RESEARCH ARTICLE

The Relationship between Poststroke Depression and Upper Limb Recovery in Patients Admitted to a Rehabilitation Unit

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Abstract

Objective: We sought to determine the relationship between poststroke depression and upper limb recovery in a cohort of patients admitted to a rehabilitation center in Singapore.

Method: We conducted a secondary analysis of an interventional study of 105 patients with a stroke. Depression was diagnosed using the Centre for Epidemiological Studies Depression Scale (CES-D) and this was correlated with the following measures: Fugl-Meyer Assessment of Upper Limb (FMA), Action Research Am Test (ARAT), Stroke Impact Scale - Upper Limb Items (SIS) and Functional Independence Measure-Selfcare (FIM-Selfcare) at 3, 7 and 15 weeks after admission to rehabilitation.

Results: Poststroke depression was present in 20% of patients on admission to rehabilitation. It was negatively correlated to SIS and FIM-Selfcare at 7 weeks and to FMA, ARAT, SIS and FIM-Selfcare at 15 weeks after rehabilitation admission. Depression on rehabilitation admission did not influence upper limb recovery at 3 weeks, 7 weeks, and 15 weeks after admission to rehabilitation.

Conclusion: Given the negative impact of depression on upper limb impairment, function and performance of selfcare, routine screening of depression should be considered in subacute stroke patients, especially in those with poorer upper limb function.

Keywords

Stroke; depression; upper limb; recovery

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Introduction

Post-stroke depression (PSD) is one of the most common neuropsychiatric sequelae after stroke with one recent meta-analysis reporting that 31% of patients developed depression at any time point up to 5 years following stroke.[1] PSD is associated with impaired performance in activities of daily living, especially in those with severe PSD.[1] PSD on initial examination after stroke also predicts poor functional recovery after stroke. 2-5 In a study of 390 stroke patients, Pohjasvaara et al. demonstrated that patients with PSD using the Beck's Depression Inventory had poorer functional outcome as measured on the Rankin Scale and Barthel Index at 3 months and 15 months poststroke.[4]

While the impact of PSD on functional status is well elucidated, what is less known is the relationship between PSD and upper limb recovery. Understanding this is relevant given that upper limb weakness is a common consequence after stroke, with up to 66% of survivors experiencing upper limb impairment at 6 months after stroke onset.[6] Loss of upper limb function is associated with greater dependence in the performance of selfcare skills like feeding, dressing and bathing.[7] A literature review revealed only 2 studies looking at PSD and upper limb recovery and these were in Western patients. Weaver et al, in a retrospective secondary analysis of an upper limb interventional study, examined the relationship between minimal depression as measured on the Beck's Depression Inventory and upper limb impairment and function in 122 patients, and reported no relationship between minimal

depression and upper limb impairment and function.[8] In the other study of 20 stroke patients taking part in a repetitive task practice program, cognitive impairments and depressive symptoms had no significant impact on upper limb recovery.[9] Thus, it appears that the relationship between PSD and upper limb recovery is still uncertain, and it is for this reason that this retrospective study was conducted.

Methods

Study design

This study was a secondary analysis of data gathered as part of a three-group randomized, controlled trial comparing virtual reality gaming with matched-duration conventional therapy, and control, in subjects with upper limb weakness within 6 weeks of a stroke, admitted to a rehabilitation unit in Singapore. The methodology and results of this study has been published recently.[10] The study showed that a 3-week period of augmented upper limb exercises via virtual reality or conventional therapy did not enhance upper limb motor recovery compared to control. As part of the study, depressive symptoms as measured on the Centre for Epidemiologic Studies Depression Scale (CES-D) were captured. [11]

Participants

Subjects admitted to the inpatient stroke rehabilitation program of a rehabilitation centre in Singapore and who met the following inclusion and exclusion criteria were eligible for the study:

- Inclusion criteria
- Age 21 - 80 years
- First clinical stroke, ischemic or hemorrhagic, with diagnosis of stroke confirmed on CT/MRI brain scan.
- Less than 6 weeks after stroke onset
- Upper limb weakness of Medical Research Council (MRC) motor power of grade 2-4 motor power in the shoulder, elbow or the fingers of the hemiplegic upper extremity
- Subject is able to understand simple instructions and learn

Exclusion criteria

- Recurrent stroke
- History of epilepsy
- Presence of arthritis or pain in the affected upper limb restricting repetitive exercises
- Severe aphasia or cognitive impairment, or other psychiatric illnesses that limits ability to participate or give consent.

Study procedures and intervention

After giving informed consent, eligible subjects were allocated to one of 3 groups according to a pre-determined block randomization schedule using computer-generated random numbers. The 3 groups were a) virtual reality gaming, b) matched duration conventional therapy, and c) control. Subjects in the first two groups received 12 sessions of the assigned treatment delivered 4 times a week over 3 weeks, with each session lasting about 60 minutes. As part of their standard inpatient rehabilitation program, all subjects also received one hour of physical and occupational therapy daily from Monday to Friday.

Assessment intervals

All subjects were assessed at the following intervals:

1. Before intervention (week 0)
2. After intervention (week 3)
3. Four weeks after intervention (week 7)
4. Twelve weeks after intervention (week 15)

Baseline and outcome measures

Baseline characteristics, including demographics (age and gender) and co-morbid conditions, and stroke characteristics, including location, type and stroke severity, were collected and assessed on the National Institute of Health Stroke Scale (NIHSS).[12]

The outcome measures were

- Centre for Epidemiological Studies Depression Scale (CES-D). The CES-D comprises 20 self-report questions and has been validated in stroke patients.[11] Depression was defined as a score of ≥ 16.
- Fugl-Meyer Assessment of Upper Limb (FMA). This measures upper limb impairment and scores from 0 to 66, the higher the score, the less the impairment.[13]
- Action Research Arm Test (ARAT). This measures arm and hand function and ranges from 0 to 57, the higher the score, the better the upper limb function. [14]
- Stroke Impact Scale - Upper Limb Items (SIS). This evaluates use of the affected upper limb in activities of daily living.[15] It measures the ability to perform five upper limb activities ranging from carrying heaving objects to picking up a dime, and scores from 5 to 25, with 25 indicating optimal upper limb functions.
- Selfcare domains of the Functional Independence Measure (FIM-Selfcare) to measure ability to perform selfcare activities.[16] The domains measured include feeding, grooming, dressing, toileting, bathing and bladder and bowel continence.

All study interventions were conducted by dedicated trial staff and the outcome measures were measured by two trained raters who were not involved in administration of study interventions and were blinded to subject randomization. The ethics committee of the local institution approved the study protocol.

Statistical analysis

The sample size for this study was calculated to be 105.10 Statistical analyses was carried out using SPSS software (version 16). The independent sample t test was used for comparison of continuous variables between subjects with and without depressive symptoms. For categorical variables, *chi*-square test was used. Descriptive statistics, independent sample *t* - test, *chi*-square test and Pearson correlation coefficients were used to analyze the subjects' relevant characteristics and for each variable as required. All tests were carried out at 5% level of significance.

Results

From December 2011 to January 2013, a total of 105 subjects were enrolled in the study. Three subjects did not complete the study intervention (2 withdrew from the study and 1 died), 3 subjects did not complete week 7 (lost to follow up) and 2 subjects did not complete week 15 evaluation. The number of subjects evaluated at week 3, week 7 and week 15 were 102, 99 and 97 respectively.

Rates of depression over time

Patients were enrolled at a mean of 13.7±8.9 days after stroke. At week 0 (baseline), 21 subjects (20%) had depression. The demographic and baseline characteristics of subjects with and without depression are shown in Table 1. There were no statistically significant differences in age, gender, (ethnicity) nature and site of stroke, NIHSS, FMA, ARAT, SIS and FIM-Selfcare scores between subjects with and without depression. At weeks 3, 7 and 15, the number of subjects with depression were 11 (10.8%), 18 (18.2%) and 15 (18.6%) respectively. Of the 21 patients who had depression at week 0, 15 recovered at week 15. Patients who recovered from depression had significantly higher week 15 mean FMA (43.1±16.3 vs 27.0±16.0, p=0.05), ARAT (33.8±20.3 vs 17.1±14.5, p=0.05), SIS (16.2±6.7 vs 6.3±3.2, p=0.001) and FIM (51.0±7.1 vs 33.5±14.7, p=0.03) scores than those who remained depressed. On the other hand, of the 84 patients without depression at week 0, 13 developed depression at week 15. Apart from the FIM score, patients who developed depression at had significantly lower week 15 FMA (24.5±18.1 vs 41.5±20.1, p=0.007), ARAT (15.1±16.4 vs 33.6±20.5, p=0.002) and SIS (7.5±5.6 vs 13.4±7.8, p=0.004) scores than non-depressed patients. The week 15 FIM score was however not significantly different between depressed and non-depressed patients (43.1±12.7 vs 48.9±9.7, p=0.11).

Table 1. Baseline clinical characteristics of study cohort

Clinical variable	Depression Yes	No	*p* value
*Age at stroke onset (yrs)	57.9±11.0	56.7±15.0	0.67
Gender			
Male	16	61	0.74
Female	5	23	
Ethnicity			
Chinese	15	68	0.50
Malay	3	9	
Indian	3	7	
Time from stroke to randomization (days)	14.4±8.9	13.7±8.9	0.72
Side of hemiparesis			
Left	15	67	0.39
Right	6	17	
Stroke type			
Infarct	15	50	0.45
Haemorrhage	6	34	
Site of stroke			
Cortical	5	23	0.45
Subcortical	13	40	
Brainstem	3	21	
*NIHSS score	6.6±1.7	6.3±1.7	0.38
*FMA score	17.1±14.9	13.2±10.4	0.26
*ARAT score	4.6±8.8	7.9±13.5	0.29
*SIS score	6.3±2.5	6.8±2.9	0.49
*FIM-Selfcare score	68.9±15.9	74.0±15.1	0.17

*mean (standard deviation)

Relationship between depression and upper limb recovery over time

The relationship between depression and measures of upper limb and selfcare function are shown in Table 2. Subjects with depression had significantly lower SIS and FIM-Selfcare scores at week 7 (p=0.05), and lower FMA, ARAT, SIS and FIM-Selfcare scores at week 15 (p<0.001).

Table 2. Correlation between depression and upper limb measures over time

Depression	Yes	No	*p* value (95% CI)
Week 3			
FMA	34.3±18.4	29.4±18.4	0.40 (-16.0, 6.4)
ARAT	25.3.0±18.4	19.0±18.2	0.27 (-17.5, 4.9)
SIS	8.5±5.8	9.5±6.4	0.59 (-2.8, 4.8)
FIM-Selfcare	33.7±9.2	38.6±9.1	0.08 (-0.6, 10.4)
Week 7			
FMA	32.4±19.3	30.7±20.7	0.40 (-6.2, 14.8)
ARAT	22.6±20.9	27.1±22.	00.42 (-6.7, 15.7)
SIS	8.8±5.3	12.4±7.3	0.05 (-0.1, 7.1)
FIM-Selfcare	42.1±12.2	47.2±9.6	0.05 (-0.1, 10.3)
Week 15			
FMA	25.3±17.2	41.8±19.6	0.001 (6.8, 28.1)
ARAT	15.7.0±15.4	33.7±20.8	0.001 (7.8, 27.9)
SIS	7.1±4.9	13.9±7.7	0.001 (3.2, 0.5)
FIM-Selfcare	25.3±17.2	41.8±19.5	0.001 (4.1, 14.3)

Depression at baseline and its impact on upper limb recovery

The presence of baseline depression did not significantly influence upper limb recovery or selfcare function over time (Table 3). Similar improvements in FMA, ARAT, SIS and FIM-Selfcare scores at weeks 3, 7 and 15 were noted patients with and without baseline depression.

Apart from the above, significant correlations were also noted between the various outcome measures. FMA was highly correlated to ARAT (correlation coefficient ranging from 0.86 to 0.95), moderately correlated to SIS (correlation coefficient ranging from 0.60 to 0.78) and mildly correlated to FIM-Selfcare score (correlation coefficients ranging from 0.25 to 0.47).

Table 3. Depression at baseline and upper limb measures over time

Depression (Baseline)	Yes	No	*p* value (95%CI)
Week 3			
FMA	29.8±14.5	30.0±19.2	0.95 (-8.6, 9.2)
ARAT	17.7±16.6	20.2±18.8	0.58 (-6.5, 11.4)
SIS	9.1±5.8	9.5±6.4	0.79 (-2.6, 3.4)
FIM-Selfcare	37.3±10.2	38.1±8.8	0.88 (-4.1, 4.8)
Week 7			
FMA	37.1±18.0	35.7±21.1	0.77 (-11.6, 8.2)
ARAT	26.1±21.2	26.4±22.0	0.96 (-10.6, 10.2)
SIS	11.3±6.2	11.9±7.3	0.72 (-2.8, 4.4)
FIM-Selfcare	45.7±10.3	46.5±10.3	0.76 (-4.4, 5.8)
Week 15			
FMA	38.5±17.6	38.8±20.7	0.94 (-9.1, 10.8)
ARAT	29.3±21.2	30.6±20.0	0.75 (-8.5, 11.2)
SIS	13.4±7.4	12.5±7.8	0.65 (-4.1, 2.6)
FIM-Selfcare	46.3±12.2	48.1±10.4	0.45 (-3.7, 6.8)

Discussion

While the impact of poststroke depression on functional status is fairly well studied and established,1 what is less known is its impact on specific motor impairments and function, in particular, that of the upper limb. To the best of our knowledge, there are only 2 previous studies evaluating the impact of poststroke depression on upper limb function. The first study was a retrospective secondary analysis of an upper limb interventional study involving 122 patients within 6 months of a stroke, where the relationship between minimal depression and upper limb impairment and function before upper limb intervention was explored.[8] Depression was measured using the Beck's Depression Inventory while upper limb impairment and function were measured using the Fugl-Meyer Assessment and Arm Motor Activity Test respectively. No significant association between depression and upper limb measures of impairment and function was reported. The second study looked at the impact of baseline cognitive impairments and depression on upper limb recovery in 20 chronic stroke patients participating in a repetitive task practice program.[9] Depression was measured using the Hamilton Rating Scale, and upper limb function was measured using the Action Research Arm Test. Patients with and without depression made similar gains in upper limb function, which indicates that upper limb recovery is not affected by the presence of baseline depression.

There are several major differences between our study and those mentioned above. Firstly, the patients in our study were homogeneously in the subacute phase of a stroke as only patients within 6 weeks of stroke onset were recruited. Secondly, detailed and different upper limb measures of impairment and function were evaluated, including the Stroke Impact Scale, which reflects upper limb function from the patient's perspective. Finally, depression and upper limb impairment and function were serially assessed over 4 fairly close time intervals. As a result, we were able to have a clearer understanding of the temporal evolution of depression and its impact on upper limb impairment, function and selfcare.

There are several key findings from this study. Firstly, depression is not uncommon, being present in 20% of the study cohort on rehabilitation admission. This finding is quite similar to previous studies of depression in stroke patients admitted to rehabilitation settings.[17] There were no differences in age, sex and ethnicity in patients and severity of upper limb impairment and function in patients with and without baseline depression. Interesting is how the rate of depression trended over time, decreasing to 10.8% at week 3, before picking up again to almost 20% at weeks 7 and 15. Between weeks 0 and 3, all patients were inpatients at the rehabilitation center, receiving daily rehabilitation, encouragement and support from the rehabilitation team. Regular counseling and psychotherapy were also provided by

psychologists, especially in those who were depressed. This probably explains the decline in rate of depression to 10.8% at week 3. But by weeks 7 and 15, 90.9% and 100% of patients respectively had completed their inpatient rehabilitation programs and were discharged back to the community. Compared to inpatient care, the level and intensity of rehabilitation and psychological support in the community is significantly lower and we believe that that transition from inpatient to community care is a major reason for the rise in depression rates to almost baseline levels.

Secondly, depression was associated with significantly worse upper limb measures at week 7 and week 15. This was especially so at week 15, where measures of upper limb impairment, function and performance of ADLs were all lower in patients with depression. This finding is different from 2 earlier studies looking at poststroke depression and upper limb recovery.

Finally, baseline depression had no significant influence on upper limb recovery and performance of selfcare activities. This finding is different from some other studies showing baseline depression as an adverse prognostic indicator of functional status.2-4 One possible reason for this finding is the temporal nature of depression, that is, patients who had depression at an earlier time interval do have resolution of depression later on, and vice versa. In this study, it was noted that 12 (57.1%) of the 21 subjects with depression at baseline had resolution of depression at week 15, and 13 (15.5%) of the 84 patients without depression at baseline were depressed at week 15. The finding that patients who remained depressed or developed depression at week 15 had poorer upper scores reinforces the significant negative impact of depression on upper limb function.

There are several limitations in this study. Firstly, it was a secondary analysis of a group of patients for which depression was not the primary outcome measure and the number of patients with depression was relatively small. Secondly, the diagnosis of depression was based on the CES-D and was not corroborated with a structured clinical interview. Thirdly, the impact of certain significant confounding variables was not evaluated. These include the use of anti-depressants, and the intensity and type of therapy received by patients after they were discharged from rehabilitation. The use of anti-depressants, especially, Fluoxetine, is particularly relevant, as it has been shown that this drug facilitates motor recovery, even in patients who are not depressed. [18]

Despite this, the findings of this study do offer new insight into the relationship between depression and different measures of upper limb function in the trajectory of stroke recovery in the subacute phase.

Conclusion

Depression is not uncommon in this cohort of subacute stroke patients, and it has negative impact on upper limb function and performance of selfcare. Routine screening of depression should be considered, especially in those with poor upper limb function, so that appropriate treatment can be implemented.

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Conflict of interest

Nil

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