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Investigation of Dysarthria Rehabilitation in Stroke Patients

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Abstract

Background: Stroke is the second leading cause of death worldwide and the third leading cause of disability. It is the most common cause of aphasia, which can be associated with dysarthria and dyspraxia in some cases. The aim of this study was to compare the dysarthria of individuals with stroke before and after treatment.

Methods: The study design and implementation method were quasi-experimental. Fifteen adult patients with a mean age of 50 years, all diagnosed with dysarthria, were included in this study and evaluated using the Radboud Dysarthria Assessment (RDA). After coordinating with speech-language pathologists, neurologists, and other relevant specialists at the University of Social Welfare and Rehabilitation Sciences (USWR), individuals who had experienced a stroke at least 1 year prior and met the inclusion criteria were selected. The rate of improvement in their dysarthria was compared between pre- and post-treatment. The aim is to evaluate the effectiveness of speech therapy in improving dysarthria symptoms in stroke patients through pre- and post-treatment comparison. All patients had damage to the right hemisphere of the brain, and the ratio of women to men was 7 to 8. The average time from the onset of the subjects' illness was 6.4 months.

Results: The non-parametric Wilcoxon test was used to assess the status of the investigated variables before and after treatment. The results indicated a statistically significant difference between the conditions before and after treatment for all variables ($p < 0.02$).

Conclusion: Based on the purpose of the research, comparing the dysarthria of individuals with stroke before and after treatment, along with appropriate and regular therapeutic exercises during six months of rehabilitation, the final evaluation of the research variables concluded that a noticeable difference exists in the condition of dysarthria before and after treatment. In other words, the results show a statistically significant difference between the conditions before and after treatment for all the variables.

Keywords: Stroke, Dysarthria, Study before and after treatment, Radboud Dysarthria Assessment (RDA), Right hemisphere, Speech therapy

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Introduction

Dysarthria is a speech motor disorder that can be classified based on peripheral neuropathology and is associated with disorders of respiratory and laryngeal function, airflow direction, and speech production, leading to speech articulation and comprehension problems[1]. Dysarthria is a common feature of central and peripheral neurological diseases, including stroke, traumatic brain injury, neurological, and neuromuscular disorders[2].

Stroke is the second leading cause of death worldwide and the third leading cause of disability[3]. In addition to causing physical limitations in patients, strokes lead to a severe decline in quality of life[4]. Although timely treatments can prevent some complications, damage to brain tissue due to ischemia is usually permanent, forcing individuals to endure the complications for a long time[5]. One significant effect is the inability to move different parts of the body. When paralysis occurs in the facial area, it can lead to speech disorders such as aphasia and dysarthria[6]. If the speech centers in the brain are healthy and the person has no difficulty understanding speech but only has difficulty

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articulating words, there are various ways to intervene to treat dysarthria. The most important of these are speech rehabilitation programs and speech therapy[7]. Studies show that the best time to perform such interventions is up to three months after the onset of stroke, as the effectiveness decreases after six months, and many complications remain persistent[8].

Lack of treatment for speech disorders can affect various individual and social aspects of a person's life[9]. Stroke results from the loss of brain cells due to a lack of oxygen caused by rupture or blockage. It is a vascular condition. The risk factors for stroke are somewhat similar to those for obstructive diseases affecting coronary arteries and include high blood pressure, diabetes, hyperlipidemia, and other lifestyle-related conditions, such as alcohol and tobacco consumption, sedentary lifestyle, and abdominal obesity[10]. Among these risk factors, alcohol consumption and tobacco use are the most modifiable. Furthermore, 40% of stroke deaths can be prevented by controlling blood pressure. In developed countries, the incidence of stroke is decreasing due to effective blood pressure and smoking control; however, this issue remains a significant health problem in developing countries[10].

Despite progress, rehabilitation remains a key part of patient care. Patients often experience varying degrees of functional impairments, and many individuals and their families suffer from cognitive, physical, psychological, speech, and emotional problems that may require extensive support[10]. Symptoms of stroke vary depending on the location of the blockage or vascular injury and can include motor, sensory, balance, and central nervous system dysfunction. One notable complication is facial nerve palsy, which can cause various problems for the patient, including swallowing disorders, eyelid and eye issues, and difficulties with salivation and mouth function.

One of the most common speech-related disorders resulting from stroke is dysarthria, which can lead to aphasia or dysarthria itself. In aphasia, the brain's speech centers are affected, impairing not just speech but also speech perception. In dysarthria, although the speech centers are healthy, issues such as muscle paralysis present challenges. One cause of dysarthria is injury or obstruction of the middle cerebral artery. However, some stroke patients with damage to the right side of the brain also develop dysarthria. The diagnosis of different types of dysarthria depends on the area of brain injury; for example, if the cerebellum is damaged, the person will have ataxic dysarthria.

Dysarthria is a neurogenic speech disorder caused by dysfunction in the motor control centers of the central or peripheral nervous systems. It is characterized by disturbances in rate, coordination, articulation, and the range of movement within the musculoskeletal system. Dysarthria may involve respiratory control, articulation, prosody, and speech intelligibility. In this case, there is a possibility of impairment in voluntary and automatic activities such as chewing, swallowing, and jaw and tongue movements[11-13].

None of the side effects associated with stroke are as significant as social isolation and loss of quality of life. Therefore, many efforts toward rehabilitation for such patients have been made, including surgical treatments aimed at restoring anatomy and function. This type of surgery has been performed since 1948 for patients with facial paralysis at the LIPSG Center[14]. Unfortunately, in Iran, the incidence of stroke has also spread to younger age groups, with the average age of stroke in this study being 50.2 years. The aim of this study was to compare dysarthria in individuals with stroke: a study before and after treatment.

Materials and Methods

Participants

The study design and project implementation method were cross-sectional. Fifteen adult patients with dysarthria, with a mean age of 50 years, were included in this study and evaluated using the Radboud Dysarthria Assessment (RDA) (Appendix 1). The RDA test includes the following components: articulation, maximum repetition rate, resonance, phonation, changes in phonation quality over time, respiration, and prosody.

The dysarthria test, based on the Radboud Dysarthria Assessment, was administered to the 15 participating patients. After obtaining the necessary permits from the Ethics Committee of the University and Rofiedeh Rehabilitation Hospital, we coordinated with speech-language pathologists, neurologists, and other relevant specialists at the University of Social Welfare and Rehabilitation Sciences to select individuals who had experienced a stroke at least 1 year prior and met the inclusion criteria. The rate of improvement in their dysarthria will be compared between pre- and post-treatment.

Limitations and Future Directions

This study was limited by its small sample size and single-center recruitment, which may restrict the generalizability of findings. Furthermore, the quasi-experimental design lacked a control group, making it difficult to rule out potential confounding factors. Future research should involve larger, multicenter, randomized controlled trials to confirm the efficacy of the intervention. Additionally, long-term follow-up assessments would provide insight into the sustainability of treatment effects.

Procedure

Every year, more than 15 million people worldwide suffer from some degree of stroke and experience various complications, such as sensory-motor, cognitive, and linguistic disabilities[4, 15]. Among these, some stroke patients who have damage to the right side of their brain develop dysarthria. The diagnosis of different types of dysarthria depends on the area of the brain that is injured. For example, if the cerebellum is damaged, the person will have ataxic dysarthria, along with an analysis and interpretation of the evaluation findings for patients with right hemisphere stroke[16].

Unfortunately, in Iran, the incidence of stroke has also spread to younger age groups, with the average age of stroke patients in this study being 50.2 years, which is a significant concern. All patients had damage to the right hemisphere of the brain,

and the ratio of women to men was 7 to 8. The average time since the onset of the subjects' illness was 6.4 months.

Treatment Exercises

After evaluating patients at Rofeideh Rehabilitation Hospital, speech-language pathologists (SLPs) developed a treatment program for them. Speech therapy sessions were provided twice a day for six months. The treatment procedures were based on the motor-sensory agitation of the speech system and included the following:

Oral Motor Exercises (OME) initially began with passive activities, such as gentle touch to the face and neck muscles, along with external laryngeal and oropharyngeal simulations that required no active participation. The patient's oral and facial muscles then received massage, proprioceptive neuromuscular facilitation (PNF), and myofunctional therapy (MFT) to improve oral neuromuscular function, provide sensory stimulation, and reduce pathological reflexes.

For instance, to enhance sensory awareness of lip movement and increase lip muscle strength, the patient was instructed to press their lips tightly together for 15 seconds. To assess range of motion and strengthen the tongue and facial muscles, including the orbicularis oris, buccinator, zygomaticus, orbicularis oculi, genioglossus, and suprahyoid muscles, the patient was asked to extend the tongue, retract it, and move it left and right. Additionally, the patient was encouraged to protrude their tongue as much as possible and then move it toward the pharynx to create a gurgling sound. To increase muscle tone, slight spiral movements of the tongue depressor were employed.

Treatment also addressed dysfunctions in speech subsystems, including disorders of respiration, phonation, articulation, resonance, and prosody. Regarding respiratory corrections, the patient's sitting posture was adjusted to ensure they were seated comfortably and that the axis of the head, neck, and shoulders was straight and natural. If needed, auxiliary tools such as pillows, belts, and straps were used. Following this, exercises were implemented to correct the patient's breathing pattern to enhance physiological support for breathing control.

Regarding the patient's phonation quality, adjustments were made to improve voice loudness and clarity and to maximize phonation time (MPT). To correct articulation errors, therapeutic approaches based on auditory discrimination were emphasized, incorporating sensory-oral training, phonological awareness, and fluency enhancement. Simultaneously, diadochokinetic exercises were performed to improve speech speed and loudness, as well as overall speech intelligibility.

Results

The participants consisted of 46.6%women and 53.3% men. The frequency distribution of participants by age group is shown in Tables 1.

The non-parametric Wilcoxon test was used to assess the status of the variables under investigation before and after the treatment. The results show a statistically significant difference between the conditions before and after treatment

Table 1. Frequency distribution of participants.

N	Age range	N. par…
1	41-60	6
2	61-71	5
3	72-80	4

across all variables (Table 2).

Discussion

This study provides further evidence on the effectiveness of targeted interventions for dysarthria following stroke. Our findings demonstrated reduced facial muscle tension, improved speech loudness and rate, and, most importantly, a marked increase in speech intelligibility. These outcomes are consistent with previous research showing that timely and structured speech therapy can significantly enhance communicative abilities in stroke survivors[6, 7]. By aligning with existing literature, this study strengthens the evidence base for early intervention and highlights the potential benefits of comprehensive rehabilitation strategies.

At the same time, our results extend prior work by emphasizing that the degree of improvement may vary according to the severity of dysarthria, the neurological site of injury, and the timing of treatment initiation. This suggests that individualized treatment planning remains critical and that early initiation of therapy could maximize functional recovery.

Several limitations should be acknowledged. First, the sample size was relatively small, which restricts the generalizability of the findings. Second, the study used a quasi-experimental design without a control group, making it difficult to exclude potential confounding variables or placebo effects. Additionally, participants were recruited from a single center; therefore, the findings may not reflect broader patient populations.

To build on these findings, future research should include larger, multicenter randomized controlled trials to confirm the effectiveness of interventions and to identify which therapeutic components are most beneficial. Long-term follow-up studies are also needed to examine the durability of treatment effects. Furthermore, investigating the interaction between patient-specific factors (e.g., age, lesion site, severity of initial impairment) and therapy outcomes could help refine individualized treatment protocols.

Conclusion

According to the research, which focused on a comparative study of dysarthria in individuals with stroke—specifically, a study conducted before and after treatment—appropriate, regular therapeutic exercises during a six-month rehabilitation intervention led to significant improvements. Based on the final evaluation of the research variables, it is concluded that there is a noticeable difference in the condition of dysarthria before and after the treatment. In other words, the results indicate statistically significant differences across all variables when comparing conditions before and after treatment.

Table 2. Wilcoxon's results for comparing variable status before and after treatment (N=15).

Variables	Mean	Z	p-value
lip.M.Bef*	1.47	3.45	0.001
lip.M Af*	0.27		
Jaw.M.Bef	1.27	3.56	0.001
Jaw.M. Aft	0.20		
Tonge.M.Bef	1.27	3.36	0.001
Tonge.M. Aft	0.40		
Vowels.Bef	1.27	3.14	0.002
Vowels. Aft	0.07		
Consonants.Bef	1.40	3.04	0.002
Consonants. Aft	0.40		
Clusters.Bef	1.27	2.92	0.004
Clusters. Aft	0.40		
Syllable.Bef	1.27	3.18	0.001
Syllable. Aft	0.53		
pa.Bef	1.53	3.56	0.001
pa. Aft	0.47		
ta.Bef	1.33	3.56	0.001
ta. Aft	0.27		
ka.Bef	1.33	3.50	0.001
ka. Aft	0.40		
Pataka.Bef	1.47	3.18	0.001
Pataka. Aft	0.73		
Vocal.Quality.Bef	1.27	3.50	0.001
Vocal.Quality. Aft	0.33		
Vocal.Use.Bef	1.33	3.50	0.001
Vocal. Use. Aft	0.40		
Loudness.Bef	1.33	3.50	0.001
Loudness. Aft	0.40		
Pitch.Bef	1.33	3.16	0.002
Pitch. Aft	0.67		
Funda.Freq.Range.Bef	1.33	3.50	0.001
Funda.Freq.Range . Aft	0.40		
Max.Phon.Volume.Bef	1.80	3.78	0.001
Max.Phon.Volume . Aft	0.73		
Max.Phon.Time.Bef	1.67	3.87	0.001
Max.Phon.Time . Aft	0.67		
Inhalation.Bef	1.60	3.56	0.001
Inhalation. Aft	0.53		
During.Speech.Bef	1.60	3.87	0.001
During.Speech. Aft	0.60		
Pattern.Breath.Bef	1.67	3.87	0.001
Pattern.Breath. Aft	0.67		
Melodic.Accent.Bef	1.47	3.64	0.001
Melodic.Accent. Aft	0.47		
Dynamic.Accent.Bef	1.53	3.74	0.001
Dynamic.Accent. Aft	0.60		
Temporal.Accent.Bef	1.47	3.74	0.001

Bef=befor and Aft=after

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Ethical consideration

This research was approved by the Vice Chancellor for Research at the University of Social Welfare and Rehabilitation Sciences in Tehran, Iran (Code IR.USWR.REC.1398.113).

Competing Interests

The authors declare no conflict of interest.

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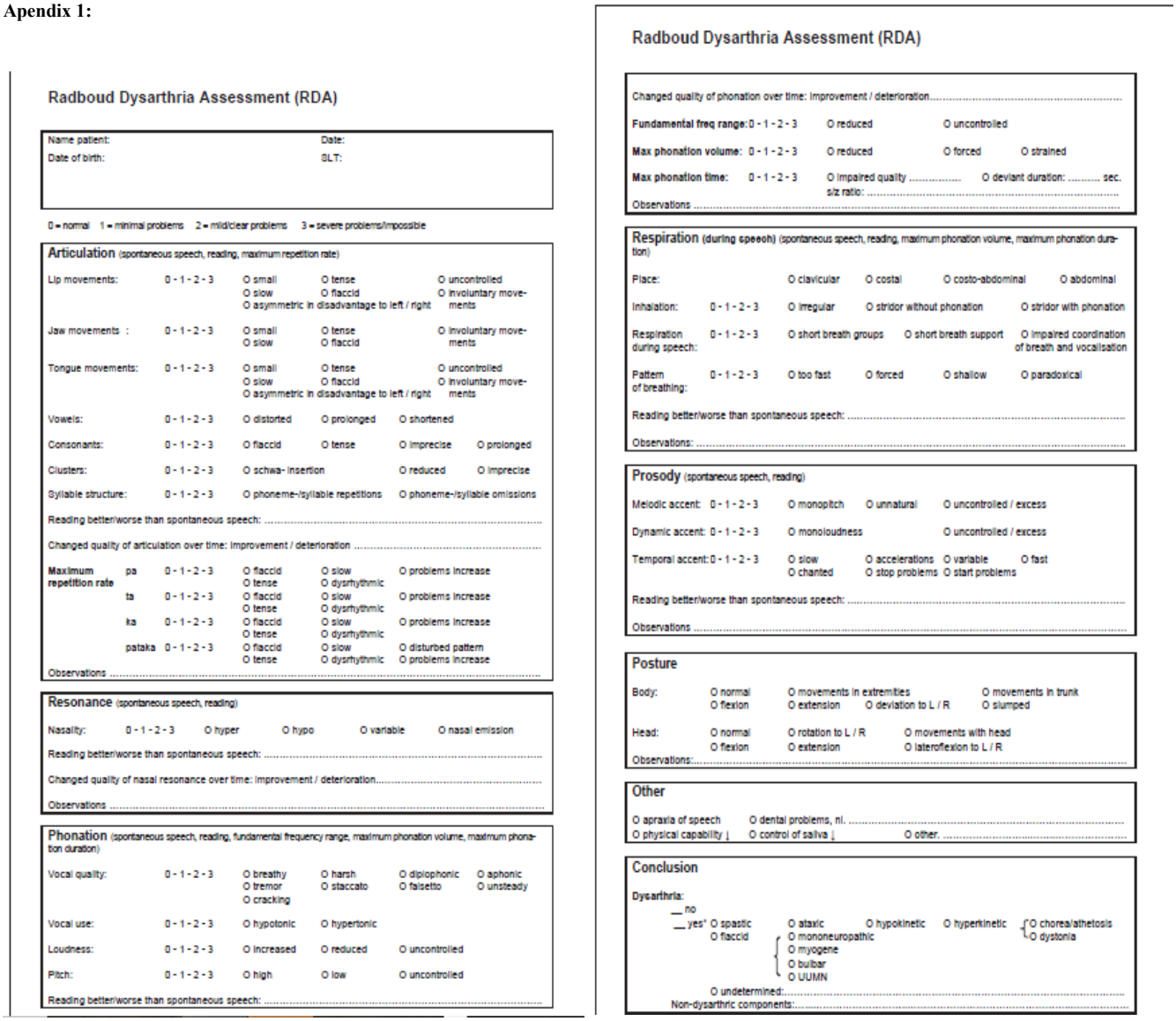
Apendix 1:



Radboud Dysarthria Assessment (RDA)

Name patient: Date:
Date of birth: SLT:

0 = normal 1 = minimal problems 2 = mild/clear problems 3 = severe problems/impossible

Articulation (spontaneous speech, reading, maximum repetition rate)

Lip movements:	0 - 1 - 2 - 3	O small O slow O asymmetric in disadvantage to left / right	O tense O flaccid	O uncontrolled O involuntary movements	
Jaw movements :	0 - 1 - 2 - 3	O small O slow	O tense O flaccid	O involuntary movements	
Tongue movements:	0 - 1 - 2 - 3	O small O slow O asymmetric in disadvantage to left / right	O tense O flaccid	O uncontrolled O involuntary movements	
Vowels:	0 - 1 - 2 - 3	O distorted	O prolonged	O shortened	
Consonants:	0 - 1 - 2 - 3	O flaccid	O tense	O imprecise	O prolonged
Clusters:	0 - 1 - 2 - 3	O schwa- insertion		O reduced	O imprecise
Syllable structure:	0 - 1 - 2 - 3	O phoneme-/syllable repetitions		O phoneme-/syllable omissions	

Reading better/worse than spontaneous speech: .....

Changed quality of articulation over time: improvement / deterioration .....

Maximum repetition rate	pa 0 - 1 - 2 - 3	O flaccid O tense	O slow O dysrhythmic	O problems increase	
	ta 0 - 1 - 2 - 3	O flaccid O tense	O slow O dysrhythmic	O problems increase	
	ka 0 - 1 - 2 - 3	O flaccid O tense	O slow O dysrhythmic	O problems increase	
	pataka 0 - 1 - 2 - 3	O flaccid O tense	O slow O dysrhythmic	O disturbed pattern O problems increase	

Observations .....

Resonance (spontaneous speech, reading)

Nasality: 0 - 1 - 2 - 3 O hyper O hypo O variable O nasal emission

Reading better/worse than spontaneous speech: .....

Changed quality of nasal resonance over time: improvement / deterioration .....

Observations .....

Phonation (spontaneous speech, reading, fundamental frequency range, maximum phonation volume, maximum phonation duration)

Vocal quality:	0 - 1 - 2 - 3	O breathy O tremor O cracking	O harsh O staccato	O diplophonic O falsetto	O aphonic O unsteady
Vocal use:	0 - 1 - 2 - 3	O hypotonic	O hypertonic		
Loudness:	0 - 1 - 2 - 3	O increased	O reduced	O uncontrolled	
Pitch:	0 - 1 - 2 - 3	O high	O low	O uncontrolled	

Reading better/worse than spontaneous speech: .....

Radboud Dysarthria Assessment (RDA)

Changed quality of phonation over time: improvement / deterioration .....

Fundamental freq range: 0 - 1 - 2 - 3 O reduced O uncontrolled

Max phonation volume: 0 - 1 - 2 - 3 O reduced O forced O strained

Max phonation time: 0 - 1 - 2 - 3 O impaired quality ..... O deviant duration: ..... sec.
s/z ratio: .....

Observations .....

Respiration (during speech) (spontaneous speech, reading, maximum phonation volume, maximum phonation duration)

Place:		O clavicular	O costal	O costo-abdominal	O abdominal
Inhalation:	0 - 1 - 2 - 3	O irregular	O stridor without phonation	O stridor with phonation	
Respiration during speech:	0 - 1 - 2 - 3	O short breath groups	O short breath support	O impaired coordination of breath and vocalisation	
Pattern of breathing:	0 - 1 - 2 - 3	O too fast	O forced	O shallow	O paradoxical

Reading better/worse than spontaneous speech: .....

Observations: .....

Prosody (spontaneous speech, reading)

Melodic accent: 0 - 1 - 2 - 3	O monopitch	O unnatural	O uncontrolled / excess	
Dynamic accent: 0 - 1 - 2 - 3	O monoloudness		O uncontrolled / excess	
Temporal accent: 0 - 1 - 2 - 3	O slow O chanted	O accelerations O stop problems	O variable O start problems	O fast

Reading better/worse than spontaneous speech: .....

Observations .....

Posture

Body:	O normal O flexion	O movements in extremities O extension	O deviation to L / R	O movements in trunk O slumped
Head:	O normal O flexion	O rotation to L / R O extension	O movements with head O lateroflexion to L / R	

Observations: .....

Other

O apraxia of speech O dental problems, nl. .....
O physical capability ↓ O control of saliva ↓ O other: .....

Conclusion

Dysarthria:
__ no
__ yes* O spastic O ataxic O hypokinetic O hyperkinetic { O chorea/athetosis / O dystonia
O flaccid { O mononeuropathic / O myogene / O bulbar / O UUMN
O undetermined: .....
Non-dysarthric components: .....

Radboud Dysarthria Assessment (RDA)

Severity scale:

0. No dysarthria
1. Minimal dysarthria: minimal problems with articulation, resonance, phonation or respiration.
2. Mild dysarthria: tonus, range of motion or speed of articulation movements are mildly affected, leading to mildly affected consonants and/or vowels. Mild problems with resonance, phonation or respiration.
3. Mild / severe dysarthria: tonus, range of motion or speed of articulation movements are clearly affected, leading to deviant consonants and/or vowels. Clearly affected resonance, phonation or respiration.
4. Severe dysarthria: tonus, range of motion or speed of articulation movements are severely affected, leading to severely affected consonants and/or vowels. Severely affected resonance, phonation or respiration. Very slow speech with only a few syllables per breath group.
5. Very severe dysarthria/anarthria: articulation movements are almost impossible, leading to mainly open vowels and very severely distorted consonants. Very severely affected resonance, phonation (aphonic) or respiration (almost no breath support).

* in case of mixed dysarthrias, tick two or more types