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Reconstruction of a large nasal–facial defect using an augmented temporal myocutaneous tube flap in a dog

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Abstract

The muzzle region of dogs contains various composite tissues, which are challenging to recreate during reconstruction. Small or moderate facial/nasal defects can be closed primarily or left for second-intention healing. However, larger defects require the application of composite tissue or labial advancement flaps. Axial pattern flaps based on the caudal auricular artery, superficial temporal artery (STA), angularis oris artery, and other cutaneous arteries have been reported. In our case, we aim to report the reconstruction of a large composite defect of the rostral and dorsal nasal regions in a dog using an augmented, axial myocutaneous flap based on bilateral STAs. This is a clinical report on a spayed female mixed-breed dog (age, 7 years; weight, 15 kg), in which a large-scale nasal–facial composite tissue defect was surgically reconstructed using an axial myocutaneous flap based on bilateral STA branches. A delay technique was applied to prefabricate the flap to enrich the blood supply. New nostrils were created on a folded, rostral hard palate. As a result, the axial tube rotational flap was successfully transferred. The use of delay technique for prefabricating the tube flap optimized its size and survival. In addition to the folded rostral hard palate, the flap fully closed the defects on the face and nose. Functional and cosmetic outcomes were satisfactory, with minimal donor-site morbidity. In, conclusion, a large-scale nasal–facial defect in a dog was successfully reconstructed using an augmented tube pedicle flap based on the bilateral STAs, which may, thus, be used to repair very large facial-nasal defects in dogs.

KEYWORDS
dog, muzzle, nasal–facial defect, pedicle flap

1 | INTRODUCTION

The muzzle region of dogs has a three-dimensional structure. It involves a variety of composite tissues, including the skin, bones, nasal turbinates and mucosa. These tissues, which individually serve different functions, are challenging to recreate during reconstruction. Small or moderate facial/nasal defects can be closed primarily or left for second-intention healing. However, larger defects typically require the application of composite tissue flaps or labial advancement flaps (Chiti et al., 2018; Losinski et al., 2015). Axial pattern flaps based on the caudal auricular artery, superficial temporal artery (STA), angularis oris artery and other cutaneous arteries have been reported in the veterinary literature (Chiti et al., 2018; Degner, 2007; Fahie & Smith, 1999; Field et al., 2015; Losinski et al., 2015; Ter Haar et al., 2013). Axial flaps provide more optimal blood supply by incorporating a direct cutaneous artery and vein and their angiosomes into the flap (Aper & Smeak,

2003). These direct cutaneous perforators improve the perfusion of the flap, allowing for the design and mobilization of larger, longer flaps with higher survival rates than those obtained with random subdermal plexus flaps (Pavletic, 2003). However, the disadvantages of axial pattern flaps include the more extensive surgical dissection required for flap elevation, potential donor-site complications and the additional surgical time required for wound reconstruction (Ter Haar et al., 2013). Furthermore, the use of axial pattern flaps for closure of large rostral facial defects may result in partial flap necrosis due to excessive flap length and potential wound healing complications at the donor site (Milton, 1970).

The purpose of this report is to describe the use of an augmented tube pedicle flap based on the STAs for the reconstruction of an extensive defect of the nasal planum in a dog and report the outcome of this approach.

2 | MATERIALS AND METHODS

2.1 | Case description

A 7-year-old spayed female mixed-breed dog was admitted for surgical consultation due to an extensive facial defect. The patient was a mildly thin rescue dog (BCS 4/9) with an unknown history and lesion etiology. Approximately 80% of the maxillary region of the dog was destroyed with severe inflammation. The nasal planum, skin, bone, turbinates and upper lip were largely missing. Both the nasal cavities and the remaining turbinates were exposed. Soft tissue swelling of the right submandibular region, limited jaw range of motion accompanied by severe drooling and frequent sneezing were similarly observed (Figures 1a and 1b). The tongue protruded to the left side but had no lesions. Despite these abnormalities, the patient was clinically healthy. The results of routine blood work, including complete blood count and a biochemistry panel, were generally unremarkable.

Computed tomography was performed to evaluate the severity of tissue damage and its possible etiology. The images revealed extensive destruction of the nasal and maxillary structures, extensive soft tissue inflammation of the right neck region, including the right submandibular salivary gland and enlargement of the submandibular and retropharyngeal lymph nodes (Figure 2). No foreign bodies were detected.

An incisional biopsy, which was performed to investigate the nature of the tissue reaction and exclude possible neoplasm, revealed severe, chronic, and active necropurulent myositis, dermatitis, and sialadenitis, with myocyte degeneration, necrosis, and granulation tissue formation. The remnant soft tissues of the nasal cavity showed chronic active and proliferative rhinitis with granulation. Aerobic and anaerobic bacterial cultures of the submandibular discharge were negative. The tentative diagnosis was facial destruction and deformation caused by earlier trauma, chemical injury and possible secondary bacterial infection.

Despite the negative findings in the bacterial culture, the inflammation of the right submandibular and neck regions gradually resolved after the administration of broad-spectrum antibiotics and anti-inflammatory drugs. Surgery was planned to reconstruct the large-


Figure 1 (a and b) The maxillary region of the dog was extensively destroyed and deformed with severe inflammation

scale composite facial defect to allow improved functional and cosmetic recoveries.

2.2 | Preparation and anesthesia

The dog was premedicated with morphine (0.4 mg/kg, IM, Morphine; Food and Drug Administration, MOHW; Taipei, Taiwan), ketamine (0.5 mg/kg, IV Karsoon mine 100; Health-Tech Pharmaceutical; Taipei, Taiwan) and lidocaine (2 mg/kg, IV, lidocaine injection 2% Tai Yu; Tai Yu Chemical and Pharmaceutical, Hsinchu, Taiwan). General anesthesia was induced with propofol (2 mg/kg, IV bolus and then titrated to effect, Lipuro; B. Braun, Taipei, Taiwan) and maintained with isoflurane in oxygen after orotracheal intubation. The patient was placed in ventral recumbency, and routine aseptic preparation of the forehead region was performed. Cephazolin (25 mg/kg, IV, Cefa; Taiwan Biotec,
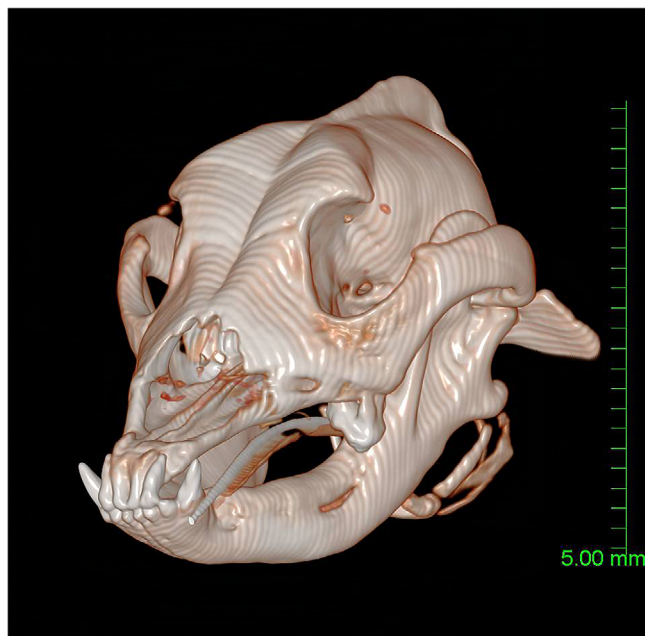
Figure 2 3D reconstructed skull image revealing the destruction of bony structures

Taoyuan, Taiwan) was administered at induction and every 90 min. Intraoperative analgesia was followed by constant rate infusion of morphine and ketamine at doses of 0.2 and 3.0 mg/kg/h IV, respectively, at a volume of 4 ml/hour. Meloxicam (0.2 mg/kg, IV, Mobic, Boehringer Ingelhelm, Taipei, Taiwan) was similarly administered for perioperative analgesia. During surgery, Ringer's solution was administered intravenously at a rate of 5–10 ml/kg/h, adjusted as needed.

2.3 | Surgical technique

The surgical procedure was planned and executed in three stages. Stage 1 involved the construction of a tube pedicle flap that was intended to cover most of the nasal–facial defects. The flap, which was 4 cm in width and 16 cm in length and based on the bilateral STAs, was constructed by making two parallel incisions on the forehead. Similarly, he thin frontalis muscle under the skin was elevated with the flap. After undermining, a tube was created by closing the bipedicle flap edges with 3–0 nylon interrupted sutures. The donor site was primarily closed (Figures 3a and 3b).

Stage 2 involved flap prefabrication. The flap was 'delayed' by half cutting the right base of the flap, the right superficial temporal vessel was severed, and the incision was re-sutured with 3–0 interrupted nylon sutures (Figure 4). After 7 days, the intact half of the right flap base was incised to the depth of the frontalis muscle and re-sutured with 3–0 interrupted nylon sutures. During the delayed stage, a pulse oximeter and laser Doppler blood flowmeter (Laser Flowmeter ALF 21, infrared laser diode; class 1; wavelength 780 nm; Maker: Advance Co. Ltd., Japan) were used to monitor the circulation and viability of the tube pedicle flap.
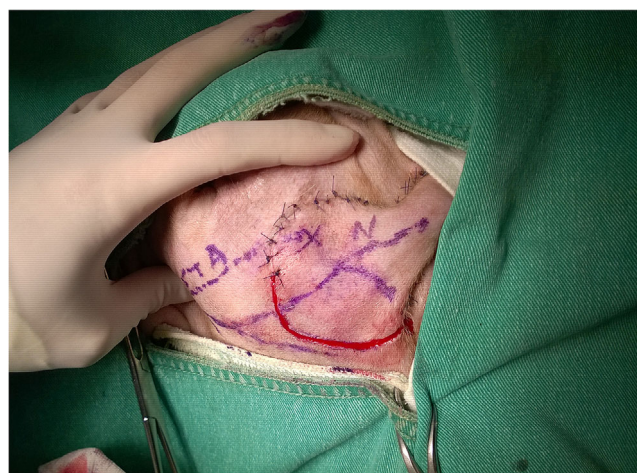

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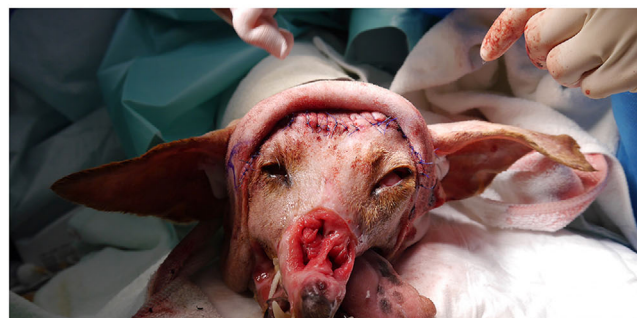

b

Figure 3 (a) A tube pedicle flap was designed based on the bilateral superficial temporal arteries (STAs). (b) The tube was created by closing the bipedicle flap edges with sutures, and the donor site was primarily closed

Figure 4 The flap was 'delayed' by half cutting the right base of the flap, and the right superficial temporal vessel was also severed

Stage 3 involved the final transplantation. After 14 days, the right base of the flap was severed, and the longitudinal suture line along the tube was re-opened. The resulting flap was a long, single-pedicle axial flap originating from the left temporal region. The viability of this flap was confirmed by abundant bleeding from the distal margin. The edges
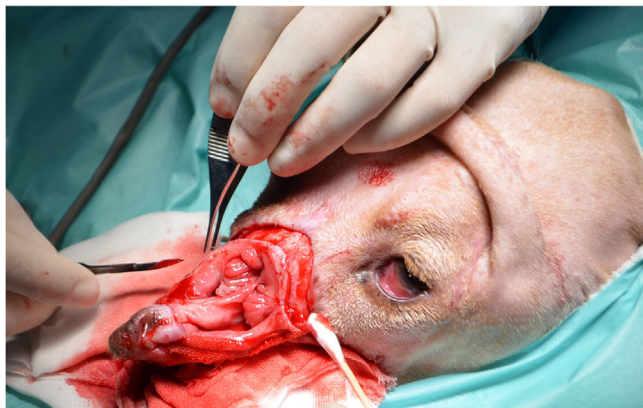
Figure 5 The circumferential edge of the facial-nasal defect was sharply trimmed so as to create a fresh wound margin to receive the flap

on either side of the nasal planum defect were sharply trimmed in partial thickness to create a fresh wound margin that would receive the flap (Figure 5). The partially incised and elevated granulation tissues on the edges of the defect were folded towards the dorsal midline and sutured with 4–0 polydioxanone sutures to form a scaffold as the lining of the reconstructed nasal cavity. The rostral hard palate, 2.5 cm in length, was cut while preserving its mucoperiosteal soft tissue in the oral cavity. Subsequently, it was folded up to 90° to serve as the nasal planum. New nostrils were made using a trephine (diameter, 0.7 cm) on an upright rostral hard plate. To prevent the nostrils from stenotic healing, two silicon stents were secured in the nostrils with stay sutures. Afterwards, the harvested single-pedicle flap was laid over the partially reconstructed nasal cavity and sutured to the peripheral skin edges with 3–0 interrupted nylon sutures.

The translocated tube pedicle flap equally partially reconstructed the bilateral labial defect. The margin of the flap was sutured to the intact oral gingiva and the mucosa. The intact portion of the right lower lip was advanced caudally and dorsally to form the commissure of the right lip.

2.4 | Postoperative care

In all three stages of the surgical procedure, meloxicam (0.1 mg/kg orally, once daily, Metacam; Boehringer Ingelheim, Taipei, Taiwan) was administered postoperatively as an analgesic to reduce inflammation and edema related to the surgical procedure for 4 days or longer as needed. An Elizabethan collar was placed postoperatively until wound healing was complete, and no specific feeding-related modifications were made. After each surgery, amoxicillin–clavulanic acid (20 mg/kg, orally, twice daily, Augmentin; GlaxoSmithKline, GSK, Taipei, Taiwan) was administered for 2 weeks.

2.5 | Follow-up

After stage 3 of the surgery, the patient was hospitalized for 3 days and provided with food and water ad libitum. On day three, the dog

appeared comfortable and maintained a good appetite with only a mild amount of subcutaneous emphysema and soft tissue swelling around the skin incision. On postoperative day 14, all sutures were removed. The translocated tube pedicle flap survived, and the wound was mostly healed. The animal was subsequently followed up by irregular clinic visits or telephonic assessments. The last hospital visit was performed 5 years after reconstruction for periodontal treatment.

3 | SURGICAL OUTCOME

A branch of the left palpebral nerve was accidentally transected during the construction of the tube pedicle. This resulted in a loss of the palpebral reflex of the left eye. However, the reflex gradually improved after two months.

On the day of the partial right flap base incision and right STA ligation (stage 2-1), laser Doppler showed decreased blood flow on the flap's right side compared to the left (with the flow in the mid-flap region being the lowest). The blood flow gradually increased and was consistent over the full length of the tube at the end of the delay procedure.

The donor site healed uneventfully despite the minor mismatch in hair length along the suture line. The flap survived the reconstruction procedure, and postoperative tissue edema resolved spontaneously within a week. Mild infection and partial dehiscence were noted between the flap and the new nasal planum. It was controlled and healed with debridement, wound re-closure, and antibiotics.

Despite the dwelling of tube stents, the reconstructed region healed within 3 weeks after reconstruction. To improve mouth breathing, two openings were made on the margin between the flap skin and nasal planum to facilitate breathing through the nasal cavity. The functional outcome was considered satisfactory. Consequently, the patient was able to eat and breathe normally, with an acceptable jaw range of motion (Figures 6a and 6b). In the follow-up assessment performed 5 years after the reconstruction, the animal showed a good quality of life and acceptable cosmetic outcomes and facial and nasal functions.

4 | DISCUSSION

This is the first published canine case utilizing a prefabricated long myocutaneous flap based on bilateral STA vessels to close a large nasal–facial composite tissue defect. Primary surgical closure with or without tension relief may be used to manage soft tissue defects on the nose and face of animal patients. However, larger wounds usually require more advanced techniques, such as local flaps, indirect flaps, axial pattern flaps or skin grafts (Pavletic, 2003). Free tissue transfer of a vascularized flap is another useful technique for complex facial reconstructions (Degner, 2007) since it provides some freedom to transfer tissues to a remote recipient site (Liu & Yeh, 2017). However, its application in veterinary practice is limited due to the requirement for special equipment and training in order to execute vessel anastomoses under magnification. Among these tissue transfer techniques,
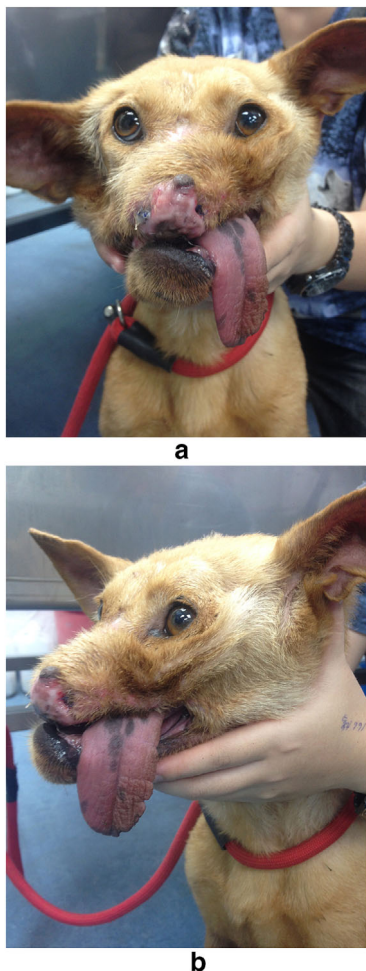
Figure 6 (a and b) The cosmetic outcome of the patient and the healed flap 2 months after the reconstruction

local flaps with or without axial circulation are still widely employed because of their versatility and minimal requirements for equipment and surgical skills.

The survival of a random flap requires the support of subdermal plexus circulation from the donor site; therefore, their optimal size or shape is limited (Milton, 1970). An axial flap contains direct cutaneous vessels from the donor site, which provides more ample circulation to the flap (Aper & Smeak, 2003; Fahie & Smith, 1999; Field et al., 2015; Losinski et al., 2015). The survival of an axial pattern flap is more promising than that of a random flap. However, established axial flap donor sites are limited and may be too small or too remote to be used on specific recipient lesions (Degner, 2007; Pavletic, 2003).

In this patient, the major challenges were the large size of the skin defect on the face and the lack of composite tissues of the nasal cavity (Yates et al., 2007). To provide an optimal amount of soft tissue for reconstruction, a modified tube pedicle long flap was designed on the patient's forehead. There are three main arteries adjacent to the defects: the STA, the angularis oris artery and the caudal auricularis artery (Degner, 2007). The longest possible STA axial flap was from

the zygomatic bone to the middle of the opposite orbital bone (Fahie & Smith, 1999). To construct a flap larger than the conventional flap, which is based on only one STA vasculature, a tube flap was designed based on the bilateral STAs, and a delay technique was adopted to increase blood perfusion from the left STA.

A delay technique is executed by partially severing the skin and undermining the subcutaneous tissues at the base of one pedicle, thus, creating partial ischaemia in the region. Such ischaemia has been shown to initiate angiogenesis/vasculogenesis and show protective effects (Holzbach et al., 2009), which include lowering the energy requirement, decreasing the levels of reactive oxygen species, increasing electrolyte homeostasis and reducing apoptosis (Hamilton et al., 2020; Yadav et al., 1999). The increased vessel densities and diameters and the redirected vessels along the axis of the flap after the delay technique increased the survival rate of the long flap after harvest (Ghali et al., 2007; Hamilton et al., 2020; Morris, 1995). In this case, the circulation from the left STA was redirected along the long axis of the flap towards the partially served right side to supply the ischaemic portion. While the ideal delay period is 1–3 weeks, the optimal delay period is likely 7 days, since angiogenesis occurs on the third to seventh days. (Morris, 1995)

Surveillance of flap viability in the stages of preparation is crucial. A pulse oximeter, ultrasound Doppler and laser Doppler were used to monitor the circulation of the flap during the delay process. The pulse oximeter and ultrasound Doppler can better detect the existence of blood flow, while the laser Doppler can better monitor the volume of perfusion (Choi & Bennett, 2003; Yuen & Feng, 2000). However, fluctuations of the detected readings precluded systemic and statistical analysis of flap perfusion. Further studies are needed to compare the efficiencies of different detection methods.

To further reduce the defect size of the nasal cavity and reconstruct the nostrils, the rostral hard palate was 'folded up' to form the nasal planum of the nasal cavity, which also accommodated the new nostrils. The peripheral granulating margin of the nasal cavity defect was sharply incised and reflected to the midline to partially substitute the dorsal mucosa of the nasal cavity that no longer exists. Over these structures, the flap was able to fully cover the facial defect with minimal tension. In the present case, the short-term complications of the STA flap included iatrogenic palpebral nerve injury, temporary mild deformity of the right face due to skin tension and severe flap edema in the early postoperative period. Fortunately, all of these complications were self-limiting.

It was a major challenge to construct the nostrils on the bony hard palate in this patient. Despite applying silicone tube stents in the reconstructed nostrils and administering corticosteroids, the nostrils were gradually sealed by the granulation tissue. Nevertheless, the patient was able to breathe through the openings made between the skin and the nasal planum margin, and the cosmetic and functional outcomes in the immediate postoperative period and on long-term follow-up assessments were acceptable.

In conclusion, a novel long tube flap based on bilateral STAs and the palatal elevation technique were applied for the reconstruction of a large nasal and facial defect in a dog. Donor-site morbidity was

minimal, and the oral and nasal cavities were successfully reconstructed with acceptable functional and cosmetic outcomes.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to this report.

AUTHOR CONTRIBUTIONS

Conceptualization, data curation, formal analysis, methodology, resources, software, writing-original draft, writing-review and editing: Mei-Jyun Ciou. Conceptualization, data curation, formal analysis, methodology, resources, software, supervision, validation, visualization, writing-review and editing: Lih-Seng Yeh.

PEER REVIEW

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