Mandibular Rim Excision in Seven Dogs

BOAZ ARZI, DVM and FRANK J. M. VERSTRAETE, DrMedVet, MMedVet, Diplomate AVDC & ECVS

Objective—To describe a surgical technique for excision of minimally invasive mandibular tumors at the level of the premolar and molar teeth, and report outcome in 7 dogs that had mandibular rim excision.

Study Design—Case series.

Animals—Dogs (n = 7) with a mandibular tumor at the level of the premolar and molar teeth.

Methods—Using an intraoral approach to the mandible, buccal, and lingual mucosal incisions are made to obtain a 10 mm clean margin beyond neoplastic tissue. After subperiosteal soft tissue elevation, a curvilinear rim mandibulectomy is performed, leaving the mandibular canal and ventral cortex intact, followed by osteoplasty. The remaining attached gingiva and alveolar mucosa are sutured over the bony defect.

Results—Seven dogs were treated (1997–2008) for odontogenic and early malignant neoplasms involving the mandible by mandibular rim excision. All dogs had healed, healthy gingival covering over the surgical defect, very good postoperative function, and good quality of life.

Conclusion—Mandibular rim excision, with preservation of the ventral cortex and mandibular canal content, can be a good option for treatment of early odontogenic and malignant lesions of the mandible in medium to large breed dogs.

Clinical Relevance—In medium to large dogs with minimally invasive mandibular neoplasia, mandibular rim excision should be considered as a viable surgical option.

INTRODUCTION

CANINE ORAL cavity neoplastic lesions (odontogenic and nonodontogenic tumor types) represent ~ 6% of canine cancer and are the 4th most common cancer overall.1 Understanding the biologic behavior of the tumor enables the surgeon to select the method of treatment. For malignant oral tumors and benign but locally invasive lesions of the mandible, surgical treatment by mandibulectomy is most commonly indicated.2 In 1987, a rim mandibulectomy procedure that removed the occlusal aspect of the mandible but left a strong ventral aspect was proposed to treat mandibular tumors with early bone invasion in people.3 In people, this technique is an effective oncologic procedure that may provide local cancer control comparable with segmental mandibulectomy.4 This procedure has the main advantages of superior postoperative function, absence of mandibular drift, esthetics, as well as improved capacity for reconstruction and rehabilitation.5 Postoperative iatrogenic fractures occur in up to 15% in people.3 Fracture occurrence is most likely caused by sharp-angled excision technique and diminished blood supply secondary to site irradiation, excessive periosteal stripping, and wound dehiscence.5 There are strong indications in people that curvilinear excision resists higher occlusal forces, with smaller residual ventral segments, than do right-angled excisions.4,5 Additionally, in people neoplastic growth generally follows an elliptiform pattern, and therefore a curvilinear excision is more bone sparing, because it follows the form of lesion more closely than right angled excision (Fig 1).4,5
When examining the architecture of the mandible, it is obvious that most of the thick cortical bone is at the ventral border and provides much of the strength of the mandible. In addition, there is a need to spare the mandibular canal content: inferior alveolar nerve, vein and artery. Inclusion of the mandibular canal content in the excised tissue is likely to jeopardize the stability of the residual rim without any benefit to tumor control; however, the surgeon needs to be aware that any sign of tumor invasion of the mandibular canal precludes rim excision. Small dogs have proportionally larger mandibular 1st molar teeth relative to mandibular height compared with larger dogs. This anatomic consideration precludes small dogs from being candidates for mandibular rim excision as the roots of the 1st mandibular molar teeth are in close proximity to the ventral cortex of the mandible. Studies in people demonstrate that preserving the ventral cortex and periosteum will eventually result in spontaneous bone healing with bone filling the osseous defect, further adding to the strength and integrity of the mandible.

Although this technique has been generally described in dogs, we report this technique with additional consideration and modification as well as our experience with 7 dogs treated by means of mandibular rim excision for treatment of odontogenic and small malignant tumors.

Fig 1. Diagram of rim excision of increasing size, completed in right-angled, and curvilinear configuration.

**MATERIALS AND METHODS**

**Preoperative Considerations**

We routinely perform periodontal treatment during the anesthetic episode of the clinical staging, diagnostic imaging, and biopsy, especially if there is large amount of dental calculus and plaque present.

Routine preoperative investigations include dental radiography and computerized tomography (CT) preferably in 1 mm sections, with and without contrast. We use both investigations together before the procedure to try and predict the likely presence and extent of mandibular invasion. In addition, measurement of predictive length of the associated mandibular teeth roots and the distance required to achieve 10 mm of clean margins is obtained from the combination of imaging techniques (Fig 2A and B). Considerable hemorrhage is possible and therefore we assess hemostasis by means of mucosal bleeding test; however, other tests may be required. We also routinely perform cross-matching before this surgery.

The oral cavity is rinsed with chlorhexidine gluconate in an aqueous nonalcohol-containing solution to decrease bacterial burden during surgery. We prefer positioning the dog in sternal recumbency, with the head elevated and the maxillas suspended between intravenous poles or secured to the anesthesia screen. We use a cuffed endotracheal tube and secured pharyngeal pack to prevent aspiration.

Inferior alveolar nerve block using a long-acting local anesthetic facilitates analgesia during the procedure. Currently, we administer ampicillin (20 mg/kg intravenously [IV]) at the time of induction in the presence of systemic disease, hematologic abnormalities, presence of implants, immunodeficiency, animals undergoing chemotherapy, or if the surgical site has been previously irradiated. The planned surgical margins and incision line are outlined using a sterile surgical skin marker (Secureline surgical skin marker; Precision Dynamic Corp., San Fernando, CA).

**Surgical Technique**

A full-thickness mucoperiosteal incision using a 15 scalpel blade is made 10 mm from the tumor margins at the interproximal space of the teeth distal and mesial to the tumor. The soft tissues are elevated away from the planned ostectomy site using a 24 G periosteal elevator (Hu-Friedy, Chicago, IL). The attached gingiva at the margin of the incision is preserved to not compromise the teeth on either side of the ostectomy site and to be able to cover the bone with soft tissues without tension. With the soft tissues protected, ostectomy is performed from 1 interdental space to the other in a curvilinear fashion including the teeth distal and mesial to the tumor in the removed bone fragment (Fig 3A and B). Care should be taken to avoid the mandibular canal. If the mandibular canal content is accidentally damaged, hemostasis is achieved by means of ligature or Hemoclips (Teleflex Medical, NC). We currently use a surgical hand piece (INTRAsurge 300; KaVo America Corp., Lake Zurich, IL) designed for major oral surgery (no air insufflation, built-in sterile fluid irrigation).
combined with an ostectomy bur (Lindemann bur; Hu Friedy, Chicago, IL). After removal of the tumor-containing bone fragment, a careful inspection is performed to make sure that root tips have not been left behind as they may cause focus of infection and pain. Osteoplasty to smooth the cut bone margins is performed using a round diamond bur. After copious flushing with sterile saline (0.9% NaCl) solution, the remaining attached gingiva on either side of the defect and the alveolar mucosa are sutured over the bony defect with 4-0 monofilament absorbable suture on a small reverse cutting needle avoiding tension (Fig 4).

The removed tumor-containing bony segment is color-coded for determination of surgical margins (Fig 5) using the Davidson Marking System (Bradley Products Inc., Bloomington, MN).20

**Postoperative Considerations**

IV fluid therapy is continued until normal oral intake is resumed.2 Water is offered after 12 hours and soft food after 24 hours.11 Nutritional support by means of enteral feeding tube is very rarely, if at all, needed. Soft food is continued until soft tissues are healed. Pain management is achieved by a dual approach that combines nonsteroidal antiinflammatory agents and opioids. A fentanyl patch is applied at the end of the surgery and the dog is maintained on either morphine, oxymorphone, or hydromorphone for the first 12–24 hours. Nonsteroidal antiinflammatory agents are administered parenterally for the first 24 hours and continued orally for 7–10 days.

Chlorhexidine gluconate 0.12% oral hygiene rinse (C.E.T\textsuperscript{4}, Virbac Animal Health, Fort Worth, TX) is prescribed for a period of 10–14 days to keep the surgical area clean and to decrease the bacterial burden on the wound. Wound healing is assessed in 14 days after the surgery. The surgical site is monitored every 3–6 months for signs of recurrence.

**RESULTS**

All dogs (Table 1) had good physical condition and results of hematological, serum biochemical analysis, and
urinalysis were considered normal. Thoracic radiographs and abdominal ultrasonography performed during tumor staging revealed no abnormalities. The mandibular mass did not involve the ventral cortex and the mandibular canal in any dog. No surgical complications occurred. No neoplastic cells were identified in the surgical margins of the submitted specimens.

In all dogs, the 3–4-week, 6-month, and yearly rechecks of the surgical site demonstrated intact gingival covering of the surgical defect and on digital palpation, the ventral mandibular cortex was intact. Dental radiographs obtained at 4 weeks (dog 3; Fig 7), 6 months (dogs 1, 5), and 9 months (dog 4) demonstrated that bone was filling in the defect, without any radiographic signs of tumor recurrence. At each recheck examination, owners reported no apparent medical problems.

**DISCUSSION**

Mandibular rim excision is a promising technique for treatment of minimally invasive odontogenic and malignant tumors of the canine mandible. Segmental and total mandibulectomy have the inherent complications of mandibular drift, traumatic malocclusion, and long-term patient discomfort. The main advantage of mandibular rim excision over segmental or total mandibulectomy is the comparative simplicity of the reconstruction, the quick return to normal function, and absence of malocclusion (e.g., mandibular drift). The decision to proceed to a rim resection was taken after an assessment of the preoperative imaging, clinical examination, intraoperative observation, and the absence of distant metastasis. CT with and without contrast is highly recommended for preoperative planning. Tumors may grossly invade the mandibular canal or extend down the periodontal ligament in the vicinity of tumor. Extension of the tumor into the canal would preclude rim excision. Gross periodontal ligament involvement may or may not allow rim excision depending upon the margins and tooth root–bone relationship. The information obtained from CT should be interpreted in light of the biological behavior of the tumor and the recommended surgical margins.

The use of a surgical hand piece designed for major oral surgery without air insufflation and built-in sterile fluid irrigation combined with an ostectomy bur is highly recommended. Piezoelectric osteotomy is a relatively new technique in craniofacial surgery that can also be advantageous for mandibular rim excision. Piezoelectric osteotomy permits micrometric selective cutting and clear surgical site because of the cavitation effect created by the cooling solution and the oscillating tip, and has minimal to no damage to adjacent soft tissues. However, the
overall operative time may increase as compared with use of a conventional bur. The use of air driven, high-speed rotary instrument is not recommended as its use near open wounds may cause subcutaneous emphysema, orbital emphysema, and involvement of vital structures. Also, the use of an orthopedic cutting saw is discouraged because it may be technically impossible to create a delicate curvilinear ostectomy at the mandible.

All specimens were color-coded for evaluation of surgical margins using the Davidson Marking System (Bradley Products Inc., Bloomington, MN), and all were analyzed as having clean surgical margins. The current veterinary literature does not provide a uniform opinion regarding the extent of surgery needed to obtain clean margins. Most of the reports are anecdotal and suggest obtaining 10 mm margins for all oral tumor types, whereas others suggest obtaining 20 mm margins for oral squamous cell carcinoma, malignant melanoma, and fibrosarcoma. One undifferentiated sarcoma and 1 fibrosarcoma were treated by means of mandibular rim excision.

### Table 1. Summary Data for 7 Dogs that had Mandibular Rim Excision for Oral Cavity Neoplasia

<table>
<thead>
<tr>
<th>Dog</th>
<th>Age</th>
<th>Sex</th>
<th>Breed</th>
<th>Weight (kg)</th>
<th>Type</th>
<th>Size</th>
<th>Location (Mandible, Teeth)</th>
<th>Excision Site</th>
<th>Follow-Up (No Gross Signs Tumor Recurrence)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>13 m</td>
<td>FS</td>
<td>Australian shepherd</td>
<td>19.4</td>
<td>Complex odontoma</td>
<td>2 coalescing masses 2–20 mm diameter, Intero proximal space Right P3–M3</td>
<td>Mesial aspect, RmandM3 to distal aspect RmandM2</td>
<td>12 y</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>3 y</td>
<td>M</td>
<td>Shetland</td>
<td>11.4</td>
<td>Undifferentiated sarcoma</td>
<td>20 mm diameter</td>
<td>Interproximal space Right P4–M1</td>
<td>Mesial aspect, RmandP4 to mesial aspect RmandM2 (Fig 6)</td>
<td>5 y</td>
</tr>
<tr>
<td>3</td>
<td>6 m</td>
<td>FS</td>
<td>Golden retriever</td>
<td>17.7</td>
<td>Compound odontoma</td>
<td>Multilobulated 20 mm diameter, Left M1–M2</td>
<td>Mesial aspect, LmandM1 to rostral aspect of ramus</td>
<td>8 y</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>6.5 y</td>
<td>MC</td>
<td>Weimaraner</td>
<td>42</td>
<td>Fibrosarcoma</td>
<td>Gross tumor not visible, previous excision biopsy, Interproximal space Right P3–P4</td>
<td>Mesial aspect, RmandP3 to mesial aspect RmandM1</td>
<td>2 y</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1 y</td>
<td>MC</td>
<td>Labrador retriever</td>
<td>36</td>
<td>Peripheral odontogenic fibroma</td>
<td>Gross tumor not visible, previous excision biopsy, Lingual aspect Left M1</td>
<td>Mesial aspect, LmandM3 up to mesial aspect LmandM2</td>
<td>1.5 y</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>8 y</td>
<td>MC</td>
<td>Springer spaniel</td>
<td>23</td>
<td>Acanthomatous ameloblastoma</td>
<td>10 mm diameter</td>
<td>Interproximal space, Left P4–M1</td>
<td>Mesial aspect, LmandP4 to mesial aspect LmandM2</td>
<td>1.5 y</td>
</tr>
<tr>
<td>7</td>
<td>12 y</td>
<td>FS</td>
<td>Golden retriever</td>
<td>33.4</td>
<td>Plasmacytoma</td>
<td>10 mm diameter</td>
<td>Buccal aspect Left M1</td>
<td>Mesial aspect, LmandP4 to mesial aspect LmandM3</td>
<td>1 y</td>
</tr>
</tbody>
</table>

m, month; y, year; M, male; MC, Male castrate; FS, Female spayed.
excision attempting to obtain 10 mm margins. In these 2 dogs, we observed the presence of intact gingival covering at the surgical defect and the absence of gross tumor recurrence for 12 years (dog 1) and 2 years (dog 4). These findings are anecdotal and more clinical studies are needed to evaluate less invasive resection of early malignant tumors of the mandible in certain instances. Because of mandibular anatomy, attempting to obtain 20 mm clean margins may technically preclude most dogs from benefiting from mandibular rim excision. Follow-up radiographs of the surgical area obtained for 4 dogs indicated that there was new bone formation that was filling the surgically created bony defect. These findings are in agreement with previous studies in people.9

We concluded that mandibular rim excision is a sound oncologic operation to treat small odontogenic and nonodontogenic tumors with limited ventral mandibular involvement. Preoperative examination, appropriate imaging studies, and proper surgical judgment are essential when selecting dogs for mandibular rim excision. Preserving the integrity of the mandible contributes greatly to the postoperative function and rehabilitation.

ACKNOWLEDGMENTS

We thank Mr. John Doval from the Media Laboratory, Department of Surgical and Radiological Sciences, University of California, Davis, for the artwork.

REFERENCES