

Combined Electrical Stimulation and Motor Relearning Program for Right Hemiparesis After Ischemic Stroke

Wildanul Ibrahim¹, Diah Rosyida Maulidina², Nurma Auliya Hamidah³

^{1,3}Diploma III Physiotherapy Study Program, Faculty of Health Sciences, Universitas Muhammadiyah Lamongan, Lamongan, East Java, Indonesia

²Department of Physiotherapy, Faculty of Health Sciences, Universitas Muhammadiyah Lamongan, Lamongan, East Java, Indonesia

Corresponding author:

Name: Wildanul Ibrahim

E-mail: wildanibm123@gmail.com

Phone: +62 856-4842-8371

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Abstract

Background: Ischemic stroke commonly causes hemiparesis, resulting in impaired muscle strength, joint mobility, balance, and functional mobility. Electrical Stimulation (ES) and Motor Relearning Program (MRP) are used in stroke rehabilitation, but reports describing their combined application remain limited.

Objective: To describe the physiotherapy management and clinical outcomes of combined ES and MRP on joint range of motion, muscle strength, spasticity, balance, and functional motor performance in a patient with right hemiparesis following ischemic stroke.

Methods: This case report involved a 36-year-old man with right hemiparesis secondary to ischemic stroke who received six physiotherapy sessions combining ES and MRP. Outcomes were assessed before treatment and after the sixth session using goniometry, Manual Muscle Testing (MMT), Modified Ashworth Scale (MAS), Berg Balance Scale (BBS), and Modified Motor Assessment Scale (MMAS). Descriptive comparison was performed between baseline and final assessments.

Results: Shoulder abduction improved from 160° to 170°, shoulder flexion from 165° to 170°, hip flexion from 115° to 125°, and ankle dorsiflexion from 10° to 20°. Muscle strength improved in selected groups, including shoulder flexors (3+ to 4), shoulder abductors (3+ to 4), elbow extensors (3+ to 5+), hip abductors (3+ to 4), hip internal rotators (3+ to 4), and knee extensors (3+ to 4). BBS increased from 39 to 46. MAS remained unchanged, with mild elbow flexor spasticity, and MMAS remained 47.

Conclusion: Six sessions of combined ES and MRP were associated with improvements in selected joint range of motion, muscle strength, and balance, but not spasticity or functional motor performance.

Keywords

Ischemic Stroke; Hemiparesis; Electric Stimulation Therapy; Motor Learning; Rehabilitation

Introduction

Ischemic stroke is a major cause of long term disability worldwide and remains an important public health problem because of its substantial incidence, mortality, and persistent functional consequences. Ischemic stroke occurs when cerebral blood flow is interrupted by arterial occlusion, resulting in cerebral ischemia and, when prolonged, irreversible neuronal injury. In Indonesia, stroke represents a substantial burden of disease and is associated with modifiable risk factors, including hypertension, diabetes mellitus, dyslipidemia, obesity, smoking, and physical inactivity. These factors may contribute to stroke occurrence and may influence the severity of neurological impairment and subsequent disability.¹ Recent stroke rehabilitation guidelines emphasize early, individualized, and task specific rehabilitation to reduce disability and promote functional recovery after stroke.

Motor impairment is among the most common consequences of stroke, with hemiparesis frequently contributing to limitations in mobility and activities of daily living. Damage to the corticospinal tract and related motor pathways may result in reduced voluntary muscle activation, muscle weakness, restricted joint mobility, abnormal muscle tone, impaired postural control, and deficits in coordination. These impairments may interact with one another and consequently restrict functional independence and participation.² Physiotherapy therefore plays an important role in post stroke rehabilitation by addressing neuromuscular activation, movement control, balance, mobility, and functional performance through individualized therapeutic interventions.

Electrical Stimulation (ES) is commonly incorporated into neurological rehabilitation to facilitate muscle contraction through peripheral motor nerve stimulation. The intervention may support neuromuscular recruitment, reduce the consequences of disuse, and facilitate voluntary motor activation when combined with active rehabilitation. Evidence has indicated that ES can contribute to improvements in muscle strength and motor performance in patients undergoing stroke rehabilitation.³ Motor Relearning Program (MRP), in contrast, is a task oriented approach based on motor learning and neuroplasticity principles. MRP emphasizes repetitive practice of meaningful functional activities, with attention to movement quality, postural control, and integration of motor components into functional tasks. Previous studies have reported beneficial effects of task specific rehabilitation and MRP on balance, gait, upper limb function, and functional performance after stroke.⁴

Although ES and MRP have each been investigated as rehabilitation approaches for stroke, the existing evidence does not provide a sufficiently detailed description of their combined implementation within an individualized clinical rehabilitation program. Previous research has predominantly examined ES as an adjunct to conventional rehabilitation or evaluated task oriented and motor relearning approaches independently.^{4,5} Consequently, evidence describing how ES can be integrated sequentially with MRP during routine physiotherapy, including the progression of treatment and corresponding changes across multiple motor domains, remains limited. In addition, experimental studies generally evaluate outcomes at the group level, whereas detailed case based documentation can provide complementary clinical information regarding the temporal pattern of individual recovery, particularly when improvements in body function do not occur simultaneously with changes in functional performance.⁵

The present case report addresses this gap by documenting the clinical management and longitudinal outcomes of combined ES and MRP in a patient with right hemiparesis following ischemic stroke. Unlike studies that primarily evaluate the efficacy of a single intervention or compare treatment groups, this report describes the sequential application of ES and task specific MRP across six physiotherapy sessions and evaluates changes in joint range of motion, muscle strength, muscle tone, balance, and functional motor performance. The report therefore provides clinically contextualized information regarding which domains demonstrated observable changes during a short rehabilitation period and which domains remained unchanged. This distinction is relevant because recovery after stroke may occur at different levels of the International Classification of Functioning, Disability and Health framework, with improvements in body functions not necessarily accompanied by immediate improvements in complex activities.⁶

Therefore, this study aimed to describe the physiotherapy management process and clinical outcomes of combined ES and MRP on joint range of motion, muscle strength, spasticity, balance, and functional motor performance in a patient with right hemiparesis following ischemic stroke.

Methods

This study was designed as a descriptive case report documenting the physiotherapy management and clinical outcomes of a patient with right hemiparesis secondary to ischemic stroke who received combined Electrical Stimulation (ES) and Motor Relearning Program (MRP). The manuscript was prepared with reference to the CARE (CAse REport) Guideline to improve transparency in reporting the patient's clinical presentation, diagnostic assessment, therapeutic intervention, clinical outcomes, and follow up. The report was conducted at ABR Physiotherapy, Bojonegoro, Indonesia. The intervention was provided as part of routine neurological physiotherapy practice and consisted of six treatment sessions combining ES and MRP.⁷

The patient was a 36 year old man with right hemiparesis secondary to ischemic stroke. The stroke diagnosis had previously been established by the attending neurologist based on clinical evaluation and neurological examination documented in the patient's medical record. Information regarding the results of neuroimaging, including computed tomography or magnetic resonance imaging, was not available in the physiotherapy documentation and therefore was not reconstructed or inferred for this report. The available documentation also did not provide sufficient information regarding stroke onset, duration since stroke, previous rehabilitation, comorbidities, risk factors, or medication history. These unavailable clinical details are explicitly acknowledged to avoid introducing unsupported information into the case description.

The patient was selected purposively because the documented clinical presentation was consistent with the therapeutic objectives of the intervention. The inclusion criteria were a confirmed diagnosis of ischemic stroke with right hemiparesis, medical stability permitting participation in physiotherapy, ability to understand and follow therapist instructions, and willingness to participate with written informed consent. The exclusion criteria included an unstable cardiovascular condition, severe cognitive impairment preventing active participation, contraindications to ES, musculoskeletal conditions that could limit exercise performance, and withdrawal of consent during the intervention period. The available clinical documentation did not indicate that any of the specified exclusion criteria occurred during the treatment period.

Before the intervention, a comprehensive physiotherapy assessment was performed, including history taking, physical examination, evaluation of joint range of motion (ROM), muscle strength, muscle tone, balance, and functional motor performance. The patient's documented characteristics included age, sex, diagnosis, presenting condition, and functional limitations. Joint ROM was assessed using a universal goniometer. Muscle strength was assessed using Manual Muscle Testing (MMT), muscle tone using the Modified Ashworth Scale (MAS), balance using the Berg Balance Scale (BBS), and functional motor performance using the Modified Motor Assessment Scale (MMAS). These instruments were selected because they address different domains of post stroke motor impairment and activity performance. References supporting the validity and reliability of each measurement instrument should be incorporated during final reference verification.⁸

The intervention comprised six physiotherapy sessions integrating ES and MRP. Each session was delivered by a licensed physiotherapist at ABR Physiotherapy as part of the clinic's routine neurological rehabilitation practice. The available documentation did not record the provider's specific years of clinical experience or additional neurological rehabilitation certification; therefore, these details are not reported.⁴ ES was administered before task oriented exercise with the intention of facilitating neuromuscular activation before functional training. According to the available treatment records, ES was delivered at a frequency of 10 Hz, current intensity of 100 mA, and duration of 15 minutes during each treatment session. The original clinical documentation did not contain information regarding waveform, pulse width, duty cycle, electrode placement, target muscles, or stimulation intensity relative to motor threshold. These parameters therefore cannot be reported without introducing unsupported information. The rationale documented for the treatment sequence was to facilitate muscle contraction before functional exercise.

Following ES, MRP based exercise was performed using repetitive and task specific activities according to the patient's functional capacity. The first session included theraband ankle exercises, hand grip exercise, and wrist curl exercise. The second session included bridging, sit to stand training, hip flexor strengthening, and mini squat exercise. The third session incorporated shoulder strengthening, overhead triceps extension, and wrist curl exercise. The fourth session emphasized standing balance training, single leg standing, lateral walking, and mini squat exercise. The fifth session included ankle dorsiflexion, ankle eversion, hip flexor strengthening, and hand grip exercise. The sixth session focused on forward and backward walking, standing while reaching to retrieve an object from the floor, sit to stand training, and bridging exercise. Strengthening exercises were performed using one to three sets of 10 to 12 repetitions according to patient tolerance. Detailed information regarding the duration of individual exercises, rest intervals, exercise intensity, external resistance progression, and predefined criteria for progression was not available in the original clinical record and therefore is not reported.

The intervention was implemented over six sessions, with the treatment content progressing from strengthening and basic functional exercises toward balance, gait, and integrated functional activities. ES was administered during each treatment session using the documented parameters of 10 Hz, 100 mA, and 15 minutes. Sessions one to three emphasized strengthening activities involving the lower and upper extremities, whereas sessions four to six progressively incorporated balance, gait, and functional task activities. The progression was therefore based on the documented treatment sequence and the patient's functional capacity rather than on a predefined quantitative progression criterion. The absence of detailed progression criteria is considered a limitation of the available treatment documentation and should be taken into account when interpreting the reproducibility of the intervention.

Baseline assessment was performed immediately before the first treatment session (T0), and the final assessment was performed after completion of the sixth treatment session (T6). The same outcome domains were assessed at both time points to facilitate descriptive comparison of changes during the intervention period. ROM was assessed using a universal goniometer, MMT

using standardized manual muscle grading, MAS for muscle tone, BBS for balance, and MMAS for functional motor performance. The principal clinical outcomes were changes between T0 and T6 in joint mobility, muscle strength, muscle tone, balance, and functional motor performance. Because the study involved a single patient, no inferential statistical analysis was performed, and the findings were presented descriptively.

The clinical course consisted of initial referral for physiotherapy, baseline assessment, confirmation of eligibility, written informed consent, six sessions of combined ES and MRP, and final assessment using the same outcome measures. All six planned treatment sessions were completed according to the documented intervention sequence. No modification to the planned treatment protocol was recorded during the intervention period. No adverse events or treatment related complications were documented during any of the six sessions.

Written informed consent was obtained from the patient before data collection for physiotherapy management and for publication of anonymized clinical information and photographs. The available study documentation did not contain an institutional ethics committee approval letter, ethical clearance number, or approval date. Consequently, no ethical approval details are reported in this manuscript because doing so would require unsupported information. The authors should verify the institutional and journal requirements for case report ethics review and insert the committee name, approval number, and approval date if an applicable ethical approval was obtained separately. If no separate ethical approval was required for this case report, the final manuscript should provide the institutionally appropriate statement explaining the applicable ethical determination.

Results

A 36-year-old man with right hemiparesis secondary to ischemic stroke completed six physiotherapy sessions combining Electrical Stimulation (ES) and Motor Relearning Program (MRP) at ABR Physiotherapy, Bojonegoro. Clinical assessments were performed before the first treatment session (T0) and after completion of the sixth session (T6). The assessed domains included joint range of motion (ROM), muscle strength, muscle tone, balance, and functional motor performance. The baseline characteristics of the patient and the overall intervention exposure are summarized in Table 1 to provide the clinical context for interpretation of the subsequent outcomes.

Table 1. Patient Characteristics

Variable	Description
Study design	Case report
Sex	Male
Age	36 years
Diagnosis	Right hemiparesis secondary to ischemic stroke
Treatment facility	ABR Physiotherapy, Bojonegoro
Intervention	Electrical Stimulation + Motor Relearning Program
Number of sessions	Six sessions

The intervention was delivered over six sessions, with the treatment content progressing from strengthening activities toward balance, gait, and integrated functional tasks. ES was administered before the exercise component in each session using the documented parameters of 10 Hz, 100 mA, and 15 minutes. The exercise component varied according to the session, with upper and lower extremity strengthening introduced during the early sessions and progressively more functional activities incorporated during later sessions. The session specific treatment sequence is presented in Table 2, while the documented progression of the intervention is summarized in Table 3.

Table 2. Physiotherapy Intervention Program

Session	Core Activities
Initial assessment	History taking, physical examination, ROM, MMT, MAS, BBS, MMAS
Session 1	ES, theraband ankle exercise, hand grip, wrist curl
Session 2	ES, bridging, sit to stand, hip flexor strengthening, mini squat
Session 3	ES, shoulder strengthening, overhead triceps extension, wrist curl
Session 4	ES, standing balance training, single leg standing, lateral walking, mini squat
Session 5	ES, ankle dorsiflexion, ankle eversion, hip flexor strengthening, hand grip
Session 6	ES, forward and backward walking, object retrieval from floor, sit to stand, bridging
Final assessment	ROM, MMT, MAS, BBS, MMAS

Table 3. Intervention Timeline and Progression

Session	Intervention	Documented Dosage
1	ES + strengthening exercises	ES: 10 Hz, 100 mA, 15 min; strengthening: 1–3 sets × 10–12 repetitions
2	ES + functional strengthening	Same documented ES and exercise dosage
3	ES + upper limb strengthening	Same documented ES and exercise dosage
4	ES + balance training	Same documented ES and exercise dosage
5	ES + lower limb strengthening	Same documented ES and exercise dosage
6	ES + gait and functional activities	Same documented ES and exercise dosage

The treatment sequence indicates a progression from isolated or relatively basic strengthening activities toward tasks requiring greater postural control and functional integration. Sessions four to six included standing balance, lateral walking, gait activities, reaching, and object retrieval, representing a greater emphasis on activity based motor practice. However, the available clinical record did not provide session specific duration, rest intervals, quantitative intensity, or predefined progression criteria. Therefore, the observed sequence describes the documented clinical progression rather than a quantitatively standardized progression protocol.

Changes in joint ROM between T0 and T6 are presented in Table 4. Improvements were observed in shoulder abduction, shoulder flexion, hip flexion, and ankle dorsiflexion, with increases of 10°, 5°, 10°, and 10°, respectively. The remaining assessed movements showed no change between baseline and final assessment. No reduction in ROM was documented during the six session

intervention period, indicating that the observed changes were confined to selected joint movements rather than representing a generalized increase across all assessed joints.

Table 4. Joint Range of Motion at Baseline and Final Assessment

Joint Movement	Baseline (T0)	Final (T6)	Clinical Change
Shoulder abduction	160°	170°	↑10°
Shoulder flexion	165°	170°	↑5°
Shoulder rotation	90°	90°	No change
Elbow	150°	150°	No change
Wrist extension	60°	60°	No change
Wrist flexion	20°	20°	No change
Hip flexion	115°	125°	↑10°
Hip extension	45°	45°	No change
Hip rotation	45°	45°	No change
Knee flexion	135°	135°	No change
Ankle dorsiflexion	10°	20°	↑10°
Ankle plantarflexion	30°	30°	No change

Changes in muscle strength were not uniform across the assessed muscle groups. As shown in Table 5, improvements occurred in the shoulder flexors, shoulder abductors, elbow extensors, wrist extensors, hip abductors, hip internal rotators, and knee extensors. The largest documented change was observed in elbow extensor strength, which increased from 3+ to 5+. Several other muscle groups demonstrated an increase from 3+ to 4, whereas the remaining assessed muscle groups remained unchanged. These findings indicate that strength gains occurred selectively rather than across all tested muscle groups.

Table 5. Manual Muscle Testing Results

Muscle Group	Baseline	Final	Clinical Change
Shoulder flexor	3+	4	Improved
Shoulder extensor	4	4	Stable
Shoulder abductor	3+	4	Improved
Shoulder adductor	4	4	Stable
Shoulder internal rotator	4	4	Stable
Shoulder external rotator	4	4	Stable
Elbow flexor	4	4	Stable
Elbow extensor	3+	5+	Improved
Wrist extensor	3+	4	Improved
Wrist flexor	4	4	Stable
Radial deviation	4	4	Stable
Ulnar deviation	4	4	Stable
Hip flexor	3+	3+	Stable
Hip extensor	3+	3+	Stable
Hip adductor	3+	3+	Stable
Hip abductor	3+	4	Improved
Hip internal rotator	3+	4	Improved
Hip external rotator	3+	3+	Stable
Knee flexor	3+	3+	Stable
Knee extensor	3+	4	Improved
Ankle dorsiflexor	3+	3+	Stable
Ankle plantarflexor	3+	3+	Stable

Muscle tone remained unchanged between the two assessment points. Table 6 shows that the patient had mild elbow flexor spasticity at baseline, represented by an MAS score of 1, which remained unchanged at T6. All other assessed muscle groups had an MAS score of 0 at both assessments. Thus, the six treatment sessions were not accompanied by a detectable change in the documented muscle tone.

Table 6. Modified Ashworth Scale Results

Muscle Group	Baseline (T0)	Final (T6)
Shoulder flexor	0	0
Shoulder extensor	0	0
Elbow flexor	1	1
Elbow extensor	0	0
Wrist	0	0
Hip	0	0
Knee	0	0
Ankle	0	0

In contrast to the unchanged muscle tone, balance performance improved during the intervention period. As shown in Table 7, the BBS total score increased from 39 at T0 to 46 at T6, representing an absolute increase of seven points. The documented improvement was mainly associated with tasks involving sit to stand, standing with eyes closed, turning, tandem standing, and stepping. This change indicates an improvement in the patient's observed balance performance over the six session period, although the single case design does not allow attribution of the change to the intervention independently of other factors.

Table 7. Berg Balance Scale Results

Assessment	Baseline (T0)	Final (T6)
Total score	39	46

Functional motor performance demonstrated a different pattern from balance and selected impairment outcomes. Table 8 shows that the MMAS score remained unchanged at 47 between T0 and T6. Thus, despite improvements in selected ROM, muscle strength, and BBS performance, no measurable change was observed in the functional motor performance assessed by MMAS during the six treatment sessions.

Table 8. Modified Motor Assessment Scale Results

Assessment	Baseline (T0)	Final (T6)
MMAS score	47	47

For an integrated interpretation of the clinical findings, the principal outcomes are summarized in Table 9. The overall pattern demonstrates improvement in selected body function measures, particularly joint mobility and muscle strength, together with improved balance performance. In contrast, muscle tone and functional motor performance remained unchanged over the same treatment period. These findings describe a heterogeneous response across clinical domains and indicate that changes in impairment based outcomes were not accompanied by measurable change in the assessed functional motor outcome within six sessions.

Table 9. Summary of Clinical Outcomes

Outcome Measure	Baseline	Final	Clinical Interpretation
Joint range of motion	Selected movements restricted	Selected movements improved	Improvement in selected movements
Muscle strength	Multiple muscle groups graded 3+ to 4	Improvement in selected muscle groups	Selective strength improvement
Muscle tone (MAS)	Mild elbow flexor spasticity	Unchanged	No observed change
Balance (BBS)	39	46	Improvement
Functional motor performance (MMAS)	47	47	No observed change

The clinical outcomes therefore showed a domain specific pattern following six sessions of combined ES and MRP. Improvements were observed in four selected ROM measurements, seven muscle groups, and the total BBS score, whereas MAS and MMAS did not change. The findings should be interpreted as descriptive observations within a single patient rather than evidence of treatment efficacy. No inferential statistical analysis was performed, and no p values or confidence intervals were calculated because the study involved one patient and was designed to describe the individual clinical course.

Discussion

This case report described the clinical course of a patient with right hemiparesis following ischemic stroke who received six physiotherapy sessions combining Electrical Stimulation (ES) and Motor Relearning Program (MRP). Improvements were observed in selected joint range of motion (ROM), muscle strength, and balance, whereas muscle tone and functional motor performance remained unchanged. The pattern of response was therefore heterogeneous across the assessed clinical domains. Because this study involved a single patient without a control condition, the observed changes cannot be interpreted as evidence of treatment efficacy or as being attributable exclusively to the combined intervention. Nevertheless, the longitudinal findings provide clinically relevant information regarding the domains that changed during the six session rehabilitation period and those that remained stable.

The improvement in selected ROM measurements may be related to repeated active movement and task specific exercise performed throughout the intervention. Shoulder abduction increased from 160° to 170°, shoulder flexion from 165° to 170°, hip flexion from 115° to 125°, and ankle dorsiflexion from 10° to 20°. These changes occurred in movements that were repeatedly incorporated into the rehabilitation program through strengthening, functional transitions, gait activities, and lower limb exercises. ES was administered before exercise and was intended to facilitate neuromuscular activation, while MRP emphasized repeated functional movement. Previous evidence has indicated that ES can support motor recovery and movement performance after stroke, whereas task oriented and motor relearning approaches emphasize repetitive practice of purposeful movement to improve motor control.^{7,8} The present findings are therefore compatible with the proposed complementary roles of neuromuscular activation and repetitive functional practice, although the contribution of either component cannot be isolated in this single case.

Muscle strength demonstrated improvement in several muscle groups, including the shoulder flexors, shoulder abductors, elbow extensors, wrist extensors, hip abductors, hip internal rotators, and knee extensors. The largest observed change occurred in elbow extensor strength, which increased from 3+ to 5+, whereas several other muscles improved from 3+ to 4. This selective response may reflect differences in baseline impairment, voluntary activation, movement repetition, and the functional demands placed on individual muscle groups during treatment. ES may facilitate peripheral neuromuscular activation, while repetitive active exercise provides opportunities for voluntary recruitment and task specific practice.⁶ However, the nonuniform pattern of strength improvement indicates that the response cannot be assumed to occur equally across all muscle groups, particularly within a short rehabilitation period.

The findings should also be interpreted in relation to the evidence for ES and MRP individually. Studies cited in the present manuscript have reported beneficial effects of ES on neuromuscular activation and motor recovery and have described improvements associated with MRP or task oriented exercise in balance, gait, and upper limb function.⁶ However, these bodies of evidence do not establish that the specific combination used in this case is superior to either intervention delivered independently. The current report differs from controlled intervention studies because it documents the sequential delivery of ES followed by task specific exercise in one patient within routine clinical practice. Consequently, its principal contribution is descriptive rather than comparative: it illustrates the pattern of individual clinical changes associated with a combined rehabilitation approach while highlighting the limitations of interpreting such changes as treatment effects.

Balance demonstrated the clearest change among the activity related outcomes. The BBS score increased from 39 at baseline to 46 after six treatment sessions, an absolute increase of seven points. The intervention included sit to stand training, standing balance exercises, single leg standing, lateral walking, forward and backward walking, reaching, and object retrieval from the floor. These activities require repeated postural adjustments, weight transfer, anticipatory control, and integration of lower and upper limb movements. The improvement is consistent with the theoretical basis of MRP and previous reports describing beneficial

effects of task specific rehabilitation on balance and mobility after stroke.⁹ Nevertheless, because the study did not include repeated measurements between T0 and T6 or a comparison condition, it is not possible to determine whether the improvement occurred progressively throughout treatment or whether it was influenced by spontaneous recovery, learning effects, or other contextual factors.

In contrast, muscle tone did not change during the intervention. Mild elbow flexor spasticity remained at an MAS score of 1, while the other assessed muscle groups remained at 0. The absence of change does not necessarily contradict the improvements observed in strength and balance because post stroke spasticity involves altered neural excitability and changes in the interaction between neural and mechanical components of the motor system. Management of post stroke spasticity may require individualized and multimodal strategies, and clinically observable changes may depend on the severity and distribution of spasticity, treatment duration, and intervention intensity. The six session treatment period in this case may therefore have been insufficient to produce a detectable change in muscle tone. However, this interpretation remains provisional because the case report did not include additional neurophysiological measures or longer term follow up.

Functional motor performance also remained unchanged, with the MMAS score remaining at 47 at both assessment points. This finding contrasts with the improvements observed in selected impairment measures and balance. Recovery after stroke is multidimensional, and improvements in muscle strength, ROM, or postural control do not necessarily translate immediately into improved performance of complex motor activities. Functional tasks require the integration of strength, coordination, balance, motor planning, endurance, and adaptive strategies, and these components may develop at different rates.¹⁰ The unchanged MMAS score may therefore indicate that six sessions were insufficient to produce a detectable change in the broader functional domain, rather than demonstrating an absence of change in all aspects of motor recovery.

The contrast between the BBS and MMAS findings is particularly relevant to interpretation of this case. Balance improved despite the absence of change in overall functional motor performance, suggesting that changes in specific components of postural control may precede measurable changes in broader functional motor performance. This pattern is compatible with the multidimensional nature of stroke recovery and supports the value of using multiple outcome measures rather than relying on a single functional scale. The use of ROM, MMT, MAS, BBS, and MMAS allowed the present report to identify changes across different domains and to demonstrate that improvement was not uniform across all outcomes. Further prospective research should investigate whether similar domain specific patterns occur when combined ES and MRP are delivered for longer periods and under standardized treatment conditions.¹¹

Compared with previous rehabilitation research, the present case shows both areas of agreement and important differences. The observed improvement in selected muscle strength and balance is broadly consistent with evidence supporting ES and task specific rehabilitation after stroke.⁶ However, the absence of measurable change in spasticity and functional motor performance differs from studies reporting broader functional improvements after longer or more structured rehabilitation programs.¹⁰ Several factors may explain this difference, including the single patient design, short treatment duration, baseline clinical characteristics, intervention dosage, and differences in outcome measures. These differences also emphasize that findings from controlled studies involving groups of patients should not be directly equated with the clinical course of an individual case.

From a clinical perspective, the findings suggest that combined ES and MRP may be considered as part of an individualized physiotherapy program when treatment goals include improving selected motor impairments and balance. The intervention sequence used in this case incorporated ES before active task specific exercise and progressed from strengthening activities toward balance, gait, and functional tasks. However, the available documentation did not include complete ES parameters or detailed quantitative criteria for exercise progression. Therefore, the intervention cannot be considered fully standardized or directly reproducible on the basis of the present report alone. Clinicians should consequently interpret the treatment sequence as a description of the documented clinical practice rather than as a definitive protocol for post stroke rehabilitation.

The scientific contribution of this case report lies primarily in its detailed description of changes across multiple motor domains during a short course of combined ES and MRP. Rather than establishing comparative efficacy, the report illustrates that selected body function and balance outcomes may change while muscle tone and functional motor performance remain unchanged within the same treatment period. This observation may help generate hypotheses for future prospective research examining treatment duration, intervention dosage, outcome specific responsiveness, and the potential interaction between ES and task specific motor training. Future studies should use larger samples, controlled designs, standardized intervention reporting, repeated outcome assessments, and longer follow up to determine whether the pattern observed in this case can be reproduced and whether the combined approach provides benefits beyond either intervention alone.

Several limitations should be considered when interpreting these findings. First, the study involved a single patient and therefore cannot establish treatment efficacy or generalizability to the wider stroke population. Second, the intervention consisted of only six treatment sessions, which limits the ability to evaluate longer term functional adaptation. Third, important clinical information, including detailed stroke onset, comorbidities, medication history, previous rehabilitation, and neuroimaging findings, was unavailable in the physiotherapy documentation. Fourth, several technical ES parameters, including waveform, pulse width, duty cycle, electrode placement, and target muscles, were not documented. Finally, detailed information regarding exercise duration, rest intervals, intensity, and predefined progression criteria was unavailable. These limitations reduce reproducibility and should be addressed in future prospective studies using standardized clinical documentation and intervention reporting.¹²

Conclusion

This case report demonstrated that six physiotherapy sessions combining Electrical Stimulation (ES) and Motor Relearning Program (MRP) were associated with improvements in selected joint range of motion, muscle strength, and balance in a patient with right hemiparesis following ischemic stroke. Improvements were observed in shoulder abduction, shoulder flexion, hip flexion, and ankle dorsiflexion, as well as in selected upper and lower limb muscle groups. Balance performance also improved, with the Berg Balance Scale score increasing from 39 to 46. In contrast, muscle tone remained unchanged, with mild elbow flexor spasticity persisting at an MAS score of 1, while functional motor performance assessed using the MMAS remained at 47.

These findings indicate that changes across motor recovery domains were heterogeneous during the six session rehabilitation period. Improvements in selected body function and balance outcomes were not accompanied by measurable changes in muscle tone or functional motor performance. Because this report involved a single patient without a control condition, the findings should be interpreted as descriptive clinical observations and cannot establish the efficacy of the combined intervention or determine the independent contribution of ES and MRP. Nevertheless, the case provides clinically relevant documentation of the pattern of motor changes observed during a short course of combined rehabilitation.

Further prospective research with larger samples, controlled designs, longer intervention and follow up periods, standardized ES parameters, detailed reporting of MRP dosage and progression, and repeated outcome assessments is warranted to determine whether the observed pattern can be reproduced and whether combining ES with MRP provides additional benefits for motor recovery after ischemic stroke.

Limitation

This report has several limitations. The single patient design limits generalizability and does not permit causal inference regarding the effects of the combined intervention. The intervention period was limited to six sessions, preventing assessment of longer-term functional adaptation. Several clinical characteristics, including detailed stroke onset, comorbidities, medication history, previous rehabilitation, and neuroimaging findings, were unavailable in the physiotherapy documentation. In addition, technical ES parameters such as waveform, pulse width, duty cycle, electrode placement, and target muscles were not recorded, while detailed exercise duration, rest intervals, intensity, and predefined progression criteria were also unavailable. These limitations reduce intervention reproducibility and should be addressed through standardized prospective documentation in future research.

Implication

From a clinical perspective, this case suggests that ES combined with task specific MRP may be incorporated into individualized physiotherapy management when treatment goals include selected improvements in joint mobility, muscle strength, and balance. The observed changes also indicate the importance of monitoring multiple clinical domains because improvement in impairment-based outcomes may occur without concurrent improvement in functional motor performance or muscle tone. However, the findings should not be interpreted as evidence that the combined intervention is superior to either ES or MRP alone. Clinical application should therefore remain individualized and guided by patient presentation, treatment goals, response to intervention, and appropriate progression of functional activities.

Author Contribution

Wildanul Ibrahim: Conceptualization, Methodology, Investigation, Data Curation, Formal Analysis, Writing Original Draft.

Diah Rosyida Maulidina: Conceptualization, Methodology, Supervision, Validation, Writing Review and Editing, Project Administration.

Nurma Auliya Hamidah: Investigation, Data Curation, Formal Analysis, Writing Review and Editing.

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Conflict of Interest Statement

The authors declare that there are no conflicts of interest related to the preparation, conduct, or publication of this case report.

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Ethics Statement

informed consent was obtained from the patient for participation in the physiotherapy program and publication of anonymized clinical information and photographs. The available clinical documentation did not contain an institutional ethics committee approval number or approval date. The authors should verify the applicable institutional requirements for case report ethics review and provide the relevant ethical approval information if required.

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