Afr J. Med. Med. Sci. (2017) 46, 83-91

Effects of trunk rotation and limb activation in the management of unilateral spatial neglect in adult stroke survivors

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Abstract

Background: Unilateral Spatial Neglect (USN) is a disabling feature and a frequent behavioural syndrome in stroke survivors. This study was designed to determine the effects of trunk rotation and limb activation in the management of USN in adult stroke survivors.

Method: Participants were 19 stroke survivors with USN. They were randomly assigned to an intervention group (n=10) and a control group (n=9). All participants took part in conventional physiotherapy protocol thrice a week for four weeks. During the same period, participants in the intervention group also received trunk rotation and limb activation treatment. Cognition, Functional Independence in Activities of Daily Living (ADLs) and severity of USN were assessed using Mini-Mental State Examination (MMSE), Barthel Index (BI) and Behavioural Inattention Test (BIT) respectively.

Results: In the Intervention group, the mean BIT scores increased from 111.20±44.87 to 209.60±13.48, mean BI scores increased from 42.50±29.74 to 74.00±18.07, while MMSE scores increased from 26.60±1.71 to 28.50±1.51. The changes were significant ($p \leq 0.05$). In the Control group, the mean BIT scores increased from 130.56±32.99 to 195.89±14.59, mean BI scores increased from 81.11±26.67 to 91.67±11.18, while MMSE scores increased from 27.33±1.23 to 28.56±0.53. The changes were significant ($p \leq 0.05$) except for the BI score. Between-group comparison showed significant post-intervention differences in BIT and BI ($p < 0.05$) scores, but not in MMSE score.

Conclusion: It was concluded that conventional physiotherapy, trunk rotation and limb activation were efficacious in the management of USN in stroke survivors.

Keywords: *Stroke, physiotherapy, unilateral spatial neglect, trunk rotation, limb activation.*

Résumé

Contexte: La Négligence Spatiale Unilatérale (NSU) est une caractéristique handicapante et un syndrome comportemental fréquent chez les survivants d'attaque paralytique. Cette étude a été conçue pour déterminer les effets de la rotation du tronc et de l'activation des membres dans la prise en charge de l'NSU chez les survivants adultesd'attaque paralytique.

Méthode: Les participants étaient 19 survivants d'attaque paralytique avec NSU. Ils ont été répartis au hasard entre un groupe d'intervention (n = 10) et un groupe témoin (n = 9). Tous les participants ont pris part au protocole de physiothérapie conventionnelle trois fois par semaine pendant quatre semaines. Au cours de la même période, les participants au groupe d'intervention ont également reçu une rotation du tronc et un traitement d'activation des membres. La cognition, l'indépendance fonctionnelle dans les activités de la vie quotidienne (AVQ) et la gravité de l'NSU ont été évalués à l'aide du Mini- Examen de l'Etat Mental (MEEM), l'IndexBarthel (IB) et du Test d'InattentionComportemental (TIC) respectivement.

Résultats: Dans le groupe d'Intervention, les scores moyens de TIC ont augmenté de 111.20 ± 44.87 à 209.60 ± 13.48, les scores moyens d'IB ont augmenté de 42.50 ± 29.74 à 74.00 ± 18.07, tandis que les scores de MEEM sont passés de 26.60 ± 1.71 à 28.50 ± 1.51. Les changements étaient significatifs (pd"0,05). Dans le groupe témoin, les scores moyens de BIT ont augmenté de 130,56 ± 32,99 à 195,89 ± 14,59, les scores moyens d'IB ont augmenté de 81,11 ± 26,67 à 91,67 ± 11,18, tandis que les scores de MEEM ont augmenté de 27,33 ± 1,23 à 28,56 ± 0,53. Les changements étaient significatifs (pd"0,05), sauf pour le score IB. La comparaison entre les groupes a montré des différences significatives après l'intervention dans les scores TIC et IB ($p < 0,05$), mais pas dans le score MEEM.

Conclusion: Il a été conclu que la physiothérapie conventionnelle, la rotation du tronc et l'activation des membres étaient efficaces dans la prise en charge de l'NSU chez les survivants d'attaque paralytique.

Mots-clés: *Attaque paralytique, physiothérapie, négligence spatiale unilatérale, rotation du tronc, activation des membres.*

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Introduction

Unilateral Spatial Neglect (USN) is one of the disabling features and a common behavioural syndrome in patients with stroke [1,2]. It is a neuropsychological disorder characterized by the inability to orient, explore, report or respond to stimuli appearing on the side contralateral to the brain lesion i.e. patients with USN fail to be aware of or acknowledge items on the contra lesional side (the left side for patients with right brain lesion) and attend instead to items towards the same side as the brain damage (the ipsi lesional side) [3,4]. Unilateral spatial neglect may be so profound that patients are unaware of large objects or even people in extra personal space and the neglect may also extend or be confined to personal space with patients failing to acknowledge their own contra lesional body parts in Activities of Daily Living (ADLs) [3,5].

Among stroke associated impairments that result in clinical deficit, the presence of USN has been consistently associated with slower functional progress during rehabilitation (longer rehabilitation and longer length of stay in the hospital), reduced ability to function in ADLs (most especially self-care activities), a greater risk for falls, poor functional recovery, and degrading Quality of Life (QoL) [6-9]. The reported prevalence of USN varies widely from 10% to 82% following right hemispheric stroke and from 15% to 65% following left hemispheric stroke [10,11]. Unilateral spatial neglect is frequently observed in right-handed patients following right hemispheric brain damage [13,14] and may also result from damage to the following parts of the brain: posterior parietal cortex, frontal lobe, cingulate gyrus, striatum and thalamus [10,13,14].

The presence of USN may be determined on the basis of a left-right asymmetry in performance of a variety of measures including line and letter cancellation, reading, drawing, mental imagery, attention to the body and naturalistic action tasks [5]. Different assessment tools have been developed for assessing USN in people who have suffered stroke. These instruments range from paper and pencil tests e.g. Albert's Test [15], Diller's Test [16], Line Bisection test [17], figure copying [18], Bells test [19], writing tests to behavioural tests e.g. the Behavioural Inattention Test (BIT), the Catherine Bergego Scale (CBS) and the Perceptual Assessment Battery [20-23].

Spontaneous recovery usually occurs in the majority of USN but symptoms remain severe in some patients [24]. Different treatment approaches have been developed to manage USN [25,26]. The treatments for USN fall under two types of behavioural approaches [2]. They are either recruiting the hemiplegic limbs to reduce a spatial preference over the ipsilesional space or improving awareness of contra lesional space to promote patients' attention [2,27]. Some of the approaches used in the management of USN include constraint-induced therapy [28], limb activation [29], neck muscle vibration [30], Functional Electrical Stimulation (FES) [31], trunk rotation [32], Transcutaneous Electrical Nerve Stimulation (TENS) [33], ipsilateral eye patching [34], spatial cueing [35] and visual scanning therapy [36].

It has been reported that trunk rotation therapy elicited improvement in patients with USN and it has been proposed that this effect is based on the relationship of the trunk position to the neck position [37]. Limb activation treatment consists of the joint activation of spatio-motor brain maps that enhance conscious representation of specific spatial sectors and may also facilitate multisensory integration [29,38]. Limb activation is based on the idea that any movement of the contra lesional side may function as a motor stimulus activating the brain and improving USN [37]. Empirical evidence which would be included in treatment approaches in the management of USN in stroke survivors would be of immense importance to clinical practice. Hence, this study was designed to evaluate the effects of trunk rotation and limb activation in the management of USN in adult stroke survivors.

Method

The study participants were drawn from a population of patients with stroke referred for outpatient management in two tertiary hospitals in Lagos metropolis. Inclusion criteria were first-episode single stroke with USN, stroke duration of less than six months, scoring less than 196 for the total Behavioural Inattention Test (BIT) and more than 23 points on the Mini-Mental State Examination (MMSE). Random assignment of participants to an intervention group or a control group was done by asking them to blindly draw one of two crushed pieces of paper from a can. Prior to the commencement of the study, ethical approval was sought and obtained from the Health Research and Ethics Committees of the two hospitals (ADM/DCST/HREC/2070 and LREC/10/06/455). Participants also gave written informed consent to take part in the study. A flowchart of the recruitment and allocation of subjects is presented in Figure 1.

On each day of treatment / training, participants observed a pre-exercise rest period of

10 minutes. Thereafter, participants in the intervention group received conventional physiotherapy protocol followed by counselling on USN and half an hour trunk rotation and limb activation treatment. Those in the control group took part in conventional physiotherapy protocol followed by counselling on USN. The conventional physiotherapy protocol consisted of active and passive range of motion (ROM) exercises, strength training, balance training, motor learning techniques and proprioceptive neuromuscular facilitation techniques. These procedures were carried out thrice a week; and for a total duration of four weeks.

Trunk rotation was performed by assisting or actively rotating the trunk 15–35 degrees from the vertical midline toward the neglected side within the peri-personal space. The important element is that the upper trunk initiates the rotation by activating the ipsilesional upper extremity which moves across the midline of the body to the contra lesional space by visual spatial motor cueing. The trunk rotation was performed in three different positions: supine lying on a mat, sitting unsupported on a plinth and standing in a standing frame with feet together. Limb activation is the active or assisted movement of the left upper and lower limbs along the left hemispace. The essentials of the method involve encouraging the participants to actively move the left extremities even in a small range during exploration of space. The movements were performed grossly for both upper and lower limbs and in three different positions: supine lying on a mat, sitting unsupported on a plinth, and standing in a standing frame.

The assessment protocol followed this sequence: Mini-Mental State Examination (MMSE), Barthel Index (BI) assessment and Behavioural Inattention Test (BIT). The MMSE is a brief screening tool that provides a quantitative assessment of cognitive impairment. It consists of 11 simple questions or tasks, typically grouped into 7 cognitive domains: orientation to time, orientation to place, registration of three words, attention and calculation, recall of three words, language and visual construction. The test yields a total score of 30; and levels of impairment are classified as: none (24-30); mild (18-23) and severe (0-17) [39]. The Barthel Index consists of ten common functional ADLs and administered through direct observation. Eight of the items represent activities related to personal care: feeding, bathing, grooming, dressing, bowels continent, bladder continent, toilet use and transfer (bed to chair and back); the remaining two are related to mobility on level surfaces and stairs. The index yields a total score out of 100, the higher the score, the greater the degree of functional independence [40].

The BIT was assessed by sitting the patient on a chair and a table placed in front of the patient. The BIT is a 15-item standardized test battery for assessing USN. It is divided into two major sections, each of which has its own set of subtests. The conventional section of the BIT (BITC) comprised the following 6 subtests: line crossing, letter cancellation, star cancellation, figure and shape copying, line bisection, and representational drawing. The behavioural section of BIT (BITB) comprised the following 9 subtests: picture scanning, phone dialling, menu reading, article reading, telling and setting the time, coin sorting, address and sentence copying, map navigation, and card sorting [41]. The BIT yields a total score of 227 with lower scores indicating greater degrees of USN [42]. Cut-offs have been established for the total BIT as well as for each of the subsections such that a diagnosis of USN is suggested if a patients' score is lower than the cut-off [7,43]. The cut-off for the total BIT is 196 out of 227, 129 out of 146 for the BITC, and 67 out of 81 for the BITB [44]. The severity of USN can also be ranged as severe (BITC score 1–65) and less severe (BITC score 66–128).

Participants in both groups were assessed on the outcome measures pre- and post-intervention. Treatment administration and assessment of outcomes were done by different therapists. Scores from the subsets of MMSE, BI and BIT were summed together to provide the total score for each specific assessment at baseline and post-intervention.

Data were analysed using the Statistical Package for Social Sciences (SPSS) version 17.0. Mann-Whitney *U* test and Wilcoxon signed-rank test were used for comparisons between the baseline and post-intervention assessment scores between groups and within groups respectively. Spearman's rank correlation coefficient (r) was used to determine relationship between functional recovery of ADLs, cognition and severity of USN at baseline. The level of significance was $p \leq 0.05$.

Results

A total of 59 patients with right hemispheric stroke were screened for inclusion in the study. Nineteen (19) subjects comprising 13 males and 6 females satisfied the inclusion criteria. There were ten (10) patients in the Intervention group and nine (9) in the Control group. The socio-demographic and clinical profile of the patients is presented in Table 1.

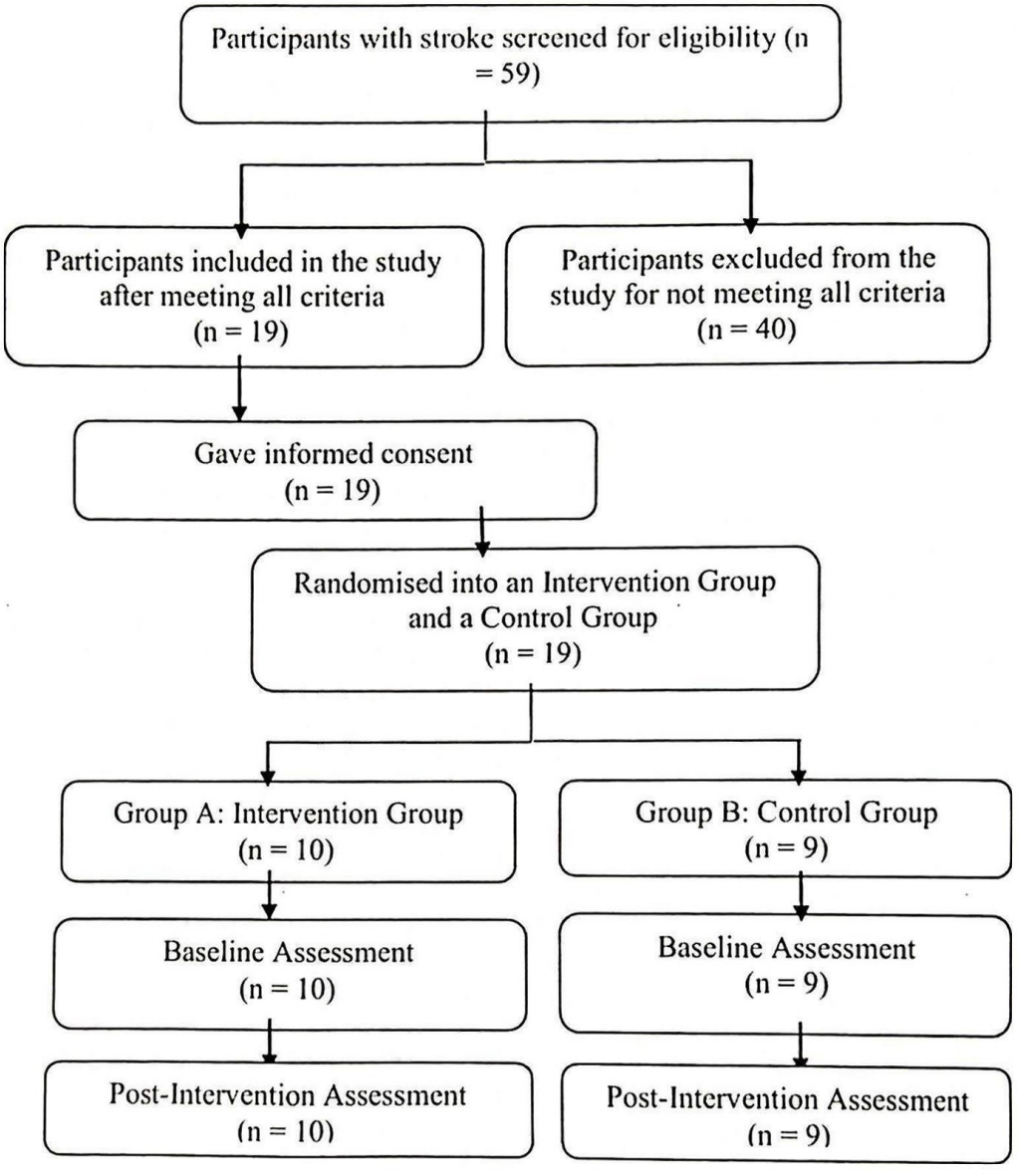
Participants with stroke screened for eligibility (n = 59)
Participants included in the study after meeting all criteria (n = 19)
Participants excluded from the study for not meeting all criteria (n = 40)
Gave informed consent (n = 19)
Randomised into an Intervention Group and a Control Group (n = 19)
Group A: Intervention Group (n = 10)
Group B: Control Group (n = 9)
Baseline Assessment (n = 10)
Baseline Assessment (n = 9)
Post-Intervention Assessment (n = 10)
Post-Intervention Assessment (n = 9)

Table 1: Socio-demographic and clinical profile of participants at baseline

Characteristics	Parameters	Intervention Group Mean±SD	Control Group Mean±SD	*z*-value	*p*-value
BaselineAssessment	Age (years)	52.50±8.48	55.67±8.31	-0.777	0.437
	Weeks post stroke	5.30±4.30	9.11±5.82	-1.521	0.128
	Length of hospital stay (days)	3.10±1.10	3.44±1.13	-0.907	0.365
	Days of unconsciousness	0.70±2.21	0.00±0.00	0.949	0.343
	Pre-BIT	111.20±44.87	130.56±32.99	-1.143	0.253
	Pre-BI	42.50±29.74	81.11±26.67	-2.711	0.007*
	Pre-MMSE	26.60±1.71	27.33±1.22	-0.930	0.352

*Significant at $p \leq 0.05$

Key
z-value: Wilcoxon rank-sum test value
SD: Standard Deviation
Pre-MMSE: Pre-Intervention Mini-Mental State Examination
Pre-BI: Pre-Intervention Barthel Index
Pre-BIT: Pre-Intervention Behavioural Inattention Test

Table 2: Changes in outcome measures within the groups

Groups	Outcome Measures	Pre-Intervention Mean±SD	Post-Intervention Mean±SD	*z*-value	*p*-value
Intervention Group					
	BIT	111.20±44.87	209.60±13.48	-2.803	0.005*
	BI	42.50±29.74	74.00±18.07	-2.680	0.007*
	MMSE	26.60±1.71	28.50±1.51	-2.699	0.007*
Control Group					
	BIT	130.56±32.99	195.89±14.59	-2.668	0.008*
	BI	81.11±26.67	91.67±11.18	-1.826	0.068
	MMSE	27.33±1.23	28.56±0.53	-2.414	0.016*

**Significant at $p \leq 0.05$*

Key
z-value: Wilcoxon signed-rank test
SD: Standard Deviation
MMSE: Mini-Mental State Examination
BI: Barthel Index
BIT: Behavioural Inattention Test

Changes in outcome measures

The changes in outcome measures for the two groups are shown in Table 2. In the Intervention group, the mean BIT scores increased from 111.20±44.87 to 209.60±13.48, mean BI scores increased from 42.50±29.74 to 74.00±18.07, while MMSE scores increased from 26.60±1.71 to 28.50±1.51 after 4 weeks of rehabilitation. The changes were significant ($p \leq 0.05$). In the Control group, the mean BIT scores increased from 130.56±32.99 to 195.89±14.59, mean BI scores increased from 81.11±26.67 to 91.67±11.18, while MMSE scores increased from 27.33±1.23 to 28.56±0.53 after 4 weeks of rehabilitation. The changes in BIT and MMSE scores were significant ($p \leq 0.05$).

Table 3: Between group comparison of changes in outcome measures

Outcome Measure	Intervention group Mean±SD	Control group Mean±SD	*U*-value	*z*-value	*p*-value
BIT	-98.40±38.83	-65.33±22.42	21.00	-1.960	0.050*
BI	-31.50±23.58	10.56±17.76	18.50	-2.207	0.027*
MMSE	-1.90±1.52	-1.22±0.97	34.00	-0.944	0.345

**Significant at $p \leq 0.05$*

Key
U-value: Mann-Whitney U value
z-value: Wilcoxon rank-sum test value
SD: Standard Deviation
MMSE: Mini-Mental State Examination
BI: Barthel Index
BIT: Behavioural Inattention Test

Between-group comparison of mean changes in outcome measures

The mean changes in the pre-intervention and post-intervention scores of MMSE, BI and BIT scores of the participants in both groups were compared. The comparisons are shown in Table 3. There was a significant difference ($p \leq 0.05$) in changes of BI and BIT scores between the intervention and control groups but there was no significant difference in MMSE scores ($p > 0.05$).

Discussion

This study was conducted to evaluate the effects of trunk rotation and limb activation in the management of unilateral spatial neglect (USN) in adult stroke survivors. Significant differences were observed between the baseline and post-intervention scores of Behavioural Inattention Test (BIT), Barthel Index (BI) and Mini-Mental State Examination (MMSE) in participants treated with conventional physiotherapy protocol combined with trunk rotation and limb activation. This means that the severity of USN reduced, functional recovery of ADLs increased and cognition increased. Also, changes in BIT and BI scores between the intervention and control groups were significant at the end of four weeks of intervention.

The small sample size was one of the limitations of this study. A larger number of patients would probably have yielded more robust and comparable results. Also, subjects for the study were heterogeneous (i.e. ischaemic and haemorrhagic) in terms of nature of stroke. Functional outcomes of rehabilitation in such patients are more difficult to elicit than in a homogeneous group of patients with stroke. The results of the study might also have been weakened by the fact that different physiotherapists conducted the treatments and assessments. Patient management was also limited to 3 sessions per week and the total duration was four weeks.

Patients in the two groups recorded significant changes in BIT scores after four weeks of rehabilitation; but changes observed in the intervention group were higher. Similar results have been reported in other studies. In a study [45] it was reported that stroke survivors with USN in the limb activation group recovered signiûcantly in the Conventional section of Behavioural Inattention Test (BITC) scores after rehabilitation. Reduction in severity of USN had also been reported in patients who had conventional physiotherapy protocol combined with trunk rotation and visual scanning [46]. In another study, subjects who were treated using the limb activation approach demonstrated reduction in USN in a single-subject series using either a scanning and cueing strategy or a left-limb activation strategy [47].

The outcome of this study also showed that there was significant difference between the baseline and post-treatment scores of BIT and MMSE in participants treated with conventional physiotherapy protocol. This indicates a reduction in severity of USN and increase in cognition in stroke survivors treated with conventional physiotherapy protocol. In some studies [2,32,46], conventional physiotherapy protocol was reported to have yielded results similar to those of the present study. There was no significant difference between the baseline and post-treatment scores of BI in participants treated with conventional physiotherapy protocol. This means that there was no significant change in the functional recovery of

ADLs. Hence, the outcome of this study did not demonstrate any beneficial effect of conventional physiotherapy protocol on functional recovery of ADLs.

The results of the study also showed reduction in the severity of USN and increase in functional recovery of ADLs in the intervention group compared with the control group. This finding is different from the reports of another study where it was reported that there was no significant difference among voluntary trunk rotation, voluntary trunk rotation and half-field eye-patching and controls in functional performance and severity of USN after 30 days of intervention [32]. In the same study [32], it was reported that voluntary trunk rotation was initiated by the ipsilesional (right) hand and this might abolish the advantage of left limb activation, and therefore might provide an explanation as to why the trunk rotation group had resulted in improvements in mobility rather than unilateral neglect. Another study [2] reported that participants who had sensory cueing and limb activation treatment were not different from those that did not receive sensory cueing and limb activation treatment to reduce USN.

The outcome of this study also showed that there was significant relationship between severity of USN, functional recovery of ADLs and cognition in right hemispheric stroke survivors with USN at baseline. This observation is similar to that made in an earlier study [47] where it was reported that patients with USN have greater functional disabilities. In another study [7] it was reported that there was correlation and significant association between severity of USN and functional recovery of ADLs measured with FIM at admission. Also, it has been stated that patients with USN have lower FIM scores than patients without USN, and USN is a major predictor of func-tional outcome from admission to follow up in patients with left hemiplegic stroke [2].

Conclusion

Based on the findings of this study, it was concluded that conventional physiotherapy and conventional physiotherapy protocol combined with trunk rotation and limb activation were efficacious in the management of USN in stroke survivors. The present study did not examine the influence of premorbid hand dominance/laterality on recovery of USN and this is recommended for further studies.

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