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Motor Learning–Based Orofacial Rehabilitation for Ataxic Dysarthria Following Cerebellar Stroke: A Case Report

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Case Report

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Abstract

Objective

The purpose of this study is to describe the clinical presentation of a patient with ataxic (drunken) dysarthria after a recurrent cerebellar stroke and assess the short-term efficacy of a structured Motor Learning–Based Oro-facial Rehabilitation (MLBOR) protocol in improving orofacial coordination and speech intelligibility.

Methods

A 68-year-old man who had previously experienced a cerebellar infarction showed signs of right-sided facial incoordination, irregular diadochokinesis, diminished breath-speech coordination, and slurred, scanning speech. The design of a phased MLBR protocol included three phases: functional communication training with quality-of-life assessment in Phase 3, imitation-based speech drills in Phase 2, and orofacial muscle strengthening in Phase 1. Only Phase 1 was implemented for three weeks due to time constraints. The motor learning principles of repetition, task specificity, graded progression, and feedback were used to deliver the intervention, which included blowing exercises, balloon blowing, cheek puffing, straw-assisted tasks, tongue presses, smile holding, and upward facial facilitation techniques. Throughout the intervention period, daily speech audio recordings were made to track continued improvements in coordination and clarity. Perceptual speech analysis, patient self-report, bystander feedback, and assessment of the daily evaluation.

Results

The patient showed better lip seal, better tongue and buccal coordination, and less speech slurring after the intervention. Perceptual improvements in speech intelligibility were accompanied by functional improvements in breath-speech control. Over the course of the three weeks, daily audio recordings showed increasing improvements, corroborating both observer-reported and subjective results. Feedback from patients and bystanders revealed a significant improvement in the confidence and clarity of communication.

Discussion

This case reveals that early functional improvements in cerebellar ataxic dysarthria can be achieved through an organized motor learning-based orofacial strengthening program. Repetitive, task-specific training that focuses on coordination rather than just strength seems to be helpful. These results encourage more study on thorough MLBR protocols in post-stroke dysarthria rehabilitation, despite being restricted to Phase 1 and short-term follow-up.

INTRODUCTION

Globally, stroke continues to be one of the main causes of functional dependence and long-term disability. Stroke is the second most common cause of death worldwide and a significant contributor to years lived with disability, according to the World Health Organization.[1] Cerebellar strokes make up 2–3% of all ischemic strokes, although supratentorial strokes are more common. Because of their subtle early clinical presentations, cerebellar strokes are often underdiagnosed. Cerebellar strokes are less common, but they can cause severe impairments in speech, balance, coordination, and motor timing, which can significantly impact functional independence, especially in older adults.[2]

About 20–40% of acute stroke cases are associated with dysarthria, a common communication disorder after the stroke. Lesions of the cerebellum or its afferent and efferent pathways are traditionally linked to ataxic dysarthria(drunken dysarthria), one of its subtypes.[3] The symptoms of ataxic dysarthria include abnormal articulatory breakdowns, excessive and equal stress patterns, scanning speech, prolonged phonemes, distorted vowel production, and variable speech rate. These symptoms are caused by impaired coordination, timing, and scaling of the speech musculature. Joseph Darley and associates were the first to systematically classify the disorder, characterizing it as a motor speech disorder that results from cerebellar dysfunction as opposed to primary muscle weakness or spasticity.[4, 5]

Patients with ataxic dysarthria may have poor Oro-motor coordination, which can lead to issues with bolus control and drooling, in addition to reduced speech intelligibility.[6] Rather than being solely caused by primary weakness, drooling in this population is frequently linked to poor lip seal, decreased oral sensory-motor control, and incoordination. Communication, eating habits, social interaction, and general quality of life are all adversely affected by these impairments.[7]

While referring to the multidisciplinary rehabilitation of people who have had cerebellar stroke, physiotherapy is crucial. In order to improve neuroplasticity and functional recovery, a motor learning-based approach prioritizes task-specific practice, repetition, feedback modulation, graded complexity, and contextual variability.[8]The timing and coordination of speech musculature can be enhanced by facilitation techniques that focus on respiratory control, oro-facial coordination, postural stability, and speech-related motor tasks.[9] Research indicates that by increasing coordinated motor output, structured motor facilitation exercises—such as lip closure exercises, articulatory precision drills, rhythmic cueing, and breath control training—may lessen drooling and increase speech intelligibility.[10]

Dysarthria following a stroke has a major impact on psychological health, social engagement, and quality of life.[11] Speech and language therapy, with an emphasis on respiratory support, articulatory accuracy, prosodic modulation, and rate control, is the mainstay of traditional management. According to systematic reviews, people with post-stroke dysarthria can benefit from structured speech rehabilitation in terms of phonatory control and speech intelligibility.[12] Nevertheless, new research indicates that task-oriented training and motor learning concepts may improve neural plasticity and functional recovery in rehabilitation techniques.[13]

Structured physiotherapy-based Oro-motor rehabilitation procedures are still limited in the literature, despite the fact that cerebellar stroke-related ataxic dysarthria considerably impairs speech intelligibility, drooling control, and quality of life. A motor learning-based framework might offer a systematic approach to enhance breath-speech control and articulatory quality given the cerebellum's essential involvement in motor coordination and adaptive learning. This case study examines the implementation and clinical evaluation of a phased, structured Motor Learning-Based Rehabilitation Protocol for drunken dysarthria. This report's objectives are to outline the patient's presentation and physiotherapy treatment, as well as to assess how well this protocol works to enhance speech intelligibility, drooling control, facial muscular strength, and communication-related quality of life.

CASE DESCRIPTION

The 68-year-old man came in with a past medical history of a cerebrovascular accident in 2015. At that time, cerebellar infarct was discovered by neuroimaging (MRI), primarily in the superior cerebellar artery (SCA) territory. The patient reported that the event occurred suddenly at night while he was asleep. He worked as a health inspector, and had completed his usual day at work before going to bed. The following morning, he was unable to rise from bed, and family members noticed deviation of the lower quadrant of his face. He was immediately taken to the hospital for evaluation and management. After the first incident, he showed Oro-motor weakness, ataxic speech variations, deviation of the lower quadrant of the face, and weakness in the right upper and lower limbs. After receiving physiotherapy rehabilitation, he showed a functional improvement in his balance and limb strength. However, adherence to structured Oro-motor rehabilitation protocols was limited, and improvements in speech clarity (slurring) were relatively slow.

The patient maintained functional independence and was able to operate a motorcycle and scooty despite any remaining impairments. Approximately one year prior to the present evaluation, he began experiencing progressive deviation of the body toward the right side, difficulty maintaining balance while walking, and increased leaning to the right during ambulation. Additionally, he reported increased slurring of speech, which was characterized as "drunken-like" speech, difficulty controlling food boluses, and food spilling from the corner of his mouth.

Following a medical consultation, a follow-up MRI shows hyperintense lesion in the left cerebellar hemisphere ,basal ganglia ,pons, thalami and periventricular white matter on T2 weighted and flair images which are hypointense on T1 weighted image-old infracts and gliosis, which indicate a recurrent cerebrovascular event that happened almost 15 years after the first stroke. The recurrence worsened pre-existing deficiencies in speech and coordination but did not result in any appreciable new limb weakness.

The patient is on regular medical management for secondary stroke prevention. He takes anti-hypertensive and antiplatelet medication. In order to achieve the best possible blood pressure control after his second cerebrovascular event within 15 years, the antihypertensive dosage was suitably titrated

under medical supervision. Additionally, he reports taking multivitamin supplements on a regular basis. He continues to receive stable medication adherence and periodic neurological follow-up.

During the current assessment, the patient was a tall, thin-built i.e. ectomorphic, elderly male with a right-hand dominant laterality, according to the general physical examination. He was about 178 cm (1.78 m) tall. He weighed 60 kg, which, using the standard formula (kg/m2), translated to a Body Mass Index (BMI) of 18.9 kg/m². According to the World Health Organization, this BMI is in the lower range of normal, on close to of becoming underweight, which could have an impact on total muscle mass and endurance capacity.[14]

A comprehensive physiotherapy assessment was performed to evaluate motor, postural, coordination, cranial nerve, and speech-related impairments. The patient was able to follow complex verbal instructions and was conscious, alert, and well-oriented to time, place, and people. A persistent truncal deviation toward the right side was observed during postural observation while standing and sitting, along with a compromised midline orientation. Weight-bearing evaluation revealed increased loading through the left lower limb despite the trunk's rightward tilt, suggesting a compensatory shift away from the unstable side. Upon motor examination, the left side showed normal strength, but the right upper and lower limbs showed mild residual weakness (Medical Research Council grade 4/5). There was no indication of spasticity ,but mild hypotonia on the right side, and muscle tone was within functional bounds. Classical ipsilateral cerebellar signs on the right were identified by coordination testing. These included a positive rebound phenomenon, dysmetria on finger-to-nose testing, poor heel-to-shin performance, and dysdiadochokinesia during rapid alternating movements. The results of the gait analysis showed a wide-based ataxic gait with a rightward lean and decreased trunk control, which made it difficult to ride a two-wheeler and caused instability when walking.

Right-sided facial motor involvement was confirmed by cranial nerve and Oro-facial motor examination, which showed a deviation of the lower quadrant of the face toward the left. There was less voluntary activation of the right buccinator and orbicularis orris muscles, which resulted in a weaker lip seal and less control over the right oral commissure. The right side's facial muscle power was rated at about a 3+/5, with deficiencies primarily attributed to incoordination rather than outright weakness. The results of the reflex evaluation showed a mildly reduced gag reflex, an intact corneal reflex, and a normal jaw jerk reflex. An Oro-motor evaluation showed poor bolus containment during simulated functional tasks, incomplete lip closure at rest, and decreased tongue coordination toward the right. Clinical observations of food spillage from the right corner of the mouth were linked to decreased Oro-motor control and impaired labial coordination rather than hypersalivation.

In physiotherapeutic evaluation of speech, the patient showed signs typical of ataxic dysarthria. In perceptual analysis of spontaneous speech and controlled speech tasks, there was irregular breakdown of articulation, scanning speech pattern, redundancy and equal stress on syllables, varying rate of speech, and reduced overall intelligibility. The speech quality was quite slurred, and there was a “drunken-like” quality to the speech, which indicated poor cerebellar coordination rather than mere

muscular weakness. In diadochokinetic testing, the production of rapid alternating syllables (/pa/, /ta/, /ka/, and /pa-ta-ka/) showed irregular rhythm, reduced rate, and disrupted sequence, which indicated poor timing, coordination, and sequencing of articulatory movements. Assessment of respiratory–phonatory control revealed reduced expiratory control during sustained phonation and shortened maximum phonation duration, reflecting impaired breath–speech coordination. These findings, interpreted within the context of recurrent right-sided cerebellar–pontine involvement, indicate predominant coordination-based motor speech impairment, thereby reinforcing the need for a structured, motor learning–based physiotherapy approach focusing on respiratory control, articulatory precision, and coordinated speech production.

DISCUSSION

The medical conditions of drunken dysarthria, a motor speech disorder frequently linked to cerebellar lesions, include slurred speech, imprecise articulation, irregular rhythm, and poor orofacial muscle coordination[15]. The main clinical feature in this case was slurred speech that sounded like drunken speech, along with Oro-motor weakness, facial asymmetry (lower quadrant deviation), and diminished control over the tongue and lips. These deficiencies were in line with ataxic-type dysarthria, a condition in which the timing, sequencing, and coordination of the muscles needed to produce speech are disrupted by cerebellar involvement.

When exercises are progressive and targeted, structured Oro-facial rehabilitation can result in a notable improvement in articulatory control and speech clarity, in contrast to limb rehabilitation, which frequently exhibits quick functional gains. When applied methodically using the principles of motor learning, Oro motor exercises can yield quantifiable improvements in functional outcomes that are on level with or even better than those observed in lower limb rehabilitation, particularly in patients with residual cerebellar deficits.[16, 17, 18]A motor learning-based approach proved suitable due to the patient's ongoing Oro-motor weakness. In order to promote neuroplasticity and the acquisition of functional skills, motor learning principles place an emphasis on high repetition, task-specific practice with increasing difficulty and feedback.[16, 17]

A novel Motor Learning-Based Rehabilitation Protocol for Drunken Dysarthria was used in this instance. Oro-facial muscle strengthening(phase 1), imitation-based speech drills(phase 2), and functional outcome evaluation(phase 3) were the three progressive stages of the protocol's design by using the various article references.[22, 23, 24, 25, 26, 27]

Due to time constraints, only Phase 1 of the Motor Learning-Based Rehabilitation Protocol, which focuses on orofacial muscle strengthening, was administered for three weeks. The intervention included structured exercises such as blowing, cheek puffing, balloon blowing, straw-assisted drinking, tongue presses to the oral roof, oral floor, and lateral walls of the mouth, smile holding, and upward-direction facial massage to improve facial and tongue muscle strength, endurance, and coordination, which are essential components for articulatory precision in cerebellar dysarthria. After a three-week treatment,

audio recordings, patient self-report, and bystander feedback revealed considerable increases in speech clarity. Prior research suggests that subsequent phases, including imitation-based speech drills and functional outcome assessment, can improve speech intelligibility and Oro-facial motor control through task-specific motor learning and integration into functional communication.[19,20,21]. In order to facilitate the generalization of motor improvements into real-life communicative contexts, Phase 3 focused on functional communication training. In order to improve intelligibility and communicative participation, this phase included contextual speech activities, spontaneous speech practice, and structured conversational tasks. The ASHA Quality of Life (ASHA-QOL) questionnaire was used to measure changes in communication ability, participation, and psychosocial impact in order to objectively assess the efficacy of functional carryover. By connecting gains at the impairment level to improvements at the activity and participation levels, the inclusion of functional outcome measurement enhances the protocol's clinical relevance. Only Phase 1 was administered. Structured Oro-motor rehabilitation is effective as part of a complete motor learning approach for patients with cerebellar ataxic dysarthria. [26]

Table 1
A NOVEL MOTOR-LEARNING BASED ORO-FACIAL REHABILITATION PROTOCOL [MLBR]

PHASE	INTERVENTION/ EXERCISE	CLINICAL INDICATION
Phase 1: ORO-FACIAL MUSCLE STRENGTHENING(3 WEEKS)	1.blowing exercise (sustained exhalation-10 repetition x 3 times)[24] 2.puffing of cheeks(bilateral /unilateral with 10 second hold with 10 repetition x 3 times)[23] 3.balloon blowing 4.straw assisted drinking and water holding 5.toungue presses : oral roof, oral floor, lateral walls (10 sec hold x 10 rep)[22] 6.smile holding and fascial expression exercises[25] 7.upward fascial muscle massage using creams or oils	Strengthens orofacial muscles, increases lip seal, tongue movement, and endurance. Progressive resistance (air to water) improves neuromuscular control. Improves articulatory precision, which serves as a foundation for functional speech. Cerebellar dysarthria with slurring, facial asymmetry, and poor tongue/lip control make this treatment especially appropriate for this patient.
Phase 2: imitation based speech drills[26]	1.syllable repetition[pa-ta-ka] 2.word and phrase repetition 3.exaggerated articulation 4.Prosody exercises: rhythmic and paced speech practice 5.breathing exercise; Target breath support and voice control to improve phonation stability	Reinforces motor patterns taught in Phase 1 while improving coordination, timing, and speaking accuracy. Task-specific practice improves neuroplasticity and functional speech outcomes. Indicated for the patient to use strengthened muscles to produce regulated articulation and comprehensible speech.
Phase 3: functional outcome assessment	1.contextual speech activities 2.spontaneous speech practice 3.structured conversational tasks and evaluated by the Administration of ASHA quality of life (ASHA-QOL) questionnaire[27]	Assesses patient-reported functional communication, social participation, and emotional effect. Confirms whether clinical gains lead to meaningful daily communication. It is critical for this patient to monitor the real-life benefit of the intervention.

Pre- and post-intervention speech clarity assessments revealed significant improvement, as proven by audio recordings, patient self-report, and bystander observations. Structured Oro-motor training improved tongue and buccal muscle strength over three weeks, resulting in less slurring and little bolus

spillage. Although recovery from cerebellar or other neurogenic diseases normally necessitates extensive therapy, the focused, progressive nature of this motor learning-based paradigm enabled significant gains in muscle control, articulatory precision, and overall Oro-facial function.

Image 1A-D- Exercises incorporating Motor -Learning Based Orofacial Rehabilitation Protocol

CONCLUSION

This case study shows that a structured, motor learning-based Oro motor rehabilitation protocol can result in significant improvement in facial muscle strength and speech clarity in patients with cerebellar ataxic dysarthria, even after only three weeks of intervention. Targeted activities such as blowing, cheek puffing, tongue pushes, and smile holding improved tongue and buccal muscle coordination, reduced slurring, and reduced small bolus spillage, as evidenced by audio recordings, patient comments, and bystander observations. While neurogenic speech deficits normally require prolonged rehabilitation, the progressive, task-specific aspect of this technique allowed for early functional gains and provided physicians with a repeatable framework. These findings support the inclusion of structured Oro motor exercises into normal post-stroke dysarthria care, emphasizing the potential for improving both muscular control and communicative outcomes in patients with cerebellar injuries.

RECOMMENDATIONS

Only Phase 1 (Oro-facial strengthening and motor activation) of the Motor Learning–Based Rehabilitation Protocol was used in this instance due to time constraints. Despite improvements in drooling, lip seal control, facial muscle activation, and partial speech clarity, it was not possible to fully assess the overall efficacy of the entire structured protocol. The entire protocol, including Phase 2 (speech drills based on imitation) and Phase 3 (functional communication training with evaluation using the ASHA Quality of Life questionnaire to assess effectiveness), should be used in future research.

There would be more proof of the intervention's effect on speech intelligibility and communication-related quality of life if it were carried out over a longer period of time with larger sample sizes. This case may serve as a preliminary clinical reference for further research on motor learning–based rehabilitation in ataxic (drunken) dysarthria following cerebellar stroke.

Declarations

The participants provided written informed consent for participating in the study and publish the clinical findings

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Figures



Image 1 A- Puffing of cheeks with the hold of 10 second

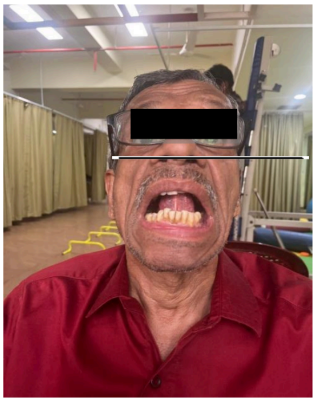


Image 1B- Tongue presses on roof of oral cavity



Image 1C- Blowing exercise with the hold of 10 second(sustained exhalation)



Image 1D- Tongue press on lateral wall of oral cavity

Figure 1

See image above for figure legend