iMAX: A new tool for assessment of motor axon excitability

A multicenter prospective study

ECCN 2023 | 18th European Congress of Clinical Neurophysiology | MARSEILLE // FRANCE

Tyberghein M[a], Grapperon A-M[b], Bouquiaux O[c], Puma A[d], Attarian S[b], Wang FC[a]

[a] University Hospital, Liège, Belgium ; [b] Timone University Hospital, Marseille, France ; [c] Neurologic Center, Fraiture, Belgium ; [d] Université Côte d'Azur, Nice, France

Introduction. We develop a novel and practical electrodiagnosis (EDX) technique called the iMAX to assess peripheral motor axon excitability in patients with peripheral neuropathies. This technique allows to measure nerve excitability in few minutes with a simple electrodiagnostic device and classic recording and stimulating electrode settings. We conducted a multicenter study to establish the reliability of this new technique evaluating motor axon excitability.

Methods. Three parameters (minimal threshold, iUP, iMAX) were prospectively derived from three nerves (median at the wrist, ulnar at the elbow, fibular at the knee) in healthy volunteers and patients with peripheral neuropathies in four university centers (Liège, Marseille, Fraiture, Nice). Healthy volunteers were tested twice at least two days apart.
The exact stimulation sites were determined where the maximal CMAP could be obtained at minimal stimulus. The minimal motor threshold was first measured. It was the minimal intensity stimulation with a 1 ms duration evoking a reproducible motor response of at least 0.1 mV. Then, the stimulus intensity was gradually increased, with increments of 1 mA, until a maximal CMAP amplitude was obtained. The stimulation intensity at this stage was called iUP. A stimulation increased by 50% of this iUP was applied in order to ensure a maximum CMAP amplitude, with a precision of 0.1 mV. The stimulus intensity was then reduced progressively with decrements of 0.1 mA until a decline of the motor response was obtained. Then, the stimulus intensity was increased anew with increments of 0.1 mA until reaching the maximal response evoked earlier. The stimulus intensity at this stage of the procedure was the iMAX, the lowest and most precise intensity allowing a maximal CMAP (Figure 1).

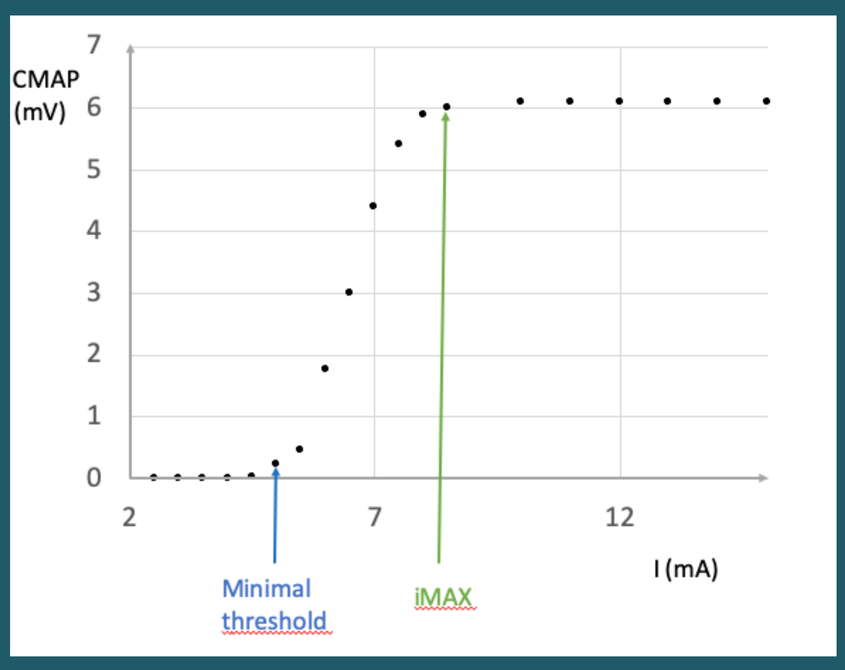

***Figure 1**. Stimulus-response curve. The minimal threshold is the minimal intensity stimulation with a 1 ms duration evoking a reproducible motor response of at least 0.1 mV and iMAX is the lowest intensity, with a precision of 0.1 mV, allowing a maximal CMAP.*

Results. Twenty-eight healthy volunteers participated in the study and 32 patients with peripheral neuropathies were recruited (13 CIDP, 8 GBS, and 7 CMT1A and 4 axonal neuropathy). Healthy volunteers results were not significantly different between centers (Wilcoxon signed-rank analysis). Spearman correlation coefficients between test and retest were moderate (Figure 2). Upper limits of normal for minimal threshold-iUP-iMAX were established using the 95th percentile (n = 28): 2.3-6.0-5.8 mA for median nerve ; 2.7-7.0-6.8 mA for ulnar nerve ; 2.6-8.0-7.5 mA for fibular nerve. Comparison of volunteers and patient groups (Kruskal-Wallis analysis) indicated significant increases in iMAX parameters especially for the CMT1a and CIDP groups (Figure 3). In CMT1a, iMAX abnormalities were homogeneous at the three stimulation sites, which was not the case for CIDP (Table 1).

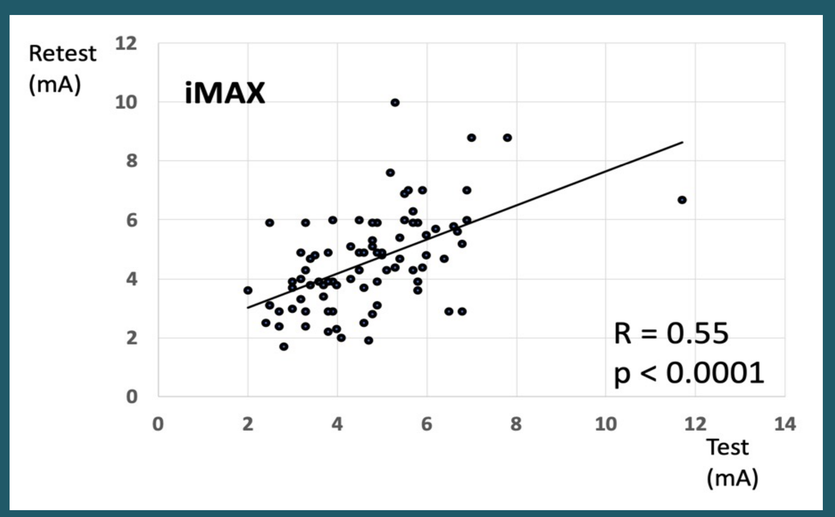

***Figure 2.** Spearman correlation analysis between test and retest in the same population for iMAX (n = 84).*

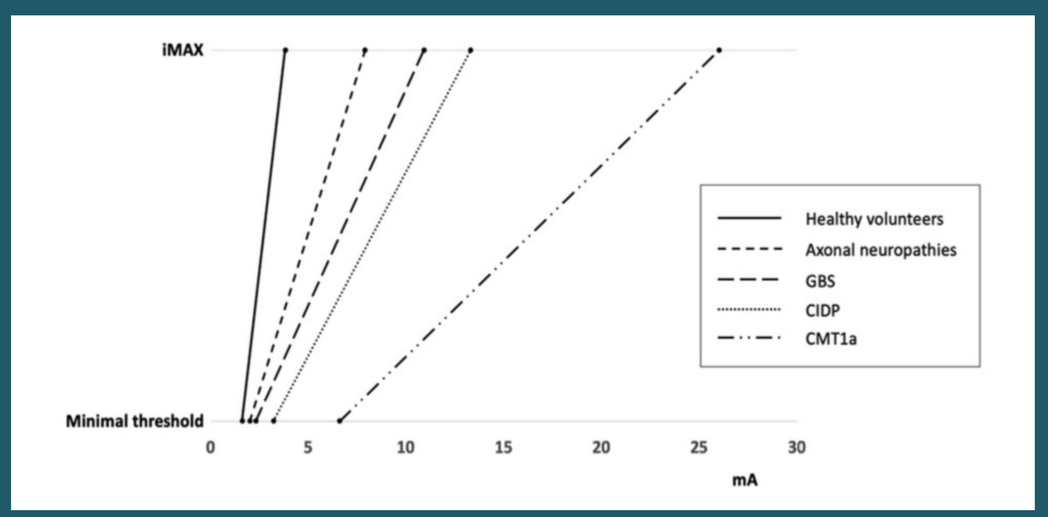

***Figure 3.** Median values for minimal threshold and iMAX recorded from the median nerve among the five groups.*

Table1. Percentage of abnormalities in patients with peripheral neuropathies for the three stimulation sites, established by comparison of individual data to upper limits of normal.

		Median nerve	Ulnar nerve	Fibular nerve	Three abnormal parameters at the 3 sites
Axonal neuropathy (n=4)	**Threshold**	0	0	0	
	iUP	75	25	50	0
	iMAX	75	25	50	
Axonal GBS (n=3)	**Threshold**	67	67	33	
	iUP	100	67	33	33
	iMAX	100	67	33	
Demyelinating GBS (n=5)	**Threshold**	40	20	20	
	iUP	80	60	20	0
	iMAX	80	60	20	
CIDP (n=13)	**Threshold**	77	77	25	
	iUP	100	92	50	0
	iMAX	100	91	50	
CMT1a (n=7)	**Threshold**	100	100	100	
	iUP	100	100	100	100
	iMAX	100	100	100	

CIDP = chronic inflammatory demyelinating polyneuropathy; GBS = Guillain-Barré syndrome; CMT = Charcot-Marie-Tooth

Conclusion. The iMAX procedure is reliable and allows the monitoring of motor axon excitability disorders. This technique should prove useful to monitor motor axonal excitability in routine clinical practice as it is a fast, non-invasive procedure, easily applicable without specific software or devices.

CHU de Liège