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RESEARCH PAPER

# Measurement of the puncture profile and extradural pressure of cattle during extradural anaesthesia

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## Abstract

**Objective** To measure the pressure profile during caudal extradural puncture and subsequent extradural anaesthesia in cattle and to investigate the presence of extradural pressure waves.

**Study design** Prospective experimental study.

**Animals** Eleven cattle aged 4.1 ± 2.5 years (range 0.8 to 8.8 years), with a body weight of 613 ± 162 kg (range 302–840 kg).

**Methods** Caudal extradural puncture was performed. To measure the extradural pressure profile, the needle was connected to an electronic pressure transducer placed at the height of the base of the tail. The pressure profile was recorded for 3 minutes following extradural puncture. Lack of resistance to injection of saline was assessed. One minute and 10 minutes after extradural anaesthesia with procaine extradural pressure was recorded. Correct extradural needle placement was assessed by clinical response.

**Results** Three minutes after extradural puncture the median pressure was −16 (range −25 to 25) mmHg. Pressure in the extradural space 1 minute after the lack of resistance, 3 seconds after injection, and 10 minutes after injection was −15 (−24 to 33) mmHg, 8 (−17 to 84) mmHg, and −7 (−25 to 27) mmHg respectively. Pressure waves were visible after puncture, after lack of resistance, 3 seconds and 10 minutes after injection, in 4, 6, 8 and 7 cattle respectively. Pressure after testing lack of resistance, after the injection of local anaesthetic, as well as at the end of the measurement, period was significantly higher than baseline. All cattle showed clinical signs indicative of successful extradural needle placement.

**Conclusion and clinical relevance** Extradural pressure was sub-atmospheric in 82% of the animals. Pressure waves were not consistently present before or after extradural injection, which limits their usefulness to confirm correct extradural needle placement. Extradural pressures increase significantly after injection of local anaesthetic solution. However, the clinical significance of the increase in extradural pressures was not clear.

*Keywords* cattle, epidural anaesthesia, extradural anaesthesia, extradural pressure, extradural pressure waves.

## Introduction

In cattle, surgery is often performed in the standing animal to avoid side effects linked to general anaesthesia and recumbency. Various surgical and obstetric procedures are routinely performed following extradural application of a local anaesthetic drug (Thurmon et al. 1996). Correct needle placement is required to obtain sufficient analgesia and anaesthesia needed to perform surgery without a pain response and for safe conditions for the veterinarian. Correct positioning of the needle has been emphasized in experimental studies dealing with the effectiveness of extradurally administered drugs (Lee et al. 2004; Lee & Yamada 2005).

Different methods to confirm the correct placement of the needle in the extradural space have been described. The 'loss of resistance-method' and the 'hanging drop' technique (Thurmon et al. 1996) based on the premise of a negative extradural pressure (Lee et al. 2001) are commonly used. Another method which relies on the detection of extradural pressure waves has been considered effective in humans and dogs (Ghia et al. 2001; Iff et al. 2007).

The purpose of the present study was to demonstrate changes in pressure during puncture of the caudal extradural space and to record extradural pressure waves and determine their usefulness in the identification of the extradural space in cattle. Additionally, it was hypothesized that extradural pressure increases after injection of a local anaesthetic.

## Materials and methods

In this experimental study, 12 adult cattle of different breeds (including Brown Swiss, Simmental, Blonde d'Aquitaine) were used. The study procedure was approved by the institutional ethics committee and had governmental approval. The animals were judged to be healthy and free of neurological disease based on physical examination and routine blood analysis. One cow was excluded because of hypersensitivity in the tail region, when extradural puncture was attempted. All of the animals were weighed and assigned a body condition score (BCS) (Ferguson et al. 1994). The animals had free access to food and water until they were placed in stocks. After surgical preparation a branch of the caudal auricular artery was cannulated with a 20 gauge catheter to display the arterial pressure waveform. The transducer for the measurement of arterial pressure was placed at the level of the point of the shoulder. An apex base electrocardiogram (ECG), the arterial pressure waveform and extradural pressure profile were displayed with a Datex S5 Monitor (Datex Ohmeda, Duisburg, Germany) and recorded on a laptop computer with S5 Data Collect (Datex Ohmeda, Duisburg, Germany) every 5 seconds for the duration of the procedure.

All the animals were sedated with xylazine, 0.05 mg $kg^{-1}$ (Xylapam; Vétoquinol, Vienna, Austria) by intravenous injection through a catheter in the contralateral ear. The head and neck were positioned by a handler, keeping the zygomatic bone approximately at the level of the withers. Extradural puncture was performed in the caudal extradural space after aseptic preparation and skin infiltration with procaine hydrochloride (Procainhydrochloride 2%; VMD nv/sa, Arendonk, Belgium). Extradural puncture was performed by the same person. The tail was moved up and down to identify the movement between the first and second coccygeal vertebrae. Needle insertion was performed at the first coccygeal interspace after a stab incision with a scalpel blade. An 18 gauge Tuohy needle (PortexTuohy; Smithmedical, Vienna, Austria) was introduced with the needle bevel directed cranially at an angle of approximately 60° to the skin surface. To measure the extradural pressure, the Tuohy needle was connected to a pressure transducer (Combitrans Monitoring-set arteriell; Braun, Melsungen, Germany) via a nondistensible pressure line and the pressures were displayed on a screen. The transducer was placed at the height of the base of the tail. Both electronic pressure transducers were calibrated before each measurement period using an aneroid sphygmomanometer (Bosch und Sohn; Jungingen, Germany). Pressure measurements were recorded during the penetration of the different tissue layers before entering the extradural space. The presence of a 'pop' felt by the anaesthetist when the needle penetrated the interarcuate ligament was recorded as well as the length of needle insertion. Following extradural puncture an equilibration period of 3 minutes was allowed before measuring baseline pressure.

Lack of resistance (LOR) to injection of a standardized volume of 0.006 mL $kg^{-1}$ of sterile 0.9% saline (resulting in a total volume from 1.8 to 5 mL per animal) through a-three-way stopcock was assessed using a Portex LORD syringe (PortexLORD; Smith medical,Vienna, Austria). The LOR test was scored 'present' when injection of saline was easy and scored 'absent' when resistance was encountered. Following the LOR test the pressure was recorded for 1 minute before extradural injection. For extradural anaesthesia 0.02 mL $kg^{-1}$ procaine hydrochloride was used. The local anaesthetic was injected into the extradural space using a syringe pump (Graseby 3400; SIMS Graseby, Watford, UK) with a speed of 0.1 mL $second^{-1}$. The drug delivery line of the syringe pump and the pressure-measuring line were connected via a three-way stopcock to

  