Società Italiana di Neurofisiologia Clinica

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Neuromodulative effects of Vagal Nerve Stimulation (VNS): a study of somatosensory evoked potentials (SEPs) and quantitative EEG (qEEG)

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Dichiaro di non avere conflitti di interesse

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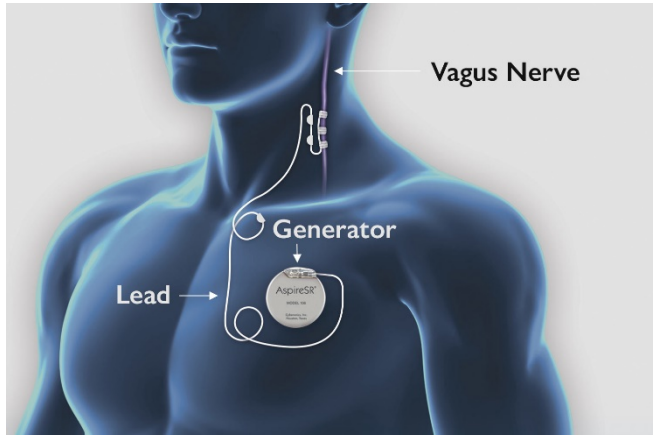
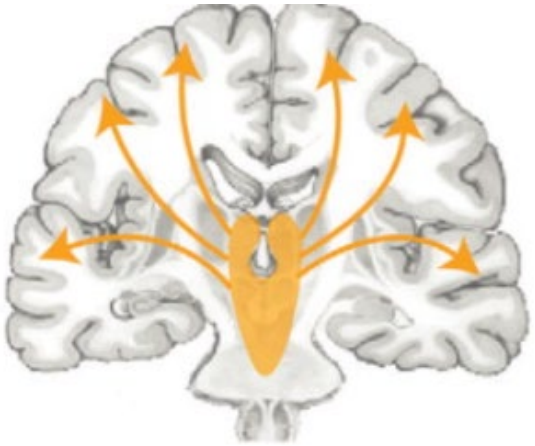
Rational





Englot D J et al, *Brain* 2010

Vagal Nerve Stimulation (VNS) is a viable choice in non-surgical cases of DRE due to its profile of efficacy and safety (Wheless et al, 2018).

It is estimated that **about 50% of PwE treated** with VNS has a **seizure frequency reduction of 45-65% after one year** from implantation (Toffa et al, 2020) and this range further increases with years of stimulation (Kawai et al, 2017).

We demonstrated in our previous studies (Lanzone et al., 2020; Assenza et al., 2020) that **SEPs** allow to explore the functioning of both thalamo-cortical and intracortical networks of PwE, thus they could represent a useful neurophysiological tool to explore changes in subcortical-cortical excitability related to VNS.

Quantitative electroencephalography (**qEEG**) also revealed to be a valid instrument to predict good response to ASMs therapy (Croce et al, 2021; Ricci et al, 2021) and specifically to VNS (Ravan et al, 2017).

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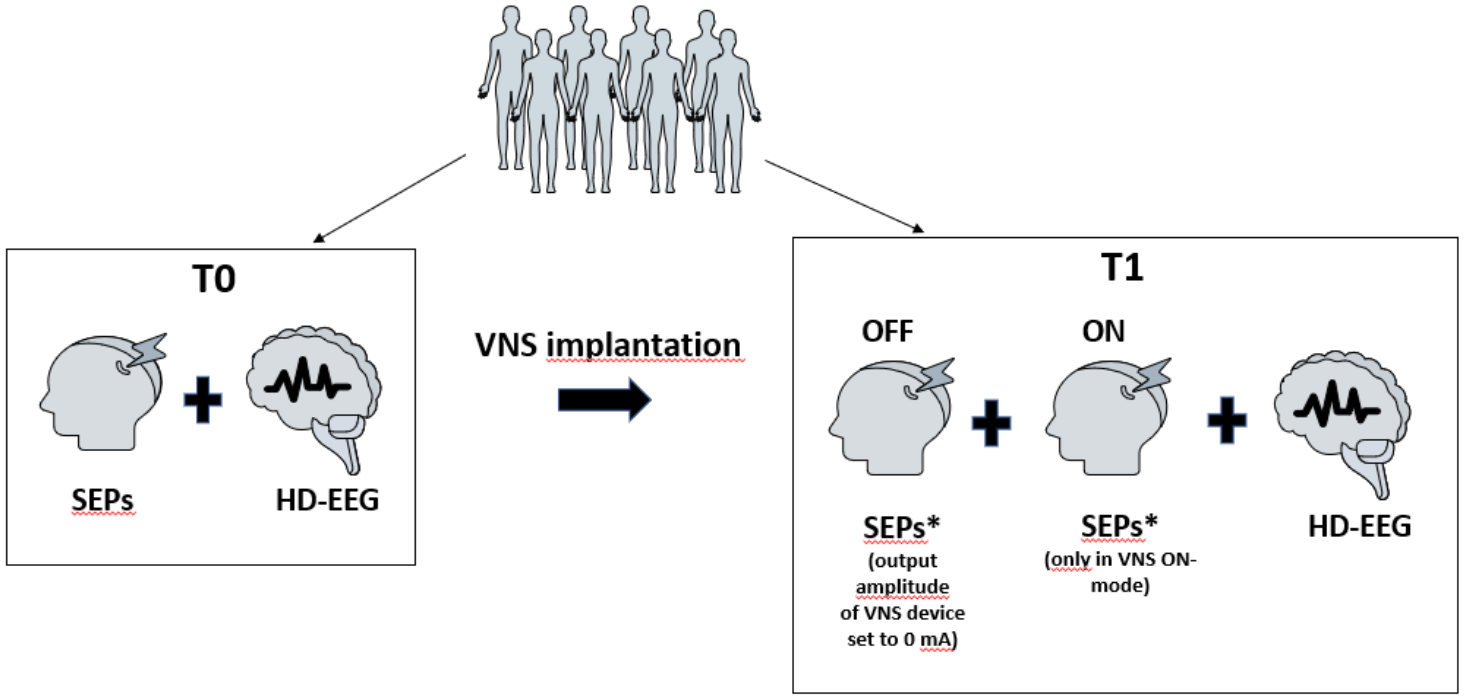
Methods

Eight patients with a **focal drug resistant epilepsy** (four men and four women) were enrolled



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Methods

McHugh classification, McHugh J C, *Epilepsia*, 2007

TABLE 2. *Proposed classification of outcome after VNS insertion, with presentation of results from our population*

		All patients, no. (%)
Class I	80–100% reduction in seizure frequency	8 (16.5)
	Class IA: improved ictal or postictal severity	6 (12.5)
	Class IB: no improvement in ictal or postictal severity	2 (4)
Class II	50–79% reduction in seizure frequency	10 (21)
	Class IIA: improved ictal or postictal severity	5 (10.5)
	Class IIB: no improvement in ictal or postictal severity	5 (10.5)
Class III	<50% reduction in seizure frequency	12 (25)
	Class IIIA: improved ictal or postictal severity	8 (16.5)
	Class IIIB: no improvement in ictal or postictal severity	4 (8.5)
Class IV	Magnet benefit only	3 (6)
Class V	No improvement	15 (31.5)

Forty-eight adult patients: median follow-up, 18 months.

GCI-I score, Berk et al, *Journal of Evaluation in Clinical Practise*, 2007

1	Substantial improvement
2	Moderate improvement
3	Minimum improvement
4	No change
5	Minimum worsening
6	Moderate worsening
7	Substantial worsening

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Methods

	Sex	Age	Diagnosis	Epileptic focus	ASMs n°	ASMs dose	Responder	SF	McHugh	GCI-I	VNS output current	Magnet	AE
1	F	58	Focal symp post- trau				o	No	V	4	1 mA	Not work	Cough, hoarseness
2	F	56	Focal symp of unknow				o	No	III A	3	1.5 mA	Not used	Hoarseness, throat tightening
3	M	57	Focal symp of unknow				o	No	III A	2	1.25 mA	Not used	Hoarseness
4	M	47	Focal symp post-trau				o	No	V	4	1.5 mA	Not used	Hoarseness
5	F	24	Focal symptomatic (glioblastoma)	Right temporal lobe	1	ESL 1600	No	No	III A	3	1.5 mA	Efficient	None
6								No	III A	2	2 mA	Not used	None
7								No	III B	3	2 mA	Not used	None
8								No	III B	3	2 mA	Not used	None

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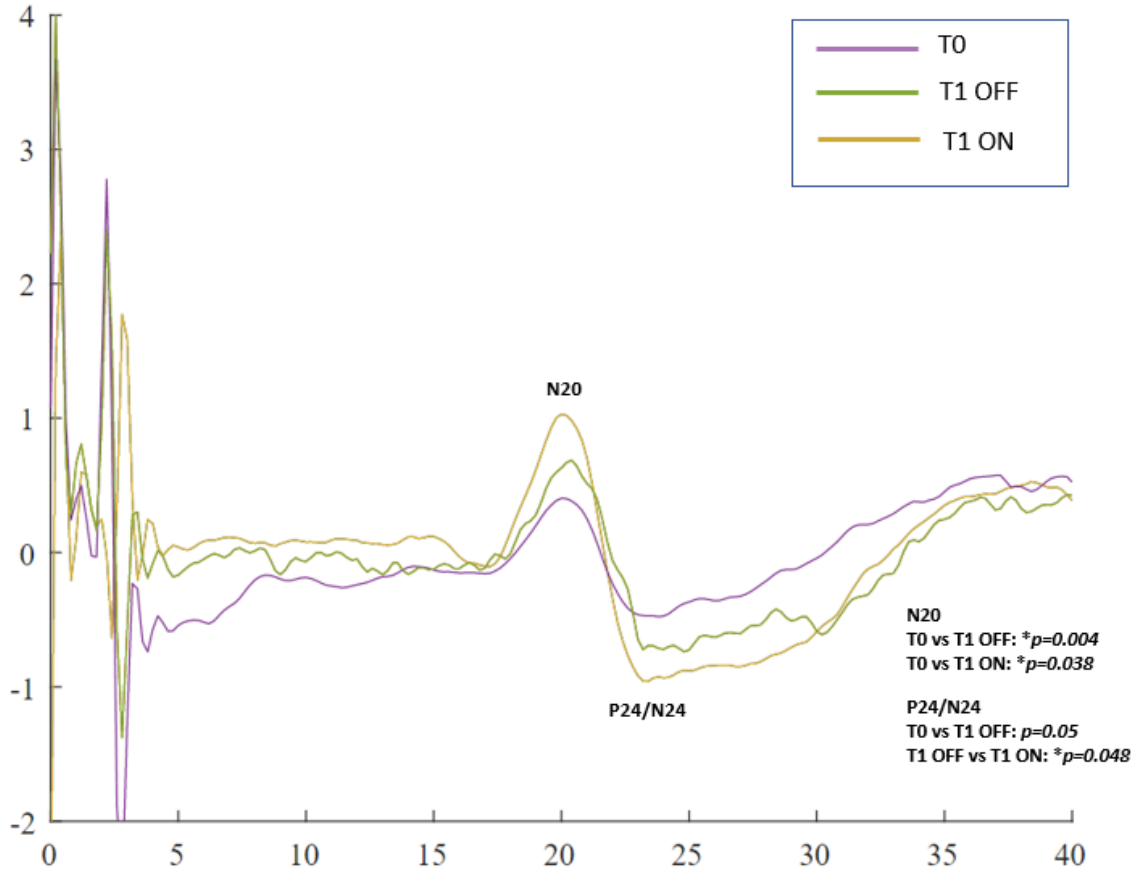
Results - SEPs

Figure 2



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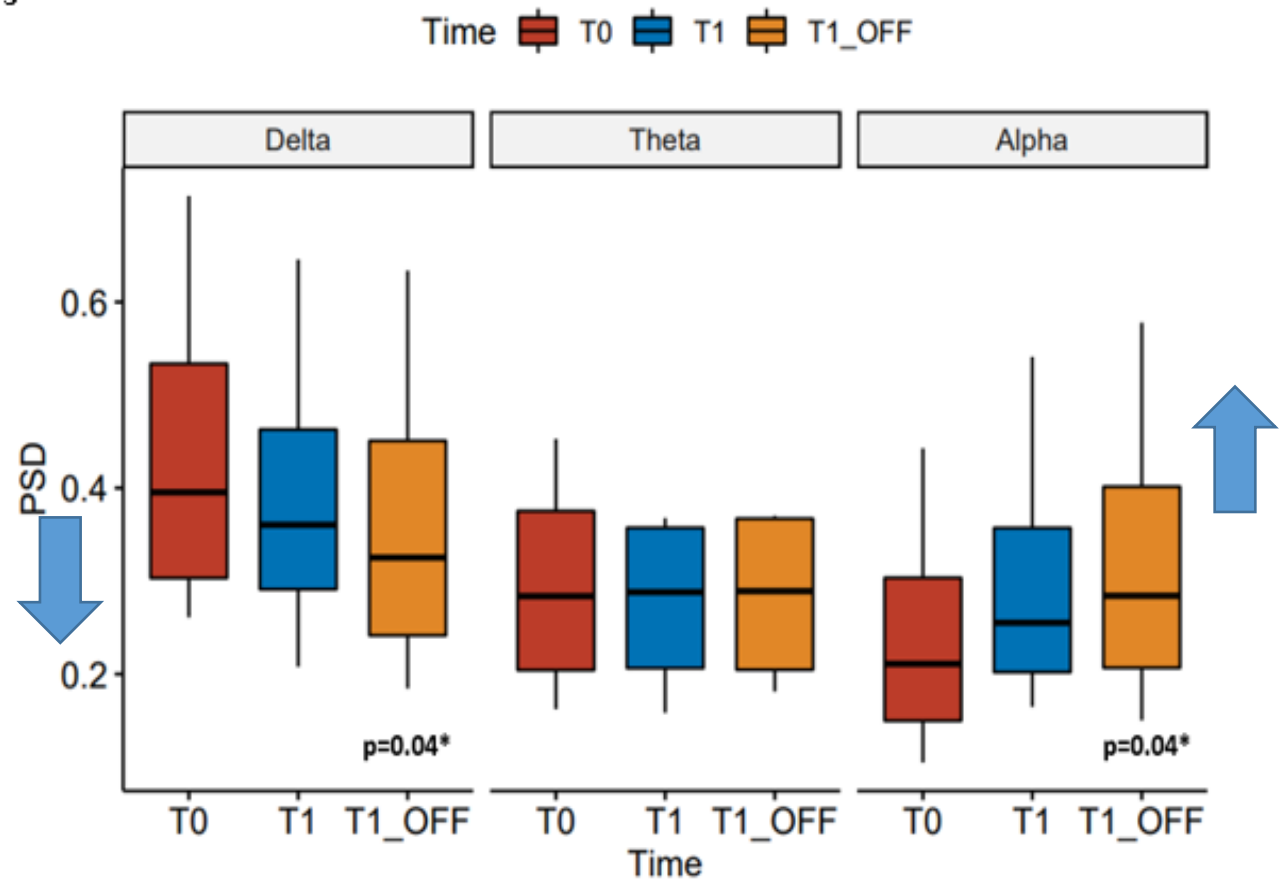
Results – qEEG

Figure 3



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Discussion

SEPs results:

- VNS **increased the amplitude of N20 potential** after six months of stimulation in both the modalities of VNS accension (ON and OFF) → possible role of VNS in chronically modulating cortical afferences from subcortical structures throughout mechanisms of cortical plasticity which are independent from VNS activation ?

- VNS **increased the amplitude of the P24/N24 component** → possible inhibitory effect mediated by VNS repetitive trains of stimuli throughout subcortical-cortical pathways ?

qEEG analysis:

- PSD analysis evidenced an **increase in alpha power and a decrease in slow frequencies (delta band),** particularly when comparing T0 with T1 in OFF mode → an increase in alpha and a decrease in delta power on EEG is positively related to a good performance on cognitive and memory tasks

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Conclusion – Key points

1. The 75% of our PwE were classified as reporting a “much improved” and a “minimal improvement” of global condition on GCI-I scale although only one of them could be defined seizure-responder after 6 months from implantation. This may be correlated with the finding that a 50% of our PwE reported an improvement of Mc-Hugh classification (reaching a III-A score) which corresponds to a decrease in ictal and post-ictal severity.

2. Our SEPs findings, expression of a sort of subcortical-cortical pathways “disinhibition”, along with the PSD changes induced by VNS, could support the role of VNS in improving cognition and vigilance.

3. We suppose that both these SEPs and qEEG modifications are possible biomarkers of a role of VNS in improving cognitive performances and quality of life of PwE that could justify the global satisfaction reported by our patients patients despite a not significant seizure frequency reduction.

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