Intraoperative Changes in Somatosensory Evoked Potentials as a Predictor of Perioperative Stroke in Carotid Endarterectomy

Justin W. Meinert BPhil[1], Eyad E. Saca MD[2], Jeffrey R. Balzer PhD[2], Donald J. Crammond PhD[2], Parthasarathy D. Thirumala MD, MS[2]

[1]Drexel College of Medicine
[2]University of Pittsburgh Medical Center Center for Clinical Neurophysiology

INTRODUCTION

Perioperative stroke is a known but severe neurological complication that can occur after carotid endarterectomy (CEA). Intraoperative neurophysiological monitoring with somatosensory evoked potentials (SSEPs) is utilized to warn the surgical team of potential ischemic changes. Current alarm criteria are an amplitude decrease of at least 50% or a latency increase of 10% or more.

OBJECTIVES

To assess the usefulness of intraoperative changes in cortical SSEPs in predicting perioperative strokes during CEA.

METHODS

This was a retrospective cohort study identifying all perioperative strokes that occurred at UPMC between 2010-2015. We defined perioperative stroke as all new onset neurological deficits occurring within the hospital stay and up to 30 days following the procedure. We further classified into major and minor strokes based on the presence of life altering deficits. Baseline amplitudes and latencies of cortical SSEPs were measured at pre-incision, incision, heparin administration, and pre-clamp. Comparison time points were measured at consistent time intervals post-clamp and post-closure.

Figure #1: Classic example typical of SSEP

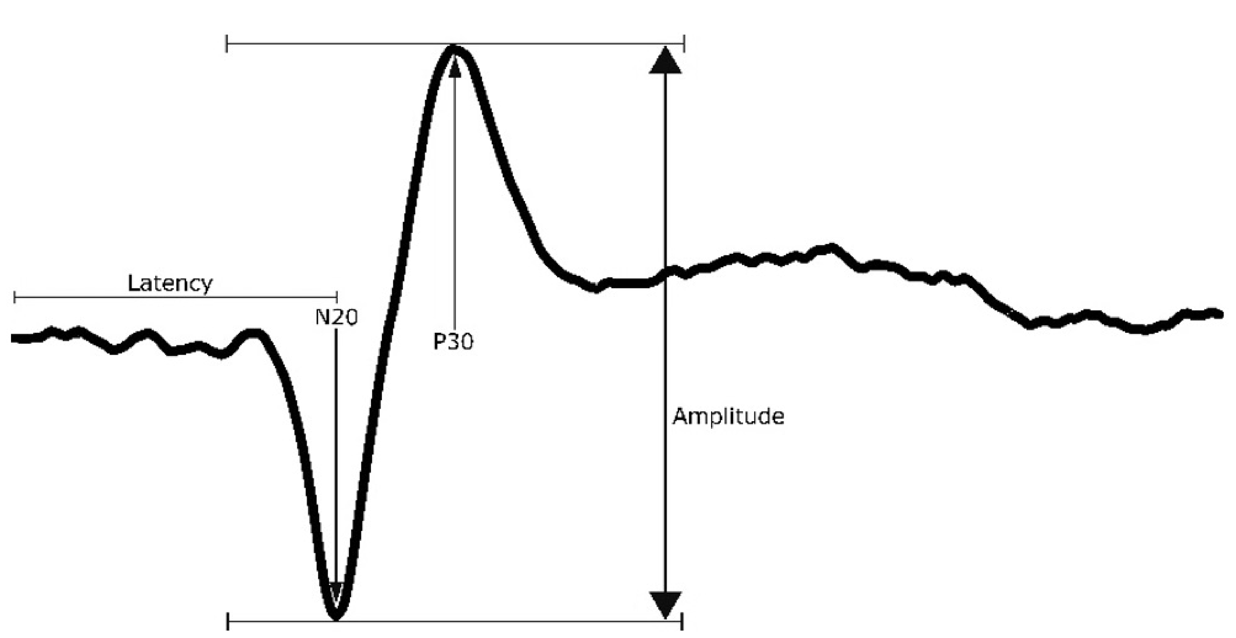


Figure #2: Receiver-Operator Characteristic curve analysis of % change from proposed amplitude and latency baselines

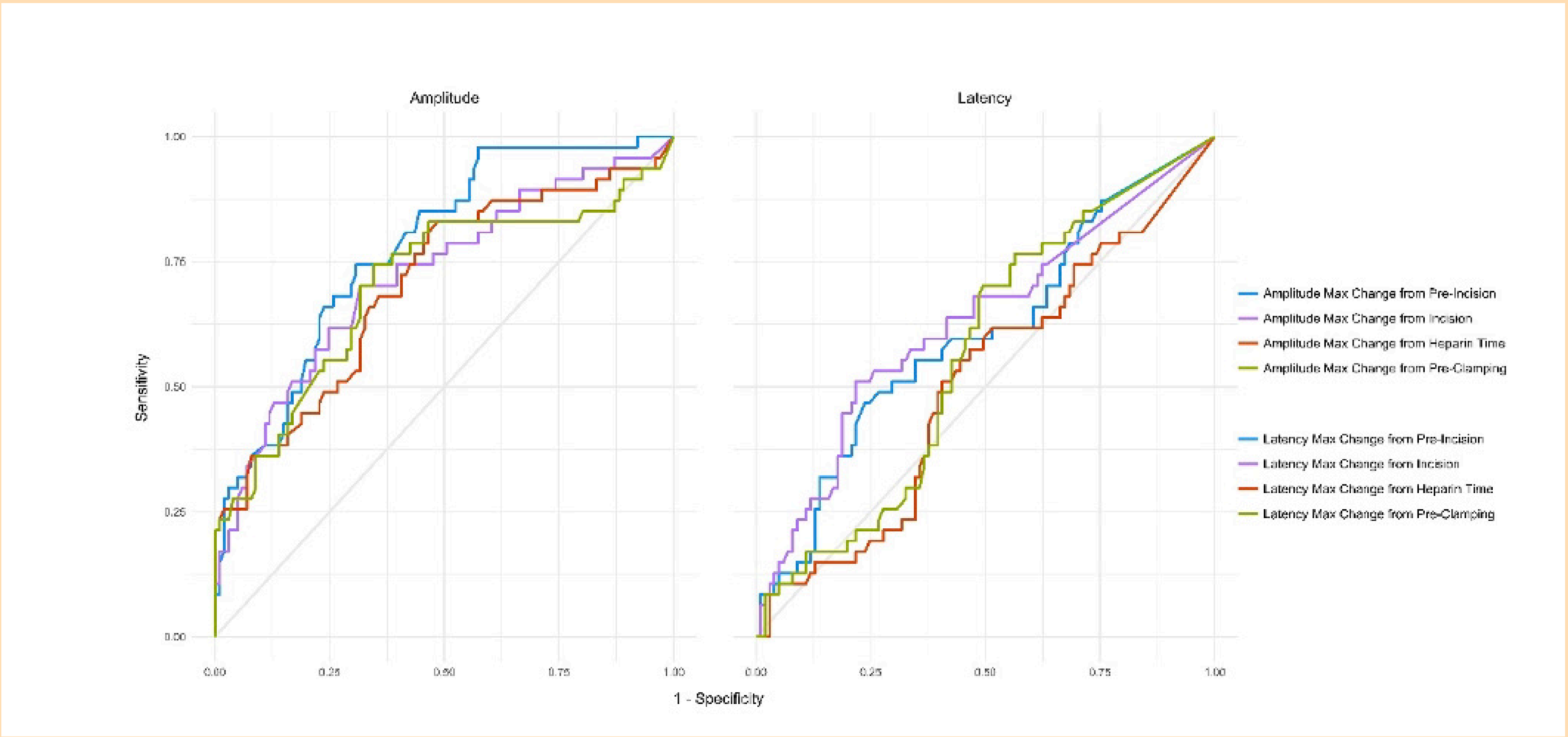


Table #1: Area under the curve, sensitivity and specificity of SSEPs in predicting stroke from each baseline

Significant Change Modality	Optimal Cutoff (%)	AUC	95% CI:	Sensitivity	Specificity
Major stroke amplitude changes as a predictor					
Pre-incision	55%	0.829	0.747-0.911	0.846	0.693
Incision	50%	0.804	0.698-0.911	0.846	0.683
Heparin	38%	0.744	0.621-0.866	0.731	0.663
Pre-clamp	38%	0.744	0.619-0.868	0.808	0.653
Major stroke latency changes as a predictor					
Pre-incision	3.9%	0.649	0.527-0.770	0.500	0.772
Incision	3.9%	0.591	0.460-0.721	0.462	0.782
Heparin	2.5%	0.523	0.396-0.650	0.577	0.554
Pre-clamp	2.1%	0.585	0.466-0.703	0.769	0.505

RESULTS

There was a significant difference in mean amplitude change between controls and strokes at all time points after pre-incision, not including the end of the surgery. Patients with perioperative strokes had a significant intraoperative decrease in amplitude from all four baselines. An amplitude decrease of 50% or more was predictive of all strokes and major strokes alone from all four baselines. Receiver-Operator Characteristic (ROC) curve analysis identified changes from the pre-incision timepoint as the most reliable baseline for predicting stroke with an optimal cutoff of 55%.

CONCLUSIONS

A representative pre-incision time point should be used as baseline during CEA. Latency changes were very specific but are virtually insensitive, and do not appear to be very useful. The current alarm criteria of 50% decrease predicts stroke meaning it is inadequate as an alarm. Further studies should look at an an appropriate alarm criteria to prevent stroke.

Figure #3: Density plots comparing mean % change from baseline in controls vs strokes

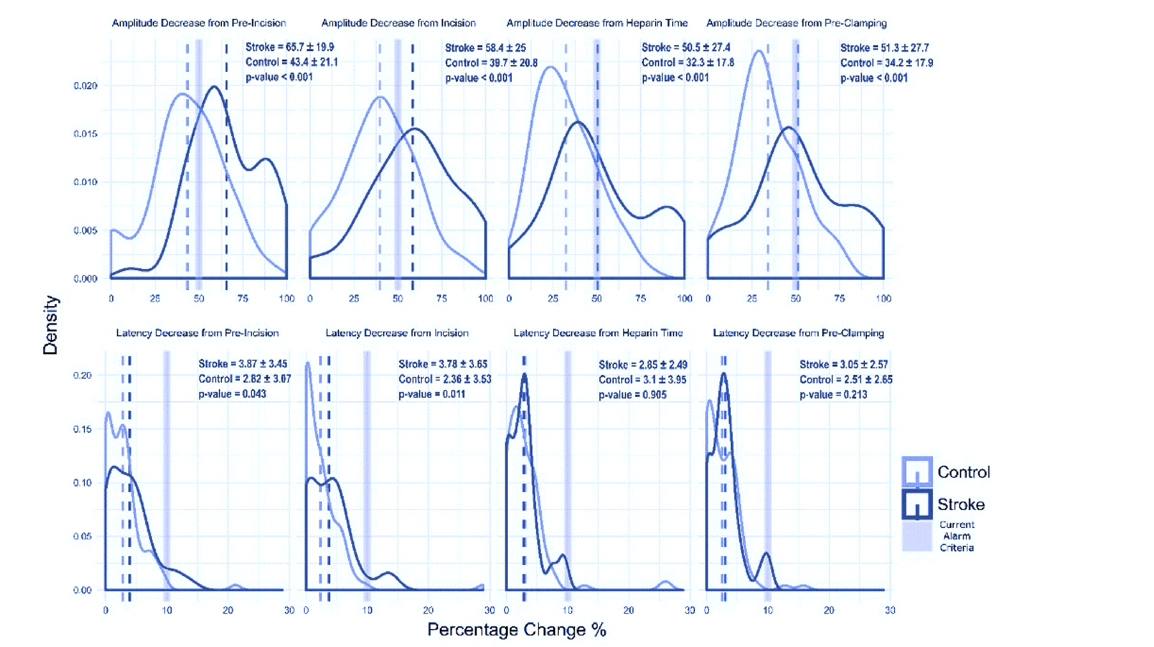
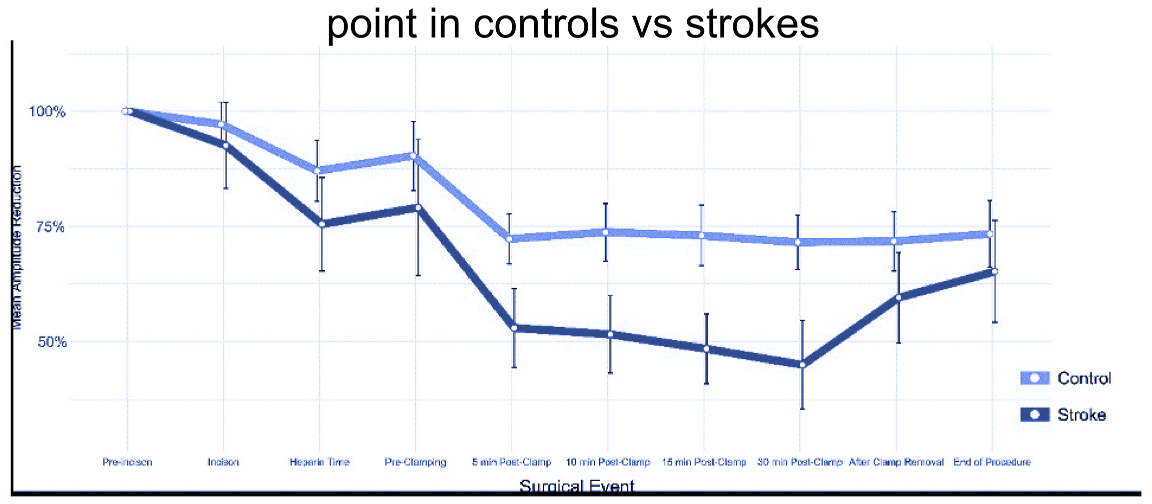


Figure #4: % change from baseline at each measured time point in controls vs strokes



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Presenter Contact Information:
Justin Meinert, MS4
Drexel College of Medicine
Phone: 724-814-1351
Email: jwm323@drexel.edu

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