

Influence of age and time of use of the Stimulating Palatal Plate by children with Trisomy 21 on orofacial myofunctional changes perceived by parents, children's adaptation, and family's satisfaction after four months of treatment

Influência da idade e do tempo de uso da Placa Palatina de Memória por crianças com Trissomia do 21 nas mudanças miofuncionais orofaciais percebidas pelos pais, na adaptação e satisfação da família após quatro meses de tratamento

Influencia de la edad y el tiempo de uso de la placa de memoria palatina por niños con trisomía 21 sobre los cambios miofuncionales orofaciales percibidos por los padres, adaptación y satisfacción familiar después de cuatro meses de tratamiento

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Abstract

Purpose: to verify if the age of children with Trisomy 21 and the time of use per day of the stimulating palatal plate influence the child's adaptation to the plate, the orofacial myofunctional changes perceived by the parents, and the family's satisfaction, after four months of treatment. **Methods:** 14 parents or legal guardians of children with Trisomy 21, aged between 3 and 20 months, participated in the study. Treatment with the stimulating palatal plate was carried out for four months. The child's adaptation to the plate, the orofacial myofunctional changes perceived by the parents, and the families' satisfaction with the treatment were investigated through a questionnaire prepared by the research authors and answered by the mothers after four months of treatment. **Results:** The mean age of the children who participated in the study was 10 months and the standard deviation was 4.9 months. The results of the questionnaire indicated an association between age and lip posture, reported by parents, during the use of the stimulating palatal plate, and all children under 10 months maintained lip closure, according to the parents, during the use of the plate. Age was also associated with satisfaction with the service, as the mothers of younger children were more satisfied. **Conclusion:** The study results indicate an association between age and lip posture, reported by the parents, during the use of the plate, and between age and satisfaction with the service. Thus, it suggests that early treatment with the stimulating palatal plate benefits children with Trisomy 21.

Keywords: Down Syndrome; Child; Treatment Adherence and Compliance; Rehabilitation; Orthotic Devices.

Resumo

Objetivo: verificar se a idade das crianças com Trissomia do 21 e o tempo de uso por dia da placa palatina de memória influenciam a adaptação da criança à placa, as mudanças miofuncionais orofaciais percebidas pelos pais e a satisfação da família, após quatro meses de tratamento. **Métodos:** participaram do estudo 14 pais ou responsáveis legais de crianças com Trissomia do 21, com idades de 3 a 20 meses. O tratamento com a placa palatina de memória foi realizado durante quatro meses. A adaptação da criança à placa, as mudanças miofuncionais orofaciais percebidas pelos pais e a satisfação das famílias em relação ao tratamento foram investigadas por meio de questionário elaborado pelos autores da pesquisa e respondido pelas mães após quatro meses de tratamento. **Resultados:** a média de idade das crianças que participaram do estudo foi 10 meses e o desvio-padrão de 4,9 meses. O resultado do questionário indicou associação entre idade e postura de lábios relatada pelos pais com o uso da placa palatina de memória, sendo que todas as crianças menores de 10 meses mantiveram o selamento labial, de acordo com os pais, durante o uso da placa; bem como entre idade e satisfação com o tratamento, sendo que as mães das crianças menores mostraram-se mais satisfeitas. **Conclusão:** os resultados do estudo indicam que houve associação entre idade e postura de lábios relatada pelos pais com o uso da placa, bem como entre idade e satisfação com o tratamento e sugerem que o tratamento precoce com a placa palatina de memória beneficia as crianças com Trissomia do 21.

Palavras-chave: Síndrome de Down; Criança; Cooperação e adesão ao tratamento; Reabilitação; Aparelhos Ortopédicos.

Resumen

Objetivo: verificar si la edad de los niños con Trisomía 21 y el tiempo de uso por día de la placa palatina de memoria influyen en la adaptación del niño a la placa, los cambios miofuncionales orofaciales percibidos por los padres y la satisfacción de la familia, después de cuatro meses de tratamiento. **Métodos:** Participaron en el estudio 14 padres o tutores legales de niños con trisomía 21, con edades comprendidas entre los 3 y los 20 meses. El tratamiento con la placa de memoria palatina se llevó a cabo durante cuatro meses. La adaptación del niño al plato, los cambios miofuncionales orofaciales percibidos por los padres y la satisfacción de las familias con el tratamiento fueron investigados a través de un cuestionario elaborado por los autores y respondido por las madres, después de cuatro meses de

tratamiento. **Resultados:** La edad media de los niños que participaron en el estudio fue de 10 meses y la desviación estándar fue de 4,9. El resultado del cuestionario indicó una asociación entre la edad y la postura de los labios, reportada por los padres, con el uso de la placa de memoria palatina, y todos los niños menores de 10 meses mantuvieron el sello de los labios, según los padres, durante el uso de la placa de memoria palatina, así como entre la edad y la satisfacción con el servicio. Las madres de niños más pequeños estaban más satisfechas. **Conclusión:** Los resultados del estudio indican que hubo asociación entre la edad y la postura de los labios, reportada por los padres, con el uso de la placa, así como entre la edad y la satisfacción con el servicio, y sugieren que el tratamiento temprano con la placa de memoria palatina beneficia a los niños con trisomía 21.

Palabras clave: Síndrome de Down; Niño; Cumplimiento y Adherencia al Tratamiento; Rehabilitación; Aparatos Ortopédicos.

Introduction

Trisomy 21 (T21) is a chromosomal change characterized by the presence of an additional autosomal chromosome in all the person's cells, which is due to an inadequate chromosomal distribution during meiosis in cell division¹. According to 2019 data from the Ministry of Health, one out of every 700 births is estimated to have T21 totaling about 270 thousand people².

People with T21 have peculiar characteristics that affect both soft and hard tissues in the craniofacial morphology and oral cavity³. These characteristics include apparently larger and hypotonic tongue, decreased orbicularis oris and buccinator muscle tone, and incorrect tongue posture – which may cause malocclusion and impair stomatognathic functions (breathing, mastication, and swallowing)⁴.

Castillo Morales distinguishes pathological disorders in children with T21 between primary and secondary ones. Primary disorders involve orofacial muscle hypotonia, decreased temporomandibular joint muscle tone, hypotonic tongue with midline diastasis, a smaller midface, maxillary hypoplasia, lower palate, late dentition, microdontia, and dental agenesis. Secondary pathologies occur due to the malfunctioning of oral and respiratory structures and include mandible subluxation, mouth breathing, respiratory tract infections, malocclusion, speech articulation disorders, lowered mandible posture, sialorrhea, everted lower lip, hypofunctioning upper lip, and decreased nasolabial angle⁵.

Children with T21 need multidisciplinary care from birth, including speech-language-hearing (SLH) and dental therapy, given their multiple primary and secondary orofacial disorders⁶. They must

have orofacial myofunctional therapy to improve the tone and habitual posture of orofacial muscle structures and especially improve functional performance. Dental rehabilitation is likewise important from the first months of life until adulthood⁷ to monitor and correct functional abnormalities and help develop dental and facial structures⁶.

Using a stimulating palatal plate (SPP) in combination with orofacial stimulation therapy is a therapeutic approach indicated for children with hypotonic orofacial muscles, including those with T21. SPP is an intraoral appliance produced by the dentist based on the model of the child's palate and used in therapy for children functionally diagnosed with hypotonic orofacial muscles, tongue protrusion, and parted lips⁸⁻¹¹. It has been used to complement the treatment of children with T21 to improve lip closure and tongue posture. Moreover, it is easy to apply and produce in the laboratory and has a high percentage of success in children with T21⁹.

The literature reports good therapeutic results in children with T21 using Castillo-Morales' therapy method – which consists of using SPP and orofacial regulation therapy concomitantly⁶. According to a systematic review¹², the effects of SPP are only obtained in combination with orofacial regulation therapy.

It must be highlighted that the factors that influence the child's adaptation to SPP, satisfaction with the treatment, and its better results are not known for sure – it is suspected that they are influenced by the child's age and the time of SSP use per day. Furthermore, no research addresses these factors, although knowing them is essential for professionals to plan therapies. Hence, this study aimed to verify whether the age of children with T21 and the time of SPP use per day influenced their adaptation to it, orofacial myofunctional changes

perceived by the parents, and their satisfaction after 4 months of treatment.

Material and method

This cross-sectional observational study was conducted in a convenience sample. It was approved by the Research Ethics Committee of the Federal University of Minas Gerais under CAAE no. 37828920.1.0000.5149. All participants signed an informed consent form.

Participants

The study sample had 14 parents/guardians of children with T21 undergoing treatment with SPP at the Dental School of the Federal University of Minas Gerais, in Belo Horizonte, Brazil.

The study selected parents/guardians whose children met the following inclusion criteria: diagnosed with T21 and aged 0 to 24 months. It excluded parents of children with other associated syndromes, craniofacial malformations, abnormal lingual frenulum, obstructed upper airways, and those who did not adhere to the treatment.

Research participants were recruited from among those referred for care at an outreach program for children with T21 carried out at School of Dentistry of the Federal University of Minas

Gerais. These children are assessed by dentists and SLH therapists, who work interdisciplinarily – dentists mold, produce, install, and periodically adjust the plates, while SLH therapists, along with SLH undergraduate students, are responsible for the orofacial myofunctional therapy. Figure 1 shows an example of an SPP produced in this program. Professionals follow up on patients periodically regarding SPP use, and parents are instructed to have SPP used for 30 minutes at least three times a day^{13,14} and to make exercises as in the orofacial regulation therapy¹¹ (Chart 1), likewise three times a day. Patients had return visits 15 days, 1 month, 2 months, and 3 months after installing the appliance for a routine consultation when parents were again instructed on doing the exercises and using the plate for the designated time in these four moments.



Figure 1. Model of a stimulating palatal plate

Chart 1. Exercises indicated in the treatment

Exercise	Description	Repetition
1) Strengthening the masseter	Sliding the fingertips of both hands from the angle of the mandible up toward the eyes.	10 times each movement
2) Stretching the upper lip	Sliding the tips of the index fingers and thumbs from the center of the upper lip to the commissures.	10 times each movement
3) Stretching the lower lip	Sliding the tips of the index fingers and thumbs from the center of the lower lip to the commissures.	10 times each movement
4) Stimulating the lower nasal motor zone	Pressing the index finger horizontally above the upper lip and vibrating it up and backward.	10 times each movement
5) Stimulating the lip motor zone	Pressing the tips of the index fingers on the zygomaticus major muscle, simultaneously vibrating and pulling it.	10 times each movement
6) Stimulating the chin motor zone	Placing the index finger under the face and the thumb on the chin and making downward movements, simultaneously pressing and vibrating them.	10 times each movement
7) Stimulating the tongue motor zone	Pressing the thumb or index finger under the face, in the submandibular region of the neck, and vibrating intermittently.	10 times each movement
8) Tongue vibration	Pressing the index finger over the tongue and vibrating it intermittently. Then, perform mandible control.	20 times each movement
9) Lifting the tip of the tongue	Placing the index finger behind the lower gingiva (without touching the teeth) and the thumb in the submandibular region, then lifting the tip of the index finger to take the tongue near the upper teeth. Then, perform mandible control.	10 times each movement
10) Tongue tapering	Touching the lateral margins of the tongue backward with the index finger or a toothbrush.	10 times on each side of the tongue
11) Lip vibration	Flexing the finger joints to cup the hand, placing it over the child's lips carefully not to hinder nose breathing. Then pressing the lips and face with a vacuum effect and vibrating upward.	20 times each movement
12) Mandible control	Placing the index finger on the chin, the middle finger below the mandible, and the thumb along the border of the mandible and resting the head on the arm.	Whenever the child needs alignment.

Source: Castillo-Morales R. Terapia de regulación orofacial. São Paulo: Memnon, 2002. 195 p.

Data collection

After 4 months of treatment, participants answered a questionnaire in Google Forms, developed by the research authors (Figure 2) with 15 questions on the child's age and receptivity to SPP, the

need for using an adhesive substance (Corega®) to hold SPP in place, time of SPP use, lip and tongue position, changes in eating habits and suction, and degree of satisfaction with the treatment.

1. Age of the child: _____
2. Did you need to use Corega® denture adhesives?
<input type="checkbox"/> Yes <input type="checkbox"/> No
3. Was your child receptive to the plate?
<input type="checkbox"/> Yes <input type="checkbox"/> No
4. How long is your child using the plate per day?
<input type="checkbox"/> < 30 minutes <input type="checkbox"/> 30 minutes to 1 hour <input type="checkbox"/> 1 to 2 hours <input type="checkbox"/> More than 2 hours
If more than 2, how many hours are they using it per day? _____
5. Is your child expelling the plate (removing it with the tongue) on their own?
<input type="checkbox"/> Yes <input type="checkbox"/> No
6. Is your child removing the plate with their hands?
<input type="checkbox"/> Yes <input type="checkbox"/> No
7. Have you noticed any change in the position of your child's tongue after using the plate?
<input type="checkbox"/> Yes <input type="checkbox"/> No
8. What is the position of your child's tongue with the plate?
<input type="checkbox"/> on the roof of the mouth <input type="checkbox"/> on the floor of the mouth
<input type="checkbox"/> between the teeth <input type="checkbox"/> outside the line of the teeth (between the lips)
9. What is the position of your child's tongue without the plate?
<input type="checkbox"/> on the roof of the mouth <input type="checkbox"/> on the floor of the mouth
<input type="checkbox"/> between the teeth <input type="checkbox"/> outside the line of the teeth (between the lips)
10. Have you noticed any change in the position of your child's lips after using the plate?
<input type="checkbox"/> Yes <input type="checkbox"/> No
11. What is the position of your child's lips with the plate?
<input type="checkbox"/> Parted <input type="checkbox"/> Closed
12. What is the position of your child's lips without the plate?
<input type="checkbox"/> Parted <input type="checkbox"/> Closed
13. Have you noticed any change in your child's eating habits after using the plate?
<input type="checkbox"/> No <input type="checkbox"/> Yes If so, <input type="checkbox"/> It improved <input type="checkbox"/> It got worse
14. Have you noticed any difference in your child's suction/breastfeeding after using the plate?
<input type="checkbox"/> No <input type="checkbox"/> Yes If so, <input type="checkbox"/> It improved <input type="checkbox"/> It got worse
15. How satisfied are you with the treatment/service?
<input type="checkbox"/> completely dissatisfied <input type="checkbox"/> dissatisfied <input type="checkbox"/> satisfied <input type="checkbox"/> very satisfied

Figure 2. Study data collection instrument

Data analysis

The response variables in this research were those on the child's adaptation to SPP (the need for an adhesive substance to hold SPP in place; the child's receptivity to SPP; and whether they removed SPP with their tongue or hands), on orofacial myofunctional changes perceived by the parents after 4 months of treatment (tongue posture with SPP; tongue posture without SPP; lip posture with SPP; lip posture without SPP; and improved eating habits and suction), and on the family's satisfaction with the treatment. The explanatory variables were the child's age and time of SPP use. The age cutoff was defined as the median (10 months) when they dissociate tongue and mandible movements¹⁵. Hence, SPP use is believed to become more difficult after 10 months old.

The descriptive data analysis was performed with the frequency distribution of categorical variables and the measures of central tendency and variability of the continuous variables. The chi-square test was applied to verify the association between response and explanatory variables, setting the level of significance at 5%.

Results

The children's ages ranged from 3 to 20 months, with a mean and median age of 10 months and a standard deviation of 4.9 months. Age was associated with lip posture with SPP, as perceived by the parents – all children under 10 months old had closed lips while using SPP. Age was also associated with satisfaction with the treatment – the mothers of children who began the treatment at a younger age were more satisfied (Table 1).

Table 1. Association between age at the beginning of the treatment and frequency of the other variables

Age	< 10 months	> 10 months	p-value*
Well-fitted SPP			
Yes	5 (71.4%)	6 (85.7%)	0.515
No	2 (28.6%)	1 (14.3%)	
Use of Corega® denture adhesive			
Yes	6 (85.7%)	6 (85.7%)	1.000
No	1 (14.3%)	1 (14.3%)	
Well accepted by the child			
Yes	4 (67.1%)	3 (42.9%)	0.593
No	3 (42.9%)	4 (67.1%)	
Time of SPP use			
< 30 min/day	1 (14.3%)	1 (14.3%)	0.644
From 30 min to 1 hour	1 (14.3%)	1 (14.3%)	
From 1 to 2 hours	2 (28.6%)	4 (67.1%)	
> 2 hours	3 (42.9%)	1 (14.3%)	
Removes SPP with the tongue			
Yes	6 (85.7%)	6 (85.7%)	1.000
No	1 (14.3%)	1 (14.3%)	
Removes SPP with the hand			
Yes	1 (14.3%)	1 (14.3%)	1.000
No	6 (85.7%)	6 (85.7%)	
Tongue position with SPP			
On the palate	4 (67.1%)	4 (67.1%)	0.721
On the floor of the mouth	1 (14.3%)	1 (14.3%)	
Between the teeth	1 (14.3%)	0	
Outside the teeth	1 (14.3%)	2 (28.6%)	
Tongue position without SPP			
On the palate	1 (14.3%)	0	0.392
On the floor of the mouth	1 (14.3%)	3 (42.9%)	
Between the teeth	1 (14.3%)	0	
Outside the teeth	4 (67.1%)	4 (67.1%)	
Lip position with SPP			
Closed	7 (100%)	4 (67.1%)	0.050
Parted	0	3 (42.9%)	
Lip position without SPP			
Closed	4 (67.1%)	2 (28.6%)	0.280
Parted	3 (42.9%)	5 (71.4%)	
Improved eating habits			
Yes	4 (67.1%)	1 (14.3%)	0.094
No	3 (42.9%)	6 (85.7%)	
Improved suction			
Yes	3 (42.9%)	2 (28.6%)	0.420
No	3 (42.9%)	5 (71.4%)	
Satisfaction with the treatment			
Completely dissatisfied	0	0	0.031
Dissatisfied	0	0	
Satisfied	2 (28.6%)	6 (85.7%)	
Very satisfied	5 (71.4%)	1 (14.3%)	

*Chi-square test; SPP = stimulating palatal plate.

The time of SPP use per day was not associated with the frequency of the other variables. However, the analysis between the satisfaction with the treatment and the time of SPP use showed a p-value =

0.057, quite near the significance value ($p < 0.05$). Mothers seem to be more satisfied as their children spend more time a day using SPP (Table 2).

Table 2. Association between the time using the stimulating palatal plate per day and the frequency of the other variables.

Time of SPP use	< 30 min	30 min – 1 h	1 to 2 hrs	> 2 hrs	p-value*
Tongue position with SPP					
On the palate	1 (50%)	1 (50%)	4 (66.6%)	2 (50%)	0.257
On the floor of the mouth	1 (50%)	0	1 (16.7%)	0	
Between the teeth	0	1 (50%)	0	0	
Outside the teeth	0	0	1 (16.7%)	2 (50%)	
Tongue position without SPP					
On the palate	0	0	1 (16.7%)	0	0.086
On the floor of the mouth	2 (100%)	0	2 (33.3%)	0	
Between the teeth	0	1 (50%)	0	0	
Outside the teeth	0	1 (50%)	3 (50%)	4 (100%)	
Lip position with SPP					
Closed	2 (100%)	2 (100%)	4 (66.7%)	3 (75%)	0.653
Parted	0	0	2 (33.3%)	1 (25%)	
Lip position without SPP					
Closed	2 (100%)	1 (50%)	3 (50%)	0	0.120
Parted	0	1 (50%)	3 (50%)	4 (100%)	
Improved eating habits					
Yes	0	0	2 (33.3%)	3 (75%)	0.177
No	2 (100%)	2 (100%)	4 (66.7%)	1 (25%)	
Improved suction					
Yes	0	1 (50%)	1 (20%)	3 (75%)	0.227
No	2(100%)	1 (50%)	4 (80%)	1 (25%)	
Satisfaction with the treatment					
Completely dissatisfied	0	0	0	0	0.057
Dissatisfied	0	0	0	0	
Satisfied	2 (100%)	0	5 (83.3%)	1 (25%)	
Very satisfied	0	2 (100%)	1 (16.7%)	3 (25%)	

* Chi-square test; SPP = stimulating palatal plate.

Discussion

The best results reported by parents regarding lip posture were found in children who began the treatment at a younger age. According to the parents, all those under 10 months old maintained their lips closed while using SPP by the end of the treatment. This finding, which reinforces early interventions, agrees with other studies^{13,14,16,17}. According to the literature, stimulating the tongue to be positioned on the palate associated with lip closure in the first months of life sets better conditions for facial growth and development¹⁸.

Studies suggest beginning the treatment early because the central nervous system has greater development in the first weeks of life^{19,20}. Also, the adaptation is more difficult when teeth begin erupting, which oftentimes forces the interruption of the treatment¹⁹. As the nervous system matures, children acquire skills to move the tongue sideways (usually by 6 months old) and separately from the mandible (by 10 months old)¹⁵ – however, greater tongue movement dexterity makes it easier for children to expel SPP from their mouth, hindering and diminishing its time of use.

Carneiro et al. (2012) emphasize the importance of early SLH intervention along with SPP



use to intensify the benefits of the treatment. Its exercises not only strengthen the orofacial muscle tone but also desensitize the intraoral region, which may help children accept SPP introduction²¹. All study participants reported having done the exercise throughout the treatment.

Authors point out that children's primary orofacial signs (e.g., tongue protrusion and hypotonic perioral, labial, and mastication muscles) may occur up to the first year of life⁹. If these conditions are not treated early, secondary orofacial problems (e.g., sialorrhea and changes in swallowing, suction, and dentition) can appear at school age⁹. According to Limbrock and collaborators⁹, most disorders of children with T21 result from primary problems that had not been previously treated, highlighting the importance of beginning the treatment early.

Studies also demonstrate that early orofacial stimulation with SPP associated with facial muscle stimulation results in better occlusion development and tongue position (diminishing tongue protrusion) and decreased sialorrhea, with stable long-term results^{13,14,16,17}. The present study reaffirmed the data of previous ones on the importance of early treatment, as it verified that the age of children with T21 influenced orofacial myofunctional changes – which is believed to be why the mothers of younger children were more satisfied with the treatment.

According to the study by Sixou et al. (2017), the results of SPP treatment associated with facial muscle stimulation in children with T21 in the first months of life can be seen in the short, medium, and long run. The authors state that the benefits of the treatment are mainly visible in motor function and facial expression, but also include speech development²². Moreover, a recent study by Carvalho et al. (2020) concluded that preventive dental interventions with intraoral appliances help children with T21 to have better biopsychosocial development with a positive influence on their quality of life²³.

The literature is not assertive concerning the minimum or ideal time of SPP use. Some authors advise using SPP for as long as possible because maintaining the neuromuscular structure in the right position for a long time conditions reflex stimuli that can remain throughout their lives¹⁴. Others suggest using it for only one hour a day in the first days of treatment, increasing to three or four 1-hour periods a day, but not recommending continuous use to prevent the child from getting used to the

stimuli so that it no longer has any effect on postural change²⁴. Some authors suggest using SPP for two of three 30-minute periods^{15,16} – which were the recommendations followed by the present study. The time children with T21 used SPP per day was not associated with the other variables in this study, which may have been due to the short time of the study or the small sample, or even indicate the need for using it for longer than what was recommended in the present research to obtain the desired results.

Generally, studies on the therapeutic approach used in the present research do not indicate orofacial muscle stimulation strategies or their frequency. No other studies were found that assessed the influence of the time of SPP use per day or the age at the beginning of the treatment, which are strong and unprecedented aspects of this research.

The limitations of this study include using only a parent-report questionnaire in the investigation (without assessing the children's orofacial myofunctional clinical condition), the few children in the sample, and the duration of the treatment, limited to 4 months. Hence, it is suggested that further research investigate the effects of the treatment on the children's structures (with clinical assessments and video recording) and stomatognathic functions, assessing them in different treatment durations. The literature indicates that after 2 months, it is possible to perceive differences in the orofacial muscles due to myofunctional exercises, and that after 3 months, such changes are generally perceived²⁵. Since the sample comprised babies with T21, it was decided to make the first investigation after 4 months of treatment. Future research should investigate the effects after different treatment durations.

Conclusion

The study results suggest that early treatment with SPP and orofacial muscle exercises benefits children with T21, as the parents reported that all children under 10 months old maintained closed lips while using SPP, and the mothers of younger children were more satisfied with the treatment. Age was not associated with the children's adaptation to SPP, and there was no relationship between the time of SPP use per day and the other variables.



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