# Intracranial Intra-arachnoid Diverticula and Cyst-like Abnormalities of the Brain

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**KEYWORDS**

• Intracranial • Arachnoid • Cysts • Dogs • MRI

**KEY POINTS**

- Intracranial cysts are classically lesions with an epithelial lining filled with fluid.
- If a cyst has an incomplete epithelial lining it is called a diverticula.
- The most common primary congenital intracranial cysts are intra-arachnoid, dermoid, and epidermoid.
- Intracranial cysts cause clinical signs directly by compressing local brain tissue.
- Diagnosis is often possible with advanced imaging techniques, such as MRI.

## INTRODUCTION

Intracranial cysts are classically lesions with an epithelial lining filled with fluid that can directly cause clinical signs from compression of the brain or indirectly by producing obstructive hydrocephalus.[1,2] Intracranial cysts may enlarge by secreting cerebrospinal fluid (CSF) into the cyst, by way of an osmotic gradient depending on the cyst contents, or by exfoliation of cyst lining or materials into the lumen.[1,2] Cystic lesions of the brain are easily recognized on MRI and computed tomography (CT) scanning by way of their morphologic features, which include a rounded shape, well-defined borders, size, and cyst wall thickness. Further characterization is possible based on their radiographic attenuation properties on CT scans or by their signal intensity on MRI.[2,3]

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## INTRACRANIAL INTRA-ARACHNOID DIVERTICULA

Intracranial intra-arachnoid cyst-like lesions represent accumulations of CSF that occur because of splitting or duplication of the arachnoid membrane.[4,5] Because in some cases there is no evidence of a complete encapsulating membrane in which case the fluid is surrounded by normal tissue, the lesions are more appropriately termed diverticula.[6] These diverticulae constitute 1% of all nontraumatic, space-occupying intracranial lesions in human adults[7] and occur in 2.6% of children,[8] with supratentorial and infratentorial locations.[9] In dogs, more than 60 cases of intracranial intra-arachnoid diverticula (IADs) have been reported, all located within the caudal fossa; most seem to occur in a region comparable with the quadrigeminal cistern in humans, and therefore have often been called quadrigeminal cysts.[5,10–21] An extensive review of canine MRI brain scans documented a low prevalence of the condition, with 0.7% of dogs being screened for brain disease affected.[19]

### *Pathophysiology*

It has been postulated that during embryonic development the perimedullary mesh experiences a splitting in the arachnoid layer because of aberrant CSF flow; this mesh surrounds the developing neural tube and is normally divided by CSF flow into the pia and arachnoid layers.[18] Evaluation of the lining of these cysts has determined there to be multiple structural variants, which may explain their differential clinical behavior.[22] Secondary intracranial IADs can also occur and represent acquired accumulations of CSF that result from loculation of the subarachnoid space resulting from head injury, intracranial infection/inflammation, neoplasia, or hemorrhage, and are surrounded by arachnoid scarring rather than normal arachnoid tissue.[14,18,23]

The mechanism by which a cyst expands is controversial. There is some evidence that the lining of the cyst wall may have secretory abilities; however, many cysts do not enlarge and can even resolve, which implies that this cannot be universal in all patients.[24] Additionally, a one-way or “ball-valve” effect has been hypothesized and there has been evidence of one-way flow suggested by cine MRI with confirmation of a slit-valve structure confirmed via endoscopy.[25,26]

Three heterogeneous phenotypes of IAD (quadrigeminal) have been described in dogs: they can appear associated with either the third or fourth ventricle, or may have a loculated appearance and be associated with both third and fourth ventricles.[19] The heterogeneous appearance and lack of a true “cyst” wall has led some to refer to them as supracollicular fluid accumulations instead of IADs.[19] The association found between ventricles in some of these cysts must not be confused with the term communicating and noncommunicating IADs, because this refers to their communication with the subarachnoid space,[7,18,26] which cannot be determined with conventional imaging.

### *Clinical Signs*

Small breed brachycephalic male dogs seem to be predisposed to IADs with the most common breed reported being the Shih Tzu.[10,11,14,16–20] Subarachnoid diverticula have been reported within the fourth ventricle in five nonbrachycephalic large breed dogs, indicating that the brachycephalic predisposition may only occur for IADs in dogs. Age at presentation varies widely, and is likely related to whether the IAD is incidental or contributes to clinical signs along with another intracranial disease. The onset of clinical signs in elderly patients has been reported with intracystic hemorrhage occurring after trauma.[9,14] Variable clinical significance of IADs is reported for humans and dogs. They might be an incidental imaging or postmortem finding[18,19,23,27–29] or give