR.

Sooryadas (2010) also observed absent PLR in dogs suffering with cataract. Plummer (2016) noted that in the dogs with vision impairment, absent or diminished PLR were indicative of location of lesion in the retina or optic nerve and a intact PLR indicated that the lesion obscure the visual axis or interferes with the cortical processing of visual information as found in cataract, corneal pigment and edema.

Postoperatively, in group-I, sluggish PLR score was obtained in D2, D5 and D6 dogs, out of which D6 showed strong PLR on day 7 and 15. PLR score in D5 improved on day 15 observation. However, D2 continued to show sluggish PLR on all days of observation. Two of the dogs, D1 and D4 with positive preoperative PLR, failed to elicit positive PLR, postoperatively due to extensive corneal opacity.

Among group-II dogs, D1, D4 and D6 dogs elicited sluggish PLR on day 3 and 7, postoperative observation. On day 15 postoperative observation, all the dogs (D1, D4 and D6) elicited a strong PLR. Two of the dog (D2, D5), which have positive preoperative PLR, failed to elicit positive PLR, postoperatively.

D1, D3, D4 and D6 dogs of Group-III, exhibited sluggish PLR on day 3 and 7 postoperatively. However, on day 15, PLR improved and all of these dogs showed strong PLR. All of these dogs had sluggish PLR, preoperatively and regained strong PLR on day15 postoperatively. Two of the dogs (D2, D5), which showed negative PLR preoperatively, exhibited negative PLR on all postoperative observation days.

Similar trend was observed in group-IV, in which, D2, D3 and D6 dogs showed sluggish PLR on day 3 and 7, postoperatively and improved strong PLR was observed on day 15, postoperatively. All of these dogs had sluggish PLR, preoperatively. However, D1 and D4 dogs, who had positive PLR, preoperatively, failed to elicit positive PLR, postoperatively due to extensive corneal opacity. Dog (D5), who showed, negative PLR preoperatively and exhibited negative PLR on all postoperative observations.

Present study confirms findings of Ahmad (2016), who reported that dogs, who were positive for PLR, preoperatively, regained their vision after surgery, thus this reflex is a reliable indicator of intact retinal, sensory and optic nerve functions. It was noted further, that in majority of the dogs, PLR could not be ascertained properly due to

Table 1: Comparative neuro-opthalmic test scores at various days of observation.

Days		0	3	7	15
Groups			**Menace response scores (Mean±SE)**		
	I	$0.00^{a} \pm 0.00$	$1.00^{b} \pm 0.45$	$1.17^{b} \pm 0.54$	$1.33^{b} \pm 0.61$
	II	$0.67^{b} \pm 0.42$	$1.00^{b} \pm 0.45$	$1.00^{b} \pm 0.45$	$1.50^{b} \pm 0.67$
	III	$0.67^{b} \pm 0.42$	$1.33^{b} \pm 0.42$	$1.83^{b} \pm 0.60$	$2.00^{b} \pm 1.55$
	IV	$0.33^{b} \pm 0.33$	$1.00^{b} \pm 0.45$	$1.33^{b} \pm 0.61$	$1.50^{b} \pm 0.67$
			Pupillary light reflex scores (Mean±SE)		
	I	$1.33^{a} \pm 0.42$	$1.00^{a} \pm 0.45$	$1.16^{a} \pm 0.54$	$1.33^{a} \pm 0.61$
	II	$1.33^{a} \pm 0.42$	$1.00^{a} \pm 0.45$	$1.00^{a} \pm 0.45$	$1.50^{a} \pm 0.67$
	III	$1.33^{a} \pm 0.42$	$1.33^{a} \pm 0.42$	$1.33^{a} \pm 0.42$	$2.00^{a} \pm 0.63$
	IV	$1.67^{a} \pm 0.33$	$1.00^{a} \pm 0.45$	$1.00^{a} \pm 0.45$	$1.50^{a} \pm 0.67$
			Obstacle course test scores (Mean±SE)		
	I	$0.00^{a} \pm 0.00$	$0.50^{b} \pm 0.22$	$0.66^{b} \pm 0.33$	$1.00^{b} \pm 0.45$
	II	$0.00^{a} \pm 0.00$	$0.50^{b} \pm 0.22$	$1.00^{b} \pm 0.45$	1.00b±0.45
	III	$0.00^{a} \pm 0.00$	$0.67^{b} \pm 0.21$	$1.16^{b} \pm 0.40$	$1.33^{b} \pm 0.42$
	IV	$0.00^{a} \pm 0.00$	$0.50^{b} \pm 0.22$	$0.67^{b} \pm 0.33$	$1.00^{b} \pm 0.45$
			Moving object test scores (Mean±SE)		
	I	$0.00^{a} \pm 0.00$	$1.00^{b} \pm 0.45$	$1.00^{b} \pm 0.45$	$1.33^{b} \pm 0.61$
	II	$0.00^{a} \pm 0.00$	$1.00^{b} \pm 0.45$	$1.00^{b} \pm 0.45$	$1.50^{b} \pm 0.67$
	III	$0.00^{a} \pm 0.00$	$1.33^{b} \pm 0.42$	$1.33^{b} \pm 0.42$	$2.00^{b} \pm 0.63$
	IV	$0.00^{a} \pm 0.00$	$1.00^{b} \pm 0.45$	$1.00^{b} \pm 0.45$	$1.50^{b} \pm 0.67$

Mean values bearing different superscript (a-b) in a row show significant difference ($p<0.05$).

extensive corneal opacity. Grozdanic *et al.* (2013) also stated that patients with severe forms of iris atrophy or prominent intraocular inflammation could have significantly attenuated PLR responses. In the current study, the varying degrees of PLR visualized may be due to gradual reduction in inflammation and opacity on subsequent postoperative days.

Preoperatively, none of the dogs passed obstacle course test both in photoptic or scotoptic environment. Honsho *et al*. (2007) suggested that the cause of the pre-operative inability to navigate through the course was attributed to the mature stage of the cataract. Sooryadas (2010) too noted failure of dogs to pass obstacle course test, preoperatively. However, Ahmad (2016) noted ability of dog with immature cataract and unilateral cataract to pass the test under photoptic conditions, preoperatively. In the present study, negative response was obtained as most of the dogs were with mature (n=12) and hypermature (n=7) cataract, however, another reason for negative response in many dogs might be nervousness and fear as suggested by Lewin *et al.* (2013).

In group-I, on day 3 postoperative, D2, D5 and D6 were able to negotiate obstacles in photopic conditions. On day 7, D6 improved and tackled obstacles in both photopic and scotopic conditions. D2 and D5 achieved photopic and scotopic vision on day 15. Remaining three dogs were not able to negotiate obstacles, either in photopic or scotopic conditions on postoperative day 15.

Similarly, in group-II, D1, D4 and D6 dogs tackled obstacles under photopic conditions on day 3, postoperatively. Day 7 observation revealed restoration of both photopic and scotopic vision in D1, D4 and D6. Remaining three dogs failed to negotiate obstacles on any observation days under any condition.

Postoperatively, on day 3 observation, photopic vision was found in D1, D3, D4 and D6 dogs. This later improved in D3, D4 and D6 dogs on day 7, as they were able to negotiate obstacles under both photopic and scotopic conditions. On day 15, obstacle course tests were cleared by D1, D3, D4 and D6 under both photopic and scotopic conditions. Remaining two dogs failed the test, as no improvements in scores were observed.

In group-IV, D2, D3 and D6 dogs negotiated obstacle test under photopic condition on day 3. Out of these, D2 achieved both photopic and scotopic vision on day 7 and D3 and D6 on day 15, postoperatively. All the other dogs failed the tests.

The mean score of obstacle course tests scores improved significantly ($p<0.05$) from 0.00±0.00 to 1.00±0.45 in group I, 0.00±0.00 to 1.33±0.0.42 in group III, 0.00±0.00 to 1.00±0.45 in group IV and improved non significantly from 0.00±0.00 to 1.00±0.45 in group-II on day 0 to 15. Obstacle course test scores between different groups on various postoperative observation days did not differ significantly (Table 1).

These findings were in agreement with earlier workers like Sooryadas (2010), who reported restoration of photopic vision in 66.66% dogs on day 7 postoperatively and both photopic and scotopic vision in 50.00% dogs on day 14, onwards. In the current study 50.00% dogs in the group I, II and IV and 66.66% dogs in group-III achieved photopic and scotopic vision on day 15, postoperatively. This may be due to decrease in inflammation and corneal opacity and subsequent restoration of functional vision due to clearance of visual axis in dogs.

Preoperatively, none of the dogs in any of the groups reacted positively to moving object test. These results were consistent with findings of Sooryadas (2010), who found negative response in all the cataractous dogs to cotton ball test, preoperatively. Plummer (2016) suggested that the patient’s vision can be evaluated by noting its response to cotton balls (or some such noiseless, scentless object) tossed into the visual field or observing the visual placing reaction. Most of the dogs responded negatively to the test because of advanced stage mature (n=12) and hypermature (n=7) cataract, however, overexcitement and fear might be another reason as suggested by Lewin *et al*. (2013).

Postoperatively, in group-I, Sluggish response to the test was recorded for D2, D5 and D6 on day 3 and 7, postoperatively. Improvement was observed on day 15 postoperative in D5 and D6 dogs, which scored better. However, D2 continued to respond sluggishly to the test. All the other dogs (n=3) in group-I remained non responsive for moving object test on all postoperative observation days.

D1, D4 and D6 dogs of group-II, showed sluggish response on day 3 and 7 postoperative and responded better on day 15 postoperative to moving object test. All the other dogs (n=3) of group responded negatively to the test.

On the day 3 postoperative observation, D1, D3, D4 and D6 dogs responded sluggishly to the test and continued to do so on day 7, postoperatively. Better response was noted in these dogs on the day 15 observation. All the other dogs (n=2) responded negatively on day 15 observation.

Group-IV dogs followed the earlier trend and D2, D3 and D6 dogs showed sluggish response on day 3 and 7 observation and improved their response on day 15, postoperatively. Negative response was noted in all the other dogs (n=3) on all the postoperative days.

As depicted in Table 1, mean values of moving object test scores of day 0 (0.00±0.00) improved non significantly from day 15 score (1.33±0.61) in group I. However, scores obtained for group II, III and IV on day 15 showed significant ($p<0.05$) improvement over score obtained on day 0 as 1.50±0.67, 2.00±0.63 and 1.50±0.67 in comparison to 0.00±0.00, 0.00±0.00 and 0.00±0.00, respectively. No significant difference was recorded between moving object tests scores of different groups on postoperative observation days.

Sooryadas (2010) reported 33.33% dogs (n=2) were able to detect motion on the day 1, postoperatively and 83.33% dogs (n=5) were able to detect movement on the day 7 postoperatively. It was further suggested to correlate outcome of moving object test to that of obstacle course test and that retinal integrity is a major factor in outcome of moving object test. In the current study, it was observed that a positive correlation exists between scores of obstacle course test and moving object test. Dogs that clear obstacle course test, scored positively for moving object test also.

CONCLUSION

In dogs, the incidence of cataract significantly increases with age. It was observed in current study that eyes with immature cataract showed sluggish menace response preoperatively, whereas eyes with mature and hyper mature cataract failed completely to elicit menace response. Postsurgical positive menace response may be due to clearance of opaque lens and normal functioning of visual pathways in dogs. However, it was also observed that, eyes affected with hyper mature and mature cataract with negative preoperative menace response, fail to achieve vision post operatively, which might possibly be due to underlying pathologies. Present study confirms that dogs, who were positive for PLR, preoperatively, regained their vision after surgery, thus PLR is a reliable indicator of intact retinal, sensory and optic nerve functions. Preoperatively, none of the dogs passed obstacle course test both in photoptic or scotoptic environment or reacted to moving object test. Apart from obscured visual axis additional reason for negative response in many dogs might be nervousness and fear. Thus, it was imperative to calm and familiarize the animal with environment before undertaking these tests. However, postoperatively, positive response to test might be attributed to the decrease in inflammation and corneal opacity and subsequent restoration of functional vision due to clearance of visual axis in dogs. Thus based on above outcomes of various neuro-opthalmic tests it was concluded that Dogs with cataract having unimpaired visual pathways, when subjected to phacoemulsification stand better chance to achieve vision restoration. The menace response, pupillary light reflex, obstacle course tests and moving object tests are a valuable tool for prognosis of cataract correction through phacoemulsification.

Conflict of interest

The authors declare that there are no conflicts of interest.

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