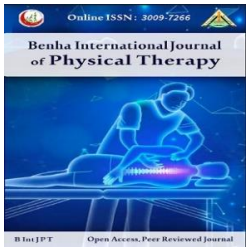
B Int J PT 2025 Jun;3(1):100 -112. DOI: 10.21608/BIJPT.2025.355750.1061

Benha International Journal of Physical Therapy

Online ISSN: 3009-7266 Home page: https://bijpt.journals.ekb.eg/



Original research

The role of kinesiotape in speech rehabilitation and oral motor improvement in children with developmental Apraxia: A Case Control Study

Rana E Amer [1,*], Walid T Mansour [2]

1 A PhD student Department of Educational and Psychological Sciences Special Education Faculty of specific Education Benha University

2 Professor of physiotherapy for neurological diseases and surgery, and dean of the Faculty of Physiotherapy, Benha University

Correspondene to:** ***Rana E Amer, *A* **PhD student Department of Educational and Psychological Sciences Special Education Faculty of specific Education Benha University**

E-mail:

rana.amerr642@gmail.com

Article history:

Submitted: 21-12-2024

Revised: 25-01-2025

Accepted: 14-02-2025

Abstract:

Background: Kinesio Tape (KT) is a flexible tape, can support and stimulate muscles, providing sensory feedback to enhance muscle awareness and coordination. **Purpose:** This study aims to assess the effectiveness of KT combined with oral motor training in improving speech performance and oral motor skills. **Methods:** A two-group experimental design was carried out on 10 children with developmental apraxia, divided into two equal groups: an experimental group and a control group. The intervention consisted of KT application, oral motor training, and sensory stimulation, provided to the experimental group, while the control group received regular speech therapy. The intervention lasted six months, with progress measured before and after using the assessment tools developed by the researcher. **Results:** There was a significant improvement in speech clarity, fluency, sound articulation, oral motor coordination, and oral muscle strength following the intervention with KT ($p < 0.05$). Specifically, speech clarity improved by 60.87%, oral muscle strength by 58.33%, and sound articulation by 59.09%, Sensory processing also improved, particularly in responses to tactile stimuli ($p = 0.042$, effect size = 1.22). Post-intervention analysis showed a clinically meaningful improvement in verbal and motor performance metrics. KT had the most significant positive impact ($p = 0.005$, effect size = 2.55) on verbal articulation, oral muscle strength, and motor coordination. **Conclusion:** KT was considered as an effective tool for improving verbal and oral motor performance in children with apraxia, based on the results showing significant improvements in speech clarity, fluency, articulation, and oral muscle strength.

Keywords: Developmental Apraxia, Kinesio Tape, Speech Rehabilitation, Oral Motor Improvement.

Introduction

Childhood Apraxia of Speech (CAS) is a motor speech disorder where individuals struggle to plan and coordinate the complex movements needed for speech. This condition, often linked to damage in brain regions like the left subcortex, insula, and Broca's area, results in speech errors such as substitutions, additions, repetitions, and omissions of sounds [1]. These errors are most noticeable at the beginning of words and in sounds requiring

intricate muscular coordination, and they worsen with word length and complexity. The precise neural mechanisms behind CAS remain unclear, with possible causes ranging from vascular lesions to tumors [2,3].

Verbal apraxia, a subtype of CAS, refers to difficulty in performing voluntary, complex movements required for speech, even when natural coordination exists between the speech organs. It is not due to muscle weakness but rather problems in coordinating and organizing the speech motor movements. Common characteristics of verbal apraxia include a reduced speech rate, distorted sounds, and incorrect substitutions, which are more pronounced in longer or more complex speech segments. This disorder may occur alongside aphasia (language disorder) and dysarthria (motor speech disorder) [4,5,6].

Speech disorders in CAS can also result from structural and physiological changes in the oral cavity and facial muscles, though not all speech errors are directly linked to these changes. These disorders can be developmental or arise from trauma, injury, or neurological conditions. Treatment often involves enhancing motor planning and coordination to improve speech production [7,8].

A promising therapy for CAS is Kinesiology Tape (KT), a flexible, water-resistant tape used in neurological rehabilitation. KT provides support to muscles and joints without restricting movement, making it suitable for improving proprioception and motor function. KT is applied to stimulate sensory receptors, aiding in the activation of muscles and enhancing coordination between muscle groups. It works by creating a tactile stress field on the skin that affects mechanoreceptors and deep sensory receptors in the muscles, potentially reducing pain and improving motor function [9,10,11]. KT has various types based on application techniques, including Standard KT, Advanced KT (for deep muscle stabilization), Lymphatic KT (to promote fluid flow and reduce swelling), and Functional KT (to support muscle movement in daily activities). In the context of CAS, KT is applied to the face and oral muscles to enhance deep sensory feedback, stabilize muscles, and improve coordination of the muscles involved in speech, such as the tongue, lips, and jaw. By supporting the muscles and balancing muscle activity, KT aids in improving oral motor harmony and flexibility [12,13].

The therapeutic application of KT helps children with verbal apraxia gradually improve their ability to execute the complex motor tasks necessary for speech.

This study aimed to assess the effectiveness of KT combined with oral motor training in improving speech performance and oral motor skills.

Methods

Participants:

The study included 10 children, divided into two groups: an experimental group and a control group, with 5 children in each group. A structured intervention program was implemented over a period of 6 months, where the experimental group received KT application combined with oral motor training and sensory stimulation activities, while the control group participated in standard speech therapy without the use of KT. Each session lasted between 30 to 45 minutes, occurring three times a week. The assessment tools used included a verbal performance evaluation form, an oral motor performance assessment form, and a sensory oral processing evaluation form, all developed by the researcher.

The experimental group received the intervention, which involved the application of KT along with structured oral motor training and sensory stimulation activities. The control group received regular speech therapy without the use of KT. The KT was applied to specific areas of the face and jaw to provide sensory feedback and enhance motor coordination. The sessions also included oral motor exercises targeting the lips, tongue, and jaw to improve oral motor skills and speech production. In addition, sensory stimulation activities were integrated to enhance sensory awareness and coordination between the oral muscles. These activities included direct sensory contact using specialized tools to stimulate areas around the mouth, as well as light pressure on the face and mouth to enhance muscle response. Visual sensory stimulation was introduced through mirrors to help the children monitor their mouth movements during the exercises, along with auditory sensory stimulation using speech exercise sounds. Furthermore, the environment was adjusted to stimulate various senses, such as changing seating positions or adding visual and auditory stimuli,

providing additional cues to enhance the coordination between the senses and muscles.

The progress of the children was assessed before and after the intervention using verbal performance evaluation forms, oral motor performance assessments, and sensory oral processing questionnaires. The results were analyzed to determine the impact of KT on speech clarity, motor coordination, and sensory processing in children with developmental apraxia. Progress was measured pre- and post-intervention using the aforementioned assessment tools. The assessment tools included a verbal performance evaluation form to assess speech clarity, fluency, and articulation; an oral motor performance assessment form to evaluate the strength, coordination, and range of motion of the speech organs (e.g., lips, tongue, jaw); and a sensory oral processing evaluation form to examine sensory responses related to oral motor functions.

Therapeutic tools included KT: flexible and elastic therapeutic tape used for application on the facial and oral muscles; oral massage tools to stimulate sensory awareness and reduce muscle tension; and training materials for oral motor exercises, including visual and tactile aids such as mirrors, resistance tools, and chewing devices. Program materials included a structured intervention program manual, prepared by the researcher, detailing the step-by-step application of KT and accompanying exercises, as well as logbooks for tracking progress, including daily records of participant responses to the intervention. Measurement instruments included pre- and post-intervention evaluation forms to measure the effectiveness of the program, and video recording equipment for documenting changes in oral motor and speech performance over time (optional, based on participant consent).

Preparing the tape involved using flexible kinesiology tape and cutting it into appropriate longitudinal strips. The skin was cleaned thoroughly before applying the tape, ensuring the area around the lips and jaw was dry and free from oils. The tape was applied gently on the lips from the outer corner towards the center to support movement during speaking or breathing, and on the jaw from the lower jaw to the chin line to provide stability during muscle movements. The tape was applied in a slightly stretched position to enhance motor coordination and encourage sensory response, ensuring it did not cause discomfort or pain for the child.

A comprehensive clinical evaluation involved gathering detailed information about the child's medical and developmental history, along with clinical observations of speech and movement patterns. Standardized tests were used to measure speech and motor abilities, such as speech and language evaluation tests. Clinical observation focused on the child's performance in speech and movement tasks to identify abnormal patterns or difficulties in motor coordination. A sensory-nervous assessment evaluated sensory and motor capabilities related to speech, including touch, pressure, and movement. Functional assessment analyzed the impact of motor speech disorder on the child's daily communication and activities.

Sensory-motor awareness training aimed at enhancing the child's ability to recognize the required movements for speech and improving the motor coordination of speech organs. Progressive speech training began with simple words and progressed to more complex words and sentences, focusing on articulation accuracy[14,15]. The use of assistive techniques, such as hand gestures or pictures, supported communication and understanding. Motor coordination training focused on improving the coordination between respiratory, vocal, and motor movements necessary for speech production, while phonological awareness training helped the child recognize and differentiate sounds, contributing to improved speech. Tailoring therapy to the individual needs of each child, with an emphasis on repetition and consistent practice, was a key approach to achieving the best results

Ethics approval and consent to participate:

The study received approval from the Ethical Committee and Informed consent was obtained from the parents or guardians before the commencement of the study.

Figures 1*: show the clinical application of KT in oral motor rehabilitation for children with developmental apraxia*

An explanatory table of what was applied"

Condition	Problem	Taping Method	Sounds/Letters Improved After Treatment	Goal	Auxiliary Exercises
Dental Closure Issue	Excessive tension in the jaw and lip muscles preventing natural mouth movements.	- Two strips from the corners of the mouth to the middle of the cheek (light tension 10-15%). - Horizontal strip below the chin (light tension).	Improving articulation of sounds like /b/, /m/, /f/ with clear, correct production.	Reduce muscle tension and increase lip and jaw flexibility.	Lip compression exercise and gently blowing into a cup of water.
Open Mouth and Drooling	Weakness in the mouth and lower jaw muscles, leading to difficulty closing the	- Two angled strips from the corners of the mouth to the middle of the lower jaw	Support for sounds requiring lip closure and correcting distorted pronunciation.	Strengthen muscles and promote natural mouth closure.	Balloon blowing exercise and sipping water through a straw.

	mouth and drooling.	(light tension 10-20%). - Horizontal strip below the lower lip (medium tension 20%). - Small strip below the chin.			
Constant Smile Position	Excessive tension in the side muscles and weakness in the lip closure muscles.	- Two horizontal strips from the corners of the mouth to the middle of the cheek (light tension 10%). - Arch-shaped strip below the lower lip (medium tension 20%).	Improve articulation of sounds that require balanced lip opening and closure.	Reduce lateral tension and restore natural lip coordination.	Straw sucking exercise with light resistance.
Unstable Jaw	Jaw instability and difficulty controlling mouth movements during	- Two angled strips from beneath the chin to the sides (medium tension 20%). -	Enhance control of sounds requiring stability, such as /t/, /d/.	Improve muscle stability and provide motor control for the jaw.	Slow and steady mouth opening and closing exercise.

	speech and eating.	Horizontal strip below the lower lip (light tension).			
Involuntary Lip Sucking	Over-sucking or protruding lips due to weak muscle control.	- Horizontal strip below the lower lip (medium tension). - Angled strips on both sides of the mouth to stimulate the lip closure muscles.	Improve articulation of sounds requiring lip control, such as /b/, /f/.	Reduce random movements and enhance muscle control.	Light lip pressure with fingertips.
Involuntary Tongue Thrust	Pushing the tongue outside the mouth during swallowing or speaking.	- Small strip below the chin towards the neck (medium tension). - Arch-shaped strip below the upper lip to encourage lip closure.	Improve articulation of sounds like /l/, /r/, and back sounds.	Reduce abnormal tongue movements and enhance muscle balance.	Slowly push the tongue back into the mouth exercise.
Tongue Movement Difficulty (Ankyloglossia)	Difficulty in tongue movement affecting speech and eating.	- Small strip below the chin downwards to stimulate muscles. - Vertical	Improve articulation of sounds that require fine tongue movements, such as /l/, /ʃ/.	Strengthen muscles responsible for tongue movement and improve its flexibility.	Circular tongue movement exercise within the mouth.

		strip on the throat (as needed).			
Laryngeal Weakness and Voice Disorders	Weak control of vocal cords resulting in a weak or strained voice.	- Angled strip on both sides of the neck from the larynx to the base of the neck (medium tension).	Improve voice sounds and tone and increase clarity of speech.	Improve vocal cord control and reduce muscular strain.	Deep breathing exercises and vocal training.
Swallowing Difficulty (Dysphagia)	Weakness in throat and mouth muscles obstructing the swallowing process.	- Vertical strip below the chin towards the neck to stimulate swallowing muscles. - Two small strips on both sides of the throat to support the larynx.	Improve articulation during swallowing for sounds like /ʁ/, /χ/.	Strengthen swallowing muscles and enhance their function.	Slow water drinking exercise with the head slightly tilted.

Data analysis

The data collected from the assessments before and after the intervention were analyzed using appropriate statistical methods. Descriptive statistics were first used to summarize the demographic characteristics of the participants and their baseline measurements. To evaluate the impact of the intervention, a paired t-test was conducted to compare pre- and post-intervention scores within each group (experimental and control). Additionally, an independent t-test was used to compare the differences between experimental and control groups post-intervention. ANOVA (Analysis of Variance) was performed to assess the significance of changes across various variables, such as speech clarity, fluency, sound articulation, oral muscle strength, and motor coordination.

Results

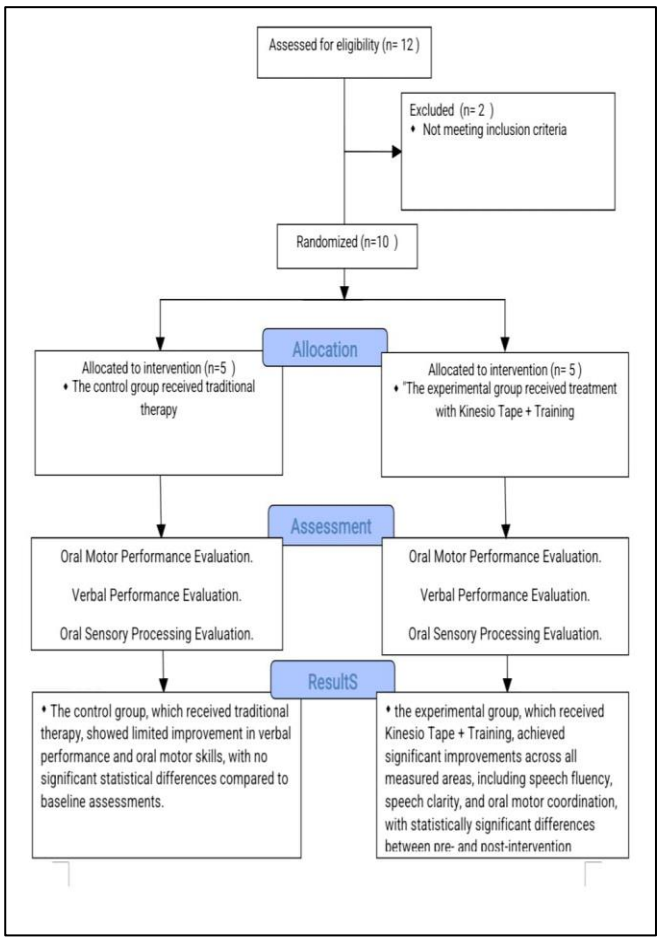


Figure 2: Flow chart *of the study*

***Subject characteristics*:**

Regarding verbal assessment, the mean of speech clarity was 2.3±0.5 in experimental Group (Pre), 3.7±0.6 in experimental group (Post), 2.5±0.4 in control group (pre) and 2.6±0.5 control group (post), speech fluency was 2.5±0.4 in experimental Group (Pre), 3.6±0.5 in experimental group (Post), 2.7±0.5 in control group (pre) and 2.8±0.4 control group (post), sound articulation was 2.2±0.4 in experimental Group (Pre), 3.5±0.7 in experimental group (Post), 2.4±0.5 in control group (pre) and 2.5±0.5 control group (post). Regarding performance assessment, Oral muscle strength was 2.4±0.6 in experimental Group (Pre), 3.8±0.5 in experimental group (Post), 2.6±0.5 in control group (pre) and 2.7±0.4 control group (post), oral movement coordination was 2.3±0.5 in experimental Group (Pre), 3.6±0.6 in experimental group (Post), 2.5±0.4 in control group (pre) and 2.6±0.5 control group (post), and range of motion was 2.2±0.5 in experimental Group (Pre), 3.5±0.6 in experimental group (Post), 2.3±0.4 in control group (pre) and 2.5±0.5 control group (post). **Table 1**

Table 1: Verbal and oral motor performance assessment - pre and post intervention

	Experimental Group (Pre)	Experimental Group (Post)	Control Group (Pre)	Control Group (Post)
Verbal assessment				
Speech Clarity	2.3±0.5	3.7±0.6	2.5±0.4	2.6±0.5
Speech Fluency	2.5±0.4	3.6±0.5	2.7±0.5	2.8±0.4
Sound Articulation	2.2±0.4	3.5±0.7	2.4±0.5	2.5±0.5
Performance Assessment				
Oral Muscle Strength	2.4±0.6	3.8±0.5	2.6±0.5	2.7±0.4
Oral Movement Coordination	2.3±0.5	3.6±0.6	2.5±0.4	2.6±0.5
Range of Motion	2.2±0.5	3.5±0.6	2.3±0.4	2.5±0.5

Data are presented as mean± SD

Regarding oral sensory processing assessment, the mean of response to tactile stimuli was 2.3 ± 0.5 in experimental Group (Pre), 3.7 ± 0.6 in experimental group (Post), 2.5 ± 0.5 in control group (pre) and 2.6 ± 0.4 control group (post). The mean value of response to thermal stimuli was 2.4 ± 0.5 in experimental Group (Pre), 3.6 ± 0.6 in experimental group (Post), 2.6 ± 0.5 in control group (pre) and 2.7 ± 0.5 control group (post). The mean value of response to gustatory stimuli was 2.2 ± 0.6 in experimental Group (Pre), 3.5 ± 0.5 in experimental group (Post), 2.3 ± 0.4 in control group (pre) and 2.5 ± 0.4 control group (post). The mean value of Response to Kinetic Stimuli was 2.3 ± 0.5 in experimental Group (Pre), 3.6 ± 0.5 in experimental group (Post), 2.4 ± 0.4 in control group (pre) and 2.5 ± 0.5control group (post). **Table 2**

Table 2: Oral sensory processing assessment - pre and post intervention

	Experimental group (Pre)	Experimental group (Post)	Control group (Pre)	Control group (Post)
Response to Tactile Stimuli	2.3±0.5	3.7±0.6	2.5±0.5	2.6±0.4
Response to Thermal Stimuli	2.4±0.5	3.6±0.6	2.6±0.5	2.7±0.5
Response to Gustatory Stimuli	2.2±0.6	3.5±0.5	2.3±0.4	2.5±0.4
Response to Kinetic Stimuli	2.3±0.5	3.6±0.5	2.4±0.4	2.5±0.5

The mean value of speech clarity was 2.3±0.5 in experimental Group (Pre), 3.7±0.6 in experimental group (Post), 2.5±0.4 in control group (pre) and 2.6±0.5 control group (post),

Cohen's d was 2.0, percentage change (experimental group) was 60%. The mean value of speech fluency was 2.5±0.4 in experimental Group (Pre), 3.6±0.5 in experimental group (Post), 2.7±0.5 in control group (pre) and 2.8±0.4 in control group (post), Cohen's d was 1.78, percentage change (experimental group) was 44%. The mean value of sound articulation was 2.2±0.4 in experimental Group (Pre), 3.5±0.7 in experimental group (Post), 2.4±0.5 in control group (pre) and 2.5±0.5 control group (post), Cohen's d was 1.64, percentage change (experimental group) was 59%. The mean value of oral muscle strength was 2.4±0.6 in experimental Group (Pre), 3.8±0.5 in experimental group (Post), 2.6±0.5 in control group (pre) and 2.7±0.4 control group (post), Cohen's d was 2.44, percentage change (experimental group) was 58%. The mean value of oral movement coordination was 2.3±0.5 in experimental Group (Pre), 3.6±0.6 in experimental group (Post), 2.5±0.4 in control group (pre) and 2.6±0.5 control group (post), Cohen's d was 1.82, percentage change (experimental group) was 57%. **Table 3**

Table 3: Clinical measurement results with effect size and percentage changes

Measure	Experimental Group (Pre)	Experimental Group (Post)	Control Group (Pre)	Control Group (Post)	Cohen's d	Percentage Change (Experimental Group)
Speech Clarity	2.3±0.5	3.7±0.6	2.5±0.4	2.6±0.5	2.0	60%
Speech Fluency	2.5±0.4	3.6±0.5	2.7±0.5	2.8±0.4	1.78	44%
Sound Articulation	2.2±0.4	3.5±0.7	2.4±0.5	2.5±0.5	1.64	59%
Oral muscle strength	2.4±0.6	3.8±0.5	2.6±0.5	2.7±0.4	2.44	58%
Oral movement coordination	2.3±0.5	3.6±0.6	2.5±0.4	2.6±0.5	1.82	57%

Speech clarity and fluency, sound articulation, oral muscle strength, oral movement coordination and response to tactile stimuli were a significant between experimental and control group. Oral movement coordination and response to thermal stimuli were insignificant between experimental and control group. **Table 4**

Table 4: ANOVA Results

	Type of Measure (Experimental/Control)	F Value	P
Speech clarity	**Experimental/Control**	4.56	**0.033***
Speech fluency	**Experimental/Control**	3.21	**0.049***
Sound articulation	**Experimental/Control**	5.67	**0.012***
Oral movement coordination	**Experimental/Control**	2.95	0.063
Oral muscle strength	**Experimental/Control**	6.45	**0.004***
Oral movement coordination	**Experimental/Control**	4.22	**0.027***
Response to tactile stimuli	**Experimental/Control**	3.89	**0.042***
Response to thermal stimuli	**Experimental/Control**	2.34	0.089

* Significant p value <0.05.

The results showed statistically significant improvements, indicating that the intervention with KT had a positive impact on both verbal and motor performance. Multiple regression analysis was applied to examine the relationship between KT application and improvements in verbal and motor performance. A significant positive effect was observed, with a p-value of 0.005. Age and gender did not significantly influence the overall improvement, as their p-values were above 0.05. Variables such as oral muscle strength and motor coordination showed significant positive effects with p-values below 0.05. The significance level was set at $p < 0.05$, indicating that results with p-values below this threshold were considered statistically significant. **Table 5**

Table 5: Multiple Regression Analysis Results

Independent Variable	Beta (β)	t Value	P	Adjusted R^2
Age	0.22	1.67	0.101	0.35
Sex	0.10	0.92	0.376	0.35
KT	0.45	3.23	**0.005***	0.35
Oral Muscle Strength	0.39	2.91	**0.011***	0.35
Oral Motor Coordination	0.33	2.11	**0.043***	0.35

Discussion

KT, a flexible therapeutic tape often used in physical therapy, has gained attention in various rehabilitation areas, including speech therapy, particularly for children with developmental apraxia of speech (DAS). Developmental apraxia of speech is a motor speech disorder where children struggle with planning and coordinating the movements required for speech. While KT is traditionally used for musculoskeletal issues, some speech therapists have explored its potential role in improving oral motor function and speech production in children with DAS [16].

KT may help support and stabilize muscles involved in oral motor tasks, such as the lips, tongue, and jaw. By providing sensory input, it can increase awareness of these muscles and potentially improve coordination. Children with DAS often have difficulty with motor planning for speech, and KT might assist by providing proprioceptive feedback to the muscles involved in speech production [17]. Proprioceptive feedback from KT may help children with apraxia improve their awareness of oral structures, such as the lips, tongue, and palate. This sensory input could promote better control over muscle movements required for articulation and speech production [18].

Some children with apraxia experience weakness or underdeveloped oral motor muscles. KT can provide gentle support to these muscles, potentially improving their ability to perform required movements for speech. For children who struggle with proper tongue placement and jaw stability during speech, KT could provide subtle external support, helping them achieve more accurate articulatory movements. It may also reduce tension and encourage more efficient motor patterns during oral motor exercises. Tension in the oral and facial muscles can impede smooth speech production. The application of KT may help alleviate such tension, allowing for improved muscle function and speech clarity [19,20,21].

The study results demonstrated that the intervention using KT had a significant positive impact on both verbal and oral motor performance in children with apraxia. A variety of measures were employed to assess improvements in verbal performance, oral motor skills, and oral sensory processing, with clear clinical effects observed when comparing pre- and post-intervention results.

The results indicated significant clinical improvements, with substantial gains observed across all measures in the experimental group compared to the control group. Specifically, speech clarity improved from 2.3 ± 0.5 to 3.7 ± 0.6 in the experimental group (a 60% improvement). Speech fluency increased from 2.5 ± 0.4 to 3.6 ± 0.5 (a 44% improvement). Sound articulation improved from 2.2 ± 0.4 to 3.5 ± 0.7 (a 59% improvement). Oral muscle strength improved from 2.4 ± 0.6 to 3.8 ± 0.5 (a 58% improvement). Oral movement coordination showed a 57% improvement, increasing from 2.3 ± 0.5 to 3.6 ± 0.6.

Neither age nor gender had a significant impact on the overall improvements, as the p-values for these factors were greater than 0.05.

Significant positive effects were observed for oral muscle strength and motor coordination, with p-values below 0.05, emphasizing the role of these factors in the observed improvements.

In agreement with our results, Awaad et al. [22] reported that KT in oral motor rehabilitation in children with speech and motor disorders. The research suggested that KT could provide sensory feedback to the targeted muscles (such as the lips, tongue, and jaw), helping to improve motor control and speech articulation. In the case of children with DAS, this feedback could support muscle coordination and planning.

Similarly, Li LL et al. [23] showed that KT was applied to children with developmental disabilities, including speech and motor impairments. The tape was found to reduce muscle tension, which is important for children with DAS, who often exhibit excess tension in the muscles needed for speech

Limitation

small sample size, which may restrict the generalizability of the findings to a broader population of children with apraxia. A larger sample could enhance statistical power and improve the reliability of the results. Future studies should aim to include a greater number of participants to address this limitation and validate the findings in more diverse contexts.

Conclusion:

Overall, the study results showed that KT significantly contributed to the improvement of verbal and motor performance in children, with the intervention proving effective across all measured outcomes.

Acknowledgment:

The author expresses gratitude to the child and their family for participating in this study

DECLARATIONS

Consent to publish: I certify that each author has given their consent to submit the work.

Competing interests: None.

Funding: No fund.

References

1.Manasco MH. Introduction to neurogenic communication disorders: Jones & Bartlett Learning; 2020. 179:456-70179:456-70

2. Duchow H, Lindsay A, Roth K, Schell S, Allen D, Boliek CA. The co-occurrence of possible developmental coordination disorder and suspected childhood apraxia of speech.Can J Speech-Lang.2019;43:12-5.

3. Hashimoto N, Frome A. The use of modified semantic features analysis approach in aphasia. *J Commun Disord.* 2011;44(4):459-69.

4 Duffy JR. Motor speech disorders: Substrates, differential diagnosis, and management: Elsevier Health Sciences; 2012.

5. Velleman SL. Childhood apraxia of speech resource guide.Iran J Neurol.2003;18:178-200.

6. American Speech-Language-Hearing Association. Apraxia of speech Internet. Rockville: ASHA; 2017 cited 2025 Jan 21. Available from: https://www.asha.org/public/speech/disorders/childhood-apraxia-of-speech/

7 Arganbright J. Surgical management of velopharyngeal dysfunction.Facial Plast Surg Clin.2024;32:69-83.

8. Brookshire RH, McNeil MR. *Introduction to neurogenic communication disorders.* 8th ed. St. Louis: Elsevier Health Sciences; 2014.

9 Denice M. The importance of production frequency in therapy for childhood apraxia of speech. *J Autism Dev Disord.* 2011;20(2):95-110

10 Wang Y, Li X, Sun C, Xu R. Effectiveness of kinesiology taping on the functions of upper limbs in patients with stroke: a meta-analysis of randomized trial.J Neurol Sci.2022;43:4145-56.

11. Cheshmi B, Keyhan SO, Rayegani SM, Kim S-G, Ozunlu Pekyavas N, Ramezanzade S. A literature review of applications of Kinesio Taping® in the craniomaxillofacial region.CRANIO®.2024;42:499-506.

12. Kumbrink B. *K taping: An illustrated guide.* Berlin: Springer; 2012

13 Gibbons J. *A practical guide to kinesiology taping for injury prevention and common medical conditions.* 1st ed. London: Lotus Publishing; 2023.

14 Ruscello DM. Nonspeech oral motor treatment issues related to children with developmental speech sound disorders.JRM.2008;178:18-25.

15 Kahanov L, Yoshida A. The effect of kinesio taping on lower limb function. *Kinesio Taping Int Symp Rev.* 2007;45-50.

16. ELHAM ES, AHMED A, KAMEL HM, EL-SHENNAWY S. Effect of kinesio taping on grasp and release in children with spastic hemiparetic cerebral palsy: A pilot study.Med J Cairo Univ.2018;86:2177-84.

17. Lehman Blake MA. *Childhood apraxia of speech: A case-based approach.* Burlington: Jones & Bartlett Learning; 2014.

18 Martín P, editor Use of kinesio tape in pediatrics to improve oral motor control comunicación oral. 18th. Annual Kinesio Taping International Symposium Review; 2003.

19. Edythe A, Joseph R, Heather M, Keith J. The apraxia of speech rating scale: A tool for diagnosis and description of apraxia of speech. *J Commun Disord.* 2014;51:43-57

20 Shamsoddini A, Rasti Z, Kalantari M, Hollisaz MT, Sobhani V, Dalvand H, et al. The impact of Kinesio taping technique on children with cerebral palsy.Iran J Neurol.2016;15:219-21. Vahid M, Mansuri B, Farzadi F, Tohidast SA, Bagheri R, Scherer RC. Immediate effects of combining kinesio tape with voice therapy in patients with muscle tension dysphonia.J Voice.2022;179:456-70.

22. Awaad HM, Aly MG, Kamal HM. Kinesio taping versus oromotor training on drooling in children with spastic cerebral palsy: Comparative study.EJHM.2023;91:4462-7.

23. Li-Liang L, Fu-Chen C. Effects of kinesio taping on static balance performance and muscle activity in children with developmental coordination disorder: a single-group pretest-posttest study.JRM.2023;55:89-95.