التحليل الادراكي لاضطراب الرتّة المكتسب

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Perceptual analysis of acquired dysarthria

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الملخص:

يشير مصطلح "الرتّة" للكلام إلى تلف في الجهاز العصبي المركزي و / أو المحيطي، يمكن أن يرتبط بالعديد من الإصابات الدماغية العصبية الحادة من (سكتة دماغية، التصلب الضموري الجانبي)، أو من إصابات التهابية ومتطوّرة مثل (التصلب اللويحي) ، إلخ.

قد تؤثر الإصابة اضطرابات في إنتاج الكلام: النظام التنفّسي، الطبقة الحنجرية، التجاويف الفمية والأنفية. كنتيجة لذلك، تأخذ اضطرابات الرتّة أشكال متنوعة تمس إحدى وظائف الكلام أو كلّها من التنفس الصوتي، نوعية الصوت، النطق، رَجْع الصوت... مع ذلك، فالدراسات الاستكشافية في الوسط الإكلينيكي الجزائري قليلة جدًا، خاصة فيما يخص بتلك الدراسات الأرطوفونية الخاصة بتقييم والتحليل الإدراكي لإنتاج الكلام عند المصاب بالرتّة بعد السكتة الدماغية. فتحقيقا للغاية سوف نقدم من خلال هذا المقال دراسة تحليلية إدراكية لحالة تعاني من الرتّة بعد السكتة الدماغية.

.كلمات مفتاحية: الرتّة.، التحليل الادراكي.، التصنيف.، دراسة حالة.، طريقة التشخيص والتكفل.

Abstract:

The term 'dysarthria' refers to a speech motor execution disorder that arises from damage to the central and/or peripheral nervous system. The condition is linked to various neurological acute pathologies (like stroke or head trauma), neurodegenerative illnesses (such as Parkinson's disease or amyotrophic lateral sclerosis), and progressive or inflammatory disorders (like multiple sclerosis).

Neurological lesions can impact the systems involved in speech production, such as the ventilatory system, the laryngeal stage, the articulators, and the resonators. This can ultimately lead to dysarthria, which can have a wide range of effects on vocal breathing, voice quality, articulation, resonance, and prosody, either independently or in combination. However, there is little research in this field in Arabic. Currently, there is

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limited research on perceptual assessment in speech therapy. Therefore, in order to further this area of research, we will conduct a perceptual analysis on a case of post-stroke dysarthria.

Keywords: Dysarthria; Perceptual analysis; Classification; case study; Diagnosis and Care Approach.

INTRODUCTION

Dysarthria is a motor speech disorder that affects the muscles responsible for speech projection. It often occurs as a result of damage or dysfunction to the nervous system, leading to difficulties in articulation, pronunciation, and overall intelligibility. In this article, we will explore the classification of dysarthria, the assessment process, and the various techniques used in speech therapy rehabilitation for individuals in cases with dysarthria.

To better understand and categorize the various types of dysarthria, many researchers and clinicians have developed classification systems. One such system, known as the Witherspoon-Darly classification, is widely used in the part of speech pathology. This classification system provides valuable insights into the different manifestations and characteristics of dysarthria, thereby aiding in diagnosis and treatment planning (Darley, Aronson and Brown 1969).

Research Problem

Speech disorders, particularly dysarthria, are common issues accompanying various neurological conditions. Despite the classification of different types of dysarthria, accurately distinguishing between them remains a significant challenge in the medical field. Given the question of which clinical references are used to differentiate types of dysarthria, there emerges a need to explore the clinical tools and criteria employed in this area and analyze their diagnostic accuracy and efficiency in guiding treatment. This research aims to examine the clinical classification systems used in diagnosing dysarthria, with a focus on the Mayo Clinic system, to determine whether these classifications clearly reflect the differences between types and contribute to improved treatment effectiveness.

Based on this research problem, the question can be formulated as follows:

Which clinical reference allows us to distinguish between the different types of dysarthria?

Importance of the Study

The importance of the current study lies in: its contribution to improving the diagnosis of speech disorders associated with neurological conditions, especially dysarthria, thereby enabling more accurate and effective treatment plans. Understanding the distinctions between types of dysarthria using reliable clinical references, and, can help reduce diagnostic errors and guide treatment more effectively, ultimately enhancing the quality of life for patients suffering from these disorders.

Reasons for Choosing the Topic

The reason for choosing this topic stems from the urgent need to improve diagnostic tools and classification methods for types of dysarthria, given the impact of these disorders on patients' quality of life and the diagnostic and treatment challenges faced by medical professionals. By focusing on assessing the clinical classification system and distinguishing the different types of dysarthria, a deeper understanding of these disorders can be achieved, leading to more accurate and effective therapeutic strategies.

Chapter I

Classification dysarthria

The classification of dysarthria has evolved over time, with significant contributions from various studies that help clinicians understand and diagnose this complex condition. Recent research has focused on refining classification systems and enhancing assessment methodologies.

1. **Witherspoon-Darley Classification**: This system categorizes dysarthria into six main types based on underlying etiologies and speech characteristics. Each type is associated with specific speech deficits and can guide treatment approaches.
2. **Recent Studies**: A special issue in *Brain Sciences* discusses advances in understanding dysarthria through auditory-perceptual, acoustic, and physiologic assessments. It emphasizes the need for integrating new technologies and methodologies into clinical practice to improve diagnostic accuracy and treatment outcomes (Wolfram, Anja, & Theresa, 2023)
3. **Differential Diagnosis**: A new approach using the ELMS analysis (Etiology, Lesion site, Motor signs, Speech deficits) has been proposed to aid in accurately diagnosing dysarthria. This framework helps clinicians correlate symptoms with the type of dysarthria by organizing clinical information systematically (Paul & Blanchet, 2019)
4. **Case Studies**: Case studies play a crucial role in illustrating the characteristics of different dysarthria types. For example, a study involving a 39-year-old man with stroke-induced dysarthria provided insights into the speech patterns and challenges faced by individuals with this condition. Such case analyses help in understanding the variability and complexity of dysarthria, facilitating better clinical practice (Wolfram, Anja, & Theresa, 2023)
5. **Innovative Assessment Methods**: Research has also explored the role of digital health technologies and machine learning in assessing dysarthria profiles. This includes the potential for virtual-reality-based training systems to enhance speech therapy outcomes (Cummings, 2016)

1- Understanding the Witherspoon- Darley classification

The Witherspoon-Darley classification was developed by French and American speech pathologists, Frédéric Darley and Luella Witherspoon, in the 1940s. Their classification system categorizes dysarthria based on the underlying etiology or cause, as well as on the specific speech characteristics exhibited by the individual.
The Witherspoon-Darly classification system recognizes six main types of dysarthria:

2- Types of dysarthria

2-a. Flaccid dysarthria: Is characterized by weakness, reduced muscle tone, and decreased coordination of the muscles involved in speech production. it is often caused by damage of dysfunction in the lower neurons or cranial nerves or spinal neurons, leading to difficulties in articulation, phonation, and resonance, hypernasality, as the weakened velopharyngeal muscles fail to close the nasopharynx properly. Other common features include breathy and hoarse voice quality, imprecise articulation, and reduced loudness. Individuals with flaccid dysarthria may also exhibit abnormal reflexes, such as the gag reflex or tongue fasciculations. A 2022 study assessed orofacial muscle strength in 79 individuals with various types of dysarthria (including flaccid dysarthria) compared to 33 healthy controls. Results indicated significant muscle weakness in the tongue and lips of participants with flaccid dysarthria, especially in tasks like anterior tongue elevation and lip compression. This study supports that flaccid dysarthria affects specific muscle groups due to lower motor neuron impairments, directly impacting speech quality (Wolfram, Anja, & Theresa, 2023), A 2024 study focused on patients with ALS (amyotrophic lateral sclerosis) noted cortical thinning in brain regions involved in speech planning and motor control among those with flaccid dysarthria characteristics. Participants exhibited speech symptoms like breathy voice and hypernasality, indicative of flaccid dysarthria. This research highlights the neurological underpinnings of speech issues in flaccid dysarthria, especially in conditions like ALS (Zaninotto, Makary, , Rowe, , & Eshghi,, 2024)

2-b. Hypokinetic dysarthria: Hypokinesic dysarthria is associated with disorders of the basal ganglia, notably parkinson's disease. It is characterized by reduced movement, muscle rigidity, and tremors. Speech symptoms of hypokinetic dysarthria include reduced loudness (hypophonia), monotonous speech, a rapid rate, and imprecise articulation, often resulting in a monotonous or robotic quality of speech. Additionally, individuals may experience difficulty initiating speech due to the reduced range of movement in the articulatory muscles (Darley, Aronson and Brown 1975).

2-c. Hyperkinetic dysarthria: Hyperkinetic dysarthria is characterized by involuntary muscle movements, primarily caused by disorders affecting the basal ganglia, such as Huntington's disease or dystonia. Speech symptoms of hyperkinetic dysarthria vary depending on the specific disorder but often include abnormal vocal quality, such as strained or strangled voice, irregular articulation, and excessive orofacial movements.

Individuals with hyperkinetic dysarthria may also present with involuntary vocalizations or speech interruptions (Portnoy 1979).

2-d. Ataxic dysarthria: ataxic dysarthria is characterized by incoordination and a lack of muscle control, resulting from damage to the cerebellum or its connections. Speech characteristics of ataxic dysarthria include irregular articulatory breakdowns, inconsistent speech rate, irregular prosody, and excessive variability in loudness and Pitch. Individuals with ataxic dysarthria may also display problems with precise and accurate articulation, resulting in a drunken or slurred speech quality.

2-e. Spastic dysarthria: Spastic dysarthria is characterized by difficulties with coordination and control of fine motor movements required for speech. It is often caused by damage or dysfunction in the cerebellum, leading to irregular, imprecise, and uncoordinated speech.

2-f. Mixed dysarthria: In some cases, individuals may exhibit a combination of different dysarthria types, which is referred to as mixed dysarthria. Mixed dysarthria occurs when there is damage or dysfunction in multiple areas of the nervous system responsible for motor speech. The specific characteristics of mixed dysarthria will depend on the combination of the underlying dysarthria types present.

Witherspoon and Darley's classification system provides valuable insights into the distinct characteristics of different types of dysarthria. By understanding the specific features associated with each type, speech therapists can tailor their interventions to address the unique needs of individuals with dysarthria. It is essential to note that accurate diagnosis and assessment by a qualified speech therapist are crucial in determining the specific type of dysarthria and designing a targeted treatment plan.

Another reference most used today is that of the work of Darley et al (1969a, b; 1975). Based on a perceptual analysis, it offers a description of the anomalies according to the different physiological situations disturbed (breathing, phonation, resonance, articulation, prosody). It determines the motor systems affected (ventilatory, phonatory, velopharyngeal, articulatory) and the type of the impairments concerned (weakness, slowness, spasticity, incoordination, etc.). Patients are described based on their medical diagnosis (Darley, Aronson and Brown 1975).

3- Perceptual analysis of dysarthria

Perceptual analysis is widely used in clinical practice to assess motor language disorders such as dysarthria (Duffy 2013). Unfortunately, there is no standardized tool available in Arabic. Many speech therapists who examine and treat people with dysarthria regularly attempt to analyze the perceptual characteristics of voice and speech. This analysis aims to determine whether speech is indeed pathological, and to define therapeutic management objectives, and to measure language development during the long-term treatment of patients. Like, it makes it possible to quantify the severity of the disorder, and the main anomalies and the effector organs concerned with these anomalies (Hanson and Metter 1980). However, seven categories must be evaluated by

speech therapists, namely pitch, intensity, vocal quality, breathing, prosody, articulation, and intelligibility criteria, illustrated in the table below (Linebaugh 1979):

Height

1. Height
2. Height break
3. Monotony
4. Vocal tremor

Intensity

5. Mono-intensity
6. Excessive variation in intensity
7. Intensity decay
8. Instability of intensity

Voice

9. Hoarse voice
10. Wet voice
11. Breathy voice (continuous)
12. Breathy voice (intermittent)
13. Forced voice
14. Voice Stops
15. Hypernasality
16. Hyponasality
17. Nasal emission

Breathing

18. Forced inspiration-exhalation
19. Audible Inhale
20. Noise at the end of expiration

Prosody

21. Flow
22. Short sentences
23. Increased flow (segment)
24. Increased flow (overall)
25. Decreased emphasis
26. Variable flow
27. Lengthening breaks
28. Inappropriate silences
29. Paroxysmal accelerations

Global criteria

30. Intelligibility
31. Overemphasis

Joint

32. Imprecision of consonants
33. Lengthening phonemes
34. Phoneme repetition
35. Articulatory damage
36. Vowel distortions

This is how a projection of the anomalies concerning the symptoms of the types of dysarthria

Table 1. The symptoms of the types of dysarthria

	Flasque	Spastique	Ataxique	Hypokinétique	Hyperkinétique (chorée)	Hyperkinétique (dystonie)	Mixte
Hauteur		X		X			X
Rupture de hauteur		X					
Monotonie	X	X	X	X	X	X	X
Mono Intensité	X	X	X	X	X		X
Variation excessive d'intensité					X	X	
Voix rauque	X	X	X	X	X	X	X
Voix soufflée	X Continue	X Intermittente		X Continue			X Continue
Voix forcée		X			X	X	X
Arrêts vocaux						X	
Hypernasalité	X	X			X		X
Emission nasale	X						X
Inspiration audible	X						X
Débit		X	X			X	X
Phrases courtes	X	X			X	X	X
Diminution de l'accentuation		X		X	X	X	X
Débit variable				X	X		
Allongement des pauses			X		X	X	X
Silences inappropriés				X	X	X	X
Accélérations paroxystiques				X			
Accentuation excessive		X	X		X		X
Imprécision des consonnes	X	X	X	X	X	X	X
Allongement des phonèmes			X		X	X	X
Dégradations articulatoires			X		X	X	
Distorsion des voyelles		X	X		X	X	X

Source: (Auzou, 2009)

In this regard, speech therapy tests concern diadocokinesis tests which provide information on the capacity for speed or regularity of the motor system. Reflex tests, namely the chewing reflex, swallowing reflex and oral reflexes. Facial musculature test such as pursing and stretching the lips, moving the mandible, moving the tongue, etc. Even breathing which concerns crescendos, diminuendos, breathing/phonation synchronization. Phonation test with production of a high and low sound, going up and down the scale on an /a:/, pronouncing a sound out loud. Articulation; by emitting initial consonants, vowels, words and phrases. As well as a speech intelligibility test with a reading and spontaneous speech test, and finally the prosody test in order to see the maintenance and increase of flow, the use of appropriate intonation, use of different types of emphasis, maintaining rhythm (Kent, Netsell and Abbs 1979)

To implement this classification, we applied it to a pathological case.

Chapter II

Case study on acquired dysarthria

History of the disease

A.K. is a 34-years-old, businessman in the Sonatrach company, with a history of high blood pressure for 6 years, under treatment. Married, no children.

A.K. has no family history of neurological disease. The first sign of arterial hypertension was at the age of 28. Since then, a cardiologist has treated him.

In April 2023, A.K. had a cerebrovascular accident an ischemic which resulted in an intracranial hematoma and hemiplegia on the right side, As a result of the stroke, A.K. developed upper and lower right facial weakness, dysphonia, and dysarthria of cerebral origin. A.K.'s relatives noted that his speech was some what nasal and difficult to understand after the stroke. The palatal damage was attributed to flaccid weakness. All movements related to articulation, particularly those involving the palate, were impacted.

A magnetic resonance imaging (MRI) scan reveals bulbar and supra bulbar lesions.

Speech assessment

A speech and language therapy assessment was made according to Darley's criteria and the results were as follows:

A.K.'s speech muscles were affected on the right side, with spastic weakness of the lips and tongue.

Breathing at rest: normal

Respiratory flow: slow

Breathing during speech: without abnormality

Flow during speech: slow

The patient speaks on exhalation

Height: too low

No break in height

Intonation: normal, monotonous

Voice tone: hypernasal

Voice quality: breathy, weak, irregular.

Flaccid weakness of the palate

Facing at rest: falling to the right

Lip tone: lowered

Tongue at rest: normal, deviated to the right

Speech rate: too slow

Rhythm of speech: staccato, with elongations

Emphasis: insufficient

Explosive and fricative consonants: weak

Articulation: slow and difficult

Based on these symptoms, it can be concluded that A.K.'s slow articulator movements contributed to the overall slowness of his speech. There was articulatory imprecision in the production of consonants and vowels, which was linked to the slowness of movement and weakness of articulation. The patient maintained a consistent volume and pitch throughout the speech. However, there was an unusual high pitch noted. Additionally, AK presented with audible nasal emission. Excessive nasal resonance was evident during vocal segments.

The patient's speech was made less understandable by these aberrant features. AK's inefficient use of air resulted in short sentences and his slow articulatory movements further limited the length of his utterances. The lack of variation in pitch and loudness, as well as poor breath control, compromised the use of emphasis, rhythm, and intonation. AK's ability to distinguish between vowels was limited due to their breathy voice and excessive nasal resonance.

Speech therapy

La rehabilitation d'A.K. should take into account all parameters of speech production, with a particular emphasis on the control of breathing and its coordination with phonation. However, we started with work on facial musculature, specifically addressing the use of force, amplitude, and speed of movements of the tongue and lips. Additionally, tantric exercises were employed to improve the mobility of the soft palate. Once we achieved respiratory and phonatory control, as well as speed and coordination of facial musculature, we began

work on the articulation of sound into syllables, expressions, and phrases. Finally, and lastly, we conducted exercises on prosodic variation and intonation, rhythm, and pace.

CONCLUSION

The studies carried out by Darley and his colleagues have really helped to understand and differentiate between different types of dysarthria. They demonstrated the potential of combining knowledge of neuroanatomy, clinical neurology and speech pathology to provide a perceptual analysis and ultimately extract a diagnosis of the type of dysarthria.

Based on Darley's criteria and the table of dysarthria types, we conclude that patient A.K. had a mixed flaccid-spastic dysarthria.

AK's slow speech and articulatory imprecision could be attributed to spasticity that limits the range, force, and speed of articulatory movements. Poor adduction and abduction of the vocal folds, manifested by a breathy voice and audible inspiration, was suggestive of a flaccid state of the vocal folds. However, indirect laryngoscopy was not performed and therefore this impression could not be confirmed. AK's shortness of breath could also be explained by spasticity. The spastic condition of the vocal cords, manifested by extreme cord tension and reduced elasticity.

The evaluation of AK's speech focused on the functioning of speech production and the impact of deviant speech parameters on A.K.'s intelligibility. The functioning of physiological mechanisms such as phonation and breathing and the impact of alterations in these mechanisms on the speaker's intelligibility correspond to Darley's criteria.

A.K's speech therapy objective was based on 3 axes: breathing, phonation and prosody. Prosody relies on accurate voicing and proper breath control.

Breathing exercises should be done before exercises involving voice modulation. The therapy at A.K. is based on facial musculature work, which involves exercises to move the tongue and lips, as well as the mobility of the soft palate.

After a two-month rehabilitation period, a significant improvement was observed in the strength of the facial muscles and the mobility of the palate, resulting in a reduction in vocal nasality.

Subsequently, articulation and diadocokinesis exercises were conducted, which improved the patient's intelligibility.

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