Durand, A., Finck, M., Sullivan, M., and Hammond, G. (2016) Computed tomography and magnetic resonance diagnosis of variations in the anatomical location of the major salivary glands in 1680 dogs and 187 cats. Veterinary Journal, 209, pp. 156-162.

Evaluation of the Ventro20°Rostral-DorsoCaudal Oblique radiographic projection for the investigation of canine nasal disease

M. FINCK, A. DURAND, G. HAMMOND, M. SULLIVAN, A. KING

Marlene Finck, DVM MRCVS, marlene_finck@hotmail.fr

Alexane Durand, DVM MRCVS, 2055281D@student.gla.ac.uk

Gawain Hammond, MA VetMB MVM CertVDI DipECVDI FHEA MRCVS, Gawain.hammond@glasgow.ac.uk

Martin Sullivan, BVMS PhD DVR DipECVDI MRCVS, martin.sullivan@glasgow.ac.uk

Alison King, BVMS MVM DVR DipECVDI MRCVS, Alison.king@glasgow.ac.uk

From the School of Veterinary Medicine, College of Medicine, Veterinary Medicine & Life Sciences, University of Glasgow, Bearsden Road, Glasgow G61 1QH, Scotland.

Address correspondence and reprint request to Marlene Finck at the above address. E-mail: marlene_finck@hotmail.fr; +447791236606

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OBJECTIVE: To assess the ventro 20° rostral-dorsocaudal oblique (V20R-DCdO) projection for canine nasal disease as an alternative to the dorsoventral intra-oral (DVIO) view.

METHODS: Thirty-one dogs with nasal disease underwent radiography and CT with final diagnosis achieved through rhinoscopy, biopsy or cytology. Three independent observers, blinded to diagnosis, reviewed the nasal radiographs on two separate occasions. Intra- and inter-observer agreement and level of confidence on radiographic diagnosis was evaluated and radiographic diagnosis was compared with CT and definitive diagnosis.

RESULTS: The V20R-DCdO projection of canine nasal cavities was feasible in anaesthetised patients and gave diagnostic quality images in most dogs. Assessment of this view showed moderate to substantial agreement with CT diagnosis but gave lower confidence in diagnosis. Interpretation of this radiographic projection had substantial to almost perfect repeatability but moderate reproducibility.

CLINICAL SIGNIFICANCE: The V20R-DCdO projection may be used as a valuable initial screening tool for canine nasal pathology in practices without access to advanced imaging, although CT is still likely to provide greater diagnostic information.

Key words: canine, radiography, nasal disease.

INTRODUCTION

Nasal disease presents a diagnostic challenge due to non-specific clinical signs resulting from different nasal disorders (Tasker et al. 1999, Lefebvre et al. 2005). The radiological features of common nasal diseases have been described (Sullivan et al. 1986, Sullivan et al. 1987, Russo et al. 2000). Previous studies have shown radiography to have a poor specificity in differentiating inflammatory rhinitis from neoplasia or fungal rhinitis (Tasker et al. 1999, Lefebvre et al. 2005). However high accuracy and positive predictive value was found when differentiating rhinitis and nasal neoplasia based on the combination of radiographic signs (Russo et al. 2000).

Computed tomography (CT) shows a high degree of accuracy for chronic canine nasal disease (Thrall et al. 1989, Saunders et al. 2002, Saunders et al. 2003, Lefebvre et al. 2005). Endoscopy can deliver excellent sensitivity, enabling visualisation of most neoplastic masses, foreign bodies and fungal plaques, and allows guided sampling to gain a definitive diagnosis (Lent & Hawkins 1992, Tasker et al. 1999, Peeters et al. 2007).

While CT and rhinoscopy are now commonly available in referral veterinary institutions, first opinion practices frequently only have access to radiography.

Several radiographic views are used for assessment of the nasal cavity, with the dorso-ventral intra-oral view (DVIO) being considered the single most useful, as the nasal cavities are projected without superimposition of the mandible (Thrall et al. 1989, Saunders et al. 2003, Lamb, 2006). However, digital radiography systems may limit intra-oral imaging due to potential damage to expensive equipment. Intra-oral positioning of a flexible phosphor plate can lead to bite marks, causing irreversible damage but keeping the plate in the rigid protective cassette prevents it being positioned far enough caudally in the oral cavity to allow examination of the entire caudal nasal cavity and cribriform plate. Intra-oral radiography is not feasible with direct digital radiography detectors as they are too bulky (Widmer, 2008).

The ventro 20° rostral-dorsocaudal oblique (V20R-DCdO) projection of the nasal cavity (open mouth VD) reduces superimposition of the mandible without requiring the placement of film in the oral cavity thereby allowing clearer visualisation of the caudal aspect of the nasal cavity and of the cribriform plate (Schwarz et al. 2000a). The open mouth VD view has been evaluated with good results in canine cadavers (Schwarz et al. 2000a, Schwarz et al. 2000b) but to the authors' knowledge this projection has not been assessed in live dogs.

The aims of this study were to assess the feasibility of performing V20R-DCdO projections of the canine nasal cavity using a digital radiography system, and to evaluate the accuracy of the V20R-DCdO projection combined with a lateral projection for assessment and diagnosis of nasal disease. It was hypothesized that 1) the V20R-DCdO projection of nasal cavities in dogs under general anaesthesia would be feasible but time consuming; 2) observer experience would influence diagnostic accuracy when interpreting V20R-DCdO radiographs.

MATERIALS AND METHODS

This study was approved by the Ethics and Welfare Committee of our Institution.

Dogs presenting for investigation of chronic nasal disease were prospectively recruited from September 2012 to March 2014. Inclusion criteria required a final diagnosis through rhinoscopy, biopsy or cytology. Under the same anaesthetic radiographic and CT examinations of the nasal cavity were performed, followed by rhinoscopy +/- biopsy. Dogs with non-diagnostic radiographs were excluded from statistical analysis.

Each nose was radiographed in lateral and V20R-DCdO projections. This was performed randomly either immediately before or after CT using the same x-ray machine (Siemens Multix Top, Erlangen, Germany), cassettes and phosphor screen (CRMM3.0 Extremities Plate and Cassette, AGFA-Gevaert, Mortsel, Belgium), and processor (CR 35-X, AGFA-Gevaert, Mortsel, Belgium) with a non-grid technique and exposure settings of 55kV and 3.5mAs or 56kV and 5mAs depending on patient size. For the V20R-DCdO, the patients were positioned in dorsal recumbency in a trough (Redmark cradles, United Kingdom) with a small foam wedge under the neck to straighten the head and align the hard palate parallel to the table, secured with tape (Fig 1). The mandible was opened as far as possible using ties. A T-connector was placed between the endotracheal tube and the breathing system to avoid superimposition on the nasal cavity. The x-ray beam was then angled at 20° from the vertical, orientated rostro-ventrally to dorso-caudally and centred at the level of mid-hard palate (Fig 2). For the lateral view, the head was positioned in right lateral recumbency and the x-ray beam was centred at the level of mid-nasal cavities. Ease of positioning was assessed subjectively and study duration for each patient was estimated.

CT examination was performed using a dual slice CT scanner (Siemens Somatom Spirit, Siemens AG, Erlangen, Germany). Dogs were positioned in ventral recumbency. The field of view extended from the rostral aspect of the nares to the caudal aspect of the frontal sinuses. Images were reformatted with high-frequency image reconstruction algorithm (proprietary term "turbinate") and low-frequency image reconstruction algorithm (proprietary term "soft tissue").

Rhinoscopy and sampling were performed after imaging. If rhinoscopic examination was normal or if a nasal foreign body was removed, no sampling was performed. If fungal plaques were identified, sampling for culture was done. In all other cases, endoscopy-guided biospies were taken. The definitive diagnosis for each patient was based on a combination of CT, rhinoscopy, biopsy and/or culture, and classified as normal, inflammatory rhinitis, fungal rhinitis, neoplasia or other (e.g. foreign body). The category inflammatory rhinitis included lymphoplasmacytic, eosinophilic, and mixed infiltrates and/or bacterial infections. The category 'normal' included patients with clinical signs but for which CT and rhinoscopy identified no naso-sinusal anomaly. If CT and biopsy results and/or culture disagreed, final diagnosis was supported by clinical response to treatment, and if performed follow up imaging and/or biopsies.

Three independent observers (two board-certified radiologists, “A” and “B” and one first year radiology resident, “C”), blinded to the identity, signalment,history and final diagnosis, reviewed the radiographs on two separate occasions at least one month apart. Radiographic sets were randomised for each reading session. Each observer was asked to judge if the radiographs were of diagnostic quality, assess and grade multiple features based on the V20R-DCdO view. They then assessed the lateral view and stated if it provided any additional information. The grading scheme for the features, diagnosis and confidence is detailed in Table 1.

All the CT studies were subsequently interpreted consensually by the two board-certified radiologists, who assessed and graded the same features as above, gave a final imaging diagnosis and a level of confidence (Table 1).

Statistical analysis was performed with commercially available software (Stata® SE 12.1 College Station, Texas, USA). Intraobserver and interobserver agreements for radiographic individual criteria, diagnosis and level of confidence were determined by calculating either the weighted or non-weighted kappa statistics. Strength of agreement was determined based on the following values: ≤0.20 slight agreement, 0.21-0.40 fair agreement, 0.41-0.60 moderate agreement, 0.61-0.80 substantial agreement and 0.81-1.00 almost perfect agreement (Petrie & Watson, 2006).

Agreement of radiographic diagnosis and level of confidence of the readings of each observer with that of CT was also determined by calculating either the weighted or non-weighted kappa statistics. Agreement between definitive diagnosis and radiographic diagnosis of each observer was determined by calculating the non-weighted kappa statistics.

Sensitivity, specificity, positive predictive value and negative predictive value of radiographic diagnosis of the readings of each observer versus definitive diagnosis were calculated. For this purpose, the negatives were not non-diseased but just not diseased with the positive group diagnosis.

RESULTS

Thirty-one dogs were recruited. For breed distribution please see Table 2. There were 20 males and 11 females. Mean age at presentation was 7.1 years (SD 4.0; range 1–17). Definitive diagnoses were inflammatory rhinitis (n=16), neoplasia (n=10), fungal rhinitis (n=3), nasal foreign body (n=1) and normal (n=1).

Initially 20-30 minutes were required to achieve correct positioning and take both radiographic nasal views. With increasing experience this time decreased to 10-15 minutes.

Two dogs were excluded from statistical analysis because the radiographs were non-diagnostic. In one the V20R-DCdO was severely rotated and repeat radiographic study was curtailed due to an anaesthetic instability. In the second (a Boxer), the nasal cavities were very symmetrical, but there was persistent superimposition of the calvarium. The radiographers felt that it was easier to position mesaticephalic patients.

Radiographs of 29 dogs were considered diagnostic by all observers.

Sensitivity, specificity, PPV, NPV for radiographic diagnosis of each observer were calculated for rhinitis and neoplasia only and are summarised in Table 3. Low numbers of normal, fungal rhinitis or other cases precluded calculation of these values. Radiographic sensitivity for rhinitis varied among observers from 46.7% to 73.3%; specificity from 85.7% to 100%; PPV from 77.8% to 100% and NPV from 60.0% to 76.5%. For neoplasia, radiographic diagnosis of each observer had the same sensitivity, specificity, PPV and NPV of 88.9%, 95%, 88.9% and 95%.

Intraobserver agreement for radiographic features is summarised in Table 4. It varied from none (only for the cribriform plate (observer C) and for exophthalmos (observer B)) to almost perfect, with multiple criteria having substantial intraobserver agreement. Intraobserver agreement for radiographic diagnosis was substantial for observers B and C (kappa 0.66 and 0.77 respectively) and almost perfect for observer A (kappa 0.81). Intraobserver agreement for level of confidence in diagnosis was fair for observer C (kappa 0.29) and moderate for observers A and B (kappa 0.49 and 0.32).

Interobserver agreement for radiographic features is summarised in Table 5. It varied from none to almost perfect agreement. Interobserver agreement for radiographic diagnosis was moderate for all observer pairs (A vs. C kappa 0.58; A vs. B kappa 0.57; B vs. C kappa 0.43) but that of level of confidence in diagnosis was slight for A vs. C (kappa 0.12) and B vs. C (kappa 0.04), and fair for A vs. B (kappa 0.35).

Agreement of radiographic features as graded by each observer with that of CT images is summarised in Table 6. Radiographic diagnoses of observers A and C agreed moderately with that of CT (kappa 0.52 and 0.44 respectively), and radiographic diagnoses of observer B agreed substantially with CT diagnoses (kappa 0.65). However, level of confidence in radiographic diagnosis of all 3 observers agreed only slightly with that of CT.

The level of interobserver agreement as well as different level of agreement of radiographic diagnosis with that of CT and final diagnosis is illustrated in Figs 3-5.

Radiographic diagnosis of all 3 observers agreed moderately with definitive diagnosis (kappa 0.57; 0.67; 0.47). In four cases a CT diagnosis of a destructive fungal rhinitis was made, but the definitive diagnosis was inflammatory rhinitis. In one case a CT diagnosis of nasal neoplasia was made, but biopsies indicated an inflammatory process; and in another case a CT diagnosis of an inflammatory rhinitis was confirmed as nasal neoplasia on biopsy.

Subjectively, the observers judged that, except for frontal sinuses and cribriform plate assessment, the lateral view of the nasal cavities did not add much to the findings identified on the V20R-DCdO projection.

DISCUSSION

The V20R-DCdO diagnostic view was feasible in the majority of the patients, but was time consuming (with 10-15 minutes required once some experience had been gained). Interestingly, estimated time to carry out more specialised radiographic studies is generally not mentioned in standard veterinary radiography texts. It was judged that two people were required to adequately position the patient (particularly large breeds) and minimise study time when compared to the standard intra-oral view.

Two dogs out of the thirty-one were excluded from statistical analysis because of non-diagnostic radiographs. In one of these dogs it is likely that a second attempt would have reached diagnostic quality as for the other patients of similar size. However, in the other (a Boxer), this view was persistently non-diagnostic. Technical difficulties associated with this projection have previously been reported in brachycephalic dogs, with an alternative view being proposed using dorsal recumbency, mouth closed and X-ray beam angled by 30° from caudoventral to rostrodorsal (Lamb, 2006). However, in the present study the radiographs of the only other brachycephalic dog (another Boxer) were diagnostic.

Based on the findings of this study it is not possible to state categorically that the V20R-DCdO projection be avoided in brachycephalic breeds, but it may be a consideration in obtaining diagnostic images.

The lateral projection added little additional information concerning the nasal cavities, although it was helpful when there was superimposition of the mandible obscuring the frontal sinuses, caudal nasal cavity and cribriform plate, and for soft tissue swelling, as previously reported (Sullivan et al. 1987). The V20R-DCdO in the present study gave substantial evidence of nasal and sinus anomalies when present, as was the case with the DVIO (Sullivan et al. 1987).

Intraobserver agreement for radiological diagnosis was either substantial or almost perfect, indicating consistency. Intraobserver agreement on level of confidence in radiographic diagnosis of the resident was lower than that of each diplomate. This was expected, as it seems logical that experience improves and reduces variation in confidence (Sullivan et al. 1987).

There was no significant difference between interobserver agreement of each observer pair on radiographic diagnosis and level of confidence. The level of interobserver agreement in the present study is similar to that found in a previous study assessing the DVIO projection (Russo et al., 2000). The PPVs for neoplasia and rhinitis of the V20R-DCdO view in the present study was very high, similar to what was previously described with the DVIO (Russo et al., 2000). For neoplasia, each observer had exactly the same radiological diagnostic accuracy as those of CT. For rhinitis, observer B's radiographic diagnosis was similar to that of CT, while observers A and C had lower radiographic sensitivity and NPV than CT, with C (resident) having the lowest performance. This was anticipated and confirmed the initial hypothesis that more experienced observers were expected to have higher radiographic diagnostic performance than less experienced ones. However the differences in radiographic interpretation were globally not as marked as expected since the level of interobserver agreement between diplomates was the same as between each diplomate and resident. This might reflect the fact that a radiographic diagnosis is usually based on global interpretation and that minor variations in interpretation of individual features have less effect on the final diagnosis. A reasonable degree of experience is necessary in interpretation of nasal radiographs, and in non specialist practice this may prove challenging.

For comparison of radiography with CT and definitive diagnosis, the second radiographic reading was initially chosen because confidence was expected to be higher on the 2nd reading. However this proved not to be the case as there was no difference between the levels of confidence between the two readings.

Radiographic diagnoses of observer B agreed substantially with that of CT, and radiographic diagnoses of observers A and C agreed moderately with that of CT. This level of agreement between radiography and CT can be considered as satisfactory and the V20R-DCdO nasal projection in this study has a diagnostic accuracy similar to previous reports (Russo et al. 2000). It has the advantage of imaging caudal nasal structures without risking equipment. This suggests that this view is valid for initial screening for canine nasal pathology in general practice without access to CT or endoscopy, and may offer an alternative to the DVIO projection. However biopsy will be required for definitive diagnosis. As previously stated for the DVIO (Russo et al. 2000) radiographs alone should not be relied upon for guiding blind nasal biopsy as V20R-DCdO views here agreed only fairly with CT on the affected side and slightly to fairly on location, and interobserver agreement on radiographic lesion location was slight to moderate. Knowing the side of discharge in the patient would potentially have improved radiographic lesion lateralisation.

The final diagnosis in this study was based on a combination of CT, rhinoscopy, biopsy and/or culture, as well as follow up in case of disagreement between examinations. Previous studies have shown that CT gives more information than radiography on the extent of changes and greater diagnostic accuracy for chronic nasal disease (Thrall et al. 1989, Berry & Koblik 1990, Saunders & van Bree 2003, Saunders et al. 2004). As previously stated, biopsy indicating inflammation should be questioned if there are aggressive CT features, and nasal biopsies should be repeated in that case (Burk 1992). Biopsy can only sample the superficial inflammatory tissues associated with deeper neoplastic process, but epithelial dysplasia secondary to inflammation may also be mistaken for tumoral tissue (Lent & Hawkins 1992, Willard & Radlinsky 1999, Meler et al. 2008).

The main limitation of the study was the very small numbers of patients in the categories “normal”, “fungal rhinitis” and “other/foreign bodies” (even though the study was in an area with a relatively high prevalence of fungal rhinitis). This precluded calculations of sensitivity, specificity, PPV and NPV of radiographic diagnosis for these categories. In general, chronic rhinitis and nasal neoplasia remain the most prevalent canine nasal diseases at presentation, and the study population is likely to be typical of the canine population presented for nasal disease. For ethical reasons, clinically sound patients were not included, therefore only the ability of radiography to differentiate a particular positive definition (neoplasia or inflammatory rhinitis) from other potential positives was tested. This seems adapted to a clinical situation, which does not include animals without clinical signs.

An inflammatory reaction secondary to nasal neoplasia develops frequently, but even if the neoplasia cases were not truly rhinitis negative, this was not considered here as the therapeutic options differ between nasal neoplasia with or without secondary pathology, and pure inflammatory rhinitis.

In conclusion, findings from the current study indicated that the V20R-DCdO projection of canine nasal cavities is feasible in anaesthetised patients and gave diagnostic quality projections in most dogs, but that positioning could be complex and time consuming. Assessment of the V20R-DCdO view showed moderate to substantial agreement with CT diagnosis, although with lower confidence. The V20R-DCdO projection interpretation had substantial to almost perfect repeatability but moderate reproducibility. The V20R-DCdO view overcomes the potential equipment damage related with intra-oral imaging. Thus the V20R-DCdO projection may be used as a valuable initial screening tool for canine nasal pathology in practices without access to advanced imaging, and with similar results may be an alternative to the DVIO, although CT is likely to provide more useful diagnostic information.

REFERENCES

Berry, C.R. & Koblik, P.D. (1990) Evaluation of survey radiography, linear tomography and computed tomography for detecting experimental lesions of the cribriform plate in dogs. *Veterinary Radiology and Ultrasound* **31**, 146-154

Burk, R.L. (1992) Computed tomographic imaging of nasal disease in 100 dogs. *Veterinary Radiology and Ultrasound* **33**, 177-180

Lamb CR. (2006) Skull – nasal chambers and frontal sinuses. In: BSAVA Manual of canine and feline musculoskeletal imaging. Eds F.J. Barr and R.M. Kirberger. British Small Animal Veterinary Association, Gloucester, UK. pp 192-205

Lefebvre, J., Kuehn, N.F. & Wortinger, A. (2005) Computed tomography as an aid in the diagnosis of chronic nasal disease in dogs. *Journal of Small Animal Practice* **46**, 280-285

Lent, S.E. & Hawkins, E.C. (1992) Evaluation of rhinoscopy and rhinoscopy-assisted mucosal biopsy in diagnosis of nasal disease in dogs: 119 cases (1985-1989). *Journal of the American Veterinary Medical Association* **201**, 1425-1429

Meler, E., Dunn, M. & Lecuyer, M. (2008) A retrospective study of canine persistent nasal disease: 80 cases (1998-2003). *The Canadian Veterinary Journal* **49**, 71-76

Peeters, D. & Clercx, C. (2007) Update on canine sinonasal aspergillosis. *Veterinary Clinics of North America: Small Animal Practice* **37**, 901-916

Petrie, A. & Watson, P. (2006) Additional techniques. In: Statistics for Veterinary and Animal Science, 2nd ed. Eds A. Petrie and P. Watson. Blackwell Publishing, Oxford, UK. pp 191-209

Russo, M., Lamb, C.R. & Jakovljevic, S. (2000) Distinguishing between rhinitis and nasal neoplasia by radiography. *Veterinary Radiology and Ultrasound* **41**, 118-124

Saunders, J.H. & van Bree, H. (2003) Comparison of radiography and computed tomography for the diagnosis of canine nasal aspergillosis. *Veterinary Radiology and Ultrasound* **44**, 414-419

Saunders, J.H., Zonderland, J.L., Clercx, C., et al. (2002) Computed tomographic findings in 35 dogs with nasal aspergillosis. *Veterinary Radiology and Ultrasound* **43**, 5-9

Saunders, J.H., van Bree, H., Gielen, I., et al. (2003) Diagnostic value of computed tomography in dogs with chronic nasal disease. *Veterinary Radiology and Ultrasound* **44**, 409-413

Saunders, J.H., Clercx, C., Snaps, F.R., et al. (2004) Radiographic, magnetic resonance imaging, computed tomographic, and rhinoscopic features of nasal aspergillosis in dogs. *Journal of the American Veterinary Medical Association* **225**, 1703-1712

Schwarz, T., Sullivan, M. & Hartung, K. (2000a) Radiographic anatomy of the cribriform plate (lamina cribrosa). *Veterinary Radiology and Ultrasound* **41**, 220- 225

Schwarz, T., Sullivan, M. & Hartung, K. (2000b) Radiographic detection of defects of the nasal boundaries. *Veterinary Radiology and Ultrasound* **41**, 226- 230

Sullivan, M., Lee, R., Jakovljevic, S., et al. (1986) The radiological features of aspergillosis of the nasal cavity and frontal sinuses in the dog. *Journal of Small Animal Practice* **27**, 167-180

Sullivan, M., Lee, R. & Skae, C.A. (1987) The radiological features of sixty cases of intra-nasal neoplasia in the dog. *Journal of Small Animal Practice* **28**, 575-586

Tasker, S., Knottenbelt, C.M., Munro, E.A.C., et al. (1999) Aetiology and diagnosis of persistent nasal disease in the dog: a retrospective study of 42 cases. *Journal of Small Animal Practice* **40**, 473-478

Thrall, D.E., Robertson, I.D., McLeod, D.A., et al. (1989) A comparison of radiographic and computed tomographic findings in 31 dogs with malignant nasal cavity tumors. *Veterinary Radiology and Ultrasound* **30**, S259-66

Widmer, W. R. (2008) Acquisition hardware for digital imaging. *Veterinary Radiology and Ultrasound* **49**, S2-S8

Willard, M.D. & Radlinsky, M.A. (1999) Endoscopic examination of the choanae in dogs and cats: 118 cases (1988-1998). *Journal of the American Veterinary Medical Association* **215**, 1301-1305

Fig. 1. Positioning for the V20R-DCdO radiographic view of the nasal cavities, showing the position of the tape to maintain the hard palate parallel to the table top. Note that the tongue has not been placed in the final position in that image.

Fig. 2. V20R-DCdO radiograph of the nasal cavities of a dog without nasal pathology.

Fig. 3 V20R-DCdO radiograph. Radiographic diagnosis of all 3 observers was fungal rhinitis. CT consensus diagnosis was also fungal rhinitis. Rhinoscopy and histology concluded to destructive rhinitis.

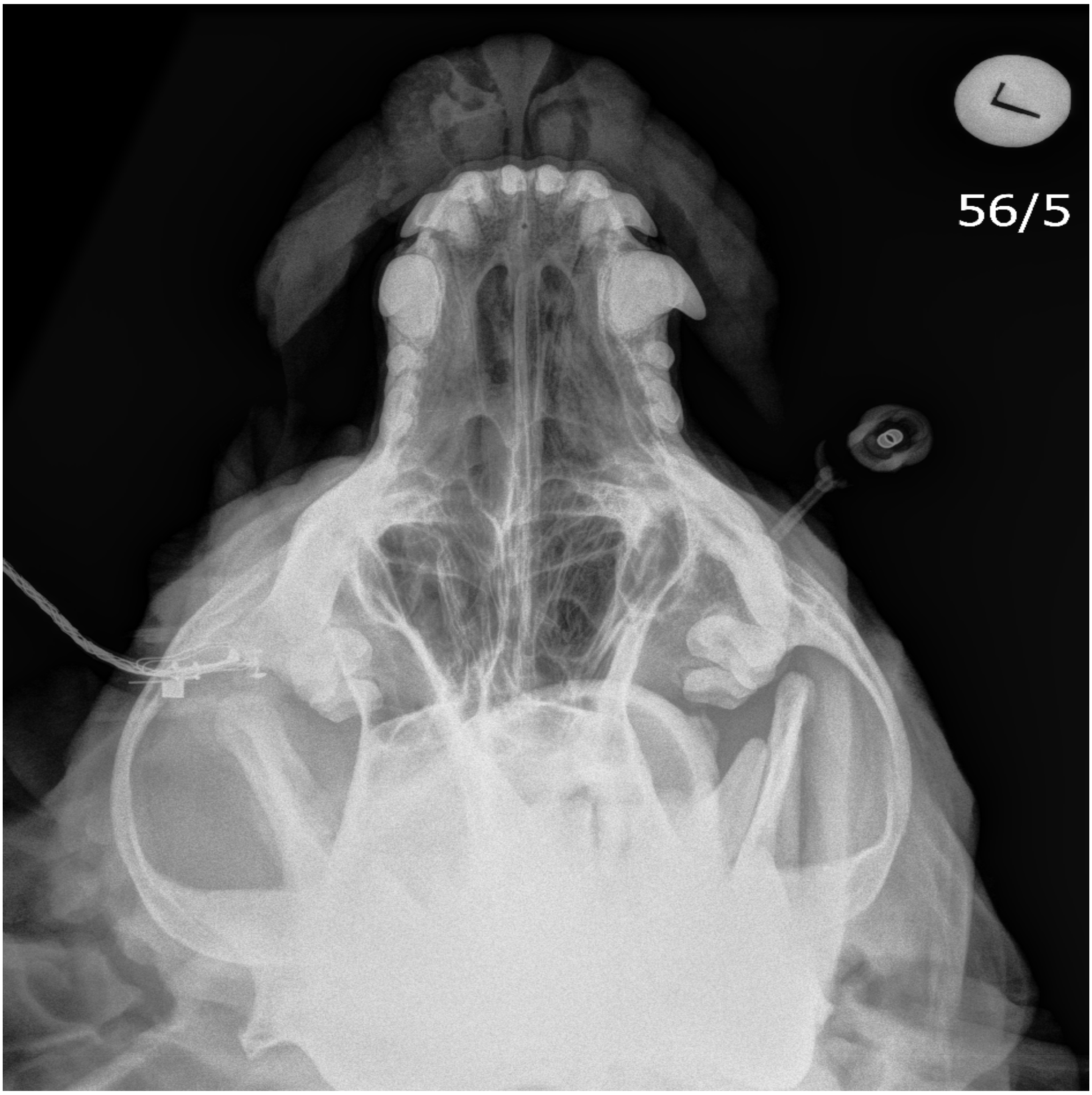

Fig. 4. V20R-DCdO radiograph. In this case, all 3 observers disagreed on radiographic diagnosis. Observer A interpreted it as neoplasia on both readings, observer B as rhinitis on first reading and fungal rhinitis on second reading, and observer C classified the diagnosis in the “other/foreign body” category. CT consensus concluded rhinitis, and histology diagnosed chronic active neutrophilic-lymphoplasmacytic rhinitis.

Fig. 5. (A) V20R-DCdO radiograph. In this case, both observers A and C interpreted the radiograph as being normal. Observer B's radiographic diagnosis was rhinitis. (B) CT image of the nasal cavity of the same patient at the level of maxillary PM3. A right-sided ventral small linear nasal foreign body (arrow) was diagnosed on CT, which proved to be a seed when removed using rhinoscopy.

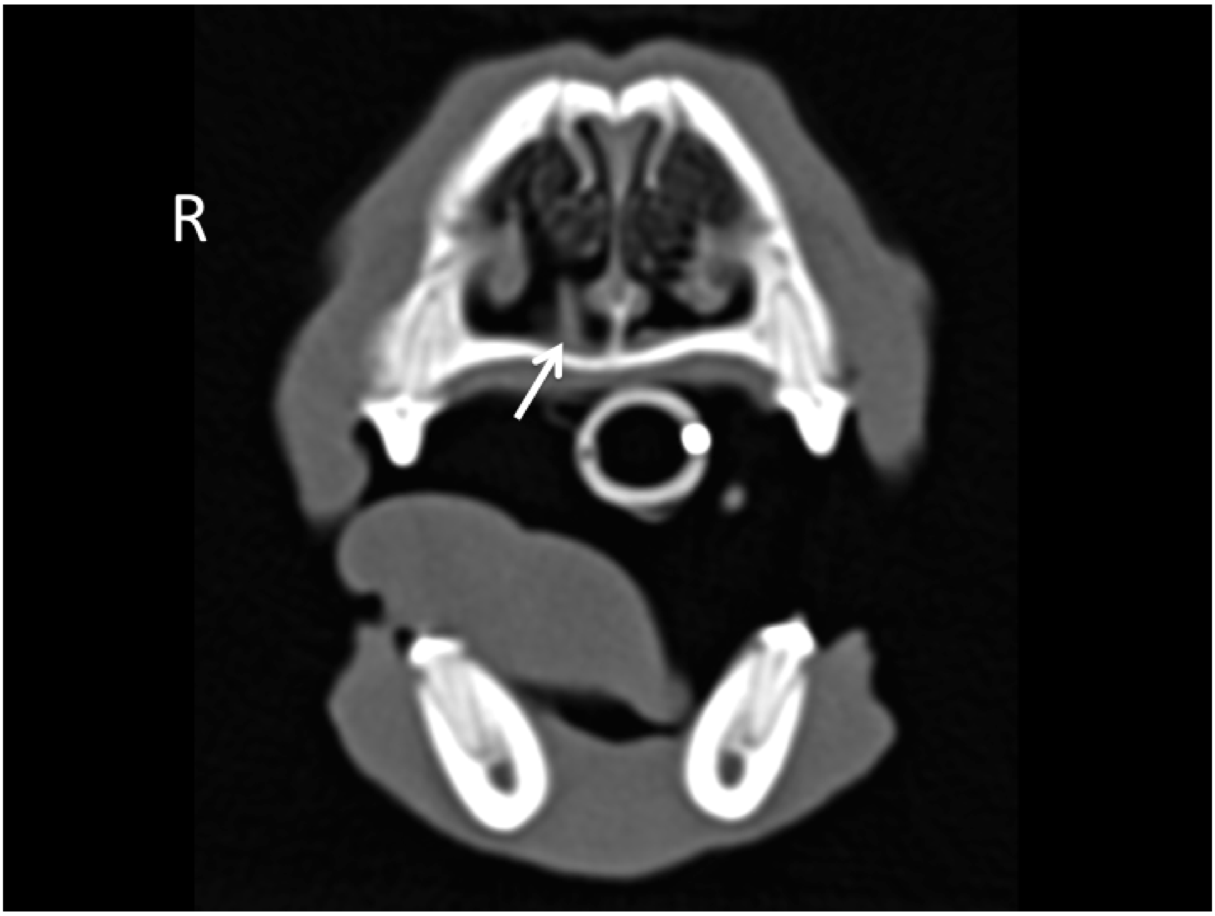
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Table 1. Template provided to each observer for radiographic features assessment, radiographic diagnosis classification and level of confidence grading

Criterion and diagnosis	Grading (categories and corresponding numerical value)				
Affected side	Right 1	Left 2	Bilateral 3	None 0	
Location	Rostral 1	Middle 2	Caudal 3	Diffuse 4	None 0
Opacity	Increased 1	Decreased 2	Normal 0	Mixed 3	
Turbinate destruction	Mild 1	Moderate 2	Severe 3	None 0	
Septal deviation/destruction	Mild 1	Moderate 2	Severe 3	None 0	Direction
Bony lysis ***(maxilla, hard palate, frontal bone)***	Mild 1	Moderate 2	Severe 3	None 0	
Bony hyperostosis	Mild 1	Moderate 2	Severe 3	None 0	
Frontal sinus changes ***(increased opacity)***	Mild 1	Moderate 2	Severe 3	None 0	
Exophthalmos	Yes 1	No 0			
Cribriform plate lysis	Yes 1	No 0			
Diagnosis	Normal 0	Rhinitis 1	Fungal rhinitis 2	Neoplasia 3	Other (e.g. foreign body) 4
Level of confidence in diagnosis	None 0	Slight 1	Fair 2	High 3	

Table 2. Breed distribution in the study group

Breed	Number of patients in each breed
Golden Retriever	4
Labrador Retriever	3
Whippet	3
Border Collie	3
Jack Russell Terrier	2
Boxer	2
Yorkshire Terrier	2
Crossbreed	2
Staffordshire Bull Terrier	1
Siberian Husky	1
Russian Terrier	1
Bernese Mountain	1
Dalmatian	1
German Shepherd Dog	1
Rhodesian Ridgeback	1
West Highland White Terrier	1
Springer Spaniel	1
Shetland Sheepdog	1