Case Report

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Facilitating Neuroplasticity in Stroke: A Single-Patient Case Report Using Action Observation Therapy

Khanak Pal[1], Sumedha Rabra (PT)[2]

[1]Physiotherapy Intern, Department of Physiotherapy, Sharda University, Greater Noida, India
[2]Assistant Professor, Department of Physiotherapy, Sharda University, Greater Noida, India

Corresponding Author: Sumedha Rabra (PT)

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ABSTRACT

Background: Stroke is a major cause of long-term disability, frequently resulting in persistent motor impairments, reduced balance, and dependence in activities of daily living. Enhancing neuroplasticity through task-specific and evidence-based rehabilitation strategies is essential for functional recovery. Action Observation Therapy (AOT), based on the mirror neuron system, has emerged as a promising adjunct to conventional physiotherapy for post-stroke motor relearning.

Objective: To evaluate the effectiveness of Action Observation Therapy combined with conventional physiotherapy in improving motor function, balance, and functional independence in a patient with post-stroke hemiparesis.

Methodology: This study is a single-patient case report of a 52-year-old female with right-sided hemiparesis following a left middle cerebral artery ischemic stroke. The patient underwent a 4-week physiotherapy program incorporating daily Action Observation Therapy (30 minutes/session) along with task-specific training, strengthening, balance, and gait training. Outcome measures assessed pre- and post-intervention included the Fugl-Meyer Assessment–Upper Extremity (FMA-UE), Wolf Motor Function Test (WMFT), Modified Barthel Index (MBI), and Berg Balance Scale (BBS).

Results: After 4 weeks of intervention, the patient demonstrated significant improvements across all outcome measures. FMA-UE scores improved from 28 to 44, WMFT from 1.5 to 3.1, MBI from 55 to 80, and BBS from 32 to 44. Improvements were also observed in range of motion, muscle strength, voluntary motor control, balance, and performance of activities of daily living.

Conclusion: The findings of this case report suggest that Action Observation Therapy, when integrated with conventional physiotherapy, can effectively facilitate neuroplasticity and enhance motor recovery, balance, and functional independence in post-stroke rehabilitation. AOT is a low-cost, feasible, and patient-centered intervention that can serve as a valuable adjunct in clinical neurorehabilitation practice.

Keywords: Stroke rehabilitation; Action Observation Therapy; Neuroplasticity; Hemiparesis; Physiotherapy; Motor recovery; Activities of daily living; Mirror neuron system

INTRODUCTION

Stroke is one of the leading causes of long-term adult disability worldwide, often resulting in persistent motor impairments that significantly affect functional independence and quality of life (1). Following a cerebrovascular accident, the interruption of blood flow leads to neuronal death and disruption of motor pathways, particularly in the corticospinal tracts responsible for voluntary movement (2). These neurophysiological changes manifest clinically as weakness, spasticity, reduced coordination, impaired motor planning, and diminished ability to perform activities of daily living (ADLs) (3). Because spontaneous recovery plateaus within the first few months post-stroke, rehabilitation strategies that promote neuroplasticity — the brain's inherent capacity to reorganize and form new neural connections — are crucial for maximizing long-term outcomes (4).

Neuroplasticity can be facilitated through interventions that provide repeated, meaningful, and task-specific sensory and motor experiences (5). Traditional physiotherapy integrates principles such as motor learning, task-oriented training, and repetitive practice, all of which reinforce cortical reorganization (6). In recent years, novel approaches that directly harness neurophysiological mechanisms have gained prominence. One such approach is Action Observation Therapy (AOT), an innovative and evidence-based technique grounded in the functioning of the mirror neuron system (MNS) (7).

The mirror neuron system is activated not only during the execution of a motor action but also when observing another individual performing the same action (8). This dual activation forms the theoretical foundation of AOT, where patients watch structured videos of goal-directed motor tasks and subsequently attempt to imitate them (9). This observation–execution cycle enhances motor planning, increases excitability of motor cortical regions, and strengthens the sensorimotor pathways required for motor recovery (8,10). AOT is particularly beneficial for patients with low voluntary motor control, as it primes the motor cortex before physical practice, improving both learning and performance (11).

Evidence suggests that AOT promotes improvements in upper-limb function, fine motor skills, balance, and gait in individuals post-stroke (12–14). The therapy is simple to administer, requires minimal equipment, and can be tailored to mimic real-life activities, making it a promising adjunct to conventional physiotherapy (13). Furthermore, AOT encourages patient engagement by using familiar tasks that enhance motivation — an essential factor in neurorehabilitation (15).

Despite growing research, there is limited clinical reporting on structured AOT programs integrated into comprehensive physiotherapy treatment plans, especially in individualized, patient-centered contexts (14,16). Case reports provide valuable insight into the practical application, feasibility, and patient-specific responses to such interventions (16).

This case report presents a comprehensive 4-week physiotherapy program incorporating Action Observation Therapy for a 52-year-old female patient recovering from a left MCA ischemic stroke. It details her clinical presentation, functional impairments, tailored therapy plan, and the outcomes achieved. By highlighting the integration of AOT within conventional physiotherapy, this report aims to contribute to the growing evidence supporting its role in promoting neuroplasticity and motor recovery after stroke.

CASE PRESENTATION

Patient Profile

- Name: Mrs. Ritu
- Age: 52 years
- Sex: Female
- Occupation: School teacher
- Medical Diagnosis: Left MCA ischemic stroke (6 weeks prior)
- Primary Impairments:
  - Right-sided hemiparesis (upper limb > lower limb)
  - Reduced hand dexterity and grip strength
  - Mild expressive aphasia
  - Diminished balance and gait speed

- o Increased flexor synergy in upper limb
- Investigations: MRI confirmed infarct in left MCA territory. No prior neurological illness.

Functional Limitations
- Difficulty reaching, grasping, lifting objects
- Impaired ability to perform ADLs: dressing, bathing, cooking
- Decreased community ambulation
- Fatigue and decreased confidence in using right upper limb

Baseline Outcome Measures
- FMA-UE: 28/66
- WMFT (functional ability score): 1.5/5
- Modified Barthel Index: 55/100
- Berg Balance Scale (BBS): 32/56

Patient Goals
1. Improve right-hand function for daily household tasks
2. Enhance balance and confidence during ambulation
3. Become more independent in ADLs
4. Reduce reliance on caregiver for upper-limb tasks

Past History
- No previous history of neurological illness.
- Hypertension for 8 years, controlled with medication (Amlodipine 5 mg/day).
- No diabetes, thyroid disorder, or cardiac disease reported.
- No history of trauma, surgery, or musculoskeletal disorders.
- Independent in all ADLs prior to stroke.
- Non-smoker, occasional stress-related headaches, no cognitive impairment before stroke.

Present History
- The patient suffered a **left MCA ischemic stroke 6 weeks prior** to physiotherapy referral.
- Immediate symptoms included:
- o Right-sided weakness (upper limb > lower limb)
- o Slurred speech and mild expressive aphasia
- o Difficulty gripping and holding objects
- o Reduced walking stability
- Initial medical management in acute phase: thrombolysis within therapeutic window, followed by neuroprotective and antihypertensive therapy.
- Referred to physiotherapy for rehabilitation due to persistent hemiparesis, decreased upper limb function, reduced balance, and dependence in ADLs.
- Right side is the dominant upper limb**.**

Photos of Investigations
MRI image

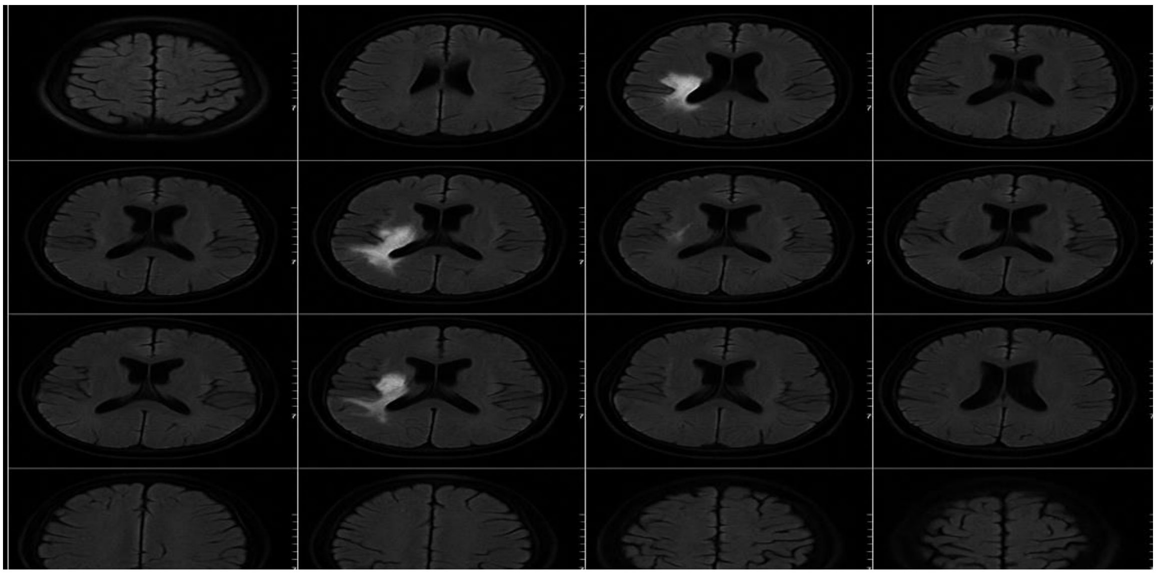

Figure- 1 MRI film showing left MCA infarct

Physiotherapy Treatment Plan (4 Weeks)
Program Components

1. Action Observation Therapy (core intervention)
2. Task-specific training
3. Strengthening of affected limb
4. Balance and gait training
5. Home exercise program

AOT Protocol (applied daily, 30 minutes/session)

- Videos of functional tasks relevant to ADLs:
  - Reaching and grasping a cup
  - Folding laundry
  - Buttoning a shirt
  - Picking coins from a table
  - Opening a jar
- Phase 1 (Observation): Patient watches 1–2-minute action clips (10 minutes)
- Phase 2 (Execution): Repeats tasks physically with therapist assistance (20 minutes)
- Tasks progressed in complexity weekly.

Week	Goals	Action Observation Therapy (AOT)	Additional Physiotherapy Interventions	Expected Progress / Indicators
Week 1 Priming Motor Networks	- Initiate voluntary movement- Reduce flexor synergy- Improve attention to the affected limb	- Observation of simple reach & grasp tasks- Execution of tasks with therapist assistance (cup picking, touching objects)	- PROM/AAROM of shoulder, elbow, wrist- Scapular mobilization- Light functional tasks (wiping table)- Static balance training (standing, weight shifting)- Supported gait practice	- Increased cortical activation- Reduced dependence on synergy patterns- Initiation of voluntary movement
Week 2 Enhancing Motor Control	- Improve hand opening & coordination- Increase selective motor control	- Observation of tasks with varied object shapes & grip types- Execution of grasp, release, hold tasks	- Fine motor tasks: peg board, sponge squeeze- Isometric → isotonic strengthening- Functional reach training- Dynamic balance: step taps- Sit-to-stand practice	- Better movement quality- Fewer compensations- Improved grip and release
Week 3 Improving Functional Use	- Enhance endurance- Improve spontaneous use of limb- Improve bilateral coordination	- Observation of complex ADL sequences (folding clothes, pouring water)- Execution of multi-step tasks	- Bimanual training- Weighted reach (0.5–1 kg)- Tandem stance, obstacle stepping- Faster gait training	- More frequent voluntary limb use- Increased functional independence
Week 4 Real-World Task Integration	- Transfer gains to real-life activities- Improve confidence & independence	- Observation of personalized daily tasks recorded from patient's home- Execution of ADL-based tasks	- Home-based functional training: meal prep, buttoning, object manipulation- Dual-task walking- 6-minute walk endurance practice- Final home program instruction	- Better ADL performance- Improved balance & walking- Higher self-efficacy in using affected limb

Week-wise Physiotherapy Plan:
Week 1: Priming Motor Networks

Goals: Reduce synergy patterns, improve initiation of movement, enhance cortical activation

Interventions:

- AOT focusing on simple reach-and-grasp tasks
- PROM/AAROM of shoulder, elbow, wrist, and fingers
- Scapular mobilization
- Task-specific practice: wiping table, holding lightweight objects
- Balance exercises: static standing, weight shifting

- Gait: short-distance walking with support

Expected Response: Increased motor activation, reduced learned non-use

Week 2: Enhancing Motor Control

Goals: Improve coordination, hand opening, and selective motor control

Interventions:

- AOT: grasping objects of varied shapes and sizes
- Fine motor tasks: peg board, sponge squeezing
- Strengthening: isometric then isotonic for major upper-limb groups
- Functional reach training
- Dynamic balance: step taps, sit-to-stand practice

Progress Indicators: Improved upper-limb movement quality, fewer compensations

Week 3: Improving Functional Use

Goals: Increase endurance, functional independence, and bilateral coordination

Interventions:

- AOT: complex sequences—folding clothes, pouring water
- Bimanual training: stabilizing with affected hand while using unaffected hand
- Weighted-reach tasks (0.5–1 kg)
- Advanced balance: tandem stance, obstacle stepping
- Gait: increased speed and consistency

Progress Indicators: More spontaneous use of right hand

Week 4: Real-World Task Integration

Goals: Translate gains into ADL performance

Interventions:

- AOT using personalized daily activities recorded from home
- Functional training: meal preparation tasks, buttoning, writing attempts
- High-level balance: reaching beyond BOS, dual-task walking
- Endurance training: 6-minute walk practice
- Home program finalization

Progress Indicators: Improved confidence and independence

Post-Treatment Outcome Measures (End of Week 4)

- FMA-UE: improved from 28 → 44/66
- WMFT: improved to 3.1/5
- Modified Barthel Index: 55 → 80/100
- Berg Balance Scale: 32 → 44/56

Patient demonstrated increased voluntary hand movement, improved coordination, and enhanced performance in ADLs.

IMPROVEMENT TABLES:

Week-Wise ROM Improvement — Right Upper Limb

Joint Movement (RUL)	Baseline (Week 0)	End of Week 1	End of Week 2	End of Week 3	End of Week 4
Shoulder Flexion	70°	82°	95°	107°	115°
Shoulder Abduction	65°	78°	90°	102°	110°
Elbow Flexion	110°	118°	127°	134°	140°
Elbow Extension	–15°	–12°	–9°	–6°	–5°
Wrist Flexion	30°	38°	46°	51°	55°
Wrist Extension	20°	28°	35°	41°	45°
Finger Flexion	50% range	60%	70%	78%	80–85%
Finger Extension (lag)	20% lag	16%	13%	11%	~10% lag

Week-Wise ROM Improvement — Right Lower Limb

Joint Movement (RLL)	Baseline (Week 0)	End of Week 1	End of Week 2	End of Week 3	End of Week 4
Hip Flexion	85°	92°	99°	105°	110°
Hip Extension	5°	7°	9°	11°	12°
Hip Abduction	20°	24°	27°	30°	32°
Hip Adduction	15°	17°	19°	21°	22°

Knee Flexion	95°	103°	112°	120°	125°
Knee Extension	–10°	–8°	–6°	–4°	–2°
Ankle Dorsiflexion	5°	7°	9°	11°	12°
Ankle Plantarflexion	25°	30°	34°	38°	40°
Ankle Inversion	12°	15°	18°	20°	22°
Ankle Eversion	5°	6°	7°	9°	10°

Week-Wise MMT Progression — Right Upper Limb

Muscle Group / Movement (RUL)	Week 0 (Baseline)	End of Week 1	End of Week 2	End of Week 3	End of Week 4
Shoulder Flexors	2/5	2+/5	3/5	3+/5	4-/5
Shoulder Abductors	2/5	2+/5	3/5	3+/5	4-/5
Elbow Flexors	3/5	3/5	3+/5	4-/5	4/5
Elbow Extensors	2+/5	3/5	3+/5	3+/5	4-/5
Wrist Flexors	2/5	2+/5	3-/5	3/5	3+/5
Wrist Extensors	1+/5	2/5	2+/5	3-/5	3/5
Finger Flexors	2/5	2+/5	3-/5	3/5	3+/5
Finger Extensors	1/5	1+/5	2/5	2+/5	3/5

Week-Wise MMT Progression — Right Lower Limb

Muscle Group / Movement (RLL)	Week 0 (Baseline)	End of Week 1	End of Week 2	End of Week 3	End of Week 4
Hip Flexors	3-/5	3/5	3+/5	4-/5	4/5
Hip Extensors	2/5	2+/5	3/5	3+/5	3+/5
Hip Abductors	2+/5	3-/5	3/5	3+/5	3+/5
Hip Adductors	3/5	3/5	3+/5	4-/5	4-/5
Knee Extensors (Quadriceps)	3-/5	3/5	3+/5	4-/5	4/5
Knee Flexors (Hamstrings)	2+/5	3-/5	3/5	3+/5	3+/5
Ankle Dorsiflexors	2/5	2+/5	3-/5	3/5	3+/5
Ankle Plantarflexors	2/5	2+/5	3-/5	3/5	3+/5
Ankle Invertors	1+/5	2/5	2+/5	3-/5	3-/5
Ankle Evertors	1/5	1+/5	2/5	2+/5	3-/5

Week-Wise Progression of All Outcome Measures

Outcome Measure	Week 0 (Baseline)	End of Week 1	End of Week 2	End of Week 3	End of Week 4 (Post-Intervention)
Fugl-Meyer Assessment – Upper Extremity (FMA-UE) *(0–66)*	28	33	38	42	44
Wolf Motor Function Test – Functional Ability Score (WMFT) *(0–5, ↑ better)*	1.5	2.0	2.4	2.8	3.1
Modified Barthel Index (MBI) *(0–100, ↑ independence)*	55	61	69	75	80
Berg Balance Scale (BBS) *(0–56)*	32	35	39	42	44
Shoulder Flexion ROM (°) *(Right Upper Limb)*	70°	82°	95°	107°	115°
Hip Flexion ROM (°) *(Right Lower Limb)*	85°	92°	99°	105°	110°
Mean MMT – Right Upper Limb *(0–5, averaged across muscle groups)*	2.0	2.3	2.8	3.2	3.6
Mean MMT – Right Lower Limb *(0–5, averaged across muscle groups)*	2.2	2.5	2.9	3.3	3.7

Clinical Interpretation Summary

Period	Clinical Significance
Week 0 → Week 1	Neural priming and familiarization with therapy led to small but noticeable gains.
Week 1 → Week 2	Marked improvement — strength, ROM, and motor control improved with task training.
Week 2 → Week 3	Fastest progression — patient began integrating learned movements functionally.
Week 3 → Week 4	Continued but slightly slower gains as recovery approached functional plateau.

Photos of treatment:

Figure- 2 static standing

Figure- 3 isometric strength training

Figure- 4 balance training

Figure- 5 core strengthening (bridges)

DISCUSSION

The present case report illustrates the clinical application and potential benefits of integrating Action Observation Therapy (AOT) into a structured physiotherapy program for a post-stroke female patient. Over four weeks, notable improvements were observed in upper-limb motor control, functional performance, balance, and independence in ADLs, consistent with findings from previous literature (12–14).

AOT is grounded in the principles of the mirror neuron system (MNS), which is activated during both observation and execution of motor tasks (7,8). Observing goal-directed actions activates premotor and parietal cortical areas, enhancing motor planning and priming neural circuits before physical execution (9). This repeated activation of motor pathways is fundamental to synaptic strengthening and cortical remapping — the hallmark of neuroplasticity (4,10). In this case, the patient's limited voluntary control early in rehabilitation benefitted from AOT by reducing the threshold for motor activation and facilitating transition to active movement (11).

Stroke survivors typically demonstrate greater impairment in upper-limb function than lower-limb ability due to the complexity of fine motor actions (3). Improvements in FMA-UE and WMFT in this case align with previous evidence showing that AOT improves fine motor skills, grip strength, and functional upper-limb task performance (12, 13, 17). The use of ADL-based action videos and personalized home recordings may have further enhanced motivation and real-world skill transfer (15).

One of the key strengths of AOT is the use of meaningful and context-driven tasks. In this case, the videos selected for observation directly reflected ADLs that the patient found challenging, such as pouring water, folding clothes, or picking up small objects. By providing visual and cognitive cues, the patient was better able to perform these tasks during execution, translating into improved ADL performance as demonstrated by higher Modified Barthel Index scores at follow-up. The progression to personalized home-recorded tasks in Week 4 further enhanced the relevance of therapy and promoted carryover of skills into the patient's daily environment. The use of familiar environments may have strengthened task-specific neural networks and improved generalization of learned skills.

Although AOT was primarily targeted toward upper-limb recovery, improvements were also observed in dynamic balance and gait speed. These improvements may be attributed to enhanced motor attention, increased engagement in therapy, and improved confidence in using the affected side. As the upper limb gained function, postural adjustments and weight distribution during gait improved, which is consistent with observations in recent research where AOT improved whole-body coordination and spatial awareness. (15)

Motivation plays a crucial role in neurorehabilitation outcomes. Traditional physiotherapy can be physically demanding, and in some cases discouraging. AOT, by allowing the patient to *see* successful completion of tasks before attempting them, may have enhanced self-efficacy and reduced anxiety associated with movement. (13, 16, 18)

The patient in this case showed increased engagement and willingness to practice independently, which likely contributed to the positive outcomes observed. The structured and predictable nature of AOT sessions also fostered a sense of control and active participation.

A critical aspect of this case is the combination of AOT with conventional physiotherapy approaches such as task-specific training, strength exercises, and gait and balance training. The synergy between AOT's neural priming effect and the repetitive, function-oriented nature of conventional therapy may have accelerated motor learning. The improvements observed in this case reflect that AOT should not be viewed as a standalone intervention, but rather as a complementary tool that enhances the effectiveness of traditional rehabilitation techniques.

Limitations of the Case

While the outcomes in this case were positive, certain limitations must be acknowledged:

1. **Single-subject design:** The findings cannot be generalized without considering individual variability in stroke severity, lesion location, and cognitive status.
2. **Short intervention duration:** Four weeks may be insufficient to capture the long-term benefits of AOT or determine whether improvements are sustained.
3. **Lack of advanced neurophysiological measures:** Tools such as functional MRI or transcranial magnetic stimulation—though not feasible clinically—could better quantify neuroplastic changes.
4. **Subjective influence on motivation:** The patient's high engagement levels may not be replicated in all individuals.

CONCLUSION

This case report demonstrates that Action Observation Therapy, when combined with structured physiotherapy, can significantly enhance neuroplasticity and functional recovery in a post-stroke female patient with right-sided hemiparesis. The patient exhibited measurable improvements in motor control, balance, and ADLs over a 4-week program. AOT is a low-cost, easily implementable intervention that can be customized to patient-specific tasks, making it a valuable tool in modern neurorehabilitation.

Declaration by Authors

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