

## Rehabilitation of hemispacial neglect in stroke

Muhammad Tawab Khalil, Umer Younas, Imran Irshad, Farooq Azam Rathore

### Abstract

Hemi-spatial neglect (HSN) is a debilitating post stroke cognitive deficit resulting in reduced attention to stimuli presented in the contra-lateral hemi-visual field. It adversely impacts patient's medical recovery, activities of daily living and quality of life. Early referral to Rehabilitation Medicine specialist for thorough evaluation, prompt recognition of functional impairments and formulation of a comprehensive rehabilitation plan unique to patient is important. It is part of the comprehensive and holistic management of stroke patients with HSN. We summarize the current management strategies used for post-stroke HSN rehabilitation with the options including non-invasive brain stimulation, visuomotor feedback training, robotic rehabilitation and trans-dermal nicotine patch.

**Keywords:** Hemispacial neglect, Stroke, Rehabilitation, Non-invasive brain stimulation, Robotic rehabilitation.

**DOI:** <https://doi.org/10.47391/JPMA.22-32>

### Introduction

Hemi-spatial neglect (HSN) is a disabling condition which results in reduced attention to the contra-lateral personal, peri or extra personal space.<sup>1</sup> Patients with HSN face difficulty in detecting, orienting and responding to stimuli presented to contra-lateral side of hemispheric lesion. For example a patient with left HSN will bump into objects on his left side and may forget to put his left leg on foot rest of wheel chair.<sup>2</sup>

HSN can occur due to lesion of any hemisphere of brain but it is more common and severe after right hemispheric lesion.<sup>2</sup> Lesion in inferior temporal lobe and temporo-parietal junction usually result in HSN. However lesions in inferior frontal lobe and superior temporal gyrus are also associated with certain manifestation of HSN.<sup>3</sup> Kinsbourne proposed the theory of classical rivalry to explain the cortical mechanisms behind HSN according to which the right hemisphere brings attention to both hemi-visual fields while left hemisphere only brings attention to right visual hemi-field.<sup>3</sup> So in case of a lesion in right hemisphere, the left hemisphere can only

Armed Forces Institute of Rehabilitation Medicine, Rawalpindi, Pakistan.

**Correspondence:** Farooq Azam Rathore. Email: farooqrathore@gmail.com

compensate for the right visual hemi-field and the patient will have reduced attention in the left visual hemi-field resulting in HSN.<sup>3</sup>

In a study conducted in Japan, the overall incidence of HSN was 43.5% (48.4% with right hemispheric lesion, 31.7% with left hemispheric lesion).<sup>2</sup> In a study conducted in Finland, HSN occurred in 79.9% of rehabilitants with right and 68.3% of those with left stroke at admission to a rehabilitation center.<sup>1</sup> There is no data on the prevalence of HSN in Pakistan. HSN is an independent predictor of rehabilitation outcomes irrespective of the side of neglect and it is associated with poor functional outcomes after rehabilitation.<sup>2</sup>

It is important that a stroke patient should be referred to Physical Medicine and Rehabilitation specialist (PMR Specialist) early for comprehensive functional evaluation and formulation of a custom-made rehabilitation plan, which will address the functional impairments unique to each patient. HSN can be clinically evaluated by several clinical tests including line bisection test, letter cancellation test, Behaviour Inattention test, Catherine Bergago Scale, Mini-mental state examination, etc.

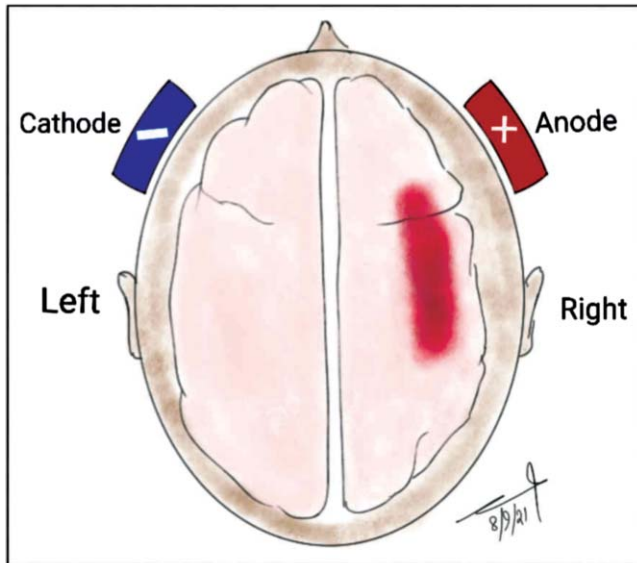
We summarize the current management options for HSN rehabilitation of HSN after stroke.

### Management options for HSN

#### 1. Non-Invasive Brain Stimulation

Non-Invasive Brain Stimulation is a potential management option for the management of HSN. It includes transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS).<sup>3</sup> Generally three protocols are used to deliver TMS; Repetitive TMS (rTMS), continuous Theta burst stimulation and intermittent theta burst stimulation (iTBS).<sup>3</sup> rTMS is usually applied over the parietal cortex. Zhang et al. found that rTMS combined with sensory cueing is better than rTMS alone.<sup>4</sup> The effect of continuous Theta burst stimulation is stronger than rTMS and lasted for a month.<sup>3</sup> Thomas et al. found that continuous Theta burst stimulation not only improves but also accelerates the recovery of HSN.<sup>5</sup>

The use of tDCS has also been studied in patients with HSN. Anode (facilitatory tDCS) is applied at affected lobe and cathode (inhibitory tDCS) on the unaffected side



**Figure:** tDCS- anode is applied over ipsi-lesional primary motor cortex and cathode is placed over contra-lateral primary motor cortex (Image made by first author).

(Figure). tDCS can be performed either by dual stimulation or single anodal stimulation. Even though both methods for performing tDCS resulted in improvement in patients, but the effect of dual stimulation was superior.<sup>3</sup>

## 2. Neuromuscular Muscle Vibration (NMV)

Neuromuscular muscle vibration (NMV) is a technique used for vibrating posterior neck muscles with frequency ranging from 60 to 800 Hz on the opposite side of affected hemisphere using a muscle vibrator. Segmental muscle vibrations stimulate muscle spindles which affect the entire egocentric coordinated system resulting in shifting of the centre of attention to the side of NMV. This in turn causes increased perception of stimuli presented to the side where vibration is applied. It has been applied in chronic stroke patients with HSN. It enhanced the effect of other forms of neglect therapy and the effect lasted for 1.4 years.<sup>3</sup>

## 3. Robotic Rehabilitation

Susanne et al. studied the effects of robotic intervention on HSN and activities of daily living (ADL).<sup>6</sup> PARO is an interactive stimulation therapeutic robot in the shape of a baby seal, which can move, produce sounds and responds to sound and touch.<sup>6</sup> Treatment session with PARO improved HSN in patients with sub-acute stroke and was readily accepted by the patients.<sup>6</sup>

Jin-Hyuck et al. investigated the effects of the robot-assisted hand training on hemispatial neglect of older patients with chronic stroke in a randomised controlled trial. All participants received 20 sessions for 4-weeks.

Robot-assisted hand training improved hemispatial neglect in elderly patients with chronic stroke.<sup>7</sup> Choi et al. found that the upper limb robotic rehabilitation had similar benefits for hemispatial neglect in stroke patients as compared to conventional neglect treatment.<sup>8</sup>

## 4. Activity based training

Activity based training focuses on development of practical skills in a patient through participating in therapeutic activities aimed to improve patient's functional ability.<sup>9</sup> Liu et al. concluded that activity based training is effective in ameliorating the effects of HSN and improving ADLs.<sup>9</sup> The results of smooth pursuit training and optokinetic stimulation are more encouraging than visual-scanning training in improving HSN. Visual scanning training improves only visual-related impairments.<sup>9</sup>

## 5. Prism Adaptation /Therapy

Prism glasses leading to prism adaptation are an effective intervention for HSN.<sup>9</sup> However successful prism adaptation requires large enough shift in optic field and repetitive training sessions.<sup>9</sup> Prism corrects the spatial biases that are associated with HSN.<sup>9</sup> Antonia et al. concluded that prism adaptation did not provide any additional benefit in sub-acute stroke patients but the treatment duration in their trial was of 10 sessions and they did not exclude hemianopia patients who might have resulted in failure of prism adaptation.<sup>10</sup>

## 6. Eye Patching

Liu et al. found that eye patching alone provided some improvement in HSN, but when combined with cognitive rehabilitation, no improvement in HSN was seen. Studies showing benefit of eye patching have small sample sizes and currently its role in HSN is controversial.<sup>9</sup>

## 7. Virtual Reality

Virtual Reality (VR) is a computer based, multisensory, stimulating and interactive environment in which a person is engaged in tasks that resemble day-to-day routine tasks. VR has been widely studied as an intervention to address HSN but promising results have not been found.<sup>11</sup> Tatiana et al. found limited evidence that VR improves HSN as compared to conventional therapy.<sup>11</sup>

## 8. Visuomotor Feedback Training

Visuomotor feedback training is an inexpensive and easy training method.<sup>12</sup> It involves grasping and lifting of rods, placed horizontally on a test mat, using the ipsilesional limb with a pincer grip and try lifting it up from its center so that it remains balanced.<sup>12</sup> Stephanie et al. concluded that a 2 week home-based visuomotor feed-back training provides short-term and long-term improvement in HSN.<sup>12</sup>

## 9. Pharmacologic Therapy

Dopaminergic therapy, cholinergic therapy and noradrenergic therapy have been studied in the treatment of HSN.<sup>13</sup> The effect of dopaminergic therapy is controversial to draw any conclusion.<sup>13</sup> Cholinergic therapy with transdermal nicotine improves spatial attention.<sup>13</sup> Noradrenergic therapy with guanafacin does not statistically improve HSN.<sup>13</sup>

## 10. Ward based/bed side Interventions for HSN

Marianne et al. studied eye patching, music therapy, mirror therapy, mental imagery training, smooth pursuit eye movement therapy (SPEMT) and limb activity training in ward settings to be implemented by nursing staff but strong evidence regarding their efficacy are lacking except in SPEMT. SPEMT can be included in ward based care (Grade B evidence).<sup>14</sup>

## 11. Galvanic Vestibular Stimulation

Galvanic Vestibular Stimulation (GVS) stimulates the vestibular system and ameliorates HSN. Junji et al. concluded that application of left cathode and right anode electrode over the mastoid process for 20 minutes improved HSN however the effect of GVS depends upon the duration of application, current intensity and polarity.<sup>15</sup>

## Conclusion

HSN is a debilitating consequence of stroke which adversely affects recovery of patient. Non-Invasive brain stimulation, visuomotor feedback training and robotic rehabilitation have the potential to improve HSN. There is limited evidence regarding use of pharmaceutical agents for management of HSN except trans-dermal nicotine patch. The patients with stroke having HSN must be referred for a PMR consultation for an appropriate rehabilitation plan.

**Acknowledgement:** Nil.

**Disclaimer:** Nothing to disclose.

**Conflict of Interest:** Nothing to disclose.

**Funding Disclosure:** Nothing to disclose.

## References

1. Tarvonen-Schröder S, Niemi T, Koivisto M. Clinical and functional differences between right and left stroke with and without contralateral spatial neglect. *J Rehabil Med* 2020; 52:jrm00072.

2. Yoshida T, Mizuno K, Miyamoto A, Kondo K, Liu M. Influence of right versus left unilateral spatial neglect on the functional recovery after rehabilitation in sub-acute stroke patients. *Neuropsychol Rehabil* 2020; 23:1-22. doi: 10.1080/09602011.2020.1798255.
3. Lucente G, Valls-Sole J, Murillo N, Rothwell J, Coll J, Davalos A, et.al. Noninvasive Brain Stimulation and Noninvasive Peripheral Stimulation for Neglect Syndrome Following Acquired Brain Injury. *Neuromodulation* 2020; 23:312-323. doi: 10.1111/ner.13062.
4. Zhang RG, Liu SX, Wang FY, Ma XC, Yang YH. [Treatment of Unilateral Neglect using Repetitive Transcranial Magnetic Stimulation (rTMS) and Sensory Cueing (SC) in Stroke Patients]. *Sichuan Da Xue Xue Bao Yi Xue Ban*. 2017; 48:309-313.
5. yffeler T, Vanbellinghen T, Kaufmann BC, Pflugshaupt T, Bauer D, Frey J, et.al. Theta burst stimulation in neglect after stroke: functional outcome and response variability origins. *Brain*. 201; 142:992-1008. doi: 10.1093/brain/awz029.
6. Karner S, Stenner H, Spate M, Behrens J, Krakow K. Effects of a robot intervention on visuospatial hemineglect in postacute stroke patients: a randomized controlled trial. *Clin Rehabil* 2019; 33:1940-1948. doi: 10.1177/0269215519865993.
7. Park JH. The effects of robot-assisted left-hand training on hemispatial neglect in older patients with chronic stroke: A pilot and randomized controlled trial. *Medicine (Baltimore)* 2021; 100:e24781. doi: 10.1097/MD.00000000000024781.
8. Choi YS, Lee KW, Lee JH, Kim SB, Park GT, Lee SJ. The Effect of an Upper Limb Rehabilitation Robot on Hemispatial Neglect in Stroke Patients. *Ann Rehabil Med* 2016; 40:611-9. doi: 10.5535/arm.2016.40.4.611.
9. Liu KPY, Hanly J, Fahey P, Fong SSM, Bye R. A Systematic Review and Meta-Analysis of Rehabilitative Interventions for Unilateral Spatial Neglect and Hemianopia Poststroke From 2006 Through 2016. *Arch Phys Med Rehabil* 2019; 100:956-979. doi: 10.1016/j.apmr.2018.05.037.
10. Ten Brink AF, Visser-Meily JMA, Schut MJ, Kouwenhoven M, Eijsackers ALH, Nijboer TCW. Prism Adaptation in Rehabilitation? No Additional Effects of Prism Adaptation on Neglect Recovery in the Subacute Phase Poststroke: A Randomized Controlled Trial. *Neurorehabil Neural Repair* 2017; 31:1017-1028. doi: 10.1177/1545968317744277.
11. Ogourtova T, Souza Silva W, Archambault PS, Lamontagne A. Virtual reality treatment and assessments for post-stroke unilateral spatial neglect: A systematic literature review. *Neuropsychol Rehabil* 2017; 27:409-454. doi: 10.1080/09602011.2015.1113187.
12. Rossit S, Benwell CSY, Szymanek L, Learmonth G, McKernan-Ward L, Corrigan E, et.al Efficacy of home-based visuomotor feedback training in stroke patients with chronic hemispatial neglect. *Neuropsychol Rehabil*. 2019; 29:251-272. doi: 10.1080/09602011.2016.1273119.
13. van der Kemp J, Dorresteyn M, Ten Brink AF, Nijboer TC, Visser-Meily JM. Pharmacological Treatment of Visuospatial Neglect: A Systematic Review. *J Stroke Cerebrovasc Dis*. 2017; 26:686-700. doi: 10.1016/j.jstrokecerebrovasdis.2017.02.012.
14. Klinke ME, Hafsteinsdóttir TB, Hjaltason H, Jónsdóttir H. Ward-based interventions for patients with hemispatial neglect in stroke rehabilitation: a systematic literature review. *Int J Nurs Stud*. 2015; 52:1375-403. doi: 10.1016/j.ijnurstu.2015.04.004.
15. Nakamura J, Kita Y, Ikuno K, Kojima K, Okada Y, Shomoto K. Influence of the stimulus parameters of galvanic vestibular stimulation on unilateral spatial neglect. *Neuroreport*. 2015; 26:462-6. doi: 10.1097/WNR.0000000000000369.