Crescentic osteotomy for resection of oral tumours in four dogs

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Keywords
Maxillectomy, mandibulectomy, oral tumours, rim resection, crescentic osteotomy

Introduction
Oral tumours compose approximately six percent of all canine tumours (1–3). The most common oral tumour types in the dog are malignant melanoma, squamous cell carcinoma, fibrosarcoma and benign tumours of odontogenic origin, including acanthomatous epulis (2, 4). Previously, it was found that more than half of all oral tumours involved bone (5, 6). For malignant tumours and acanthomatous epulis of the maxilla or mandible, en bloc resection including bone is recommended if cure is the goal. Benign and malignant oral tumours involving the mandible and maxilla can be effectively treated by wide surgical excision unless systemic metastatic spread has occurred. In general, a surgical margin of at least 1 cm surrounding the tumour has been recommended (7, 8). Other authors have suggested margins of at least 2 cm for malignant aggressive tumours such as squamous cell carcinoma, malignant melanoma and fibrosarcoma (3).

Tumours of the mandible can be removed relatively easily with wide surgical excision. Good functional outcome has been reported following subtotal and total mandibulectomy, however these procedures can lead to mandibular drift and malocclusion (9, 10). Temporomandibular degenerative changes due to instability have been experimentally created by segmental or hemimandibulectomy (9). The clinical significance of temporomandibular degenerative changes in dogs associated with mandibular drift is unknown, although it is not thought to be clinically relevant (11–13). Modified segmental mandibulectomy, or rim mandibulectomy, with preservation of the ventral aspect of the mandible has been described; this prevents mandibular drift and malocclusion (7). Rim mandibulectomy, leaving the ventral portion of the mandible intact, can be performed for benign oral tumours and non invasive malignant tumours that are caudal to the canine tooth and rostral to the vertical ramus of the mandible, unless there is insufficient unaffected bone to obtain appropriate margins with curative intent or invasion into the mandibular canal (14).

Maxillectomy and mandibulectomy have traditionally been performed using an osteotomy and mallet, an oscillating bone saw, rongeurs, a power drive burr or Gigli wire (14–16). For maxillectomy, this approach requires multiple bone cuts and may produce sharp edges which need to be smoothed with rongeurs or a pneumatic burr.

In the authors' experience, the angulated cuts obtained by traditional maxillectomies produce certain problems. The osteotomies might be incomplete at the intersection of perpendicular cuts. Also, this region is where soft-tissue reconstruction tends to be most difficult. We hypothesised that a crescentic osteotomy would minimise these difficulties. This report describes the use of a bi-radial osteotomy blade, which was originally developed for tibial plateau levelling osteotomy, for simplified excision of canine maxillary and mandibular tumours in four dogs, together with their clinical outcome.

Materials and methods

Selection of cases was based on tumour type, size, location of the mass, and degree of osseous involvement. A margin of at least 10 mm of healthy bone surrounding the gross tumour and radiographic evidence of bone involvement, in addition to sufficient bone to maintain an intact ventral cortex, were required to be considered for rim mandibulectomy. Maxillary tumours located caudal to the canine tooth and rostral to the second molar were considered appropriate for this technique of resection.

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Inclusion criteria

The medical records (January 2004 to December 2004) of dogs that were presented for surgical treatment of oral tumours were reviewed. Cases that were treated with maxillectomy, or mandibulectomy using a crescentic osteotomy were included. The signalment, tumour type and procedure were recorded. Radiographs of the area of interest were performed to determine the level of osseous involvement.

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Summary
Rim resection of mandibular tumours and a simplified technique using a biradial osteotomy blade for maxillary tumours in dogs has not previously been described. The medical records and radiographs of dogs with mandibular (n = 3) or maxillary (n = 1) tumours resected using crescentic osteotomies were reviewed. The owners of two of the dogs reported excellent outcomes without any long-term complications or tumour recurrence.

The goal of this study was to describe the surgical technique for performing a crescentic osteotomy for resection of maxillary and mandibular tumours. This technique for resection of mandibular and maxillary tumours is clinically applicable in carefully selected cases.

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Preoperative evaluation

Prior to referral for surgery, three dogs had undergone incisional biopsies verifying tumour type as being acanthomatous epulis. The fourth dog had an excisional biopsy, and grade I malignant fibrous histiocytoma was diagnosed (reclassified as atypical soft tissue sarcoma). In this case, three-view thoracic radiographs were taken to evaluate for lung metastasis and regional lymph node aspirates were performed. Intraoral radiographs were taken in all cases to assess bony involvement prior to surgical planning (Fig. 1).

Anaesthesia

All dogs were premedicated with acetylpromazine maleate (0.05 mg/kg) and morphine sulphate (0.3 mg/kg) intramuscularly. General anaesthesia was induced using thiopentone (6–10 mg/kg) via a peripheral venous catheter. Auffed endotracheal tube was placed and anaesthesia maintained using isoflurane in 100% oxygen. Intraoperative crystalloid fluid therapy (10 ml/kg/hour) was used to maintain systemic blood pressure. Intravenous cephalothin (22 mg/kg) was administered peri-operatively every 90 minutes. Intravenous meloxicam (0.2 mg/kg) was administered pre-operatively for analgesia. Anaesthetic monitoring included lingual pulse oximetry, end-tidal capnography, lead II electrocardiogram and indirect blood pressure manometry. A forced warm-air system was used intra- and post-operatively to maintain body temperature. The oral cavity was cleaned with dilute (0.05%) chlorhexidine solution. The oropharynx was packed with gauze swabs to limit blood from passing through the oropharynx into the trachea.

Surgical technique for mandibular crescentic osteotomy

The patients were positioned in lateral recumbency. A gingival mucosal incision was performed 10 mm from visible tumour margins on the labial and lingual sides of the dental arcade. The mucosa was elevated from the medial and lateral aspect of the mandible using isoflurane 100% oxygen. Intraoperative crystalloid fluid therapy (10 ml/kg/hour) was used to maintain systemic blood pressure. Intravenous cephalothin (22 mg/kg) was administered peri-operatively every 90 minutes. Intravenous meloxicam (0.2 mg/kg) was administered pre-operatively for analgesia. Anaesthetic monitoring included lingual pulse oximetry, end-tidal capnography, lead II electrocardiogram and indirect blood pressure manometry. A forced warm-air system was used intra- and post-operatively to maintain body temperature. The oral cavity was cleaned with dilute (0.05%) chlorhexidine solution. The oropharynx was packed with gauze swabs to limit blood from passing through the oropharynx into the trachea.

Surgical technique for maxillary crescentic osteotomy

The patient was positioned in lateral recumbency. A curved incision in the gingival mucosa was made 8 mm from the visible tumour margins. The gingiva was elevated from the alveolar bone using a periosteal elevator to protect soft-tissue during the osteotomy. An incision in the mucoperiosteum was performed medially, 10 mm from tumour margins, and the mucoperiosteum elevated from the underlying hard palate. A linear cut through the hard palate was performed parallel to the dental arcade using an oscillating bone saw. An appropriately sized bi-radial osteotomy blade was used to perform an osteotomy centering over the mass and including a margin of 10 mm of healthy bone (based on radiographic evidence of osseous involvement) (Fig. 3). Continuous saline irrigation was used to limit thermal necrosis of the bone. Haemostasis was achieved by vessel ligation, electrocoagulation and bone wax. Exposed tooth roots were removed using a dental elevator. The mucosa was apposed using a double layer of simple interrupted sutures of 3/0 polydioxanone. The excised portion of tissue was painted with Indian ink for margin examination and submitted for histopathology.

Postoperative management

Intraoral radiographs were taken post-operatively (Fig. 4 and 5). Post-operative anal-
Gangliososis consisted of intramuscular morphine (0.5 mg/kg every four hours for the first 24 hours) and meloxicam (0.1 mg/kg) orally. Intravenous fluids were maintained until the patients were drinking and eating (usually within 24 to 48 hours of surgery). The patients were fed only soft food for four weeks postoperatively.

Outcome

Follow-up of patients consisted of a repeated physical examination at 10–14 days post surgery to evaluate wound healing. Further follow-up (>21 months) was attempted by telephone interview of the owners. A questionnaire composed of eight questions that evaluated owners’ assessment of post-operative cosmesis, pain, function, and tumour recurrence was used.

Results

Rim mandibulectomies were performed in three dogs and curved maxillectomy in one dog. The breed, age, gender, tumour type and size, presence of osseous involvement and location are reported in Table 1.

There was not any evidence of regional lymph node or pulmonary metastasis in the dog with malignant fibrous histiocytoma. Pre-operative oral radiographs revealed osseous lysis of the mandible in two of the three dogs with mandibular tumours (Fig. 1). There was not any evidence of osseous lysis in the dog with the malignant fibrous histiocytoma. The dog with the maxillary tumour did not have any evidence of osseous involvement.

The size of the osteotomy blade was selected based on the size of the tumour and the need to obtain 10 mm surgical margins of normal bone. In cases 1, 3 and 4, a 24 mm radius blade was used for the osteotomy. In case 2, an 18 mm radius blade was used for the osteotomy.

All dogs were eating and drinking by 48 hours post-operatively, and were discharged on day three to the owners. All dogs were evaluated by physical examination between 10–14 days post-operatively. (There was no dehiscence of the incision.) The owners reported good function without any evidence of dysphagia or pain. All excised portions of tissue were examined for histological evidence of tumour and were determined to have surgical margins clear of tumour.

Three owners were available for long-term follow-up with phone interviews. The owners of dog 2 and 4 were contacted at 22 and 30 months respectively. At that time, the dogs were alive, without any evidence of tumour recurrence, eating difficulties or poor function. Dog 1 was lost to follow-up after the 14 day examination (due to non-participation from the owner), at which time complete healing without wound dehiscence and good

Fig. 3 Schematic diagram of crescentic osteotomy of the maxilla and palatine bones.

Fig. 4 Radiograph of the section of mandible postoperatively from dog in Figure 1. Note the margin of normal bone (arrow).

Fig. 5 Postoperative radiograph of dog 3, showing the ventral portion of the intact mandible and the crescentic osteotomy.
Table 1  Summary of four dogs with oral tumours.

<table>
<thead>
<tr>
<th>Case</th>
<th>Breed</th>
<th>Age (Years)</th>
<th>Weight (kg)</th>
<th>Sex</th>
<th>Location and size</th>
<th>Tumour type</th>
<th>Presence of bone invasion</th>
<th>Time to follow-up</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Corgi</td>
<td>6</td>
<td>15</td>
<td>Female, spayed</td>
<td>4 mm mass on right mandible at level of the first Molar.</td>
<td>Acanthoma tous Epulis</td>
<td>Lysis involving alveolar bone of first Molar tooth.</td>
<td>2 weeks</td>
<td>Lost to follow-up as owner was not contactable.</td>
</tr>
<tr>
<td>2</td>
<td>Maltese Cross</td>
<td>9.5</td>
<td>7</td>
<td>Female, spayed</td>
<td>Left mandibular mass at level of the second premolar. Small mass removed eight days previously.</td>
<td>Malignant fibrous Histiocytoma</td>
<td>No evidence of alveolar bone lysis.</td>
<td>22 months (phone interview)</td>
<td>None to date - still alive at follow-up.</td>
</tr>
<tr>
<td>3</td>
<td>Rottweiler</td>
<td>7.5</td>
<td>40</td>
<td>Male, neutered</td>
<td>6 mm mass on right mandible at the level of the first Molar.</td>
<td>Acanthoma tous Epulis</td>
<td>Lysis of the alveolar bone involving the first Molar.</td>
<td>1 month</td>
<td>Died one month after surgery. No necropsy was performed.</td>
</tr>
<tr>
<td>4</td>
<td>Border Collie</td>
<td>8.5</td>
<td>17</td>
<td>Female, spayed</td>
<td>3 mm mass on right maxilla at the level of the Carnassial tooth.</td>
<td>Acanthoma tous Epulis</td>
<td>No evidence of alveolar bone lysis.</td>
<td>30 months (phone interview)</td>
<td>None to date - still alive at follow-up.</td>
</tr>
</tbody>
</table>

Discussion

Advantages of a rim mandibulectomy using the bi-radial osteotomy blade include preservation of the ventral cortex and the use of a single osteotomy, rather than three or more intersecting linear osteotomies, if using an oscillating saw for the same purpose (Fig. 5). The bi-radial osteotomy blade has typically been used for procedures for cranial cruciate deficient stifles, and comes in a range of different sizes (15, 18, 21, 24, 27 and 30 mm diameter), allowing selection depending on the size of the patient and tumour.

Rim mandibulectomy is indicated for dogs with benign tumours with no evidence of invasion into the mandibular alveolar canal, for tumours located between the canine tooth and ramus of the mandible, and for tumours where 10 mm margins can be achieved without compromising the ventral mandibular cortex. Rim mandibulectomy can be considered in treatment of the acanthomatous epulides (14). Rim mandibulectomy of highly invasive or malignant tumours such as fibrosarcomas is not recommended.

Interdental lesions involving the mid-body of the mandible have traditionally been treated with segmental or central mandibulectomies with preservation of the rostral mandibular symphysis and caudal temporo-mandibular joint. The use of a cortical ulnar bone graft to stabilise the mandible has been reported in a single case with good functional outcome (17). In order to regenerate bridging bone across a mandibular defect, the critical size defects in dogs with or without preservation of the periosteum is 40 mm and 15mm respectively (18). Preservation of the ventral portion of the mandible may allow bone regeneration. Radiographs were not taken after the immediate post-operative images in this series; hence we cannot determine whether the mandibular defect filled with bone with this technique.

In the authors’ opinion, rim mandibulectomy performed with a crescentic osteotomy would be less likely to fracture post-operatively compared to intersecting linear osteotomies because of the absence of stress risers. The incidence of fracture of the ventral aspect of the mandible after rim resection of tumours in dogs has not been reported. However in biomechanical studies performed in humans, it was shown that marginal mandibular resection is biomechanically secure, with a rim resection more resistant to fracturing than a sagittal technique (19). In humans, it has been found that the minimal amount of mandible that is required to prevent fracturing is 10 mm, but this minimum dimension has not been determined in dogs. In our study, the amount of ventral cortex remaining was consistently less than 10 mm, however, fracture was not detected in any of the dogs. Further cases with long-term follow-up, including radiography, are needed to fully evaluate the incidence of mandibular fractures following preservation of the ventral cortex.

Though not evaluated in this study, it seems reasonable that the simplicity of a singular cut when performing a maxillectomy will decrease surgical time. Tumours located cranial to the canine tooth and caudal to the first molar would be difficult to remove with a crescentic osteotomy without multiple cuts in the hard palate and the zygomatic arch, reducing the reported advantage of this technique.
Studies have shown dehiscence rates associated with maxillectomy caudal to premolar one range from 7–33% (15, 20, 21). The increased incidence of dehiscence at this level is due to the difficulty in obtaining a tension-free closure (15) and the use of the electrosurgical incision to excise the palatine mucosa (11, 16). A two-layer closure using a mucosal flap based on the lip margin has been described to reduce tension and close the oronasal defect (22). This was not required in the single case performed in this study, but may be required in cases with larger defects. The rate of dehiscence associated with mandibulectomy is less than with maxillectomy (10). None of the cases in this series had wound dehiscence in the post-operative period.

In a phone survey of 27 dogs after mandibulectomy or maxillectomy for tumour removal, difficulty in eating was noted in 12 of the dogs (23). There were not any reports of difficulty with eating with any of the dogs in our study, but the small case series and incomplete follow-up precluded any comparisons.

In all four cases presented here, histopathology of the excised tissue revealed complete resection and confirmed the original tumour type. The surgical planning was based on radiographic images rather than computed tomography (CT) despite the fact that radiographs are less sensitive than CT in evaluation of extent of bone tumours (24). Computed tomography would be preferred to radiography in selecting cases for mandibular circular osteotomy to ensure adequate margins are obtainable, however it was not available to the authors at the time.

All dogs recovered well post-operatively with excellent function and no post-operative complications. The limitations of this report included the limited number of cases, lack of follow-up radiography, and the use of client phone interview for long-term follow-up. In the authors’ opinion the technique described here for rim mandibulectomy is easily performed, provides an excellent cosmetic outcome and minimises the risk of complications associated with mandibular drift, such as ulceration of the palate by the remaining lower canine tooth. Other proposed advantages include a single cut involving the mandible and increased ease of cutting the maxilla. Prospective studies including larger numbers of dogs are needed to evaluate if this technique is superior to conventional techniques.

References