Journal of Animal and Veterinary Advances 12 (7): 803-806, 2013
ISSN: 1680-5593

Ultrasonographic Biometry and Relationship with Gender, Age and Weight in Healthy Donkeys

Fulvio Laus, Emanuele Paggi, Vanessa Faillace, Andrea Marchegiani,
Daniele Spaziante, Matteo Cerquetella and Beniamino Tesei
School of Veterinary Medical Sciences, University of Camerino,
Via Circonvallazione 93/95, 62024 Matelica (MC), Italy

Abstract: With the aim to establish a correlation between ocular measurements and individual factors, 110 healthy adult donkeys of different sizes and age were used giving a total of 220 eyes. On each donkey ocular ultrasonography was performed and the Globe Axial Length (GAL), Anterior Chamber depth (ACd), Vitreous depth (VCd), Lens diameter (Ldi) and Lens thickness (Lt) were measured. The differences between groups of animals, divided according to the gender, weight (<200 and ≥200 kg) and age (<10 and ≥10 years) categories have been estimated. No gender differences have been found. After application of analysis of variance all measurements with exception of Lt were found to be correlated with the weight while only Lt had a statistical significance for differences between age categories. As in people a relationship between age and lens thickness has been established in the present work for donkeys. It appears that as with the horse, the donkey lens grows throughout the life of the animal. These data could act as a pilot study to establish the growth pattern of the crystalline lens in the donkey and its relationship to the incidence of some important diseases.

Key words: Biometry, donkey, lens, ultrasonography, eye

INTRODUCTION

The ultrasonographic evaluation of the eye is an important procedure allowing the visualization of intraocular and retrobulbar structures and the diagnosis of several abnormalities both in human and in veterinary medicine (Reef, 1998; Scotty *et al*., 2004; Michau, 2005; Dietrich, 2007; Lorente-Ramos *et al*., 2012). Ocular ultrasound in Equidae is particularly indicated when it is impossible to directly visualize deeper structures of the globe as in cases of corneal edema or opacification, cataract, ocular protrusion or indicated in suspicion of disparity in globe size (Withcomb, 2002).

Ultrasonography can be performed in the standing horse and only in selected cases will sedation or local nerve block be required. Equine ocular biometry has already been performed to establish a range of measurements for healthy animals (Mettenleiter, 1995; Rogers *et al*., 1986; McMullen and Gilger, 2006; Barsotti *et al*., 2010; Grinninger *et al*., 2010). Ultrasonographic biometry of the eye in healthy adult donkeys has also been performed by the researchers in a earlier study (Laus *et al*., 2013). Ocular measurements included Globe Axial Length (GAL), Anterior Chamber depth (ACd), Vitreous depth (VCd), Lens diameter (Ldi), and Lens thickness (Lt). The data obtained and reported in that study suggested that gender did not represent a variability factor for ocular biometry in donkeys. This has also been noted in people (Augusteyn, 2007, 2008). However, the weight of the animals was directly related to the ultrasonographic ocular size. Lens dimensions did not appear be correlated with body weight and further studies to assess a possible statistical relationship were suggested as this had been demonstrated in human subjects (Michau, 2005). The lens thickness in human is considered a significant risk factor for age-related cataract, nuclear cataract, presbyopia, hyperopia and primary angle-closure glaucoma (Shui and Beebe, 2008; Jonas *et al*., 2012). Since, it is known that equine lens grows during embryonic development and continues to grow throughout life (Colitz and McMullen, 2011) in the present research the researchers tried to verify the hypothesis that lens thickness, measured by ultrasonography is related to age in donkeys.

MATERIALS AND METHODS

One hundred and ten healthy donkeys (12 male and 98 female) of different weight (from 220-350 kg) and age (from 2-19 years old) were used in this study, giving a

Corresponding Author: Fulvio Laus, Large Animal Clinical Department, School of Veterinary Medical Sciences, Veterinary Teaching Hospital, Via Circonvallazione 93/95, 62024 Matelica (MC), Italy

total of 220 eyes for examination. A comprehensive ophthalmological examination were performed and any detected change represented a criteria for exclusion from the study.

To estimate the live weight of each donkey, the measurements of the heart girth (just behind the front legs) and the length from the tuber ischii to the elbow were recorded in centimeters. The weight in kg was than calculated using the following formula: Estimated donkey weight (kg) = $(\text{heart girth}^{2.12}) \times (\text{length}^{0.688})/3801$ (Pearson and Ouassat, 1996, 2000). The age of all animals was directly taken from their passport. Minimal restraint was used and sedation was never required.

For ultrasonography, a curvilinear transducer was used, set to the highest frequency available and placed on the closed upper eyelid (13 MHz; MyLab™One, Esaote). Depending on the animal size, ocular globe structures were displayed at 4-6 cm in depth. The following dimensions were measured for each eye of all subjects: Globe Axial Length (GAL) from the cornea to the retina; Anterior Chamber depth (ACd) from the cornea to the anterior reflection of the lens; Vitreous depth (VCd) from the posterior reflection of the lens to the retina; Lens diameter (Ldi), distance from the opposite points at the lens equator nearest the ciliary bodies; Lens thickness (Lt) from the anterior to the posterior reflection of the lens. Examinations included measurement were performed three times each and the mean values were taken.

Correlation coefficients of all measurements were calculated with weight and age. The differences between groups of animals, divided according to gender, weight (<200 and ≥200 kg) and age (<10 and ≥10 years) categories have also been estimated. The significance of correlation coefficients was tested with t-student's test. For comparison of gender, weight and age categories an ANOVA (Analysis of Variance) test has been used. p-values were fixed at 0.05 for all tests.

RESULTS

Results of the ocular biometry showed no gender differences between measurements. Mean values for each dimension, divided according to weight category are reported in Table 1. The ocular measurements divided according to age category are reported in Table 2.

A direct positive relationship (positive significance for correlation coefficient) was detected only between the weight of the donkey and ACd while no direct positive relationships between the weight of the donkey and the other measurements have been found (correlation coefficient near 0). Otherwise all measures with the exception of Lt were found to be correlated with body weight when the ANOVA (Analysis of Variance) test is applied to the weight category divisions (W<200; W≥200).

Table 1: Mean (mm) and Standard Deviation (SD) of measurements in age categories

Donkey age category (years)	n (eyes)	Mean and SD (mm)	GAL*	ACd†	VCd‡	LDi§	Lt‖
<10	136	Mean	34.44	2.90	20.53	17.26	11.15
		SD	1.65	0.51	1.60	1.41	0.77
≥10	84	Mean	34.59	2.58	20.53	17.58	11.78
		SD	1.50	0.58	1.67	1.03	0.83

Table 2: Mean (mm) and Standard Deviation (SD) of measurements in age categories

Donkey weight category (kg)	n (eyes)	Mean and SD (mm)	GAL*	ACd†	VCd‡	LDi§	Lt‖
W<200	116	Mean	33.53	2.65	19.65	16.78	11.30
		SD	1.30	0.47	1.31	1.17	0.86
W≥200	104	Mean	35.36	2.86	21.28	17.76	11.22
		SD	1.41	0.55	1.43	1.35	0.78

*GAL: Globe Axial Length; †Acd: Anterior Chamber depth; ‡VCd: Vitreous Chamber depth; §Ldi: Lens diameter; ‖Lt: Lens thickness

The correlation coefficient for age gave a positive result only for Lt and GAL. When the analysis of variance is applied to measurements divided according to the age categories, only Lt has a statistical significance for differences between categories. The correlation coefficients between measurements have also been investigated and apart from Lt no further correlation with other ocular dimensions was found (correlation coefficient near 0).

DISCUSSION

The results regarding the division between male and female should be treated carefully because the number of males (n = 12) was smaller than females (n = 98). In any case as earlier reported by the same researchers for donkeys (Laus *et al*., 2013) and by others in human beings (Larsen, 1971; Garcia-Domene *et al*., 2011) and other species (Augusteyn *et al*., 2003), no gender differences in ocular measurements have been detected. However, in a Central Indian human population, Jonas *et al*. (2012) found that a thick lens was associated with male gender, higher age, larger body stature and high body mass index. Researchers also found a relationship between lens thickness and anterior chamber depth.

The results reported in the Table 1 indicate a different relationship between lens thickness and body weight when compared to other ocular dimensions measured. As in the earlier study performed in donkeys (Laus *et al*., 2013) an indication of an inverse behaviour was observed. An ANOVA (Analysis of Variance) test confirmed a lack of statistical correlation. In this study, adult donkeys of increasing body weight show a corresponding increase in some ocular dimensions but this relationship did not extend to lens thickness. However, lens thickness does demonstrate a positive correlation with age. Similar results have been obtained in human beings (Garcia-Domene *et al.*, 2011) but contradictory opinions exist about changes in lens thickness in older people and about a true linear relationship between lens thickness and age throughout life (Garcia-Domene *et al.*, 2011). Because a flattening the process occurs in human, the thickness of the lens appear to decrease comparing newborns and 8-10 years old boys (Larsen, 1971). Knowledge of the growth pattern of the crystalline lens in the donkey may provide a useful background to the interpretation of lenticular abnormality in these animals and also contribute to the comparative data for the study of ocular structures between species. It is known that the mechanisms regulating lens growth are the same in most species with the exception of primates (Augusteyn, 2008). Why primates are different remains to be established.

Data on pre-natal, post-natal and adult lens thickness in man and animals needs to be collected and compared to assess if differences in growth patterns exist. Some researchers have suggested that lens thickness in human subjects increases to a maximum around age 50 and then after an intervening period decreases for the rest of life (Jonas *et al.*, 2012). These opinions are not supported by other observations (Augusteyn *et al.*, 2013). Clarification of inconsistency in both human and veterinary medicine may have practical medical importance in the selection and implantation of multifocal intra-ocular lenses (Wilson *et al.*, 2009).

CONCLUSION

During this research using ultrasound measurement data have been obtained on some intraocular structures and the relationship between age and lens thickness has been study in a population of adult donkeys. A series of investigations of animals of more restricted age groups may help to further define the growth patterns of parts of the eye.

ACKNOWLEDGEMENT

The researchers are grateful to Dr. Terence D Grimes of University College, Dublin, Ireland for his assistance in the preparation of this study.

REFERENCES

Augusteyn, R.C., 2007. Growth of the human eye lens. Mol. Vision, 13: 252-257.

Augusteyn, R.C., 2008. Growth of the lens: *In vitro* observations. Clin. Exp. Optometry, 91: 226-239.

Augusteyn, R.C., A. Mohamed and J.M. Parel, 2013. Lens thickness growth in humans. Clin. Exp. Opthalmol., 41: 616-617.

Augusteyn, R.C., G.M. Coulson and K.A. Landman, 2003. Determining kangaroo age from lens protein content. Aust. J. Zool., 51: 485-494.

Barsotti, G., S. Citi, M. Brovelli, E. Mussi, E. Luchetti, F. Carlucci and M. Sgorbini, 2010. Esame ecografico oftalmico nel cavallo: Valutazione di alcune misurazioni biometriche [Ophthalmic ultrasound examination in the horse: Assessment of certain biometric measurements]. Ippologia, 21: 39-43.

Colitz, C.M.H. and R.J. McMullen, 2011. Diseases and Surgery of the Lens. In: Equine Ophthalmology, Gilger, B.C. (Ed.). 2nd Edn., Saunders, Maryland Heights, MI., USA., pp: 282-316.

Dietrich, U.M., 2007. Ophthalmic Examination and Diagnostic, Part 3: Diagnostic Ultrasonography. In: Veterinary Ophthalmology, Gelatt, K.N. (Ed.). 4th Edn., Blackwell Publishing, Ames, IA., USA., pp: 507-519.

Garcia-Domene, M.C., M.A. Diez-Ajenjo, V. Gracia, A. Felipe and J.M. Artigas, 2011. A simple description of age-related changes in crystalline lens thickness. Eur. J. Ophthalmol., 21: 597-560.

Grinninger, P., M. Skalicky and B. Nell, 2010. Evaluation of healthy equine eyes by use of retinoscopy, keratometry and ultrasonographic biometry. Am. J. Vet. Res., 71: 677-681.

Jonas, J.B., V. Nangia, R. Gupta, A. Sinha and K. Bhate, 2012. Lens thickness and associated factors. Clin. Exp. Opthalmol., 40: 583-590.

Larsen, J.S., 1971. The sagittal growth of the eye: II. Ultrasonic measurement of the axial diameter of the lens and the anterior segment from birth to puberty. Acta Ophthalmologica, 49: 427-439.

Laus, F., E. Paggi, A. Marchegiani, M. Cerquetella, D. Spaziante, V. Faillace and B. Tesei, 2013. Ultrasonographic biometry of the eye in healthy adult donkey. Vet. Rec., (In Press).

Lorente-Ramos, R.M., J.A. Arman, A. Munoz-Hernandez, J.M. Garcia Gomez and S.B. de la Torre, 2012. US of the eye made easy: A comprehensive how-to review with ophthalmoscopic correlation. Radiographics, 32: E175-E200.

McMullen Jr., R.J. and B.C. Gilger, 2006. Keratometry, biometry and prediction of intraocular lens power in the equine eye. Vet. Ophthalmol., 9: 357-360.

Mettenleiter, E.M., 1995. Sonographic diagnosis (B-mode technique) for the eyes in horses. 1. Methods and normal findings. Tierarztl. Prax., 23: 481-488.

Michau, T.M., 2005. Ocular Equine Examination: Basic and Advanced Diagnostic Techniques. In: Equine Ophthalmology, Gilger, C. (Ed.). 1st Edn., Saunders, St. Louis, USA., pp: 1-62.

Pearson, R.A. and M. Ouassat, 1996. Estimation of the liveweight and body condition of working donkeys in Morocco. Vet. Rec., 138: 229-233.

Pearson, R.A. and M. Ouassat, 2000. A Guide to Body Condition Scoring and Live Weight Estimation of Donkeys. Centre for Tropical Veterinary Medicine, University of Edinburgh, Edinburgh, UK., pp: 21.

Reef, V.B., 1998. Equine Diagnostic Ultrasound. W.B. Saunders Company, Philadelphia, USA., ISBN-13: 9780721650234, Pages: 560.

Rogers, M., R.E. Cartee and W. Miller, 1986. Evaluation of the extirpated equine eye using B-mode ultrasonography. Vet. Radiol., 27: 24-29.

Scotty, N.C., T.J. Cutler, D.E. Brooks and E. Ferrell, 2004. Diagnostic ultrasonography of equine lens and posterior segment abnormalities. Vet. Ophthalmol., 7: 127-139.

Shui, Y.B. and D.C. Beebe, 2008. Age-dependent control of lens growth by hypoxia. Invest. Ophthalmol. Vision Sci., 49: 1023-1029.

Wilson, M.E., R.H. Trivedi and B.M. Burger, 2009. Eye growth in the second decade of life: Implications for the implantation of a multifocal intraocular lens. Trans. Am. Ophthalmol. Soc., 107: 120-124.

Withcomb, M.B., 2002. How to diagnose ocular abormalities with ultrasound. Proceedings from the 48th American Association of Equine Practitioners Annual Convention, December 4-8, 2002, Orlando, FL., USA., pp: 272-275.