

## Cerebrospinal Fluid (CSF) Collection Sites in Animals: Anatomical Landmarks and Clinical Significance

<sup>1</sup>Aravind S., <sup>1</sup>Aksay K.V.P., <sup>1</sup>Anjali M., <sup>1</sup>Gowri Nandana A.D. and <sup>2</sup>N. S. Sunilkumar

<sup>1</sup>BVSc&AH graduate students

<sup>2</sup>Assistant Professor, Department of Veterinary Anatomy  
College of Veterinary and Animal Sciences, Mannuthy,  
Thrissur, Kerala, India

Kerala Veterinary and Animal Sciences University

[DOI:10.5281/Vettoday.17046444](https://doi.org/10.5281/Vettoday.17046444)

### Introduction

Cerebrospinal fluid (CSF) analysis is a critical tool for diagnosis in veterinary practice, offering a unique glimpse into the health of an animal's central nervous system (CNS). This fluid, which bathes the central nervous system, provides essential insights that other tests cannot, helping veterinarians diagnose a wide range of neurological conditions. This article will explore the anatomy of CSF, the techniques used for its collection and the clinical significance of its analysis.

### Anatomy and Physiology of Cerebrospinal Fluid

CSF is a clear, colorless fluid that serves multiple vital functions for the CNS. It acts as a protective cushion, shielding the central nervous system from physical trauma. Also, it helps maintain a stable chemical environment, delivers nutrients and removes metabolic waste products.

The formation of CSF is a continuous process. The majority of CSF is secreted by the **choroid plexuses**, specialized capillary networks located within the brain's ventricles. A smaller amount is also formed by ependymal cells lining the ventricular system and the pia-glial membrane. This fluid circulates through the ventricles and into the **subarachnoid space**, the area between the arachnoid and pia mater layers that surround the CNS.

Absorption of CSF occurs primarily through specialized structures called **arachnoid villi**, which

project into the venous sinuses of dural space. This process maintains a constant volume and pressure of CSF. Under normal conditions, CSF has a low protein content and very few cells. However, any disruption to the CNS, such as inflammation, infection or bleeding, can alter its composition, making CSF analysis a powerful diagnostic tool.

### Risks, Contraindications and Patient Preparation

Collecting CSF is an invasive procedure that must be performed under general anesthesia to ensure the animal remains still and to minimize the risk of injury. The procedure carries potential risks, including accidental damage to the spinal cord or brainstem, and the introduction of infection if aseptic technique is compromised.

Therefore, several situations are considered contraindications for CSF collection:

- **Severe Intracranial Pressure (ICP):** In animals with signs of significantly elevated ICP, such as severe head trauma, brain swelling, or hydrocephalus, a CSF tap can cause a sudden pressure change, leading to **brain herniation**, a life-threatening condition.
- **Hemodynamic Instability:** Unstable vital signs or shock make anesthesia and the procedure itself too risky.
- **Coagulopathies:** Blood clotting disorders can lead to excessive bleeding at the puncture site.

- **Local Pathology:** Infection or anatomical abnormalities at the collection site increase the risk of complications.

Prior to the procedure, a thorough neurological examination and diagnostic imaging (like MRI or CT) are crucial to assess the patient's condition and rule out high-risk situations.

### Navigating the CSF Collection Sites

The two most common sites for CSF collection in veterinary medicine are the **cerebellomedullary cistern (cisterna magna)** and the **lumbar subarachnoid space**. The choice of site often depends on the suspected location of the neurological lesion. As CSF generally flows from the head down the spine, collecting a sample from a site *behind* the suspected lesion is often preferred, as it is more likely to show changes. However, for lesions in the cervical spine, a cisternal tap is often more diagnostic.

#### 1. Cerebellomedullary Cistern (Cisterna Magna) Tap

This is the most common collection site in small animals and is often considered the safest and easiest to perform. It offers the benefit of a large CSF-containing space, which reduces the risk of blood contamination.

- **Anatomical Landmarks:** The animal is placed in lateral recumbency with its head flexed.
  - A line drawn from the **external occipital protuberance** to the dorsal spine of the **axis (C2)**.
  - A vertical line drawn from the cranial border of the **wings of the first thoracic vertebrae (atlas)**.
  - The needle is guided through the skin, muscle, and atlanto-occipital membrane to reach the cistern.
- **Species-Specifics:** This approach is also widely used in **horses**.

#### 2. Lumbar Puncture

This technique is more technically challenging and carries a higher risk of blood contamination. It is performed in the **lumbar spine**, where the subarachnoid space is accessible.

- **Anatomical Landmarks:** The puncture site is typically located between specific vertebrae, guided by palpation of the dorsal

spines.

- **Dogs:** The most common sites are between **L5 and L6** or **L4 and L5**. The L6 spine is often identified as the one just cranial to the palpable wings of the ilium.
  - **Cats:** Common sites are between **L6 and L7** or **L5 and L6**.
  - **Cattle, sheep, and goats:** A **lumbosacral or sublumbar** approach is often used.
- **Technique:** The needle is carefully inserted into the interarcuate space, a small gap between the vertebral arches, aiming slightly craniomedially.

### The Diagnostic Power of CSF Analysis

A thorough CSF analysis includes a range of tests that can help differentiate various neurological conditions.

#### Physical Characteristics

- **Normal:** CSF should be **clear and colorless**, similar in appearance to water.
- **Abnormalities:**
  - **Xanthochromia:** A yellow or orange discoloration, suggesting old hemorrhage or elevated bilirubin levels.
  - **Cloudiness:** Indicates a high cell count (pleocytosis).
  - **Red:** Suggests recent blood contamination or active hemorrhage.

#### Cytological and Biochemical Analysis

- **Protein Concentration:** Normal CSF has a very low protein concentration. An elevated level is a sensitive indicator of CNS disease, especially inflammation (meningitis, encephalitis) or tumors. Protein-cell dissociation, where protein is high but the cell count is normal, can be seen in some degenerative conditions.
- **Total Nucleated Cell Count (TNCC):** A key parameter, as the normal cell count in CSF is extremely low. A count above the normal range is called **pleocytosis** and is a hallmark of CNS inflammation.
  - **Neutrophilic pleocytosis:** Suggests bacterial infection.
  - **Lymphocytic pleocytosis:** Points to viral, fungal, protozoal, or toxic causes.

- **Glucose:** In healthy animals, CSF glucose is typically 60-80% of the blood glucose level. A reduced CSF glucose level, is a strong indicator of bacterial infection, as bacteria consume glucose.
- **Other Parameters:** Other analyses, such as the detection of specific enzymes (e.g., CPK for muscle or brain injury) or the culture of the fluid, can provide further diagnostic clues. For example, a CSF culture is essential for identifying the specific organism in suspected bacterial or fungal meningitis.

### Case-Based Insights

- **Bacterial Meningoencephalitis:** Typically presents with a marked neutrophilic pleocytosis, low glucose and high protein.
- **Canine Distemper:** Can cause an increase in various enzymes like ALT, AST and CPK in the CSF.
- **Equine Protozoal Myeloencephalitis (EPM):** Diagnosis is often confirmed through serological testing of CSF for specific antibodies.

### Conclusion

CSF analysis is an indispensable tool in veterinary neurology. While the procedure is invasive and requires careful consideration of risks and contraindications, the diagnostic information it provides is often unparalleled. By understanding the anatomy of CSF, mastering collection techniques and accurately interpreting the results, veterinarians can significantly improve their ability to diagnose, treat and prognose complex neurological diseases in their patients. The continued advancement in CSF biomarker research promises to further enhance its value, offering even more precise insights into CNS disorders.

### References

- Dewey, C. W., & da Costa, R. C. (2015). *Practical Guide to Canine and Feline Neurology* (3rd ed.). Wiley-Blackwell.
- Chrisman, C. L. (1991). *Neurology for the Small Animal Practitioner*. Lea & Febiger.
- George, E. S., et al. (1996). "Cerebrospinal Fluid Analysis in Spinal Injury." *Journal of Veterinary Medicine Series A*, 43(8), 499-504.