Effects of the Application of Neck Pressure by a Collar or Harness on Intraocular Pressure in Dogs

The effect on intraocular pressure (IOP) from dogs pulling against a collar or a harness was evaluated in 51 eyes of 26 dogs. The force each dog generated while pulling against a collar or a harness was measured. Intraocular pressure measurements were obtained during application of corresponding pressures via collars or harnesses. Intraocular pressure increased significantly from baseline when pressure was applied via a collar but not via a harness. Based on the results of the study, dogs with weak or thin corneas, glaucoma, or conditions for which an increase in IOP could be harmful should wear a harness instead of a collar, especially during exercise or activity. **J Am Anim Hosp Assoc 2006;42:207-211.**

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Introduction

Intraocular pressure (IOP) is a balance between aqueous humor production, aqueous outflow through the ciliary cleft and uveoscleral vasculature, and episcleral venous pressure.[1] Alterations in any one of these factors can result in significant variations in IOP. Generally, most increases in IOP are related to decreased outflow rather than increased production.[2]

Pressure on the neck is one factor that may affect IOP. Compression of the jugular vein may result in vascular engorgement of the anterior uvea and choroid and an increase in the choroidal blood volume.[3] Anecdotally, IOP increases transiently with pressure on the neck in dogs, leading to the recommendation of avoiding pressure on the neck during IOP measurement.[4] Veterinary ophthalmologists also frequently recommend that dogs with glaucoma, a weak or thin cornea, or those that have recently undergone intraocular surgery wear a harness rather than a collar. This recommendation is based on the assumption that a harness results in less pressure on the neck and, therefore, has less of an impact on IOP. Many harnesses, however, still apply pressure at the thoracic inlet, and a harness allows the dog to pull against the leash to a greater degree than a collar. These factors may negate the usefulness of the harness and may actually result in a greater change in IOP during exercise. A recent study in humans demonstrated transient increases in IOP in association with pressure on the jugular veins from wearing tight neckties.[5] The IOP effects from pulling against a collar or a harness, however, have not been examined in dogs. The purpose of this study was to evaluate the hypothesis that application of neck pressure via a harness results in less of an increase in IOP than when the dog is wearing a collar.

Materials and Methods

Fifty-one eyes from 26 privately owned, healthy sled dogs of both sexes were included in the study. The owner of each dog gave informed consent for participation in the study. Breeds included were the Alaskan malamute (n=12), Siberian husky (n=8), American Staffordshire terrier (n=4), American cocker spaniel (n=1), and Chinook (n=1). One dog (American Staffordshire terrier) had a previous corneal perforation in the left eye, and this eye was excluded from the study. Each dog had been previously trained to pull on a tether on command in preparation for pulling a sled or weight. Slit-lamp biomicroscopy[a] and binocular indirect ophthalmoscopy[b] were performed on all dogs prior to initiation of the study. One drop of 0.5% proparacaine[c] was administered topically to both eyes, and resting IOP was measured with applanation tonometry.[d] All eyes included in the study had a resting IOP <25 mm Hg and were free of clinically relevant ocular abnormalities.

Each dog was carefully fitted with an appropriately sized nylon collar and harness. Each collar and harness had a nylon strap with a buckle that established a specified diameter opening. "Slip-collars," "choker collars," or other devices that varied in diameter when tension was applied to them were not used. An Imada digital force gauge[e] was used to measure the tension (in kilograms) each dog generated against the leash, first when wearing a collar and then when wearing a harness. Once these values were determined, each dog was then gently restrained on the ground in a standing position, and the previously measured tension was replicated by pulling on a leash attached first to a collar and then to a harness. Every effort was made to maintain a constant angle of applied force among all dogs. After 10 seconds of pulling on the leash using the previously determined tension, IOP was measured in both eyes, and the tension on the leash was released. One minute later, IOP was measured again. At least 5 minutes elapsed between trials in order to allow the IOP to return to baseline values.

Intraocular pressure measurements (pre-, 10 seconds post-, and 1 minute post-pulling) acquired by the two different techniques were compared using analysis of variance (ANOVA) between groups. When appropriate, pair-wise comparisons were made using a paired Student's t-test.[f] Age differences between groups were also evaluated with ANOVA. The level of significance was set at $P<0.05$.

Results

Thirteen males and 13 females, ranging in age from 1 year to 8.5 years and weighing 13 kg to 52 kg, participated in the study. Intraocular pressure was increased by a mean of 7.4 mm Hg with a collar (range -4.5 to 35 mm Hg) and by a mean of 2.3 mm Hg with a harness (range -6 to 14.5 mm Hg). Intraocular pressure significantly increased from baseline values when tension was applied via a leash to a collar (51.6% increase, $P=0.001$), but not to a harness (15.8% increase, $P=0.088$). Under tension with a collar, IOP increased significantly more than when under tension with a harness ($P<0.05$). At 1 minute after cessation of the force on the leash, IOP returned to baseline values for dogs wearing either a collar or harness [Figure 1; see Table].

Breed differences were apparent in the tension generated by the dogs when pulling on the leash, and also in the

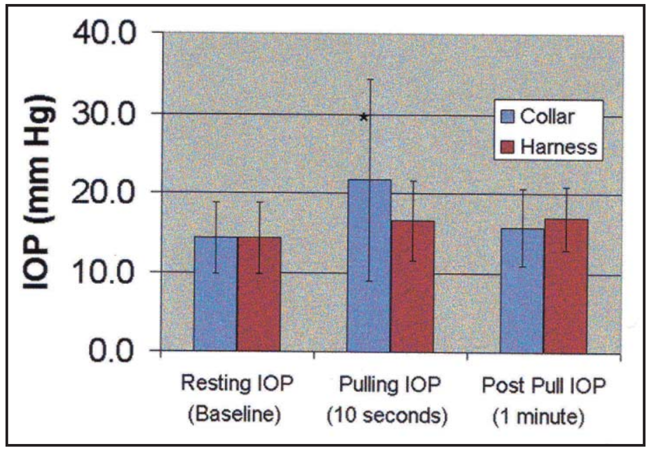

Figure 1—Comparison of intraocular pressure (IOP) increases in dogs when a force was applied to the neck via a collar (blue bars) and a harness (purple bars). Post-pull IOP refers to IOPs taken 1 minute after cessation of the force. Bars represent mean IOP ± standard deviation. The asterisk indicates a significant difference ($P<0.05$).

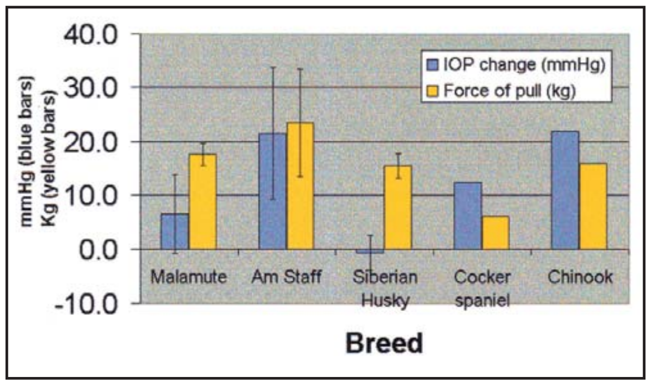

Figure 2—Breed comparisons of intraocular pressure (IOP) increases that occurred under a force applied to a collar and under the forces generated by the dogs pulling. Blue bars represent the IOP changes (mm Hg) from baseline values, and yellow bars represent the force pulled (kilograms) by the dogs. Bars represent mean IOP change or force pulled ± standard deviation. Am Staff=American Staffordshire terrier.

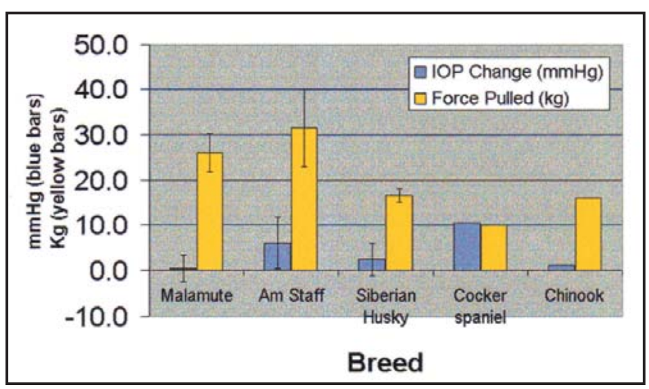

Figure 3—Breed comparisons of intraocular pressure (IOP) increases that occurred under a force applied to a harness and under the forces generated by the dogs pulling. Blue bars represent the IOP changes (mm Hg) from baseline values, and yellow bars represent the force pulled (kilograms) by the dogs. Bars represent mean IOP change or force pulled ± standard deviation. Am Staff=American Staffordshire terrier.

Table

Mean ± Standard Deviations of Intraocular Pressures (IOPs) Before, During, and After Force Was Applied to a Leash Attached to Either a Collar or Harness

	Intraocular Pressures (mm Hg)		
Technique	Resting Values	During Force Applied for 10 Sec	1 Min After Applied Force
Collar (n=26)*	14.3±4.49	21.8±12.67†	15.8±4.77
Harness (n=26)*	14.3±4.49	16.6±5.01	16.9±3.99

* n=number of dogs tested
† Results were statistically different from baseline values; $P<0.05$ using analysis of variance and a paired Student's t-test.

degree of IOP increase under the tension [Figures 2, 3]. The mean force of tension generated and the change in IOP for each breed wearing a collar were as follows: Alaskan malamutes 17.7 kg, 6.5 mm Hg; Siberian huskies 15.5 kg, -0.7 mm Hg; American Staffordshire terriers 23.5 kg, 21.5 mm Hg; American cocker spaniel 6.0 kg, 12.5 mm Hg; and Chinook 16.0 kg, 22.0 mm Hg. The mean force of tension generated and the change in IOP for each breed wearing a harness were as follows: Alaskan malamutes 26.0 kg, 0.4 mm Hg; Siberian huskies 16.6 kg, 2.3 mm Hg; American Staffordshire terriers 31.5 kg, 6.0 mm Hg; American cocker spaniel 10.0 kg, 10.5 mm Hg; and Chinook 16.0 kg, 1.0 mm Hg. Although all breeds except the Chinook usually generated greater tension with a harness than with a collar, only the difference in tension generated by the Alaskan malamutes was statistically significant ($P<0.001$). The American Staffordshire terriers generated the most tension, with a mean of 23.5 kg with the collar and 31.5 kg with the harness. The one American cocker spaniel in the study generated the least amount of tension, pulling 6.0 kg and 10.0 kg with the collar and harness, respectively. When pulling against a collar, Alaskan malamutes and Siberian huskies experienced less of an increase in IOP than did the other dogs. Although there was a slight decrease compared to baseline in the IOP of Siberian huskies when pulling against a collar, this decrease was not statistically significant.

The dogs were divided into three different age groups to allow comparison of age with IOP changes according to neck pressure. Group 1 included dogs from 1 to 3 years of age (n=11; four Alaskan malamutes, five Siberian huskies, two American Staffordshire terriers); group 2 included dogs from 4 to 6 years of age (n=9; four Alaskan malamutes, two Siberian huskies, one Chinook, one American cocker spaniel, one American Staffordshire terrier); and group 3 included dogs from 7 to 9 years of age (n=6; four Alaskan malamutes, one Siberian husky, one American Staffordshire terrier). When pulling against a collar, group 1 had a mean IOP change of 2.5 mm Hg (range -2.0 to 15.0); group 2 had a mean IOP change of 8.5 mm Hg (range -3.5 to 28.0); and group 3 had a mean IOP change of 14.7 mm Hg (range 1.5 to 35.0). When pulling against a harness, group 1 had a mean IOP change of 1.2 mm Hg (range -2.0 to 4.5); group 2 had a mean IOP change of 2.8 mm Hg (range -6.0 to 14.5); and group 3 had a mean IOP change of 3.4 mm Hg (range -0.5 to 10.5). No statistically significant differences in IOP were seen at any time among dogs of the different age groups. In dogs of increasing age, a trend toward a greater IOP increase was seen when pulling against either a collar or harness [Figure 4]. This trend did not achieve statistical significance, however. No apparent correlations were found between the increase in IOP for any age group or breed and the amount of tension applied via a collar or harness

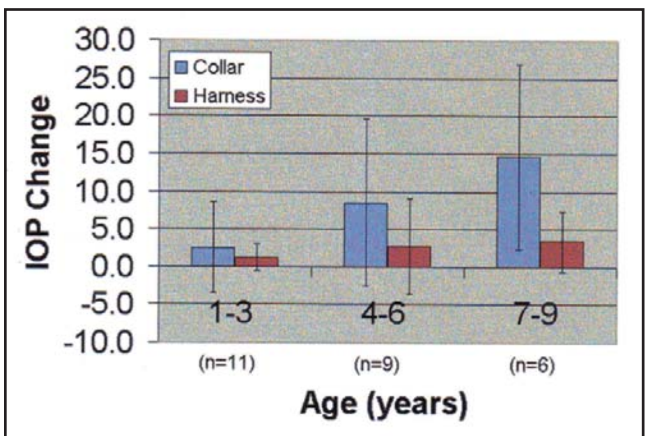

Figure 4—Comparison of intraocular pressure (IOP) increases (mm Hg) in dogs of different age groups when force was applied via a collar (blue bars) and a harness (purple bars). Bars represent mean IOP change ± standard deviation (n=number of dogs in each age group).

(R^2_{collar}=0.1014, $R^2_{harness}$=0.0113), or with the tension generated per kilogram body weight by the dog (R^2_{collar}=0.0009, $R^2_{harness}$=0.1187).

Discussion

A recent study in humans found that wearing a tight necktie may result in increased IOP.[5] In this study, it was proposed that the IOP increase was the result of compression of the jugular veins, which increased pressure in the veins to the head, including the episcleral veins of the eye. The elevated pressure in the episcleral veins may have increased the resistance for the outflow of aqueous humor from the eye.[5,6] Another proposed mechanism by which jugular venous compression may lead to increased IOP is secondary vascular engorgement of the anterior uvea and choroid, leading to an increase in the choroidal blood volume.[3] This increase in intraocular blood volume then results in a rapid rise in IOP. Either of the proposed mechanisms may occur in dogs wearing a collar, although the rapidity with which IOP increased (within 10 seconds) and decreased (within 1 minute) in the study reported here suggests that the latter mechanism may play a more important role. Elevated episcleral venous pressure would tend to result in somewhat slower changes in IOP, since IOP would increase only as continued aqueous humor production resulted in higher aqueous levels within the eye. In contrast, changes in uveal and choroidal blood volume and IOP can occur rapidly.[3,7,8]

A study of wind instrument players found a transient increase in IOP while playing wind instruments and a significantly greater incidence of visual field loss in players of high-resistance wind instruments compared to other musicians.[3] The elevation in IOP was proposed to result from a Valsalva maneuver, although subsequent debate occurred regarding this mechanism.[9] The Valsalva maneuver causes increased intrathoracic pressure, which results in increased jugular venous pressure, choroidal engorgement, and increased choroidal volume. These latter changes lead to elevated IOP.[3] The Valsalva maneuver was not likely a significant factor in the IOP changes experienced by the dogs in the current study, because the dogs were restrained at the time of force application. They were not actively straining, which is necessary for the Valsalva maneuver. When dogs are exercising on a leash, however, the Valsalva maneuver may contribute to the increase in IOP.

A trend for greater elevation in IOP in dogs of increasing age was noted in the present study. Although little is known about the effects of age on choroidal compliance in dogs, vascular compliance decreases with age in dogs.[10] Decreased compliance would lead to greater elevations in IOP from uveal and choroidal engorgement and may account for the changes found in this study. The role of corneal-scleral rigidity in any age-related changes remains unclear, and it is possible that older animals may have a less flexible cornea and sclera.

Alaskan malamutes and Siberian huskies tended to experience smaller changes in IOP than the other dogs in this study. Interestingly, some of the dogs bred to pull objects appeared to be somewhat resistant to an IOP increase. Chinooks are traditionally sled dogs; however, with only one Chinook in this study, no conclusion could be drawn regarding this breed. These breed differences may, in part, be related to differences in scleral rigidity, with certain breeds of dog having less scleral rigidity and smaller incremental changes in IOP under tension. In some Siberian huskies, the IOP actually decreased. Decreased IOP may result from the posture that dogs use to pull objects, because the positions that the dogs assumed when pulling or being pulled against varied between individuals and breeds. Many of the Alaskan malamutes and Siberian huskies assumed a lower body position when pulling, and they appeared to brace their shoulders when pulling or being pulled against, which could alter the amount of force actually applied to the jugular veins.

Although dogs with glaucoma were not included in this study, it is likely that their grossly abnormal aqueous humor dynamics would result in comparable, if not greater increases in IOP when exercising on a leash. A study in humans showed that there was no difference in IOP elevation between people with glaucoma and without glaucoma when pressure was applied to the neck.[5] In that study, however, the patients had primary open-angle glaucoma, which has a distinctly different pathophysiology from primary angle-closure glaucoma, which is the most common form of primary glaucoma in dogs.[11]

It is possible that even transient increases in IOP may have a detrimental effect on the eye. Short-term IOP elevation can alter perfusion of the optic nerve and retina.[12] One study detected measurable alterations in human optic nerve head topography after transient IOP elevations up to 50 mm Hg, which approached the 35 mm Hg increase in IOP that was experienced by one dog in the study reported here.[13] Limited studies in dogs and cats have shown that transient increases in IOP can cause short-term dysfunction of retinal photoreceptors.[14,15] The visual field loss experienced by wind instrument players discussed previously was related to the number of life-hours of playing.[3] The cumulative effect of the transient elevations in IOP detected in this study requires further investigation. The effects of IOP increase in dogs with glaucoma or a weakened cornea (i.e., corneal laceration or perforation, descemetocele, corneal incision following intraocular surgery, corneal graft procedures) also require further study.

Conclusion

Intraocular pressure was significantly increased from baseline values when a force was applied to the neck via a leash to a collar, but not to a harness, in the dogs of this study. Based on these results, dogs with weak or thin corneas, glaucoma, or any condition for which an increase in IOP could be harmful should wear a harness instead of a collar, especially during exercise or activity. Further studies are needed to evaluate whether IOP increases are greater in glaucomatous dogs while pulling against a collar or a harness.

[a] SL-14; Kowa, Tokyo, Japan
[b] Binocular indirect headset; Welch Allyn, Skaneateles Falls, NY 13153-0220
[c] Proparacaine; Fort Dodge Animal Health, Overland Park, KS 66335-5945
[d] Tono-Pen XL; Mentor, Jacksonville, FL 32216-0980
[e] DPS-220 Force Gauge; Imada, Inc., Northbrook, IL 60062
[f] http//bardeen.physics.csbsju.edu-Website for statistical calculation by College of Saint Benedict/Saint John's University, St. Joseph, MN 56374

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