Use of an electrothermal, feedback-controlled, bipolar sealing device for resection of the elongated portion of the soft palate in dogs with obstructive upper airway disease

David J. Brdecka, DVM, DACVS; Clarence A. Rawlings, DVM, PhD, DACVS; Amanda C. Perry, DVM; Jonathon R. Anderson, DVM

Objective—To evaluate efficacy and safety of using an electrothermal, feedback-controlled, bipolar sealing device (BSD) for resection of the elongated portion of the soft palate in brachycephalic dogs with upper airway obstruction.

Design—Uncontrolled clinical trial.

Animals—24 brachycephalic dogs with airway obstruction and elongated soft palate.

Procedures—In all dogs, the excess portion of the soft palate was resected with a BSD. A score for severity of clinical signs of respiratory tract obstruction was assigned before surgery, during the first 24 hours after surgery, and at the time of final follow-up 12 to 23 months after surgery. Potential scores ranged from 0 (no clinical signs even with moderate to vigorous activity) to 4 (agonal breathing or severe cyanosis).

Results—None of the dogs died or developed life-threatening complications after surgery. Clinical scores after surgery (mean ± SD, 0.3 ± 0.6) and at the time of final follow-up (0.9 ± 0.5) were significantly lower than preoperative scores (2.6 ± 0.8).

Conclusions and Clinical Relevance—Results indicated that a BSD can be safely used for resection of the elongated portion of the soft palate in brachycephalic dogs with upper airway obstruction. (*J Am Vet Med Assoc* 2008;233:1265–1269)

Upper airway obstruction with inspiratory dyspnea is common in brachycephalic dogs, especially English Bulldogs.[1] The most common lesion in affected dogs is elongation of the soft palate, although stenosis of the nares and hypoplasia of the trachea can also be seen.[1–3] Eversion of the laryngeal saccules and laryngeal collapse can develop secondary to upper airway obstruction.[1]

The standard treatment for dogs with elongation of the soft palate in which secondary laryngeal disease has not yet developed is resection.[2–10] Sharp excision with a scalpel or scissors followed by primary closure with apposition of the oropharyngeal and nasopharyngeal mucosa is the traditional method for removing the elongated portion of the soft palate.[11,12] More recently, use of electrocautery and low-temperature, high-frequency radiosurgery units for resection of the excess tissue has been described,[6,12] with suturing not required in most dogs in which a radiosurgery unit has been used for soft palate resection.[12] Use of a CO_2 laser for soft palate resection has also been described[13]; suturing was not required in most dogs, although special safety precautions were necessary. In 1 study,[14] resection of the soft palate with a CO_2 laser required less operative time than did the conventional incisional technique and yielded similar clinical outcomes.

From the Departments of Small Animal Medicine and Surgery (Brdecka, Rawlings, Anderson) and Physiology and Pharmacology (Rawlings), College of Veterinary Medicine, University of Georgia, Athens, GA 30602; and Pineywoods Veterinary Hospital, 4310 N Valdosta Rd, Valdosta, GA 31602 (Perry).
Address correspondence to Dr. Rawlings.

Abbreviation

BSD	Bipolar sealing device

An electrothermal, feedback-controlled BSD that permanently seals blood vessels up to 7 mm in diameter by means of a bipolar current adjusted on the basis of impedance to current flow through the tissue has been developed for use as an electrosurgical device during traditional open and endoscopic procedures.[15,16] In a previous study[17] in which histologic changes that occurred in the soft palate following resection with the BSD or a CO_2 laser were compared, the depth of tissue injury did not differ between the 2 devices. Hemorrhage control was excellent with both devices, but use of the BSD for soft palate resection was faster than was use of the CO_2 laser. Outcome of dogs with upper airway obstruction in which the BSD was used to resect the elongated portion of the soft palate has not been reported. The purpose of the study reported here, therefore, was to determine the efficacy of and complications associated with the use of an electrothermal, feedback-controlled BSD for resection of the elongated portion of the soft palate in brachycephalic dogs with upper airway obstruction.

Materials and Methods

Dogs—Twenty-four client-owned dogs with upper airway obstruction caused by elongation of the soft palate were included in the study. Dogs were included in the study only if they had clinical signs of upper airway obstruction and the soft palate was seen to extend past the cranial tip of the epiglottis during an examination of the oral cavity performed while the dog was anesthetized. Dogs with evidence of concurrent cardiac disease or aspiration pneumonia were excluded from the study. The study protocol was approved by the University of Georgia Veterinary Medical Teaching Hospital's Board; owners of all dogs included in the study provided written consent.

Study protocol—In all dogs, a clinical score for severity of signs of respiratory tract disease was assigned prior to surgery on the basis of history and physical examination findings. The scoring system was adapted from a scoring system used in a previous study.[14] Potential scores ranged from 0 to 4, where 0 = no clinical signs of respiratory tract disease, even with moderate to vigorous activity; 1 = mild coughing or gagging while eating or drinking or increased respiratory noise and rate with excessive activity or excitement; 2 = moderate coughing or gagging while eating or drinking or increased respiratory noise and pale mucous membranes with minimal activity or excitement; 3 = severe coughing or gagging not necessarily associated with eating or drinking, respiratory noise at rest or pale or cyanotic mucous membranes at rest; and 4 = agonal breathing or severe cyanosis. Scores were assigned independently by 2 of the authors (DJB and CAR), who then arrived at a mutually agreed on score for each dog. All dogs included in the study had a score ≥ 1 prior to surgery.

Dogs were anesthetized to allow examination of the upper airway and resection of the elongated portion of the soft palate. Most dogs were given a single dose of dexamethasone (1 mg/kg [0.45 mg/lb], IV) prior to anesthetic induction. Anesthetic protocols were selected on the basis of the attending anesthetist's preference, but in all instances, anesthesia was induced by means of IV drug administration. In most dogs, anesthesia was induced by means of IV administration of propofol or thiopental to effect, and following examination of the oral cavity, an endotracheal tube was placed and anesthesia was maintained with an inhalant anesthetic.

After surgery, dogs were maintained in the hospital's critical care unit and provided medical treatment as judged appropriate by the attending surgeon. The most consistent treatments involved administration of narcotic analgesic and sedative drugs during anesthetic recovery. Dogs were closely monitored for the first 24 hours after surgery, with special attention paid to respiratory effort and rate, gagging or coughing, respiratory noise, and activity. On the basis of clinical signs recorded during the first 24 hours after surgery, a single clinical score for severity of respiratory tract signs was assigned; the same scoring system used prior to surgery was used to assign postoperative clinical scores.

Owners were contacted by telephone between 12 and 23 months after surgery and asked to respond to a questionnaire regarding outcome after surgery. Owners were asked whether their dog had had any nasal discharge after surgery, whether their dog had ever developed aspiration pneumonia, and whether the owner had ever sought veterinary care for the dog because of respiratory tract problems after surgery. In addition, owners were asked to indicate how loud their dog's breathing was before surgery and at the time of follow-up and how active the dog was before surgery and at the time of follow-up. On the basis of owner responses to the questionnaire, a clinical score for severity of respiratory tract signs was assigned; the same scoring system used prior to surgery was used to assign scores.

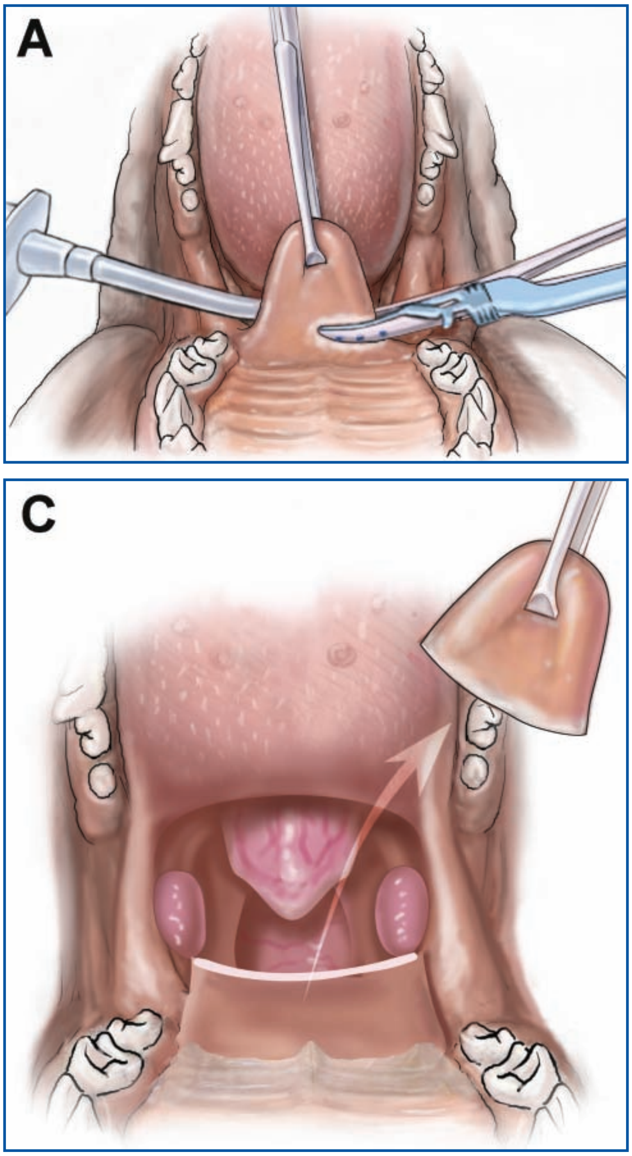
Surgical technique—For resection of the elongated portion of the soft palate, the dog was positioned in dorsal recumbency with the maxilla taped to the table in a horizontal position. The mouth was then opened to the fullest extent possible, and the mandible was taped in position. The soft palate was transected at the level of the cranial commissure of the tonsillar crypt. The most caudal tip of the soft palate was grasped on the midline with an Allis tissue forceps and pulled rostrally. Care was taken to retract excessive nasopharyngeal mucosa of the soft palate rostrally so that the eventual transection was similar on the dorsal and ventral surfaces of the soft palate. Excessive soft palate tissue was removed by placing the BSD on the lateral side of the soft palate at the cranial commissure of the tonsillar crypt. The BSD was set to its lowest setting and activated until 1 mm of blanched tissue appeared on either side of the forceps (**Figure 1**). The BSD was removed, and the palate was incised with Metzenbaum scissors, leaving no more than 1 mm of blanched tissue on the palate. The BSD was repeatedly repositioned, and tissue was incised until the resection extended to the midline. The BSD was then placed on the opposite side of the soft palate, and the procedure was repeated until the excessive portion of the soft palate was removed. In most instances, the BSD had to be placed twice on each side of the soft palate. The result was a concave excision of the soft palate, with at least 1 cm of soft palate left caudal to the hard palate to serve as an antireflux valve. No sutures were placed to appose the mucosal surfaces or to ligate the caudal palatine arteries.

Following removal of the elongated portion of the soft palate, stenosis of the nares and eversion of the laryngeal saccules were corrected when indicated, as determined by the attending surgeon.

Statistical analysis—The Komogorov-Smirnov test was used to determine whether data for clinical scores for the 3 time periods (before surgery, during the 24 hours after surgery, and at final follow-up) were normally distributed. Because data were nonparametric, values were summarized as mean and SD and indexed, and a 1-way repeated-measures ANOVA followed by the Holm-Sidak pairwise multiple comparison procedure were used to compare values among time periods. All analyses were performed with standard software.[b] A value of $P < 0.05$ was considered significant.

Results

Dogs included in the study consisted of 12 females and 12 males. Median age at the time of surgery was 37.3 months (range, 3 to 113 months). There were 20 English Bulldogs, 3 Pugs, and 1 French Bulldog. All dogs had clinical signs of upper airway obstruction prior to surgery and elongation of the soft palate evident during examination of the oral cavity. In addition



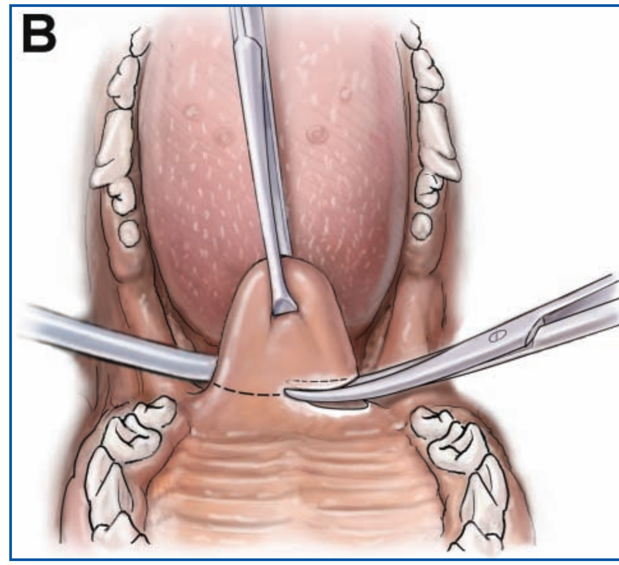


Figure 1—Illustration of the use of a BSD for resection of the elongated portion of the soft palate in a brachycephalic dog with upper airway obstruction. A—The BSD forceps was applied to the lateral aspect of the soft palate at the level of the cranial commissure of the tonsillar crypt and current was applied until 1 mm of blanched tissue was evident on either side of the forceps. B—The BSD forceps was removed, and the palate was incised with a Metzenbaum scissors, leaving no more than 1 mm of blanched tissue on the palate. C—The BSD was repeatedly repositioned and tissue was incised until the resection extended to the midline. The BSD was then placed on the opposite side of the soft palate, and the procedure was repeated until the excessive portion of the soft palate was removed. At least 1 cm of soft palate was left caudal to the hard palate. (Adapted from Brdecka D, Rawlings C, Howerth E, et al. A histopathological comparison of two techniques for soft palate resection in normal dogs. *J Am Anim Hosp Assoc* 2007;43:39–44. Reprinted with permission.)

to resection of the elongated portion of the soft palate, 6 dogs underwent reconstruction of stenotic nares and 5 dogs underwent laryngeal sacculectomy. None of the dogs died or developed life-threatening complications after surgery.

Preoperative clinical scores were available for all 24 dogs. Two dogs were assigned a score of 1, 9 were assigned a score of 2, 10 were assigned a score of 3, and 3 were assigned a score of 4. Clinical scores assigned during the 24 hours after surgery were available for 21 dogs, and clinical scores assigned at the time of long-term follow-up were available for 20 dogs. All dogs were followed up for at least 12 months, except for 1 dog that died of renal failure 8 months after surgery.

Mean ± SD preoperative clinical score was 2.6 ± 0.8, mean clinical score during the 24 hours after surgery was 0.3 ± 0.6, and mean clinical score at the time of final follow-up was 0.9 ± 0.5. Scores were significantly ($P < 0.001$) different among the 3 time periods. For all 21 dogs in which a clinical score was assigned during the 24 hours after surgery, the clinical score had improved by at least 1 point, compared with the preoperative score, with 16 of the 21 assigned a score of 0 during the 24 hours after surgery. For 19 of the 20 dogs in which a clinical score was assigned at the time of long-term follow-up, the clinical score had improved by at least 1 point, compared with the preoperative score, with 3 dogs assigned a score of 0 and 16 dogs assigned a score of 1. The 1 dog that did not have an improvement in clinical score was assigned a score of 2 prior to surgery, a score of 1 during the 24 hours after surgery, and a score of 2 at the time of final follow-up 23 months after surgery. Only 1 of 20 dogs for which long-term follow-up information was available required veterinary care for respiratory tract problems after surgery. This dog developed pneumonia 4 months after surgery and responded to antimicrobial treatment. Owners of 2 other dogs for which long-term follow-up information was available reported that their dogs occasionally had a clear nasal discharge, but that this discharge was intermittent, had not become worse, and did not require veterinary care.

Discussion

Results of the present study demonstrated that a BSD can be safely used for resection of the elongated portion of the soft palate in brachycephalic dogs with upper airway obstruction. Importantly, we did not identify any serious complications associated with the surgical procedure in the present study. This was similar to complication rates reported in 2 previous retrospective studies[18,19] involving 73 and 62 dogs, respectively. In one of those studies,[19] 1 dog died after surgery, and in the other,[18] although none of the dogs died, 5 had postoperative dyspnea severe enough that tracheostomy was required. In the present study, clinical scores were improved in all dogs during the 24 hours after surgery, compared with preoperative scores. Although this may, in part, have reflected postoperative measures for pain management and sedation, it also suggests that the BSD did not cause clinically important tissue injury or pharyngeal swelling. Comparing results of the present study with results of previously reported studies[1,2,13,14,18,19] is difficult because the present study was prospective, the percentage of cases for which follow-up information was available was low in other studies, cases in the present study were accumulated over a short period of time, and the percentage of dogs with multiple airway abnormalities may have differed among studies. Importantly, dogs with aspiration pneumonia or cardiac disease were specifically excluded from the present study. However, all of the dogs in the present study did have clinical signs of upper airway obstruction prior to surgery. Overall, results of the present study in combination with results of the 2 most recent studies[18,19] suggest that surgical correction of abnormalities associated with upper airway obstruction in brachycephalic dogs is associated with low complication rates, provided that adequate postoperative monitoring and management is provided.

Clinical scores obtained at the time of final follow-up in the present study were significantly improved, compared with preoperative scores, with 19 of 20 dogs having lower scores at this time than they did before surgery. In a previous retrospective study[19] of dogs undergoing surgery because of brachycephalic syndrome, owners of 34 of 62 dogs were contacted by telephone, and 16 of the 34 (47%) reported an excellent outcome and an additional 16 (47%) reported a good outcome. In another study,[18] owners of 46 of 73 dogs were contacted by telephone at least 19 months after surgery, and 26 of the 46 (57%) reported substantial improvement, 15 (33%) reported some improvement, and 5 (11%) reported no improvement. In both of these previous studies, as was the case in the present study, long-term follow-up information was obtained through telephone conversations with owners of treated dogs, and the individual who called the owner was also involved in case management, which may have affected the results. In addition, follow-up information was not available for substantial numbers of dogs in the previous studies. Nevertheless, we believe that our findings and those of these previous studies indicate that brachycephalic dogs with clinical signs of upper airway obstruction can have long-term benefits following surgical correction of elongated soft palate.

In previous studies,[18,19] the most common complication following soft palate resection was dyspnea. Inspiratory dyspnea has been attributed to pharyngeal edema and inflammation associated with the surgery.[11,19–21] However, some dogs may continue to have clinical signs following surgery because of concomitant abnormalities, such as hypoplasia of the trachea[19–21] and laryngeal collapse.[22,23] Treatments include sedation, pain management, supplemental oxygen, and corticosteroids.[1] When these treatments are not effective and surgical treatment of the upper airway obstruction is judged to be appropriate, a temporary tracheostomy may be needed.[11,19,20]

Long-term complications that have been reported in dogs that have undergone soft palate resection include aspiration pneumonia and nasal aspiration. In the present study, 1 dog had pneumonia after surgery, although it was transient, and 2 occasionally had clear nasal discharge, although there was no evidence of persistent nasal disease. Authors of a previous study[4] also did not see any evidence of nasal disease or swallowing problems after soft palate resection.

In the present study, we resected the soft palate at the level of the cranial commissure of the tonsillar crypt, which is more rostral than is recommended by some clinicians. In our experience, the more rostral resection has not been associated with more problems than a more caudal resection, and some dogs in which the soft palate was resected more caudally have required a second surgery. After surgery, sufficient soft palate must remain to serve as a flap valve to prevent reflux of food and water into the nasal cavity, and given that none of the dogs in the present study had signs of persistent rhinitis or nasal disease, we believe that our technique did provide a sufficient remnant of soft palate. Other clinicians have recommended that resection of the soft palate be performed such that the soft palate is barely in contact with the cranial tip of the epiglottis. However, in our experience, the position of the soft palate relative to the epiglottis varies depending on the amount of traction on the tongue and the relative positions of the head and neck.[10] In addition, previous authors[10] have suggested that the soft palate should be resected rostral to the tip of the epiglottis to provide pharyngeal space for ventilation.[10]

Positioning of the dog during resection of an elongate soft palate is largely a matter of surgeon preference, although we prefer that dogs be positioned in dorsal recumbency as this provides a direct view of the soft palate. Traction should be applied to the tongue, and the base of the tongue should be gently lifted away from the pharynx with a tongue depressor. Others have described positioning the dog in ventral recumbency,[1,19,20,24] but we find viewing of the soft palate more challenging with the dog in ventral recumbency. In addition, care must be taken to avoid external compression on the throat.

a. LigaSure with the Precise, Xtd, and Max handpieces, Covidien Animal Health, Mansfield, Mass.
b. SigmaStat, version 3.0, Systat Software Inc, Point Richard, Calif.

References

1. Hedlund CS, Fossum TW. Surgery of the upper respiratory system. In: Fossum TW, ed. *Small animal surgery.* 2nd ed. St Louis: Mosby, 2002:716–759.
2. Knecht CD. Upper airway obstruction in brachycephalic dogs. *Compend Contin Educ Pract Vet* 1979;1:25–30.
3. Baker GJ. Surgery of the canine pharynx and larynx. *J Small Anim Pract* 1972;13:505–513.
4. Harvey CE, Venker-van Haagen AJ. Surgical management of

pharyngeal and laryngeal airway obstruction in the dog. *Vet Clin North Am Small Anim Pract* 1975;5:515–535.
5. Hofmeyr CFB. Surgery of the pharynx. *Vet Clin North Am Small Anim Pract* 1972;2:3–16.
6. Leonard HC. Collapse of the larynx and adjacent structures in the dog. *J Am Vet Med Assoc* 1960;137:360–363.
7. Schlotthauer CF. Congenital defects of the stomach of a dog. *J Am Vet Med Assoc* 1929;28:370–371.
8. Singleton WB. Partial velum palatectomy for the relief of dyspnea in brachycephalic breeds. *J Small Anim Pract* 1962;3:215–216.
9. Farquharson J, Smith KW. Resection of the soft palate in the dog. *J Am Vet Med Assoc* 1942;C:427–430.
10. Harvey CE. Soft palate resection in brachycepalic dogs. *J Am Anim Hosp Assoc* 1982;18:538–544.
11. Bright RM, Wheaton LG. A modified surgical technique for elongated soft palate in dogs. *J Am Anim Hosp Assoc* 1983;19:288–292.
12. Elkins AD. Soft palate resection in brachycephalic dogs. *Vet Forum* 2005;22:43–46.
13. Clark GN, Sinibaldi KR. Use of a carbon dioxide laser for treatment of elongated soft palate in dogs. *J Am Vet Med Assoc* 1994;204:1779–1781.
14. Davidson EB, Davis MS, Campbell GA, et al. Evaluation of carbon dioxide laser and conventional incisional techniques for resection of soft palates in brachycephalic dogs. *J Am Vet Med Assoc* 2001;219:776–781.
15. Heniford BT, Matthews BD, Sing RF, et al. Initial results with an electrothermal bipolar vessel sealer. *Surg Endosc* 2001;15:799–801.
16. Kennedy JS, Stranahan PL, Taylor KD, et al. High-burst-strength, feedback-controlled bipolar vessel sealing. *Surg Endosc* 1998;12:876–878.
17. Brdecka D, Rawlings C, Howerth E, et al. A histopathological comparison of two techniques for soft palate resection in normal dogs. *J Am Anim Hosp Assoc* 2007;43:39–44.
18. Torrez CV, Hunt GB. Results of surgical correction of abnormalities associated with brachycepalic airway obstruction syndrome in dogs in Austrailia. *J Small Anim Pract* 2006;47:150–154.
19. Riecks TW, Birchard SJ, Stephens JA. Surgical correction of brachycephalic syndrome in dogs: 62 cases (1991–2004). *J Am Vet Med Assoc* 2007;230:1324–1328.
20. Monnet E. Brachycephalic airway syndrome. In: Slatter D, ed. *Textbook of small animal surgery*. 3rd ed. Philadelphia: Saunders, 2003;808–813.
21. Wykes PM. Brachycepahlic airway obstructive syndrome. *Probl Vet Med* 1991;3:188–197.
22. Koch DA, Arnold S, Hubler M, et al. Brachycephalic syndrome in dogs. *Compend Contin Educ Pract Vet* 2003;25:48–55.
23. Pink JJ, Doyle RS, Hughes JM, et al. Laryngeal collapse in seven brachycephalic puppies. *J Small Anim Pract* 2006;47:131–135.
24. Gourley IM, Gregory CR. Soft palate resection. In: Gourley IM, Gregory CR, eds. *Atlas of small animal surgery.* New York: Gower, 1992;4.6–4.8.

Selected abstract for *JAVMA* readers from the *American Journal of Veterinary Research*

Respiratory alkalosis and primary hypocapnia in Labrador Retrievers participating in field trials in high–ambient-temperature conditions

Janet E. Steiss and James C. Wright

Objective—To determine whether Labrador Retrievers participating in field trials develop respiratory alkalosis and hypocapnia primarily in conditions of high ambient temperatures.

Animals—16 Labrador Retrievers.

Procedures—At each of 5 field trials, 5 to 10 dogs were monitored during a test (retrieval of birds over a variable distance on land [1,076 to 2,200 m]; 36 assessments); ambient temperatures ranged from 2.2° to 29.4°C. For each dog, rectal temperature was measured and a venous blood sample was collected in a heparinized syringe within 5 minutes of test completion. Blood samples were analyzed on site for Hct; pH; sodium, potassium, ionized calcium, glucose, lactate, bicarbonate, and total CO_2 concentrations; and values of Pv_{O_2} and Pv_{CO_2}. Scatterplots of each variable versus ambient temperature were reviewed. Regression analysis was used to evaluate the effect of ambient temperature (≤ 21°C and > 21°C) on each variable.

Results—Compared with findings at ambient temperatures ≤ 21°C, venous blood pH was increased (mean, 7.521 vs 7.349) and Pv_{CO_2} was decreased (mean, 17.8 vs 29.3 mm Hg) at temperatures > 21°C; rectal temperature did not differ. Two dogs developed signs of heat stress in 1 test at an ambient temperature of 29°C; their rectal temperatures were higher and Pv_{CO_2} values were lower than findings in other dogs.

Conclusions and Clinical Relevance—When running distances frequently encountered at field trials, healthy Labrador Retrievers developed hyperthermia regardless of ambient temperature. Dogs developed respiratory alkalosis and hypocapnia at ambient temperatures > 21°C. (*Am J Vet Res* 2008;69:1262–1267)