Massive midline occipitotemporal resection of the skull for treatment of multilobular osteochondrosarcoma in two dogs

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Case Description—Two 6-year-old male dogs were evaluated for removal of midline occipitotemporal multilobular osteochondrosarcomas.

Clinical Findings—Physical examination revealed mild ataxia in 1 dog and large masses of the central occipitotemporal portion of the skull in both dogs. Computed tomography, magnetic resonance imaging (MRI), or both revealed large bone-origin occipitotemporal masses with impingement of the brain and the sagittal and transverse venous sinuses. Three-dimensional contrast magnetic resonance image reconstruction delineated collateral venous circulation around the tumor and venous sinus occlusion in 1 dog.

Treatment and Outcome—Tumors in both dogs were surgically removed and the skull defects repaired with polymethyl methacrylate prostheses. Twenty-four hours after surgery, 1 dog had normal mentation, cranial nerve function, and conscious proprioceptive responses, whereas the other dog had depressed mentation but no neurologic deficits. Both dogs were discharged 4 days after surgery with normal mentation and no neurologic deficits.

Clinical Relevance—Findings suggested that MRI and computed tomography can play a key role in assessment of essential cortical collateral circulation when surgical removal of tumors is likely to result in bilateral disruption of transverse venous sinuses. Without robust collateral circulation and proper preoperative planning, removal of massive skull tumors in the midline occipitotemporal region will likely result in substantial morbidity or death. However, results in the 2 dogs reported here indicate the feasibility of removing such tumors with good outcomes in the presence of well-developed collateral venous drainage. (*J Am Vet Med Assoc* 2008;233:752–757)

A 6-year-old 42-kg (92.4-lb) neutered male Labrador Retriever was evaluated at the University of Wisconsin Veterinary Teaching Hospital for surgical removal of a tumor of 4 months' duration that was approximately 5.0 cm in diameter and involved both parietal bones, portions of the nuchal crest bilaterally, the sagittal crest of the skull with the occipital protuberance, and the dorsal portion of the occipital bones. Previous biopsy and histologic evaluation had revealed an MLO. Clinical signs at initial diagnosis were mainly lethargy and occasional ataxia. The dog had been treated with prednisone (30 mg) by the referring veterinarian every 12 hours while surgical options were being considered. The dose was eventually decreased to 20 mg every 12 hours because of adverse effects such as polyuria and polydipsia, increased appetite, panting, high serum activities of liver enzymes, and muscle atrophy. The dog was still receiving this treatment when evaluated for surgery.

On physical examination, the dog was quiet, alert, responsive, and able to ambulate without detectable abnormality. The only abnormality noted on examination was mild bradycardia (heart rate, 60 beats/min). The results of a coagulation panel (prothrombin time and partial thromboplastin time) and CBC were within reference limits. Serum biochemical analyses were within reference limits except for mildly high serum albumin concentration and serum alanine aminotransferase and alkaline phosphatase activities.

Abbreviations

CT	Computed tomography
DSS	Dorsal sagittal sinus
MLO	Multilobular osteochondrosarcoma
MRI	Magnetic resonance imaging
PMMA	Polymethyl methacrylate
SSS	Superior sagittal sinus

Thoracic radiography revealed normal findings with no evidence of metastasis. A CT scan of the head, including contrast angiography, revealed a 5.1 × 5.0 × 4.6-cm lobulated mineralized mass arising from the right temporal and occipital bone and extending across midline to the left temporal and occipital areas. Approximately half the volume of the mass extended into the calvarium, markedly compressing the caudal portion of the cerebrum and the cerebellum (**Figure 1**). The cervical lymph nodes appeared normal. Via CT angiography, the rostral aspect of the DSS was deviated to the left by the mass, whereas caudally it entered the mass and could be traced approximately 2 cm before it appeared to be obstructed. The transverse venous sinuses could not be seen.

Via MRI, the same mass was seen as described on CT. Via T-weighted MRI, the signal intensity was mildly increased to muscle tissue and decreased to brain tis-

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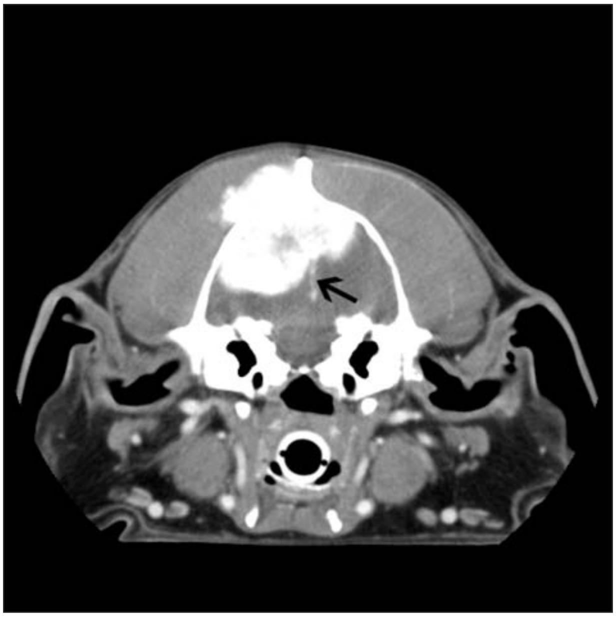

Figure 1—Transverse postcontrast CT image of the skull of a dog (dog 1); notice the lobulated and mineralized MLO arising from the right temporal and occipital bones and extending across midline. Approximately half of the volume of the mass extended into the calvarium, markedly compressing the caudal cerebrum and cerebellum. The transverse sinuses are not visible, and there is slight enhancement of a portion of the DSS (arrow).

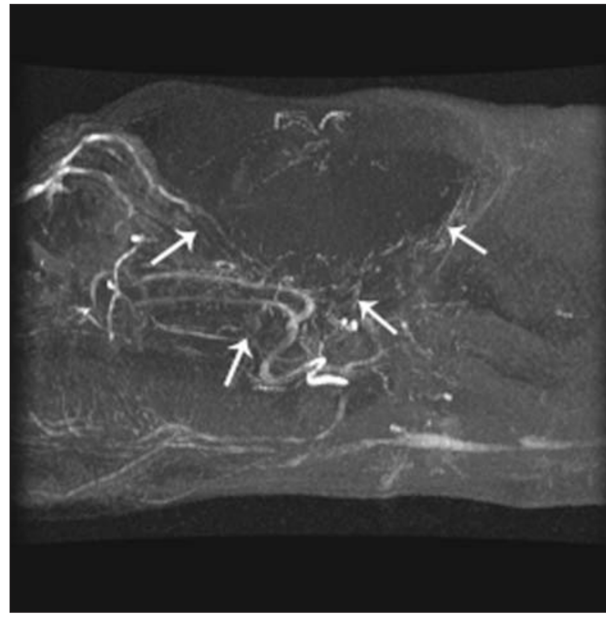

Figure 2—Sagittal time-of-flight magnetic resonance image of the dog in Figure 1; notice an extensive network of collateral vessels (arrows) bypassing the area of the mass and draining blood to the vessels at the base of the skull. Note that in the area of the mass there are few large vessels and the DSS and transverse sinuses are not visible, indicating occlusion of blood flow through these vessels.

sue. There was deviation of the cerebral sagittal fissure, compression of the cerebrum and cerebellum, marked obliteration of the right lateral ventricle, and moderate obliteration of the left lateral ventricle. The sagittal and transverse venous sinuses could not be traced caudally. Via time-of-flight MRI, an extensive network of collateral vessels, which were unable to be specifically identified, could be seen lateral to the area occluded by the mass and draining blood to the vessels at the base of the skull (**Figure 2**). These vessels were considered to be acquired collaterals because of their size and location in comparison to vessels seen in similar contrast imaging studies done in clinically normal dogs.

The dog was positioned in sternal recumbency and the dorsal aspect of the head and neck clipped and prepared for aseptic surgery. The surgical table was tilted so that the head was elevated relative to the rest of the body. The head was fixed in position by placement of the maxillary molar teeth on a padded metal frame so that the jugular veins were not compressed, and the skull was held nearly perpendicular to the axis of the cervical vertebral column, thus minimizing intracranial venous congestion that might occur from both jugular compression or positional hypostatic congestion and increasing surgical access to the occipital region.

Cefazolin (20 mg/kg [9.1 mg/lb]) was administered at the time of induction of anesthesia and repeated every 2 hours during surgery until the end of surgery. Famotidine (21 mg, IV) was administered at the time of induction because of gastric reflux at that time and was continued after surgery at 20 mg, PO, every 24 hours. A continuous rate infusion of fentanyl (2 to 8 µg/kg [0.9 to 3.6 µg/lb]/h) was used for intraoperative analgesia in combination with inhaled isoflurane anesthetic administered via endotracheal tube.

A 17-cm, linear, cranial-to-caudal skin incision was made dorsal to the mass, and the temporalis muscles were elevated off the sagittal crest and parietal bones by blunt and sharp dissection. The cervical muscles and tendinous raphe attached to the occiput and the nuchal crest were incised and retracted caudally to expose the occiput and nuchal crest. Margins of normal-appearing fascia or muscle approximately 1.0 to 1.5 cm in length were removed at the same time as the mass or afterward, where these structures contacted the mass. The skull was cut around the mass with a high-speed pneumatic drill and burrs. The skull incision traversed the sagittal crest approximately 1.5 cm caudal to the most rostral extent of the crest and extended 3 to 5 cm from midline of the parietal bone on the left and down to within 0.5 cm of the dorsal border of the zygomatic arch on the right temporal and parietal bones. The occipital bone was incised about 2 cm ventral to the nuchal crest. The entire mass was carefully elevated from the underlying dura by use of blunt probes and removed with minimal dural injury. Hemorrhage occurred from a small rent in the DSS, where a connecting vessel to the overlying calvarial bone is frequently encountered. A single cruciate suture of 6-0 polypropylene[a] was used to close the hole in the DSS and combined with an overlying application of hemostatic foam[b] to obtain hemostasis. Substantial hemorrhage from the right transverse sinus was also encountered, and hemostasis was accomplished by a combination of suture ligation and application of bone wax into the transverse canal. A transfusion of 1 unit (340 mL, over a period of 3 hours) of packed RBCs was administered to offset surgical blood loss. Inspection of the removed mass revealed margins varying from 0.3 to 1.5 cm. Where bone margins were < 1.0 cm on gross inspection, additional calvarial bone was removed to increase the size of the margins of the resection. Within the calvarium, wide margins into the adjacent soft tissues were not possible. The excised mass was submitted for histologic evaluation, and results confirmed the diagnosis of MLO but indicated incomplete margins of resection. However, it remained unclear whether the actual excision margin was clear of tumor because the outer 0.5 cm of the excised tissue was destroyed during burring of the bone required to remove the affected portions of the skull.

The defect was reconstructed by means of a molded PMMA prosthesis as described.[1] Briefly, sterile aluminum foil was molded as a dome over the brain and bony edges of the excision site to create a mold of the calvarial defect. The foil used was a commercially available nonstick product[c] and coated with sterile hydrophilic gel[d] to facilitate removal of the cast of the defect from the foil mold. The foil was removed from the defect for pouring the PMMA. Polymethylmethacrylate was poured onto the interior surface of the mold, thus making a positive cast of the bone defect and interior dome of the calvarial resection site. After solidification of this material, it was separated from the foil, and the outer surface was covered with a sterile plastic adhesive drape[e] and coated with a thin layer of hydrophilic gel to aid in release. A second layer of PMMA was then applied over this surface. The finished product was approximately 0.5 cm in thickness, had smooth surfaces, and was custom fit to the asymmetries of the boney edge of the excision site. No modification of the prosthesis was needed to create a tight fit of the device into the skull excision site. Strips of nonabsorbable knitted polypropylene mesh[f] were adhered to the outer surface of the prosthetic by application of an additional thin layer of PMMA to aid in anchoring the device and allow reattachment of the cervical musculature, fascia, and tendinous raphe where the nuchal crest had been replaced. Four holes were drilled rostrally along the cut edges of the skull and 2 caudally (1 on either side of midline for anchoring the implant with 20-gauge wire rostrally and 0-polypropylene[a] for the caudal holes). After the polypropylene mesh edges were trimmed, the rostral portion of the mesh was sutured to the temporalis fascia and periosteum along the rostral sagittal crest by means of simple interrupted sutures of 2-0-polypropylene,[a] whereas the caudal portion of the mesh was sutured to the appropriate ligaments and musculature of the neck in the same fashion. The temporalis muscles were apposed on midline over the prosthetic implant with 2-0 polyglyconate[g] in a simple continuous pattern. Deep subcutaneous tissues were closed with 3-0 polyglactin 910[h] in a simple continuous pattern, and the skin was apposed with a subcuticular pattern of 3-0 polyglactin 910[h] and skin staples, resulting in a normal appearance to the head.

The dog recovered from anesthesia without complications. The dog was maintained on a continuous rate infusion of fentanyl (2 to 8 µg/kg/h, IV), and a fentanyl transdermal patch (100 µg/h) was applied. Cefazolin (20 mg/kg) was administered every 6 hours, and prednisone (10 mg) and famotidine (20 mg, PO) were administered once per day. In addition, a suspension of sucralfate (20 mg, PO) was given every 8 hours. Tachypnea and increased lungs sounds were detected a short time after recovery from anesthesia. Aspiration pneumonia was suspected, but evidence to confirm aspiration was not present on thoracic radiographs. Twenty-four hours after surgery, the dog was quiet but alert, able to walk, had improved respiration, and was eating and drinking normally. On neurologic examination, all cranial nerve and conscious proprioceptive responses were normal. Four days after surgery, the dog was bright, alert, and ambulating almost normally with only mild ataxia but otherwise doing well. The dog was discharged from the hospital that afternoon with plans to reduce the prednisone dose over the next 3 weeks. Fifteen months after surgery, the owner reported that the dog did not have detectable neurologic abnormalities, had no visible tumor growth, and was doing exceptionally well.

A 6-year-old 36-kg (79-lb) neutered male Labrador Retriever cross was brought to the University of Wisconsin veterinary oncology service for evaluation of a large, steadily growing mass on the left side of the skull of 6 months' duration. Previous radiographs of the head and biopsy were indicative of MLO. The dog was quiet, alert, responsive and able to ambulate well on all limbs. Results of physical examination were unremarkable other than two 1-cm, subcutaneous, round, soft and movable masses on the ventral aspect of the thorax and abdomen. Results of evaluation of fine-needle aspirates of the masses were consistent with benign lipomas. The owner reported that the dog was without clinical signs from the time the skull mass was first noted 6 months prior to evaluation. Results of a CBC were within reference limits as were results of serum biochemical analyses except for slightly high activity of alkaline phosphatase (358 U/L; reference range, 13 to 289 U/L).

Thoracic radiography revealed normal findings and no evidence of metastasis. A CT scan of the head, including angiography, revealed an 8 × 7 × 8-cm bony mass arising from the caudal-most aspect of the occipital bones. The mass extended externally from the level of the temporomandibular joint to the second cervical vertebra and penetrated the caudal portion of the calvarium to fill the dorsal aspect to the tentorium cerebelli. The cerebellum was partially herniated into the cisterna magnum, and there was mild contrast enhancement of the mass. Via CT angiography, the caudal aspect of the venous sinus system was intimately involved in the mass, although only a portion of the DSS could be identified. This sinus was deviated toward the right in its caudal segment. The mass was located in the anatomic location of the straight sinus, confluences of the sinuses, and both transverse sinuses.

The dog was anesthetized and positioned in sternal recumbency, and the head and dorsal portion of the neck were clipped and aseptically prepared. The head was elevated and supported as in the first dog to minimize cranial venous congestion, avoid jugular vein compression, and maximize surgical access to the occiput.

Cefazolin (20 mg/kg) was given at the time of induction and every 2 hours during surgery. A fentanyl continuous rate infusion (2 to 8 µg/kg/h, IV) was used for intraoperative analgesia in conjunction with inhaled isoflurane anesthesia. One unit of packed RBCs (340 mL, over a period of 3 hours) was also given during surgery to offset loss from hemorrhage.

A 15-cm Y-shaped skin incision was made over the mass, extending from the cranial aspect of the sagittal crest to 4 cm caudal to C1. The mass was invading the left temporalis muscle, which was separated from the mass by blunt and sharp dissection, before elevating the remaining temporalis muscle attachments from the dorsal midline. Hemostasis was achieved with ligatures of 2-0 polyglyconate,[g] electrocautery, and application of hemostatic foam[b] as in the first dog. Performed with a high-speed pneumatic drill and burrs, the skull incision included the parietal, temporal, and occipital bones and extended 5 cm lateral to the sagittal crest on the left side of the skull and 3 cm lateral to the sagittal crest on the right side. Part of the nuchal crest on both sides was removed. The deep extent of the tumor had a thin margin of neoplastic tissue that was firmly attached to the osseous tentorium, which was not resectable without damaging the brain. The excised mass was carefully elevated and removed with minimal hemorrhage from the sagittal sinus and the osseous sinuses. Histologic examination confirmed the initial diagnosis and the presence of tumor at the deep resection margins. Hemostasis was accomplished with a single cruciate ligature of 6-0 polypropylene[a] for the sagittal sinus and bone wax for the osseous sinuses, similar to that described for the first dog. The calvarial defect was reconstructed and closed as described for the first dog, resulting in a normal appearance. A head bandage was applied.

The dog recovered from anesthesia without complications and was monitored for neurologic deficits and seizure activity. The dog continued to receive fentanyl (2 to 8 µg/kg/h, IV), and a transdermal fentanyl patch (100 µg/h) was applied and carprofen (75 mg) given every 12 hours. Cefazolin (20 mg/kg) was given every 6 hours for the first 24 hours after surgery. Twelve hours after surgery, the dog's mentation was normal, and it was able to walk outside with minimal assistance. The surgical incision site was mildly swollen, but the edges remained apposed. The bandage was not reapplied because of the absence of hemorrhage from the incision site and the presence of mild facial swelling. The dog was hypoproteinemic (3.8 g/dL; reference range, 4.0 to 8.0 g/dL) and was given fresh frozen plasma (220 mL at 20 mL/h) and hydroxyethyl starch (400 mL at 20 mL/h). An additional 150 mL of fresh frozen plasma was given during the night.

Thirty-six hours after surgery, the dog had more signs of depression but had no neurologic deficits. A moderate amount of head and facial swelling was present, and blood total protein value (4.0 g/dL) as measured via refractometry was considered low but within reference range. Blood samples were collected to measure albumin and colloid oncotic pressure and assess clotting function. A substantial thrombocytopenia (65,000 platelets/µL; reference range, 175,000 to 500,000 platelets/µL), hypoalbuminemia (1.9 g/dL; reference range, 2.6 to 4.0 g/dL), low colloid oncotic pressure (15.5 mm Hg; reference range, 20 to 25 mm Hg), and slightly delayed clotting times (prothrombin time and partial thromboplastin time) were detected. The cause of the thrombocytopenia remained undetermined, but it was presumed that consumption from surgical hemorrhage played a role in this abnormality. The dog progressively improved during the subsequent 24 hours with near total resolution of the head and facial swelling. The dog was discharged from the hospital 4 days after surgery with a 2-week course of carprofen and the fentanyl patch. Six months after surgery, the dog was euthanatized because of tumor recurrence and a poor prognosis. The dog was free of neurologic disease at the time of euthanasia.

Discussion

The biological behavior of osteomas and MLOs (synonymous terms have included chondroma rodens, multilobular tumor of bone, multilobular osteosarcoma, multilobular osteoma, calcifying aponeurotic fibroma, multilobular chondroma, cartilage analog of fibromatosis, and juvenile aponeurotic fibroma) makes complete excision the treatment of choice. Dogs with these tumors can have an excellent outcome following complete surgical excision,[1–3] but incomplete excision, local recurrence, or even distant metastasis can be problematic. Thus, a key surgical challenge in treatment of these tumors is to obtain adequate surgical margins. This can be a challenge in a site where vital structures may prevent complete excision or where damage to such structures may lead to severe or fatal outcomes.

The location of the tumor in the skull relative to the vital structures is important. Large resections will extend into the calvarium or into the sinuses if the frontal and parietal bones are involved. Such excisions can be successfully performed and the tissues reconstructed if care is taken with hemostasis and to avoid trauma to the brain.[1] Excision of caudally located skull masses that bilaterally involve the occipitotemporal regions of the skull, such as in the 2 dogs reported here, is especially challenging. In these cases, the major concern was the location of the MLO relative to the sagittal and transverse venous sinuses. These are important vascular structures that drain the venous circulation of the brain and parts of the skull and which, if acutely disrupted, can result in severe or fatal neurologic complications.[4,5]

Multilobular osteochondrosarcomas are typically slow-growing, locally invasive tumors of bone. In our experience, they do not usually invade across the meninges but instead displace the meninges and underlying neural tissues, often to a large degree in advanced cases as in the dogs reported here. When located on the rostrodorsal aspect of the calvarium, the meninges and dorsal sagittal sinus can be separated from the underside of these masses without damage to the sinus with the exception of a commonly encountered venous structure that passes from the overlying bone to the sinus (illustrated but not named in anatomic textbooks[6]), which is easily controlled once identified. As the DSS continues caudally, it enters the foramen impar, located on the rostral surface of the internal occipital protuberance dorsal to the tentorium ossium, and within this bone typically divides to form a transverse sinus contained in the bony transverse canals bilaterally within the occipital bones.[6] Dissection of the DSS and transverse sinuses within this bone is extremely difficult and typically results in their destruction. Furthermore, even if such dissection were possible, it would inevitably result in residual tumor at the excision site. Hence, a full-thickness midline calvarial excision in the area of the external occipital protuberance carries a high risk of acute obstruction of the venous outflow in the dorsal sagittal and transverse sinuses and attendant severe neurologic complications.[4,5]

Compared with the medical literature on humans, there is limited information in the veterinary field regarding the feasibility of surgical removal of skull tumors compressing or obliterating the transverse venous sinuses, confluens sinuum, and dorsal sagittal sinus such as was done in the 2 dogs reported here. In human cases in which the SSS is invaded by a meningioma, morbidity remains considerable, especially following the postoperative period. A substantial number of these patients will have worsening of neurologic signs immediately after surgery, usually secondary to brain edema or hematoma formation.[4] However, it is important to note that in that retrospective case study, there were no deaths among 30 patients that had complete resection of the encased (within the meningioma) and totally obstructed portion of the SSS, although 6 patients did have immediate and serious impairment of their neurologic status, followed by an expeditious recovery.

In contrast, the outcomes of surgeries in which patients have had chronic obstructions of slow onset of the sagittal sinus or transverse sinuses may be much better than for acute obstruction. In humans, chronic invasion of the SSS by a meningioma is almost invariably accompanied by diffuse development of hypertrophic collateral veins superficially surrounding the tumor mass and converging toward the sinuses downstream of the obstruction.[4] In those patients, no surgery-related deaths occurred.

In dogs, it also appears that vascular adaptation may play a role in lessening the potential for acute adverse effects from surgical intervention in the sagittal and transverse sinuses. This has been demonstrated in an experimental study comparing rapid versus slow sagittal sinus occlusion in dogs. In the slow occlusion study group, DSS occlusion was achieved with a modified clamp that was rotated every 15 minutes, reaching total occlusion at 4 hours. This group was then monitored for an additional 4 hours. In the rapid occlusion group, the DSS was acutely occluded with an aneurysm clip, and subjects were monitored for 4 hours. Dogs that underwent slow occlusion had mild or no brain edema, compared with dogs that underwent rapid occlusion. In addition, cerebral angiography in the slow occlusion group revealed obvious collateral flow toward the transverse sinuses, whereas in the rapid occlusion group, no substantial circulation was detected.[5] This may be related to the adaptation of the reserve capillary network system to the collateral venous system. In the rapid sinus occlusion group, there was not enough time for the collateral venous system to work properly, making it more likely that venous hypertension, extravasation, and venous infarcts will occur. Thus, it was concluded that the clinical severity of effects related to cranial venous sinus system compression was directly related to the rapidity of the compression and the capacity of the collateral venous system.

In the 2 dogs described here, the slow growth of the MLO resulted in development of a substantial collateral vascular system that appeared to bypass the obstructed area of the confluence of the dorsal sagittal and transverse sinuses. Determining whether such collateral circulation is present, both by detection of these vessels on imaging studies and confirmation on imaging of occlusion of the relevant venous sinuses prior to surgery, may be a key factor in assessing the safety and feasibility of resection of large locally invasive masses in this critical location.

Imaging studies play a key role in assessment of MLO tumors and collateral circulation. In addition to survey radiography, surgical planning for tumor removal should also include CT, MRI, or both. Computed tomography can be used to evaluate causes of focal enlargement of the calvarium, especially when survey radiographs are inconclusive, and provide a more precise definition of the lesion and surrounding affected structures. Multilobular osteochondrosarcomas have unique characteristics on CT. When they involve the occipital region, they are finely granular or stippled nonhomogeneous radiopaque masses that usually invade into the calvarium.[7] In contrast, because of its excellent soft tissue detail, MRI is useful for delineating tumors of the skull and can easily determine the extent of neurovascular involvement and soft tissue invasion.[8] Magnetic resonance imaging is noninvasive, provides multiple viewing angles, and has excellent recognition of venous sinus stenosis or thrombosis when contrast-enhanced studies are performed. In one of the dogs reported here, MRI was instrumental in delineating the extent of cortical collateral circulation, particularly when a 3-dimensional construct was generated from the images. Our current recommendation is to perform both of these imaging modalities when assessing the potential for excision of large tumors affecting the occipitotemporal region of the skull. If a collateral vascular network is not present and the venous sinuses do not have evidence of occlusion prior to surgery, it may be inadvisable to attempt resection of masses that could result in destruction of the caudal DSS or confluens sinuum.

A second important consideration in resection of MLOs in the caudal portion of the skull is maintaining adequate hemostasis. These masses tend to be highly vascular, and the surrounding venous structures are fragile and easily disrupted. Vessel ruptures can occur under the bone to be resected, and hence the source of hemorrhage may not be visible until the entire mass is removed. In some instances, the mass and affected calvarium may need to be removed in segments so that the underlying structures can be addressed in a timely manner before completing the remainder of the dissection. One extremely helpful maneuver to reduce hemorrhage is to position the animal with the head elevated relative to the remainder of the body. In the dogs described here, the head was held in position on a metal frame and the surgery table tilted so that the head remained elevated and properly positioned as well as prevented any jugular vein compression by positioning devices or vacuum packs used to stabilize the patient. This arrangement will minimize any po-

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tential for either venous hypertension or hypostatic congestion at the surgical field and reduce overall blood loss.

The short- and long-term prognosis for a good outcome following this type of surgical procedure will depend on the surgeon's experience, clinical signs at time of surgery, complete excision of the mass, and presence of collateral circulation at the time of surgery. The surgeon should be adequately prepared for potentially life-threatening hemorrhage, and the surgery should be approached with great caution and thorough preoperative planning. However, as in the 2 dogs described in this report, such surgeries can be accomplished with little morbidity and an excellent postoperative recovery. In the first dog reported here, the owner had no follow-up CT scans to evaluate recurrence but did report that the dog was doing well with no external evidence of recurrent disease 15 months after surgery. In contrast, the second dog had local recurrence of the tumor within 6 months of surgery, which emphasized the difficulty in advanced MLO cases of obtaining clear margins of excision. In particular, the second dog had both extensive invasion along the dorsal cervical musculature and deep extension of the mass along the tentorium cerebelli, a location that is unlikely to be able to be surgically excised without substantial complications. However, the slow-growing nature of these masses and the plasticity of the adaptation of the nearby neurovascular structures suggest that a substantial period of time without recurrence of clinical signs may be obtained even if the tumors do regrow.

a. Prolene, Ethicon Inc, Somerville, NJ.
b. Gelfoam, Pfizer Inc, New York, NY.
c. Reynolds Wrap Release, Alcoa Inc, Pittsburgh, Pa.
d. Surgilube, Fougera Inc, Melville, NY.
e. Steri-Drape, 3M Health Care, Saint Paul, Minn.
f. Bard Mesh, Cranston, RI.
g. Maxon, Tyco Healthcare, Norwalk, Conn.
h. Vicryl, Ethicon Inc, Somerville, NJ.

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