

Title: EPIDURAL ANESTHESIA AND EXTRACORPOREAL SHOCK WAVE LITHOTRIPSY: PATHOLOGIC EFFECTS ON THE EPIDURAL SPACE

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**Introduction.** A recent clinical report described an increased incidence of epidural anesthesia failures following the combination of continuous lumbar anesthesia (CLEA) and multiple extracorporeal shockwave lithotripsy (ESWL) treatments.<sup>1</sup> Findings included: incomplete anesthesia with limited cephalad spread, pain upon injection of local anesthetic, aspiration of unusually blood-tinged local anesthetic, and decreased compliance of the epidural space.<sup>1</sup> Repeated epidural administration of local anesthetics in an animal model has been shown to result in no pathologic changes of the epidural space.<sup>2</sup> These findings suggest that the clinical evidence of epidural pathology observed in patients undergoing repeated CLEA for ESWL may be due to the lithotripsy shock wave itself or the combination of ESWL with CLEA. The purpose of this study was to determine if repeated ESWL or the repeated combination of ESWL and CLEA cause pathologic changes of the epidural space in an animal model.

**Methods.** Seven female "Western" sheep (weight 40-60 kg) were randomly assigned to one of two groups. Group A animals (N=3) underwent general anesthesia (GA) for repeated ESWL. Group B (N=4) additionally received CLEA after introduction of GA but prior to ESWL treatments. GA was induced with 0.22 mg/kg xylazine IM and 10 mg/kg ketamine IV, and maintained with isoflurane following tracheal intubation. The common carotid artery was cannulated percutaneously, and blood pressure was continually monitored, as was EKG. An intravenous infusion of lactated Ringer's solution was administered continuously. The epidural space was identified at the L<sub>4-5</sub> interspace with a 17g Tuohy needle utilizing standard loss of resistance technique. A test dose of 3 ml of 1.5% lidocaine with 1/200,000 epinephrine was injected followed by the administration of 15 ml of the same solution and 2 ml of air. A 19g nylon epidural catheter was then introduced 3 cm into the epidural space and taped in place. Successful CLEA was verified by decreased motor tone in the hind limbs. Lithotripsy was performed in a Dornier HM-3 lithotripter; 3000 shock waves (18-26 KV) were administered to each kidney after localization with biplanar fluoroscopy. The entire protocol was repeated on four successive days to simulate the treatment of large bilateral renal calculi in humans. The animals received neurologic examinations prior to each treatment. CT scan of the vertebral column at L<sub>2</sub> and L<sub>4</sub> was performed following the last ESWL and again after 30 days. The animals were then sacrificed and underwent postmortem examination. The vertebral column was dissected and fixed in 10% formalin for 14 days. L<sub>2</sub> and L<sub>4</sub> spinal sections were then frozen, decalcified using a formic acid, sodium nitrate solution, embedded in paraffin, and sectioned. Sections were stained with hematoxylin and eosin, Brown-Hopps tissue gram stain, Luxol fast blue stain for myelin, and hematoxylin Van Gieson

stain for connective tissue and bone. Spinal histologic evaluation was performed by a neuropathologist blinded to the treatment groups.

**Results.** All four Group B (CLEA) animals exhibited sensory and motor block during each CLEA. Decreased compliance of the epidural space and return of bloody local anesthetic was noted during repeat CLEA's in all animals. Pathologic evaluation of two animals is pending.

Gross Pathology demonstrated contusions of: lung (2 animals), bowel (1), posterior chest wall and adjacent heart (1). All five animals examined had widespread contusions of psoas, paraspinous, and flank muscles.

Histopathology of cross sections of the spinal canal revealed: Group A (GA) - The two animals in this group were entirely normal. Group B (CLEA) - Marked inflammation of the epidural and subdural spaces with fibrous adhesions was noted in one animal; a normal epidural space, but lateral spinal cord edema and ventral root demyelination in another (this animal developed a transient hind limb paresis following ESWL #3.); the third was normal. CT Scan - The Group B animal noted to have histologic spinal cord edema and demyelination showed marked edema of the spinal cord in the 30-day follow-up scan not present on the initial study.

**Discussion.** Our findings demonstrate that significant pathology of the epidural space, meninges, and spinal cord do occur when CLEA is utilized for ESWL. Two animals in the CLEA group developed pathologic changes which would explain the problems observed in humans undergoing repeated CLEA for ESWL.<sup>1</sup> The GA animals, in contrast, did not, suggesting that ESWL by itself may not cause spinal damage. Air-containing organs (lung and bowel) appear particularly prone to damage from the lithotripter shock wave.<sup>3</sup> Air injected into the epidural space may predispose this area to injury as well. Additionally, the epidural catheter, like air, provides an acoustic transmission interface which may result in energy release to the surrounding tissues, causing injury. Our study also demonstrates that myocardial contusion may result from ESWL, a complication not previously reported.

Further study is needed to determine if CLEA without the placement of air or catheter in the epidural space is associated with spinal damage from ESWL.

#### References.

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