



## Types and positioning of palatal plate stimulation elements in children with Down syndrome

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### Abstract

General muscle hypotonia, including hypotonia of the oro-facial muscle complex, is one of the characteristics of Down syndrome. To eliminate this disorder, oro-facial therapy with the use of a palatal plate is employed. The aim of this study is to assess the influence of the types and positioning of stimulation elements in palatal plates on the tongue position and mimetic muscles in children with Down syndrome. The study was conducted on 50 children with Down syndrome between the ages of 3 months and 2 years (22 boys, 28 girls) who were treated by means of palatal plate therapy in the Department of Maxillofacial Orthopaedics and Orthodontics at the Poznan University of Medical Sciences. The study analysed the responses received from the parents and the orthodontist to the questions included in a questionnaire developed for this study as well as the photographic documentation produced during every appointment over a period of two years. In total, 90 palatal plates were made for the children with stimulation elements in the form of a cylinder with a "roller" or a movable bead. The plates were replaced on average every 6 months in order not to inhibit the growth of the jaw. The study found that in 50 children who underwent palatal plate oro-facial therapy there was an improvement in the visual appearance of the mimetic muscles and tongue retraction, as well as improved lip closure. None of the children experienced deterioration in their condition. The stimulator in the form of a cylinder with a "roller" had a greater influence as regards improvements in the appearance of the mimetic muscles and lip closure, whereas a movable bead threaded on a wire and secured to the plate produced a greater improvement as regards tongue retraction. The positioning of the stimulation element closer to the alveolar ridges rendered better therapeutic results in the youngest children, whereas placing it in a central or posterior position produced better results in the older children.

**Key words:** Down syndrome, Oro-facial rehabilitation, palatal plate, stimulation elements

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### Introduction

The majority of people with disabilities which involve chromosome aberrations are people with Down syndrome. The rehabilitation of children affected by this disability is not restricted to improving motor functions, but it also includes attempts to improve facial appearance [1]. Children with Down syndrome from birth are provided with multidisciplinary medical care by a team of specialists including orthodontists because such

patients suffer from a multitude of genetically determined oro-facial disorders as well as varying degrees of stomatognathic system dysfunctions. One of the components of the multi-level care for children with Down syndrome is manual oro-facial therapy according to the Castillo-Morales method which makes use of a stimulating plate. The purpose of this therapy is to eliminate tongue dysfunctions and improve the function of the orbicularis oris muscle, which produces improvements in respect of sucking, articulation, swallowing and nasal breathing, as well as activating the mimetic muscles [2, 3, 4]. Palatal plates can be used from infancy. Implementing this therapy in the early stages of a child's life provides tactile stimulation which leads to motor muscle responses of the muscles involved in swallowing, chewing and speech [5, 6]. The aim of this study was to assess the impact of the types and positioning of stimulation elements in palatal plates on the tongue position and mimetic muscles in children with Down syndrome on the basis of a questionnaire survey and medical photographic documentation. The parents were asked to evaluate the position of the tongue: hidden inside the oral cavity, positioned between the alveolar margins (dental arches), positioned between the lips, or protruding from the mouth. The same parameters were also assessed by the orthodontist before and during the course of treatment.

### Technology of preparing stimulating plates

Because of the very young age of the patients undergoing the stimulating plate therapy the technology and kind of materials used in the appliance ought to be of the highest quality [7]. The material out of which the plate is made must be safe for the patient, the technician and the orthodontist. It must also fulfil specific requirements for toxicity (level of residual monomer content), have adequate mechanical strength, be insoluble in the mouth, and its surface should be appropriately smooth (EN ISO 1597 standard; acrylic ISO 20795-2 type 1). Impressions were made in *Kromopan* alginate material using individual *Elite LC Tray* impression trays made of light-activated resins because of the anatomical conditions in the youngest patient.

In the orthodontic laboratory two models for each appliance were made of *Stodent Ortho* class III hardness plaster (EN ISO 6873): a control one and a working one. It is recommended that a working model should have a broad base which makes it easier to later attach the wire "whiskers". After trimming, the casts included complete anatomical

parts: alveolar margins, palate, attachments and lingual frenula [8,9]. An important step was putting a thin layer of *Vertex* model wax on the vestibular side of the edentulous alveolar ridge, which prevents jaw growth inhibition and extends the life of the appliance before it has to be replaced (after about 6 months).



Figure 1: Impression made on an individual impression tray



Figure 2: A plaster model with a broad base

The acrylic part of the plate covered the palate and the vestibular parts of the alveolar ridges, with an approximately 1mm gap from the roof of the oral vestibule, relief for the lingual fraenum and the attachments of buccal mucosa. The plates were manufactured by means of the pressure polymerisation method through applying acrylic dough onto a previously insulated and lubricated model, or through coating the model with a polymer and spraying it with a monomer until the appropriate thickness has been obtained. The stimulation element was placed along the line of the palatine raphe behind the alveolar ridge, in the centre of the plate or closer to the back edge of the appliance, depending on the orthodontist's recommendations. For polymerisation a pressure pot was used with the water at a temperature

of approximately 40°C and the pressure at a level of 2.5 bars, in which the appliances were placed for 25 minutes. After the required time, the plates were separated from the models and subjected to mechanical preparation. In the next stage, the retentive elements of the "whiskers" made from 0.8-0.9mm wire were mounted in grooves in the plate which were previously made using a cutter [10]. The 'exit' point of the wire on the buccal side should be where the future canines will erupt so that the wires can come out in the corners of the mouth freely without causing any lip tension, though the alignment on the cheeks is expected to produce muscle irritation. The machining and polishing were performed with the utmost care so as not to damage the wire elements. In the case of small children it is recommended to use a light-activated sealant as it ensures greater smoothness and protects the material from absorbing undesirable substances while at the same time covering the entire surface of the appliance [11].

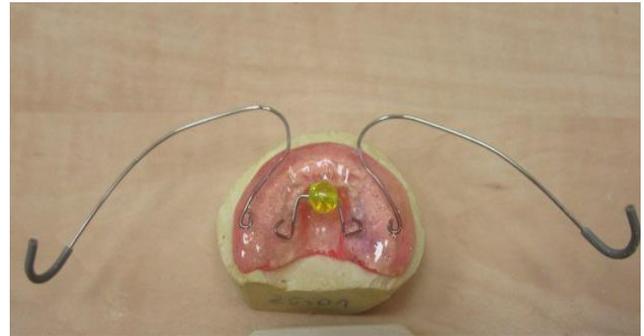
The final step was bending the wires in the extraoral section of the "whiskers" and placing them in plastic tubes to protect the child's cheeks from being chafed [11,14]. The appliance remains attached to the alveolar ridges through adhesion forces. The classic position of the stimulation element is at the rear of the plate; however, following the suggestions of some parents whose children had difficulty reaching it with their tongue, initially it was placed immediately behind the alveolar ridges; then, when the appliance was replaced it was moved to a central position and finally to the back of the plate. It is recommended that a plate should be introduced as early as possible. To begin with, due to the rapidly changing occlusal conditions, it had to be adjusted once every 4 to 6 weeks and replaced every 6 months.



**Figure 3: A palatal plate with a stimulator in the form of a cylinder**

Another stimulating element used in the palatal plates was a movable bead threaded on a wire anchored in the plate.

The efficacy of the treatment was assessed by comparing the condition before the palatal plate rehabilitation and after its completion using the Kruskal-Wallis test.



**Figure 4: A palatal plate with a stimulator in the form of a movable bead threaded on a wire**



**Figure 5: "Whiskers" which are helpful in the initial stages of treatment (exercises with a mother)**

## Results

In 44 children the first palatal plate had a cylinder with a "roller", and in 6 children with a movable bead. In 8 cases, due to problems with the tongue reaching deep into the mouth, the stimulation element was placed close to the alveolar ridge; in 30 cases it was placed in the centre; and in 12 cases it was placed at the rear of the plate.

The second stimulating plate was given to 40 children. The legal guardians of 10 of the older children had decided to withdraw from the therapy because in their opinion there was not sufficient improvement in the tongue position or the mimetic muscles.

During rehabilitation improvement was observed in respect of the mimetic muscles and the tongue position. None of the cases reported deterioration condition.

It was found that during oro-facial rehabilitation the palatal plate adaptation in children who were simultaneously undergoing manual stimulation therapy was better than in those who did not have such therapy.

Stimulation element	N	%
cylinder with a "roller"	44	88.0%
movable bead	6	12.0%

**Table 1: Type of stimulation element in the first palatal plate**

Position	N	%
close to the rear of the plate	12	24.0%
centre of the plate	30	60.0%
close to the front of the plate	8	16.0%

**Table 2: Position of the stimulation element in the first palatal plate**

Stimulation element (second plate)	N	%
cylinder with a "roller"	16	40.0%
movable bead	24	60.0%

**Table 3: Type of stimulation element in the second palatal plate**

Position (second plate)	N	%
close to the rear of the plate	29	72.5%
centre of the plate	10	25.0%
close to the front of the plate	1	2.5%

**Table 4: Position of the stimulation element in the second palatal plate**

**Table 5: Influence of the type of stimulator on the visual improvement of mimetic muscles**

Visual improvement of mimetic muscles	N	%
cylinder with a "roller"	30	60%
movable bead	14	28%
not sure	6	12%

**Table 6: Influence of the type of stimulator on lip closure**

Lip closure	N	%
cylinder with a "roller"	38	76%
movable bead	12	24%

**Table 7: Influence of the type of stimulator on tongue retraction**

Tongue retraction	N	%
cylinder with a "roller"	9	18%
movable bead	35	70%
not sure	6	12%

**Table 8: Relationship between palatal plate adaptation in children with Down syndrome and manual therapy**

Castillo-Morales manual stimulation	Plate adaptation			
	child rather quickly became discouraged from exercises	increased salivation	good plate adaptation	Total
Yes	7	8	15	30
No	5	6	9	20
Total	12	14	24	50

**Table 9: Relationship between a patient's age and palatal plate adaptation in children with Down syndrome**

Manner of plate adaptation	Average age	SD	H	p
Good plate adaptation	1.0	0.8	11.8	0.0027
Increased salivation	1.5	0.5		
Rather quick discouragement of the child	2.0	0.7		

**Discussion**

The rehabilitation of children with Down syndrome includes attempts to improve the appearance by eliminating problems relating to facial features [1]. When assessing the appearance of a

child with this disorder the important elements are tongue position and lip muscle tension as they affect facial features and play a crucial role in how the child is perceived by the people around them [2, 12].

In addition to oro-facial therapy with the use of a stimulating plate the introduction of manual rehabilitation is also recommended because the first motor responses of the oral muscles in a newborn baby are reflex responses to tactile stimuli. Irritation of the mouth area produces the rooting reflex, turning the head towards the stimulus and opening the mouth. Stimulating the gums produces automatic jaw movements, the so-called bite reflex. Such exercises help harmonise jaw and tongue movements during sucking and swallowing, which leads to the development of chewing and speech functions [8,13]. This was confirmed by the current study as better rehabilitation results were obtained for those children who were simultaneously undergoing manual stimulation therapy.

In the youngest children appliances with “whiskers” were used, made according to Poznań modifications [14]. After inserting the plates almost all the children displayed a response, also described by other authors [3,4,6,7], involving retracting the tongue into the mouth and raising it towards the stimulation element, which in the first plates was placed in the centre of the plate or behind the alveolar ridge. The children with Down syndrome who participated in the treatment programme with the first and second palatal plate had regular check-ups, usually every two months. The appliances were replaced on average every six months. A similar length of use and frequency of replacement for appliances can be found in the publications of other authors [8,15] where the appliances were replaced 2 or 3 times during the course of therapy. Other authors recommend that the plates should be worn 3 times a day for one hour, or 4 times a day for half an hour [3,16,17]. For the patients who were treated in Poznan it was recommended that 15-minute stimulation sessions should be repeated several times a day.

No publications have been found describing the treatment of children with Down syndrome using different types of stimulating plates and changes in their construction during their replacement over the course of treatment. It appears that plates with “whiskers” make the exercises easier and thus they proved more effective in the group of youngest children. In the literature there are no data regarding the relationship between the position of the stimulation element and its effectiveness. The

position of the stimulation element in the second palatal plate, which in the majority of the appliances was towards the rear of the plate, produced a favourable response, which suggests that following the treatment with the first plate the children found it easier to reach the stimulator with their tongue.

Based on an analysis of the photographic documentation and feedback from the parents of the children with Down syndrome, improvements in the appearance of facial features were observed in 50 patients and there were no instances of a deterioration in facial features. This result is higher than the one recorded in the study by Hohoff et al. (1999), where improvement was observed in 65% of patients treated with a stimulating plate, and similar to the results obtained by Radwańska [18], who in the course of treatment observed improvement in 45 out of 55 cases with respect to muscle tension, tongue position and lip closure. In the study by Shuster and Giese [19] the recorded rate of improvement was 55%, which is a lower value than in the current study.

The specialists who conduct the therapy must be aware of the fact that the legal guardians of children with Down syndrome have the right to change their decision during therapy and withdraw their consent for the treatment. However, if they decide not to comply with doctors' recommendations or to withdraw from treatment they must be aware of the implications of their decision [20]. The legal guardians of the children with Down syndrome who decided to withdraw from stimulating palatal plate therapy have been informed about the possible consequences of discontinuing the oro-facial stimulation of their children.

## Conclusions

The following conclusions can be formulated on the basis of the research conducted: the stimulator in the form of a cylinder with a “roller” had a greater influence as regards improvements in the appearance of the mimetic muscles and lip closure; whereas a movable bead threaded on a wire and secured to the plate produced greater improvements as regards tongue retraction. The positioning of the stimulation element closer to the alveolar ridges rendered better therapeutic results in the youngest children; whereas placing it in a central or posterior position, usually in the second palatal plate, produced better results in the older children.

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