Investigation of a retroesophagoscopic approach to nasopharyngoscopy as an alternative to the conventional retroflexed endoscopic approach for selected indications in feline cadavers and client-owned cats

Maxime G. Derré DVM
Elisabeth C. Snead DVM, PhD
Hugues H. Beaufrère DVM, PhD
Adrien G. Aertsens DVM

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From Department of Veterinary Clinical Sciences, Purdue University, West Lafayette, IN, 47907, USA. (Derré); Department of Small Animal Clinical Sciences, Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon, SK S7N 5B4, Canada (Snead); Department of Clinical Studies, Ontario Veterinary College, University of Guelph, ON N1G 2W1, Canada (Beaufrère); and Department of Veterinary Clinical Sciences, College of Veterinary Medicine, Iowa State University, Ames, IA 50011 (Aertsens).

Address correspondence to Dr. Derré (maximederredvm@gmail.com).

OBJECTIVE
To describe a retroesophagoscopic approach (ROSA) to nasopharyngoscopy and compare it with the conventional retroflexed endoscopic approach (REA).

ANIMALS
36 feline cadavers and 2 client-owned cats with nasopharyngeal disorders.

PROCEDURES
36 veterinarians participated in the experimental portion of the study involving feline cadavers. Each veterinarian performed the ROSA and REA to nasopharyngoscopy on a feline cadaver once, attempting to identify and biopsy 2 landmarks (soft palate and choanae) with each approach while time was recorded. Numeric scales were used to measure perceived ease of use and image quality for both techniques. Data were compared between approaches by an independent statistician. The ROSA approach was also used as part of the diagnostic workup for the 2 client-owned cats.

RESULTS
35 of the 36 (97%) veterinarians were able to identify and biopsy both landmarks using the ROSA, whereas 21 (58%) veterinarians were able to visualize both landmarks using the REA and 19 (53%) successfully biopsied the landmarks. Image quality for the soft palate was scored higher with the ROSA (median score, 7.5/10) than with the REA (4.5/10). The ROSA was fast and easy to perform. This approach was also successfully performed in the 2 client-owned cats with nasopharyngeal disorders, with no complications reported.

CONCLUSIONS AND CLINICAL RELEVANCE
The ROSA was found to be a fast, effective, and easy alternative endoscopic technique for assessment of the nasopharynx in cats. This approach may allow use of various instruments that could be relevant for interventional procedures. However, the ROSA was also invasive and should be considered for diagnostic and therapeutic purposes for selected indications only when REA is unsuccessful. (*Am J Vet Res* 2021;82:752–759)

The use of advanced imaging techniques in conjunction with endoscopy has led to the description of various conditions affecting the nasopharynx in companion animals.[1–3] Obstruction of the nasopharyngeal duct can be congenital or acquired as a result of polyps, neoplasia, cysts, abscess, granuloma, or severe local inflammation and ulceration causing stenosis.[1,4–7] Clinical signs that may prompt examination of the nasopharynx include nasal discharge, stertorous breathing, reverse sneezing, dysphagia, retching, vestibular signs, increased respiratory effort, or open-mouth breathing if a complete obstruction of the nasopharyngeal airways occurs.[1,3]

ABBREVIATIONS
IQR Interquartile (25th to 75th percentile) range
REA Retroflexed endoscopic approach
ROSA Retroesophagoscopic approach

Advanced imaging modalities such as CT or MRI are superior to radiography in the assessment of nasal and nasopharyngeal diseases in companion animals.[1,3,8–10] These modalities allow visualization of the structures surrounding the airways such as bones, ear canals, local lymph nodes, and periodontium. When combined with rhinoscopy, CT and MRI can allow comprehensive evaluation of the nasal cavity. Rhinoscopy allows direct visualization of the nasopharynx and has been shown to be both diagnostically and therapeutically useful.[1,3,4,6,7,11–13] Although rhinoscopy-assisted biopsy can cause hemorrhage, endoscopy remains less invasive than surgery and can provide a definitive diagnosis.[3,13]

Whereas anterior rhinoscopy can be attempted to visualize the nasopharynx of medium- to large-sized dogs, retroflexed nasopharyngoscopy is necessary to visualize the nasopharynx and the caudal portions

of the nasal cavity in cats and small brachycephalic dogs.[2,3,5] In such patients, retroflexed nasopharyngoscopy requires the use of relatively small flexible endoscopes and can be limited by the size and conformation of the patient's pharyngeal cavity.[5,6,14,15] These limitations can impair visualization and the operator's ability to feed biopsy forceps or other instruments through the working channel, precluding diagnostic or therapeutic interventions.[15]

The objectives of the study reported here were to describe an alternative endoscopic technique, the ROSA, for visualization and collection of biopsy specimens from the nasopharyngeal cavity in cats and to compare this approach with the conventional REA. The 2 procedures were performed on feline cadavers and compared in terms of completion rate, duration, perceived ease of use, and image quality. We hypothesized that the ROSA would be easy to perform and time efficient and would provide superior visualization of the nasopharyngeal cavity in cats for all veterinarians attempting the approach, compared with the REA. The outcomes of 2 client-owned cats that underwent ROSA for diagnostic and therapeutic purposes were also described.

Materials and Methods

Cadavers

The experimental portion of this study involving feline cadavers was conducted at the Veterinary Medical Center of the Western College of Veterinary Medicine, University of Saskatchewan, between March 2019 and May 2019. All cats had been brought to the hospital already dead or were euthanized for reasons unrelated to the study and donated for research purposes. Euthanasia was performed by IV injection of propofol, followed by an overdose of pentobarbital. Each cadaver was kept frozen within 1° of –17 °C and thawed at 4 °C for 48 hours before use. Cadavers were excluded from the study if they weighed < 2 kg or had visible tissue autolysis or lesions affecting the oral cavity, pharynx, nasopharynx, or esophagus. In preliminary work, the investigators (MGD, ECS, and AGA) attempted the ROSA on 3 feline cadavers and 2 small-breed canine cadavers (data not included) prior to the study to help inform the experimental design. For the present study, 36 cadavers of mixed-breed domestic cats were included, which was the number of veterinarians who ended up volunteering for the study over the recruitment period.

Participants

Thirty-six veterinarians were recruited to perform the ROSA and REA on 1 feline cadaver each. All veterinarians were recruited from among the authors' institution by word of mouth. Participation in the study was voluntary, each person could volunteer only once, and participants were required to be veterinarians and not veterinary students. The investigators and only 1 veterinarian were present in the endoscopic room at a time. Each veterinarian was provided with a cadaver and asked to visualize the nasopharynx using the REA and ROSA with the same flexible endoscope. One of the investigators (ECS) recorded procedure time, and a second investigator (AGA) obtained images of the nasopharynx and inserted the biopsy forceps into the working channel while the veterinarian manipulated the endoscope. A third investigator (MGD) explained both procedures to each veterinarian and recorded their feedback and previous experience (number of nasopharyngoscopy and esophageal tube placement procedures performed prior to the study).

A randomizer program[b] was used to determine with which approach each participant should start. Care was taken to minimize observation bias by requiring that the investigators only objectively describe the anatomic structures displayed on the screen, hand instruments to the veterinarian, and insert the biopsy forceps through the working channel.

Experimental procedures

For both procedures, a 4.9-mm-diameter video bronchoscope[b] connected to a light source and video processor was used to visualize and record images of the nasopharynx. This endoscope had a 120° field of view and angulation range of 130° to 180°. The instrument channel measured 2.0 mm, and 2 sizes of biopsy forceps (suitable for minimum channel diameters of 1.2 and 2.0 mm[c]) were available for use. The larger biopsy forceps suitable for a 2.0-mm endoscope channel was used first.

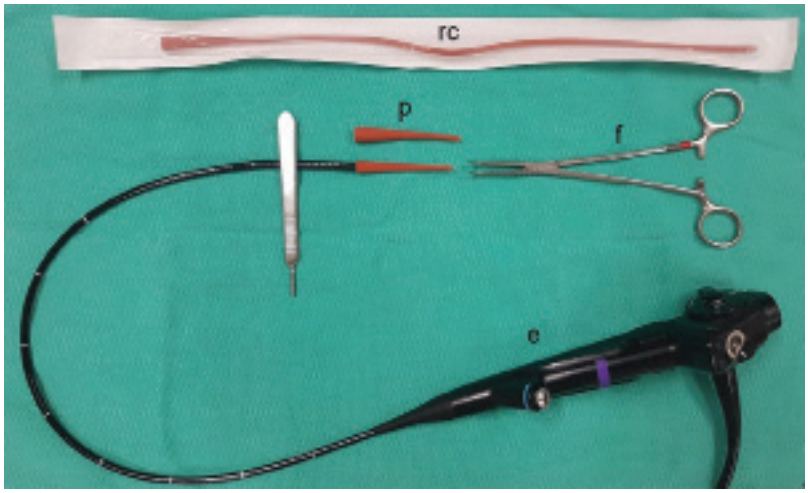

Figure 1—Photograph showing the basic supplies needed to perform the ROSA to nasopharyngoscopy in cats, including a red rubber catheter (rc) trimmed and used as a protective cap (p), a right-angle forceps (f), the endoscope (e), and a scalpel handle (provided for scale to demonstrate the size of the equipment). Notice that the proximal end of the red rubber catheter was trimmed to obtain the minimum effective diameter that would fit over the distal end of the endoscope.

Each cadaver was intubated with a 4.0-mm endotracheal tube, and a mouth gag was placed between the upper and lower right canine teeth before any procedures.

ROSA—For the ROSA, each participant was given a scalpel handle, a scalpel blade, a pair of right angle forceps (ie, the larger pair), a red rubber urinary catheter, and sterile lubricant[d] **(Figure 1)**. The flared end of a 10F red rubber catheter[e] was used as a protective cap for the endoscope, the catheter was trimmed, and the tip was used to introduce the endoscope into the stoma.

The cadaver was placed in right lateral recumbency with a rolled towel under the neck to expose the left lateral cervical region. The hair over this region was clipped, and the skin was prepared as for an esophagostomy tube placement.[16,17] A timer was started when the forceps was placed through the mouth into the esophagus **(Figure 2)**. The forceps was then pushed laterally to make a small skin tent dorsal to the jugular vein, and a 5- to 10-mm full-thickness incision was made over the tips of the forceps. Afterward, the forceps was withdrawn through the stoma the incision had created. The tip of the endoscope was gently inserted into the flared end of the red rubber catheter. Sterile lubricant was applied on the opposite end of the catheter, which was placed into the jaws of the forceps, and the jaws of the forceps were locked. The catheter and endoscope were both inserted into the stoma and eventually exteriorized as the forceps was withdrawn from the mouth. The protective cap was removed. and time 0 was recorded.

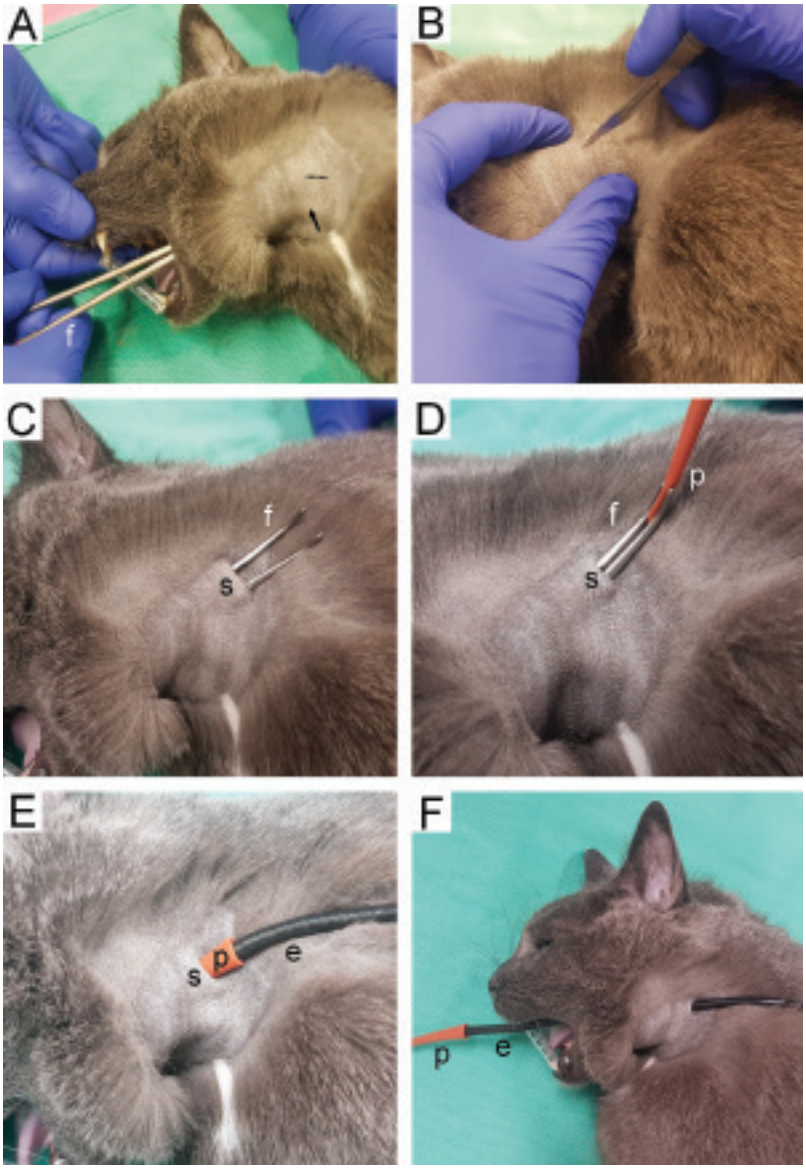

Figure 2—Photographs of the head of a feline cadaver during various stages of a ROSA procedure. A—A right-angle forceps (f) is placed through the mouth and into the esophagus. The tips of the forceps are pushed laterally to make a small tent in the skin showing the planned esophagostomy site (dotted line) dorsal to the jugular vein (arrow). B—A No. 11 scalpel blade is used to make a full-thickness incision directly over the tips of the forceps. C—The tips of the forceps (f) are pushed through the incision and opened to stretch the stoma (s). D—The tip of the endoscope is lodged into the protective cap, and the distal aspect of the protective cap (p) is grasped by the forceps (f). Notice that the cap is aligned with the tips of the forceps. E—The protective cap (p) and endoscope (e) are pulled through the stoma (s). For this step, the stoma should be lubricated with sterile lubricating jelly. F—The protective cap (p) and endoscope (e) are withdrawn from the mouth. This time point was recorded as time 0.

For participants to perform a full exploration of the nasopharynx using the ROSA, they were instructed to slowly pull the endoscope caudally against the palate until the caudal edge of the soft palate was visualized **(Figure 3)**. This time point was recorded as time 1, and an image was obtained when the caudal edge of the soft palate (landmark 1) was clearly identified. Then, participants were instructed to move the endoscope into the nasopharynx until the choanae were visualized. Time 2 was recorded, and an image was obtained when the choanae (landmark 2) were clearly identified. Lastly, participants were instructed to pull the endoscope back to landmark 1, collect a biopsy specimen from the edge of the soft palate, and collect another biopsy specimen from the choanae. Time to biopsy these 2 anatomic sites was recorded as times 3 and 4, respectively. The endoscope was then withdrawn from the esophagus.

REA—To perform the REA, the cadaver was placed in sternal recumbency with a rolled towel under the jaw to elevate the head. A timer was started when the endoscope was placed through the mouth into the pharynx. For the REA, time 0 was the time when

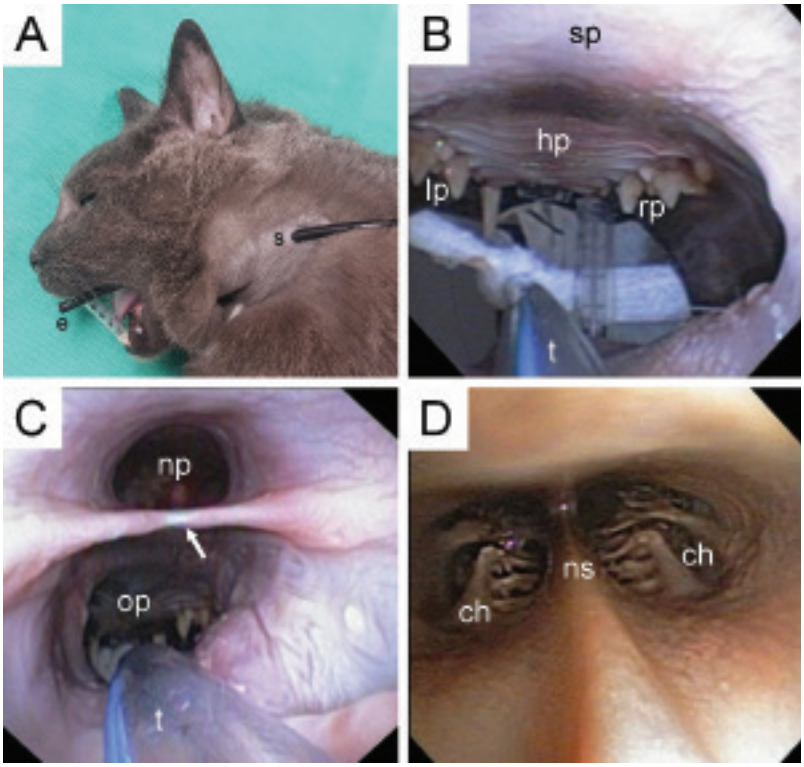

Figure 3—Photograph of the head of the same feline cadaver as in Figure 2 showing the endoscope (e) being pulled caudally into the oropharynx (A) and endoscopic images obtained with the ROSA (B to D). B—The oral cavity is shown. Notice the hard palate (hp), soft palate (sp), endotracheal tube (t), and left and right premolar teeth (lp and rp, respectively). C—The edge of the soft palate (white arrow) and the transition between oropharynx (op) and nasopharynx (np) is shown. The time point that the caudal edge of the soft palate (landmark 1) was visualized was recorded as time 1. D—The rostral portion of the nasopharynx is shown, including the nasal septum (ns) and choanae (ch). The time point that the choanae (landmark 2) were visualized was recorded as time 2.

the timer was started. Time 1 was recorded, and an image was obtained when landmark 1 was clearly identified. Then, participants were instructed to move the endoscope rostrally into the nasopharynx until landmark 2 was visualized. Time 2 was recorded, and an image was obtained when the choanae were clearly identified. Biopsy specimens were obtained following the same protocol as described for the ROSA, and then the endoscope was withdrawn through the mouth. If resistance was felt during insertion of the larger biopsy forceps, participants were asked to gently decrease the angle of flexion. If resistance persisted, the use of the smaller biopsy forceps was attempted instead. For both procedures, the more caudal and the more rostral anatomic site within the nasopharynx were selected as landmarks (edge of the soft palate and choanae, respectively) to require that participants explore the entire nasopharyngeal cavity.

Time limit—Participants were given 10 minutes to complete each procedure. If 10 minutes had elapsed and the procedure had not yet been completed, the timer was stopped and the procedure was considered to be incomplete. Participants were then asked to perform the second technique if not yet performed.

Outcome assessment

Outcomes of interest for the experimental portion of the study were procedure duration (calculated on the basis of recorded time points), perceived ease of use, and perceived image quality.

Ease of use—After both procedures were performed, participants were instructed to rate the perceived ease of use of both techniques using a numeric scale. Possible scores ranged from 0 to 10 (in 0.5-unit increments), with 0 representing very easy and 10 representing impossible.

Image quality—All images of the soft palate and choanae that were obtained during the experiment were automatically randomized in order by use of an online application,[f] and a survey was generated to capture the participants' perceived image quality. Participants were asked to rate the quality of each image using a numeric scale (in 1-unit increments) that ranged from 1 to 10, whereby 1 represented very poor quality, 5 represented fair quality, and 10 represented excellent quality. Image quality assessment was based on the ability of each participant to recognize the landmark and its surrounding anatomic structures **(Figure 4)**.

Clinical cases

After the experiment concluded, 2 cats were referred to the Veterinary Medical Center of the Western College of Veterinary Medicine and underwent the ROSA to undergo nasopharyngoscopy. Relevant details of these cases and their outcomes were described.

Statistical analysis

The REA was used as the reference technique in comparisons between the 2 approaches. The proportion of all procedures that were successful (ie, success rate) was compared between approaches with the Fisher exact test. Data pertaining to incomplete procedures were thereafter excluded from statistical analyses. For successful procedures, the times to visualization and biopsy of the edge of the 2 landmarks were compared by use of multivariable linear mixed models with approach, time point, whether (yes or no) veterinarians had previously performed > 5 nasopharyngoscopy procedures, and whether (yes or no) they had previously performed > 5 esophagostomy procedures included as fixed effects and participant included as a random effect. Medians and IQRs were reported, and data were not checked for normality of

distribution. Model assumptions were checked by examination of residual and quantile plots. Heteroscedastic models were also performed and compared with the regular models with the likelihood ratio test. Scores for ease of use were compared between approaches by means of a multivariable mixed logit model to account for prior experience in nasopharyngoscopy and esophagostomy procedures. Scores for image quality were compared between approaches with the Wilcoxon rank sum test. Statistical software[g] was used for all analyses, and values of $P < 0.05$ were considered significant.

Results

Experiment

Participants—Thirty-six veterinarians were enrolled in the study, including 9 rotating and specialty interns, 8 diplomates (American College of Veterinary Internal Medicine, n = 3; American College of Veterinary Surgery, 3; American Board of Veterinary Practitioners, 1; and American College of Veterinary Emergency Critical Care, 1), 8 residents (surgery, 3; medicine, 2; radiology, 2; and oncology, 1), 7 clinical associates, and 4 master's students who had graduated from different veterinary schools. Thirty-one (86%) participants had no prior experience with or had performed < 5 nasopharyngoscopy procedures before the study. Nineteen (53%) participants had no experience with or had performed < 5 esophageal tube placements in companion animals.

Exploration of the nasopharynx—Eighteen of the 36 (50%) participants started with the conventional REA to nasopharyngoscopy, and the remainder started with the ROSA. Overall, 35 (97%) participants were able to visualize and collect biopsy specimens from the edge of the soft palate (landmark 1) and the choanae (landmark 2) within the 10-minute limit using the ROSA. For the REA, 25 (69%) and 21 (58%) participants were able to visualize landmarks 1 and 2, respectively, representing success rates significantly ($P = 0.003$ and $P < 0.001$, respectively) lower than those for the ROSA. Also for the REA, 22 (62%) and 19 (53%) participants were able to collect a biopsy specimen from landmarks 1 and 2, respectively, again representing success rates significantly ($P < 0.001$ for both) lower than those for the ROSA.

Overall, 15 (42%) participants failed to complete the REA within the 10-minute limit. One (3%) participant was unable to complete the ROSA within the 10-minute limit and aborted the procedure when the right angle forceps was inadvertently inserted into the palatoglossal arch and through the subcutaneous tissue instead of the esophagus. This participant was also unable to visualize the 2 landmarks using the REA. Because both procedures failed for the same person, this participant was excluded from final statistical analyses. All other veterinarians were able to complete the ROSA within the 10-minute limit and insert the flared end of the catheter over the tip of the endoscope and feed the flexible endoscope into the stoma without difficulty. The remaining 14 participants who were unable to visualize the landmarks using the REA were able to visualize the 2 landmarks within the 10-minute limit using the ROSA, with a median time 2 of 218 seconds (IQR, 170 to 325 seconds).

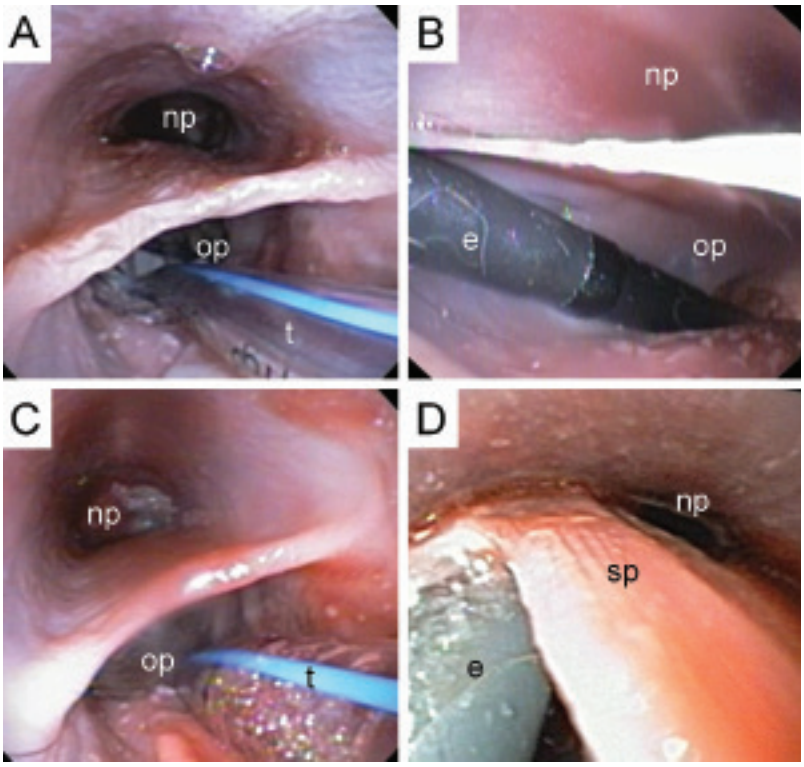

Figure 4—Endoscopic images of landmark 1 in 2 feline cadavers as obtained with the ROSA (A and C) and REA (B and D) to nasopharyngoscopy. Notice the endotracheal tube (t) and transition between oropharynx (op) and nasopharynx (np). In panel D, the endoscope (e) is obstructing assessment of the oropharynx and nasopharynx. ***See*** Figure 3 for remainder of key.

Occasionally, the endoscope became detached from the red rubber catheter as the participant pulled the forceps out of the mouth. When this occurred, the participant was instructed to pull the endoscope out of the stoma and reattempt the procedure. In this situation, the red rubber catheter remained attached to the forceps and in no situation was it lost in the esophagus. All participants who experienced endoscope detachment from the catheter were able to reinsert the curved forceps into the same esophagostomy site, and their second attempt was successful.

For the ROSA, median time to get the endoscope into the oral cavity (time 0) was 94 seconds (IQR, 60 to 125 seconds). For the participants who were

able to visualize the 2 landmarks within the 10-minute limit, median times to visualization of the edge of the soft palate (time 1) and the choanae (time 2) were 154 seconds (IQR, 112 to 181 seconds) and 217 seconds (IQR, 154 to 262 seconds), respectively, for the ROSA and 203 seconds (IQR, 67 to 302 seconds) and 298 seconds (IQR, 95 to 433 seconds), respectively, for the REA **(Figure 5)**. These values did not differ significantly (P = 0.054 and P = 0.08, respectively) between approaches, nor did prior experience in nasopharyngoscopy or esophagostomy affect these results, as determined by multivariable modeling.

During the REA, participants were unable to obtain biopsy specimens with the larger biopsy forceps because the forceps consistently became stuck in the curvature of the endoscope; consequently, participants needed to switch to the smaller forceps to complete the procedure. Despite using smaller forceps, 4 veterinarians were still unable to collect biopsy specimens with the REA. Times to collection of biopsy specimens from the edge of the soft palate (time 3) and the choanae (time 4) favored the ROSA over the REA (P < 0.001 and P = 0.03, respectively). For the ROSA, the median time 3 was 28 seconds (IQR, 23 to 40 seconds) and the median time 4 was 52 seconds (IQR, 31 to 84 seconds). For the REA, the median time 3 was 46 seconds (IQR, 25 to 63 seconds) and the median time 4 was 82 seconds (IQR, 45 to 157 seconds). Prior experience in nasopharyngoscopy or esophagostomy did not influence these results.

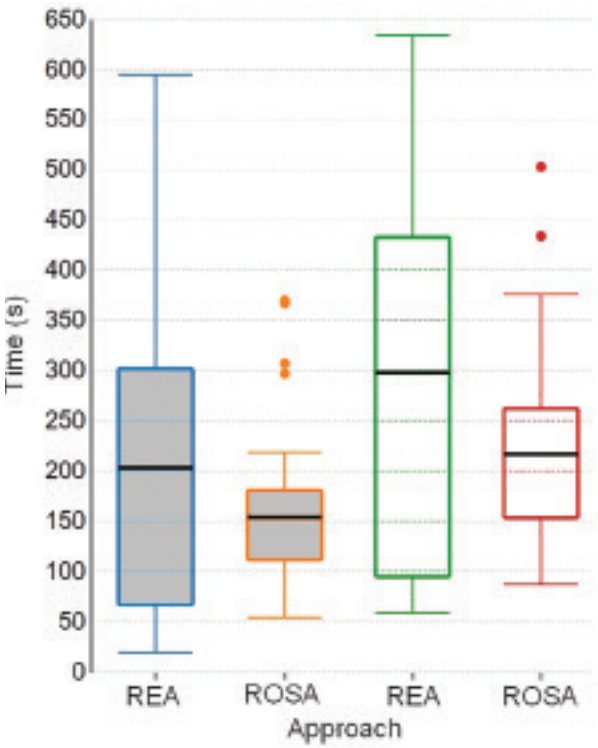

Figure 5—Box-and-whisker plots comparing time to visualization of landmarks 1 (time 1; gray boxes) and 2 (time 2; white boxes) between the REA and ROSA as performed in feline cadavers by 36 veterinarians (1 cadaver each). The bold horizontal line within each box represents the median value; the bottom and top of each box represent the 25th and 75th percentiles, respectively; and whiskers represent the range of values, excluding outliers (dots). ***See*** Figure 3 for remainder of key.

Ease of use—Only 26 of the 36 (72%) participants were asked to rate the perceived ease of use of each technique. This was because the numeric scale was introduced after 10 participants had already performed the procedure several weeks earlier and the investigators wished to avoid the recall bias that could have been introduced by including them. Of the 26 participants, 22 (85%) rated the ROSA as easier to perform than the REA, 2 (8%) rated the ROSA as easy to perform as the REA, and 1 (4%) rated the REA as marginally easier to perform than the ROSA. The participant who was unable to complete both the REA and ROSA scored both approaches as impossible (10/10). This participant had no previous experience in nasopharyngoscopy and esophageal tube placement. Overall, the ROSA (median score, 2) was found to be easier than the REA (median score, 6.5; P < 0.001). Multivariable modeling revealed that participants with more experience in esophagostomy found the ROSA easier to perform than the REA (P = 0.02). Some participants made specific comments, including 8 (22%) participants who reported the absence of interference with the endotracheal tube during the ROSA versus the REA and 4 (11%) who reported difficulties manipulating the endoscope or keeping the camera centered once in the nasopharynx during the REA.

Image quality—All participants (36/36) rated the quality of all images recorded during the experiment. Image quality for landmark 1 was rated superior for the ROSA versus the REA (P < 0.001), with a median score of 7.5/10 (IQR, 6.8 to 8) and 4.5/10 (IQR, 3.4 to 5.6), respectively. Image quality for landmark 2 was rated similarly between the 2 approaches (P = 0.29), with a median score of 7.4/10 (IQR, 6.5 to 8.2) for the ROSA and 7/10 (IQR, 5.5 to 7.9) for the REA.

Clinical cases

An 11-year-old castrated male brachycephalic domestic shorthair cat with anorexia was referred for evaluation of an abdominal mass. The cat also had a prolonged history of stertorous breathing, so the investigators approached the owner to obtain their informed consent to use the ROSA to look for nasopharyngeal disorders. The cat underwent an exploratory laparotomy, after which a ROSA was performed and an esophageal feeding tube was placed (within 5 minutes later) via the same stoma. The feeding tube was removed 1 week later after resolution of anorexia. No antimicrobial administration or surgical closing was required for the stoma, and no complications were reported at hospital discharge or at 1-week and 1-month recheck appointments.

A 3-year-old castrated male domestic shorthair cat was referred because of increased inspiratory effort. A nasopharyngeal foreign body was suspected on the basis of medical history and CT findings. Ret-

roflex nasopharyngoscopy was attempted but unsuccessful. Informed consent was then obtained from the owner, allowing the investigators to perform a ROSA to nasopharyngoscopy. A foreign body was found and removed within 5 minutes and without complications. No antimicrobial administration or surgical closing was required for the stoma, and no complications were reported at discharge or at the 2-week recheck appointment.

Discussion

In the present study, a new endoscopic approach to performance of nasopharyngoscopy was found to be fast and easy to perform, providing several advantages over the conventional REA. Thorough evaluation of the nasopharynx with the REA requires training and can sometimes be challenging.[2,3,5,6,14,15] This was confirmed in our study, in which 42% of veterinarians were unable to visualize the edge of the soft palate and the choanae using the REA, and most of the participants (85%) rated the ROSA to be easier to perform than the REA. The size of the pharynx determines the size of the flexible endoscope that can be used, and interference with the endotracheal tube can occur when the endoscope is maneuvered into the pharynx. Eight veterinarians made a specific comment about the absence of interference with the endotracheal tube during the ROSA versus the REA, and 4 veterinarians reported difficulty manipulating the endoscope or keeping the camera centered once in the nasopharynx. Image quality for the soft palate was higher for the ROSA versus the REA, which may be explained by the high success rate of the ROSA. Every veterinarian who completed the ROSA was able to biopsy both landmarks using the larger biopsy forceps, whereas veterinarians who completed the REA were unable to use those same forceps and had to use smaller ones. Larger forceps yield larger biopsy specimens, and for the same number of biopsy attempts, larger forceps are likely to increase diagnostic yield with no apparent decrement in procedure safety.[18] Despite using smaller forceps, 4 veterinarians were still unable to collect biopsy specimens with the REA because the curvature of the endoscope impeded insertion of the forceps through the working channel.

In the authors' experience, the ROSA allows use of a wide range of endoscopes and instruments. Indeed, in the aforementioned preliminary work before the experimental portion of the present study, the authors (MGD, ECS, and AGA) used a 2.7-mm-diameter rigid endoscope[h] and were able to perform a thorough assessment of the nasopharynx using the ROSA. In an informal, unpublished investigation parallel to the present study, the authors asked 12 veterinarians to perform the ROSA and REA with a 5.9-mm-diameter gastroscope.[i] All 12 veterinarians were able to visualize the soft palate and the choanae using the ROSA, whereas none were able to complete the procedure using the REA. A larger endoscope would enable the use of larger biopsy forceps and improve flushing abilities. The authors have also performed a balloon dilation procedure on a feline cadaver that had a nasopharyngeal stenosis. The endoscope was placed at the edge of the soft palate, a Foley catheter was introduced into the oropharynx, and a biopsy forceps was introduced into the working channel and used to grab the tip of the catheter. The catheter was advanced across the stenotic lesion, and the balloon was placed at the level of the narrowing and inflated 3 times, resulting in successful dilation of the stenosis. This procedure took less than 5 minutes to perform and, in the authors' opinion, offered a straight-on view of the stenosis, aiding the ballooning procedure.

Despite the fact that the ROSA requires that esophagostomy be performed, time to complete this approach in the feline cadavers of the present study did not differ significantly from that of the REA. Moreover, 15 veterinarians exceeded the 10-minute limit when performing the REA, whereas only 1 veterinarian did so when performing the ROSA. We considered whether it would be appropriate to exclude from statistical analyses the veterinarians who were judged unsuccessful in the REA given the time limit. Ultimately, we chose to categorize those attempts as failures and to compare success rates and procedure times separately.

The present study had several limitations. First, preoperative time to clip and scrub the neck is required for the ROSA but this was not included in calculations of procedure times. Inclusion of such time would have increased observed procedure times for the ROSA. Even so, the ROSA could feasibly be performed in conjunction with esophageal feeding tube placement if a cat is anorexic and requires supportive care and nutritional management,[19] as was shown by 1 of the 2 included clinical cases. Second, because the study primarily involved cadavers, no conclusions could be made about potential postoperative complications associated with the ROSA. Cat owners need to be adequately informed about the wound care recommendations and potential complications associated with the procedure, which would be similar to any patient having an esophageal tube placed.[17,20–22] If esophageal tube placement is not warranted, we would expect that the stoma created for the ROSA would heal by second intention. In a retrospective study[17] of 238 cats that underwent esophageal feeding tube placement, 89 cats had complications, the most common being premature dislodgement of the tube (36/89) and infection associated with the tube (30/89). Infection of the stoma is usually medically managed, and surgical debridement seems to be rarely required.[17,21] Complications can be prevented with daily wound care, and instruments should be thoroughly cleaned and disinfected before each procedure in accordance with the manufacturers' recommendations.[23] In both clinical cases of the present study, the stomas were left to heal by second intention and both cats healed without complication.

Third, the previous experience of veterinarians who participated in the present study was limited. In-

deed, 86% of veterinarians had performed < 5 nasopharyngoscopies and 53% had performed < 5 esophageal feeding tube placements. Not all veterinarians had prior training in endoscopy, which could have biased the results against the REA. Prior experience in esophagostomy appeared to improve the perceived ease of use in favor of the ROSA. One inexperienced veterinarian inserted the forceps through the palatoglossal arch, and such a trauma could increase the risk of infection and abscessation in living patients.

Finally, it is important to distinguish the use of nasopharyngoscopy for diagnostic purposes from endoscopically assisted interventions concerning the nasopharynx. Other alternatives to the REA exist, and visualization of the nasopharyngeal cavity can be achieved through other noninvasive procedures, such as direct visualization with the aid of a spay hook, dental mirror, and light source. A rigid endoscope can also be used with a dental mirror to magnify and illuminate the structures and record images. Endoscopes have also been developed precisely for the nasopharyngeal area, such as 120° retrograde telescopes. If the REA is unsuccessful, those alternatives are noninvasive and therefore should be favored over the ROSA.

In conclusion, an alternative endoscopic technique was described in the present report that allowed complete assessment of the nasopharyngeal cavity in feline cadavers and 2 clinical cases. However, the ROSA is invasive and should be considered for diagnostic or therapeutic purposes for selected indications only when an experienced endoscopist is unable to access the nasopharyngeal cavity using the conventional REA. Additional research is required to evaluate the safety of the ROSA for cats with nasopharyngeal disorders.

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Photographs for inclusion in the manuscript were obtained by the authors with a Samsung Galaxy S7 smartphone and Olympus Exera II BF-P180 video bronchoscope.

Footnotes

a. Coin Flipper, Randomness and Integrity Services Ltd, Dublin, Ireland. Available at: random.org. Accessed Mar 27, 2019.
b. Exera II BF-P180 video bronchoscope, Olympus Corp, Tokyo, Japan.
c. Reusable biopsy forceps FB-21C-1 (2.0 mm) and FB-56D-1 (1.2 mm), Olympus Corp, Tokyo, Japan.
d. Optilube, Optimum Medical, Leeds, England.
e. Dover Rob-Nel red rubber urethral catheter, Kendall (Covidien), Dublin, Ireland.
f. Google form, Google LLC, Mountain View, Calif.
g. R: A language and environment for statistical computing, version 4.0.3, R Foundation for Statistical Computing, Vienna, Austria.
h. Hopkins wide-angle forward-oblique telescope, Karl Storz, Tuttlingen, Germany.
i. Olympus Exera GIF-XP160 video gastroscope, Olympus Corp, Tokyo, Japan.

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