Use of an endoscope in minimally invasive lesion biopsy and removal within the skull and cranial vault in two dogs and one cat

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Case Description—2 dogs and 1 cat underwent endoscopic-assisted intracranial procedures for lesion biopsy (1 dog and 1 cat) and definitive lesion removal (1 dog).

Clinical Findings—1 cat was treated for an interhemispheric, pedunculated meningioma with an associated arachnoid cyst. Two dogs underwent endoscopic surgery procedures; 1 dog underwent removal of an intranasal dermoid cyst with extension to the olfactory bulb dura, and the other underwent lesion biopsy for histologic confirmation of suspected intracranial granular cell tumor.

Treatment and Outcome—Minimally invasive intracranial procedures were achieved by use of an endoscope to aid in lesion biopsy in a dog and a cat with neoplasia and complete lesion removal in 1 dog with a dermoid cyst. No obvious morbidity from the use of the endoscope was observed. Rapid recovery from surgery was seen in all 3 animals, and hospitalization times were a few days.

Clinical Relevance—In human and veterinary neurosurgery, minimally invasive surgical approaches for diagnosis and treatment are gaining in popularity. Minimally invasive techniques are used to achieve a decrease in surgical time, minimize brain exposure, and decrease postoperative recovery times. Keyhole and minimally invasive approaches require some degree of dexterity and knowledge of where the endoscope is in a 3-dimensional orientation and its relationship to the topography of an anatomic region. Anticipation of complications should allow for potential conversion to an open craniotomy. Use of the endoscope in minimally invasive procedures is associated with a steep learning curve to understand orientation, topography, and normal versus abnormal anatomy. (J Am Vet Med Assoc 2009;234:1573–1577)

A 10-year-old male neutered Persian cat was admitted to the hospital for a 5-month history of partial seizures, signs of neck pain, ataxia, weight loss, and behavior change. Physical examination revealed an unkempt hair coat and the cat was underweight at 3.5 kg (7.7 lb). The remainder of the physical examination was unremarkable with the exception of epiphora of the left eye. On neurologic evaluation, the cat was obtunded and had mild ataxia in 4 limbs on gait analysis. Postural reactions revealed normal conscious proprioception and delayed hopping reactions in all limbs. Spinal reflexes were normal. Cranial nerve evaluation revealed decreased menace responses in each eye, but otherwise findings were normal. The cat had signs of discomfort on palpation of the cervical portion of the vertebral column. Neuroanatomic lesion localization was compatible with cerebral or thalamic syndrome without lateralization.

Tests from the referring veterinarian included serum antibody titers against FeLV, feline infectious peritonitis, Toxoplasma gondii, and Hemobartonella felis, which all had negative results. Findings on CBC, serum biochemical analysis, 3-view thoracic radiography, and abdominal ultrasonography were within reference range limits, with the exception of indications of dehydration (increased serum albumin concentration and PCV). The cat was anesthetized for MRI. Findings on MRI revealed a pedunculated mass, extending from the falx cerebri deep between the cerebral hemispheres caudally, that was surrounded by what appeared to be an arachnoid cyst. There was severe compression of the thalamus and cerebellum associated with fluid accumulation. The cerebellar vermis was observed to be herniating through the foramen magnum (Figure 1). The cat underwent a parietotemporal craniotomy. The dura over the ventral and caudal aspect of the temporal lobe was incised, and the temporal lobe was herniating through the dura in this region so the dural incision was extended dorsally and cranially to alleviate any strangulation of the brain tissue. Endoscopic equipment for this procedure consisted of a xenon light source, video camera, and video monitor with 4.0 mm × 18-cm telescope for use as the intracranial scope. Intraoperative photographs were produced with a still recorder and medical-grade color printer. Warmed or room temperature (approx 24° to 30°C) lactated Ringer’s solution was used for irrigation. The endoscope was passed...
caudal and ventral to the temporal lobe and was passed into the region of the presumptive arachnoid cyst (Fig. 1). The cyst membrane was broken down with microscissors that were passed alongside of the endoscope as there were no working channels in this endoscope. Fluid was obtained for cytologic analysis. Cerebrospinal fluid drained from the cyst and the temporal lobe shifted medially into a more normal position. Lactated Ringer’s solution was infused through the endoscope to mildly reinflate the cystic region to obtain a biopsy specimen of the pedunculated mass. The mass itself was not removed as a result of inadequate-sized equipment to detach the mass and pull it out. After lesion biopsy, the dura was apposed without suturing over the temporal lobe, which was no longer herniating out the craniotomy site. The temporalis muscle, subcutaneous tissues, and skin were closed in a routine manner.

Within a few hours after surgery, the cat began to eat well and was discharged 2 days later. Histologic findings for the mass and cyst tissues were consistent with meningioma and arachnoid tissue. Fluid from the cyst was submitted for cytologic and biochemical analysis and revealed pleocytosis (60 WBCs/µL, 68% nondegenerate neutrophils, 18% monocytes, 12% small lymphocytes, and 2% eosinophils; CSF reference range, < 5 total nucleated cells/µL) and a high protein concentration (2,560 mg/dL; CSF reference range, < 25 mg/dL). The cat underwent 45 total Gy fractionated radiation therapy over 4 weeks in an attempt to control mass growth. At 1 and 9 months after surgery, MRI revealed that the brain remained stable. At 20 months after surgery, the cat began to have some behavior changes and MRI was repeated. Fluid had begun to redevelop within the previous cystic region. The cat was anesthetized for fluid drainage. Fluid removal was performed by elevating the temporalis muscle from the previous surgery site and passing a 20-gauge, 1.5-in (3.8-cm)-long spinal needle behind the temporal lobe into the fluid space and withdrawing 3.5 mL of fluid. After this treatment, the cat did not develop recurrence of signs of CNS disease and was euthanatized for complications arising from pulmonary carcinoma at 82 months after surgery.

A 20-month-old female spayed Cocker Spaniel was admitted to the hospital for recurrence of a nasal dermoid cyst that was removed during anesthesia for ovariohysterectomy 1 year earlier. It was not believed to be completely removed at that time. Physical examination was unremarkable with the exception of a palpable defect in the bridge of the nose. Neurologic examination findings were normal. A CBC and serum biochemical analysis were performed, and there were no abnormal findings with the exception of a mildly low serum globulin concentration of 2.4 g/dL (reference range, 2.7 to 4.4 g/dL). The following day, MRI was performed and revealed that the dermoid cyst appeared to be attached to the cribiform plate and even possibly the dura mater on the right side of the olfactory bulb (Figure 2).

The dog was prepared for a transnasal approach by use of the endoscope to facilitate a minimally invasive approach. The defect in the nasal bones was used as an entrance to the cyst, and an additional 5-mm-diameter bur hole was created caudally as a port for the endoscope or instrumentation. The cyst was entered with the endoscope (equipment as already described) and found to indeed be a dermoid cyst with the presence of hair and sebaceous material (Figure 2). The cyst wall was detached with the aid of disectomy forceps, scissors, and a 20-month-old male neutered Persian cat with a 5-month history of partial seizures, neck pain, ataxia, and behavior change. A—Preoperative T1-weighted, postcontrast, sagittal plane magnetic resonance image of the brain and cranial portion of the cervical spinal cord. There is a small, homogenously contrast-enhancing mass that appears to arise from the falx cerebri by a stalk (small arrow). The mass is surrounded by a large amount of fluid that is causing severe cerebellar compression (dotted line) and vermal herniation through the foramen magnum (large arrow). B—Intraoperative endoscopic image of the mass (arrow). A veil of arachnoid membrane shadows the mass. Dorsal is on top and rostral to the left in the picture.
and hemostats. The cyst and material were removed through the original cyst pore in the nasal bones. The caudal nasal cavity was flushed to remove any debris and was evaluated with the endoscope to ensure that the cyst was completely removed. Visual inspection via the endoscope revealed that the cyst was associated with a rent in the cribriform plate and dura. The dura was packed off with an absorbable gelatin sponge and a dural graft substitute in an effort to prevent infection. Subcutaneous tissues and skin were closed in a routine manner. The following morning, the dog was neurologically normal and was discharged from the hospital. There was no evidence of recurrence at a 2-year follow-up examination.

A 14-year-old female spayed Australian Shepherd was admitted to the hospital for a 4-month history of generalized motor seizures and substantial weight loss. Loss of house training and behavior change of 2 months' duration were reported as well. Current medication included phenobarbital (3.18 mg/kg [1.45 mg/lb], PO, q 12 h), dexamethasone (0.49 mg/kg [0.22 mg/lb], PO, q 12 h), metoclopramide (0.5 mg/kg [0.23 mg/lb], PO, q 12 h), famotidine (0.5 mg/kg, PO, q 12 h), and cephalaxin (26.5 mg/kg [12.0 mg/lb], PO, q 8 h). Physical examination revealed the dog was thin and had generalized muscle atrophy. Other findings included bilateral lenticular sclerosis, dental calculi and gingivitis, and generalized weakness. Neurologic examination findings were normal with the exception of circling to the left and collapsing during the hopping reactions in all limbs. Neuroanatomic lesion localization was compatible with left cerebral syndrome.

A CBC, serum biochemical analysis, 3-view thoracic radiography, and abdominal ultrasonography were performed. The dog had isosthenuria, mildly high serum creatinine (1.88 mg/dL; reference range, 0.5 to 1.6 mg/dL) and BUN (54.3 mg/dL; reference range, 7 to 31 mg/dL) concentrations, and a mild nonregenerative anemia (PCV, 33.8%; reference range, 35% to 52%), which were consistent with chronic renal failure. Findings on 3-view thoracic radiography and abdominal ultrasonography were normal with the exception of anatomic changes in the kidney consistent with the renal disease. The dog was anesthetized for MRI. Blood pressure and urine output were carefully monitored in an attempt to prevent acute decompensation of renal function. T2-weighted magnetic resonance images revealed severe extensive cerebral edema in the olfactory, frontal, and temporal lobes. Precontrast T1-weighted magnetic resonance images revealed extensive mild increased signal intensity in the olfactory and frontal lobe regions as well as the associated meninges with only mild tissue compression. Postcontrast T1-weighted magnetic resonance images revealed strong gadolinium uptake throughout this region. On the basis of the dog's age and renal dysfunction, a minimally invasive lesion...
biopsy of the olfactory region was performed to confirm the diagnosis before deciding on further treatment, such as surgery, chemotherapy, and radiation therapy. The dog was prepared for surgery, and an incision was made over the midline of the frontal sinus from the bridge of the nose to the confluence of the frontal sinus on midline. On the left side of the frontal sinus, 2 bur holes of approximately 6 mm in diameter were created: 1 as a port for endoscopic access and 1 as a port for working instruments. The endoscopic instrumentation was as already described. A bur hole was created in the center of the internal surface of the frontal bone on the left side. Once the periosteum was penetrated, a spinal needle was used to penetrate the dura and small biopsy forceps were used to access the abnormal tissue. The biopsied tissue was soft and granular in appearance. The dural tear and bur hole were covered with a dural graft substitute. The dog recovered without incident and was discharged from the hospital 36 hours later with stable renal function. Histologic evaluation of the biopsy tissue specimen revealed granular cell tumor. On the basis of the dog’s age, disability, and diagnosis, the client opted not to pursue further treatment. The dog’s mental status appeared to continue to decline and resulted in hypodipsia; the dog was readmitted to the hospital 3 weeks later. Serum creatinine and BUN concentrations were further increased (2.9 mg/dL and 216 mg/dL, respectively). On the basis of the overall prognosis and the decline in health, the dog was euthanized.

Discussion

The advent of minimally invasive neurosurgery is predicated on the basic principle of a keyhole approach for microneurosurgery.1–3 Perneczky and Fries4 described the keyhole approach as the choice of a craniotomy that allows the ability to enter and work within a particular region with minimal traumatization. This concept is based on the existence of anatomic windows that provide access to abnormalities in defined intracranial areas framed by important anatomic structures.5–7 In human neurosurgery, the improvement in diagnostic imaging during the last 30 years has resulted in accurate determination of topography of an anatomic region in relationship to pathologic findings.5,6 Careful preoperative study of diagnostic images is required to determine the best, but not necessarily the shortest, path to the lesion.2 The best path would inherently result in the least amount of morbidity. With the correct approach, it is possible to reduce the size of the craniotomy, decrease brain exposure, and commit less retraction.2 Originally, concepts in the keyhole approach were used in association with the operating microscope.2 The shortcomings of the so-called keyhole approaches were narrow viewing angles and reduction in light intensity, both hindering visual inspection. In addition, the design of operating microscopes allows only an optimal view of lesions if they are directly opposite of the viewing angle and not those that are hidden behind other structures.5 Advanced endoscope technology has resulted in improved light sources and lenses that have allowed higher quality images.8 Neuroendoscopy is a simple method to bring more light into the operative field and allow better access to important anatomy and pathologic findings without additional tissue trauma and thus is ideal for use in minimally invasive approaches. The fundamentals of good endoscopic technique and avoidance of complications include the following: correct patient selection, appropriate ventricular size (scope diameter), straight trajectory to the target, endoscope selection, use of an assistant, comfort with spatial orientation, and knowledge of the intracranial anatomy.9

Image-guided (MRI, computed tomography, and ultrasonography) stereotactic biopsy has been previously reported as another minimally invasive approach for obtaining tissue specimens from intracranial lesions.9,10 Advantages and disadvantages exist to these types of intracranial procedures in comparison to endoscopic-assisted lesion biopsy. Both image-based and endoscopic-assisted lesion biopsy require a minimal craniotomy (keyhole approach) to allow passage of the instruments and appear to be relatively safe and effective.9,11 Endoscopic-assisted lesion biopsy requires a cavity or fluid-filled space for optimal use. Parenchymal lesions and deep-seated lesions are more amenable to image-guided stereotactic biopsy.9,11 Hemorrhage after biopsy is 1 disadvantage of any minimally invasive procedures.9,11,13 One of the benefits of endoscopic-assisted biopsy over image-based biopsy is the recognition of substantial hemorrhage that occurs at the time of biopsy and direct visual inspection of the hemorrhage with the opportunity to address it. However, it is not uncommon for hemorrhage to occur at a later time. Infection is another possible complication of both types of procedures, but this appears to be uncommon.13–16 Another possible benefit to endoscopic-assisted procedures is the possibility of performing more definitive treatment such as with the dermoid cyst. Image-guided procedures allow a more direct pathway to the lesion by stereotactic frame (or frameless) devices, and user experience does not seem to be an important factor in achieving an adequate biopsy specimen.9,13,14,16

Endoscopic-assisted procedures are hindered by a steep learning curve of determining normal from abnormal 3-dimensional anatomy.

Animals of the current report had intracranial lesions that were considered ideal for the use of endoscopic minimally invasive approaches. The cat with the large fluid-filled cyst and pedunculated meningioma, which was deep between the hemispheres on the midline, underwent the most delicate of the procedures. It was believed that this meningioma originated from the falx cerebri. This lesion was not approachable by any other means with the exception of a midline dorsal approach or by traversing a considerable amount of cerebral tissue. The latter option did not seem justified to the authors. Midline falkine tumors present considerable risk as disruption of the dorsal sagittal sinus can lead to severe venous congestion, cerebral edema, and potentially death if venous flow is not restored. In this particular cat, it appeared that the presumptive arachnoid cyst was likely contributing to the cerebral compression and dysfunction as much, if not more, than the pedunculated mass. The minimal goal of the procedure was to decompress the fluid accumulation and biopsy the mass if possible. The optimal goal of the procedure, mass removal, was not achieved because of limitations associated with available instrumentation. In this instance, it was felt that decompression and biopsy presented the possibility of far less morbidity. Fluid removal resulted in excellent decompression of the brain tissue in this cat. However, presence of maintained distention after cyst decompression is possible. The reduction in size of a
A dermoid cyst was removed from the Cocker Spaniel of this report by a minimally invasive approach to the lesion. Dermoid cysts are best treated by complete removal as retention of the cyst capsule can result in recurrence.\(^{21-23}\) Intracranial extension of the cyst is not uncommon, and the existence of a tract from the skin to the dura can result in bacterial meningitis. Benefits of removing the dermoid cyst via minimally invasive endoscopic surgery were 2-fold. First, minimal bone removal resulted in a cosmetic appearance to the bridge of the nose. In regions with minimal bone removal, it is likely that a considerable dense fibrous tissue or possibly even osseous tissue filled the holes. Second, observation of the exposure of the dura through the small opening in the cribiform plate would have been exceedingly difficult without improved visibility and magnification afforded by the endoscope. Gross exposure of the dura to the nasal cavity enhances the risk of the patient developing epidual bacterial infection, which causes substantial morbidity and potentially death.\(^{22,23}\)

A minimally invasive biopsy was chosen for the Australian Shepherd of this report based on the suspected underlying disease and the overall health of the dog. The minimally invasive technique resulted in decreased surgical time, minimized brain exposure, and decreased the postoperative recovery. The overall outcome of this dog was not favorable, but this was not obviously related to the use of the endoscope. In fact, use of the endoscope allowed a confirmation of suspected pathologic findings without subjecting the dog to extensive surgery.

Keyhole and minimally invasive approaches require some degree of dexterity and knowledge of where the endoscope is in a 3-dimensional orientation and its relationship to topography of an anatomic region. Three-dimensional orientation is one of the most difficult concepts to learn when beginning to use the endoscope, especially in minimal approaches. Anticipation of complications should allow the potential for conversion to a larger craniotomy. The use of the endoscope in minimally invasive procedures is associated with a steep learning curve to understand orientation, topography, and normal versus abnormal anatomy.

### References