




Placement of thoracic epidural via a lumbar approach using a round J-tipped, partially styletted catheter in porcine model

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To the Editor,

Direct thoracic epidural placement can be challenging and risks severe spinal cord injury compared with a lumbar epidural placement.¹ In an animal model, we previously explored the possibility of placing a thoracic epidural from lumbar entry using a fully styletted straight-tip catheter and showed that this technique is associated with significant spinal cord damage.² We hypothesized that the sharpness of the straight tip may be the primary cause for this damage. Thus, we conducted a proof-of-concept study in a porcine model to investigate whether epidural catheter with round tip (i.e., J-shaped) with and without a stylet can be advanced to the thoracic spine from lumbar entry without spinal cord damage.¹

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We received approval from the University of Saskatchewan Animal Research Ethics Board (AUP 20180083; January 2019) and the study protocol adhered to ARRIVE 2.0 guidelines.³ Six pigs were used in the study (numbered 1 to 6). The prototype of a round J-tipped catheter with and without partial stylet was constructed (Electronic Supplementary Material [ESM] eFig. 1). The adjustable stylet from a 20G epidural catheter set (PAJUNK® 521156-35C Kit, Dyna Medical Corp, ON, Canada) was used with a 20G self-coiled catheter from a peripheral catheter set (PAJUNK Kit 52188-34C with Curl, Dyna Medical Corp, ON, Canada).

Animals were first anesthetized. An epidural needle was inserted into the L4–L5 interspace with loss-of-resistance technique into epidural space. The location of the needle tip was confirmed by fluoroscopy. An unstyletted or partially styletted (sparing the distal 3.5 cm) round J-tipped epidural catheter was inserted through the epidural needle to the epidural space. An attempt was made to advance the catheter until it reached the predetermined sixth thoracic spinous process with fluoroscopic guidance. Animals were euthanized at the end of the experiment. Necropsy was then performed by a veterinary pathologist.

In all pigs, attempts to advance an unstyletted round J-tipped epidural catheter resulted in catheter coiling within the lumbar space (ESM eFig. 2). No styletted catheter was advanced in pigs 1 and 2 (Table). Catheters were only able to accurately advance to the targeted thoracic space in pigs 3–6 when a partially styletted round J-tipped catheter was used (ESM eFig. 3). While no subarachnoid catheter placement was noted, local epidural hemorrhage at the point of entry of catheter was observed in all pigs ($n = 6$). Lumbar spinal cord damage was noted in pig 1, likely secondary to inadvertent needle trauma. Unrelated cervical

Table Summary of attempts and their results after successful placement of the epidural needle tip in the epidural space. Procedure failure or success defined as whether the epidural catheter was able to reach the target thoracic spinal level

Pig	Outcomes			
	Procedure failure		Procedure success	
	Unstyletted catheter	Styletted catheter	Styletted catheter	Spinal cord damage
1	Yes (7/7)*	Not attempted	Not attempted	Yes
2	Yes (5/5)*	Not attempted	Not attempted	No
3	Yes (1/1) *	Yes (1/2) *	Yes (1/2)*	No
4	Yes (1/1)*	No	Yes (1/1)*	No
5	Yes (1/1)*	No	Yes (1/1)*	No
6	Yes (1/1)*	No	Yes (1/1)*	No

*(procedural outcome/attempts)

subdural bleeding (the epidural catheter did not reach the cervical spine in any animal) was noted in two pigs (ESM eFig. 4).

The findings suggested that partially styletted, round J-tipped catheters can insert into the epidural space and be advanced with ease (within two attempts) to a desired thoracic level; however, it was not possible using an unstyletted round J-tipped catheter.

The macroscopic and microscopic examination of all the pigs' spines revealed epidural hemorrhage near the entry point of the catheter. Necrohaemorrhagic cavitation of the spinal cord and hemorrhage in the lumbosacral spinal cord were present in pig 1, likely secondary from direct needle trauma from multiple attempts to reach the epidural space with the unstyletted epidural catheter.

This study shows the proof of concept of advancing a round J-tipped, partially styletted epidural catheter to the thoracic epidural space from lumbar entry. With the J-tipped, partially styletted catheter, no pathological changes were directly attributed to epidural catheter placement and advancement on macroscopic and microscopic examination of the spinal cord and subdural space. The lumbar spinal cord damage in pig 1 seems unlikely in humans as the caudal termination of the human spinal cord is cranial to a lumbar needle insertion site, whereas the porcine spinal cord extends to the sacral spine.⁴ Further investigation is needed before human application.

Disclosures Dr. Ban Tsui has contributed in part to the future design of the J-tipped Pajunk-styletted epidural catheter. No other

author has any commercial or other affiliations that are or may be perceived to be a conflict of interest.

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