



Correlation of Surface EMG with Axonal Severity in Facial Palsy

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Introduction

Electrophysiological tests provide objective assessment of axonal degeneration and are widely used to predict clinical recovery in peripheral facial palsy. However, conventional modalities such as electroneurography (ENoG) and needle electromyography (nEMG) are associated with inherent limitations, including patient discomfort and invasiveness. Surface electromyography (sEMG) is a non-invasive modality that quantitatively reflects facial muscle activation. Although several studies have explored the use of sEMG in patients with facial palsy, direct comparisons between sEMG and conventional modalities remain limited. Therefore, this study aimed to evaluate the potential clinical utility of sEMG in assessing axonal severity in peripheral facial palsy.

Methods

This single-center retrospective cohort study included 61 patients with acute to subacute peripheral facial palsy (Table 1). Patients with central nervous system disorders, bilateral facial palsy, or a prior history of facial palsy were excluded. The evaluation protocol comprised sEMG and ENoG of the nasalis and frontalis muscles and nEMG of the frontalis, orbicularis oculi, nasalis, and orbicularis oris muscles. The root mean square value was used for quantitative analysis of sEMG signals, and sEMG degeneration index was calculated using the same formula as the ENoG degeneration index (sEMG degeneration index = 100% - (affected mean root mean square value/unaffected mean root mean square value) * 100%, ENoG degeneration index = 100% - (affected ENoG amplitude/unaffected ENoG amplitude) * 100%). nEMG interference patterns were graded on a five-point scale (5 = full interference pattern, 4 = reduced interference pattern, 3 = discrete activity, 2 = single voluntary motor unit action potential, 1 = no motor unit).

Results

sEMG degeneration indices of the frontalis and nasalis muscles were significantly correlated with the corresponding ENoG degeneration indices (frontalis: $r = 0.623$, nasalis: $r = 0.549$) ($p < 0.001$). They were negatively correlated with nEMG interference pattern grades (frontalis: $r = -0.528$, nasalis: $r = -0.476$) ($p < 0.001$) (Table 2). In contrast, no significant correlation was observed between sEMG degeneration index and the presence of abnormal spontaneous activity (frontalis: $r = 0.168$, nasalis: $r = 0.156$) ($p > 0.05$). ROC analysis identified optimal cut-off values of 72.3% for the frontalis (AUC = 0.887; sensitivity, 87.5%; specificity, 77.4%) and 60.1% for the nasalis (AUC = 0.825; sensitivity, 90.0%; specificity, 64.7%) for detecting severely reduced nEMG interference patterns (scale 1–3) (Table 3).

Table 1. Baseline characteristics of the patients

	Total (N=61)
Sex, numbers (%)	Male 33 (54.1%), Female 28 (45.9%)
Age (years), mean \pm SD	46.77 \pm 17.64
Diagnosis, numbers (%)	Bell's palsy 45 (73.8%), RHS 16 (26.2%)
Paralysis side, numbers (%)	Left 31 (50.8%), Right 30 (49.2%)
Onset to test (days), mean \pm SD	22.1 \pm 8.9
House-Brackmann grade at test, mean \pm SD	3.13 \pm 1.20 (I = 7, II = 10, III = 21, IV = 14, V = 9)

SD, standard deviation; RHS, Ramsay Hunt Syndrome

Table 2. Correlations among ENoG degeneration index, Needle EMG, and Surface EMG degeneration index

		Surface EMG degeneration index (%)	
		Frontalis	Nasalis
ENoG degeneration index (%)	Frontalis	0.623 (<0.001)*	
	Nasalis	0.549 (<0.001)*	
Needle EMG – Presence of ASA (Yes/No)	Frontalis	0.168 (0.196)	
	Nasalis	0.156 (0.229)	
Needle EMG - Interference pattern (scale)	Frontalis	-0.528 (<0.001)*	
	Nasalis	-0.476 (<0.001)*	

Surface EMG degeneration index = 100% - (affected mean root mean square value / unaffected mean root mean square value) * 100%
 needle EMG interference patterns were graded on a five-point scale (5 = full interference, 4 = reduced interference, 3 = discrete activity, 2 = single voluntary motor unit action potential, 1 = no motor unit)
 Values are presented as Spearman correlation coefficient (p value)
 ENoG, Electroneurography; EMG, Electromyography; ASA, Abnormal Spontaneous Activity
 * $p < 0.001$.

Table 3. Optimal cut-off values of Surface EMG degeneration indices for discriminating severe needle EMG interference patterns

		Cut off value	AUC	Sensitivity	Specificity
Surface EMG degeneration index	Frontalis	72.3	0.887	87.5	77.4
	Nasalis	60.1	0.825	90	64.7

Surface EMG degeneration index = 100% - (affected mean root mean square value / unaffected mean root mean square value) * 100%
 severe needle EMG interference pattern: scale 1-3
 EMG, Electromyography; AUC, area under the curve

Conclusion

sEMG degeneration indices were significantly correlated with both ENoG degeneration indices and nEMG interference patterns, demonstrating good diagnostic performance in identifying severe axonal involvement. These findings support the potential role of sEMG as a complementary, non-invasive adjunct to conventional electrophysiological testing in peripheral facial palsy.