

## Abstract

### Introduction

Significant progress has been made in the use, efficacy, and safety of anesthesia. However, clinical tools are not currently available to monitor and objectively evaluate the effectiveness of local anesthetics in patients. As part of ongoing research (piglet, children, adults), in this study we sought to measure the onset and density of a single nerve block in awake adults. We compared the measured differences between blocked and non-blocked ulnar nerves in awake adults using a novel technology.

### Methods

This is a prospective, open treatment, self-controlled study of healthy adult volunteers receiving an ulnar nerve block while awake. Surface sensor (EKG) pads were placed on bilateral hypothenar eminences. Subjects then received a unilateral ulnar nerve block via ultrasound guidance with 1-3ml of 2% lidocaine. Using a specially configured Nihon Kohden MEB-2300 monitor, EMG signals were acquired at bilateral hypothenar eminences just prior to the nerve block (baseline) and continuously for 90 minutes following administration of the block. Pinprick sensation was also assessed at designated time intervals.

We measured changes in power (dB) in the 100-150Hz frequency band via surface electromyogram over time. Baseline signal and time to onset of block were compared to the contralateral hypothenar eminence in the same subject at baseline, 8 and 20 minutes after injection of lidocaine. Data was analyzed using one-way ANOVA ( $\alpha < 0.05$ ).

### Results

In this pilot study, three adults (3F, 26-51 yrs) have participated to date. Baseline signal was defined as 100% in each side. Following unilateral ulnar block, discrete differences in signal were easily distinguished at 8 and 20 minutes on the blocked side (ANOVA,  $p = 0.02$ ) but not the control ( $p = 0.14$ ) indicating rapid onset of an effective block consistent with pin-prick. Time to onset (baseline to maximal depression of signal) was  $180 \pm 39$  seconds (mean  $\pm$  SEM).

### Discussion

The ability to collect and interpret data to characterize the effect of local anesthetics on peripheral nerve blockade would enable clinicians to limit toxicity, improve/optimize dosing regimens for analgesic need, manage uncooperative patients (psychological impairment, pediatric patients with developmental delay, communication barriers), and better refine intra- and postoperative placement of nerve blocks and subsequent management.

### Conclusion

Objective measurement of local anesthetic effect is feasible, permitting discrete assessment of the onset and density of a single nerve block in awake adults.

## Introduction

- Although progress has been made in the use, efficacy, and safety of local anesthetics and regional anesthesia, tools are not available to objectively monitor/evaluate block effectiveness.
- We studied a technology that measures and reports the effects of local anesthetics and report proof of principle in awake adults using a new monitor that objectively measures and reports the effect of peripheral nerve blockade
- We measured changes over time in surface electromyogram (EMG) associated with administration of local anesthetic around the ulnar nerve and on the control side
- We then analyzed various time periods for the derivation of the optimal EMG<sub>PASSBAND</sub>

## Methods & Procedures

- ✓ IRB approval- consent of prospective, open treatment, self-control study
- ✓ Healthy adult volunteers
- ✓ **Unilateral ulnar nerve block via ultrasound guidance with 1-3ml of 2% lidocaine**
- ✓ **Surface EMG** was recorded at bilateral hypothenar eminences just prior to nerve block (**baseline**) and **after injection** of local anesthetic continuously for 90 minutes
- ✓ Pinprick sensation was assessed at designated intervals
- ✓ Measured changes in the EMG signal level as the average power (dB) in the 100-150Hz frequency band (EMG<sub>PASSBAND</sub>) via surface electromyogram over time
- ✓ Baseline signal and time to onset of block were compared to the contralateral hypothenar eminence in the same subject at baseline, 8 and 20 minutes after injection of lidocaine

## Technology

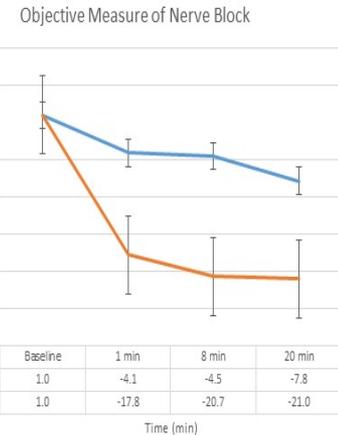
Local anesthetic effect will be seen as a change in the baseline non-stimulated surface electromyogram.



## Results

### Subject Characteristics

Block	Subjects	Gender	Age (years)
Ulnar	1	Female	26
Ulnar	1	Female	31
Ulnar	3	Female	51



## Discussion

Compared to baseline, recognizable decreases in non-stimulated EMG<sub>PASSBAND</sub> were present in all subjects upon administration of local anesthetic to the ulnar nerve but not on the control side indicating rapid onset of an effective block confirmed by loss of sensation to pinprick.

The ability to collect and interpret data to characterize the effect of local anesthetics on peripheral nerve blockade would enable clinicians to limit toxicity, improve/optimize dosing regimens for analgesic need (both in location and quality), manage uncooperative patients (adult asleep, adult uncooperative [psychological or defiant], pediatric uncooperative [developmental or communication barrier], pediatric asleep), and better refine techniques (e.g., to improve discrimination between motor/sensory blockade [differential blockade]).

This study demonstrates not only the feasibility and promise of using passive surface EMG as an objective measure of the effectiveness of regional blockade, but is also begins to optimize the post-block analysis phase. Ultimately, post-block analysis will be able to discern both the location and density of the block, guiding the clinician in future treatment or medication administration.

## References

1. JGeorge, WI, Sternberger, J Gearhart, RS Greenberg, Objective Measure of Caudal Block: A Neural Blockade Monitor in Children. American Society of Anesthesiologists Scientific Poster Presentation, Chicago, October 2011 and Association of University Anesthesiologists May 2012 "Best Poster Recognition".
2. JA Lawrence-George, WI Sternberger, J Gearhart, RS Greenberg, Improving Signal Analysis Using a Novel Neural Blockade Monitor in Children; RMS Averaging Time. American Society of Anesthesiologists Scientific Poster Presentation, Washington, DC, October 2012.
3. JA George, WI Sternberger, RS Greenberg, Objective Measurement of Neural Blockade in Piglets. Society for Pediatric Anesthesia Poster Presentation, March 2015.
4. JA George, AR Padover, WI Sternberger, RS Greenberg, An Objective Measure of Neuraxial Block Onset and Offset, Association of University Anesthesiologists, May 2017.
5. RS Greenberg, J George, WI Sternberger, J Gearhart, H DiCarlo, T Vecchione, M Suleman, Objective Measure of Neural Blockade: From Concept to Bedside. Armstrong Institute Diagnostic Excellence Summit, Baltimore, MD, April 2018.