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Novel Application of Quantitative Electromyography to Guide Botulinum Toxin Injection for Spasmodic Dysphonia

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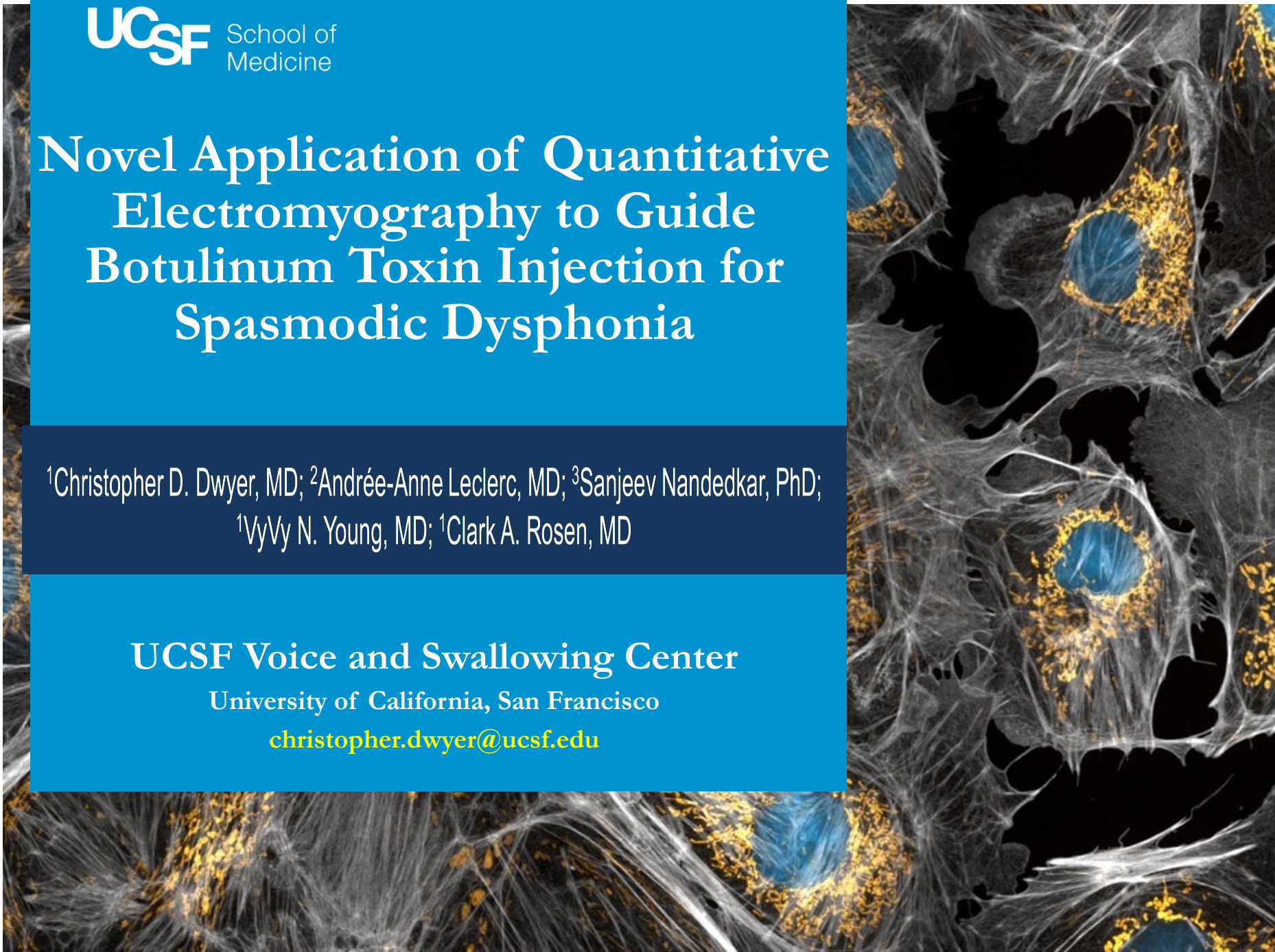


Background

- Botulinum Toxin A (BoNT-A) injection into the thyroarytenoid-lateral thyroarytenoid (TA-LCA) muscle complex is commonly performed using ***qualitative*** laryngeal electromyography (LEMG) for treatment of Adductor Spasmodic Dysphonia (AdSD)

- Anecdotally there is a learning curve before obtaining consistent results

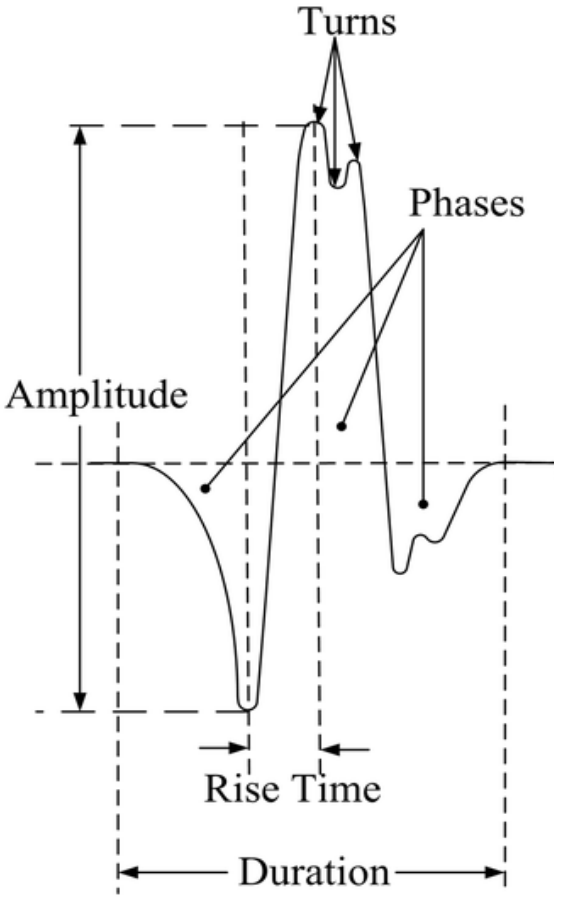
- Even experienced clinicians occasionally have unsatisfactory results and “misses”

Background

- Automated ***quantitative*** LEMG measures of ***rise time*** and ***number of small segments*** (NSS) correlate with the distance between the electrode needle and sampled motor unit action potentials[1,2]

- **RISE TIME**
  - Time between max. negative peak and preceding max. positive peak

- **NSS**
  - Number of segments with short duration and amplitudes <2mV
  - Includes all potentials with rise times < 500 µs



Göker, İmran. "Detection and Conditioning of EMG." Applications, Challenges, and Advancements in Electromyography Signal Processing, edited by Ganesh R. Naik, IGI Global, 2014, pp. 58-94

Objectives

- Determine if ***quantitative*** LEMG measures of ***rise time*** and ***NSS*** can be used as adjunctive tools to enhance the success rate of BoNT-A injection for AdSD

Methods: Study Design

- Prospective, blinded study
- Laryngologist performed qualitative EMG-guided BoNT-A injection as per usual practice
  - ****** blinded to all quantitative EMG data acquisition ******
- Automated quantitative LEMG data collected during usual BoNT-A injection procedure
  - Activity, Turns Analysis, Amplitude, NSS
- Outcome measures collected on day of BoNT-A injection at at 4-6 weeks follow up
  - Overall injection comparison (-5 through +5) & VHI-10

Results

- n= 45 subjects enrolled (28 F, 17M, age 60.8 ±12.8 yrs)
- Mean #yrs receiving BoNT-A: 13 ± 8.95 years
- Mean #previous injections: 41 (range 3-140)

		Mean Botulinum Toxin-A Dosing (MU)			
	Number of Subjects	Total	Per Vocal Fold	Left Vocal Fold	Right Vocal Fold
Total Cohort	45	2.284	1.415	1.407	1.427
Unilateral Cohort	18 (14 left, 4 right)	1.325	1.325	1.150	1.875
Bilateral Cohort	27	2.885	1.433	1.525	1.361

Results

- Data reported as mean ± SD for insertional activity and phonation just prior to BoNT-A injection

- For bilateral injections, quantitative measures obtained from the right and left TA-LCA complexes were averaged

	Turns (/sec)	Amplitude (mV)	NSS (/sec)	Activity (ms)	NSS/Turns Ratio
Insertional	406 ± 231	269 ± 87.2	213 ± 227	167 ± 175	0.44 ± 0.19
Phonation	708 ± 292	349 ± 111	524 ± 323	408 ± 231	0.66 ± 0.21

*SD, standard deviation; NSS, number of small segments

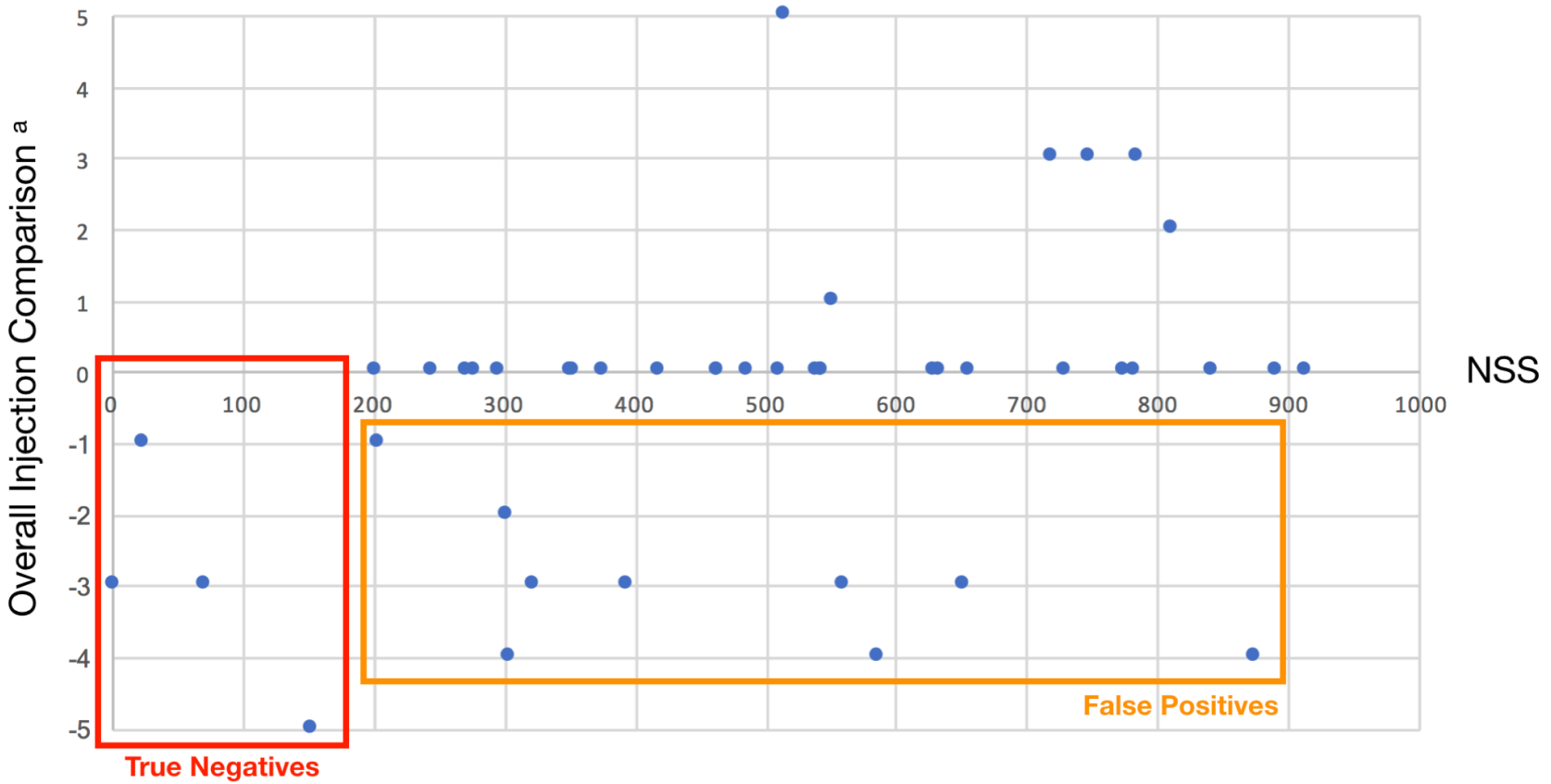
Results

- Mean follow up 36.5 ± 9.4 (range 28-60) days
- 1 patient lost to follow up, n=44 included in statistical analysis

	Pre-Injection	Post-Injection	Difference	p-Value
Patient Reported Voice Severity [a]	6.2 ± 2.1	3.1 ± 2.4	-3.1	<0.001
Physician Reported Voice Severity [a]	6.3 ± 1.8	3.1 ± 1.9	-3.2	<0.001
VHI-10	24.1 ± 9.4	16.4 ± 10.7	-7.8	<0.001
Duration of breathiness/weak voice (days)	12.3 ± 8.9	14.4 ± 9.7	1.7	0.206
Number of subjects reporting dysphagia	13	11	-2	0.036
Efficacy of most recent injection [b]	8.3 ± 1.9	-	-	-

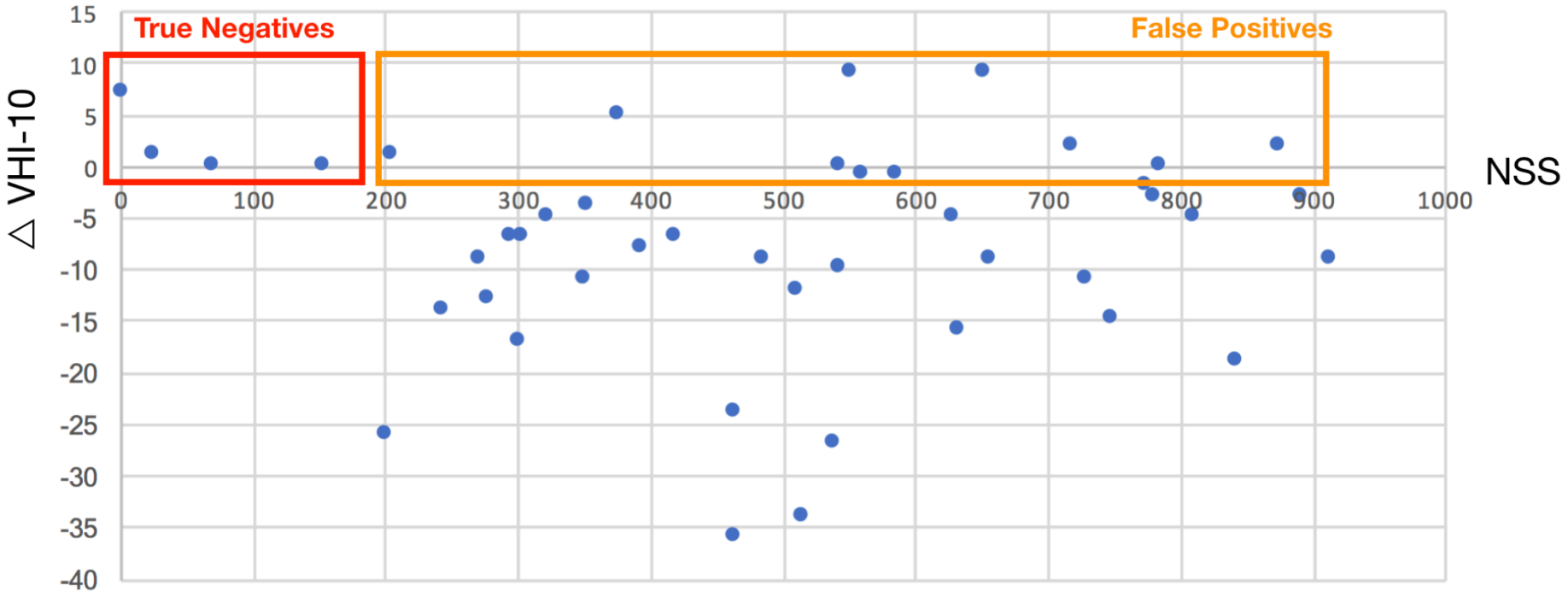
*VHI-10, Voice Handicap Index-10; [a] nominal scale of 0-10; [b] nominal scale of 1-10

Overall Injection Comparison vs NSS Acquired During Phonation



*NSS: number small segments; a: Nominal scale of -5 to +5 (-5 = significantly worse, 0 = same as previous injection, +5 = significantly better)

△VHI-10 vs NSS Acquired During Phonation



*△VHI-10: post-injection Voice Handicap Index 10 – pre-injection Voice Handicap Index 10; NSS: number small segments

DISCUSSION

Take Home Points

- *An NSS value < 200 taken during phonation is predictive of suboptimal BoNT-A injection result and voice outcome.*

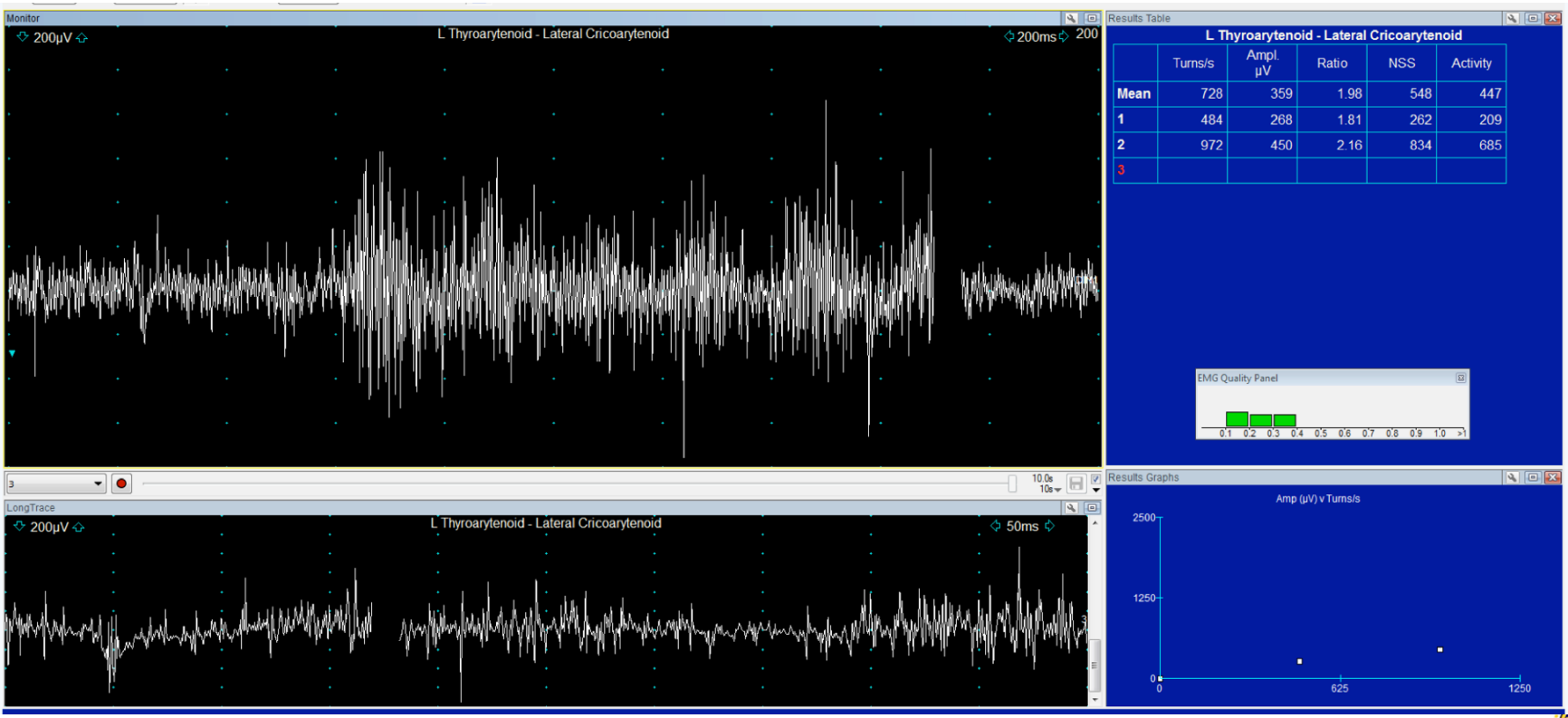
- If the sampled NSS < 200, the electrode injection needle should be repositioned, even if the clinician's qualitative assessment seems adequate.

- Small, micro-adjustments of needle position with re-assessment can result in an improved NSS value, reflected by an improved qualitative appearance on the EMG quality panel

- Quantitative LEMG may help guide novice injectors and improve their outcome results

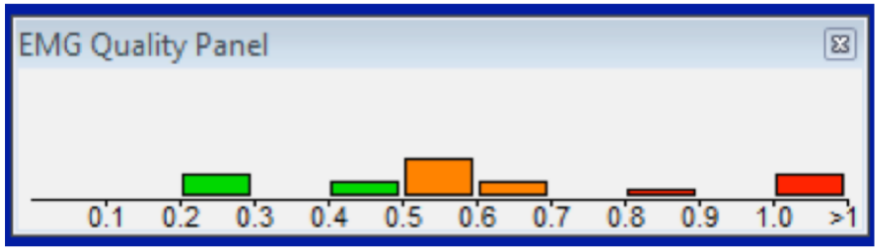
Discussion

- Quantitative LEMG values can be instantaneously sampled, which includes the *NSS value*.
- Alternatively, the “EMG signal quality” bars are readily displayed which includes the sampled *Rise Times*



Discussion

A



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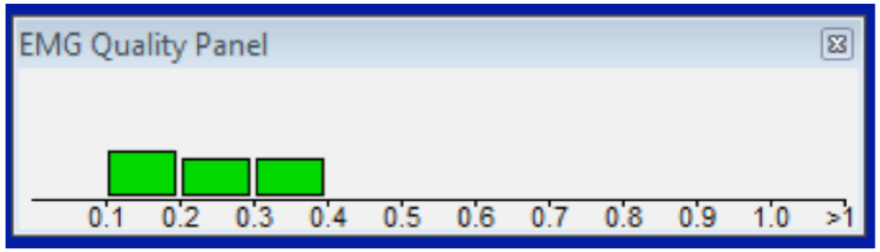

- **A**: EMG quality panel with a wide range of sampled MUAP rise times representing an unfavorable injection location (ie. low NSS)

- **B**: EMG quality panel whereby sampled MUAPs have rise times < 500 µs, correlating with an increased number of small segments (NSS) value and more favorable injection location

CONCLUSIONS

- First report on use of *rise time* and *NSS* to guide BoNT-A injection for AdSD.
- An NSS threshold value of 200 during phonation should be the minimally accepted value prior to proceeding with BoNT-A injection.
- Further studies and refinement of the technique may allow for improved accuracy and consistency of BoNT-A injection in the treatment of AdSD patients—especially for the novice injector.

References

- [1]Nandedkar SD, Sanders DB, Stalberg EV. Automatic analysis of the electromyographic interference pattern. Part I: Development of quantitative features. Muscle Nerve 1986; 9:431-439.

- [2]Stalberg E, Chu J, Bril V, Nandedkar S, Stalberg S, Ericsson M. Automatic analysis of the EMG interference pattern. Electroencephalogr Clin Neurophysiol 1983; 56:672-681.

- [3]Göker, İmran. "Detection and Conditioning of EMG." Applications, Challenges, and Advancements in Electromyography Signal Processing, edited by Ganesh R. Naik, IGI Global, 2014, pp. 58-94