Correlation of morphologic features of the iridocorneal angle to intraocular pressure in Samoyeds

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SUMMARY

The iridocorneal angle of the left eye was investigated in 203 Samoyeds. Comparison was made of judgements of the width of the anterior opening of the ciliary cleft, when performing gonioscopy with an objective method of estimation based on measurements on goniophotographs. Results indicated high degree of correlation. Various degrees of narrowness of the iridocorneal angle width were revealed and clinical glaucoma with total-angle closing was found in 6 of 203 dogs. The intraocular pressure was significantly (P < 0.01) higher in eyes with closed iridocorneal angles than in eyes with any other width of the angle. Appearance of the structures of the iridocorneal angle, particularly the pigment bands, indicated extensive individual variation. In approximately 25% of the eyes, dysplasia of the pectinate ligaments of variable degree existed, indicating that this anomaly is common in the Samoyed breed. Significant difference was not evident in intraocular pressure in eyes with different degrees of dysplasia of the pectinate ligaments.

Intraocular pressure (IOP) is maintained by a dynamic equilibrium between production and outflow of aqueous humor. The major route of aqueous drainage in mammals is through the iridocorneal angle in the anterior chamber of the eye, and only small volumes are eliminated through other means.1,2 The iridocorneal angle in dogs is limited by the base of the iris, the anterior part of the ciliary body, the anterior inner surface of the sclera, and the interior of the peripheral cornea. A row of thin processes, the pectinate ligaments, spans the anterior opening of the iridocorneal angle. Between these ligaments are distinct spaces, which lead to the more posterior parts of the ciliary cleft.3,4 Aberrations in the iridocorneal angle are of great importance because it is postulated that they may impair the outflow of the aqueous humor and cause intraocular hypertension, which will, if permanent, result in glaucoma.3,5-7 Primary glaucomas associated with angle closure, dysplastic pectinate ligaments, or combinations of these anomalies have been reported in several breeds.5,6,10

In the Samoyed breed, primary glaucoma is considered to develop because of angle closure or a congenital defect in the iridocorneal angle, goniodysgenesis.11,12 The appearance of the anterior parts of the canine iridocorneal angle can easily be viewed and documented in vivo by gonioscopy and goniophotography.13,14 The degree of deflection in width of the anterior opening of the ciliary cleft and appearance of the pectinate ligaments is judged subjectively by the examiner. A method of estimating the width of the anterior opening of the ciliary cleft by comparing the width of the anterior opening of the ciliary cleft to the peripheral thickness of the cornea is used in human ophthalmology. This comparison between 2 distances at the same level in the eye simplifies the estimation of the width of the anterior opening of the ciliary cleft.15 The distribution of dysplastic pectinate ligaments can be estimated in fractions of the circumference.16

The purposes of the study reported here were to investigate the possibilities of measuring the width of the canine iridocorneal angle (ie, the width of the anterior opening of the ciliary cleft) in an objective way and to map the appearance of the iridocorneal angle in Samoyeds. Also, we wished to elucidate whether correlation exists between high IOP and narrow or dysplastic iridocorneal angle.

Materials and Methods

Dogs and ophthalmic examinations—The study included 203 purebred Samoyeds, 111 female and 92 male, aged 4 months to 13 years. After general clinical examination of the dogs, direct and indirect ophthalmoscopy, slit-lamp biomicroscopy, and tonometrya were performed on both eyes (nondilated pupils) in the order mentioned. Gonioscopyb was performed as the last procedure, for practical reasons, only on the left eye of each dog. In 3 dogs, the left eye had been enucleated because of high IOP and gonioscopy was, therefore, performed on the right eye. Results were documented in writing, and goniophotographsc were taken of the nasal aspect of the iridocorneal angle. In cases of heterogeneous appearance of the angle, other parts were documented as well. All examinations were performed on conscious, nonsedated dogs.

Measurements—The width of the iridocorneal angle, as well as the distribution of dysplastic pectinate ligaments, was estimated subjectively. The anterior width of the ciliary cleft (the distance from the origin to the insertion of the pectinate ligamentsd) and the total distance from the origin of the pectinate ligaments to the anterior corneal surface was measured from the goniophotographs. The ratio between these 2 variables was then calculated. The basis for grading the anterior width was determined (Fig

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*a Tono-Pen 2, Oculab Inc, Glendale, Calif.

*b Barkan Lovac, Medical Workshop, Groningen, The Netherlands.

*c Kowa RC-2, Kowa Co Ltd, Tokyo, Japan.
Terminology Closed Numerical grade 0
Relatively narrow (x=A/B)  0.15<x<0.30
Narrow  0.15<x<0.30
Slightly narrow  0.30<x<0.45
Open  0.45<x<0.55
Wide open  0.55<x

Figure 1 — Schematic drawing representing the grading system for width of the iridocorneal angle. The width of the anterior opening of the ciliary cleft (A) and the distance from the origin of the pectinate ligaments to the anterior surface of the cornea (B) are measured from gonioscopic photographs and the quote is calculated. Pupil (C); iris (D); pectinate ligament (E); deep band of the pigment zone (F); superficial band of the pigment zone (G); and cornea (H).

Figure 2 — Schematic drawing of dysplastic pectinate ligaments (black). The arrow (with a perpendicular bar every 1/16 of the circumference of the iridocorneal angle) indicates extension of the dysplasia.

1). A pectinate ligament was considered to be dysplastic if it extended over more than 1/16 of the circumference without being interrupted by normal interligamentary spaces (Fig 2). The extension was subjectively estimated by the examiner.

Analysis of data — The Student t test was used to determine statistical significance.

Results

Major ophthalmoscopic and slit-lamp biomicroscopic abnormalities were discovered in 6 dogs with clinical glaucoma. Secondary complete bilateral cataracts were observed in a 6-year-old bitch with chronic diabetes mellitus. The degree of pigmentation in the superficial and deep bands of the pigment zone, as well as pigmentation of the structures in the iridocorneal angle, varied extensively between eyes of various dogs, but often a difference was apparent between parts of the circumference within the same eye. The pectinate ligaments were generally more heavily pigmented than the peripheral part of the iris. The site of insertion on the cornea was usually marked by a distinct deep band of pigment. In one dog, the partially blue iris was extremely poorly pigmented and bands of pigment were not discernible.

The pectinate ligaments had extensive variation in width and form, not only in different dogs, but also in different parts of the same eye. Lateral branching (except at the site of insertion) and crossing over of primary pectinate ligaments were seen in a few eyes (Fig 3). Iridal strands anterior to the rows of pectinate ligaments were seen in one dog.

Dysplasia of the pectinate ligaments was seen in many dogs. Multiple minor areas of dysplasia spread around the
Figure 4—The anterior opening of the iridocorneal angle in a 5.6-year-old normotensive Samoyed bitch. Partial dysplasia of the pectinate ligaments can be observed. Only a single crater-shaped opening (arrow) can be found in the dysplastic area. The pigment bands cannot be seen in this part of the eye.

Figure 5—Closed iridocorneal angle in a 3.9-year-old male Samoyed with glaucoma. The anterior opening of the iridocorneal angle cannot be examined. Arrows indicate the borders of the peripheral corneal transection. The photograph is indistinct owing to corneal edema.

Figure 6—Narrow iridocorneal angle (grade 1) and generalized dysplasia of the pectinate ligaments in a 9.8-year-old normotensive male Samoyed. Several slit-like openings can be observed (arrows). A pigmented zone is seen anterior to the insertion of the dysplastic sheath, but distinct division into a superficial and a deep band is not possible.

Table 1—Width of the iridocorneal angle in 203 Samoyeds (204 eyes) estimated by subjective judgement and as a ratio between the width of the anterior opening and the distance from the origin of the pectinate ligaments to the peripheral anterior surface of the cornea

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circumference were observed, as well as larger, continuous bands (Fig 4). Dysplastic pectinate ligaments were found in 49 of 198 eyes examined (24.7%). In 16 (8.1%) of these eyes more than half the circumference was covered by dysplastic ligaments. In 6 eyes, the iridocorneal angle was so narrow that the anterior region of the angle could not be thoroughly examined (Fig 5).

The open spaces between the pectinate ligaments often varied substantially within an eye. Distinct openings of the same length as the pectinate ligaments were usually seen in areas without dysplastic pectinate ligaments. In areas with dysplasia, the interligamentary spaces were slit-like, or more commonly, were crater-shaped, round holes (Fig 6). The diameter of these holes was often considerably less than the width of the angle. In 2 dogs, the pectinate ligaments were normally differentiated, but an almost solid sheath of tissue was located caudal to the rows of pectinate ligaments. This sheath did not appear to encircle the whole circumference in any case and it was interrupted by a small number of large flow holes. The diameter of the flow holes varied from a third to two-thirds the length of the pectinate ligaments.

Results of grading the anterior width of ciliary clefts were obtained in 5 groups, using both methods of estimation (Table 1). Comparison of these methods indicates that dissimilarities developed in approximately 4.4% of the dogs. Furthermore, statistical analysis proved that dissimilarities between the methods were not significant. All dogs with clinical glaucoma were found in group 0, using both methods of estimation.

Intraocular pressure of the gonioscopically examined eyes was related to the anterior width of the ciliary cleft and a comparison of the intraocular pressure was made between the 5 numerical grades (Fig 1). Mean (± SD) IOP was significantly higher (P < 0.01) in eyes with closed iridocorneal angles (40 ± 11 mm of Hg) than in any of the other groups (15 ± 3.8 mm of Hg). Significant differences in IOP were not evident when the groups graded 1 to 4 were compared. To determine whether relationship existed between IOP and the degree of dysplasia of pectinate ligaments in gonioscopically examined eyes, the
The aforementioned variables were compared. Significant differences were not found, however.

**Discussion**

The iridocorneal angle in Samoyeds has great morphologic variation between eyes of individuals and between different parts of the circumference in the same eye. Individual variation included essentially the degree and distribution of pigmentation, width of the pectinate ligaments, and width and frequency of the openings to the ciliary cleft. The anterior width of the ciliary cleft was considerably more constant within the same eye, but variation between dogs was pronounced. We also documented that dysplasia of pectinate ligaments is a common finding in Samoyeds in Sweden. Minor dysplastic strands could be seen in most dogs and were considered normal in this study. Correlation was not found between the extension of pectinate ligaments and IOP. Thus, dysplasia of pectinate ligaments, even in cases of comprehensive extension, is not sufficient to cause permanent intraocular hypertension.

Narrowed and closed iridocorneal angles, the latter in cases of acute clinical glaucoma, indicate that angle-closure glaucomas do develop in this breed. The IOP was significantly higher only in eyes with closed iridocorneal angles and not in eyes with variation in the anterior width of the ciliary cleft, with or without dysplasia of the pectinate ligaments. Lack of high IOP in cases of narrow, but still open, iridocorneal angles indicates that other initiating factors must be present to further impair the outflow of aqueous, resulting in clinical glaucoma. It is, however, important to know the normal variation of the iridocorneal angle in a breed and to be able to observe alterations of this structure in dogs of predisposed breeds.

Our results indicate that a method based on calculating the ratio between the length of the pectinate ligaments and the distance from the origin of the pectinate ligaments to the anterior surface of the peripheral part of the cornea after measurements on goniophotographs agrees well with the grading method obtained by direct, subjective estimation of the width of the iridocorneal angle. One advantage of the former method is that a minimum of experience is needed to measure the aforementioned structures by means of goniophotographs. The calculated value is a ratio between 2 structures at the same level, which then becomes almost independent of different magnifications and the angle between the film and the iridocorneal angle.

**References**