Integrated Assisted Diagnostic Tools for Hand Tremor

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Summary

We integrated on iPad a spiral test integrated with electromyography for identifying tremor-contributing muscles. A two-dimensional muscle contribution model merges muscle activation with spiral-drawing data, offering an objective foundation for botulinum toxin interventions. Among 11 patients (aged 69.82 ± 5.53 years), the new platform reduced operation time by over half compared to previous methods. Output parameters demonstrated strong reliability, with intraclass correlation coefficients above 0.8. EMG data and the muscle contribution graph consistently identified tremulous muscles, supporting targeted treatment. Overall this integrated system improves diagnostic efficiency in clinical settings.

Introduction

Essential Tremor (ET) is the most common hand tremor disorder, affecting 4.6% of individuals over 65 years of age and significantly impacting daily activities and emotional well-being. Although oral medications benefit approximately 70% of patients, improvements rarely exceed 50% [1], and side effects are a concern. Botulinum Toxin (BTX) injections have gained popularity due to favorable outcomes and minimal systemic side effects. However, the absence of both subjective and quantitative assessment tools hinders accurate muscle targeting and reliable tremor evaluation. Therefore, this study proposes an integrated system combining the spiral drawing platform developed by Lin [2] with the MYO Armband to capture EMG signals to reduce operation time and improve clinical diagnostic accuracy.

Methods

We integrated software and hardware platform using an iPad Pro (Apple, USA) with a MYO Armband (Thalmic Labs, Canada) to capture participant's spiral drawing performance and electromyography (EMG) of hand muscles simultaneously. Eleven ET participants (4 females) were recruited, each scoring at least one point on the upper limb tremor section of the Fahn-Tolosa-Marin Tremor Rating Scale (FTM-TRS). Participants were evaluated twice, before and after treatment: (1) completion FTM-TRS, (2) measurement of grip strength, and (3) five guided spiral drawings with simultaneous EMG measurements.

Results and Discussion

The four spiral-drawing parameters (dr/dt $_{SD}$, dr/dθ $_{Mean}$, main frequency, and area under the curve) demonstrated promising reliability across participants, with a mean intraclass correlation coefficient of 0.82. According to clinical staff, the newly designed system and interface (Figure 1) improved readability and provided valuable quantitative data. By reducing redundant calibration, this system achieved a 52.5% reduction in setup time and an 80% weight reduction compared to its predecessor. Additionally, the newly proposed 2D muscle contribution graph effectively ranked tremulous muscles through average muscle activation and EMG correlation to the dr/dt parameter, facilitating the assessment of treatment efficacy and identifying areas requiring further intervention.

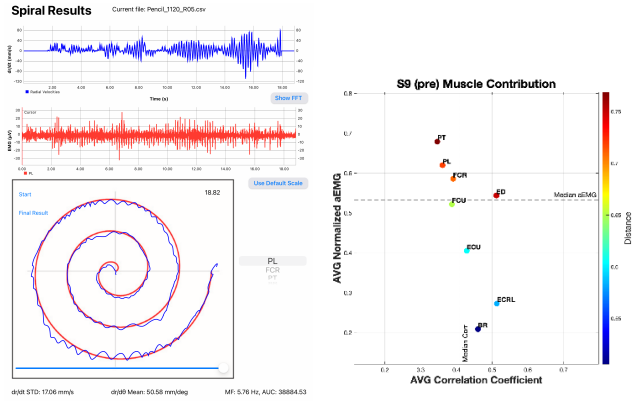

Figure 1: Left: diagnostic app's results page, displaying (top to bottom) a dr/dt chart, an EMG chart, a spiral-drawing replay area, and four key parameters. Right: our proposed muscle contribution app, which plots two parameters: correlation coefficient along the horizontal axis and average EMG along the vertical axis.

Conclusions

This integrated, portable system demonstrated strong reliability and efficiency for assessing tremor severity and localizing tremor-contributing muscles. By reducing setup time and providing objective clinical data, it offers a promising tool for enhancing BTX treatment decisions. Future work will focus on larger-scale validation and additional refinements to further improve clinical applicability.

References

[1] Niemann, N., & Jankovic, J. (2018). *Toxins*, ***10*(7)**, 299.
[2] Lin et al. (2018) *BMC Neurol*, ***18*(1)**, 25.