Ultrasonographic Examination of the Spinal Cord and Collection of Cerebrospinal Fluid from the Atlanto-Occipital Space in Cattle

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KEYWORDS

• Cattle • Ultrasonography • Spinal cord • Atlanto-occipital space
• Cerebrospinal fluid

KEY POINTS

- The spinal cord and its surrounding structures can readily be identified using ultrasonography.
- It is possible to collect cerebrospinal fluid (CSF) without blood contamination.
- Ultrasound guidance eliminates the need for marked ventroflexion of the head, which in turn minimizes defensive reactions that commonly occur when the blind technique is used.
- Ultrasound-guided collection of CSF is convenient and safe, and therefore, the method of choice for collection of CSF in cattle.

INTRODUCTION

The examination of cerebrospinal fluid (CSF) plays a major role in the diagnosis of central nervous system diseases in cattle. There are 2 sites from which CSF can be collected in cattle: the first is the atlanto-occipital (AO) space and the second is the lumbosacral foramen (LSF).[1,2] The exact site of needle insertion at both locations is determined by skeletal landmarks, but puncture is carried out blindly without visualization of the subarachnoid space.[1–4] For collection from the AO space, the head is ventroflexed at a 90° angle and the needle is inserted at the intersection between the dorsal midline and an imaginary line connecting the cranial edges of the wings

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of the atlas[2,4] or slightly cranial to that intersection.[1] A spinal needle is introduced into the subarachnoid space parallel to the longitudinal axis of the flexed head.[1,4] The depth to which the needle is inserted is not exactly predictable, and the needle is advanced slowly and carefully and monitored for free flow of CSF by removing the stylet at regular intervals.[2] Puncture of the spinal cord must be avoided because it can lead to nerve damage or even death of the patient.[2,5] Strong ventroflexion of the head required for this technique often provokes avoidance movements in the animal and may impair respiration. Furthermore, blind aspiration of CSF from the AO space frequently results in contamination of the sample with blood,[6,7] which can impair the diagnosis.[8–12] Finally, the spinal cord may be punctured during blind aspiration despite the precautions outlined above and results in pain evidenced by violent twitching. Based on experiences in the collection of CSF under ultrasonographic guidance in the horse,[13–15] the spinal canal of cattle was examined ultrasonographically and the feasibility of ultrasound-guided collection of CSF was investigated.[16,17] Another study described the ultrasonographic findings of diplomyelia of the lumbar spine in a calf,[18] and the ultrasonographic examination of the spinal cord in healthy calves was presented.[19] The purpose of this article is to describe the ultrasonographic findings of the spinal cord and its surrounding structures and the ultrasound-guided collection of CSF from the AO space in cattle.

ANATOMY OF THE ATLANTO-OCCIPITAL SPACE

The AO space is bordered by the occiput cranially and by the atlas caudally and is covered by the skin, the nuchal ligament, various muscles, and the AO membrane.[2,20] Ventral to this membrane is the cranial-most section of the vertebral canal, which contains the spinal cord surrounded by 3 meninges. The outermost meninx is the dura mater, which is separated from the vertebral periosteum by the epidural space.[21] The middle meninx is the dura arachnoidea, which is enveloped by the dura mater and consists of 3 layers. The outermost layer is made up of fibrocytes and collagen fibers and is separated from the dura mater by a so-called neurothelium. Avascular bundles of collagen fibers covered by neurothelium, referred to as arachnoid trabeculae, connect the outer layer with the inner layer of the dura arachnoidea, which also consists of collagen fibers and fibrocytes.[21,22] These trabeculae are in the middle layer and form a spider web-like network surrounded by CSF. The middle layer of the dura arachnoidea is referred to as the subarachnoid space[22] and contains the arteries that supply the central nervous system.[21] The innermost layer of the dura arachnoidea follows the superficial surface of the brain and spinal cord, whereas the outermost layer, together with the dura mater, forms a straight sac, which envelops the spinal cord. The innermost meninx, the pia mater, adheres to the surface of the brain and spinal cord and closely follows their contours. CSF-filled spaces, referred to as subarachnoid cisternae, are formed in the regions where the dura arachnoidea and pia mater separate over depressions in the brain or spinal cord. The cerebellomedullary cistern, also called the cisterna magna, is formed between the caudal aspect of the cerebellum and the medulla oblongata and in most domestic animals is of clinical importance for the collection of CSF from the AO space.[21,22] However, in cattle, the cerebellomedullary cistern cannot be accessed because of the caudal elongation of the occipital bone, and therefore, the caudal extension of the cistern, is punctured for collection of CSF.[23] The pia mater consists of loose connective tissue including blood vessels and nerves. It is tightly associated with the surface of the brain and spinal cord and is adjacent to the superficial glial cells of the central nervous system. The pia mater forms 2 narrow fibrous strips on either side of the spinal cord, called