Brain Tumors in Dogs and Radiation Therapy

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Primary brain tumors are frequently encountered in dogs. Primary brain tumors arise from cells within the cranium. Most primary brain tumors are solitary, but multiple primary brain tumors have been reported. Secondary brain tumors are metastatic cells from a primary tumor located outside the cranium. The more common secondary tumors include hemangiosarcoma, mammary gland adenocarcinoma, pulmonary carcinoma and lymphoma. Tertiary brain tumors arise from cells from a surrounding structure. Multilobular osteochondroma of the skull, pituitary tumors, and nasal adenocarcinoma are tertiary tumors. Brain tumors can occur in dogs of all breeds, age, and either sex, although the incidence increases over 4-5 years of age.

Primary tumors are typically slow growing and produce progressive clinical signs. Acute signs may be seen secondary to hemorrhage, infarct, or changes in intracranial pressure. Common primary brain tumors include meningiomas (covering of the brain), choroid plexus tumors, ependymomas (lining of the ventricles) and glial tumors (brain parenchyma). Primary brain tumors rarely metastasize extracranially.

The most common primary brain tumor reported in the dog is the meningioma. These are more commonly seen in dolichocephalic breeds (Golden Retrievers, Labradors Retrievers, German Shepherd Dog, Collies). Approximately 95% of the dogs with meningiomas are older than 5 years of age. Meningiomas are most commonly found in the frontal lobe, along the falx cerebri, and the cerebellopontine angle. Some meningiomas can be cystic as a result of tumor necrosis or pocketing of cerebrospinal fluid. Cystic meningiomas are more often located in the frontal lobe.

Glial tumors (astrocytoma, oligodendroglioma, and glioma) are the second most common brain tumor in dogs. These are more commonly seen in brachycephalic breeds (Boston Terriers, Bulldogs, French Bulldogs, Boxers). The incidence of brain tumors does increase with age. A brain tumor is a differential in any dog that is 4 years of age or older with the appropriate clinical signs.

Clinical signs are dependent upon the location of the brain tumor, rate of growth, and the degree of secondary changes (peritumoral edema, hemorrhage, obstructive hydrocephalus, increased intracranial pressure, and herniation). The tumor can cause clinical signs by compressing normal brain structures, infiltrating normal brain tissue, disrupting the cerebral blood flow, and creating local necrosis and hemorrhage.

Slow growing primary brain tumors allow the brain to adapt to the slow increase in intracranial pressure. Some dogs may exhibit vague clinical signs and behavior changes during this time. Clinical signs then may progress rapidly when the brain's compensatory

mechanisms have been reached. Dogs with rapidly growing primary brain tumors can present with a sudden onset of neurological signs. Seizures, behavior changes, dullness, circling, head pressing, compulsive walking, blindness, dysmetria, ataxia, nystagmus, cranial nerve deficits and hemiparesis are some of the clinical signs that can be seen.

Complete blood work, thoracic +/- abdominal radiographs and a blood pressure should be performed in all animals prior to advanced imaging. Thoracic radiographs are important to screen for metastatic pulmonary disease, megaesophagus / aspiration pneumonia (if cranial nerve dysfunction), and infectious processes. Plain skull radiographs are of limited value when trying to diagnose a primary brain tumor, plus require general anesthesia for proper positioning.

Both computed tomography (CT) and magnetic resonance imaging (MRI) can provide information about the location and size of primary brain tumors. Magnetic resonance imaging is the gold standard for imaging the brain and is preferred over CT. Magnetic resonance imaging has superior soft tissue detail and greater contrast resolution, plus it has greater detail for tumors located in the caudal fossa as it does not have beam hardening artifact like CT does. Magnetic resonance imaging is superior to CT in detecting many features of brain tumors such as edema, cyst formation, vascular changes, hemorrhage and necrosis. Ideally, any intra-cranial mass should be biopsied prior to therapy, but this is rarely performed due to practical reasons such as morbidity and cost.

Analysis of cerebrospinal fluid (CSF) is performed occasionally. The results may help rule out inflammatory brain disease and may support a diagnosis of tumor (primarily lymphoma). The main risk of performing a spinal tap in an animal with increased intracranial pressure is brain herniation secondary to the pressure change that accompanies the collection of the spinal fluid. Many patients develop respiratory arrest associated with early herniation and require hyperventilation and mannitol therapy. Some patients may develop full cardiopulmonary arrest. The decision to perform the cerebrospinal fluid analysis is generally made by the neurologist after reviewing the MRI and taking into account clinical signs associated with increased intra-cranial pressure. A CSF analysis is rarely performed prior to advanced imaging.

The goals of therapy for primary brain tumors are to eliminate or shrink the tumor and to control the secondary changes (peritumoral edema, hemorrhage, obstructive hydrocephalus, increased intracranial pressure, and herniation). The main goal is to provide the best quality of life for the longest possible amount of time as most primary brain tumors can be treated, but few can be completely cured.

There are 3 basic types of therapy: medical, surgical, and radiation therapy (RT). The treatment and prognosis will vary depending on tumor type. The most appropriate treatment plan depends on many factors including the location and type of tumor, general health of the patient, and treatment availability.

Medical therapy includes steroids, mannitol, furosemide, anticonvulsants, and chemotherapy. Steroids have great anti-inflammatory effects, decrease peritumoral

edema, decrease CSF production and stabilize the cellular membranes and blood brain barrier. Diuretics decrease intracranial pressure. Phenobarbital is the best anti-convulsant to control generalized or partial seizures. The main side effects of these drugs (polydipsia, polyuria, nocturia, polyphagia, and sedation) can be overwhelming to deal with for some clients initially. Chemotherapy options are very limited due to the blood brain barrier. Many drugs can not penetrate this barrier. The average survival time with medical therapy alone has been reported to be 1-3 months.

Surgical debulking or resection is an option in some cases. The decision to perform surgery is based on the location, size, type of tumor, and whether debulking versus complete resection of the tumor is possible. Surgical debulking or resection of a primary brain tumor can provide a histological diagnosis, can decrease or eliminate clinical signs, and may improve the patient's overall condition prior to adjuvant therapy such as RT. Survival time is based on tumor type, location, surgical accessibility, peri-operative and post-operative complications. Complications that could occur include seizures, aspiration pneumonia, tension pneumocephalus, and neurological deterioration (coma). The average survival time in the dog has been reported to be 1 year.

Radiation therapy is an option for almost every primary brain tumor. Radiation therapy is superior to medical therapy and is useful for tumors that are not operable or are infiltrative. It may be used as the sole agent or in combination with the other therapies. Many owners choose RT over surgery as it is non-invasive and avoids potential peri-operative and post-operative complications. The benefits from RT occur over 1-3 months. Minimizing the clinical signs with medical therapy is important before starting and during the RT. The benefits of RT far outweigh the risks in most patients.

Acute side effects are generally mild and can include hair loss at the site, otitis externa, and keratitis sicca if the eyes are in the treatment fields. Early delayed side effects are secondary to transient demyelination which is usually steroid responsive. Late side effects are due to brain necrosis. Late side effects are rare and can be minimized through careful treatment planning.

The radiation tolerance of healthy brain tissue is the limiting factor for the overall radiation dose. Careful RT planning by a radiation oncologist is essential. Radiation oncologists minimize the chances of harmful side effects by adjusting the total radiation dose as well as the dose per fraction. They also use highly specialized computer treatment plans, accurate positioning, and multiple treatment beams to minimize dose to healthy tissues. A short general anesthesia is required for each treatment and most brain tumor protocols require 15-16 treatments of 3 Gy fractions. The tumor type dictates responsiveness. Recently reported median survival time is 10 months to 2 years for all brain tumors.