EFFECT OF ACTION OBSERVATION VERSUS INTEGRATED ACTION WITH SENSORY OBSERVATION ON UPPER LIMB MOTOR RECOVERY IN POST STROKE SUBJECTS

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ABSTRACT

Background and Objective: Sensorimotor dysfunction is a common complication after stroke which can affects the motor recovery in rehabilitation. Action observation and Integrated Action with Sensory observation are recent literature in physiotherapy to improveupper limb motor recovery. The objective of this study was asses to effect of action observation versus integrated action with sensory observation on upper limb motor recoveryin post stroke subjects.

Methods: This quasi-experimental study involved 76 subjects, all over the mean age of 50, with aclinical diagnosis of post-stroke sensorimotor dysfunction. The participants were randomly divided into two groups: Group A (n = 38) received action observation combined with conventional physiotherapy, while Group B (n = 38) underwent integrated action with sensory observation along with conventional physiotherapy. The interventions were conducted three days a week for four weeks, and the effectiveness of the interventions was assessed using the Fugl-Meyer Assessment for Upper Extremity (FMA-UE).

Results: An independent t-test compared mean differences, and a paired t-test assessed pre-and post-test scores of the FMA-UE. Results showed significant within-group improvementsfor both groups but the integrated action with sensory observation group out performed the action observation group in between-group comparisons.

Conclusion: The present study concludes Action observation and integrated action with sensory observation groups showed significant improvements in motor recovery in post stroke subjects. However, integrated action with sensory observation group was moreeffective than Action observation group.

Keywords: Post Stroke, Sensorimotor Dysfunction, Action Observation, FMA-UE,integrated action with sensory observation.

INTRODUCTION

Stroke is also known as cerebrovascular accident (CVA) which is one of the main causes of physical disability in adults. As defined by the WHO, stroke is "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death, with no apparent cause other than vascular origin. It is a neurological disease characterized by the dysfunction of different areas of the brain caused by a sudden vascular (either arterial or venous) disease[1].

A stroke can be either ischemic or hemorrhagic. An ischemic stroke is caused by a significant decrease in the blood flow to a part of the brain. This lack of blood supply produces a cerebral infarction, generated by an embolus, leading to the death of neurons due to a lack of oxygen supply and nutrients in the blood. On the other hand, hemorrhagic strokes are associated with higher mortality rates, however, in the long term, recovery from the sequelae is usually better. They are the result of a hemorrhage caused by the rupture of a cerebral vessel, causing bleeding and extravasation into the cerebral space[2].

According to Global Burden of Diseases Study 2019, the incident cases of stroke are 12.2 million, & the prevalent cases of stroke are 101 million cases, 143 million Disability Adjusted Life Years [DALYS] due to stroke, 6.5 million deaths from stroke[3]. In India, the crude incidence of stroke ranged from 108 to 172/ 100000 persons per year, and the crude prevalence of stroke ranged from 26 to 757/ 100000 persons in different parts of the country during the past decade[4].

After the event, commonly seen impairments are sensory, motor, posture, balance, cognitive, bowel, bladder and speech, language, and swallowing. Sensory problems include pain, abnormal sensations, visual changes as well as motor problems include weakness, altered tone, abnormal synergy, and reflexes, altered voluntary control and proprioception.

One of the most prevalent dysfunctions following a stroke is sensorimotor impairment, and regaining it has long been a crucial and difficult aspect of neurorehabilitation[5]. The term "somatosensory impairments" refers to deficiencies in skin, muscle, or joint sensation. A deficiency in proprioception, discriminative skills, or the ability to feel touch, pressure, or pain are some examples of these deficits. Deficits in sensory motor skills result in limitations in daily living activities and social involvement[6].

According to a recent study, 78% of stroke survivors had either a single or multiple sensorimotor impairments in the afflicted upper limb at one week after the stroke[7]. Following a stroke, deficits in somatic sensations body senses like touch, warmth, pain, and proprioception are prevalent; prevalence rates range from 11 to 85% [8].

In accordance with the sequential transmission of afferent sensory activity from the spinal cord to Primary somatosensory cortices and subsequently to Primary motor cortex, sensory gating is affected by integrating afferent somatosensory inputs from peripheral receptors with the motor output at multiple levels in the ascending sensory pathway and in the cerebral cortex[9].

The Fugl-Meyer Assessment (FMA) is a stroke-specific, performance-based impairment index. It is designed to assess motor functioning, sensation, balance, joint range of motion and joint pain in patients with post-stroke hemiplegia[10].

Neural facilitation, motor relearning, sensory retraining, transcutaneous electrical nerve stimulation, and other methods are examples of conventional rehabilitation therapies that can help with motor function recovery to some degree. However, impairment to sensory pathways is frequently present after stroke, which limits the effectiveness of traditional rehabilitation techniques. In order to augment or replace conventional therapy, we must investigate and create more potent rehabilitation techniques[11,12,13].

In recent years, rehabilitation methods like Action observation (AO) have been established based on the mirror neuron theory and applied to motor rehabilitation after stroke[14,54]. It is a new method used in upper limb rehabilitation of various neurological disorders, especially in stroke. During the AO procedure, participants view a video or live performance of certain motions and activities of healthy participants they then attempt to mimic and execute those actions[16].

AO treatment has strong evidence to help stroke survivors' motor function[17,18]. Systematic observation of a human movement or activity can prime execution of the same action, according to substantial evidence. Observational learning, action recognition, and imitation can all be enhanced by an internal motor representation of the target movement[19,20]. By simulating observed motions, the mirror neuron system can be used to improve upper limb function and reorganize damaged neuronal circuits to restore motor function following a stroke[21,22]. After AO therapy of daily tasks in stroke patients, research demonstrates large increases in neurophysiological activity in premotor areas and considerable improvements in upper-limb function[23].

Sensorimotor videos (Integrated of Action with Sensory observation) show such tasks as a brush, brushing one side by therapist on affected upper limb of subjects during motor action. Eighty-five percent of subjects who have had strokes have sensory impairments of the upper limb, especially touch and proprioception impairments[24]. Research has demonstrated that effective motor output and ADL depend on sensory input, so motor performance may be impacted by sensory impairment. Recuperation and motor control also depend on remodeling sensory circuits and enhancing sensory function[25,26].

Therefore, it is possible that simultaneous activation of the motor and sensory cortices will facilitate better remodeling and enhancement of both motor and sensory functions particularly the promotion of motor function[27].

The majority of studies focuses on other clinical signs rather than motor function. There are numerous studies which focuses on stroke disease rehabilitation concentrating on motor treatment and benefits of motor rehabilitation. Research articles support that integrated action with sensory observation is improving the motor function than action observation on post stroke subject. However, to the best of our knowledge, there are no studies which are reporting that integrated action with sensory observation helps in motor function in stroke disease subjects. The goal of the current study is to determine whether effect of action observation versus integrated action with sensory observation is beneficial for upper limb motor recovery in post stroke subjects.

NEED OF THE STUDY

Stroke is the third most cause of mortality after heart disease and cancer in India. Prevalence rates of stroke vary from one study to another, and there has been a definite increase in the prevalence and incidence of stroke disorder in India over the last 30 years.

Stroke survivors often experience sensorimotor dysfunction leads to chronic motor deficits especially in the upper limb, resulting in diminished capacity to perform skilled voluntary movements of the upper limb affected by the stroke.

Action observation is the promotion of neural reorganization and motor learning. By observing others perform specific movements, stroke survivors can stimulate their brain's mirror neuron system, which enhances their ability to plan and execute similar actions. This can lead to improved motor control, coordination, and overall functional recovery in the affected upper limb. Integrated action with sensory

observation is the enhancement of proprioceptive and sensory feedback. By observing movements, individuals can improve their awareness of body positioning and movement dynamics, which helps refine their motor skills. This improved sensory input can lead to better coordination, control, and overall functional recovery of the affected limb.

There were less number of studies in the literature to determine which methods of action and sensory observation are effective in improving motor recovery after stroke. There is limited study available that compares action observation and integrated action with sensory observation on upper limb motor recovery in post stroke patients. So, the need of the study arises to see the effect of action observation versus integrated action with sensory observation on upper limb motor recovery in post stroke subjects.

MATERIALS AND METHODS:

STUDY DESIGN: Quasi-experimental study design.

ETHICAL CLEARANCE AND INFORMED CONSENT: This study protocol was approved by the Ethical Committee of GSL Medical College & General Hospital (Annexure-I), the investigator explained the purpose of the study and given the patient information sheet. The participants were requested to provide their consent to participate in the study. All the participants signed the informed consent and the rights of the included participants have been secured.

STUDY POPULATION: Subjects clinically diagnosed as Post stroke by a NeuroPhysician.

STUDY SETTING: The study was conducted at Department of Physiotherapy,Tertiary care Hospital, Rajamahendravaram, Andhra Pradesh, India.

STUDY DURATION: The study had been conducted during a period between August 1st 2023 to July 31st 2024

INTERVENTION DURATION: 12sessions, 3 Days , for 4 weeks.

STUDY S AMPLING METHOD: Convenience sampling

SAMPLE SIZE: A total of 80 subjects were screened, in that 76 subjects both male andfemale with Sensorimotor impairment after stroke who are willing to participate in the study were included in the study, all the recruited participants were explained about the study. After obtaining informed consent form and meeting the criteria, total 76 subjects were allocated into two groups equally by convenience method.

76 subjects were selected for the prevalence of stroke 0.757%, by the formula $n = Z^2PQ/L^2$

$Z = 1.96$ at level of significance 2%, P= Prevalence (0.757%),

$Q = 100-P$, L= Absolute error (1-6%), here it is considered as 2%.]

Group A–Action Observation (38 subjects)

Group B – Integrated Action with Sensory Observation (38 subjects)

GROUPS	NO. OF SUBJECTS	TREATMENT
GROUP A	38	ACTION OBSERVATION
GROUP B	38	INTEGRATED ACTION WITH SENSORY OBSERVATION

MATERIALS USED

- Electrical stimulator
- Stool
- Examination couch
- Data collection forms
- Smart phone
- Straps
- Electrodes
- Ice pack
- Chair

CRITERIA FOR SAMPLE COLLECTION:

INCLUSION CRITERIA

- Unilateral ischemic (or) hemorrhagic stroke lesion confirmed by computerized tomography or magnetic resonance imaging, diagnosed by neurologist or general physician
- First incidence of stroke
- Adequate communication ability
- Subjects who have upper limb impairment caused by stroke
- Having atleast 20^0 wrist extension and 10^0 active extension of metacarpophalangeal joints,interphalangeal joint of all digits, 10^0 extension of the affected upper limb.

EXCLUSION CRITERIA

- Aphasia

- Occurrence of orthopaedic lesions in the upper extremity
- Hearing problem and Visual problem
- Cognitive impairments
- Inability to sit at least one hour independently on a chair

OUTCOME MEASURES:

Fugl-Meyer Assessment Upper Extremity (FMA-UE)[28]:

The Fugl-Meyer Assessment of upper extremity (FMA-UE) is a stroke-specific, performancebased impairment index. It is designed to assess motor functioning, balance, sensation and joint functioning in patients with post-stroke hemiplegia. It is applied clinically and in research to determine disease severity, describe motor recovery, and to plan and assess treatment.

A 3-point ordinal scale is used to measure impairments of volitional movements with gradesranging from 0 to 2. 0 indicates item cannot be performed, 1 indicates performed partly & 2indicate item can be fully performed. Specific descriptions for performance accompany individual test items. Subtests exist for upper extremity function. And subtest scores i.e., upperextremity maximum score is 66.

INTERVENTION:

This is a 4-week study which includes Action observation for Group–A and Integrated actionwith sensory observation for Group -B. The outcomes were measured by the Fugl-Meyer Assessment Upper Extremity for upper limb motor function. All the subjects who were eligible for the criteria were randomly allocated into Group A and Group B.

GROUP A - ACTION OBSERVATION[29]

The subjects in the group A were follow the neurological rehabilitation program (PNF, stretching, cryotherapy, neuromuscular electrical stimulation, activity-based exercises etc.) tothe affected upper limb and lower limb in the rehabilitation unit. Additionally subjects in the group A was received Action observation of the upper limb of paretic side. AO was used to retrain improve motor function and promote reorganization of the motor cortex. We gave3 sessions to observe and practice each task. So, a total of 12 sessions was consider for the 4 tasks (3 times a week). To maintain the effects of the previous practiced task, at the end of each task practice period (after 3 sessions). At the beginning of the next sessions, the previous tasks had been viewed as a complete task for 6 minutes and then performed as a whole. For example, Activity I was selected for the first 3 sessions and activity II for the next 3 sessions. Therefore, In the fourth session of the study, before observing and performing the components of activityII, the whole task observation/execution of the activity I should have been performed for 6 minutes (3 minutes observation + 3 minutes execution). Each of the I– IV activities includedfunctional components that was briefly explained to the subjects at the beginning of each of the three intervention sessions. Each session lasted 30minutes, and the steps was followed ineach session as described below:

1. The video of how to perform each component (part task) was play from 3 angles for a total of about 2 minutes; each angle will being shown approximately 3 times
2. After watching the video (action observation) of each activity component, the participant should have performed the same movements and tasks for 3 minutes. If necessary,in addition to monitoring the intervention session, the therapist provides appropriate physical assistance for the subjects to complete the activity.
3. Before the end of each session and after observing and performing all the components, the whole task will shown for about 3 minutes in 3 angles (i.e., each angle for 1 minute)
4. After watching the whole task video, the participants should have practice the same movements and tasks for 3 minute
5. TASK 1 – Pour water from bottle to glass
6. TASK 2 – Eating food manually
7. TASK 3 – Drinking water from a glass
8. TASK 4 – Eat a piece of carrot with fork
9. Each subject will receive total of 12 sessions, three days per week for 4weeks with eachsession lasting 30 min.

Fig no: 1 TASK 1 – POUR WATER FROM BOTTLE TO GLASS
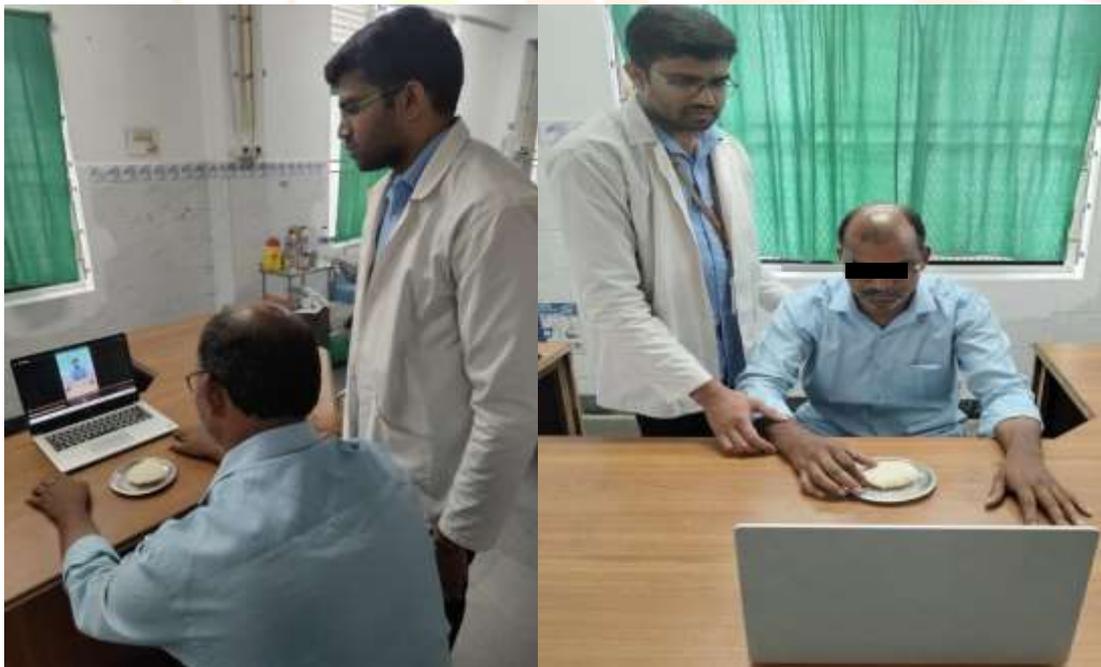
Fig no: 2 Task 2 – EATING FOOD MANUALLY

Fig no:3 TASK 3 – DRINKING WATER FROM A GLASS

Fig no: 4 TASK 4 – EAT A PIECE OF CARROT WITH FORK

CONVENTIONAL PHYSIOTHERAPY:

The treatment techniques in conventional physiotherapy to treat upper limb motor function which includes, prolonged stretching, proprioceptive neuromuscular techniquesand cryotherapy, neuromuscular stimulation to the paretic side of the patient.

Cryotherapy[30]Cryotherapy was performed for 25 minutes on the ventral surface of the spastic upper limb and lower limb using a plastic bag containing ice and a wet towel around it.

Stretching[31] of the involved muscle is the commonly used physical modality for the management of spasticity. Prolonged and regular stretching was given to upper limb and lower limb muscles with three repetitions each with 30 seconds hold can reduces arcomere shortening, and help increase or preserve the length of the muscles and othermusculoskeletal structures.

PNF techniques[32] rely mainly on stimulation of the proprioceptors for increasing thedemand made on the neuromuscular mechanism to obtain and facilitate its response. It uses proprioceptive, cutaneous, auditory input to produce functional improvement in motor output and in the rehabilitation of many injuries. The techniques of PNF are composed of both rotational and diagonal exercise patterns. The patterns of facilitation i.e. D1 and D2 flexion extension for both upper limb and lower limb with stretch stimulusand stretch reflex. The D1 flexion for upper limb included flexion abduction with lateral rotation and D1 extension included extension-adduction with medial rotation. The D2 flexion includedflexion- adduction with lateral rotation and D2 extension included extension-abduction with medial rotation. Similarly, for lower limb, D1flexion included flexion-abduction with medial rotation and D1 extension included extension-adduction with lateral rotation. The D2 flexion included flexion-adduction with lateral rotation and D2 extension included extension-abduction with medial rotation.

Neuromuscular electrical stimulation[33] was given to the affected side of the patient with stroke. The stimulation was given to upper and lower limb muscles at a frequency adjusted in between20 and50Hz and amplitude was adjusted to a suitable amount for the patient (0-100 mA).

Gait training[34,] was performed manually on parallel bars. This training mainly focused on shifting of weight properly, step length uniformity, control of gait speed, andmaintaining correct alignment of trunk and pelvis during gait. The training was given 10to12 sessions of ambulation for 10 meters. Auditory and visual feedback was provided in the form of physiotherapists command and mirror image respectively.

Fig no: 5 STRETCHING OF UPPER LIMB MUSCLES

Fig no: 6 STRETCHING OF LOWER LIMB MUSCLES

Fig no: 7 PNF PATTERNS OF UPPER LIMB
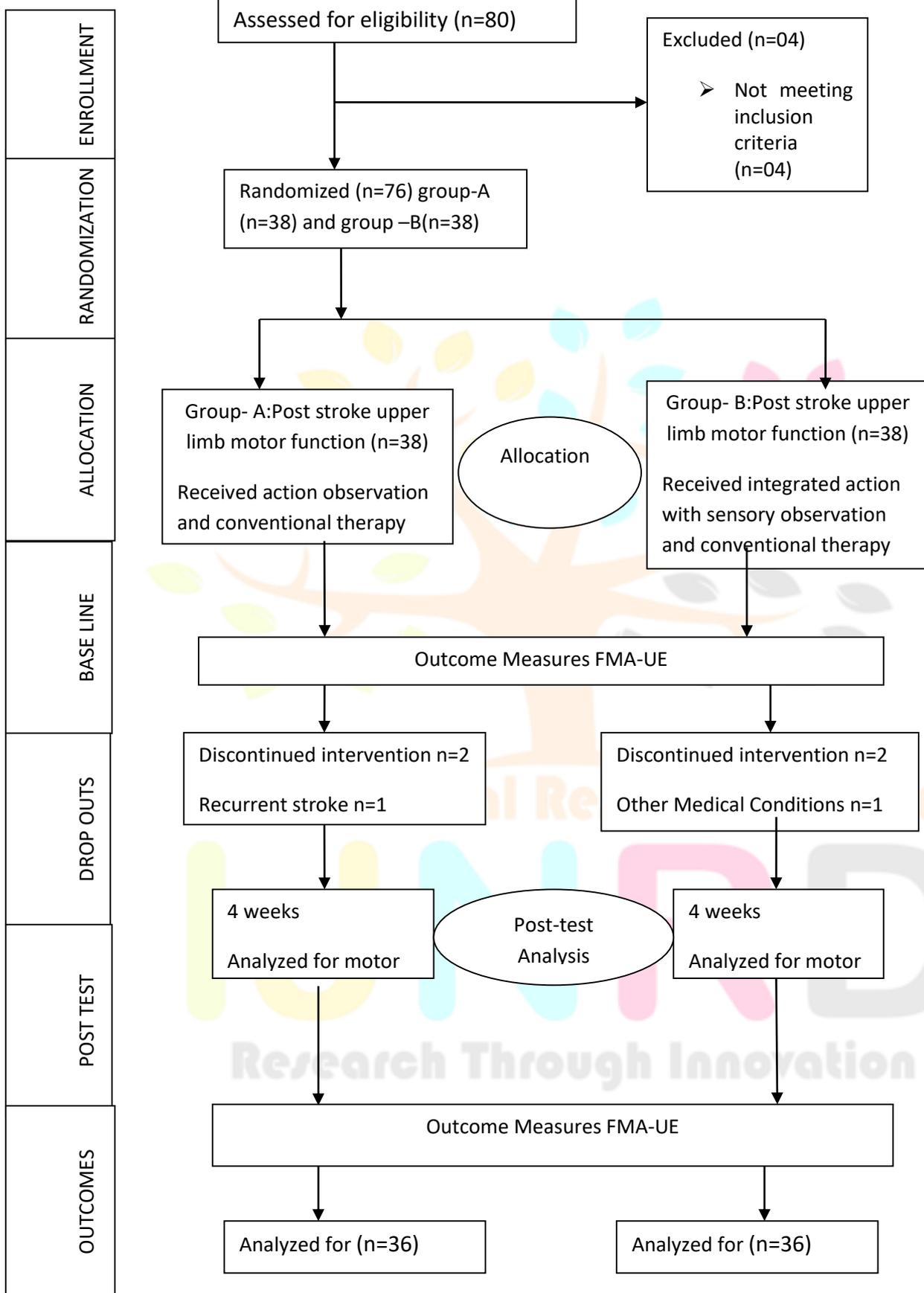

Fig no: 8 PNF PATTERNS OF LOWER LIMB

Fig no: 9 APPLICATION OF NEUROMUSCULAR ELECTRICAL STIMULATION FOR AFFECTED SIDE UPPER AND LOWER LIMB

Fig no: 10 GAIT TRAINING

GROUP B : INTEGRATED ACTION AND SENSORY OBSERVATION[35]

Group B will receive integrated action and sensory observation. Their will be Four Tasksaccording to patient situation for daily upper limb activities. Sensorimotor videos tasks as a brush, brushing one side by therapist on affected upper limb of patient during motoraction and it improves sensorimotor functions.

TASK 1 – Pour water from bottle to glass

TASK 2 – Eating food bimanually

TASK3 – Drinking water from a glass

TASK 4 – eat a piece of carrot with fork.

Fig no: 11 TASK 1 – POUR WATER FROM BOTTLE TO GLASS

Fig no: 12 TASK 2 – EATING FOOD MANUALLY

Fig no: 13 TASK 3 – DRINKING WATER FROM A GLASS

Fig no: 14 TASK 4 – EAT A PIECE OF CARROT WITH FORK

Group B The subject received conventional physiotherapy same as given in group A.

Fig no: 15 STRETCHING OF UPPER LIMB MUSCLES

Fig no: 16 STRETCHING OF LOWER LIMB MUSCLES

Fig no: 17 PNF PATTERNS OF UPPER LIMB

Fig no: 18 PNF PATTERNS OF LOWER LIMB

Fig no:19 APPLICATION OF NEUROMUSCULAR ELECTRICAL STIMULATION FOR AFFECTED SIDE UPPER AND LOWER LIMB MUSCLES

Fig no: 20 GAIT TRAINING

FLOW CHART:

ENROLLMENT	
RANDOMIZATION	
ALLOCATION	
BASE LINE	
DROP OUTS	
POST TEST	
OUTCOMES	

Assessed for eligibility (n=80)

Excluded (n=04)

➢ Not meeting inclusion criteria (n=04)

Randomized (n=76) group-A (n=38) and group –B(n=38)

Group- A:Post stroke upper limb motor function (n=38)

Received action observation and conventional therapy

Allocation

Group- B:Post stroke upper limb motor function (n=38)

Received integrated action with sensory observation and conventional therapy

Outcome Measures FMA-UE

Discontinued intervention n=2

Recurrent stroke n=1

Discontinued intervention n=2

Other Medical Conditions n=1

4 weeks

Analyzed for motor

Post-test Analysis

4 weeks

Analyzed for motor

Outcome Measures FMA-UE

Analyzed for (n=36)

Analyzed for (n=36)

STATISTICAL ANALYSIS:

All statistical analysis was performed done by using SPSS software version 20.0 and MS excel – 2010. All descriptive statistical data was presented as mean ± standard deviation and main differences were calculated and presented.

Within the groups: Paired student "t" test was performed to assess the statistical difference with in the groups for upper limb motor recovery from pre test and post test values.

Between the groups: Independent student "t" test was performed to assess the statistically significant difference in mean value between the groups for Fugl-Meyer Assessment upper limb motor recovery.

Data was also tabulated and graphically represented.

For all statistical analysis, P<0.05 was considered as statistically significant.

RESULTS:

The results of the study were analyzed by FMA –UE to see the improvement in upperlimb motor recovery.

The consort flow chart of the study showed the study organization in terms of SubjectsScreening, Random allocation and Analysis following the intervention.

A total of 80 screened for eligibility, among 76 subjects were included in the study trail. All the 76 subjects undergone baseline assessment and subjects who met the inclusion criteria were randomized into two groups consisting 38 each.

In this study 36 subjects completed training in Group -A and 36 subjects completed training in Group – B with dropouts of 2 in respective groups, results showed that there is a statistical difference in two group

ANALYSIS OF MEAN SCORES OF FMA-UE WITH IN THE GROUP– A

| Groups		Mean	Standard Deviation	P-value	Inference
Group–A	FMA-UE Pre-test	40.83333333	5.168586433	0.001	Highly significant
	FMA-UE Post-test	47.19444	5.322832		

TABLE -1
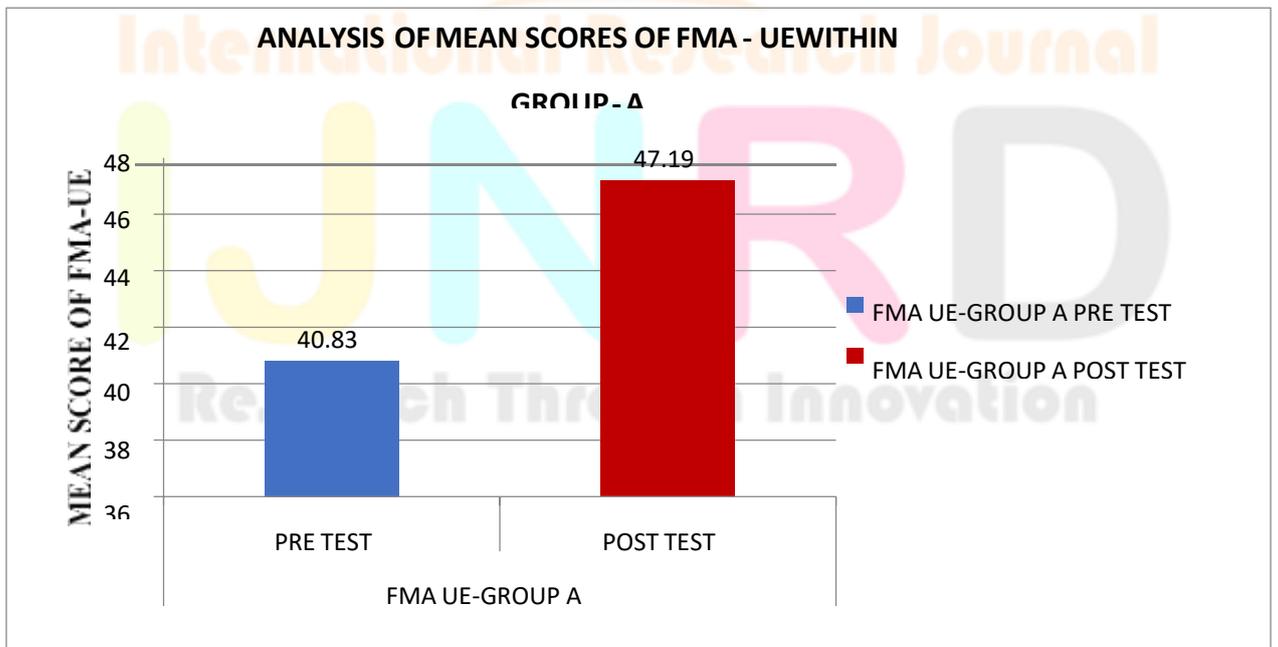
GRAPH–1

RESULTS: The above table and graph depicts the mean score of FMA-UE changes from pretest to posttest values within Group-A were found to be statistically significant (P<0.005).

ANALYSIS OF MEAN SCORES OF FMA-UE WITHIN THE GROUP- B

Groups		Mean	Standard Deviation	P-Value	Inference
Group-B	FMA-UE Pre-test	41.02778	5.245331	0.001	Highly significant
	FMA-UE Post-test	51.52778	5.162979		

TABLE-2
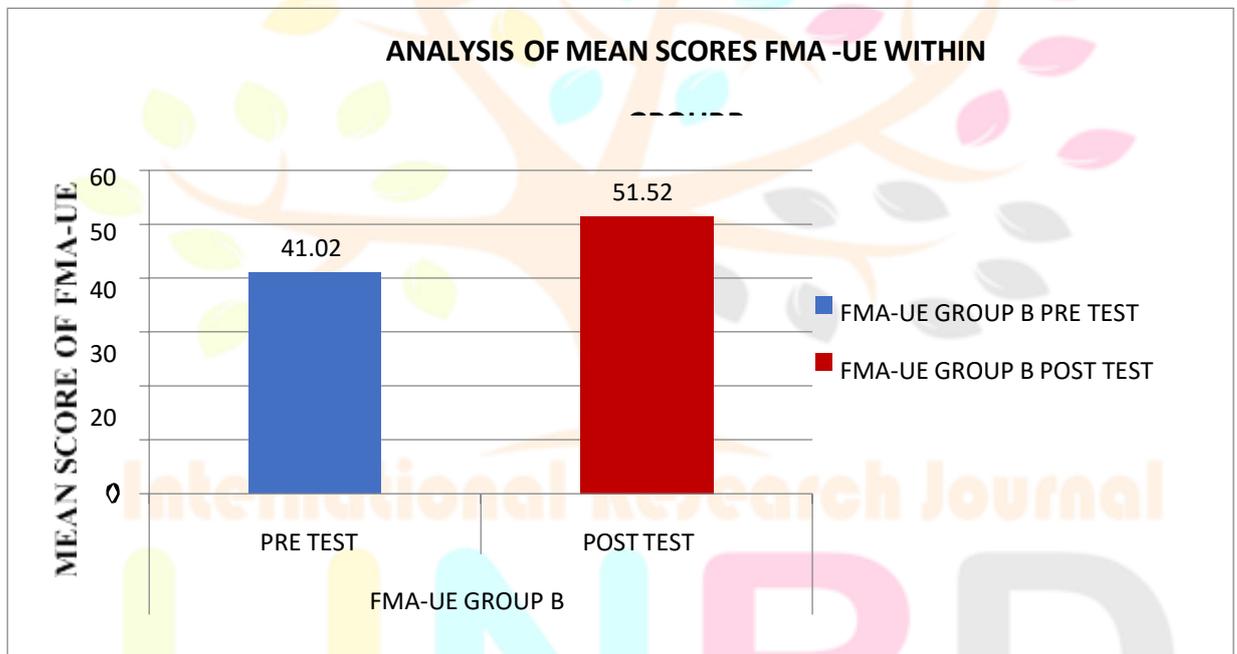
GRAPH-2

RESULTS: The above table and graph depicts the mean score of FMA-UE changes fromPre test to posttest values within Group-B were found to be statistically significant (P<0.005).

**COMPARISON OF MEAN SCORES OF FMA -UE BETWEEN THEGROUPS GROUP A & B(PRE-TEST)**

Groups		Mean	Standard Deviation	P-Value	Inference
FMA-UE Pre-test	Group-A	40.83333333	5.168586433	0.616733	Insignificant
	Group- B	41.02778	5.245331		

TABLE-3

COMPARISON OF MEAN SCORES OF FMA -UE INBETWEEN THE GROUPS (PRE TEST)
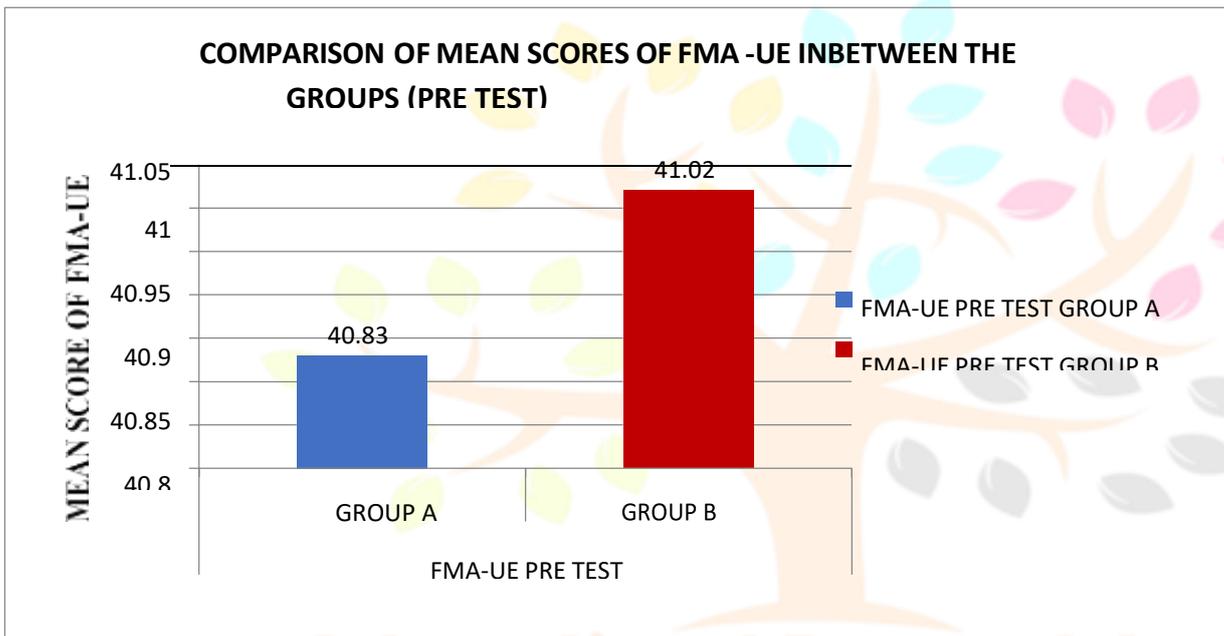
GRAPH-3

RESULTS: The above table and graph depicts the base line measurement of FMA-UE inGroup– A (40.83) and Group– B (41.02) were found to be statistically insignificant.
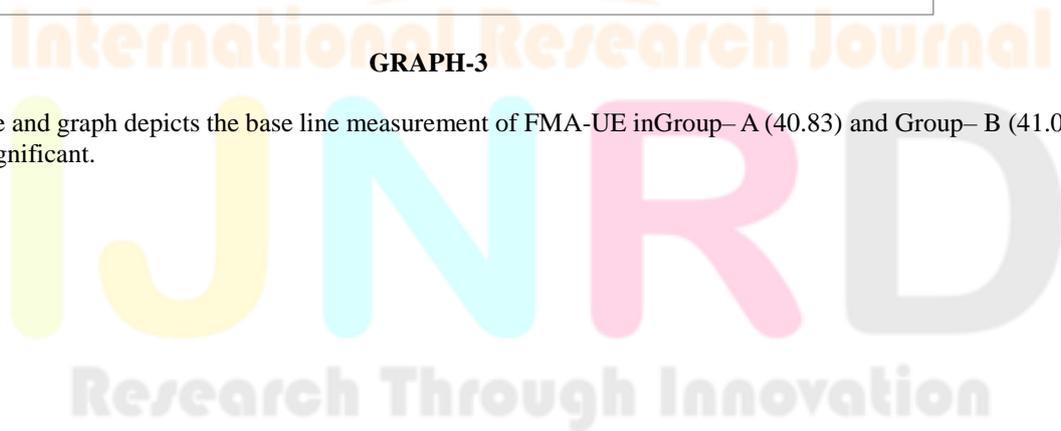
COMPARISON OF MEAN SCORES OF FMA-UE BETWEEN THEGROUPS GROUP A&B (POST-TEST)

Groups		Mean	Standard Deviation	P-Value	Inference
FMA-UE Post-test	Group-A	47.19444	5.322832	0.00586	Highly significant
	Group–B	51.52778	5.162979		

TABLE-4
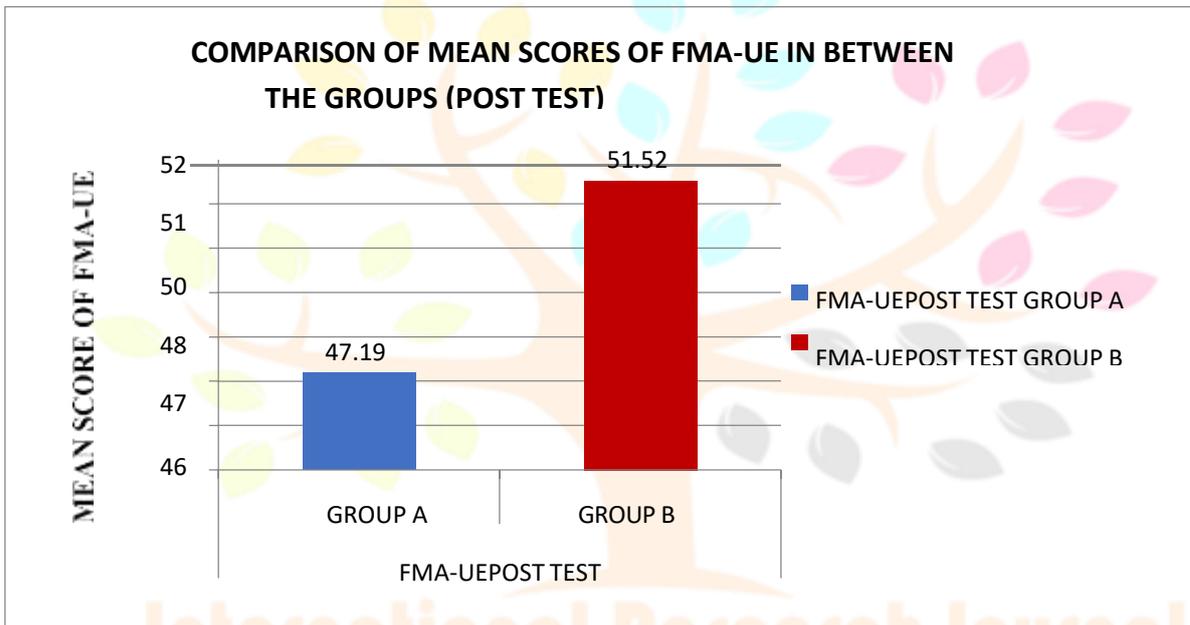
GRAPH-4

RESULTS: The above table and graph depicts the post-test measurement of mean score of FMA-UE changes between the Group-A (47.19) and Group B(51.52)were found to be statisticallysignificant (P<0)
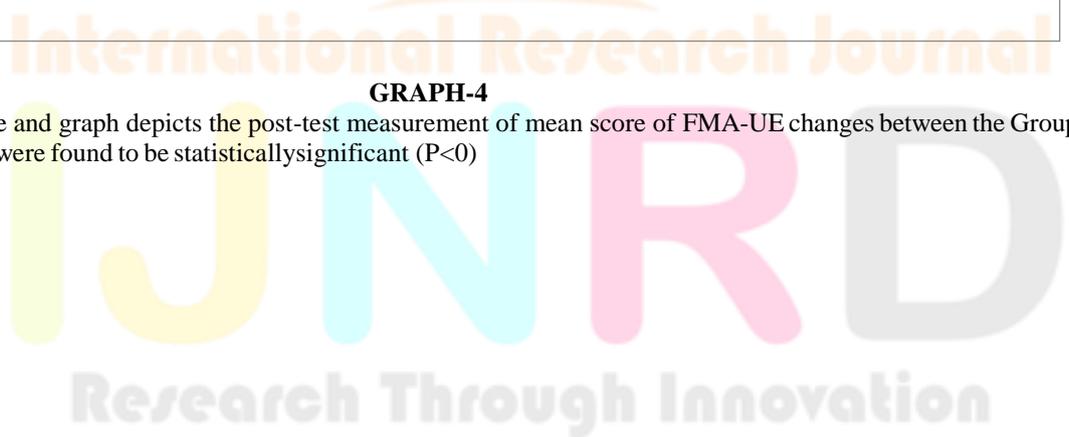
DISCUSSION:

The Aim of the study was to assess effect of action observation versus integrated action with sensory observation on upper limb motor recovery in post strokesubjects. Recently action observation has been used increasingly in neurological injuries such as stroke, spinal cord injuries, or other neurological disorders and Integrated action with sensory observation has been used in neurological injuries such as stroke, spinal cord injuries, or other neurological disorders. Only limited studies were there in comparison between action observation and integrated action with sensory observation techniques in post stroke subjects.

Subjects were assessed for upper limb motor function at base line and at end of intervention using FMA-UE for motor function. There were two drop-outs in Group-A (Action observation+ Conventional Physiotherapy), one due to recurrent stroke &one due to other medical conditions and in Group-B (Integrated action with sensoryobservation plus Conventional Physiotherapy), there were two drop outs one due to recurrent stroke and one dropouts due to other medical conditions.

In Group-A there is statistically more significant improvement in FMA- UE(P=0.001). Peppino Tropea et al[36]. claim that AOT uses the MNS network to activate the brain networks that are active during action execution in order to improve motor functions in individuals who have motor deficits. The physiologicalmechanisms underlying motor learning may be improved by imitating seen gestures,which may increase the primary motor cortex's remodeling and aid in the development of motor memories of the action. It is commonly recognized that the MNS is crucial for our capacity to learn by imitation and for taking into account thebehaviors of others. Additionally, the subsequent active performance of observed activities appears to strengthen the activation of motor regions by AOT.

In fact, AOT has emerged as a new motor learning training method as a motor representation methodology. A study by Zhiqing Zhou et al[37,] examined how upper limb sensorimotor function inchronic stroke patients was affected by integrated action and sensory observation therapy, which was founded on the embodied cognition theory and mirror neurons. AOT can improve upper limb motor function and ADLs for stroke patients by promoting motor cortex activity with mu suppression, increasing motion-evoked potential, and decreasing central motion conduction delays, according to research. The best time to use AOT is still up for dispute, though, since one study found that when compared to traditional physical therapy, AOT had minimal effect on motor function in individuals less than 31 days following a stroke.

Ruther et al[38]., for instance, discovered that when participants saw a novel item creation task from a visual picture matching cue or a partner who sat opposite, the action observation network which is made up of sensorimotor brain regions was activated. Importantly, although AO has been shown to stimulate activity in the brainregions that partially overlap with those in charge of carrying out movements, one of its drawbacks is that it only shows an action visually, without necessarilyinvolving the observer's sense of agency or encouraging attention to one's own bodyschema and the associated kinaesthetic sensations of the action being seen.

A task-based fmri study comparing somatosensory stimulation and sensory observation in mirror neurons and the sensorimotor network was carried out by Zhiqing Zhou et al. Research demonstrates that certain areas of the MNS, namely the frontal and parietal lobes, have an action observation–action execution matchingmechanism. By stimulating this particular MNS, AO treatment helped stroke patientsregain their motor function.

The motor areas of the observer will resonate when an action is understood. Notably, AO treatment creates motor representations to help with action execution by relying on visual feedback and emphasizing the kinaesthetic feeling of observed motion[39].

Current study AO plus Conventional physiotherapy group is having positive correlation with previous studies mechanisms because the improvements in motor recovery are measured on FMA.

Group-B (INTEGRATED ACTION WITH SENSORY OBSERVATION) of current study had significant improvements on FMA-UE (P=0.001). According to research by Chunlei Shanet al[40], there is a strong relationship betweenmotor control and sensory systems. Prior research has demonstrated that in stroke survivors, impaired sensory function may be a sign of a delayed recovery of motor function and ADLs. Because of brain plasticity, new axons emerging from the sensorimotor related cortex and peri-infarct will reorganize in stroke patients.

According to research by Ono et al[41], neurofeedback training in MI using genuine proprioceptive input may improve event-related desynchronization, which is arepresentation of motor cortex excitation. According to a different study, somatosensory stimulation triggered by both AOT and MI at the same time can increase motor cortex excitability more than either AOT or MI alone[42].

According to research byParkkonen et al[43]., Sensorimotor integration is crucial for stroke patients who have a satisfactory motor recovery. Nonetheless, motor functionimpairment and recovery remain the main focus of many post-stroke upper limb rehabilitation techniques. It has been discovered that the somatosensory cortex can be triggered in healthy adults whether they are looking at the hand being touched inthe first or third person.

Furthermore, another study shows that the brain affected bya stroke has stronger parietofrontal connectivity during visually guided movements,suggesting that AOT activates the sensorimotor network. This gives us a foundationfor using AOT+SOT to help stroke patients' sensorimotor function. In our earlier research, we discovered that in healthy people, somatosensory stimulation (SS) andsensory observation (SO) might activate the precentral gyrus, supplementary motorregion, and postcentral gyrus. These areas of the brain are in charge of sensory integration, movement preparation, and execution.

According to research on phantom limb occurrences, people who have real sensoryand motor loss yet maintain awareness of and feel a sense of body continuity and onenes[44]. The rubber hand illusion also demonstrates that visual usually takes precedence over somatic experience when multimodal stimulation is present, and that the virtual body may be perceived as one's own[45].

For the hypothesis of embodied cognition, which holds that the brain systems that sense those features can represent semantic knowledge of perceptual properties, these results constitute crucial proof. By using visual stimuli, may sensory observation (SO) assist create sensory representations of experienced sensory eventsand map them to the sensory nerve system. It has been demonstrated that mirror neurons are

both sensory and motor neurons. Consequently, it is logical to believe that SO may activate the sensory regions of the MSN and create sensory representations by comprehending sensory information beforehand, given the combination of mirror neurons and embodied cognition theory.

Additionally, the integration of sensory and motor networks may be facilitated by the stimulation of the sensory nerve system[46]. According to Nasrallah et al.,[47] motor output, which controls the integration of sensorimotor networks, depends on efficient sensory input.

As a result, the recoveryof motor function may greatly benefit from the enhancement of sensory function through sensory input-based rehabilitation training. Prior research in sensory rehabilitation has concentrated on somatosensory stimulation (SS) via peripheral sensory inputs that are "bottom-up". However, in situations where sensory circuits are damaged, the impact of SS may be diminished.

According to Mikkel et al[48]. tactile discrimination and acuity were enhanced by visual signal input. Visual stimulus may enhance primary somatosensory cortex activity and raise primary motor cortex excitability, which in turn causes brain plasticity. As a result, we questioned if SO creating a subjective experience could have consequences skin to those of sensory stimulation. Could sensory-motorintegration be facilitated by these "top-down" sensory representations activating motor or sensory areas in the sensorimotor network.

As neuroimaging techniques have advanced, neuroanatomical and functional changes in sensation and movement have been studied using task-based functional magnetic resonance imaging (fMRI)[49]. It gives us a solid basis for studying how thesensorimotor network and mirror neurons are activated during SO. In order to use atask-based fMRI to uncover the potential brain mechanisms behind the changes in sensorimotor function and their relationship to mirror neurons in healthy individuals,this study created the tasks SO and SS[50].

The protocol of conventional physiotherapy of this study was taken from previousstudy. In our current study, participants were taken proprioceptive neuromuscular facilitation, passive muscle stretching, cryotherapy, gait training and NMES. Cryotherapy[31] in the treatment of spasticity has as primarily objective to reduceVisco-elastic monoarticular tension and facilitate neuromuscular function.

Thephysiological effect of ice is reduction of muscle spindle, neuromuscular junctionand peripheral nerve activity ,Monaghan K[33], et al., stated that proprioceptive neuromuscular facilitation training,stretching, cryotherapy and NMES were aimed at improving the functional activitiesof hemiplegic patients such as muscular tone, strength and flexibility and the mechanism behind the improvements is reciprocal inhibition and Golgi tendon activation and inhibition of excitability of alpha motor neurons leads to an increase in the extensibility of soft tissues.

Pallavi Sahay[35] et al., stated that gait training in parallel bars has greater improvements in the functional outcomes, as the parallel bars provided support anddecreased the fear of fall providing stable background to practice gait. Therefore strategies for decreasing movement speed through mechanical constraints resulting from holding on to the parallel bars and visual feedback from the mirror helping thepatient to slow down the speed of movement may outweigh the negative consequences of increased inertia.

The study findings indicating that after 4 weeks of interventions both groups were statistically significant in improving upper limb motor function. However integratedaction with sensory observation along with conventional physical therapy was statistically more significant in FMA-UE (P=0.001) than action observation along with conventional physical therapy in FMA-UE (P=0.001) in improving upper limb motor function. Thus this study concludes that integrated action with sensory observation is a useful adjunct upper limb motor function in post stroke subjects.

LIMITATIONS
1. Due to Small sample size in this study results couldn't be generalized to large group ofpopulation.
2. No blinding evaluators of outcomes was done.
3. There is no follow up in this study to evaluate the sustained effectiveness of theintervention over time.

RECOMMENDATIONS OF FURTHER RESEARCH
1. Future research could benefit from employing a more rigorous randomization techniqueand considering a large sample size to enhance the robustness of results.
2. The study may benefit from long term follow-up assessments to evaluate the effectivenessof intervention over time.
3. In this study, we have focused solely on the motor component. Future studies shouldinclude both the sensory component and the motor component for a more comprehensive analysis.

CONCLUSION:
The present study concludes Action observation and Integrated action with sensoryobservation group showed significant improvements in motor recovery in post stroke subjects. However, Integrated action with sensory observation group was more effective than Action observation group. According to findings of this study, Integrated action withsensory observation therapy used as an adjunct in stroke rehabilitation.

ACKNOWLEDGEMENT:

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INSTITUTIONAL ETHICS COMMITTEE
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GSLMC/ RC:1084-EC/1084-07/2023   *Date: 25.07.2023*

Communication of Decision of the Institutional Ethics Committee [IEC] - Institutional Review Board [IRB]

To: Mr. MOHAMMAD RAZAK,1ˢᵗ YEAR MPT (NEUROLOGY), GSL College of Physiotherapy & Rehabilitation, Rajahmundry.

IEC/IRB Ref No: *1084-EC/1084-07/2023*

Protocol Title: "EFFECT OF ACTION OBSERVATION VERSUS INTEGRATED ACTION WITH SENSORY OBSERVATION ON UPPER LIMB MOTOR RECOVERY IN POST STROKE SUBJECTS"	
Principal Investigator: Mr. MOHAMMAD RAZAK	
Name & Address of Institution: GSL College of Physiotherapy & Rehabilitation, Rajahmundry	

New review	√	Revised Review		Expedited review	

Date of review [D/M/Y]: 2 5 0 7 2 0 2 3

Date of previous review (if revised application):

Documents reviewed:

Current CV of the investigator	√	Trial protocol	√	Investigator's Brochure	√
Proposed methods	√	Informed consent form	√	Agreement with the Sponsor	
Compensation protocol	√	Investigators undertaking	√	Case Report Form	√

Any other/ additional documents (Specify)

Decision of the IEC / IRB:
Recommended [√]   Recommended with suggestions [ ]   Revision [ ]   Deferred [ ]   Rejected [ ]

Suggestion/Reasons/Remarks: APPROVED √

Recommended for a period of :
One Year [ ]   Three Years [√]   Five Years [ ]

Please note:
➢ Inform IEC/ IRB immediately in case of any Advance events and Serious adverse events
➢ Inform IEC/IRB in case of any change of study procedure, site and investigator.
➢ This permission is only for period mentioned above. Annual report to be submitted to IEC/IRB.
➢ Members of IEC/IRB have right to monitor the trial with prior intimation.

Signature of MEMBER SECRETARY
IEC/IRB

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