ORIGINAL ARTICLE

Effect of two rhinoplasty techniques combined with vestibuloplasty on the cross-sectional area of the rostral nasal cavity in brachycephalic dogs with stenotic nares

K Shimura,* CD Franklin and AK House

Objective To compare preoperative and postoperative cross-sectional areas (CSAs) of the external nares and nasal vestibule on computed tomography (CT) transverse sections in brachycephalic dogs that underwent a vestibuloplasty in combination with either a Trader's technique or vertical wedge resection rhinoplasty.

Methods Medical records and corresponding preoperative and postoperative head computed tomographic images were reviewed to measure CSA at two defined points on transverse sections of the nasal cavities.

Results Nine brachycephalic dogs were included for analysis. Trader's technique and vestibuloplasty were performed in five dogs. Vertical wedge resection and vestibuloplasty were performed in four dogs. CSAs were significantly increased in all rostral nasal cavities postoperatively in both combination of techniques. The mean difference in CSA of the right and left external nares were 37.12 mm^2 (95% confidence interval [CI] 24.59, 49.66) and 64.3 mm^2 (95% CI 28.78, 60. 04), respectively. The mean difference in CSA of the right and left nasal vestibules were 25.08 mm^2 (95% CI 11.44, 38.73) and 28.73 mm^2 (95% CI 11.83, 45.64), respectively.

Clinical Significance Vestibuloplasty in combination with either Trader's technique or vertical wedge resection significantly increased the CSA of the external nares and nasal vestibules. These techniques did not result in recurrent stenosis or collapse of the alar wings in all evaluated rostral nasal cavities in this case series.

Keywords brachycephalic; computed tomography images; cross-sectional area; nares; nasal vestibule; rhinoplasty; vestibuloplasty

Aust Vet J 2025;103:199–205 doi: 10.1111/avj.13404

Brachycephalic breeds continue to increase in popularity around the world. Simultaneously, there is growing awareness of the upper airway obstruction experienced by these breeds amongst pet owners and increasing discussion on the recommendations on the diagnostic tests and surgical management of brachycephalic obstructive airway syndrome (BOAS) amongst veterinary clinicians. BOAS is characterised by several primary anatomic anomalies including stenotic nares, elongated soft palate, thickened soft palate, aberrant nasopharyngeal turbinates and hypoplastic trachea.[1–13] Secondary lesions, such as laryngeal collapse, pharyngeal collapse and enlarged tonsils further contribute to the upper airway obstruction in these breeds.[1–10]

The nasal cavity contributes 76.5% of total airflow resistance in normocephalic dogs with this increasing to 80% in brachycephalic dogs.[1,11,12,14] In these breeds, stenosis at the level of the nares and nasal vestibules, and presence of aberrant nasal turbinates contribute to the increased airway resistance in the nasal cavities.[2,11,15–17] Stenotic nares are reportedly identified in 77% of BOAS-affected dogs[3] and is managed surgically with procedures aiming to increase the width of the nares and to increase the cross-sectional area (CSA) of the nares thereby reducing airflow resistance. There are a number of reported or traditionally practiced techniques for the surgical treatment of stenotic nares including various wedge resection (VWR) techniques,[8,18,19] Trader's technique (TT),[20] alapexy,[21] dorsal offset rhinoplasty[22] and punch resection alaplasty[23] that have been previously described. More recently, ala-vestibuloplasty has been recommended to alleviate the stenosis in the nasal vestibule by including resection of the alar fold in addition to the management of the stenosis of the external nares through removal of the alar wings.[17,24,25]

There are limited data that interrogate the efficacy of isolated surgical procedures aimed at resolving upper airway obstruction associated with BOAS due to these patients typically requiring multilevel surgery. Investigations to date have evaluated the efficacy of conventional multilevel surgery or modified multilevel surgery[13,25–27] that address nasal, pharyngeal and laryngeal components involved in the airway obstruction and hence the individual validity of each procedure is poorly understood. A single study comparing the airflow patterns in French bulldogs with varying degrees of stenotic nares reported decreased airflow resistance in the external nares in one case after a wedge rhinoplasty for the management of severe stenotic nares was performed.[28] Although there are studies evaluating the use of and efficacy of laser-assisted turbinectomy in the management of aberrant turbinates in brachycephalic dogs as part of multilevel BOAS surgery,[15,24,26] there is a lack of data on the efficacy of the surgical management of stenotic nares at both the level of the external nares and nasal vestibule.

A recent study demonstrated the increase in CSA of the nostrils and nasal vestibule with three different rhinoplasty techniques on three dimensional (3D) printed models of a French Bulldog nose, with the ala-vestibuloplasty resulting in the largest average percentage increase in CSA from the nostrils to the caudal vestibule.[29] This is the first study that evaluates the effect of rhinoplasty techniques

*Corresponding author.
Peninsula Vet Emergency and Referral Hospital, Mornington, Victoria, Australia; k.r.shimura@gmail.com

alone on the CSA of nasal airways of client owned brachycephalic dogs. To date there is no published literature on the effect of ala-vestibuloplasty or other modifications of the ala-vestibuloplasty on the CSA or volume of the nares of brachycephalic dogs in a clinical setting. Additionally, there are limited data evaluating the long-term preservation of nostril diameter after surgery.[20]

The aim of this study was to retrospectively compare the preoperative and postoperative computed tomography (CT) transverse sections of the CSA of the nares in brachycephalic canine patients to determine if traditional rhinoplasty techniques combined with vestibuloplasty significantly increased the CSA of the external nares and nasal vestibule in these patients. An additional aim was to determine if the external nares diameter would be preserved over time on visual examination. The hypothesis was that both rhinoplasty combination techniques would significantly increase the CSA of both the external nares and nasal vestibule without long-term collapse of the alar wings or recurrence of stenosis.

Materials and methods

Case selection

Electronic medical records at a single referral institution were searched to identify brachycephalic dogs that were referred to the specialist surgery service at the hospital between October 2021 to March 2022 for management of BOAS. The electronic medical record software database was searched using the following search terms: brachycephalic obstructive airway syndrome (BOAS), brachycephalic obstructive airway disease, stenotic nares, elongated soft palate, eversion of laryngeal saccules, everted laryngeal saccules, hypoplastic trachea, laryngeal collapse, rhinoplasty, alarplasty, vestibuloplasty or ala-vestibuloplasty.

Cases were included in the study if records contained both preoperative and postoperative CT of the head from the rostral tip of the nose to the first cervical vertebra, had pre- and postoperative photographs of the nostrils and underwent a combined alarplasty and vestibuloplasty procedure for management of stenotic nares with a complete description of the surgical procedures performed and complete records of the postoperative reassessment 10 to 14 days after the procedure. Patients that had received prior surgical treatment for any component of BOAS were excluded. Details obtained from the medical records were breed, surgical techniques performed, surgeon performing the techniques, postoperative reassessment examination findings and owner satisfaction report.

CT image review

The head CT datasets saved as digital imaging and communication (DICOM) files were retrospectively reviewed using an open-source medical image viewer by a single veterinarian. There was a variation in slice thickness between 0.625 and 1.25 mm was present in the images reviewed. Three dimensional (3D) multiplanar reconstruction of the images displayed in the bone window was performed. Two points of the rostral skull were defined to consistently measure CSA of the rostral nasal passage of the pre- and postoperative (mm^2) data in each patient on the transverse plane in the bone window. These measurement locations were the prosthion and the level at the junction of the caudolateral margin of the right third maxillary incisor tooth and the alveolar bone (Figure 1). These two points correspond to the level of the external nares and the nasal vestibule. The CSA of the nasal cavity at these two specified points were measured using the closed polygon tool for each patient on the pre- and postoperative CT images.

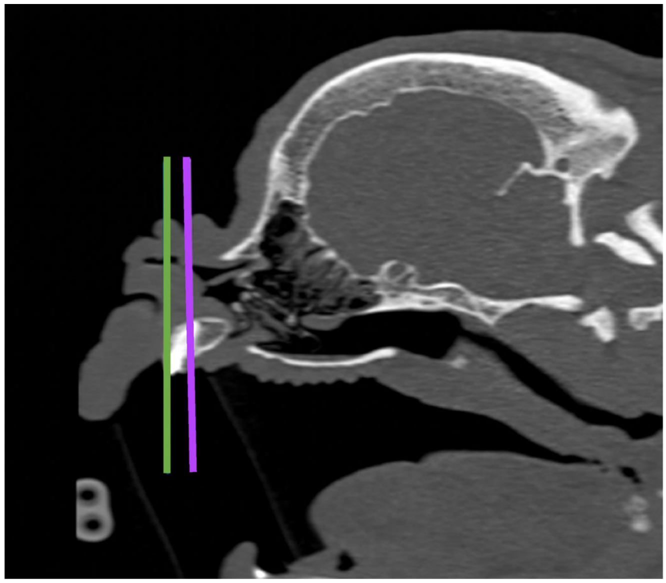

Figure 1. Sagittal skull view illustrating the two points at which the cross-sectional areas (CSAs) were measured: point 1 corresponding to the level of the prosthion (green vertical line) and point 2 corresponding to the level of the level at the junction of the caudolateral margin of the right third maxillary incisor tooth and the alveolar bone (purple vertical line).

Follow-up

In addition to routine two-week post operative examinations, telephone or physical follow-up of the cases were performed 3 to 8 months postoperatively for subjective owner reports on the cosmetic appearance of the external nares. Photographs of the nostrils were taken by the owners if a telephone follow-up was performed and examined for visual evidence of collapse of the alar wings or appearance of reversion to the preoperative level of stenosis, as graded using the Cambridge BOAS research group nostril grading[2].

Statistical analysis

Paired *t*-tests were performed using software Minitab Statistical Software (Version 19.2020.1.0, Minitab LLC, State College, PA) to determine if the means of the preoperative and postoperative measurements were significantly different. The level of statistical significance was set at $P < 0.05$.

Results

Sixteen brachycephalic dogs and their pre- and postoperative head CT datasets met the inclusion criteria for this study. Seven dogs were excluded from the CT analysis due to the presence of haemorrhage that prevented accurate measurement of CSA of the nares and nasal vestibule. One Pug, one English Bulldog, one Australian Bulldog and six French Bulldogs were included in the study. Five dogs that had a vestibuloplasty in combination with TT had photographs taken or submitted by owners that allowed visualisation of the external nares and subjective assessment of preservation of the open nares achieved with ala-vestibuloplasty. Three of these were French Bulldogs, one was an Australian Bulldog and one was a Pug.

Surgical technique

All dogs underwent a vestibuloplasty in combination with either a TT (five dogs) or VWR (four dogs), depending on surgeon preference. The surgery was performed by a board-certified specialist surgeon (five dogs) or a third-year surgical resident (four dogs).

Vestibuloplasty was performed with the same technique by both surgeons in all dogs. The Trader's technique was performed by the board-certified surgeon in five dogs and vertical wedge resection was performed by the third-year resident surgeon in four dogs. The vestibuloplasty was achieved by blind resection with CT-guided measurements of depth and expected size of alar fold excision. The surgical technique for a vestibuloplasty was modified from the previously described ala-vestibuloplasty[17] and performed as described: a curved haemostat was used to grasp the alar fold that extends into the nasal vestibule. A number 11 scalpel blade was used to sharply incise the junction of the dorsal and ventral lateral cartilage in the horizontal plane in a medial to lateral direction, allowing release of the ventral portion of the alar fold in the nasal vestibule. The number 11 blade was then inserted into the nasal vestibule and the resection was completed in the vertical plane in a dorsal to ventral direction (Figure 2).

The Trader's technique was performed as previously described. In brief, the ventral portion of the alar wing was grasped with Adson-Brown thumb forceps and a number 11 scalpel blade inserted into the dorsal aspect of the nares. The blade was oriented in an oblique dorsomedial to ventrolateral direction and the alar wing excised at approximately 45 degrees in a single incision. Vertical wedge resection was performed as previously described using a number 11 blade to create a vertical pyramid shaped wedge in the alar wings with the incisions extending into the dorsal lateral nasal cartilages, and the wedge defect closed with monofilament absorbable sutures in a simple interrupted pattern. Haemostasis was achieved by application of direct pressure using compression by insertion of large cotton buds into the nasal passage for 5 to 10 minutes. If this failed to achieve haemostasis, 1 to 2 mL of noradrenaline was infused into each cotton bud and the cotton bud reinserted for a further 5 to 10 minutes. The nasal cavity was suctioned of blood before postoperative CT assessment.

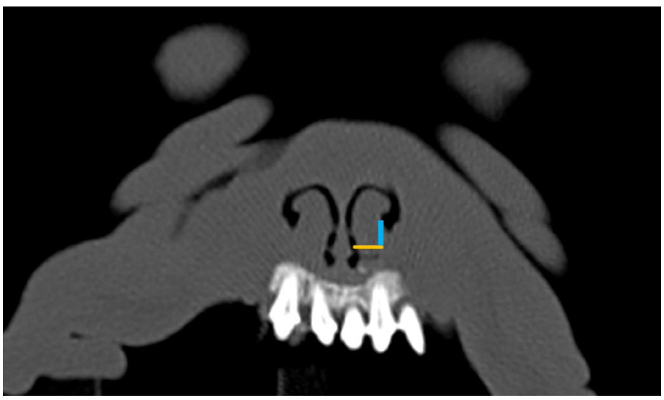

Figure 2. Transverse section of the head CT of a French Bulldog illustrating the sites of vertical (blue line) and horizontal (orange line) incisions when performing the vestibuloplasty in the nasal vestibule.

CT cross-sectional area

In two dogs, incomplete excision of the alar fold within the nasal vestibule resulted in revision of the vestibuloplasty at the time of the surgery and a subsequent postoperative CT being performed. In these cases, the post revision CT dataset was utilised for CSA measurements.

Comparison of the pre- and postoperative head CT images showed an increase in the CSA at both points in both the right and left sides corresponding to the external nares and nasal vestibule as demonstrated in one case in Figures 3 and 4. The range of the preoperative CSA measurements recorded of the right and left nares at point 1 were 6.72 to 45.3 mm^2 and 6.833 to 41.1 mm^2, respectively; and of the right and left nares at point 2 were 12.9 to 35.1 mm^2 and 12.0 to 35.0 mm^2, respectively. The range of the postoperative CSA measurements of the right and left nares at point 1 were 31.2 to 84.8 mm^2, and 31.8 to 81.8 mm^2, respectively. At point 2 postoperatively the range was from 17.2 to 89.4 mm^2 on the right side and 23.1 to 107.3 mm^2 on the left side. The mean CSA of the two measured points were significantly increased postoperatively in all nasal cavities. The percentage CSA increase ranged from 86.9% to 850% on the right side and 86.3% to 273% on the left side at point 1, and 16.5% to 336% on the right side and 17.9% to 234% on the left side at point 2. The mean CSA of the right and left external nares preoperatively were 20.8 and 19.9 mm^2, respectively (Table 1). The mean CSA of the right and left external nares points postoperatively were 57.9 and 64.3 mm^2, respectively. The mean CSA of the nasal vestibule points preoperatively were 25.2 and 25.6 mm^2, respectively. The mean CSA of the right and left nasal vestibule points postoperatively were 50.2 and 54.4 mm^2, respectively. There was a significant increase in the mean difference in CSA in both nares and nasal vestibules at both points (Figures 3 and 4). The mean difference in CSA of the right and left external nares points was 37.12 mm^2 ($P < 0.001$, standard deviation [SD] 16.30) and 64.3 mm^2 ($P < 0.001$, SD 20.34), respectively. The mean difference in CSA of the right and left nasal vestibules were 25.08 mm^2 ($P = 0.003$, SD 17.75) and 28.73 mm^2 ($P = 0.004$, SD 21.99), respectively (Table 2).

Follow-up

All owners reported satisfaction with cosmetic outcome of the rhinoplasty combined with vestibuloplasty at the time of the 10-to-14-day postoperative examination. Additionally, early return of pigmentation of the epithelium at the cut margins of the nasal planum was observed in dogs who had a Trader's technique performed (Figures 5 and 6).

Telephone or clinical examination follow-ups were acquired at 3 to 8 months postoperatively. Two of nine cases were examined within the clinic, the remaining seven dogs had follow-up via telephone discussion. All owners reported satisfaction with cosmetic outcome. There was no apparent reduction in the diameter of the nares compared with the immediate postoperative period on assessment of the patients directly or on photographs of their nares (Figures 5 and 6). All owners reported no obvious change in the cosmetic appearance of the external nares in the postoperative period.

SMALL ANIMALS

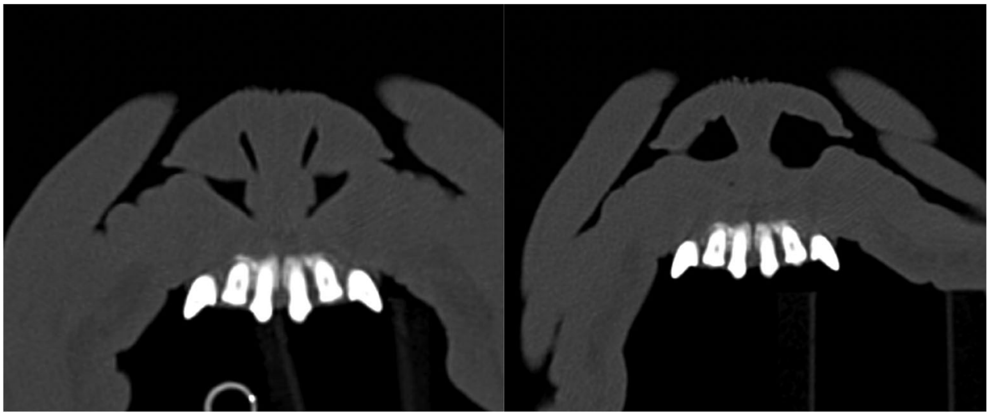

Figure 3. Transverse section of a French Bulldog head CT of the nares at point 1 preoperatively (left) and postoperatively (right).

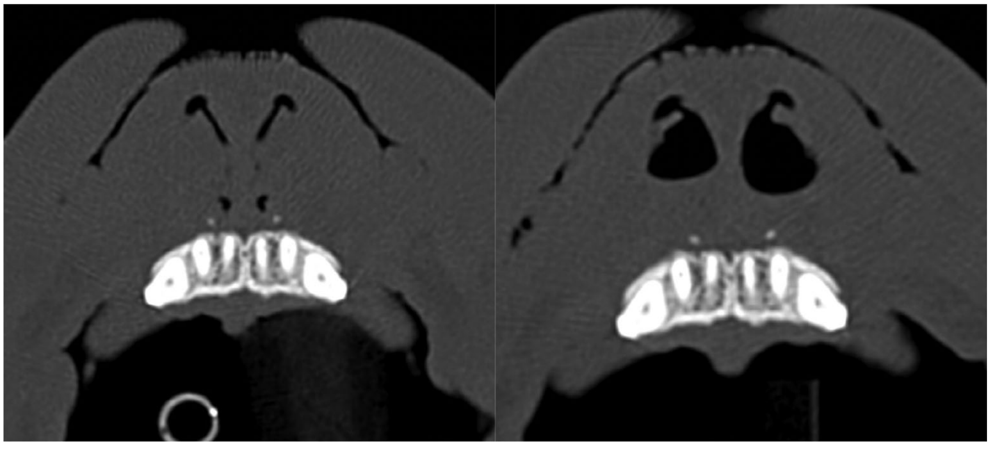

Figure 4. Transverse sections of a French Bulldog head CT of the nasal vestibule at point 2 preoperatively (left) and postoperatively (right).

Table 1. Mean cross-sectional areas (CSA) of nares of two defined points (Point 1: at the prosthion, Point 2: at the level of the caudal margin of the right third maxillary incisors and maxillary alveolar bone on the transverse plane of the reformatted head CT images)

	Preoperative CSA (mm²)				Postoperative CSA (mm²)			
	Point 1		Point 2		Point 1		Point 2	
	Right	Left	Right	Left	Right	Left	Right	Left
Mean	20.8	19.9	25.2	25.6	57.9	64.3	50.2	54.4

Table 2. Mean difference in cross-sectional area (CSA) of nares and nasal vestibule

Point within nasal cavity	Nares side	Mean difference (mm²)	95% CI	*P*-value	SD
1	Right	37.12	24.59, 49.66	<0.001	16.30
1	Left	44.41	28.78, 60. 04	<0.001	20.34
2	Right	25.08	11.44, 38.73	0.003	17.75
2	Left	28.73	1183, 45.64	0.004	21.99

CI, Confidence Interval; SD, Standard Deviation.

For five dogs that had TT combined with vestibuloplasty, photographs of the nostrils were available. Evaluation of these photographs revealed that all five dogs had open nares, using the Cambridge BOAS Research Group nostril grading[2], with no evidence of collapse of the alar wings (Figures 5 and 6).

Complications

No major complications necessitating additional treatment, prolonged hospitalization or euthanasia were identified in these cases. All dogs had varying degrees of haemorrhage that necessitated use of noradrenaline topically to achieve haemostasis when pressure was insufficient after vestibuloplasty.

Discussion

Our data revealed that the use of a modified ala-vestibuloplasty, vestibuloplasty combined with either TT or VWR, in a clinical setting significantly increased the CSA of the nares and nasal vestibule in the dogs studied. This increase ranged from 86.9% to 850% across

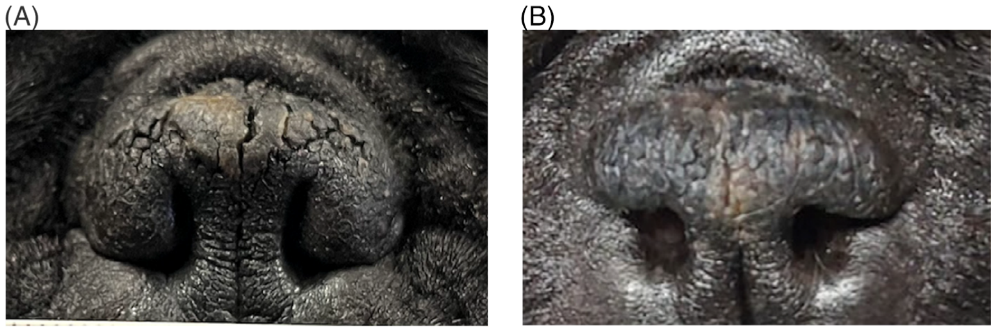

Figure 5. **(A) Preoperative photograph of French Bulldog nares with moderate stenosis. (B) The same dog 8 months after Trader's technique rhinoplasty and vestibuloplasty.**

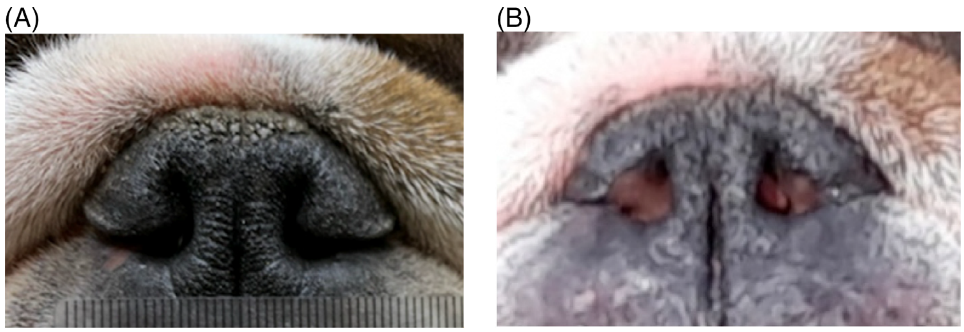

Figure 6. **(A) Preoperative photograph of English Bulldog nares with moderate stenosis. (B) The same dog 8 months after Trader's technique rhinoplasty and vestibuloplasty.**

the dogs studied. The two points in the rostral nasal cavity were defined at levels that correspond to a fixed point within the region of the external nares or nasal vestibule. The measurements of CSA were performed at these two points without evaluation of CSA at every level of the rostral nasal cavity in this study. Although the significant increase in CSA was based on these two defined points in this study, the resection of tissue was performed en bloc, and hence, it was expected to result in a relatively uniform increase in CSA from the rostral to the caudal point of the vestibuloplasty. This was evident when reviewing the CT images. The aim of determining the presence of significant change in CSA within the nasal vestibule was achieved. This finding provides valuable information for guiding the surgical management of nasal stenosis in brachycephalic canine patients.

This was a retrospective study and had inherent limitations associated including the involvement of two different surgeons that may have produced variability in the outcomes. Additionally, the rhinoplasty technique that was performed with the vestibuloplasty was one of two techniques dependent on the surgeon preference with one surgeon who consistently performed the TT and vestibuloplasty, whereas the other consistently performed VWR combined with vestibuloplasty. Both techniques resulted in an increase in CSA in both nasal cavities at the two measured points in all cases in this study; however, no assessment on the difference in percentage increase or clinical outcomes between the patients were made, and thus, conclusions can only be made on the impact of two rhinoplasty techniques performed in conjunction with the vestibuloplasty rather than between these approaches or between different surgeons. A study with a larger sample size would allow for investigation in any differences between techniques and between surgeons.

The presence of blood clots in the nasal vestibules observed in the postoperative head CT images may have impacted CSA measurements and resulted in seven dogs that initially matched the inclusion criteria to be subsequently excluded from analysis. In the reviewed postoperative CT images, there remained in some cases small volumes of suspected haemorrhage in the nasal vestibule. Small volumes of haemorrhage would have reduced the CSA, and hence, the increase may have been larger than measured.

In this case series, CT provided a guide for the surgeons to ensure adequate resection the alar fold for the vestibuloplasty. The alar fold cannot be directly visualised within the nasal vestibule, and hence, excision was performed based on estimated measurements of the alar fold on the preoperative CT. The value of postoperative CT images, when performed, was highlighted in two dogs in which residual alar fold was observed on the postoperative CT images that had resulted in a return to theatre for further resection. The insufficient removal of alar fold in the nasal vestibule likely represents the learning curve of performing this technique blind. In contrast to the ex vivo studies using 3D printed models, the study provided insights into potential complications in the clinical setting. These data suggest that surgeons need to be aware that incomplete excision can occur and post-procedural CT can be of benefit to assess surgical outcome.

No postoperative complications were observed at postoperative physical examination at 10 to 14 days in all patients, and 3 to 8 months postoperatively in the patients that were examined. Considering that the TT and vestibuloplasty do not attempt to close the excised mucosa, postoperative stenosis secondary to scar formation is a theoretical risk. In this case series, no evidence of postoperative stenosis secondary to wound healing was observed. Additionally, collapse of the alar wings due to loss of the supporting alar folds as a consequence of the vestibuloplasty was not observed. Histological analysis of the surgically resected alae nasi of in 10 of 11 French

Bulldogs revealed absence of cartilage,[30] but further investigation in the significance of the histological differences in the alae nasi of dogs and potential for collapse of the alar wings is required to understand this potential complication. Prospective controlled studies with a follow-up CT and/or endoscopic assessment would provide a direct assessment for recurrent stenosis, particularly at the level of the nasal vestibule. In our study, quantitative evaluation of the CSA of external nares of photographs were not performed due to the lack of standardisation of postoperative photographs for appropriate measurement. Nostril grading was therefore used to determine whether there was reversion of the stenosis at the level of the external nares.

No owners reported a perceived reduction in the diameter of nares from the postoperative assessment at 14 days to the follow-up assessment 3 to 8 months postoperatively. All owners reported the nares to be noticeably more open compared with the preoperative appearance of external nares and perceived the postoperative cosmetic outcome to be good. Although TT, unlike the VWR, does not create a cosmetic closure of the alar wing all owners, irrespective of technique, reported a satisfactory cosmetic outcome.

In this study, one individual performed the measurements the CT CSA measurements and was not blinded. The measurements were performed at two defined positions to facilitate consistency and eliminate interobserver variations; however, no evaluation of observer variability was performed. Considering the dramatic increase in cross sectional observed, it is unlikely that the failure to blind the observer or interobserver variations would have been sufficiently large enough to impact the study findings.

It is important to consider that despite these data revealing a dramatic increase in CSA, they do not demonstrate an improvement in respiratory function after vestibuloplasty combined with either VWR or TT, nor do they evaluate the clinical efficacy of the rhinoplasty techniques in combination with vestibuloplasty. Moreover, the data do not allow for any evaluation on whether vestibuloplasty will result in preferential clinical outcomes to traditional rhinoplasty techniques performed in isolation. Prospective comparisons of vestibuloplasty technique and other traditionally practised rhinoplasty techniques combined with objective measures of respiratory function would be required in order to investigate the quantitative efficacy of one technique over another.

Conclusion

Vestibuloplasty performed in combination with vertical wedge resection or Trader's technique to surgically correct stenotic nares in brachycephalic dogs significantly increased the CSA of the rostral nasal cavity in all dogs. No externally visible collapse of the alar wings or evidence of recurrent stenosis was observed in any of the cases postoperatively. Postoperative head CT, when performed, provided subjective, visual guidance to clinicians on sufficient resection of the alar fold in the nasal vestibule. Further, larger, prospective studies are indicated to evaluate the efficacy of ala-vestibuloplasty in respiratory function in different brachycephalic breed dogs in comparison with other rhinoplasty techniques.

Acknowledgments

The authors thank Sue Finch, PhD for the statistical advice of our data.

Conflicts of interest and sources of funding

The authors declare no conflicts of interest or sources of funding for the work presented here.

Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

References

1. Meola SD. Brachycephalic airway syndrome. *Top Companion Anim Med* 2013; 28:91–96.
2. Liu NC, Troconis EL, Kalmar L et al. Conformational risk factors of brachycephalic obstructive airway syndrome (BOAS) in pugs, French bulldogs, and bulldogs. *PLoS One* 2017;12:24.
3. Fasanella FJ, Shivley JM, Wardlaw JL et al. Brachycephalic airway obstructive syndrome in dogs: 90 cases (1991–2008). *JAVMA-J Am Vet Med Assoc* 2010;237: 1048–1051.
4. Dupre G, Findji L, Oechtering G. *Brachycephalic airway syndrome*. Oxford, Blackwell Science Publications, 2013.
5. Heidenreich D, Gradner G, Kneissl S et al. Nasopharyngeal dimensions from computed tomography of pugs and French bulldogs with brachycephalic airway syndrome. *Vet Surg* 2016;45:83–90.
6. Grand JGR, Bureau S. Structural characteristics of the soft palate and meatus nasopharyngeus in brachycephalic and non-brachycephalic dogs analysed by CT. *J Small Anim Pract* 2011;52:232–239.
7. Oechtering TH, Oechtering GU, Noller C. Structural characteristics of the nose in brachycephalic dog breeds analysed by computed tomography. *Tierarztl Prax Ausg Kleintiere Heimtiere* 2007;35:177–187.
8. Riecks TW, Birchard SJ, Stephens JA. Surgical correction of brachycephalic syndrome in dogs: 62 cases (1991–2004). *JAVMA-J Am Vet Med Assoc* 2007;230: 1324–1328.
9. Ravn-Molby EM, Sindahl L, Nielsen SS et al. Breeding French bulldogs so that they breathe well-a long way to go. *PLoS One* 2019;14:14.
10. Torrez CV, Hunt GB. Results of surgical correction of abnormalities associated with brachycephalic airway obstruction syndrome in dogs in Australia. *J Small Anim Pract* 2006;47:150–154.
11. Hostnik ET, Scansen BA, Zielinski R et al. Quantification of nasal airflow resistance in English bulldogs using computed tomography and computational fluid dynamics. *Vet Radiol Ultrasound* 2017;58:542–551.
12. Schuenemann R, Oechtering G. Inside the brachycephalic nose: Conchal regrowth and mucosal contact points after laser-assisted turbinectomy. *J Am Anim Hosp Assoc* 2014;50:237–246.
13. Krainer D, Dupre G. Brachycephalic obstructive airway syndrome. *Vet Clin N Am-Small Anim Pract* 2022;52:749–780.
14. Phillips H. Updates in upper respiratory surgery. *Vet Clin N Am-Small Anim Pract* 2022;52:339–368.
15. Schuenemann R, Pohl S, Oechtering GU. A novel approach to brachycephalic syndrome. 3. Isolated laser-assisted turbinectomy of caudal aberrant turbinates (CAT LATE). *Vet Surg* 2017;46:32–38.
16. Oechtering GU, Pohl S, Schlueter C et al. A novel approach to brachycephalic syndrome. 1. Evaluation of anatomical intranasal airway obstruction. *Vet Surg* 2016;45:165–172.
17. Oechtering G, Schuenemann R. *Brachycephalics: trapped in a man-made misery?* Cambridge, Turbinate Ablation in BAOS, 2010.
18. Seneviratne M, Kaye BM, Ter Haar G. Prognostic indicators of short-term outcome in dogs undergoing surgery for brachycephalic obstructive airway syndrome. *Vet Rec* 2020;187:403.

19. Schmiedt CW. Nasal planum, nasal cavity, and sinuses. In: Johnston SA, Tobias KM, editors. *Veterinary surgery: small animal*. Second edn. Elsevier, St Louis, MO, 2018;1920–1934.
20. Huck JL, Stanley BJ, Hauptman JG. Technique and outcome of nares amputation (trader's technique) in immature shih tzus. *J Am Anim Hosp Assoc* 2008; 44:82–85.
21. Ellison GW. Alapexy: an alternative technique for repair of stenotic nares in dogs. *J Am Anim Hosp Assoc* 2004;40:484–489.
22. Dickerson VM, Dillard CMB, Grimes JA et al. Dorsal offset rhinoplasty for treatment of stenotic nares in 34 brachycephalic dogs. *Vet Surg* 2020;49: 1497–1502.
23. Trostel CT, Frankel DJ. Punch resection Alaplasty technique in dogs and cats with stenotic nares: 14 cases. *J Am Anim Hosp Assoc* 2010;46:5–11.
24. Oechtering GU, Pohl S, Schlueter C et al. A novel approach to brachycephalic syndrome. 2. Laser-assisted turbinectomy (LATE). *Vet Surg* 2016;45:173–181.
25. Liu NC, Oechtering GU, Adams VJ et al. Outcomes and prognostic factors of surgical treatments for brachycephalic obstructive airway syndrome in 3 breeds. *Vet Surg* 2017;46:271–280.
26. Liu NC, Genain MA, Kalmar L et al. Objective effectiveness of and indications for laser-assisted turbinectomy in brachycephalic obstructive airway syndrome. *Vet Surg* 2019;48:79–87.
27. Riggs J, Liu NC, Sutton DR et al. Validation of exercise testing and laryngeal auscultation for grading brachycephalic obstructive airway syndrome in pugs, French bulldogs, and English bulldogs by using whole-body barometric plethysmography. *Vet Surg* 2019;48:488–496.
28. Khoa ND, Phuong NL, Tani K et al. Computational fluid dynamics comparison of impaired breathing function in French bulldogs with nostril stenosis and an examination of the efficacy of rhinoplasty. *Comput Biol Med* 2021;134:15.
29. Franklin PH, Riggs J, Liu NC. Comparison of the effectiveness of three different rhinoplasty techniques to correct stenotic nostrils using silicone models: a case study. *Vet Surg* 2024;53:104–112.
30. di Virgilio F, Guelette V, Prata D et al. Comparative histological analysis of the alae nasi in French bulldogs with brachycephalic obstructive airway syndrome and unaffected non-brachycephalic dogs. *Vet Rec* 2023;7:193.

(Accepted for publication 14 November 2024)