Comparing Epidural Wave Form Analysis to Fluoroscopic Guidance for Thoracic Epidural Access

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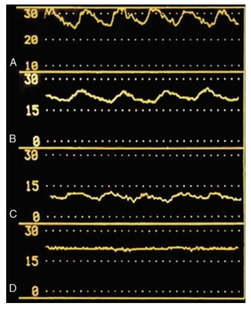
INTRODUCTION

Thoracic epidural catheters are an important component of anesthetic management.



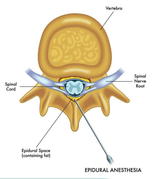
Epidural waveforms. A) Strong. B) Moderate. C) Weak. D) Absent[1]

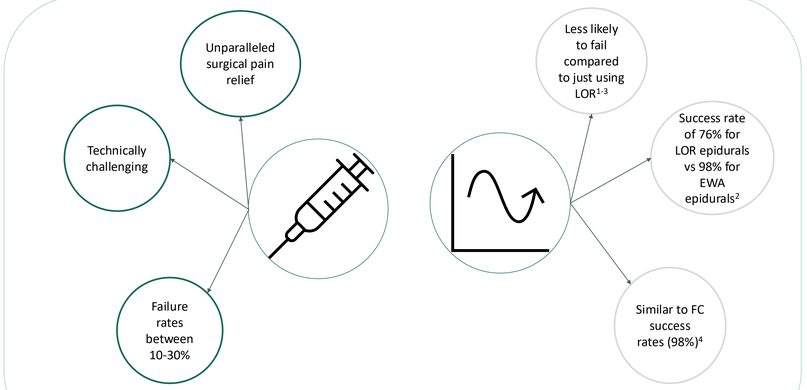
Study Objectives

1) To assess the accuracy with which epidural waveform analysis (EWA) can confirm epidural access in comparison to the gold standard of fluoroscopic confirmation (FC)
2) To assess resident physician (trainee) comfort with using EWA to place thoracic epidurals
3) Collect data to refine EWA analysis methods

Hypothesis

The accuracy of FC is superior to EWA as determined by the Positive Predictive Value and Negative Predictive Value of EWA referenced to FC.





Thoracic Epidural Catheters | **EWA-Guided Thoracic Epidurals**

Thoracic Epidural Placement

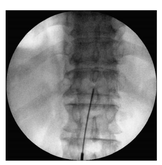
Loss of Resistance (LOR)

A needle, usually a 17-18 gauge Touhy needle is connected to a syringe filled with saline, and advanced until it reaches the epidural space.

Resistance decreases and saline can be pushed through.

Catheter is is advanced through the Touhy needle into the epidural space

Fluoroscopy* confirms the placement, since LOR false positives are common

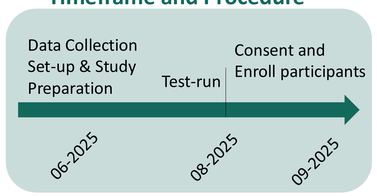


Touhy needle in epidural space viewed by Fluoroscopy[5]

*DHMC is unique as the Anesthesiology department performs a vast number of FC thoracic epidurals yearly, making it one of the few (if not only) places in the country where EWA and FC can be directly compared.

METHODS

Timeframe and Procedure



1) Measure waveform as needle is placed in epidural space
2) Identify waveform as "present", "absent", or "indeterminate"
3) FC confirmation
4) Measure waveform as catheter is placed; Repeat steps 2-3
5) Likert scale survey to assess comfort and confidence using EWA

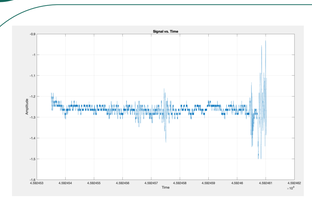
Study Parameters

- 160 participants
- Data collection with Philips M1006B Invasive Pressure Module and NI-DAQ + LabVIEW
- Saline-filled tubing connected to Touhy needle with fluid flushing mechanism (500 mL bag of saline)

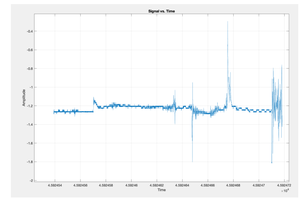
Fluid flushing and transducer system to prevent back-filling and eliminate air bubble interference

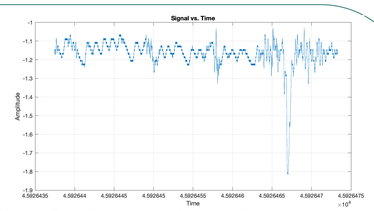
Philips IntelliVue Operating Room monitor depicting waveforms

PRELIMINARY RESULTS

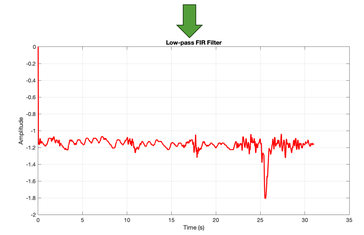


Raw, unfiltered waveforms during Touhy needle placement (above) vs catheter placement (below) for Patient 4 of the clinical study





Patient 5 unfiltered waveform during catheter placement



Patient 5 waveform during catheter placement with FIR (Finite Impulse Response) low-pass filter generated in MATLAB for high-frequency EWA (fs=1000, fc = 20)

DISCUSSION

Waveforms can be captured and displayed in thoracic epidural placements and used to assess access to the epidural space.

- Optimization of the data collection process is important to promote efficiency and reduce interference in clinical management
- It was found that waveform data can be reliably collected with a data acquisition unit connected to a pressure module
- Filters can be applied to acquired data to "smooth" the waveform and allow for analysis
- EWA waveforms from the Touhy needle may have different characteristics than through the catheter due to changes in flow and pressure between the two vessels

Future Directions

- Determine Positive Predictive Value and Negative Predictive Value of EWA referenced to FC
- Analyze waveform data looking for patterns and varying amplitudes
- If EWA performs reasonably well compared to FC, then EWA could be used in settings where there is no access to FC or limited expertise with FC
- Follow up study examining EWA confirmation in obstetric epidural placements

CONCLUSIONS

EWA offers a low budget, easily accessible option for epidural access confirmation that may be comparable to the gold standard of FC. EWA accuracy is testable in a clinical environment with minimal risk and no interference on patient care or outcomes.

References

[1]Leurcharusmee, P., Arnuntasupakul, V., De La Garza, D. C., Vijitpavan, A., Ah-Kye, S., Saelao, A., ... & Tran, D. Q. (2015). *Reliability of waveform analysis as an adjunct to loss of resistance for thoracic epidural blocks*. Regional Anesthesia & Pain Medicine, 40(6), 694-697.

[2]Arnuntasupakul, V., Van Zundert, T. C., Vijitpavan, A., Aliste, J., Engsusophon, P., Leurcharusmee, P., ... & Tran, D. Q. (2016). *A randomized comparison between conventional and waveform-confirmed loss of resistance for thoracic epidural blocks*. Regional Anesthesia & Pain Medicine, 41(3), 368-373.

[3]McKendry, R. A., & Muchatuta, N. A. (2018). *Pressure waveforms to assess epidural placement: is there a role on delivery suite?*. Obstetric Anesthesia Digest, 38(2), 87.

[4]Parra, M. C., Washburn, K., Brown, J. R., Beach, M. L., Yeager, M. P., Barr, P., ... & Loftus, R. W. (2017). *Fluoroscopic guidance increases the incidence of thoracic epidural catheter placement within the epidural space: a randomized trial*. Regional Anesthesia & Pain Medicine, 42(1), 17-24.

[5]Hong, Ji & Cho, Eun & Shim, Jin & Park, Ki. (2022). *Comparison of postoperative back pain between paramedian and midline approach for thoracic epidural anesthesia*. Anesthesia and Pain Medicine. 17. 320-326. 10.17085/apm.22139.

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