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Light at the end of the tunnel: Improvement of post-stroke visual field defect after open-label navigated perilesional rTMS

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Cortical visual field defects (cVFD) usually show a narrow window of recovery not exceeding a few months. In some studies recovery was mostly in the first 10 days of insult followed by decrease in recovery rate that nearly plateaus 10–12 weeks after insult, and only 5% of patients will show full recovery of their visual field [1–5].

Areas of residual vision (ARV) at the borders of those of absolute blindness are the functional counterpart of partially damaged brain regions at the perilesional areas [6].

In the current study, we hypothesize that stimulation of the perilesional, seemingly healthy brain tissue, close to infarcted area would result in clinical improvement. To achieve this precise targeting, we used navigated rTMS.

This is an open-label pilot case series study conducted in the neuromodulation unit, neurology department, Ain Shams University after approval by Ain Shams University faculty of medicine local research ethics committee.

A total of 12 patients with cortical visual field defect (cVFD) secondary to ischemic stroke participated in the study after giving an informed written consent. All patients were above 18 years, with a duration of illness of at least 3 months.

Patients were excluded if they had cVFD due to lesions outside the visual cortex or had any contraindication to rTMS.

Assessment was done prior to and after 16 rTMS sessions using National Eye Institute Visual Functioning Questionnaire-25 (VFQ-25) and automated perimetry to examine 30-degree field of vision from center of fixation using the full threshold 30-2 and obtain the mean deviation (MD) and visual field index.

An MRI Brain T1WI with 0.9 mm sections was used to create a three-dimensional virtual head model for each patient. The target for stimulation was then determined and marked. Four targets were selected to be along the outer border in the perilesional area in the nearest seemingly-healthy tissue to the involved visual cortex. Each target was stimulated for 4 consecutive sessions of 1000 pulses for a total of 4000 pulses.

Stimulation parameters: Motor threshold was detected in the abductor pollicis brevis according to the method described by Rossini et al. [7]. Patients received a total of 16, every other day sessions of rTMS at 10 Hz frequency, 90% of motor threshold, 25 trains − 40 pulses per train with 20 seconds intertrain interval and a total of 1000 pulses. The coil handle was directed downwards at 45° of the sagittal plain to ensure that the induced electric field be perpendicular to the underlying gyrus (Fig. 1) [8]. MagVenture MagPro X100 repetitive transcranial magnetic stimulator with Magoption and a figure of eight coil of 13 cm diameter was used.

Eight patients completed the study and a ninth patient completed the VFQ-25 interview but not the perimetry. Duration of illness ranged from 3 to 24 months (mean = 6.56 months). Results showed statically significant improvement in MD (Baseline -18.58 ± 6.75 dB, follow up -14.20 ± 6.48 dB) ($p = 0.046$) and VFQ-25 (Baseline 303.59 ± 151.10, follow up 444.60 ± 170.37) ($p = 0.001$). Visual field index showed important improvement as well (Baseline $45.56\% \pm 20.18$, follow up $58.17\% \pm 17.58$) ($p = 0.057$). Two patients did not show any improvement.

The change in MD was variable ranging from 2.19 to 12.77 dB. This variability could not be explained by the duration or severity of cVFD at baseline as both showed no significant correlation with the change in MD ($r = 0.43$, $p = 0.287$), ($r = 0.43$, $p = 0.283$), respectively. An example of visual field at baseline and after treatment is shown in Fig. 1. Side effects were minimal, two patients reported transient headache that did not require treatment and one patient developed transient vertigo and tinnitus that resolved spontaneously.

We assume that the improvement observed could be attributed to rTMS rather than spontaneous recovery, since patients had already reported a stationary course before therapy followed by a relatively quick improvement over the short period of applying rTMS.

We encountered what has been described by several authors as "*the mismatch problem*"; a mismatch observed in some patients between improvement in the perimetry and subjective improvement reported by the patient [6]. The mismatch problem can be explained by improvement in other qualities of vision not being measured by perimetry [9].

Lack of controls is the most remarkable limitation. A follow up randomized case control trial is currently underway.

Abbreviations: ARV, areas of residual vision; MD, mean deviation; rTMS, repetitive transcranial magnetic stimulation; cVFD, cortical visual field defects; VFI, visual field index; VFQ-25, visual functioning questionnaire-25.

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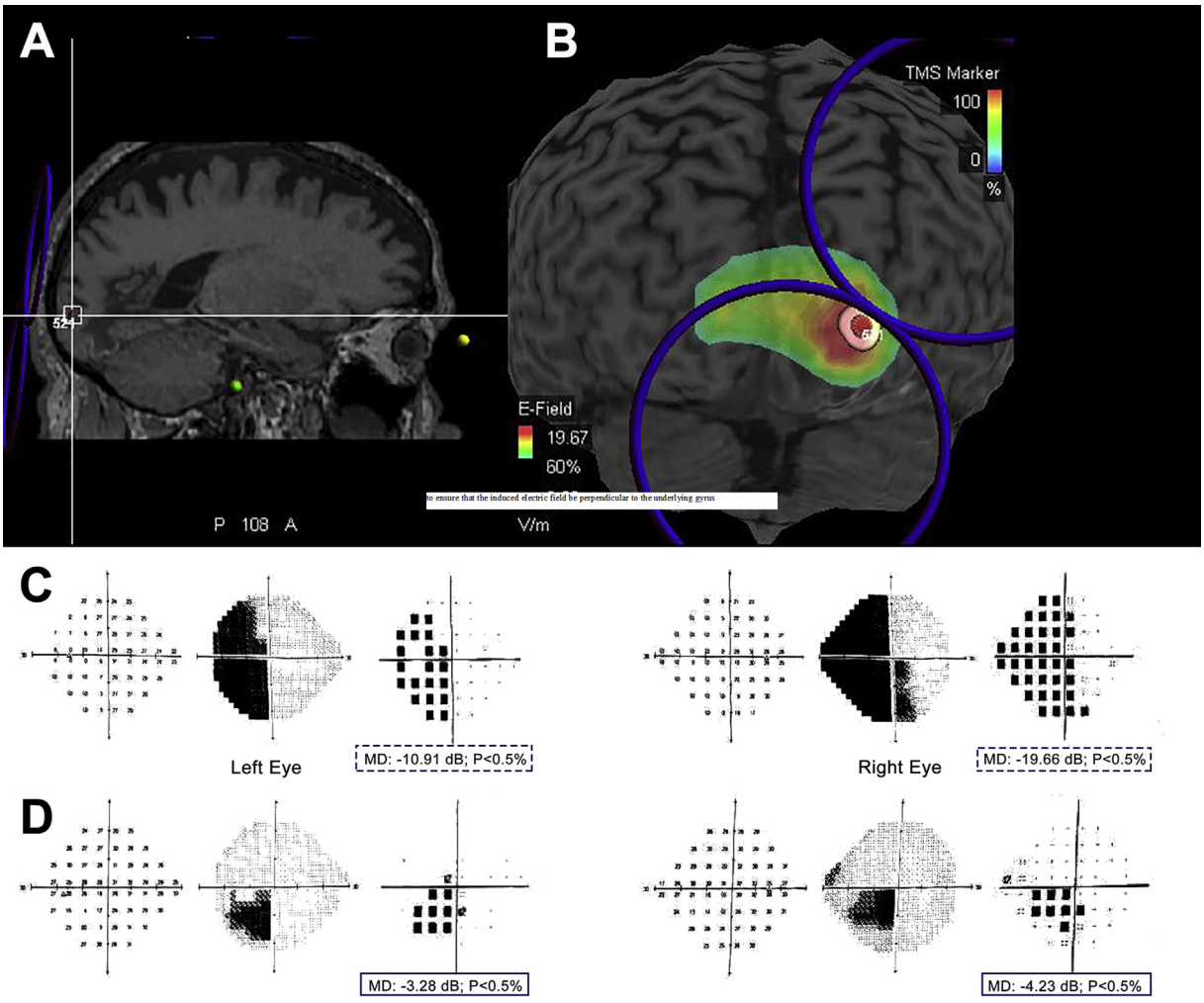

Fig. 1. MRI brain and Automated Perimetry. A, Both the perilesional stimulation target (crosshair) and coil orientation can be seen. B, Head model showing the perilesional target (small white circle) and coil orientation (figure of 8) during a TMS session. C, Automated perimetry at baseline showing complete homonymous hemianopia (MD shown within a dashed box). D, Automated perimetry after receiving 16 sessions of perilesional rTMS (MD shown within a solid box).

Sixteen sessions of high frequency perilesional navigated rTMS led to improvement in cVFDs both functionally and by perimetry even after 3 months of stroke.

Conflicts of interest

None.

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