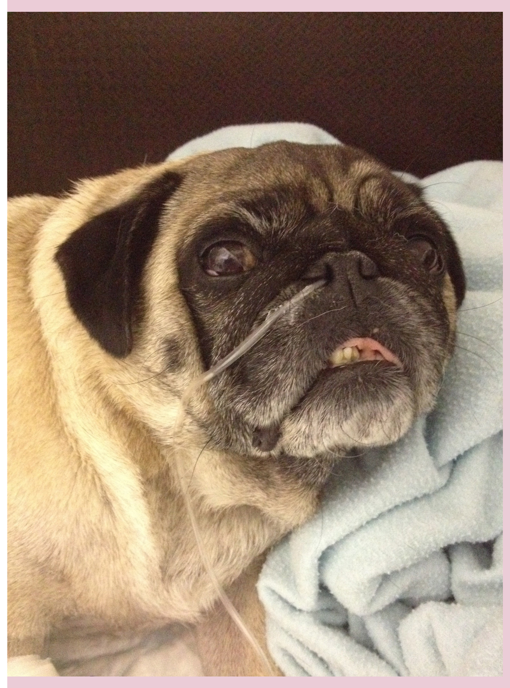
Use of Cone Beam CT for Objective Assessment of BOAS

MVDr. Jana Langerová, Animal Clinic Praha
MVDr. Ludmila Bicanová, Animal Clinic Praha

Summary

The goal of this study was to find an objective diagnostic approach in BOAS cases by using a combination of Cone Beam CT and endoscopic evaluation of the respiratory system in brachycephalic dogs. In the study were included 22 brachycephalic dogs and as a control group 31 normocephalic dogs. All brachycephalics had at least one of the BOAS symptoms. All patients underwent head and pharyngeal area computed tomography. All patients with brachycephalic syndrome were also endoscopically evaluated. The study looks for a correlation between the lenght and width of the soft palate relative to the meatus pharyngeus diameter and compares measurements in brachycephalic and normocephalic dogs.



Preface

Brachycephalic dogs have very unique upper respiratory anatomy which in some cases can lead to upper airway obstruction.[1,2] The typical anatomic abnormalities are shortened skull, compressed nasal passage, stenotic nares, enlarged tonsils, elongated and hypertrophic soft palate, everted laryngeal saccules, narrowed rima glottidis and collapse of the larynx and trachea.[3] In most of these dogs a combination of compressed and shortened structures of upper airway leeds to increased negative pressure on inspiration to adequate ventilation.[4,5] The primary components of BOAS are stenotic nares, elongated soft palate and hypoplastic trachea. Secondary components such as everted laryngeal saccules (Fig.1), soft palate thickening, laryngeal collapse and everted tonsils are the result of high negative pressure. The effect of BOAS on gastrointestinal tract is also not negligible.[1,6,7,8]

Fig.1 Everted laryngeal saccules

Materials and Methods

A total of 22 brachycephalic dogs which underwent CT imaging of the skull in the time between March 2013 and August 2014 at our Clinic were included in this study. The most common breed was the French bulldog (n 6), followed by pug (n 4), boxer (n 3), English bulldog (n 2), chihuahua (n 2), Boston terrier (n 1), bullmastiff (n 1), Yorkshire terrier (n 1), Cavalier King Charles spaniel (n 1) and griffon (n 1).

A total of 31 dogs from different breeds were included in the group of normocephalic dogs. They underwent the CT imaging of the skull because of different reasons than respiratory disorders.

Computed tomographic imaging by Cone Beam CT (CBCT) was used (Fig.2). It is quite a new imaging technology which has found its use in veterinary medicine in last three years. In contrast with fan-beam CT, CBCT reaches the image by rotation of one X-ray tube around the patient. Beams passing through the object are caught by dynamic flat-panel detector on the opposite side and the data is processed for picture reconstruction by the computer. As in a conventional CT transversal, sagital and dorsal reconstruction of the image are created. In addition, images can be processed into a 3D reconstruction.

Fig.2 Fidex Cone Beam CT

The CT scan was performed on all dogs in sternal recumbency in an extended neutral position under general inhalation anaesthesia with isoflurane in oxygen administered via a cuffed endotracheal tube.

The measurements were taken in the midsagittal images at the level of the deepest point of sella turcica. At this projection the length of the soft palate (SPL) from the caudal margin of the hard palate to the tip of the soft palate (Fig.3) and the width of the soft palate (SPW) at the level of sella turcica (Fig.4) and the dorsoventral cross-sectional diameter of the meatus nasopharyngeus (MNP) (Fig.5) were measured. The absolute numbers could not be compared directly because of the difference in the breeds present. Therefore the ratio between SP length and MNP diameter and the ratio between SP width and MNP diameter were used. These were summarised as the mean (resp. median) and were compared between the brachycephalic and normocephalic groups.

All the brachycephalic dogs also underwent a retrograde endoscopical examination of nasopharynx and laryngo-, tracheo- and bronchoscopy for further BOAS evaluation.

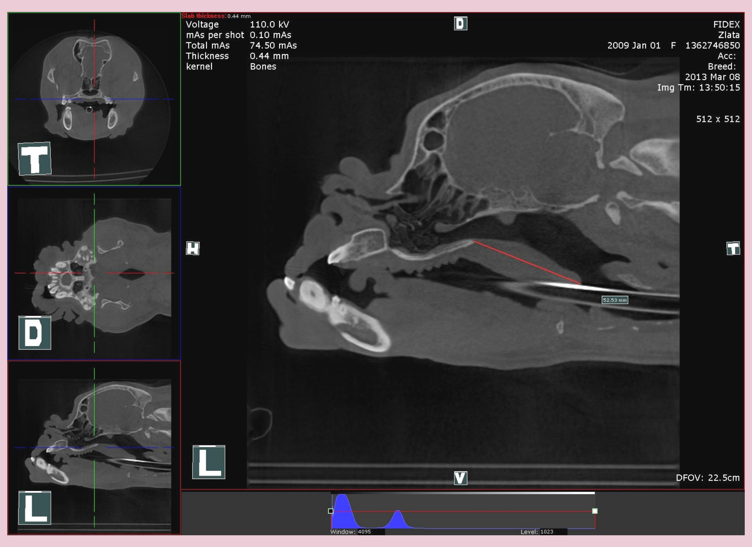
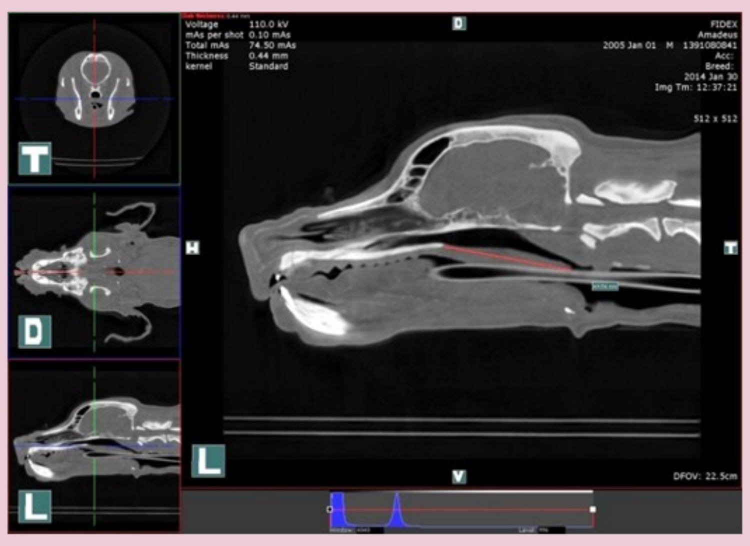


Fig.3 Measurement of soft palate length (SPL)



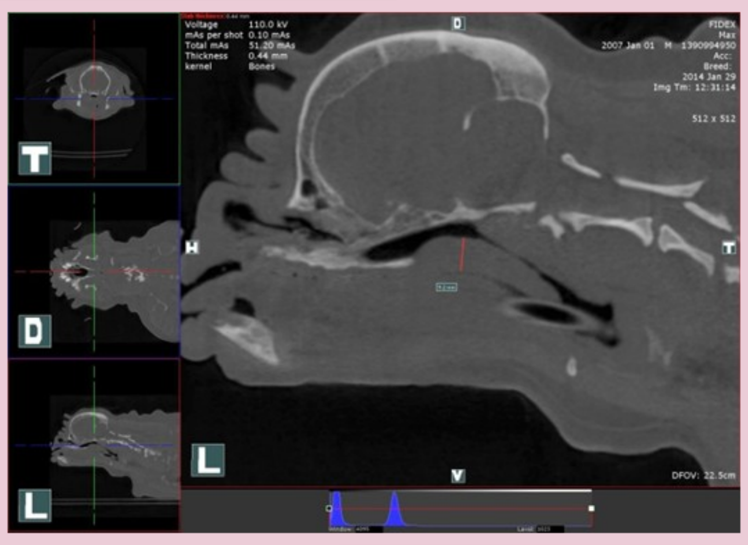


Fig.4 Measurement of soft palate width (SPW)

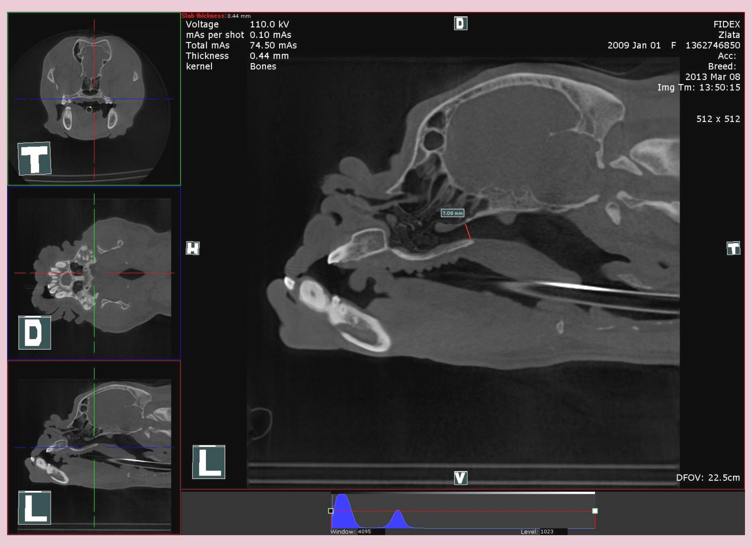
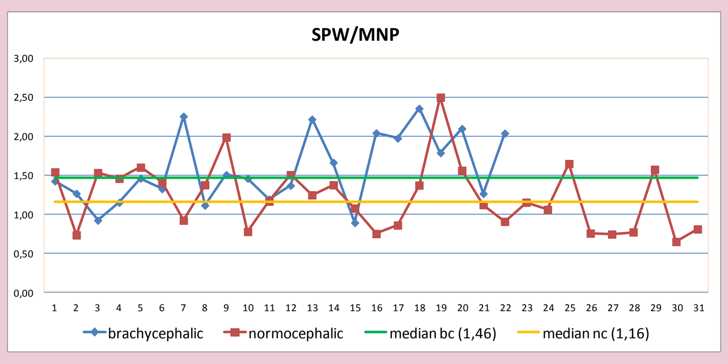


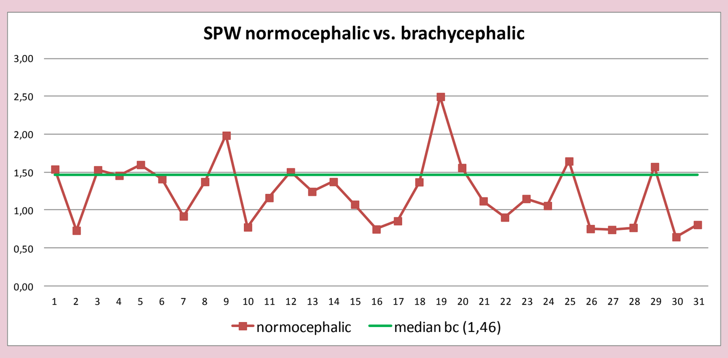
Fig.5 Measurement of meatus nasopharyngeus diameter (MNP)

Results

The most obvious finding in our study is that brachycephalic dogs have significantly thicker soft palates compared to normocephalic dogs. (Tab.1) The majority of the normocephalic dogs have the SPW/MNP ratio under the median value of the brachycephalic dogs. (Tab.2)

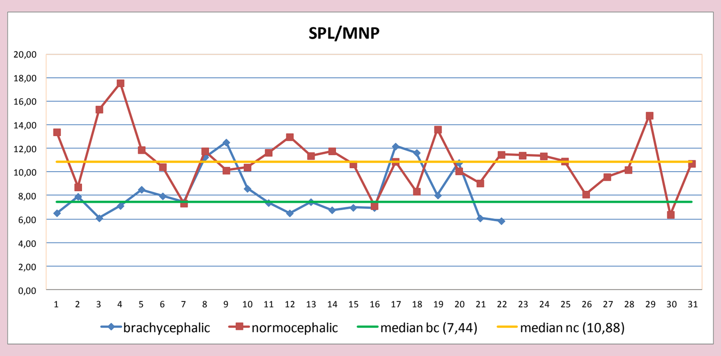


Tab.1 Soft palate width compared to meatus nasopharyngeus diameter in brachy- and normocephalic dogs

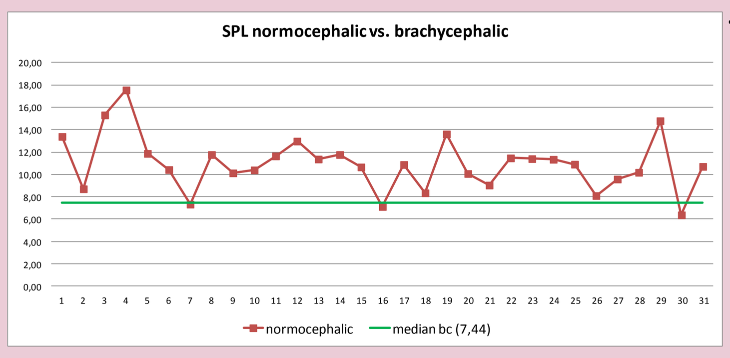


Tab.2 Soft palate width in normocephalic dogs compared to median of SPW in brachycephalic dogs

Interestingly enough, this was not proven by the length of the soft palate. The majority of the normocephalic dogs have the SPL/MNP ratio above the median value of the brachycephalic dogs. (Tab.3,4)



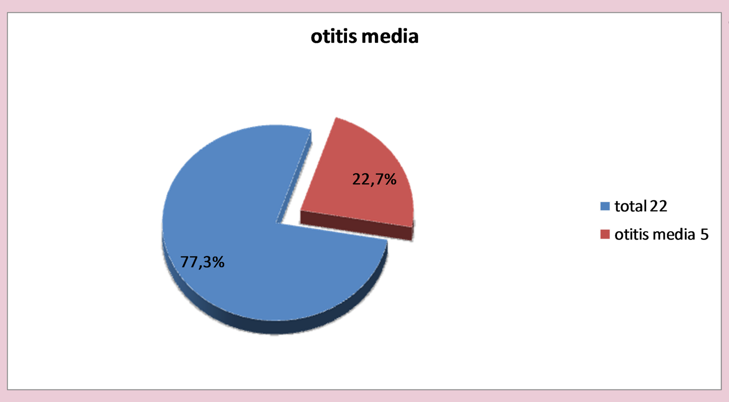
Tab.3 Soft palate length compared to meatus nasopharyngeus diameter in brachy– and normocephalic dogs



Tab.4 Soft palate length in normocephalic dogs compared to median of SPL in brachycephalic dogs

Anyway, we could not find any clear line for the objective assessment of the width or the length of the soft palate. This evaluation still remains very subjective and dependent on the surgeon‘s experience.

As an incidental finding in the significant part (22,7%) of the examined brachycephalic dogs fluid or solid material in tympanic bulla was found. (Tab.5) (Fig.6) Dogs with other skin disorders were excluded from this calculation.



Tab.5 Incidental finding of otitis media in significant part of brachycephalic dogs

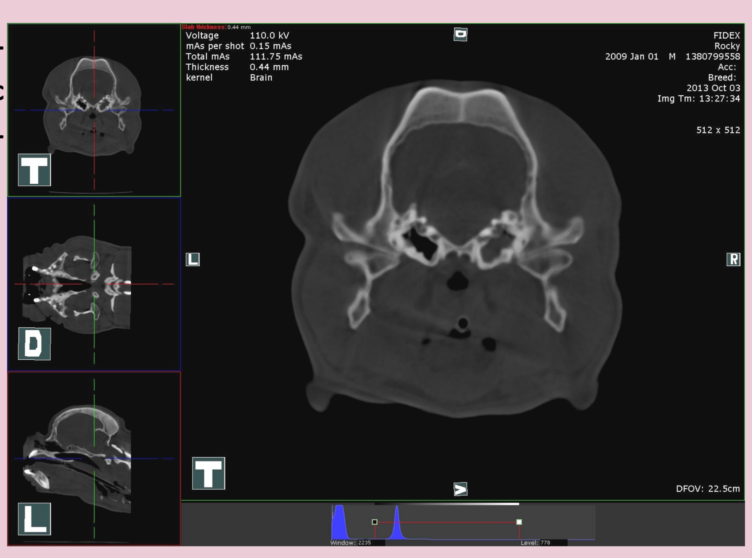


Fig.6 Fluid or solid content in the right tympanic bulla of the brachycephalic dog

Discussion

Our measurements confirm the findings in recent studies in which the soft palate width seems to be a very important component in patients with severe signs of BOAS (Brachycephalic Obstructive Airway Syndrom).[11] Whether this thickening is a primary abnormality or a secondary event could not be determined. This thickening could be explained by a muscular hypertrophy, mucosal oedema, or both. This modifications could be induced as an adaptation to the increased intranasal airflow resistance at the level of nares, vestibulum nasi and cavum nasi.[3,7,10]

Critical attitude has to be taken in assessment of the soft palate length because the measurements were made on static CT scan images on sleeping dogs with endotracheal tube so the dynamic features in awake and asleep states with regard to the respiratory phase could not be compared.[3]

Conclusion

Currently, the combination of CT imaging and endoscopy is considered to be a gold standard in evaluation of the severity of BOAS.[3,9,10]

The endoscopy allows to assess the in situ conditions and evaluate the dynamic airway features during the respiratory cycle. By the retrograde endoscopy the nasopharynx diameter, mucosal and/or lymphatic tissue hyperplasia, caudal aberrant turbinates presence can be detected. (Fig.7) The trachea and bronchi are then observed for the presence of collapse or other anomalies. Interestingly, the left-side cranial subsegmental branches are affected more often than the right-side bronchi.[4] Also, it has been recommended by some authors to assess the GI tract during the endoscopy because of the presence of typical gastrointestinal disorders in these breeds. Some evidence-based studies show better recovery from corrective surgery of BOAS in patients treated simultaneously with antacids and prokinetics.[6,12,14]

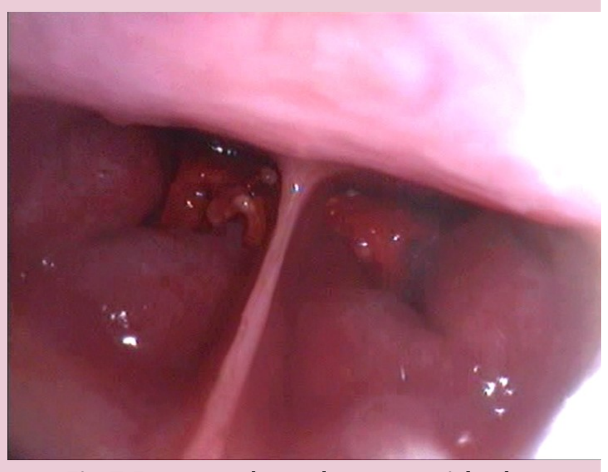


Fig.7 Retrograde endoscopy with aberrant caudal turbinates

Computer tomography is a non-invasive imaging method that permits a detailed assessment of the entire upper airways. Especially, the nose structure of brachycephalic dogs is very complicated. Oechtering and others utilized this in 2007 and they proved the hypothesis of abnormal intranasal structures such as rostral and caudal aberrant turbinates, narrowed asymmetric and distorted nasal passages, mucosal folds, deviation of the nasal septum, nasal conchae occupying the nasal passages and meatus nasopharyngeus etc. (Fig.8) This clarified why the outcome after the surgical correction of stenotic nares, elongated soft palate and everted laryngeal saccules is not always satisfactory.[10] Using the CT imaging also allows us to asses the structural characteristics of the pharynx, especially the length and width of the soft palate.[3]

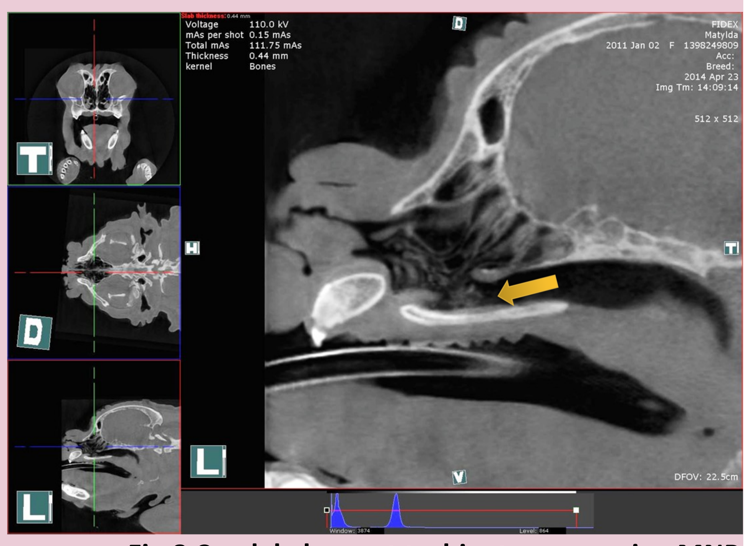


Fig.8 Caudal aberrant turbinates occupying MNP

On the basis of this examination it is possible to assess critically the severity of BOAS in the concrete patient and schedule the individual plan of treatment and eliminate the risks. Many studies support the suggestion that young immature brachycephalic dogs with BOAS should undergo assessment and, if required, surgery as soon as possible because of severe secondary changes.[13,14]

In conclusion these patients still remain a diagnostic challenge. Despite all known information an objective system for BOAS evaluation is still missing. The assessment is more subjective and a successful outcome is strongly dependent on the surgeon´s experience.

References

1. Fasanella, F. J., Shivley, J. M., Wardlaw, J. L., Givaruangsawat, S. Brachycephalic airway obstructive syndrome in dogs: 90 cases (1991-2008). JAVMA 2010; 237, 1048-1051
2. Wykes, P.M., Brachycephalic airway obstructive syndrome, Probl Vet Med 1991;3:188-197
3. Grand, J-G. R., Bureau, S. Structural characteristics of the soft palate and meatus nasopharyngeus in brachycephalic and non-brachycephalic dogs analysed by CT. Journal of Small Animal Practice 2011; 52, 232-239
4. De Lorenzi, D., Bertoncello, D., Drigo, M. Bronchial abnormalities found in a consecutive series of 40 brachycephalic dogs. JAVMA 2009; 235, 835-840
5. McFawn, P.K., Mitchell, H.W. Effect of transmural pressure on preloads and collapse of immature bronchi, Eur Respir J 1997; 10:322-239
6. Lecoindre, P., Richard, S. Digestive disorders associated with the chronic obstructive respiratory syndrome of brachycephalic dogs: 30 cases (1999-2001). Revue Méd. Vét. 2004; 155, 141-146
7. Pichetto, M., Arrighi, S., Roccabianca, P., Romussi, S. The anatomy of the dog soft palate. II. Histological evaluation of the caudal soft palate in brachycephalic breeds with grade I brachycephalic airway obstructive syndrome. The Anatomical Record 2011; 294, 1267-1272
8. Hendericks, J.C., Recognition and treatment of congenital respiratory tract defects in brachycephalics. In: Bonagura J.D., Kirk R.W., eds. Kirk´s current veterinary Therapy XII. Philadelphia: Saunders, 1995; 892-894
9. Hussein, A. K., Sullivan, M., Penderis, J. Effect of brachycephalic, mesaticephalic, and dolichocephalic head conformations on olfactory bulb angle and orientation in dogs as determined by use of in vivo magnetic resonance imaging. AJVR Jul 2012; 7: 946-951
10. Oechtering, T. H., Oechtering, G. U., Noeller, C. Computed tomographic imaging of the nose in brachycephalic dog breeds. Tierärztliche Praxis Kleintiere 2007; 35, 177-187
11. Findji, L., Dupré, G. Folded flap palatoplasty for treatment of elongated soft palate in 55 dogs. Wiener Tierärztliche Monatsschrift 2008; 95, 56-63
12. Poncet, C. M., Dupré, G. P., Freiche, V. G., Bouvy, B. M. Long-term results of upper respiratory syndrome surgery and gastrointestinal tract medical treatment in 51 brachycephalic dogs. Journal of Small Animal Practice 2006; 47, 137-142
13. Pink, J. J., Doyle, R. S., Hughes, J. M. L., Tobin, E., Bellenger, C. R. Laryngeal collapse in seven brachyce phalic puppies. Journal of Small Animal Practice 2006; 47, 131-135
14. Torrez, C. V., Hunt, G.B. Results of surgical correction of abnormalities associated with brachycephalic airway obstruction syndrome in dogs in Australia. Journal of Small Animal Practice 2006; 47, 150-154

Adresa autora: MVDr. Jana Langerová, Animal Clinic Bílá Hora, Čistovická 44, Praha 6
www.animalclinic.cz