Can J Anesth/J Can Anesth (2022) 69:1182–1184
https://doi.org/10.1007/s12630-022-02269-2

CORRESPONDENCE

A simulated model investigation of dry tap associated with needle-through-needle technique in combined spinal epidurals

Cody Tran, BSc · Kristina Kim, MD, HBSc · Daniel Cordovani, MD, MSc

Received: 10 November 2021 / Revised: 3 April 2022 / Accepted: 11 April 2022 / Published online: 18 May 2022

Keywords combined spinal epidural (CSE) · dry tap · needle-through-needle · neuraxial anesthesia · obstetrical anesthesia

To the Editor,

Combined spinal epidurals (CSEs) are common in anesthesia practice.[1] In reports and in our experience, CSEs using a spinal-needle-through-epidural-needle technique can result in a "dry tap," where presumed advancement of a spinal needle into the intrathecal space does not yield cerebral spinal fluid (CSF) flow. Confirmation of intrathecal needle placement happens, instead, by adequate analgesia after local anesthetic injection.[2]

Many commercially available CSE kits include a double-orifice Tuohy needle. The spinal needle orifice is in the center of the barrel to reduce deflection, while the catheter orifice is cephalad. We hypothesized that spinal needle deflection caused by incorrect passage through the orifice intended for epidural catheter exit may increase resistance to CSF flow, thereby increasing the incidence of dry tap (Figure). We created a simulated model of the lumbar spine and used commercially available CSE kits with dual-orifice Tuohy needles to test this hypothesis.

Our primary outcome was the incidence of dry tap, defined as no visible water (i.e., simulated CSF) at the spinal needle hub after one minute of inserting the spinal needle into our model. We assessed the incidence of dry tap in four kits under four conditions: 50 correct and 50 incorrect exits of the spinal needle at both a CSF pressure of 13 cm H_2O and at 6 cm H_2O (average and lower limit of normal CSF pressures, respectively).[3,4] Our model replicated these CSF pressures, and silicone was used to create a watertight seal at the point of spinal needle insertion (Figure). Consequently, water flowed only through the spinal needle. We assessed the presence of significant differences in dry tap incidence among all four kits with the use of Chi-square analysis.

The secondary outcome was the incidence of incorrect exits of the spinal needle through the Tuohy bevel, which we labeled as "kit failure." The spinal needle was inserted into the Tuohy needle 500 times in each of the four CSE kits (total n = 2,000).

Detailed results are presented in the Table. Across all kits and in both pressure conditions, incorrect spinal needle exits resulted in a higher incidence of dry tap than correct needle exits did (18% *vs* 4%; $P < 0.001$). Furthermore, insertions at 6 cm H_2O resulted in a higher incidence of dry tap than 13 cm H_2O did (15% *vs* 7%, $P < 0.001$). The overall incidence of incorrect spinal needle exits through the Tuohy bevel was 13%.

Our findings using a simulated model support the hypothesis that the deflection in the spinal needle due to its incorrect exit through the Tuohy bevel increases resistance to CSF flow, thereby contributing to dry tap. Additionally, even when dry tap did not occur, it took

C. Tran, BSc (✉)
Michael G. DeGroote School of Medicine, McMaster University, Hamilton, ON, Canada
e-mail: cody.tran@medportal.ca

K. Kim, MD, HBSc · D. Cordovani, MD, MSc
Michael G. DeGroote School of Medicine, McMaster University, Hamilton, ON, Canada

Department of Anesthesia, McMaster University, Hamilton, ON, Canada

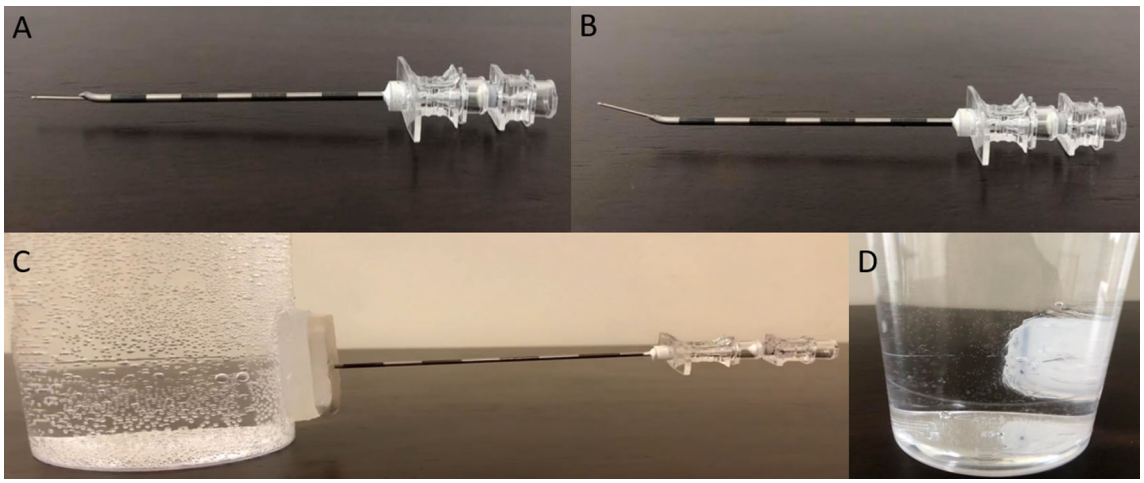

Figure (A) Correct exit of spinal needle through spinal orifice. (B) Incorrect exit of spinal needle through Tuohy bevel. (C) Insertion of spinal needle into model. (D) Spinal needle within model.

Table Dry tap incidence at 13 cm H2O and 6 cm H2O during correct and incorrect spinal needle exits and overall CSE kit failure rate

Outcome	Dry tap incidence						Failure rate[a]
	Low pressure condition 6 cm H_2O			High pressure condition 13 cm H_2O			
	Correct exits, *n*/total *N* (%)[b]	Incorrect exits, *n*/total *N* (%)[b]	*P* value[c]	Correct exits, *n*/total *N* (%)[b]	Incorrect exits, *n*/total *N* (%)[b]	*P* value[c]	
Kit 1[d]	4/50 (8%)	23/50 (46%)	< 0.001	3/50 (6%)	8/50 (16%)	0.11	76/500 (15%)
Kit 2[e]	0/50 (0%)	10/50 (20%)	< 0.001	1/50 (2%)	9/50 (18%)	0.01	34/500 (7%)
Kit 3[f]	6/50 (12%)	11/50 (22%)	0.18	0/50 (0%)	5/50 (10%)	0.02	29/500 (6%)
Kit 4[g]	2/50 (4%)	5/50 (10%)	0.24	0/50 (0%)	1/50 (2%)	0.32	121/500 (24%)
Total	12/200 (6%)	49/200 (24.5%)	< 0.001	4/200 (2%)	23/200 (12%)	< 0.001	260/2000 (13%)

[a] 500 exit attempts were performed in total for each CSE kit; CSE kit failure was defined as spinal needle exit through the curved catheter orifice

[b] 50 spinal needle insertions into simulated intrathecal space were performed with the correct spinal needle exit and the incorrect spinal needle exit

[c] Chi-square test comparing correct spinal needle exit and incorrect spinal needle exits at 13 and 6 cm H_2O, yielding $P < 0.001$ in both pressure conditions

[d] Epsocan™ Tuohy epidural needle – 18G × 3.5 inch (8.9 cm) with Pencan® spinal needle – 27G × 5 inch (12.7 cm), B. Braun Medical Inc., Bethlehem PA, USA

[e] Epsocan™ (ES1725) Tuohy epidural needle – 17G × 3.5 inch (8.9 cm) with Pencan® spinal needle – 25G × 5 inch (12.7 cm), B. Braun Medical Inc., Bethlehem PA, USA

[f] Epsocan™ (ES1727L) Tuohy epidural needle – 17G × 4.5 inch (11.4 cm) with Pencan® spinal needle – 27G × 6 inch (15.2 cm), B. Braun Medical Inc., Bethlehem PA, USA

[g] Avanos™ Tuohy epidural needle – 17G × 3.15 inch (8.0 cm) with Whitacre point spinal needle – 26G × 4.5 inch (11.4 cm), Avanos Medical Inc., Alpharetta GA, USA

CSE = combined spinal epidural

longer for the first drop of water to fall from the spinal needle hub. At 6 cm H_2O, mean time to first drip was significantly greater during incorrect exits than during correct exits for all kits tested [mean (standard deviation) time: 216 (62) sec *vs* 167 (54) sec; $P < 0.001$]. Nevertheless, at 13 cm H_2O, there was no significant difference in mean time to first drip. It is also revealing that the incidence of kit failure was high, albeit with varied incidence among the different kits. This could be due to varying gauge and length of the spinal needles.

Caution is warranted when trying to extrapolate these findings to *in vivo* situations. Limitations in our study include the multiuse nature of both the model and the CSE kits. These repetitions may have led to equipment

wear, while in clinical practice a CSE kit is often used once.

Furthermore, other factors that contribute to dry tap, such as patient positioning and needle insertion point were not tested.[5]

Disclosures None.

Funding statement The authors have no sources of funding to declare for this manuscript.

Editorial responsibility This submission was handled by Dr. Stephan K. W. Schwarz, Editor-in-Chief, *Canadian Journal of Anesthesia/Journal canadien d'anesthésie.*

References

1. *Blanshard HJ, Cook TM*. Use of combined spinal-epidural by obstetric anaesthetists. Anaesthesia 2004; 59: 922–3; https://doi.org/10.1111/j.1365-2044.2004.03918.x
2. *Doo AR, Shin YS, Choi JW, Yoo S, Kang S, Son JS*. Failed dural puncture during needle-through-needle combined spinal–epidural anesthesia: a case series. J Pain Res 2019; 12: 1615–19; https://doi.org/10.2147/jpr.s178640
3. *Lee SC, Lueck CJ*. Cerebrospinal fluid pressure in adults. J Neuroophthalmol 2014; 34: 278–83; https://doi.org/10.1097/wno.0000000000000155
4. *Butterworth JF IV, Mackey DC, Wasnick JD*. Morgan & Mikhail's Clinical Anesthesiology, 6th ed. New York: McGraw-Hill Education; 2018.
5. *Fettes PD, Jansson JR, Wildsmith JA*. Failed spinal anaesthesia: mechanisms, management, and prevention. Br J Anaesth 2009; 102: 739–48; https://doi.org/10.1093/bja/aep096