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Cognitive Dysfunction in Ischemic versus Hemorrhagic stroke

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ABSTRACT

Background: Stroke is one of the major causes of physical and mental disability among people. Vascular cognitive impairment (VCI) represents a wide spectrum from mild cognitive impairment to dementia following cerebrovascular disorder that is resulting in either ischemic or hemorrhagic stroke. **Purpose of study:** This study was conducted to investigate the difference in cognitive functions' affection following ischemic versus hemorrhagic stroke. **Subjects:** 75 subjects were enrolled in this study, 25 healthy subjects and 50 stroke patient (25 ischemic and 25 hemorrhagic stroke patients) of both sexes with age range between 45 and 55 years old, duration of illness was between 6 to 12 months and years of education of patients and subjects participated in this study was at least nine years. The patients were selected from outpatient clinic, Faculty of Physical Therapy, Cairo University, Egypt. Subjects were classified into three groups: GA (25 healthy subjects), GB (25 ischemic stroke patients) and GC (25 hemorrhagic stroke patients). **Methods**: Both of healthy subjects and stroke (ischemic and hemorrhagic) patients received cognitive assessment via Montreal cognitive assessment scale (MOCA) and Rehacom system as four categories were assessed which are figural memory, attention concentration, reaction behavior and logical thinking; each category was assessed for 30min. **Results**: This study results showed that there was a significant difference between the results of MOCA scale and Rehacom system among the three groups , with ($P \leq 0.05$). Also, there was a significant difference between GB (ischemic stroke) and GC (hemorrhagic stroke). **Conclusion:** on the basis of the present data , it can be concluded that healthy subjects have better preserved cognitive functions in comparison with stroke patients (either ischemic or hemorrhagic stroke) , based on MOCA scale results , deterioration in cognitive functions in hemorrhagic stroke was greater than in ischemic stroke , based on Rehacom System results , figural memory and logical thinking were more affected in patients with hemorrhagic stroke in comparison with ischemic stroke patients and reaction behavior and attention concentration were more affected in patients with ischemic stroke in comparison with haemorrhagic stroke patients .

INTRODUCTION

The world health organization defined stroke as rapidly developing clinical signs of localized or generalized cerebral functions with symptoms lasting about 24 hours or more or leading to death without any other cause of vascular origin [1]. Stroke is considered the second-leading cause of death and the third-leading cause of death, disability and impairment in activities of daily living (ADL) in the world [2].

Globally, there are above 101 million subjects currently living who have experienced stroke. 22% of subjects who have developed a stroke and are currently living are with age range between 15-49 years of age. There are over 7.6 million new ischemic strokes each year. In general, over 62% of all incident vascular strokes are of ischemic type. There are over 3.4 million new intracerebral hemorrhages each year. In general, over 28% of all incident vascular strokes are of hemorrhagic type [2].

The worldwide prevalence of stroke in 2013 was 25.7 million, with 10.3 million individuals suffering from a first stroke. The prevalence of ischemic stroke was higher than that of hemorrhagic stroke as of every 3 stroke, 2 of them are of ischemic type of stroke. Stroke is the most common reason of disability among individuals affected by it [3], [4].

In Ischemic stroke, there is occlusion of the blood supply to the brain that can be caused by either thrombus or embolus. In case of occlusion by thrombus so resulting in obstruction of the blood flow to the brain that occurs as a result of atherosclerosis or arterial dissection. In case of embolic occlusion, debris from other place that comes and make blocking of the vessel with diameter smaller than its diameter [5], [6].

Hemorrhagic stroke occurs due to bleeding into the brain as a result of rupture of one of the blood vessels due to increasing the pressure inside this vessel and the most common cause of hemorrhagic stroke is hypertension. It is associated with high levels of mortality and morbidity [7].

Post stroke dementia is one of the most common types of dementia and acts to increase the liability for recurrent stroke and death [8]. It is defined as the presence of dementia three months after an acute stroke, its prevalence varies from 6% to 55% and may decrease years after stroke [9].

Cognitive impairment after stroke becomes common to develop and varies from mild cognitive impairment to dementia [10]. It is common following all types of stroke either ischemic, hemorrhagic or even transient ischemic attack (TIA) of stroke [11]. It affects many cognitive functions including memory, attention, concentration, language, visuospatial and executive functions. [12], [13]. The incidence of mild cognitive impairment following stroke is about 80% and about 7% of stroke patients can develop dementia [14].

The risk of cognitive impairment following stroke increases from 4 to 12 times. It can be called as vascular dementia. Post-stroke dementia (PSD) acts to increase the susceptibility for recurrent stroke and mortality. The cognitive impairments following stroke deserves care while putting the plane of rehabilitation of stroke patients [15], [16], [17].

The hypothesis of this study was to investigate the difference in cognitive functions affection between both of ischemic and haemorrhagic stroke patients.

SUBJECTS, MATERIALS AND METHODS

Patients and methods:

The present study was held in the outpatient clinic, Faculty of Physical Therapy, Cairo University between Jan 2022 till Nov 2022. It is a randomized controlled trial; it was approved by the ethical committee of the faculty of physical therapy, Cairo University, Egypt (Approval Number: P.T.REC/ /012/002752).

Subjects:

Seventy –five subjects were selected to participate at this study, 25 healthy subjects with age and sex matched, 25 patients with ischemic stroke and 25 patients with hemorrhagic stroke. Stroke patients were from both sexes. The stroke was diagnosed depending on the guidelines of the World Health Organization (WHO) and the diagnosis was confirmed by clinical examination and magnetic resonance imaging (MRI). [18].

Inclusion criteria: included in this study : Patients with age range between 45 and 55 years' old, patients were of both sexes, patients with duration of illness between 6 to 12 months, patients can read or write with no impairment at hearing or vision, patients with the ability to understand instructions and follow commands , Patients with mild cognitive impairment with score between 19 and 23 according to mini mental state examination (MMSE)and patients with at least of nine years of education.

Exclusion criteria: excluded in this study patients with severe psychiatric disorder, patients with moderate or severe cognitive impairment, patients with uncontrolled hypertension or diabetes mellitus, patients with agraphia, alexia or aphasia. Patients with neurodegenerative disorder like Alzheimer disease (AD), parkinsonism or schizophrenia and patients with problems at communication.

Assessment procedure:

The Montreal Cognitive Assessment (MOCA):

It is a rapid cognitive screening tool for patients with mild cognitive impairment (MCI). It is used to differentiate normal healthy cognitive aging from Mild Cognitive Impairment (MCI) occurring due to another disorder affecting cognition. The MOCA was published in 2005 at McGill University as a result of several years of working at memory clinics in Montreal [21]. It assesses different cognitive domains including attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation [21].

Procedure:

The patient sits in a comfortable position. The therapist gives the patient a sheet containing the MOCA test. MOCA is a 30-question test with duration of testing between 10 to 12 minutes to complete [22], [23], [24] [25]. The total score is 30 points; the cutoff point of the MOCA is 26 as subjects with a score of 26 or above is considered normal [19], [20] , [26] .

Rehacom system: Rehacom manufactured by (Schuhfrted, model No. 454, D- 14482 posted am, Karl-Liepknecht, Austria), Hasomed RehaCom (CE certified, EN-ISO-13485), (G S: RehaCom Version 5. Basic Manual. 2003, 2012). It is a software package that is used at assessment and rehabilitation of patients with cognitive dysfunctions [27].

Procedure:

The physiotherapist enters the data of the subjects, then adjusts the parameters of the Rehacom system. The four categories of assessment of the Rehacom system are attention concentration, figural memory, reaction behavior and logical thinking. The duration of assessment of each was 30 minutes. The therapist teaches the patient the method of dealing with the system and using the panel of the Rehacom system.

The patient sits at the level of the Rehacom system screen comfortably after learning how to deal with the system and the control panel. Each area was assessed for 30 min. At the end of assessment there is a report that is generated. Concerning to the figural memory, the report contains level of difficulty- acquisition time – solution time .Concerning to the attention concentration , the report contains level of difficulty – maximum reaction time –minimum reaction time .Concerning to the Reaction Behavior , the report contains level of difficulty , quartile reaction time 1 and quartile reaction time 3 and finally concerning to the Logical Thinking report contains level of difficulty , quartile reaction time 1 and quartile reaction time 3.

Statistical analysis:

The collected data of this study were analyzed using the Statistical Program for Social Science (SPSS) version 22, IBM Corp., Chicago, USA, 2013. Quantitative data were expressed as mean ± standard deviation (SD). Qualitative data were expressed as frequency and percentage. For quantitative data, independent t test was used to compare between two independent variables with parametric data and paired t test to compare between two dependent variables. A one-way analysis of variance (ANOVA) was used to compare between more than two variables. Post hoc was used to test possible combinations of groups to determine where the significant differences are located. P-value < 0.05 was considered significant and p-value <0.01 was considered highly significant.

RESULTS

The main purpose of this study was to investigate the variations in cognitive functions affection between ischemic and hemorrhagic stroke patients. 75 subjects were enrolled in the study, 25 healthy subjects in the control group, 25 ischemic stroke patients and 25 hemorrhagic stroke patients. The three groups were assessed via MOCA scale and Rehacom system.

Subject characteristics:

This study included a total of 75 subjects, 25 healthy subjects, 25 patients with ischemic stroke and 25 patients with hemorrhagic stroke. (Figure 1) illustrates the flow diagram including subjects.

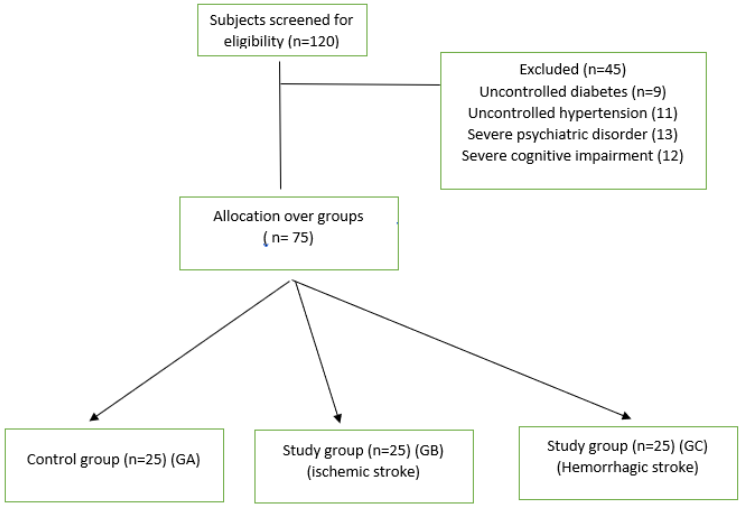

Fig. (1): Consort flow diagram of subjects of the study

The age of patients ranged from 45 to 55 years with mean age of 50.760 for GA, 50.600 for GB and 50.320 for GC. General characteristics of groups was shown in table 1.

Table 1: Demographic data of GA, GB and GC

Item	GA(Healthy)	GB (Ischemic)	GC (Hemorrhagic)	Comparison		S
	Mean ± SD	Mean ± SD	Mean ± SD	F-value	P-value	
Age	50.760±2.934	50.600±3.028	50.320±3.211	0.1325	0.8761	Ns
Height (cm)	169.28±5.004	170.56±5.672	171.68±6.581			Ns
Weight	79.040±9.960	79.400±7.450	80.040±9.117	0.0809	0.9224	Ns
Duration of illness (years)	8.840±1.951	8.760±2.006	8.880±1.986	0.02378	0.9765	Ns

Concerning to MOCA scale scores:
Results showed that there was a statistically significant difference between the control GA and the study groups GB and GC with p- value of 0.0001 as the cognitive functions in general are more affected in hemorrhagic stroke (GC) with mean value of 20.000 in comparison with mean values of ischemic stroke patients which was 21.640 as shown in Fig. (1).

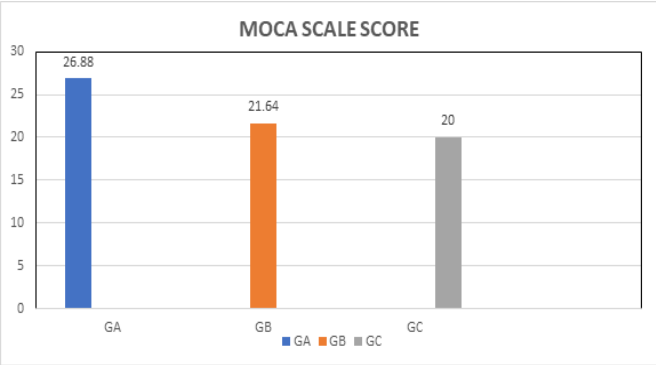

FIG. (1): Mean values of MOCA scale score between GA-GB-GC

Concerning to Rehacom system scores
Concerning to Figural Memory, the results showed that there was statistically significant difference between the mean values of level, Acquisition time and Solution time between GA, GB and GC with p-value of 0.0001. Concerning to comparison between GB and GC , the levels reached by patients with ischemic stroke were higher than those reached by the haemorrhagic stroke patients, shown in Fig.2.

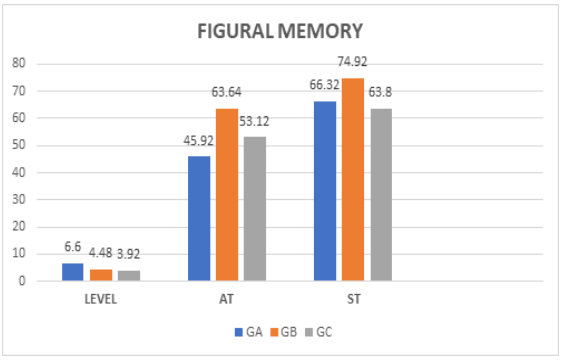

Fig (2): Mean values of Figural memory level, acquisition time and solution time

AT: Acquisition time, ST: Solution time

Concerning to Attention Concentration, the results showed that there was statistically significant difference between the mean values of level, Maximum Reaction Time and Minimum Reaction Time between GA, GB and GC with p-value of 0.0001. Concerning to comparison between GB and GC the levels reached by patients with ischemic stroke were lower than those reached by haemorrhagic stroke patients shown in Fig. 3, 4.

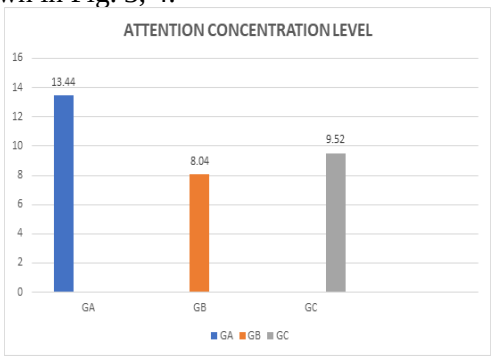

Fig.(3) : Mean values of Attention Concentration Level in GA, GB and GC

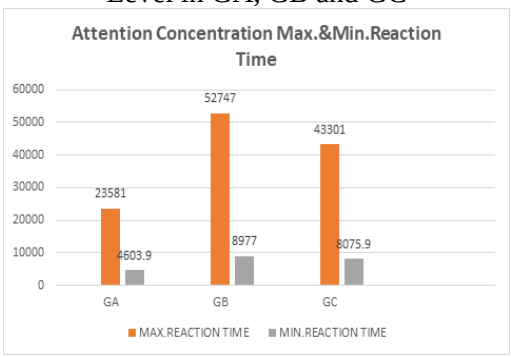

Fig. (4): Mean values of Attention Concentration maximum & minimum reaction time in GA, GB and GC

REACTION BEHAVIOR

Concerning to Reaction Behaviour, the results showed that there was statistically significant difference between the mean values of level, Quartile Reaction Time 1 and Quartile Reaction Time 3 between GA, GB and GC with p-value of 0. 0001.Concerning to comparison between GB and GC, the levels reached by patients with haemorrhagic stroke were higher than those reached by ischemic stroke patients shown in Fig. 5, 6.

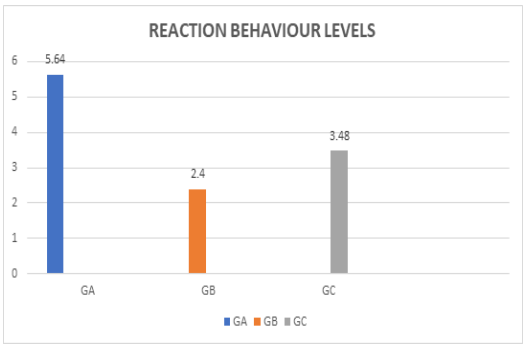

Fig. (5): Mean values of Reaction Behaviour Levels in GA, GB and GC

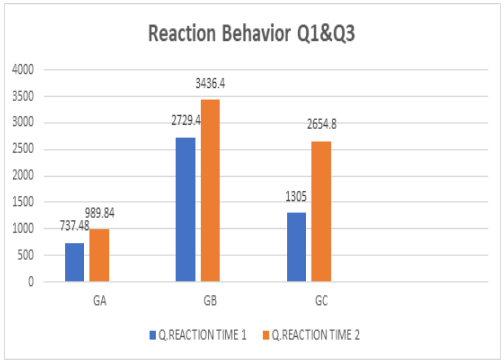

Fig. (6): Mean values of Reaction Behaviour Quartile Reaction Time 1 & 3 in GA, GB and GC

Logical reasoning:

Concerning to logical reasoning, the results showed that there was statistically significant difference between the mean values of level, Quartile Reaction Time 1 and Quartile Reaction Time 3 between GA, GB and GC with p-value of 0.0001. Concerning to comparison between GB and GC , the levels reached by patients with haemorrhagic stroke were lower than those reached by ischemic stroke patients shown in Fig. 7, 8.

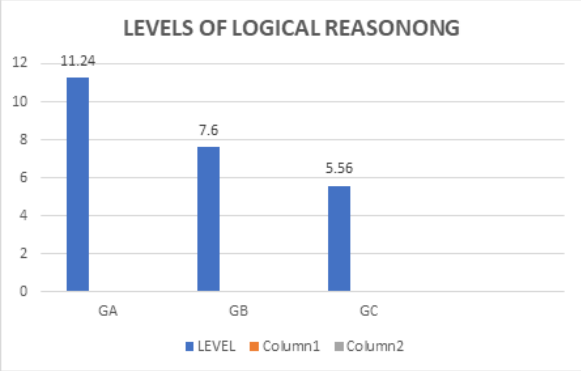

Fig. (7): mean values of levels of logical reasoning between GA, GB and GC

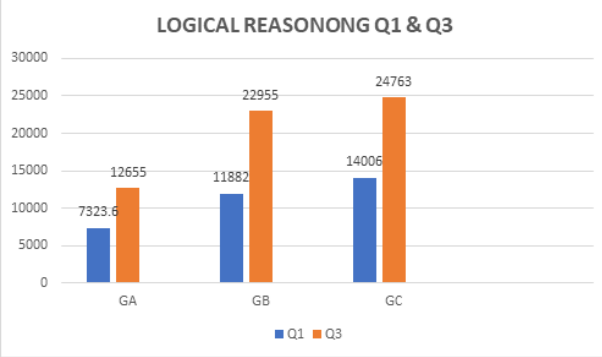

Fig. (8): Mean values of Quartile reaction time 1&3 of logical reasoning

DISCUSSION

The present study was conducted to investigate the difference in cognitive functions' affection following both ischemic and haemorrhagic stroke.

It was found that cognitive functions are affected by higher degrees following haemorrhagic stroke in comparison with ischemic stroke and this appeared at MOCA scale scores as MOCA scores of ischemic stroke was 21.640 while hemorrhagic stroke was 20.000.

This coincides with the results of **Renjen., 2015** who reported that many patients with haemorrhagic strokes about 84.6% had cognitive impairment compared to those with ischemic strokes with percentage of about 67.5%, P = 0.077 [28].

Concerning to **figural memory,** it was found that it was affected at haemorrhagic stroke patients more than ischemic stroke patients and this appeared at **levels** as mean values of figural memory levels at GA (Healthy subjects) was 6.600, at GB (ischemic stroke) was 4.480 and at GC (haemorrhagic stroke) was 3.920 so the levels reached by ischemic stroke patients were higher than those reached by hemorrhagic stroke patients.

Concerning to **figural memory acquisition time,** the acquisition time of GA (Healthy subjects) was 45.920, GB (ischemic stroke) was 63.640 and at GC (haemorrhagic stroke) was 53.120. The time taken by GB was higher than that taken by GC as the levels reached by GB were higher than those reached by GC so taking longer time.

Concerning to **figural memory solution time,** the solution time of GA (Healthy subjects) was 66.320, GB (ischemic stroke) was 74.920 and at GC (haemorrhagic stroke) was 63.800. The time taken by GB was higher than that taken by GC as the levels reached by GB were higher than those reached by GC so taking longer time.

These study results were supported by the findings of **B. O. HUÈ TTER., 1995,** who stated that cognitive deficits were found in visual short-term memory by a percentage of 46% of patients with haemorrhagic stroke [29].

Concerning to **attention concentration**, it was affected at patients with ischemic stroke more than those with hemorrhagic stroke, the level of attention concentration reached by GA was 13.440, GB was 8.040 and GC was 9.520.

Concerning to **attention concentration maximum reaction time,** maximum reaction time of GA was 23581, GB was 52747 and GC was 43301. As the affection at ischemic stroke was more than hemorrhagic stroke, so more maximum reaction time was taken at patients with ischemic strike in comparison to those with hemorrhagic stroke to complete the level.

Concerning to **attention concentration minimum reaction time,** minimum reaction time of GA was 4603.9, GB was 8977.0 and GC was 8075.9. As the affection at ischemic stroke was more than hemorrhagic stroke, so more minimum reaction time was taken at patients with ischemic stroke in comparison to those with hemorrhagic stroke to complete the level.

These study results coincided with the results obtained by **Simona., 2019** who stated that attention deficits are more common among patients with ischemic stroke with percent from 46% to 92%. It was found that more than 80% of stroke patients complained from a significant impairment in at least one of attention tasks [30], [31],[32].

Concerning to **Reaction Behaviour** it was affected at patients with ischemic stroke more than those with hemorrhagic stroke, the level of reaction behavior reached by GA was 5.640, GB was 2.400 and GC was 3.480.

Concerning to **Reaction Behaviour Quartile Reaction Time 1,** Quartile reaction time 1 of GA was 737.48, GB was 2729.4 and GC was 1305.0. As the affection at ischemic stroke was more than hemorrhagic stroke, so more Quartile reaction time 1was taken at patients with ischemic stroke in comparison to those with hemorrhagic stroke to complete the level.

Concerning to **Reaction Behaviour Quartile Reaction Time 3,** Quartile reaction time 3 of GA was 989.84, GB was 3436.4 and GC was 2654.8. As the affection at ischemic stroke was more than hemorrhagic stroke, so more Quartile reaction time 3 was taken at patients with ischemic stroke in comparison to those with hemorrhagic stroke to complete the level.

Our study results come in consistent with the results of **Ladurner., 1985** who stated that the reaction time is more affected in patients with ischemic stroke as the reaction time is higher in patients with stroke in comparison with healthy subjects with age and sex matched, reaction time is more commonly prolonged in patients with focal brain lesion especially patients with brain infarction and when the lesion is in the dominant hemisphere [33],[34],[35].

Concerning to **logical reasoning,** it was affected at patients with hemorrhagic stroke more than those with ischemic stroke, the level of logical reasoning reached by GA was 11.240, GB was 7.600 and GC was 5.560.

Concerning to **Logical Reasoning Quartile Reaction Time 1,** Quartile reaction time 1 of GA was 7323.6, GB was 11882 and GC was 14006. As the affection at hemorrhagic stroke was more than ischemic stroke, so more Quartile reaction time 1was taken at patients with hemorrhagic stroke in comparison to those with ischemic stroke to complete the level.

Concerning to **Logical Reasoning Quartile Reaction Time 3,** Quartile reaction time 3 of GA was 12655, GB was 22955 and GC was 24763. As the affection at hemorrhagic stroke was more than ischemic stroke, so more Quartile reaction time 3 was taken at patients with hemorrhagic stroke in comparison to those with ischemic stroke to complete the level.

These findings of logical reasoning coincide with the findings of **Doyle KP., 2015** who stated that patients with haemorrhagic stroke show problems with tasks that require some degree of planning so even simple tasks, such as making a cup of tea, are difficult and frustrating for them [36].

CONCLUSION

On the basis of the present data, it can be concluded that cognitive functions in general are affected at patients with haemorrhagic stroke by greater degree in comparison with those with ischemic stroke, depending on data obtained by Rehacom system, figural memory and logical reasoning are more affected at haemorrhagic stroke patients , attention concentration and reaction behaviour are more affected at ischemic stroke patients , so it is important to take these points into consideration during rehabilitation of either ischemic or haemorrhagic stroke patients for better prognosis and improvement for them .

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