Removal of Oral Hard Tissue Tumors

Alexander M. Reiter, Dipl. Tzt., Dr. med. vet., Dipl. AVDC, EVDC
Associate Professor of Dentistry and Oral Surgery
University of Pennsylvania, School of Veterinary Medicine, Department of Clinical Studies
3900 Delancey Street, Philadelphia, PA 19104, USA
Reiter@vet.upenn.edu

Introduction
The relatively small size of the head of the cat, proximity of the upper jaw to the nasal cavity and orbit, and the rather short and tight upper lips (limiting the amount of soft tissue available for wound closure) make radical maxillectomy far more challenging in the cat compared to the dog. Therefore, maxillectomy in the cat is probably reserved to small and rostrally located tumors of the upper jaw. Mid and caudal maxillary malignancies could appear small on clinical examination, but they have a tendency to invade the nasal cavity, orbit and zygomatic arch. In addition to that, surgical efficiency is critical when performing maxillectomies because bleeding may not be controlled effectively until the affected piece of jaw is removed. Also, the cat’s tongue appears relatively short, and invasion of malignant lesions deep into lingual tissue makes tongue resection a less amenable treatment option than in dog.

Upper Jaw Anatomy
Gingiva is firmly attached to the tooth and alveolar bone. Elastic alveolar mucosa faces the alveolar bone and is separated from the gingiva by the mucogingival junction. The hard palate mucosa is firmly attached to underlying maxillae and palatine bones, is non-elastic and has several transverse ridges and depressions, continuing caudally into the elastic mucosa of the soft palate. The upper jaw and the face consist of the paired incisive bones, maxillae, palatine, nasal, zygomatic and temporal bones and the unpaired vomer bone. The incisive bones carry the upper incisor teeth, and the maxillae carry the upper canines, premolars and molars. The infraorbital canal (containing the infraorbital artery, vein and nerv) penetrates the maxilla in the area of the upper fourth premolar and first molar teeth. The main blood supply to the hard palate mucosa is provided by the paired major palatine arteries which pass through the palatine canals and emerge at the major palatine foramina palatal to the level of the upper fourth premolar tooth about halfway towards the midline, from where it runs rostrally in the palatine sulcus towards the palatine fissures. When the tongue is withdrawn from the mouth, palatoglossal folds can be seen that run from the body of the tongue to the rostrolateral aspect of the muscular and elastic soft palate which receives its main blood supply from the paired minor palatine arteries. The maxillary artery provides blood supply to the upper jaw via infraorbital, palatine (major and minor), and sphenopalatine arteries. Veins often exist concurrently with arteries and empty via the maxillary vein into the external jugular vein. The facial nerve provides motor function to many cutaneous facial muscles and the caudal belly of the digastricus muscle.

Lower Jaw Anatomy
The lower jaw consists of the paired mandibular bones. The ventral third of each mandible includes the mandibular canal, which contains the inferior alveolar artery, vein and nerve. There are three mental foraminae, giving rise to the caudal, middle and rostral mental arteries, veins and nerves. Right and left mandibles carry all lower teeth and are separated rostrally by a fibrocartilaginous synchondrosis (mandibular symphysis). The temporomandibular joint is formed by the condylar process of the mandible and the
mandibular fossa and retroarticular process of the temporal bone. A thin fibrocartilagenous disc lies between the hyaline cartilage-covered articular surfaces. A thick band of fibrous tissue on the lateral aspect of the joint capsule forms the lateral ligament, which tightens when the jaw opens.

Oral mucosa covering the mandibles includes the firmly attached gingiva, the very flexible and elastic alveolar mucosa, and the labial and buccal mucosae. The masticatory musculature includes the masseter, temporal, pterygoid (medial and lateral), which close the mouth, and the digastricus muscles, which opens the mouth. They all have insertions at the mandibles.

**Maxillectomy Techniques**

The practical limit of maxillectomy ranges from partial resection of the rostral upper jaw on one or both sides (rostral maxillectomy), a central or caudal portion of the maxilla (central or caudal maxillectomy), the entire dental arch on one side including the palate to the midline (total maxillectomy), to the entire palate and both sides of the dental arch. For more caudally located lesions that extend onto the side of the face, the bones forming the ventral and lateral limits of the orbit can be resected (partial orbitectomy).

Incisions are made with a cold scalpel down to the bone (except in areas where vessels must be dissected free and ligated) and should be at least 1 cm away from gross or radiographically visible margins of the tumor. The use of electrosurgical/radiosurgical or laser equipment along the incised mucosal edges that will be sutured is to be avoided. Making the ‘cut’ through a tooth in the desired area of excision (with extraction of the remaining tooth portion after tumor resection) allows for ‘tapering’ of the alveolar bone at each end, providing a better underlying surface for mucosa to be sutured at the completion of the procedure. The mucosa is reflected with a periosteal elevator to expose the underlying bone. Hemorrhage at palatal incisions can be controlled by digital pressure and gauze sponges until the resected tissue is lifted out. When performing large resective surgery on the upper jaw and nose it is advisable to score the bone and then use leverage to break the remaining bony attachments. This technique avoids unnecessary trauma to intranasal structures and allows for safe ligation of the infraorbital vessels. Bones are channeled along the excision lines under lactated Ringer’s irrigation with a dental bur on a high-speed handpiece, sagittal/oscillating bone saw, or a piezotome. Hemorrhage may be so profuse that continued ‘blind’ cutting of bone with power equipment may cause further harm to underlying tissue of the nasal cavity. Thus, using an osteotome and mallet may be helpful. A large dental or periosteal elevator is inserted into cutting lines and rotated to break any remaining bony attachments. If the line of excision includes the infraorbital canal, the infraorbital vessels must be identified and ligated. Remaining attachments are separated, and the section is removed en bloc. Traumatized turbinates are cut with scissors to leave a clean edge. Hemorrhage that cannot be controlled by ligation or pressure may respond to surface application of a mixture (0.05-0.1 mL/kg in cats) of 0.25 mL phenylephrine 1% and 50 mL lidocaine 2%. Absorbable gelatin sponges, thrombin in a gelatin matrix, and microporous polysaccharide beads may also be useful. Unilateral carotid artery ligation is recommended if severe hemorrhage continues and cannot be controlled.

If obstruction of nasal airflow is likely to occur when the labial or buccal flap is closed across the defect, sections of nasal conchae can be resected with scissors to create free air space. The defect between the nasal and oral cavities is covered with a labial or buccal flap that is undermined until sufficient tissue can cover the defect without tension. The tissues are apposed with simple interrupted (or interspersed simple interrupted and vertical mattress) synthetic absorbable sutures. A two-layer closure is preferred, with the first layer apposing connective tissues of the flap and palate, to relieve tension on the second mucosal layer.
Maxillectomy in most circumstances in the cat causes facial asymmetry such as a palpable or visible concavity on the side of the face. If the resection includes both incisive bones and rostral portions of the maxilla, the snout will droop due to loss of the ventral support for the nasal cartilages and nasal plane. The connective tissue surface of the flap that faces the nasal cavity will heal by granulation and epithelialization. There will be some blood-tinged nasal discharge for several days or weeks after surgery as the nasal tissues heal. Ipsilateral mandibular teeth that could irritate and lacerate the buccal flap may be extracted, or their crowns surgically reduced.

Mandibulectomy Techniques
The extent and location of the mucosal incisions and possible extraction of additional teeth on either side of the desired area of excision are determined in similar fashion as for maxillectomies. The practical limit for resection of the lower jaw ranges from partial resection of the mandible on one or both sides (dorsal marginal mandibulectomy [rim excision], unilateral or bilateral rostral mandibulectomy, segmental mandibulectomy, and caudal mandibulectomy), one entire mandible (total mandibulectomy) to one entire mandible and a portion of the mandible on the other side.
For caudally located lesions the mandibular ramus or a portion of it can be resected by means of a dorsolateral approach through the zygomatic arch and the masseter and temporal muscles. Bilateral rostral mandibulectomy immediately distal to the mandibular canines usually provides good function and esthetics. Bilateral resection caudal to this level results in progressively greater problems with tongue retention, eating and grooming. Resection of the mandibular symphysis causes the two remaining mandibular sections to ‘float,’ which is functionally and esthetically acceptable.
Mandibulectomies are often performed in lateral or dorsal recumbency. A mouth prop may be placed between the teeth on the normal side to slightly open the mouth. Nerve blocks are performed with 0.5% bupivacaine. The skin over the surgical area is clipped and antiseptically prepared, and the oral cavity is rinsed with 0.2% chlorhexidine solution. Sterile towels are used to separate and outline the surgical field. Marginal resection with small amounts of unaffected surrounding tissue is restricted to small and benign mandibular tumors.
Radical resection of invasive and malignant tumors should include at least 1 cm of apparently healthy tissue (including skin) surrounding the neoplastic lesion. The mucosa is incised with a cold scalpel and is reflected with a periosteal elevator to expose the underlying bone. Hemorrhage can usually be controlled by digital pressure with gauze sponges. For partial mandibulectomies caudal to the middle mental foramen, the bone is channeled with a powered instrument to reach close to the mandibular canal. The specimen is levered by insertion of a large dental or periosteal elevator into the cutting lines until it cracks off the remaining mandible. The inferior alveolar vessels are identified, ligated and transected. Rough edges of bone are burred smooth, and the connective tissue is sutured to decrease dead space, followed by suturing the labial/buccal and sublingual mucosal edges across the remaining mandible.
Total mandibulectomy requires separation of the symphysis with a cold scalpel or osteotome and mallet. Incisions are made well away from the lesional tissue in the labial/buccal and sublingual mucosa, and the mandible is undermined by blunt dissection. The lateral attachments of the tongue (genioglossus and hyoglossus muscles) are separated, leaving the mandibular and sublingual ducts intact if possible, which frees the mandible so that it can be swung independently. The lip commissure may be incised caudally, which greatly facilitates dissection of the masseter and pterygoid muscles from their attachments. These muscles are reflected laterally and medially, thus exposing the ramus of the mandible. The vessels
entering/exiting the mandibular canal through the mandibular foramen on the medial surface of the mandible must be dissected carefully prior to ligation and transection. The temporomandibular capsule and lateral ligament are exposed by rotating the mandible and incised. The temporal muscle attachments on the rostral and dorsal edges of the coronoid process are dissected free with scissors, and the mandible is lifted out. The incision is closed with synthetic absorbable sutures, apposing connective tissue and the incised oral mucosal edges. The opposite mandible will usually swing over toward the midline, which may result in the remaining mandibular canine tooth to impinge on the palate when the mouth is closed. This can be prevented by extraction or crown reduction of the mandibular canine tooth. Intentional crown build-up and the use of an elastic device for the prevention of mandibular drift following mandibulectomy have also been described. After more involved mandibulectomy procedures, the tongue will lose its ventrolateral support and often hangs out on one side, resulting in drooling and chronic dermatitis. This can be partially corrected by rostral advancement of the lip commissure on one or both sides to the level of the maxillary second premolars (commissuroplasty). Combined therapy (surgery plus radiotherapy and/or chemotherapy) may be indicated, particularly for tumors with regional or distant metastasis. When surgical excision is not an option, efforts should be made to decrease the rate of growth (radiotherapy, chemotherapy) and to provide relief from discomfort (extraction of teeth impinging on the tumor, administration of pain medications, nutritional support).