Surgical correction of lens luxation in the horse: visual outcomes

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Abstract

Background: The purpose of this study was to describe the visual outcomes of surgical therapy for lens luxation/subluxation in the horse.

Methods: The medical records of horses that had surgical correction of lens luxation/subluxation at the University of Florida Veterinary Medical Center, Gainesville, Florida, USA; North Carolina State University, Raleigh, North Carolina, USA; Eye Care for Animals, Reno, NV, USA; Pinecrest Veterinary Hospital, Miami, FL, USA; and the Animal Health Trust, Newmarket, UK were retrospectively reviewed. Data collected from the medical records included signalment, clinical descriptions of ocular lesions, type of surgical procedure performed, any surgical complications noted, and the visual outcomes.

Results: Phacoemulsification under general anesthesia was performed in ten horses (two Quarter Horse mares (14 years; 16 years), one Thoroughbred gelding (10 years), three Thoroughbred fillies (4 months; 1 year; 4 years), two Quarter Horse geldings (9 years, 11 years), one Arabian stallion (6 years), and one Arabian mare (12 years)) with lens luxation/subluxation in one eye. Intracapsular lens extraction (ICLE) was performed under general anesthesia in five horses (one Standardbred filly (6 months), one Icelandic pony mare (8 years), one Westphalian gelding (10 years), one Appaloosa gelding (11 years) and one Arabian gelding (28 years)) with lens luxation/subluxation in one eye. Surgical complications included incision dehiscence, stromal abscesses, corneal ulceration, ulcerative keratitis with keratomalacia, hyphema, iridocyclitis, glaucoma, displaced lens fragments, expulsive choroidal hemorrhage, bullous keratopathy, retinal detachment, and infectious endophthalmitis. Five eyes were quickly enucleated postoperatively (33.3%), four eyes became rapidly phthisical (26.7%), two eyes became acutely glaucomatous, one eye developed retinal detachment, one eye had compromised vision (menace response positive but marked progressive corneal opacification) at 3 years, one eye was visual at eight months postoperatively, and one eye had light perception despite severe posterior capsular fibrosis ten years postoperatively. Only the latter three cases (20.0%) had any evidence of visual capability in the operated eye.

Conclusions: Surgical removal of a very unstable subluxated or completely luxated lens in a horse is a difficult endeavor with a high rate of severe intraoperative and postoperative complications, and generally poor visual outcomes.

Keywords: Equine, lens luxation, subluxation, surgical

Introduction

The lens is an avascular transparent biconvex sphere whose primary purpose is to refract and focus light rays onto the retinal photoreceptors [1-4]. It consists of cellular lens fibers with a peripheral cortex and central nucleus surrounded by an elastic capsule [2]. Transparent zonular ligaments arise on and between the ciliary body processes and fuse to the lens capsule in the equatorial region of the horse lens to suspend the lens between the iris and vitreous [2].

There are basically two significant diseases of the lens, lens opacification or cataract, and partial or complete dislocation in lens position termed subluxation or luxation respectively [5]. A cataract is an optical opacity in the lens cortex, nucleus or capsule caused by biochemical and mechanical disruption of the normal architectural arrangement of the lens fibers or capsule [5-8]. The opacity can range in size from a small focal

opacity to a cataract that involves the entire lens. Cataracts in the horse may be classified as to age of onset, etiology, anatomical location, and the degree of maturation [5-8].

Dislocation of the lens from its normal position due to zonular weakness or rupture is termed subluxation if the lens is partially dislocated, and luxation if the lens is completely dislocated into the anterior chamber or vitreous (Figures 1-2) [5-11]. Corneal edema, iridodonesis, aphakic crescents, shallow or deep anterior chambers depending on the location of the dislocated lens, and cataract formation may also be noticed in eyes with dislocated lenses [5-11]. It is not unusual for a luxated lens to freely move between the anterior chamber and vitreal chamber with changes in globe and head position [5].

Lens luxation/subluxation may be developmental, primary, or secondary in the horse [1,5], and have been noted previously [11-18]. A developmental zonular deficiency and/or zonular

Figure 1. Line drawing of a posteriorly luxated lens noted in a horse by Nicolas [15].

Figure 2. A traumatic induced subluxated lens is present in this 14 year old Quarterhorse mare.

hypoplasia in foals may cause the lens to be subluxated or unstable in its normal position, or be completely luxated anteriorly into the anterior chamber or luxated posteriorly into the vitreal chamber [5,9]. Cataract and lens subluxation are also associated with corneal and uveal abnormalities in anterior segment dysgenesis in the Rocky Mountain horse [5]. Primary lens subluxation/luxation due to inherent zonular dysplasia with a bilateral potential in adult horses and no detectable ocular disease or predilection for specific equine breeds (as noted in canine terrier breeds) is not specifically reported in the horse, but still may occur. Acquired secondary subluxation/luxation of the lens is encountered more often in horses as a sequelae to zonular degeneration in iridocyclitis such as equine recurrent uveitis (ERU), zonular rupture from blunt ocular trauma and glaucoma induced buphthalmia, or a combination of factors [5,9].

Lens instability in subluxation/luxation is associated with slight visual impairment to complete blindness [1,4,5]. There is

generally little detectable effect on vision in horses with moderately subluxated lenses, while eyes with completely luxated lenses may be so far-sighted (hyperopic) that they are functionally blind [19]. Subluxated lenses can become cataractous with time to impair vision [5].

Medical therapy for horses with lens subluxation

Medical therapy with topical prostaglandin analogs is a therapeutic approach in managing slightly subluxated lenses or lenses luxated into the vitreal chamber without surgery, and can be attempted in horses in order to preserve vision in order for the horse to perform its regular activities [5,19]. Accompanying iridocyclitis in such eyes would also require medical therapy. The prostaglandin analogs cause potent miosis in horses and may help to prevent movement of the posteriorly luxated lens into the anterior chamber [20]. Some eyes with mild to moderate degrees of lens subluxation may retain vision for long periods and do not require surgical intervention [1,5,10]. Short or long-term evaluation of this medical approach to posterior lens luxations has not been critically evaluated. Posteriorly luxated lenses in the vitreal chamber are at high risk for inducing retinal detachment and glaucoma [5,11,21].

Surgical therapy for horses with anterior and posterior lens luxation

Anterior and posterior lens luxations have more severe effects on vision than subluxated lenses with complications related to hyperopia, retinal detachment, persistent uveitis, and corneal edema [1,5]. If the lens is in the anterior chamber it can be removed by ICLE or by phacoemulsification according to the surgeon's preferred method [21]. Surgical removal of a posteriorly luxated lens is a more difficult endeavor than anteriorly luxated lenses due to the requirement for vitrectomy and the need to elevate the lens anteriorly with viscoelastics for its extraction [21].

There is considerable diversity of opinion among veterinary ophthalmologists regarding when unstable lenses should be removed, and some individuals avoid surgical intervention for as long as possible [5,19]. Others believe that visual eyes with slightly unstable lenses should be removed as soon as the instability is detected and any uveitis controlled in the horse.

Recent advances in surgical techniques have increased the success of equine cataract surgery [1,5,11,21-27]. Intracapsular lens extraction and phacoemulsification lens removal surgical procedures have both been utilized to successfully remove subluxated/luxated lenses in humans [28], dogs [29-30], and cats [31]. Surgical removal of subluxated or luxated lenses of the horse or foal is healthy, has no or controlled uveitis, the globe remains visual, can be done if the animal and the horse has the personality and temperament to tolerate aggressive postoperative topical therapy and repeat postoperative ophthalmic examinations [5]. There is however little outcome data for surgical removal of subluxated/luxated lens in horses

in the literature [5,11,22].

The purpose of this study was to find out whether surgery to remove subluxated and luxated lenses in horses has been a procedure with the potential for a good visual outcome.

Methods

This is a retrospective medical records study of horses that had surgical correction of lens luxation/subluxation at the University of Florida Veterinary Medical Center in Gainesville, Florida, North Carolina State University in Raleigh NC, Pinecrest Veterinary Hospital in Miami, Florida, the Animal Health Trust, in Newmarket, UK, and Eye Care for Animals in Reno, NV. Data collected from the medical records included signalment, clinical descriptions of ocular lesions, types of surgical complications, and visual outcomes.

Patient selection for lens subluxation/luxation surgery

Preoperative eye examination of these horses included evaluation of menace responses, and dazzle and pupillary light reflexes (PLR), slit-lamp biomicroscopy, tonometry and ophthalmoscopy. Signs of anterior uveitis delayed lens removal surgery until the inflammation had been successfully reduced [1,5,19,21,25,27,32].

Surgical lens removal techniques pre-operative medications

A similar pre-operative medical plan for phacoemulsification or ICLE of dislocated lenses was used in these horse cases. Topical and systemic antibiotics were administered both preoperatively and postoperatively to reduce the chance of infection. Topically administered corticosteroids, and systemic NSAIDs were also used preoperatively and postoperatively to minimize intraocular inflammation. Topical atropine, tropicamide or epinephrine were generally not utilized preoperatively to dilate the pupil of globes with a subluxated/luxated lens due to the risk of a luxated lens dropping into the vitreal chamber if the vitreous was degenerate and less viscous than normal. Mydriatic/cycloplegics were utilized postoperatively to stabilize the blood aqueous barrier and dilate the pupil.

phacoemulsification

Phacoemulsification is the preferred lens extraction technique for the horse eye with a cataract, the horse eye with a slightly subluxated lens, and the horse eye with a completely luxated lens in the anterior chamber [27-28]. This technique is best with dislocated lenses that still have some zonular attachment. The subluxated or anteriorly luxated lens is trapped and stabilized against the iris by inducing miosis with a prostaglandin analogue. Phacoemulsification through a small corneal or limbal incision utilizes a piezoelectric handpiece with a titanium needle in a silicone sleeve to ultrasonically fragment and emulsify the lens nucleus and cortex following continuous curvilinear capsulorrhexis (removal of a circular

portion of the anterior capsule). The emulsified lens cortex is then aspirated from the eye while intraocular pressure is maintained by infusion of lactated Ringer's solution. The posterior capsule is removed with Utrata forceps in the luxated lenses. The scleral incision and conjunctiva are closed in a simple interrupted pattern. Intraocular lenses were not placed and the eyes left aphakic.

Interacapsular lens extraction

The traditional approach of surgical removal of a completely luxated lens is the intracapsular lens extraction technique (ICLE). This method can be utilized when the phacoemulsification equipment is not available, if the subluxated lens is not stable enough for phacoemulsification, or if the lens is completely luxated [21,22]. A 160-180 degree, two-thirds depth, corneal groove is made with a blade. The anterior chamber is entered with a blade or a keratome and the incision extended full thickness with scissors. Viscoelastic material was injected behind the lens to prevent posterior lens displacement. A nitrous oxide cataract probe was used to engage the anterior lens capsule, a 3 to 4-mm in diameter ice ball was made, and the lens then slowly extracted from the globe. Another method preferred by some ophthalmologists uses a lens loupe to deliver the viscoelastic-coated lens. In both methods, the cornea is elevated to keep it out of the way of either the cryoprobe or the lens as the lens is removed. Anterior movement of the lens was aided by injecting viscoelastic material posterior to the lens to float the lens towards and out the corneal incision. Strong attachment of vitreous to the posterior capsule was removed by gentle cutting with the scissor blades in order to minimize disruption of the vitreal face. Vitreous in the incision was removed by manual or automated vitrectomy. Once the lens had been removed from the globe, the incision was closed in a simple interrupted or simple continuous pattern. Intraocular lenses were not placed and the eyes left aphakic.

Results

Phacoemulsification in one eye was performed under general anesthesia in ten horses (two Quarter Horse mares (14 years; 16 years), one Thoroughbred gelding (10 years), three Thoroughbred fillies (4 months; 1 year; 4 years), two Quarter Horse geldings (9 years, 11 years), one Arabian stallion (6 years), and one Arabian mare (12 years) with lens luxation/subluxation (Figures 3-8 and 9). All eyes were visual or had visual potential preoperatively but were considered at risk of blindness if surgery was not performed.

Intracapsular lens extraction in one eye was performed under general anesthesia in five horses (one Standardbred filly (6 months), one Icelandic pony mare (8 years), one Westphalian gelding (10 years), one Appaloosa gelding (11 years) and one Arabian gelding (28 years) with lens luxation/subluxation (Figures 10-12 and 13-16). All eyes were visual or had visual potential preoperatively but were considered at risk of blindness if surgery was not performed.

Figure 3. Hyphema and hypotony are present 10 days post phacoemulsification in the eye in [Figure 2](#). The globe became phthisical by one month.

Figure 6. Severe capsular opacification is present 10 years postoperatively in the eye in [Figures 4](#) and [5](#). The eye still had light perception.

Figure 4. A subluxated lens occurred following ocular trauma from cross ties in this 9 year old Quarterhorse gelding. The lens was removed by phacoemulsification.

Figure 7. Intraoperative image demonstrates a traumatic induced subluxated lens in a one year old Thoroughbred filly that was treated by phacoemulsification.

Figure 5. Hyphema and corneal edema are present 1 day postoperatively in the case in [Figure 4](#).

Figure 8. Intraoperative image of retinal folding associated with hypotony in the eye in [Figure 7](#). The globe became phthisical in one month.

Figure 9. Anterior lens luxation in a 16 year old Quarter horse mare caused by ocular trauma was removed by phacoemulsification but became phthysical in one month.

Figure 11. The incision is dehiscing 14 days following ICLE in the eye in [Figure 10](#). A large superficial corneal ulcer is also present. The globe was enucleated two weeks postoperatively.

The etiology of the lens luxation/subluxation was believed to be traumatic in six cases, with nine having clinical evidence of iridocyclitis and/or glaucoma. Surgical complications included incision dehiscence, corneal edema, stromal abscesses, corneal ulceration, ulcerative keratitis with keratomalacia, anterior uveitis, glaucoma, hyphema, hypotony, displaced

Figure 10. Hyphema is present 3 days following ICLE for a traumatic lens luxation in this 6 month old Standardbred filly.

Figure 12. The incision is dehiscing 2 days following ICLE in a 28 year old Arabian gelding.

lens fragments, expulsive choroidal hemorrhage, retinal detachment, and infectious endophthalmitis.

Visual outcomes were poor. Five eyes were quickly enucleated postoperatively (33.3%), four eyes became rapidly phthysical (26.7%), two eyes became acutely glaucomatous, one eye developed retinal detachment, one eye had compromised vision (menace response positive but marked

progressive corneal opacification) at 3 years, one eye was visual at eight months postoperatively, and one eye had light perception despite severe posterior capsular fibrosis ten years postoperatively. Only the latter three cases (20.0%) had any evidence of visual capability in the operated eye.

Discussion

The success with ICLE in dogs with lens subluxation or luxation was 72% postoperatively, but declined to 53% at one year postoperatively in one study [29]. The most common cause of postoperative blindness in the dogs was glaucoma [28]. Vision was retained in 70% (14/20) of dog eyes with primary lens dislocation treated with ICLE and sulcus IOL placement, and a mean time to vision loss of 41 months in the remaining eyes due to glaucoma, retinal detachment, or retinal degeneration

Figure 13. A large, bulging conjunctival flap covers the incision in the eye in [Figure 12](#) but the eye was enucleated two weeks postoperatively due to painful endophthalmitis.

Figure 15. The eye in [Figure 14](#) eight months postoperatively is comfortable and visual. There is no overt signs intraocular inflammation. A dorsal corneal scar at the incision site, ventral/paracentral edema, and endothelial fibrosis consistent with corneal endothelial layer damage are present.

Figure 14. Lens luxation and vitreal prolapse in a 10 yr old Westphalian gelding with some evidence of uveitis was treated with an ICLE.

Figure 16. Eighteen months postoperatively the eye in [Figures 14](#) and [15](#) had superficial corneal ulceration and diffuse corneal edema with bullous keratopathy and band keratopathy.

in a second study of lens luxation and ICLE in dogs [30]. A study of ICLE therapy for lens dislocation in cats found that 89.5% of the cats benefited from the procedure. Glaucoma occurred in 37% [31]. A study of surgical therapy of humans with lens subluxation found the success rate defined as an improvement in acuity with phacoemulsification to be 75% [28]. Surgical removal of a subluxated or luxated lens in a horse is a difficult endeavor with a high rate of severe intraoperative and postoperative complications [5]. The reasons for this are not clear. The available microsurgical technology at the times of these surgeries met the standards of care, and all

the surgeons had extensive microsurgical experience with cataract surgery in horses. The large lens volume of the horse often requires longer phacoemulsification surgery times that may contribute to these poor results. It may be that the horse eye does not tolerate the large corneal incisions necessary for ICLE which increase the risk of dehiscence. The pre-existing conditions that cause the lens subluxation/luxation in the horse eye such as the iridocyclitis from equine recurrent uveitis or blunt trauma could leave the affected horse eye with a highly fragile blood aqueous barrier and extensive ciliary body degeneration that doom the surgical result.

Most reliable reports of vision after successful cataract surgery in the horse indicate that vision is functionally normal, although the short and long-term results still need

to be carefully evaluated [23-26]. From an optical standpoint, the aphakic eye should be quite farsighted, or hyperopic, postoperatively and, in one study, was 19.94 D [26]. Intraocular lens (IOL) placement in aphakic horse eyes could improve postoperative visual outcome [33,34]. An intraocular lens with a refractive power of 14D resulted in the amelioration of hyperopia in one study of pseudophakic horses [33]. It is not possible to place sulcus based IOLs in the aphakic horse eye following ICLE due the lack of commercial availability of such IOLs for the horse, although this can be done in dogs and cats to attempt to achieve emmetropia in the aphakic eye [35].

It has been stated that "The eye of the horse appears to be naturally more disposed to disease than that of any other animal with which we are acquainted; and most assuredly there is no domestic animal, the treatment of whose diseases is so much at variance with common sense" [17]. Early veterinarians considered surgery of the lens to have "no sort of success" [13], and to be "peculiarly disheartening" [36], with poor visual outcomes noted [12,16,18,36]. It appears that this remains particularly true concerning surgical correction of lens luxation/subluxation in the horse.

Conclusions

Surgical removal of an unstable or luxated lens in a horse is a difficult endeavor with a high rate of severe intraoperative and postoperative complication, and generally poor visual outcomes.

List of Abbreviations

ICLE: Intracapsular cataract extraction

PLR: Pupillary light reflex

IOL: Intraocular lens

D: Diopter

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Authors' contributions	DEB	BCG	CEP	CH	DD	JDL	LGK
Research concept and design	✓	✓	✓	✓	✓	✓	✓
Collection and/or assembly of data	✓	✓	✓	✓	✓	✓	✓
Data analysis and interpretation	✓	--	✓	✓	✓	--	--
Writing the article	✓	--	✓	✓	✓	✓	--
Critical revision of the article	✓	✓	✓	✓	✓	✓	✓
Final approval of article	✓	✓	✓	✓	✓	✓	✓

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References

1. Lavach JD. **Large Animal Ophthalmology**. St. Louis: CV Mosby. 1990; 198-200.
2. Samuelson DA: Ophthalmic Anatomy, in Gelatt KN (ed). **Veterinary**

Ophthalmology 3rd ed. Philadelphia, PA, Lippincott, Williams and Wilkins. 1999; 98-110.

3. Prince JH. **Crystalline Lens**, in **Comparative Anatomy of the Eye**. Springfield, IL, CC Thomas. 1956; 215-227. | [Book](#)
4. Kroger RH, Campbell MC, Fernald RD and Wagner HJ. **Multifocal lenses compensate for chromatic defocus in vertebrate eyes**. *J Comp Physiol A*. 1999; **184**:361-9. | [Article](#) | [PubMed](#)
5. Brooks D.E and Matthews A.G. **Chapter 25, Equine Ophthalmology**. In Gelatt K.N. (ed.), **Veterinary Ophthalmology**, 4th ed. Blackwell Pub Ames, IA. 2007; 1165-1274.
6. Gelatt KN. **Congenital and acquired ophthalmic diseases in the foal**. *Anim Eye Res*. 1993; **1-2**:15-27.
7. Roberts SM. **Congenital ocular anomalies**. *Vet Clin North Am Equine Pract*. 1992; **8**:459-78. | [PubMed](#)
8. Latimer CA, Wyman M and Hamilton J. **An ophthalmic survey of the neonatal horse**. *Equine Vet*. 1983; **2**:9-14. | [Article](#)
9. Matthews A G and Handscombe M. **Bilateral cataract formation and subluxation of the lenses in a foal. A case report**. *Equine vet. J*. 1983; **15**:23-24. | [Article](#)
10. McLaughlin SA, Whitley RD and Gilger BC. **Diagnosis and treatment of lens diseases**. *Vet Clin North Am Equine Pract*. 1992; **8**:575-85. | [PubMed](#)
11. McCluskie LK, Woodford NS and Carter WJ. **Posterior lens luxation with associated glaucoma in a pony**. *Equine Vet J*. 2009; **21**:228-230. | [Article](#)
12. Dadd GH. **Modern Horse Doctor**. JP Jewett Publisher. Boston, 1854; 178-179. | [Book](#)
13. Percivall W. **Hippopathology: Disorders and Lamenesses of the Horse**. Longman, Brown, Green and Longmans, London. 1843; **3**:70, 86, 102, 124. | [Book](#)
14. Fitzwygram F. **Horses and Stables**. Longmans Green and Co. London. 1901; 407. | [Book](#)
15. Nicolas E (translated by Gray H). **Veterinary and Comparative Ophthalmology**. H and W Brown, London. 1925; 373-389. | [Book](#)
16. Sharp WN. **Ophthalmology for veterinarians**. Philadelphia, WB Saunders. 1913; 143. | [Article](#)
17. Youatt W. **The Horse; with a Treatise on Draught**. Baldwin and Cradock, London. 1831; 162. | [Article](#)
18. Kenny DE, Dugan SJ, Knightly F and Baier J. **Intracapsular lens removal in a Przewalski's wild horse (Equus caballus przewalskii)**. *J Zoo Wildl Med*. 2003; **34**:284-6. | [Article](#) | [PubMed](#)
19. Brooks DE. **Ophthalmology for the Equine Practitioner**. Ed 2. Teton New Media. Jackson, Wyoming. 2008.
20. Willis AM, Diehl KA, Hoshaw-Woodard S, Kobayashi I, Vitucci MP and Schmall LM. **Effects of topical administration of 0.005% latanoprost solution on eyes of clinically normal horses**. *Am J Vet Res*. 2001; **62**:1945-51. | [Article](#) | [PubMed](#)
21. Gelatt KN and Gelatt JP. **Small Animal Ophthalmic Surgery**. Butterworth Heinemann, Oxford, UK. 2001; 306-319.
22. Vankruiningen HJ. **Intracapsular Cataract Extraction in the Horse**. *J Am Vet Med Assoc*. 1964; **145**:773-85. | [PubMed](#)
23. Fife TM, Gemensky-Metzler AJ, Wilkie DA, Colitz CM, Bras ID and Klages DC. **Clinical features and outcomes of phacoemulsification in 39 horses: a retrospective study (1993-2003)**. *Vet Ophthalmol*. 2006; **9**:361-8. | [Article](#) | [PubMed](#)
24. Dziezyc J, Millichamp NJ and Keller CB. **Use of phacoemulsification for cataract removal in horses: 12 cases (1985-1989)**. *J Am Vet Med Assoc*. 1991; **198**:1774-8. | [PubMed](#)
25. Dziezyc J. **Intraocular surgery**, in: Auer JA (ed): **Equine Surgery**. Philadelphia, PA, WB Saunders. 1992; 648-654.
26. Farrall H and Handscombe MC. **Follow-up report of a case of surgical aphakia with an analysis of equine visual function**. *Equine Vet J Suppl*. 1990; **91**:3. | [Article](#) | [PubMed](#)
27. Brooks DE. **Phacoemulsification cataract surgery in the horse**. *Curr Tech Eq Prac*. 2005; **4**:11-20. | [Article](#)
28. Kakin KN, Jacobs M, Rosen P, Taylor D and Cooling RJ. **Management of**

- the subluxated crystalline lens.** *Ophthalmol.* 1992; **99**: 542-545. | [Article](#)
29. Glover TL, Davidson MG, Nasisse MP and Olivero DK. **The intracapsular extraction of displaced lenses in dogs: a retrospective study of 57 cases (1984-1990).** *J Am Anim Hosp Assoc.* 1995; **31**:77-81. | [Article](#) | [PubMed](#)
30. Stuhr CM, Schilke HK and Forte C. **Intracapsular lenectomy and sulcus intraocular lens fixation in dogs with primary lens luxation or subluxation.** *Vet Ophthalmol.* 2009; **12**:357-60. | [Article](#) | [PubMed](#)
31. Olivero DK, Riis RC, Dutton AG, Murphy CJ, Nasisse MP and Davidson MG. **Feline Lens Displacement. A Retrospective Analysis of 345 Cases.** *Progress in Vet Comp Ophthal.* 1991; **1**:239-244.
32. Nasisse MP and Glover TL. **Surgery for lens instability.** *Vet Clin North Am Small Anim Pract.* 1997; **27**:1175-92. | [PubMed](#)
33. Townsend WM, Jacobi S and Bartoe JT. **Phacoemulsification and implantation of foldable +14 diopter intraocular lenses in five mature horses.** *Equine Vet J.* 2012; **44**:238-43. | [Article](#) | [PubMed](#)
34. Por YM and Lavin MJ. **Techniques of intraocular lens suspension in the absence of capsular/zonular support.** *Surv Ophthalmol.* 2005; **50**:429-62. | [Article](#) | [PubMed](#)
35. Wilkie DA, Gemensky-Metzler AJ, Stone SG, Basham CR and Norris KN. **A modified ab externo approach for suture fixation of an intraocular lens implant in the dog.** *Vet Ophthalmol.* 2008; **11**:43-8. | [Article](#) | [PubMed](#)
36. Mayhew E. **The Illustrated Horse Doctor.** Appleton and Co, New York, 1867; **52-53**:56-57. | [Website](#)

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