Impact of Visual Imagery Versus Auditory Imagery on Upper Extremity Function in Subjects with Chronic Stroke

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Abstract

Background: Stroke is a major public health problem with an annual incidence estimate of 15 million people worldwide. Globally, it is the third leading cause of mortality. Up to 85% of survivors experience some degree of paresis of the upper limb at the onset and only 20% to 56% of survivors regain complete functional use of the affected upper limb even after therapeutic intervention. Motor recovery has been shown to be the most influential factor in determining well-being one year after stroke and hence the emphasis of rehabilitation interventions is to improve upper limb function and reduce long term disability.

Objectives: To compare the effects of visual imagery versus auditory imagery on upper extremity function in subjects with chronic stroke.

Materials and methods: 30 stroke subjects were recruited for the study and divided into two groups based on simple random sampling. Evaluation consisting the demographic details and clinical characteristics of the subjects were recorded. Group A received Visual Imagery Training along with conventional therapy. Group B received Auditory Imagery Training with conventional therapy. The treatment sessions were scheduled for 30 minutes per day, 4 times per week, for 4 weeks.

Results: Comparison of post test scores of upper extremity function (FMA-UE) in between the groups, the mean and SD of post test FMA-UE of the stroke subjects administered by Visual Imagery in group-A was 40.33±11.39. It was more or less same the mean and SD of stroke subjects treated by Auditory Imagery in group B of 41.20±11.73.

Conclusion: It evidenced that upper extremity function (FMA-UE) was significantly more improved within the groups among the stroke subjects administered by Visual Imagery and Auditory Imagery but no statistically significant differences were seen in between the groups. The study concluded that both the groups were equally effective in improving the upper extremity function.

Keywords: Chronic stroke, Visual Imagery, Auditory Imagery, Upper extremity function.

Introduction:

Stroke or CVA is the sudden loss of neurological function caused by interruption of the blood flow to the brain. It is one of the major causes for physical and functional disability in adult population globally.[1] There has been a wide increase in the incidence of stroke in low and middle income countries including India. The cumulative incidence ranged from 105-152/1,00,000 persons per year and crude prevalence ranged from 44.29-559/1,00,000 persons in different parts of the country.[2] Developing countries like India are facing a double burden of communicable and non-communicable diseases. Stroke is becoming an important cause of premature death and disability in low-income and middle-income countries like India, largely driven by demographic changes and enhanced by the increasing prevalence of the key modifiable risk factors. The estimated adjusted prevalence rate of stroke range, 84-262/100,000 in rural and 334-424/ 100,000 in urban areas. The incidence rate is 119- 145/100,000 based on the recent population based studies. There is also a wide variation in case fatality rates with the highest being 42% in Kolkata.[3] Out of the two forms: Ischemic stroke is the most common type, affecting about 80% of the individuals compared to hemorrhagic stroke accounting for 10-20% of all strokes. Clinically, there are changes in the level of consciousness, and impairments of motor, sensory, cognitive, perceptual and language functions.[1] Stroke is one of the leading causes of morbidity and mortality throughout the world. In India and other developing countries, an alarming increase in the incidence of stroke has been observed owing to an increased life span with rising trends of hypertension, diabetes, smoking and stress in daily life.[4] Major risk factors for stroke are hypertension, diabetes mellitus, smoking, use of oral contraceptives in women, cardiovascular diseases etc, are modifiable whereas, age, gender, ethnicity/race, low birth weight, family history of stroke and genetics/heredity are non-modifiable risk factors.[5]

Cerebrovascular disorders (CVD) are increasing in prevalence and incidence in India due to rapid escalation of risk factors including hypertension diabetes mellitus, smoking and obesity affecting considerable proportion of adult population. Global Burden of Disease study shows that of the 9.4 million deaths in India, 619,000 were due to stroke and Disability Adjusted Life Years (DALYs) lost were 28.5 million highlighting the fact that CVD leads to considerable mortality and morbidity. Another issue of concern is that 20-30% of strokes occur in people younger than 45 years and is more frequently seen in India compared to the west.[6] The consensus symptoms are sudden numbness or weakness of face, arm, or leg, especially on one side of the body; sudden confusion or trouble speaking or understanding speech; sudden trouble seeing in one or both eyes; sudden trouble walking, dizziness, or loss of balance or coordination; and sudden severe headache with no known cause. [7] Sudden cessation of cerebral blood flow and oxygen-glucose deprivation sets in motion a series of pathological events. Within minutes neurons die within the ischemic core tissue, while the majority of the neurons in the surrounding penumbra survive for a slightly longer time. Cell survival depends largely on the severity and duration of the ischemic stroke. Ischemic stroke produces cerebral edema which is the most frequent cause of death in acute stroke.[1] Brain injury after focal ischemia evolves along two basically different patho physiologies, depending on the severity of the primary flow reduction and the dynamics of post ischemic recirculation. In permanent and gradually reversed focal ischemia as after thromboembolic occlusion, primary core injury is irreversible but the expansion of the core into the penumbra can be alleviated by hemodynamic and molecular interventions. Such alleviation can only be achieved within 3 hours after the onset of ischemia because untreated core injury expands to near maximum size during this interval. In promptly reversed transient ischemia as after mechanical vascular occlusion, primary core injury may recover but a secondary delayed injury evolves after a free interval of as long as 6 to12 hours.[8] Functional recovery of the paretic upper extremity, post-stroke, continues to be one of the greatest challenges faced by rehabilitation professionals. Although most individuals, regain walking ability, only 5% of adults regain full arm function after stroke, and 20% do not regain any functional use. Hence, alternative strategies are needed to reduce long-term disability and functional impairment caused by stroke.[10] Upper extremity impairments chronically affect the functional independence and satisfaction in 50–70% of all stroke patients. [11] Stroke patients commonly use the unaffected UE for performing daily living activities and avoid using the affected side; this leads to decreased UE muscle strength and movement and can greatly affect independence in daily life. Recovery of UE function is important for effective rehabilitation, and the plasticity of neural networks is vital to recover damaged motor functions or acquire new motor functions, as it is the basis for recovery of cognitive function and motor learning.12 Interdisciplinary complex rehabilitation interventions represent the mainstay of poststroke care. Stroke rehabilitation aims at providing all possible means to recover lost function and to increase the autonomy of stroke patients taking into account the remaining impairments and disabilities. Carr and Shepherd suggested that poor upper extremity recovery may be due to the direct impact of the stroke itself as well as to insufficient, inadequate or inappropriate therapeutic interventions. Though the efficacy of some interventions may be under debate motor skill learning and some new technological approaches give promising outcome prognosis in stroke motor rehabilitation.[11]

Depending on the sensory nature of the object, mental imagery is characterized by a vivid re-experience of previously viewed visual material, heard auditory content or perceived other types of sensory information. In a study conducted using functional magnetic resonance imaging to reveal supramodal and modality-specific networks of mental imagery for auditory and visual information, it is revealed that both auditory and visual information widely suppressed the activity of primary sensory and motor areas, for example deactivation network. These findings have important implications for understanding the mechanisms that are involved in generation of mental imagery.[17]

The Fugl-Meyer Upper Extremity (FMUE) sub scale is a widely used and highly recommended stroke-specific, performance-based measure of impairment. It is designed to assess reflex activity, movement control and muscle strength in the upper extremity of individuals with post-stroke hemiplegia. It has been extensively used as an outcome measure in rehabilitation trials and to record post-stroke recovery. The FMUE Scale comprises of 33 items, each scored on a scale of 0 to 2, where 0 = cannot perform, 1 = performs partially and 2 = performs fully. It is free, requires only household items for testing, and takes up to 30 minutes to administer.[18] The Fugl-Meyer assessment is well suited as a research tool because it is relatively easy to establish a high degree of reliability among several raters.(reliability of fma) To increase affected UE movement, several promising rehabilitative interventions have been tested. In testing stroke rehabilitative regimens, authors frequently have used the UE motor section of the Fugl-Meyer Assessment of Sensorimotor Impairment (UE-FM) to determine intervention response. It is one of the most established and commonly used outcome measures in stroke rehabilitative trials.[19]

METHODOLOGY

Source of Data:

- Uttaranchal PG College of Bio-Medical Sciences Hospital : Dehradun
- Healing Hands Physio-care: Dehradun
- Ezy Life Physiotherapy Clinic : Dehradun

Method of collection of data:

- Population : Subjects with chronic Stroke
- Sampling : Simple Random Sampling
- Sample size : 30

- Type of Study : Pre-Post Experimental study design
- Duration of the Study : 6 months

Inclusion Criteria:
- Subjects diagnosed with stroke (> 6months).
- Both gender. • Age group between 40 and 60 years.
- Subjects who score 24 or more on MMSE (MMSE ≥24).
- Brunnstorm stage of motor recovery 5-7.

Exclusion Criteria:
- Any upper limb musculoskeletal or neurological conditions other than stroke.
- Any visual or somato sensory impairments or auditory impairments.
- No perceptual deficits.
- Uncooperative subjects.

Materials Required:
- Pen
- Paper
- Chair
- Percussion hammer
- Cup
- Video tape
- Audio tape

Methodology:
- The subjects were recruited voluntarily based on the inclusion and exclusion criteria.
- Permission was obtained from the respective Institutions and the subjects to carry out the study and informed consent was taken from the subjects.
- 30 subjects were randomly assigned into Group A and Group B.
- Demographic variables such as age, gender, dominance and side of affection were documented.
- Prior to the treatment the upper extremity function was assessed using FMA-UE.
- Post intervention, the two parameters were assessed again using the same outcome measure.
- Both the groups were explained about the five functional tasks of upper extremity mentioned below prior to the interventions that the subjects need to practice during the treatment.

The functional tasks are:
- Bringing the hand to the mouth
- Turning the pages of a book
- Opening up elastic band- round fingers and thumb o Picking up buttons and dropping them in to the saucer.
- Brushing or combing hair.
- For each of the sessions, the subjects will sit on a chair comfortably with the hips, knees and ankles at 90 degrees, with the head held directly over pelvis with an erect spine.
- The forearms will be resting on the table without elevation or depression of the shoulder girdle.

Intervention to be conducted on the subjects:

Group A: (n=15) This group underwent Visual Imagery training program (4 times a week for 4 weeks, 30 minutes per session)

The intervention was given as follows:

- The first step involves relaxation of the subjects as instructed by the therapist, 2 minutes of deep breathing exercises, followed by 3 minutes of progressive muscular relaxation.
- In the second step, the subjects were made to watch a video tape of the above mentioned 5 functional tasks of upper extremity at a normal speed performed by a normal individual which they are supposed to imagine.
- In the third step, the subjects were instructed to perform the functional tasks with the non-paretic UE.
- In the fourth step, the subjects were asked to imagine the same functional tasks on the paretic UE while watching the video and try to analyze the problems they have with the affected side compared to the normal side.
- In the final step, the subjects mentally rehearsed the tasks with the paretic UE – three repetitions and correct them without actually performing them.
- The session concluded with the individuals being given time to refocus on the room they are in.

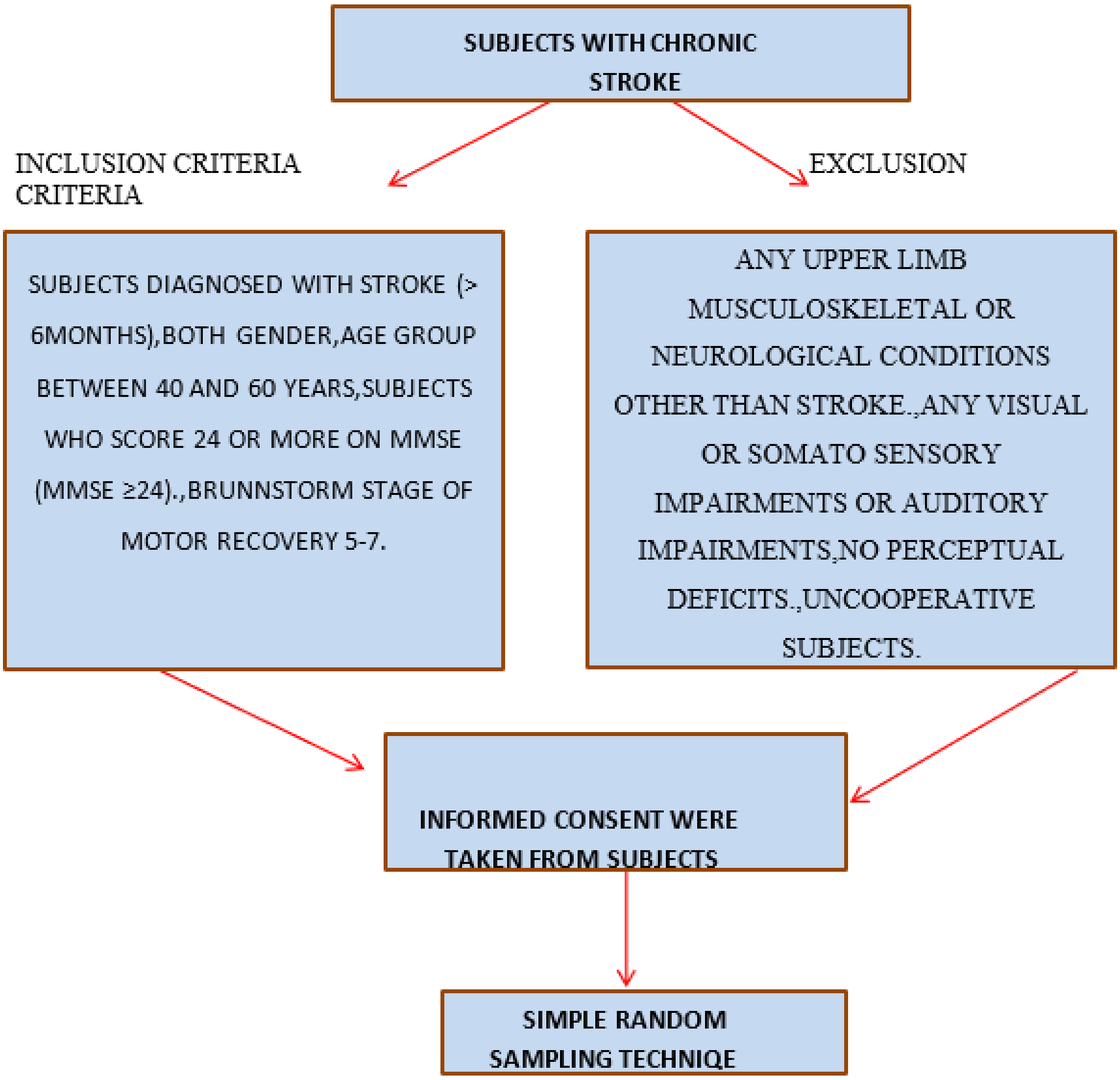
Group B (n=15)

This group underwent Auditory Imagery training program (4 times a week for 4 weeks, 30 minutes per session).

- The first step involves relaxation of the subject as instructed by the therapist, 2 minutes of deep breathing exercises, followed by 3 minutes of progressive muscular relaxation.
- In the second step, the subjects were made to listen to an audio tape of the same functional tasks of upper extremity as mentioned which they are supposed to imagine.
- In the third step, the subjects were instructed to perform the functional tasks with the non-paretic UE. • In the fourth step, the subjects were asked to imagine the same functional tasks on the paretic UE while listening to the audio and try to analyze the problems they have with the affected side compared to the normal side.
- In the final step, the subjects mentally rehearsed the tasks with the paretic UE, correct them without actually performing them.
- The session concluded with the individuals being given time to refocus on the room they are in.4,18 Apart from this, both the groups will receive conventional physiotherapy for another 15 minutes which consists of stretching, strengthening and range of motion exercises.

Outcome Measure: Fugl-Meyer Assessment of Physical Performance (FMAUE) subscale - to assess the motor function of UE.

FLOW CHART OF METHODOLOGY



DATA ANALYSIS

- The data collected on baseline characteristics and outcome measures of stroke subjects was carefully collected, recorded and analysed through statistical software SPSS 20.0 version. The level of significance was at 5% level (0.05). Following statistical techniques were used:
- Frequency and percentage analysis was used to describe the demographic data of the stroke subjects.
- Range, mean and standard deviation was used to describe the age, pre and post- test outcome measures of FMA-UE.
- The Wilcoxon test was used to test the significant difference between the pre and post- test outcome measure in each group.
- The Mann-whitney U test was used to test the significant difference of outcome measure in between the groups.
- Chi-square test was used to test the gender proportion of the subjects in both the groups.
- Unpaired t-test was used to test the significant difference of age of the subjects in between the groups.

- The MS word, MS excel was used to generate the tables and graphs.

RESULTS

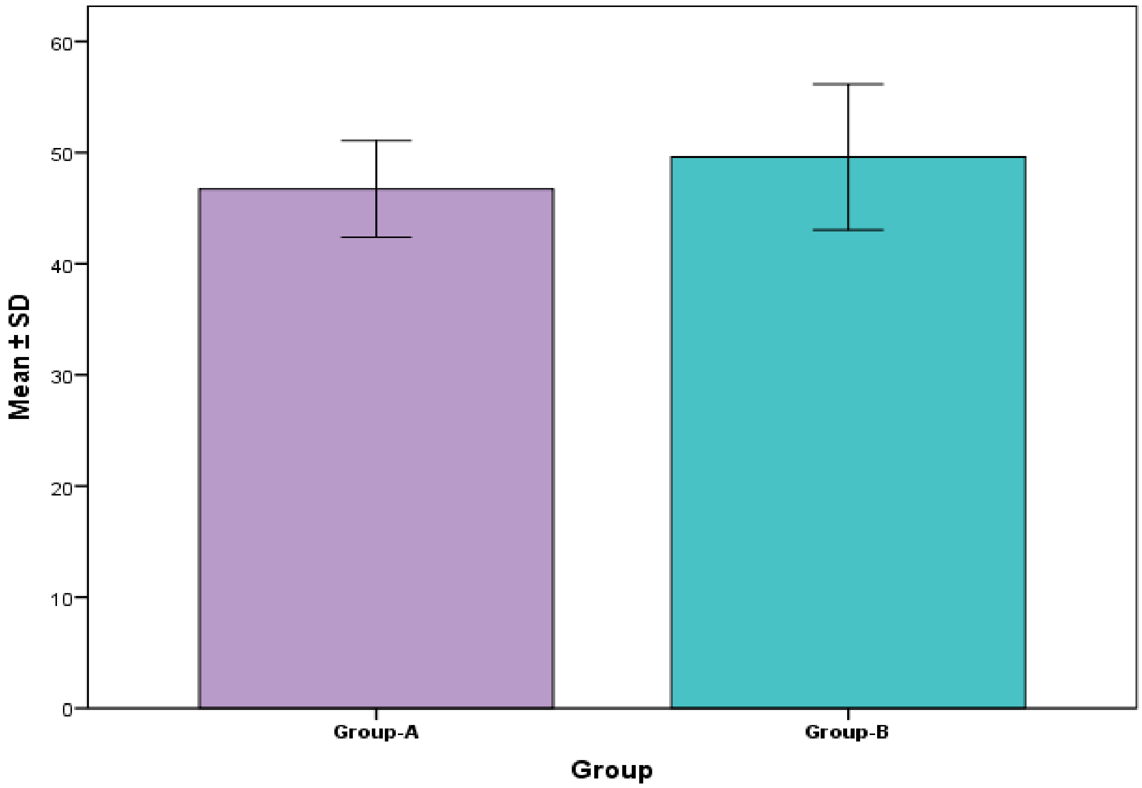
Table-1: Range, mean and SD of age of the subjects with chronic stroke in both the groups

Sno	Variable	Group-A		Group-B		Unpaired t-test
		Range	Mean ± SD	Range	Mean ± SD	
1	**Age (years)**	40-55	46.73±4.35	40-60	49.60±6.56	t=1.410, p>0.05, NS
2	**Duration of stroke**	8-72	28.00±19.83	6-84	32.00±23.42	t=0.659, P>0.05, NS

NS-Not significant. ie.,p>0.05.

The table 1 presents the outcomes of age in years and duration of stroke in months of the stroke subjects in both the groups. In Group-A administered with Visual Imagery training the subjects were ranging within the age of 40-55 with mean and SD of 46.73±4.35. In Group-B, the subjects administered with Auditory Imagery training were ranging within the age of 40-60 with mean and SD of 49.60±6.56. Similarly, in Group A the subjects were ranging within the duration of 8-72 months with mean and SD of 28.00±19.83. In Group-B, the subjects were ranging within the duration of 6-84 months with mean and SD of 32.00±23.42. The unpaired t-test was carried to compare the means, which was found to be not significant at 5% level (ie., p>0.05). It revealed that the baseline characteristic of age and duration were similar in both the groups.

Graph-1a: Mean and SD of age of subjects with chronic stroke in both the groups



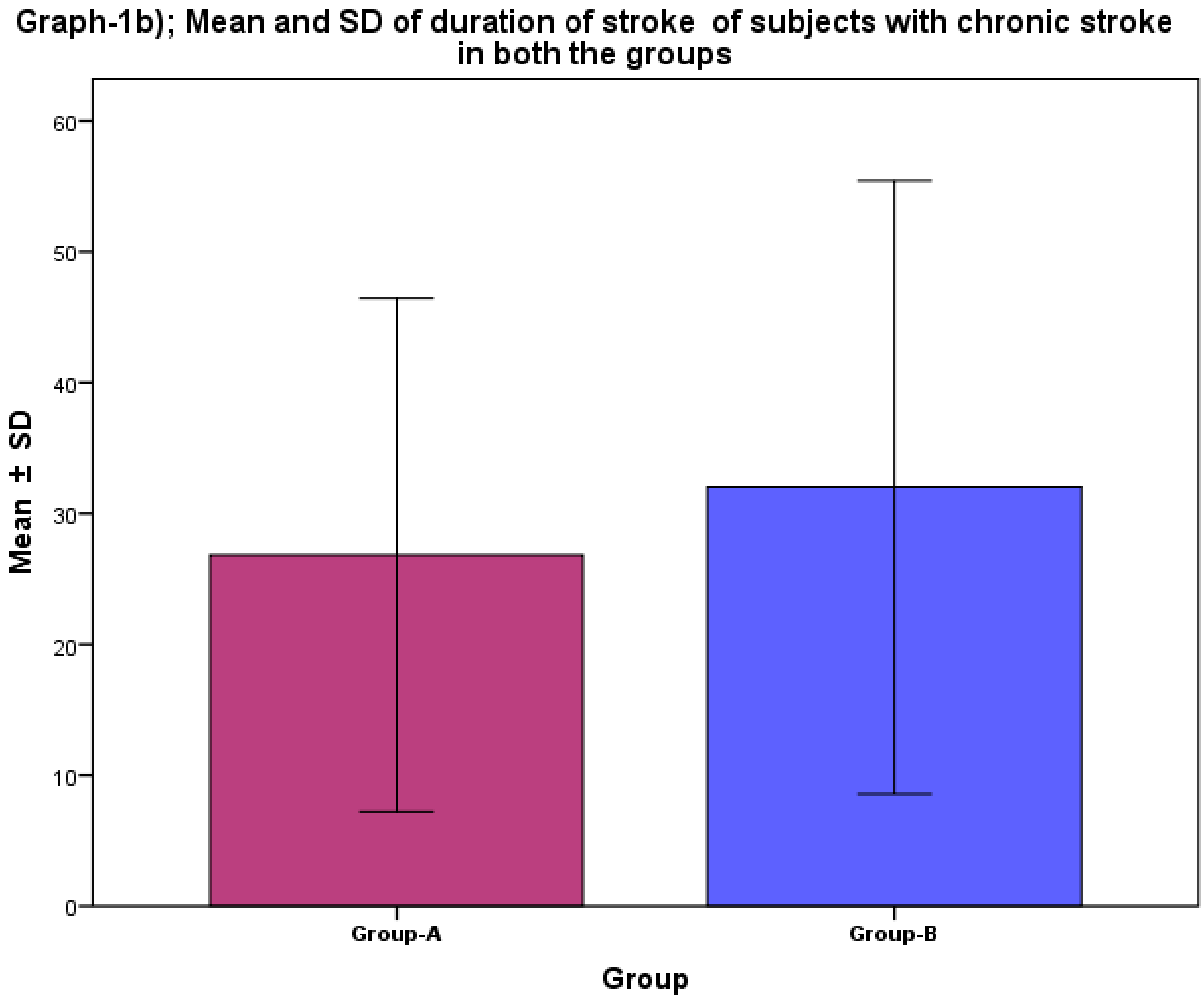
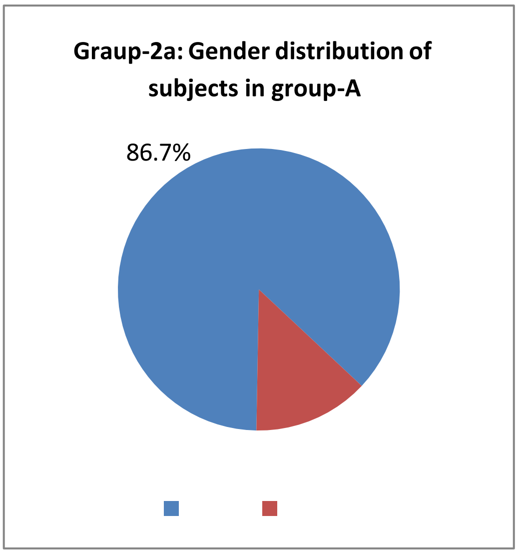


Table-2: Distribution of subjects with chronic stroke according to gender over the groups.

Sno	Gender	Group	
		Group-A	Group-B
1	**Male**	13(86.7%)	13(86.7%)
2	**Female**	2(13.3%)	2(13.3%)
		Chi-Square value=0, df=1, p>0.05,NS	

NS-Not significant. ie.,p>0.05.

The table 2 shows the proportion of stroke subjects according to gender. In Group-A the subjects administered with Visual Imagery training 13(86.7%) of them were males and 2(13.3%) of them were females. In Group-B the subjects administered with Auditory Imagery training, 13(86.7%) were males and 2(13.3%) were females. There was exact proportion of gender in between the groups according to gender and it was found to be not statistically significant (χ^2=0, df=1) at 5% level ie., p>0.05. It evidenced the baseline characteristic of gender is homogeneous in both groups. The following pie diagrams depicted the proportion of Stroke subjects according to gender.



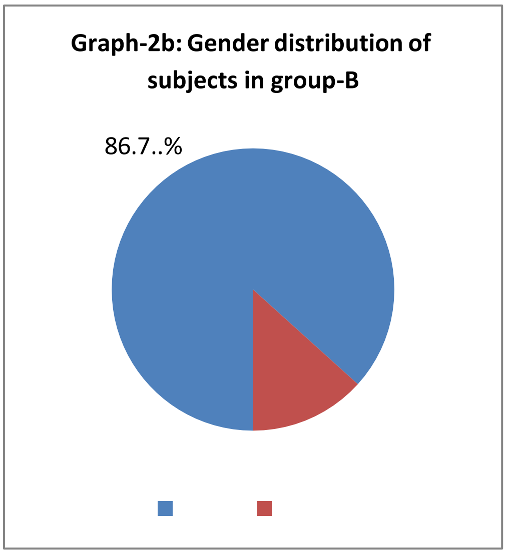
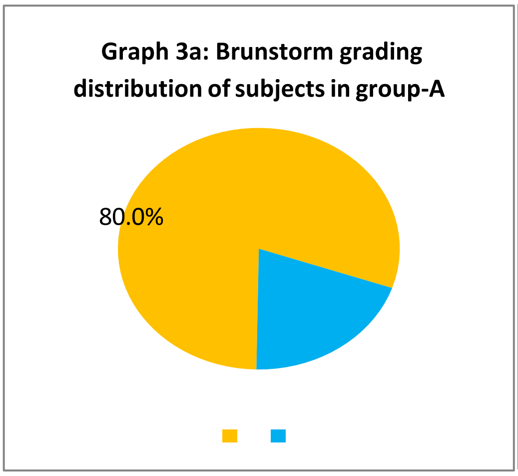


Table-3: Distribution of subjects with chronic stroke according to Brunnstorm grading over the groups.

Sno	unnstorm grading	Group	
		Group-A	Group-B
1	5	12(80.0%)	11(73.3%)
2	6	3(20.0%)	4(26.7%)
		Chi-Square value=0.186, df=1, p>0.05,NS	

NS-Not significant. ie.,p>0.05.

Table 3 shows the proportion of stroke subjects according to brunnstorm grading. In Group A, 12(80.0%) of the subjects belonged to grade 5 and 3(20.0%) belonged to grade 6. In Group B, 11(73.3%) of the subjects belonged to grade 5 and 4(26.7%) belonged to grade 6. There was no much variation in between the groups according to the Brunnstorm grading and it was found to be not statistically significant (χ^2=0.186, df=1) at 5% level ie., p>0.05. It evidenced that the baseline characteristic of the Brunnstorm grading is homogeneous in both groups. The following pie diagrams depicted the proportion of Stroke subjects according to Brunnstorm grading.



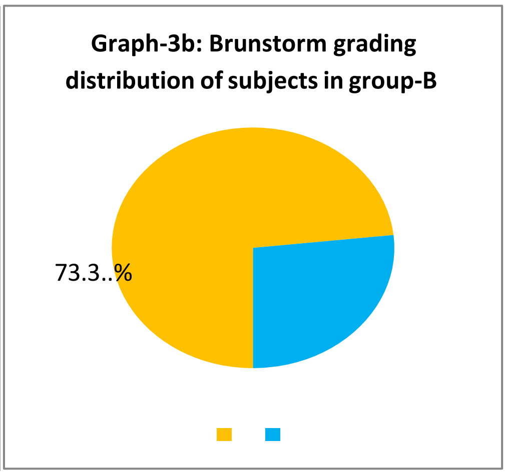
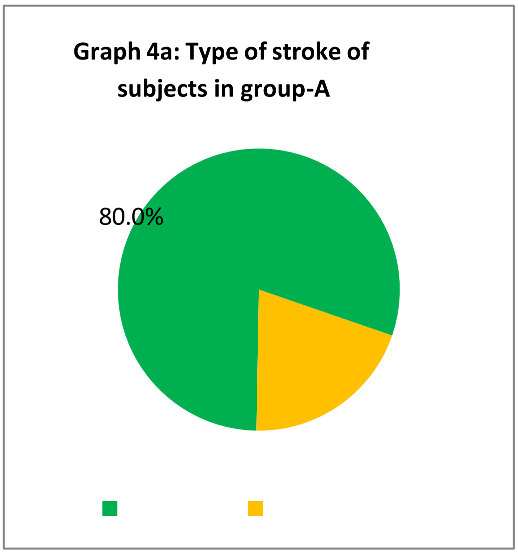


Table-4: Distribution of subjects with chronic stroke according to type of stroke over the groups.

Sno	Type of stroke	Group	
		Group-A	Group-B
1	Ischemic	12(80.0%)	11(73.3%)
2	Haemorrhagic	3(20.0%)	4(26.7%)
		-Square value=0.186, df=1, p>0.05,NS	

NS-Not significant. ie.,p>0.05.

The table shows the proportion of stroke subjects according to the type of stroke. In Group-A the subjects administered with Visual Imagery training 12(80%) of them were ischemic and 3(20%) of them were heamorrhagic. In Group-B the subjects administered with Auditory Imagery training, 11(73.3%) were ischemic and 4(26.7%) were haemorrhagic. There was no much variation in between the groups according to the type of stroke and it was found to be not statistically significant (χ^2=0.186, df=1) at 5% level ie., p>0.05. It evidenced the baseline characteristic of the type of stroke is homogeneous in both groups. The following pie diagrams depicted the proportion of Stroke subjects according to type of stroke.



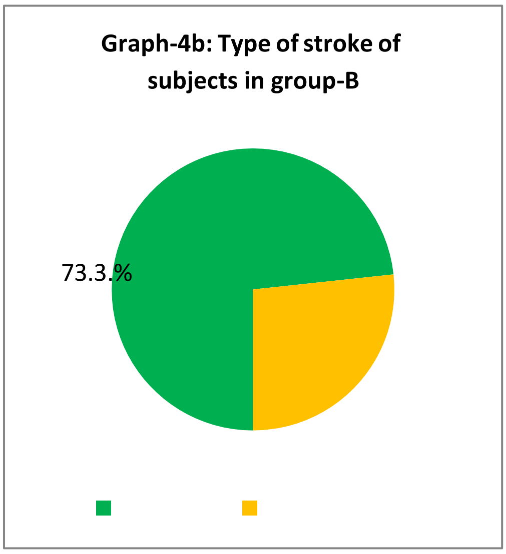


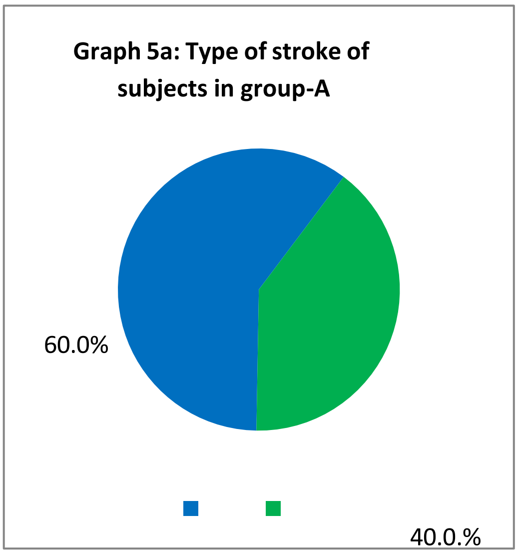
Table-5: Distribution of subjects with chronic stroke according to side affected over the groups.

Sno	Side affected	Group	
		Group-A	Group-B
1	Left	9(60.0%)	8(53.3%)
2	Right	6(40.0%)	7(46.7%)
		-Square value=0.135, df=1, p>0.05,NS	

NS-Not significant. ie.,p>0.05.

The table shows the proportion of stroke subjects according to the side affected. In Group-A the subjects administered with Visual Imagery training 9(60.0%) of them were left side affected and 6(40.0%) of them were right side affected. In Group-B the subjects administered with Auditory

Imagery training, 8(53.3%) were left and 7(46.7%) were right. There was no much variation in between the groups according to the side affected and it was found to be not statistically significant (χ^2=0.135, df=1) at 5% level ie., p>0.05. It evidenced the baseline characteristic of the side affected is homogeneous in both groups. The following pie diagrams depicted the proportion of Stroke subjects according to the side affected.



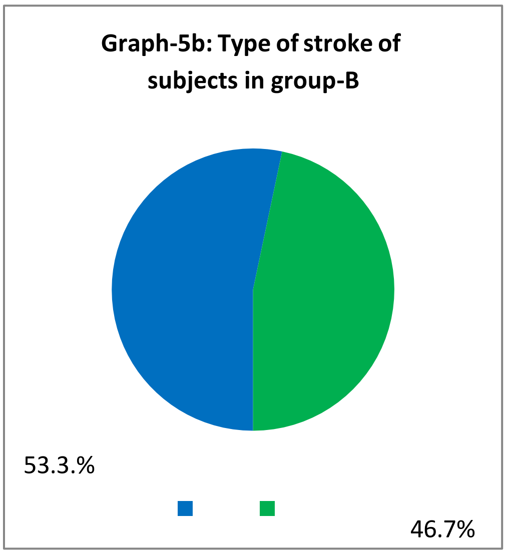


Table-6 Range, mean and SD of outcome measures of subjects with chronic stroke in group-A.

Sno	Outcome measures	Group-A				Wilcoxon test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	**FMA-UE**	19-41	28.80±8.24	19-59	40.33±11.39	z=3.308*	p<0.001

Note; * denotes –Significant.,(p<0.05)

The above table-6 shows the pre and post test outcomes of FMA-UE among the stroke subjects in Group-A administered with Visual Imagery training. In pre test, FMA-UE was ranging within 19-41 with mean and SD of 28.80±8.24. But in post test, it was found to be increased to the range 19-59 with mean and SD of 40.33± 11.39. The non parametric test for comparison of dependent outcomes, when ordinal, the Wilcoxon test was carried out and it was found to be significant(p<0.001). It evidenced that there is a significant increase of FMA-UE among stroke subjects administered with Visual Imagery training in Group-A.

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Graph-6: Pre and post test FMA of subects with chronic stroke in group-A

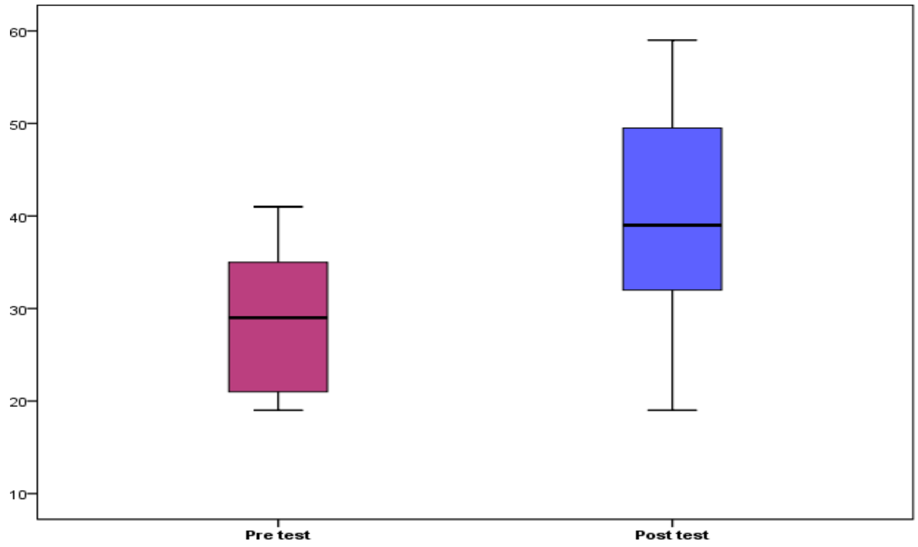


Table -7 Range, mean and SD of outcome measures of subjects with chronic stroke in group-B.

Sno	Outcome measures	Group-B				Wilcoxon test	p-value
		Pre test		Post test			
		Range	Mean ±SD	Range	Mean ±SD		
1	FMA-UE	19-46	33.62±9.61	22-57	41.20±11.73	z=3.125*	p<0.001

Note; * denotes –Significant.,(p<0.05)

The above table-7 shows the pre and post test outcomes of FMA-UE among the stroke subjects in Group-B administered with Auditory Imagery training. In pre test, upper extremity function FMA-UE was ranging within 19-46 with mean and SD of 33.62±9.61. But in post test, it was found to be increased to the range 22-57 with mean and SD of 41.20±11.73. The non parametric test for comparison of dependent outcomes, when ordinal, the Wilcoxon test was carried out and it was found to be significant(p<0.001). It evidence that there is a significant increase of upper extremity function (FMA-UE) among stroke subjects administered with Auditory Imagery training in group-B.

Graph-7: Pre and post test FMA of subjects with chronic stroke in group-B

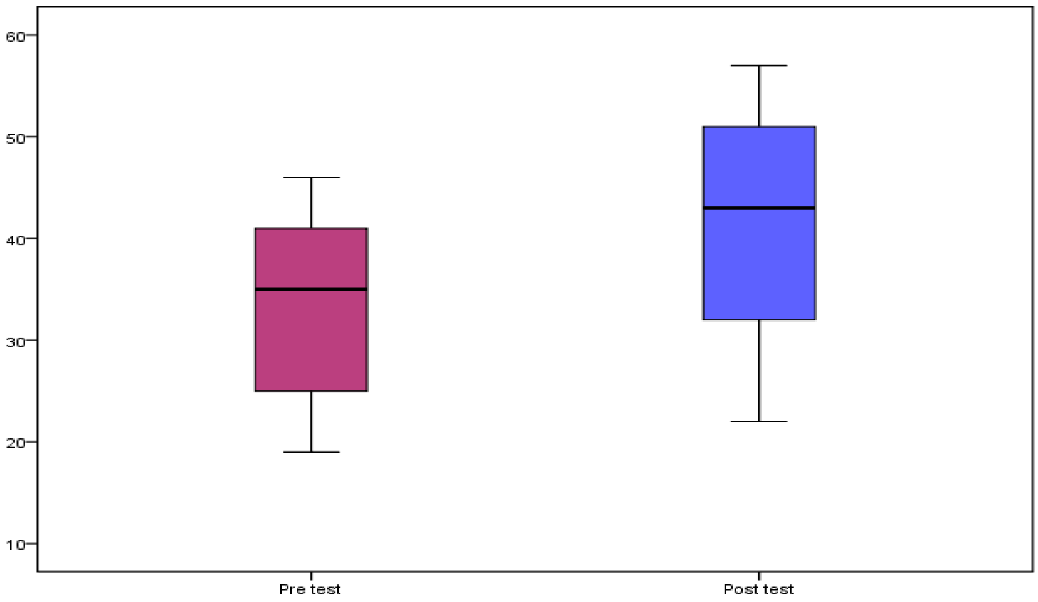


Table -8: Mean and SD of pre and post test outcome measure of subjects with chronic stroke in between the groups

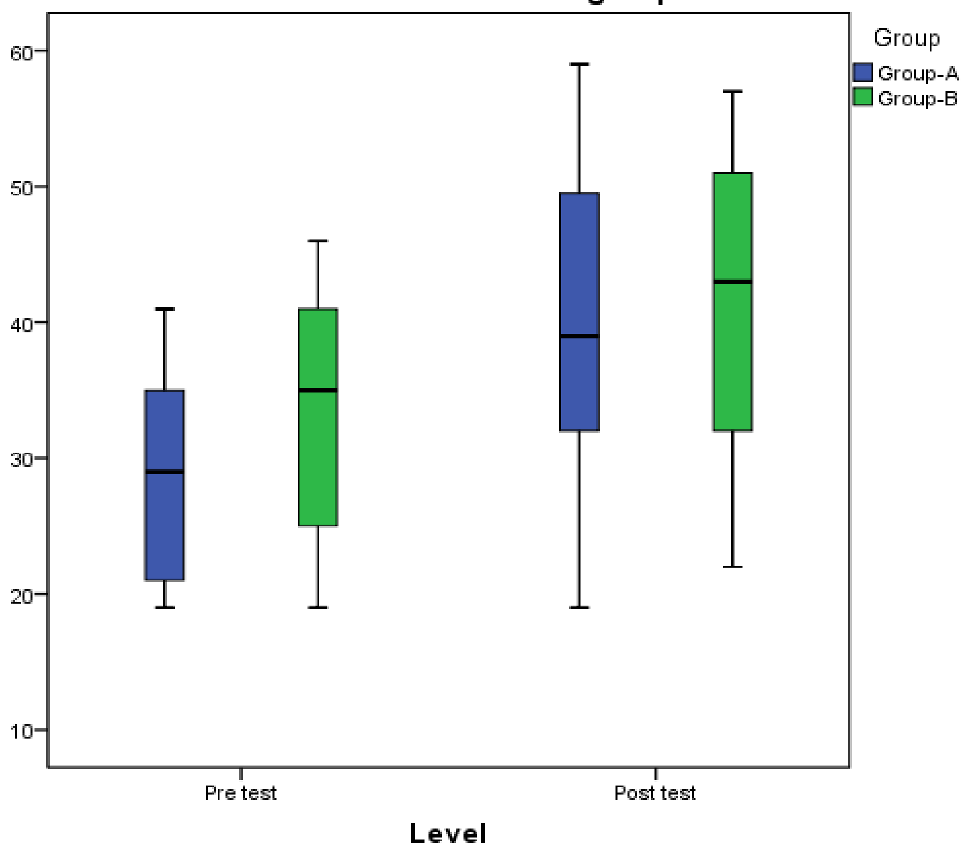
Sno	Outcome measures	Pre test		Post test	
		Group-A	Group-B	Group-A	Group-B
		Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD
1	**FMA-UE**	28.80±8.24	33.62±9.61	40.33±11.39	41.20±11.73
Between group comparison Mann-Whitney U test		FMA: z=1.291, p>0.05, NS		FMA: z=0.332, p>0.05, NS	

S- significant (p<0.05); NS – not significant (p>0.05)

The above table-8 presents the outcomes of between group comparison of pre and post test FMA-UE among stroke subjects. The pre test scores of FMA-UE was 28.80±8.24 in Group-A and in Group-B it was 33.62±9.61 and not significant (p>0.05), It evidenced that initially before the intervention the Stroke subjects were similar in FMA-UE in both the groups.

Similarly, comparison of post test scores of upper extremity FMA-UE in between the groups, the mean and SD of post test upper extremity function FMA-UE of the stroke subjects administered by Visual Imagery training in Group-A was 40.33±11.39. It was more or less same the mean and SD of stroke subjects treated by Auditory Imagery training of 41.20±11.73. The non-parametric test for independent outcomes of two groups, when the scores were ordinal the Mann- Whitney U test was applied and it was statistically not significant (p>0.05).

Graph-8: Pre and post test FMA scores of subjects with chronic stroke in between the groups



DISCUSSION

The purpose of the study was to compare the effects of Visual Imagery versus Auditory Imagery on upper extremity function in subjects with chronic stroke. In this study, 30 subjects with chronic stroke between the age group of 40-60 years, both gender, were taken after fulfilling the inclusion and exclusion criteria. The subjects were assigned into two groups randomly. Group A received Visual Imagery training and Group B received Auditory Imagery training. Upper extremity function was assessed prior to and after the training in both the groups using FMA-UE. In Group-A, 13(86.7%) of them were males and 2(13.3%) of them were females. In group-B, 13(86.7%) of them were males and 2(13.3%) of them were females. There was exact proportion of gender in between the groups and it was found to be not statistically significant ($\chi 2=0$, df=1) at 5% level ie., $p>0.05$. It evidenced the baseline characteristic of gender is homogenous in both groups. All the subjects included in the study were ranging within 5-6 of the Brunnstorm grades of motor recovery. In group A, 12(80.0%) of the subjects had grade 5 and 3(20.0%) had grade 6. In group B, 11(73.3%) of the subjects had grade 5 and 4(26.7%) had grade 6. There was no much variation in between the groups according to the Brunnstorm grading and it was found to be not statistically significant ($\chi 2=0.186$, df=1) at 5% level ie., $p>0.05$. It evidenced that the baseline characteristic of the brunnstorm grading is homogeneous in both groups. All the baseline demographic variables were homogenous in nature in both the groups.

Demographic variables included age, gender, duration, type of stroke, dominance and side affected which were homogenous in nature. In Group-A, subjects were administered with Visual Imagery training. The pre test FMA-UE was from 19-41 with mean and SD of 28.80±8.24. In post test, it was found to be increased to 19-59 with mean and SD of 40.33±11.39. The non parametric test for comparison of dependent outcomes, when ordinal, the Wilcoxon test was carried out and it was found to be significant($p<0.001$). It evidenced that there is a significant increase of upper extremity function when the subjects were given visual imagery training.

In the present study, Visual Imagery was implemented by asking the subjects to observe each movement that they were subsequently asked to imagine. Patients were asked to imagine if it was their own hand making the movements. According to Grezes and Decety, passive observation of movement has been shown to activate cortical motor areas. Recovery of motor function after stroke is accompanied by a redistribution of activity within a network of parallelacting multiple cortical motor areas and reinforcement of the spared area adjacent to the lesion.[32]

It is necessary to develop effective exercise interventions that are based on recovery mechanisms that include the theories of neural plasticity and visual information feedback to improve paretic hand movement and facilitate the usage of paretic arms, which will restore functional performance and increase the independence of people with chronic stroke.[33] Gert et al., in their study addressed the question of how rapidly a visual cue stimulus in a motor imagery task can modify oscillations in the alpha and lower beta band in sensorimotor areas.

Stimulus-related changes in ongoing electroencephalography (EEG) over sensorimotor areas were investigated during a visually cued motor imagery task which provided an evidence that the perception of a visual cue stimulus can specifically modify the activity in primary sensorimotor areas as early as 250 ms after stimulus-onset.[34] Holmes and Collins demonstrated how timing needs consideration in optimizing mental practice, which is why the natural movement tempo in the use of mirrors and video was important in the intervention. [32] In Group-B, subjects were administered with Auditory Imagery training. The pre test FMA-UE was from 19-46 with mean and SD of 33.62±9.61. In post test, it was found to be increased to 22-57 with mean and SD of 41.20±11.73. The non parametric test for comparison of dependent outcomes, when ordinal, the Wilcoxon test was carried out and it was found to be significant($p<0.001$). It evidenced a significant increase of upper extremity function when the subjects were given Auditory Imagery training. In the present study, Auditory Imagery was implemented by asking the subjects to listen to each movement that they were subsequently asked to imagine. Patients were asked to imagine as it was their own hand making the movements. Auditory cueing may be an effective means of improving functional movement when it is presented repeatedly at appropriate time intervals from motor responses. Previous studies have reported that muscle activity may be improved by stimulation with an auditory rhythmic pattern: the activity can be performed in synchrony with the pattern. Furthermore, all steps of motor planning may be closely associated with auditory feedback, which functions by influencing timing of motor skills, enhancing movement performance, facilitating reaction time and response quality. Several studies performed in a clinical setting have recognized the usefulness of auditory stimulation in enhancing functional rehabilitation of patients with hemiparesis.[27] In a study done by Page et al., the MP interventions were provided on audiotape, to improve motor skills. The tape was followed by suggestions for internal, cognitive polysensory images related to using the affected arm in the functional tasks. Participation in an MP protocol may increase a stroke patient's use of his/her more affected limb using audio taped instructing tasks because the same neuromuscular structures are activated during MP as during physical practice. Some researchers have posited that repeated MP induces use-dependent brain reorganizations that are responsible for functional improvements. It was informally observed that stroke patients participating in MP protocols exhibit increased use of their affected limb after intervention. It seems plausible that MP regimens may cause the increased use simply by making it more salient or palatable to patients. MP may also overcome limb nonuse by establishing new motor schema that incorporate the more affected limb, or it may alter pre existing motor schema that cause the more affected limb to be neglected.[28] Another study done by page et al., on the feasibility and efficacy of imagery using audio tapes showed significant improvements on the outcome measures. Imagery is a clinically feasible, cost-effective complement to therapy that may improve outcomes more than participation in therapy only. After intervention, Fugl-Meyer and ARAT scores of patients in the therapy only group remained virtually the same; therapy plus imagery group scores improved by 13.8 and 16.4 points, respectively, on the Fugl-Meyer and ARAT. [35] Specifically, it is possible that, during imagery, concurrent activity in the musculature, as well as in the appropriate neuromotor pathways, occurred. Consistent with PM theory, this correlative neuromotor activity was similar to that which occurs with repetitive physical practice and was responsible for the behavioural improvements exhibited after imagery.35 When comparing in between the groups, the pre test scores of FMA-UE in Group A was 28.80±8.24 and in Group-B was 33.62±9.61 not significant statistically ($p>0.05$), It evidenced that initially before the intervention the Stroke subjects were similar in FMA-UE in both the groups. Similarly, comparison of post test scores of FMA-UE in between the groups, the post test value of FMA-UE in Group-A was 40.33±11.39 and Group B was 41.20±11.73. The non-parametric test for independent outcomes of two groups, when the scores were ordinal the Mann- Whitney U test was applied and it was statistically not significant ($p>0.05$). Some authors have claimed that familiarity is a prerequisite for successful use of MI practice. The notion that effectiveness of mental practice is related to familiarity with the motor task, with familiar tasks being associated with better outcomes than practice of unfamiliar tasks. As a result in this study also the functional tasks being familiar would have been associated with better outcomes in both the groups.[14] Heremans et al., in their study have concluded that external cues,(visual or auditory) however, decreased patients' MI duration and increased the spatial accuracy of their imagined movements. The results indicated that MS patients imagine movements in a better way when they are provided with external cues during MI. These findings are important for developing rehabilitation strategies based on MI in patients.[36]

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