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Clinical Study on Improving Articulation Clarity in Spastic Cerebral Palsy with 120 Cases of Oral-Facial Acupressure Combined with Oral Placement Therapy

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Abstract: *Objective:* To observe the efficacy of oral-facial acupressure combined with oral placement therapy (OPT) in improving articulation clarity in 120 children with spastic cerebral palsy, and to explore effective therapeutic solutions for speech disorders associated with spastic cerebral palsy. *Methods:* A total of 120 children with spastic cerebral palsy and speech disorders, meeting the inclusion criteria, were randomly assigned into two groups: 60 cases in the treatment group and 60 cases in the control group. The treatment group received orofacial acupressure combined with OPT, while the control group received only OPT. The Oral Motor Function Assessment Scale (OMFAS), developed by the China Rehabilitation Research Centre (CRRC), was used to evaluate the treatment outcomes before and after the intervention. *Results:* After the treatment, both the treatment and control groups showed improved mobility of the mandible, lips, and tongue. However, the treatment group exhibited significantly better improvement than the control group, with the difference between the two groups being statistically significant ($P < 0.05$). *Conclusion:* Oral-facial acupressure combined with OPT can effectively improve articulation clarity in children with spastic cerebral palsy. This combined therapy is recommended for clinical promotion and application.

Keywords: Oral-facial acupressure; Oral placement therapy (OPT); Speech disorders in children with spastic cerebral palsy; Speech intelligibility

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1. Introduction

Cerebral palsy is a group of syndromes characterized predominantly by motor disorders, often accompanied by speech, cognitive, communication, and behavioral disorders [1]. These conditions seriously affect the physical and mental development of infants, toddlers, and children due to non-progressive brain injury in fetuses, infants, and young children, resulting in persistent central motor and postural developmental disorders and activity limitations.

According to survey results in China, the incidence rate of cerebral palsy is about 2.48 per thousand [2], and the total prevalence rate is about 2.45 per thousand, indicating a relatively high incidence rate. There are approximately 6 million children with cerebral palsy in China, with the number increasing by about 46,000 per year [3]. Spastic cerebral palsy (SCP) is the most common type, accounting for about 60% to 70% of cases [4]. SCP primarily affects the motor areas of the cerebral cortex and the pyramidal tracts of affected children, with clinical manifestations such as increased muscle tone, joint contractures, and motor dysfunction. Statistics show that the percentage of children with cerebral palsy who have speech impairments is as high as 75% [5], making communication with others difficult and increasing the challenges of social integration.

However, speech therapy for children with cerebral palsy in China is still in the exploratory stage, with clinical studies on correcting articulation clarity in children with spastic cerebral palsy remaining at an empirical level, lacking systematic programs and clinical data support [6]. Therefore, it is of positive significance to actively explore effective treatment programs to improve the speech disorders of children with spastic cerebral palsy. Enhancing their social integration, improving their daily life abilities, and alleviating the burden on families and society are crucial goals. Our research group has conducted relevant studies on spastic cerebral palsy, and preliminary findings confirm that oral-facial acupressure combined with OPT can effectively improve the articulation clarity of children with spastic cerebral palsy. This study was carried out to further validate the clinical efficacy of this approach.

2. Materials and methods

2.1. General information

This study involved 120 children diagnosed with spastic cerebral palsy between October 2017 and November 2019 at Xi'an Hospital of Traditional Chinese Medicine and Cerebral Diseases. The participants were randomly divided into two groups: the treatment group and the control group. The treatment group comprised 60 children with an average age of 4.2 ± 1.5 years, and the control group also had 60 children with an average age of 4.1 ± 1.3 years.

2.2. Diagnostic criteria

2.2.1. Cerebral palsy diagnostic criteria and typing

The diagnostic criteria and typing were based on the definition, diagnosis, and clinical typing of cerebral palsy outlined in the "China Cerebral Palsy Rehabilitation Guidelines" issued by the Children's Rehabilitation Committee of the Chinese Society of Rehabilitation Medicine and the Pediatric Cerebral Palsy Rehabilitation Committee of the Chinese Association for the Rehabilitation of the Disabled in 2015.

Diagnostic criteria include:

(1) Requirements: (a) Persistence of central movement disorder; (b) Abnormalities in motor and postural development; (c) Abnormalities in reflex development; (d) Abnormalities in muscle tone and strength.

(2) Reference conditions: (a) An etiological basis for the cause of cerebral palsy; (b) Cranial imaging corroboration (52%–92%).

The diagnosis of cerebral palsy requires all four necessary conditions, while the reference conditions help identify the cause.

Clinical classification of spastic cerebral palsy:

(1) Spastic quadriplegia: Increased muscle tone of the limbs, upper limb dorsiflexion, pronation, thumb pronation, trunk flexion, lower limb pronation, crossover, knee flexion, scissor step, pointed foot, foot inversion, arched back sitting, hyperactive tendon reflexes, ankle clonus, folding knife sign, and

pyramidal bundle sign.

(2) Spastic diplegia: Similar symptoms to spastic quadriplegia, with more severe spasticity and dysfunction in the lower limbs compared to the upper limbs.

(3) Spastic hemiplegia: Similar symptoms to spastic quadriplegia, but affecting only one side of the body.

2.2.2. Diagnostic criteria for dysarthria

(1) Presence of organ abnormalities and dyskinesias in the organs responsible for sound production.

(2) Abnormalities in articulation, such as distortions, errors, and substitutions of produced syllables, due to the disruption of purposeful movement by involuntary movements of the organs involved in phonological composition.

(3) At the age of speech development, abnormalities in the range of movement, speed of movement, precision of movement, and smoothness of movement generally occur after the production of meaningful language.

2.3. Inclusion, Exclusion, and Rejection Criteria

(1) Inclusion criteria: (a) Patients meeting the diagnostic criteria for dysarthria in spastic cerebral palsy; (b) Children aged 3.5–6.5 years, of either sex, who can adhere to the treatment for a full three months; (c) Children whose guardians are aware of and have signed an informed consent form.

(2) Exclusion criteria: (a) Children under 3.5 years of age with poor cognitive abilities; (b) Those suffering from severe epilepsy, congenital heart disease, hematological disorders, liver, kidney, and psychiatric disorders; (c) Children exhibiting severe self-injurious behavior, failure to cooperate with treatment, and those undergoing treatment for less than three months; (d) Speech problems not caused by cerebral palsy, such as autism, hearing disability, and sequelae of encephalitis.

(3) Rejection criteria: (a) Children with poor cooperation, unable to adhere to the full course of treatment, and lacking data on treatment outcomes.

2.4. Treatment

The treatment group received oral-facial acupressure + oral muscle positioning therapy, whereas the control group received conventional oral muscle positioning training.

2.4.1. Oral-facial acupressure

Acupressure points on the mouth and face:

(1) Facial acupoints: Dicang, Cheche, Yingxiang, Lianquan, Chengju, Renzhong

(2) Methods of operation: Massage the external laryngeal muscles, upper and lower hyoid muscles, orbicularis oris, masticatory muscles, and buccal muscles following the direction of muscle texture until the skin becomes reddish. During the process, use the thumb and forefinger to apply stimulation by pressing, kneading, and massaging the facial acupoints for 2 minutes each.

2.4.2. Oral placement therapy

Training supplies such as tongue depressor, massage toothbrush, cotton swabs, mouth training kit, gauze, whistle, vibrating toothbrush, and training breathing mouthpiece are required for OPT.

Methods:

(1) Jaw positioning training: (a) Passive training: The therapist holds the head steady with one hand while using the thumb and index finger of the other hand to passively lift and pull down the jaw; (b)

Active training: With the help of dental glue sticks and tongue depressors, the child performs chewing movements. Mandibular-graded control is achieved using different thicknesses of dental glue for high, medium-high, medium-low, and low-graded control, holding each part for 10 seconds.

(2) Lip positioning training: (a) Passive movement: The therapist uses the thumb and forefinger to perform passive lip closure, opening, rounding, and spreading movements; (b) Active movement: The child completes these movements when prompted by instructions or with the help of a tongue depressor or straw tool; (c) Lip muscle training: The child's lips clamp onto a tongue depressor while the therapist pulls the depressor outward, or wraps the lips around a button while the therapist pulls outward on the rope to train lip muscle strength.

(3) Tongue positioning training: (a) Passive training: Use a toothbrush to push or gauze to pull the passive tongue forwards, backward, left, right, up, and down; (b) Active training: Use food to induce the child to move the tongue in all directions. For tongue muscle strength training, apply resistance with a tongue depressor in all directions of tongue movement.

(4) Sensory training: (a) External stimulation: Use brushes and tactile balls to stimulate the orofacial muscles from the outside to the inside; (b) Internal stimulation: Use a toothbrush, vibrating toothbrush, and sponge stick inside the mouth. Perform three turns on each of the right and left cheeks, two turns on the orbicularis oris muscle from top to bottom and bottom to top, three horizontal rolls on the left and right sides of the tongue, three brushes on both sides of the tongue from the inside to the outside, and three turns on the palate to the outer lip.

(5) Breathing training: (a) Passive maneuver: In the sitting position, the therapist stands behind the patient, places both hands on the 11th and 12th ribs, and has the patient breathe naturally. At the end of exhalation, the therapist squeezes to expel the residual air. In the supine position, the method is the same, with the therapist pushing upwards and closing inwards while squeezing; (b) Active training: Activities include blowing candles, different types of flutes, and bubbles.

(6) Vocal training: (a) Repeat the "a-a-a" sound, with a pause of 3-5 seconds after each pronunciation. Train consonant-vowel combinations such as "pa-da."

(7) Resonance training: (a) Nasal resonance: Have the child touch their nose while making the "eng" sound; (b) Oral resonance: Have the child touch their neck while making the "a" sound; (c) Nasal-oral resonance: Practice converting between "eng" and "a."

2.5. Assessment of efficacy

(1) Observation indexes: Changes in articulation clarity before and after treatment.

(2) Assessment methods: The therapeutic effect was observed for 3 months. Before and after the treatment, the children were assessed by our evaluators using the dysarthria assessment scale developed by the China Rehabilitation Research Centre. The children's speech intelligibility was assessed using the Oral Motor Function Assessment Scale.

(3) Criteria for evaluating the efficacy of the treatment: The criteria for speech disability refer to the "Second National Disability Sampling Survey Disability Criteria for Speech Disability" [8]. A comparison of the Chinese speech intelligibility test recordings performed before and after treatment was conducted. The formula for calculating speech intelligibility was as follows: Phonological clarity = (number of correct syllables ÷ total number of syllables read) × 100%. The evaluation was as follows: (a) Cure: Complete correction. Speech clarity matches perfectly with normal human syllable articulation; (b) Significant effect: Voice clarity is significantly improved. Voice clarity improved by

2 levels; (c) Effective: Voice clarity improved. Voice clarity improved by 1 level; (d) Ineffective: No improvement in speech intelligibility.

2.6. Statistical Analysis

The experimental results were analyzed using SPSS 25.0 software. Measurement data were expressed as mean ± standard deviation (SD). A rank sum test was used to compare the efficacy between the two groups. A *P*-value of less than 0.05 was considered statistically significant.

3. Results

A total of 120 cases were included in the study, with 6 cases dropping out (4 cases in the treatment group and 2 cases in the control group, resulting in a dropout rate of 5%). The final number of cases included in the study was 56 in the treatment group (37 males and 19 females) and 58 in the control group (36 males and 22 females), with a completion rate of 95%. After three months of treatment, the treatment group had 9 cases cured, 32 cases with significant improvement, 15 cases with improvement, and 0 cases with no improvement, resulting in an apparent efficacy rate of 73% and a total effective rate of 100%. In the control group, there were 4 cases cured, 28 cases with significant improvement, 26 cases with improvement, and 0 cases with no improvement, resulting in an apparent efficacy rate of 55% and a total effective rate of 100%.

3.1. Analysis of demographic information

A comparison of gender and age between the two groups was conducted using the chi-squared and *t*-tests, which showed no significant difference ($P > 0.05$). See **Table 1**.

Table 1. Comparison of gender and age between the two groups [*n* (%); mean ± SD]

Group	Gender		Age (years)
	Male	Female	
Treatment group (n = 56)	37 (50.7%)	19 (46.3%)	4.009 ± 1.208
Control group (n = 58)	36 (49.3%)	22 (53.7%)	4.250 ± 1.954
P	0.656		0.432

3.2. Comparative analysis of indicators before treatment in the two groups

A comparison of the indicators of the two groups before treatment showed no significant difference ($P > 0.05$), indicating comparability. See **Table 3**.

Table 3. Comparison of the indicators before treatment between the two groups (mean ± SD)

	Group	Activity level	*t*	*P*
Mandibular	Treatment group	35.691 ± 15.486	0.129	0.898
	Control group	31.781 ± 16.977		
Lip	Treatment group	36.517 ± 15.164	-1.345	0.182
	Control group	32.146 ± 17.576		
Tongue	Treatment group	28.121 ± 18.859	-0.64	0.524
	Control group	25.983 ± 14.616		

3.3. Comparative analysis of mobility before and after treatment in both groups

A comparison of mandibular, lip, and tongue mobility before and after treatment in the treatment and control groups showed statistically significant improvement after the paired *t*-test ($P < 0.05$). Mobility after treatment was significantly improved compared to before treatment. See **Table 4**.

Table 4. Comparison of mobility before and after treatment (mean ± SD)

		Treatment group	Control group
Mandibular mobility	Before treatment	35.691 ± 15.486	31.781 ± 16.977
	After treatment	47.977 ± 16.519	33.849 ± 17.354
	t	-12.508	-8.155
	P	< 0.05	< 0.05
Lip mobility	Before treatment	36.517 ± 15.164	32.146 ± 17.576
	After treatment	47.827 ± 15.797	34.594 ± 17.959
	t	-9.076	-5.385
	P	< 0.05	< 0.05
Tongue mobility	Before treatment	28.121 ± 18.859	25.983 ± 14.616
	After treatment	37.927 ± 19.544	28.286 ± 15.407
	t	-11.036	-5.927
	P	< 0.05	< 0.05

3.4. Comparative analysis of mandibular, lip, and tongue mobility after treatment in the two groups

A comparison of mandibular mobility, lip mobility, and tongue mobility between the two groups after treatment using the t-test showed a significant difference ($P < 0.05$), indicating that the efficacy in the treatment group was better than that in the control group. See **Table 5**.

Table 5. Comparison of mandibular, lip, and tongue mobility between the two groups after treatment (mean ± SD)

Group	Mandibular mobility	Lip mobility	Tongue mobility
Treatment group	47.977 ± 16.519	47.827 ± 15.797	37.927 ± 19.544
Control group	33.849 ± 17.354	34.594 ± 17.959	28.286 ± 15.407
t	-4.211	-3.951	-2.767
P	0.0025	0.0012	0.007

3.5. Comparative analysis of the efficiency of the two groups.

A comparison of the efficiency of the two groups using the rank sum test showed a statistically significant difference ($Z = -2.241$, $P < 0.05$), indicating that the efficacy of the treatment group was better than that of the control group. See **Table 6**.

Table 9. Comparison of effective rate between the two groups

Group	Cure	Significant effect	Effective	Ineffective	Z	*P*
Treatment group (n = 56)	9	32	15	0	-2.241	0.025
Control group (n = 58)	4	28	26	0		

4. Discussion

Good verbal fluency improves the clarity of the speaker's speech [9]. Social communication is severely affected by the presence of fluency disorders [10]. Most children with spastic cerebral palsy have speech fluency disorders due to non-progressive brain injury affecting the speech muscles involved in the speech production process. This may be caused by the inability of the organs to move accurately or in a coordinated manner during articulation [11,12].

Chinese medicine classifies cerebral palsy speech dysfunction as "delayed speech," "hardness of the mouth," and "softness of the mouth." If a child is not well endowed at birth or is not well nourished later in life, and the spleen and kidneys are deficient, it may lead to insufficiency of blood and fluid, affecting the heart and liver. This insufficiency can result in delayed growth and development of sinews, muscles, teeth, and language. Therefore, the treatment involves nourishing the liver and kidneys, strengthening the muscles and bones, and enlightening the mind as the main therapeutic principles. Oral muscle training involves professional physiotherapy exercises to reduce muscle tension around the mouth, allowing the surrounding muscles to relax and coordinate, thus improving dysarthria caused by abnormalities in oral muscle tension, ultimately enhancing language expression [13].

4.1. Efficacy analysis from oral placement therapy

OPT is a comprehensive training method that improves oral muscle activity, agility, precision, and endurance for children with weak oral perception, oral structure, and oral muscle strength [14]. OPT can be passive or active and aims to relieve muscle atrophy, improve overall oral muscle strength, increase coordination of oral muscle activity, promote the recovery of the swallowing reflex, and enhance oral motility, the ability to push food in the mouth, and swallowing power [15]. OPT can also stimulate peripheral neurons, maximizing the brain tissue's potential and promoting the formation of new conduction pathways between the brain's motor neurons and the lesion [16]. Repeated stimulation can help the child establish correct articulation and improve speech intelligibility.

4.2. Efficacy analysis from massage therapy

Children are often afraid of invasive procedures, so using lighter stimulation and less painful treatments can improve compliance [17]. Therefore, massage therapy is a primary treatment in Chinese medicine for children with spastic cerebral palsy. It functions to regulate yin and yang, internal organs, qi and blood, and dredge meridians to activate blood circulation. From a modern medical perspective, massage can relieve muscle spasms, improve joint mobility, and enhance limb function, making it widely used in treating this condition with notable results [18]. Studies have shown that perinasal meridian acupressure, which creatively applies acupressure to perinasal, oral, and internal meridians in children with cerebral palsy and speech disorders, promotes language development [19]. Another study showed that selecting acupoints such as Jinjin, Yuji, Buccal Carriage, Fengchi, Dicang, Chengjian, Mute Gate, Lianquan, and Juquan combined with rehabilitation training significantly improved swallowing and speech functions in children with cerebral palsy, with remarkable clinical efficacy [20].

4.3. Efficacy analysis from the choice of acupuncture points

Acupoint matching is crucial to the therapeutic effect [21]. In this study, the acupoints were mainly from the hand-foot Yangming meridian, the Directing Vessel, and the Ren Vessel. These meridian acupoints worked together to replenish qi and blood, clear the orifices, and restore the child's voice function. Cheek Che, Di Cang, and Ying Xiang are Yang Ming meridian points, essential for treating unfavorable teeth and mouth silence.

Pressing Cheek Che and Di Cang can enhance muscle strength and tone of the biting muscles, adjust jaw joint mobility, improve mouth and lip functions, and subsequently improve pronunciation. Chengjian belongs to the Ren meridian, generating fluids, soothing tendons, and activating collaterals; Lianquan, a meeting point of the Yinwei and Ren meridians, detoxifies and promotes tongue and collateral health; Renzhong, meeting the Dushi meridian, opens collaterals and voice. Combined, these points open channels and the throat and voice. During massage, the left rotation (kneading) and right rotation (mo) are tonic and diarrhea methods, respectively. For spastic cerebral palsy, which mainly requires diarrhea, acupoints are stimulated by clockwise massage.

Through clinical research and evaluation of 114 patients over 3 months, the differences in gender, age, and pre-treatment indicators between the two groups were not statistically significant ($P > 0.05$), making them comparable. However, the comparison of efficacy showed statistically significant differences ($P < 0.05$), with the treatment group performing better than the control group. Comparison within groups revealed significant improvements in mandibular, lip, and tongue mobility post-treatment compared to pre-treatment ($P < 0.05$) in both groups. Comparing between groups, the treatment group showed better mandibular, lip, and tongue mobility improvement than the control group ($P < 0.05$). The results indicate that the combination of oral-facial acupressure and OPT can improve jaw joint, lip, and tongue mobility in children with spastic cerebral palsy, enhancing speech clarity and significantly improving quality of life as patients regain confidence in their speech.

A preliminary study of 120 cases demonstrated the efficacy of orofacial acupressure combined with OPT in improving speech intelligibility in children with spastic cerebral palsy. However, more clinical and laboratory data are needed to support these results and establish this treatment as a common clinical practice.

Disclosure statement

The authors declare no conflict of interest.

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