Reference values for intraocular pressure and Schirmer tear test in healthy wild European mouflons (*Ovis orientalis musimon*)

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**SUMMARY**

**Introduction** - In the context of the eye investigation, standard diagnostic ophthalmic test, as intraocular pressure (IOP) and Schirmer Tear Test (STT) values, could be useful to improve the clinical ophthalmic approach to the domestic animals. Large interspecies and intraspecies variations in reference STT and IOP values have been documented.

**Aim** - The current study was undertaken to establish reference values for STT and IOP in European wild mouflons living on the Island of Sardinia.

**Materials and methods** - Thirty-six healthy wild mouflons with no evidence of ocular disease were enrolled in this study. All animals were ≥ 2 years of age; mean (± standard deviation) age of the animals (26 male and 10 female) was 34.2 ± 7.5 months. Tear production was measured using the Schirmer tear test type I; intraocular pressure was recorded using an applanation tonometer. The unsedated animals were placed in sternal decubitus. Statistical analysis of data was performed using multivariate analysis of variance (MANOVA) in order to determine significant effects of different gender (male; female), age (24-36 months; 37-48 months) and eye (right; left) on the parameters studied.

**Results and discussion** - Comparison between mean STT and IOP values in males (n = 26) and females (n = 10) showed a significant difference (P<0.001). This can be related to the type of sample disproportionately in favor of males, which may have distorted the statistical comparison. However, this finding is in accordance with some studies that report that gender may affect IOP only in some species, including humans and lions. No significant effects of animal age (24-36 months; 37-48 months) and eye (left versus right) on STT and IOP values were found in this study. Mean STT values were 15.50 ± 1.71 mm/min (n=52) when measurements from both eyes were averaged (range of 11-18 mm/min). Mean IOP values for all mouflon eyes (n=52) were 18.05 ± 4.85 mmHg, with a range of 11-25.66 mmHg.

**Conclusions** - This study reports STT and IOP findings in European mouflons and provide means and ranges for these ocular diagnostic parameters as useful data for evaluating of ocular diseases in this animal specie.

**KEY WORDS**

Intraocular pressure; Schirmer tear test; *Ovis orientalis musimon*; wild sheep.

**INTRODUCTION**

Mouflon is a subspecies group of the wild sheep. These animals were introduced to the islands of Corsica, Sardinia, Rhodes and Cyprus during the Neolithic period as feral domesticated animals, where they have naturalized over the past few thousand years, giving rise to the subspecies known as European mouflon¹. Groves and Leslie, 2011¹ suggest that the Anatolian Sheep or Asiatic Mouflon (*Ovis gmelini*) is likely the ancestor of domestic sheep and that European mouflons, sometimes referred to as *O. musimon* or *O. orientalis musimon*, are the feral descendants of the first domestic sheep brought to Europe. In Island of Sardinia (Italy) the expansion of sheep farming has eroded the available habitat of the European mouflon, resulting in a reduction in their numbers and their dispersal into small isolated groups. So, in order to preserve this autochthonous population by the risk of extinction and to improve the management of this wild sheep, in recent years various investigations were carried out¹. In the context of the eye investigation, standard diagnostic ophthalmic test, as intraocular pressure (IOP) and Schirmer Tear Test (STT) values, could be useful to improve the clinical ophthalmic approach to the mouflon in Europe. Large interspecies and intraspecies variations in reference IOP and STT values have been documented¹. In addition, it is not possible to extrapolate normal values from closely-related species. Therefore, in order to improve the veterinary care of wild animals and to further understanding of comparative ocular physiology, it is necessary to determine the normal reference values of ophthalmic for each species¹. During the last few years several investigations of normal mean IOP and STT values were reported for an elevated number of domestic and wild animal species. Among large animals, these parameters were evaluated in sheep¹, goat¹, cattle¹, horse¹, buffalo¹, eland and deer¹, lion¹ and in various other species¹. Literature search indicate that there is no published study in regard to normal values of ophthalmic test such as IOP and STT results in European mouflon. It is very important to establish normal ranges in healthy mouflon, to avoid diagnostic misinterpretations during the ophthalmic examination. So, the purpose of this study was to report normal reference values for intraocular pressure and tear production in European mouflons.

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MATERIALS AND METHODS

The study was performed in 36 normal Sardinian wild mouflons of different sex and age living in the Regional Fauna Center at Bonassai (SS), Oliena (NU) and Monte Arcosu (NU) of Sardinia (Italy).

All animals were ≥ 2 years of age; mean (± standard deviation) age of the animals (26 male and 10 female) was 34.2 ± 7.5 months. The animals were placed in sternal decubitus, with their head in a normal position and muzzle slightly lowered away from the side opposite the eye to be examined. Chemical sedation and local nerve blocks were not employed. During restraint, no pressure on the neck was applied and the eyelids were minimally manipulated.

All animals were healthy, as determined by a thorough physical examination, including a complete blood count and serum biochemistry panel. Tear production was estimated applying the Schirmer tear test I and using commercial sterile test strips (Dina strip Schirmer-Plus®) of a single lot number (lot no. 12-2268). The values were measured by inserting the strip for 1 min in the lower conjunctival fornix of each eye. Measurements were conducted prior to any manipulation or examination of the eye. Following evaluation of tear production, IOP was evaluated through an applanation tonometer (Tonopen® XL, Mentor Ophthalmic, INC; Norwell, MA, USA), after instillation into the conjunctival sac of an anesthetic eye drops - oxybuprocaine hydrochloride 0.4% (Novesina®). The latex cover of the instrument was replaced prior to the recording in each animal. The instrument is calibrated at the beginning of the work session and then is rechecked every half an hour; it made a variable number of recordings and then the display indicates the mean IOP and its coefficient of variation. Only IOP readings with a 5% variance were recorded. Three such recordings were recorded from each eye. All STT and IOP measurements were conducted in outdoor, by the same observer and between 07:00 and 10:00 a.m. Following tonometry measurement a complete ophthalmic examination, including slit lamp biomicroscopy and indirect ophthalmoscopy, was performed. No ocular abnormalities were detected in all animals. In order to evaluate the effect of age on considered parameters, the examined animals were divided in two groups: one group with age ranged from 24 to 36 months and one group with age ranged from 37 to 48 months. Statistical analysis of data was performed using multivariate analysis of variance (MANOVA) in order to determine significant effects of different gender (male; female), age (24-36 months; 37-48 months) and eye (right; left) on the parameters studied. P value <0.05 was considered statistically significant. Bonferroni’s multiple comparison test was applied for post hoc comparison. Obtained data has been analysed using the software STATISTICA 8 (Stat Soft Inc.).

RESULTS

All results were expressed as mean ± standard deviation (SD) and were reported in Table 1. The statistical analysis is reported in Figure 1. Comparison between the mean STT and IOP values in males (n = 26) and females (n = 10) showed a significant difference (P=0.001 and P<0.001 respectively).

<table>
<thead>
<tr>
<th>Gender</th>
<th>STT (mm/min)</th>
<th>IOP (mmHg)</th>
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</thead>
<tbody>
<tr>
<td>males</td>
<td>15.07 ± 1.79</td>
<td>16.56 ± 3.27</td>
</tr>
<tr>
<td>females</td>
<td>16.6 ± 0.8</td>
<td>21.89 ± 4.0</td>
</tr>
</tbody>
</table>

Mean STT in male animals was 15.07 ± 1.79 mm/min whereas mean STT in female mouflons was 16.6 ± 0.8 mm/min. Mean ± SD IOP values by applanation tonometry were 16.56 ± 3.27 and 21.89 ± 4.0 mmHg for males and females, respectively.

No significant effects of animal age (24-36 months; 37-48 months) and eye (left versus right) on STT and IOP values were found in this study.

The mean STT value was 15.38 ± 1.64 mm/min in the group with age ranged from 24 to 36 months, and 15.67 ± 1.79 mm/min in the group with age ranged from 37 to 48 months.

The mean IOP value was 17.59 ± 4.86 mmHg in the first group and 18.63 ± 4.85 mmHg in the second group.

Mean STT value was 15.62 ± 1.37 mm/min in the right eye and 15.38 ± 2.01 mm/min in the left eye. Mean IOP values for right and left eye were 19.14 ± 5.25 mmHg and 16.90 ± 4.40 mmHg respectively. Comparison between STT and IOP values of right eyes and left eyes revealed no significant differences (P=0.86 and P>0.05 respectively), so the data for both eyes were pooled. Mean STT values in the present study were 15.50 ± 1.71 mm/min (n=52) when measurements from both eyes were averaged (range of 11-18 mm/min). Mean IOP values for all mouflon eyes (n=52) were 18.05 ± 4.85 mmHg, with a range of 11-25.66 mmHg.

DISCUSSION

As stated in the introduction, baseline IOP and STT I using applanation tonometry and sterile strip Schirmer Tear Test respectively has been determined for many species of animals, but to our knowledge a controlled study measuring baseline STT I and IOP in European mouflons has not been reported. Results of this report provide preliminary information on ranges of values for STT and IOP in healthy wild European mouflons. Both the STT I and tonometry were well-tolerated in the mouflons without need for sedation or local nerve blocks and neither test appeared to cause undue stress to the animals. Thus, these diagnostic measures may be used routinely for ophthalmic examination of this species. The mean STT ± SD for all mouflon eyes was 15.50 ± 1.71 mm/min (range 11-18 mm/min) and is comparable to several other ruminants, including cattle, eland, deer, pygmy goats, and Sanjabi sheep. Schirmer tear test I measurements assess basal and reflex tearing and they can vary depending on inconsistencies in the absorptive capacities of STT strips due to differences in filter papers, the individual
Figure 1 - Schirmer tear test type I (STT-I) and IOP graphics in mouflons divided in groups by sex, age and eye. Significant difference was found comparing males vs females.
performing the test and location of strip placement within the conjunctival sac. In the present study, all measurements were performed by one examiner and STT values were obtained by strips of the same manufacture and lot number. Some Authors found that STT I values of juvenile dogs are lower than that of adult dogs. Although there was no detectable correlation between age and STT I values in our study, this may be a result of a narrow age range of the mouflons. Inadequate tear production can result in keratoconjunctivitis sicca in various species, but the condition has not yet to be reported in mouflons. Obviously, this does not mean that the disease does not exist in these animals. With regard to IOP, we found representative reference values for the mouflon, using the applanation tonometry technique. The IOP value is an important indicator of ocular health and disease states, and disorders such as glaucoma and uveitis are frequently associated with changes in the IOP. Because the wide variations in the IOP among animals, it is very important to determine a species-specific reference value for the IOP in each animal species. Applanation tonometry provides a short-time relatively simple means of indirectly examination of intraocular pressure in a clinical setting and in routine ophthalmic examination. A local anesthetic needs to be applied to the corneal surface prior to using the tonometer to assess IOP. Another way to assess IOP in large animals is rebound tonometry using TonoVet, a hand-held tonometer. It is a noninvasive device for IOP measurements and does not require local anesthesia. Both applanation and rebound tonometry are considered to be helpful methods of assessing IOP in ruminants. In this study during the IOP measurement each animal was placed in sternal decubitus with head in normal and upright position. In fact, studies in horses and dogs indicated that the position of head and body has a significant effect on the intraocular pressure. Normal IOP values have been determined in the number of domestic, laboratory and wild animal species. Using the TonoPen XL, the mean IOP for all mouflon eyes was 18.05 ± 4.85 mmHg, with a range of 11-25.66 mmHg, which is similar to previously reported IOP values for cattle and other ruminants. In this investigation the results about the effect of sex on both ocular diagnostic parameters of mouflons showed a significant difference between male and female. This can be related to the type of sample disproportionately in favor of males, which may have distorted the statistical comparison. However this finding is in accordance with some studies that report that gender may affect IOP only in some species, including humans and lions.

CONCLUSIONS

In conclusion, this study reports STT and IOP findings in European mouflon and provide means and ranges for these ocular diagnostic parameters as useful data for evaluation of ocular diseases in this animal. Further investigations could be carry out in the target population, in order to increase the numbers of examined animals and to study the chronobiological rhythms of parameters considered.

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References