Case Report

Radical maxillectomy as a successful treatment for gunshot-induced maxillary and nasal cavity trauma in a dog

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Introduction

Total and subtotal maxillectomy are well documented surgical procedures that are used in humans (1–5). These techniques are most commonly indicated for the treatment of neoplasia. The surgery often involves reconstruction of the defect with myocutaneous and musculoskeletal autogenous grafts (1–5). Severely comminuted facial fractures secondary to trauma in humans are most often reconstructed through a combination of internal fixation and bone grafting (6–9).

There are a few reports in the veterinary literature of the use of reconstructive techniques involving bone plate fracture fixation in cases of maxillary fractures (10–12). Reports also exist of reconstruction of craniofacial defects in dogs through the use of bone grafts (autograft or allograft), muscle transposition techniques, mesh grafts, and bone cement (13–18). Utilization of these surgical techniques may not be applicable to all veterinary patients at this time due to the requirement for highly specialized materials and advanced surgical technical procedures. Furthermore, extensive postoperative recuperation and care preclude application of these techniques in certain animals.

Maxillectomy is most commonly reported in the veterinary literature for local treatment of several benign and malignant neoplastic conditions (19–21). Most veterinary reports describe premaxillectomy, partial maxillectomy (hemimaxillectomy), or unilateral or bilateral rostral maxillectomy), or nasal planectomy procedures (19–24). Reports also exist of central or caudal maxillectomy involving neoplasms localized to various regions of the maxilla (24). No reports have been published describing a complete maxillectomy procedure in a dog with good postoperative outcome. Structural and functional deficiencies can complicate the postoperative recovery associated with maxillectomy, and the restoration of functional capabilities becomes a critical element of reconstructive surgery.

Given the lack of information on radical maxillectomy following severe traumatic injury in dogs, the purpose of this case report was to describe the management and outcome of highly comminuted maxillary and nasal cavity fractures following gunshot-induced trauma.

Clinical report

A two-year-old, intact male Labrador retriever dog weighing approximately 35 kg was admitted for evaluation of a gunshot wound to the face that occurred the evening before presentation. The dog had jumped and grabbed the barrel of the shotgun with its mouth as the owner fired a shot while hunting. The shot entered the hard palate and exploded out the right side of the dog’s maxilla. The dog was immediately transported to its primary care veterinarian where supportive care, including crystalloid fluid therapy and buprenorphine, was administered. Stabilization wires were placed in the right maxilla, and superficial wounds on the muzzle were sutured over alloid fluid therapy and buprenorphine, was administered. Stabilization wires were placed in the right maxilla, and superficial wounds on the muzzle were sutured over.
A thorough oral examination was not performed with the dog awake. The eyes were not visible due to sedation-induced enophthalmos and periorbital swelling. There were not any other obvious orthopaedic or soft tissue injuries apparent beyond the maxillofacial defects.

Oral examination under general anaesthesia revealed multiple primarily right-sided mucosal defects and fractures of the hard palate. Palpation of the maxilla identified multiple unstable and comminuted segmental fractures of the rostral and right maxillary dental arcade. External palpation indicated segments of nasal and maxillary bone were missing; the maxillary skin in these regions was depressed to the hard palate. The lateral maxillary bones were crushed rostrally and intact caudally. Skull radiographs (Fig. 2) demonstrated extensive bone loss and comminuted fractures of the hard palate, nasal cavity, and maxilla rostral to the eyes.

The lack of remaining maxillary bone together with the presence of small bone fragments and unstable nasal passages precluded reconstruction of the maxilla. A therapeutic plan of complete maxillectomy and perioperative supportive care including percutaneous endoscopic gastrostomy tube insertion, pain management, antibiotic therapy, and intravenous fluid support was recommended. The owner was informed of the radical nature of a complete maxillectomy as well as the disfigured postoperative appearance and potential complications of infection, dehiscence, nasal mucosa compromise, and inability to prehend food without assistance. The need for extensive postoperative care and the potential for euthanasia if complications became severe or good quality of life was not achieved was discussed with the owner. The owners elected to proceed with the proposed surgical intervention.

A gastrostomy tube was inserted with endoscopic assistance to allow for the administration of supplemental nutrition. The dog was recovered from anaesthesia, and surgery was postponed by three days to allow time for patient stabilization and initiation of nutritional support. During this interval, the dog’s condition remained stable, and there was not any change in the findings of the physical examination or vital parameters. Pain was effectively controlled throughout this time with hydrocortisone (0.1 mg/kg IV every 6 hours).

Four days after the initial injury, the dog was anaesthetized and positioned in ventral recumbency and the maxillary region was aseptically prepared for surgery (Fig. 3). A dorsal transverse skin incision was made across the entire maxilla, 2 cm rostral to the eyes and saving 2 cm of lateral maxillary skin dorsal to each lateral upper lip margin to be used for closure. The nasal cavity was opened to expose haematoma, numerous comminuted bone fragments, and fractured nasal turbinates. The remaining portion of maxillary bone was excised with the exception of 1 cm of the caudal aspect, including the left and right maxillary molar 2 and approximately 3 mm of healthy palatal mucosa (Fig. 4). The site was thoroughly debrided and lavaged. An air drill\(^a\) was used to smooth the edges of the remaining maxillary bone. Multiple drill holes were created along the edges of the remaining maxillary bone and used as anchor points to suture the skin to bone using 2–0 polypropylene suture in simple interrupted or cruciate patterns. The lateral maxillary skin was transposed to midline and sutured to the palatal mucosa using 2–0 poliglecaprone 25 suture in a simple interrupted pattern to create a dorsal lip (Fig. 5). Recovery from anaesthesia was uneventful. The dog was treated postoperatively with cefazolin (22 mg/kg IV every 8

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\(^a\) Hall Surgairtome II Air Drill: Hall Power, Largo, FL, USA
hours), and postoperative pain was effectively controlled with a hydromorphone (0.05 mg/kg/hr)-lidocaine (15 mcg/kg/min)-ketamine (0.6 mg/kg/hr) IV constant rate infusion.

The following morning the dog was sedate but comfortable and stable. The nasal opening and sutured regions appeared as they had immediately postoperatively (Fig. 6). Soft tissue swelling and copious serosanguinous discharge at the nasal stoma site were present, but adequate airflow was maintained through the stoma. Attitude and energy steadily improved in the following days. Upper airway sounds and nasal discharge progressively decreased. The administration of the hydromorphone-lidocaine-ketamine infusion was gradually reduced and then stopped. The gastrostomy tube feedings began the day after surgery were well tolerated. The dog began oral feedings with canned dog food four days after surgery.

The dog was hospitalized for five days postoperatively and then discharged with instructions for administration of carprofen (2.2 mg/kg via gastrostomy tube every 12 hours for 7 days), tramadol (2.2 mg/kg via gastrostomy tube every 12 hours for 7 days), sucralfate (30 mg/kg orally as slurry every 8 hours for 5 days), ciprofloxacin (15 mg/kg via gastrostomy tube every 24 hours for 10 days), and amoxicillin (30 mg/kg via gastrostomy tube every 12 hours for 10 days).

On follow-up evaluation 11 days postoperatively, the dog was eating and drinking without assistance. The gastrostomy tube was removed and the insertion site appeared healthy. The skin sutures were removed 23 days postoperatively. The nasal stoma appeared well healed except for a 0.5 cm wide and 1.5 cm long edge of maxillary bone exposed on the left dorsal side of the nasal stoma and 1 cm of bone exposed on the right maxillary region. The recommended course of action was to allow an additional four weeks of healing after which the exposed regions of bone could be shortened surgically with a high-speed burr and skin sutured over the defects. The dog was next evaluated seven weeks postoperatively at which time the nasal stoma was well healed. The previously exposed areas of bone were covered with skin and no further surgery was necessary (Fig. 7). The surgeon noted that the redundant skin forming the rostral upper lip folded into the mouth between the last pairs of molars. However, examination of the skin and mucosal surfaces found no evidence of trauma. Surgical revision was offered to the owner but declined because it did not appear to be bothering the dog. According to the owner, the dog was eating well, drinking well, and energetic. The dog readily demonstrated the ability to catch a...
tennis ball in his mouth and was swimming within three months of surgery. Long-term care involved cleaning of the stoma. The owners were very pleased with the postoperative outcome and return to normal activity.

Discussion

In light of the severity of the maxillary damage in this case, the only two options were considered to be total maxillectomy or euthanasia. Reconstructive techniques including fracture fixation and grafting have been described previously for maxillary fractures in dogs and cats but were precluded in this case by the large bone defects (10–14). A similar technique to the one reported here has been previously described and involved cosmetic reconstruction of the nasal planum with rotation-advancement flaps using the non-haired, pigmented, mucocutaneous margins of the labia bilaterally (25). This technique would have been an attractive option to attenuate the disfiguring effect of a total maxillectomy and afforded a much more cosmetic outcome with less drying of the nasal cavity. Although it contained numerous small holes and defects, the maxillary skin in this present case was viable. This skin was used to reconstruct the rostral lip as well as to maintain a mucocutaneous junction and shelf of mucosa inside the mouth, similar to techniques described in the previous report (25). By using the tissue of the lip margin to construct a nasal planum at the site of the new nasal stoma, a smaller initial stoma could have been created, also allowing for preservation of a larger portion of the lip margin. However, this was not performed for two reasons: firstly, the resection in this case was much more extensive, and the level of resection was much further caudal on the maxilla; secondly, a larger stoma was intentionally created knowing that the site would constrict and become stenotic over time. The goal was to ensure that even following this constriction, the dog would still be capable of breathing through the stoma. The potential for drying of the nasal cavity was considered. However, it was suspected that similar to a permanent tracheostomy, the respiratory mucosa would adapt over time. Drying of the nasal mucosa did not appear to be a clinical problem in this case.

The lack of other injuries noted on physical examination in a previously healthy dog suggested a potentially favourable outcome with total maxillectomy surgery. Other extensive injuries, pre-existing medical conditions or inability to stabilize the patient may be contraindications to this type of procedure.

Potential intraoperative problems and postoperative complications with maxillectomy surgery are common but usually treatable. Intraoperative complications pertain mainly to technical problems of the surgical procedure. Reported postoperative complications include infection, incisional dehiscence, postoperative pain, prehension difficulties, subcutaneous emphysema, ocular problems, and cosmetic defects (26–27). Abnormal salivation with secondary cheilitis or dermatitis, salivary duct injury, and parotid duct obstruction following caudal maxillectomy in a dog have also been reported (27–28). None of these complications were noted in the dog described in the present case. The only significant complication encountered was delayed wound healing in some regions of the surgical site.

Owner awareness of potential complications and postoperative appearance as well as willingness to undertake aftercare were crucial prior to attempting surgical correction. Furthermore, it is important to educate the owner on the potential for functional defects and decreased quality of life. In a previous study, 85% of owners were satisfied with their decision to treat oral tumours in dogs with partial maxillectomy or mandibulectomy (29). Difficulty prehending food was noted in 44% of dogs, but signs of pain were perceived to be reduced following surgery in most of these animals (29). All owners considered the cosmetic appearance of the dog acceptable after regrowth of facial hair (29). It is important to note that these patients only underwent partial maxillectomy and owner acceptance may be different following complete maxillectomy, as this procedure would have a more disfigured postoperative appearance. Most pet owners felt the pet’s postoperative quality of life was improved by surgery (29). The quality of the pets’ lives was considered very good overall, but it was considered least improved after partial maxillectomy (29). Owner perception was significantly associated with the location and extent of surgical excision because improved quality of life was reported more frequently with rostral mandibulectomy than with partial maxillectomy or mandibulectomy (29). Owner satisfaction was directly proportional to the increase in pet lifespan (29). Considering that total maxillectomy following traumatic injury could potentially result in normal lifespan, a high level of owner satisfaction may potentially be achieved.
To the authors’ knowledge, this is the first reported case of complete maxillectomy following traumatic injury in a dog. Surgical repair in this case resulted in good functional outcome suggesting that radical maxillectomy could be considered an alternative to euthanasia for other dogs presenting with severe traumatic injury to the maxilla.

Conflict of interest
The authors have no conflicts of interest to report for this manuscript. The authors have not received any grants or financial support.

Online Supplementary Material
Colour versions of the Figures from this paper can be found online at www.vcott-online.com.

References