Effect of palatal plate therapy in children with Down syndrome

A 1-year study

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The effect of palatal plate therapy on oral dysfunction in children with Down syndrome was studied during a 1-year period. Twenty-nine subjects with a mean age of 24 months were randomized to a test group or to a control group. The variables concerning orofacial muscle function—that is, 'closed mouth', 'tip of the tongue visible', 'open mouth', 'inactive protrusion of the tongue', and 'active protrusion of the tongue'—were monitored by video recordings. After 12 months of therapy the mean duration of the factor 'closed mouth' was significantly longer ($p < 0.001$) and 'inactive protrusion of the tongue' significantly shorter ($p < 0.001$) in the test group than in the control group. The results indicate that in children with Down syndrome, palatal plate therapy may be a valuable complement to a training program for improving orofacial muscle function. □ *Mental retardation; muscles; open mouth; oral dysfunction*

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Down syndrome (DS), an autosomal chromosomal anomaly related to trisomy of the 21st chromosome, is the largest diagnostic entity among mentally handicapped children, with an incidence of 1:800 (1).

Characteristic features of the syndrome include protrusion of the tongue and an open-mouth habit, general hypotonia of the musculature of the tongue, upper lip, and the ligamentary apparatus of the temporomandibular joint, together with underdevelopment of the maxilla (2). Orofacial muscle movements and intraoral air pressure, both of which are needed to coordinate the velum, lips, and cheeks in swallowing and speech articulation, are also abnormal in children with Down syndrome (3, 4).

Orofacial physical therapy has been introduced at an early age in children with Down syndrome (5–8). The therapy consists of an exercise program for the orofacial muscles and a palatal plate designed to stimulate the tongue and upper lip (6). The effect of palatal plate therapy on orofacial dysfunction in Down syndrome children has been reported to improve mouth closure and reduce tongue protrusion (6, 7, 9–16). However, an adequate control group—that is, untreated Down syndrome children—was not included in those studies.

The aim of the present study was therefore to evaluate the effect of palatal plate therapy for 1 year in Down syndrome patients, with regard to orofacial muscle function, compared with an untreated group of Down syndrome patients.

Patients and methods

Twenty-nine children with Down syndrome, referred to the Department of Pediatric Dentistry, Karolinska Institute, participated in the study. The test group consisted of 14 children (10 boys, 4 girls), and the control group of 15 children (6 boys, 9 girls) matched within 6 months with regard to age. The age of the children at the start of treatment ranged between 3 months and 5 years, with an average age of 24 ± 6 months. The children in the test group received a palatal plate, a removable orthodontic device, with stimulation areas for the tongue and upper lip (6, 10).

In children without erupted teeth the plate had a bowl-shaped depression at the A-line to minimize tongue protrusion and to stimulate mouth closure (Fig. 1). In children more than 18 months of age, the plate was also designed with a rotatable pearl located behind the upper incisors. The vestibular part of the plate was equipped with 'knobs', to stimulate the upper lip. The plates were molded from an acrylic material to fit the infants' palate snugly and were refabricated every 4–5 months to accommodate the jaw growth. The children used the plate 1/2–1 h twice a day. Children in both the test and control groups were given a regular physiotherapy exercise program for the oral region by their speech therapist (17).

To document oral function, video recordings were made of all 29 children at base line and every 3rd month during the 1-year observation period. The children in the treatment group were filmed without the plate. Most of the video recordings were performed in the mornings, approximately 15 h after the appliance was used. A 10-min section of the video recording was selected for the evaluation. During that period, the mouth of the child was clearly visible on the video tape. Five positions of the lips and tongue were recorded,

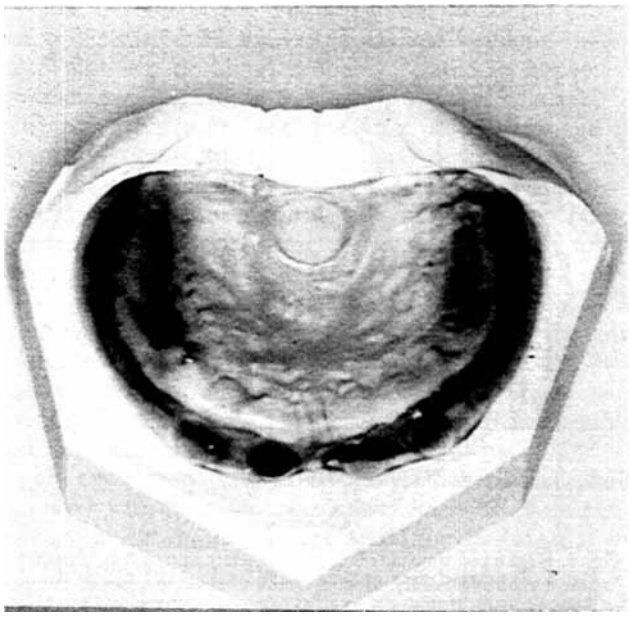

Fig. 1. The appliance, a palatal plate with a bowl-shaped depression at the A-line and vestibular knobs.

both in the test and control groups. The duration of the factors 'closed mouth', 'tip of the tongue visible', 'open mouth', 'inactive protrusion of the tongue', and 'active protrusion of the tongue' was determined (7). 'Closed mouth' was defined as lips totally closed together. 'Open mouth' was defined as lips not in contact, and the tongue inside the mouth. 'Active protrusion of the tongue' was classified as positive when the tongue was outside the mouth and mobile. 'Inactive protrusion of the tongue' was defined as the tongue outside the mouth and immobile.

Video recordings were evaluated twice. A third recording was made if the difference between two determinations of the duration of each factor exceeded 10 sec (6 times of 145 recordings). Using the formula $S(i) = \sqrt{d2/2N}$, the average error of the method was 2.3 sec for the factor 'closed mouth', and 6.8 and 6.1 sec for the factors 'inactive and active protrusion of the tongue', respectively.

Statistical analyses

Student's t test was used to compare differences between the test and control groups. To evaluate the effects of treatment as compared with the base line within the two groups, a paired t test was used.

Results

The effect of palatal plate therapy on the duration of the variables 'closed mouth', 'tip of the tongue visible', 'open mouth', 'inactive protrusion of the tongue', and 'active protrusion of the tongue' recorded on video tape is shown in Table 1.

At base line no significant differences were observed between the test and the control groups. After 9 months of plate therapy the duration of 'closed mouth' was longer ($p < 0.01$) and the duration of 'inactive protrusion of the tongue' shorter ($p < 0.01$) in the test group than in the controls. After 12 months the children in the test group also showed a decreased duration of 'active protrusion of the tongue' ($p < 0.05$) than the controls (Table 1).

In children in the test group, unlike the controls, the duration of the factor 'closed mouth' continuously increased during the study period (Fig. 2).

The duration of 'inactive protrusion of the tongue' in both the test and the control groups during the study period is presented in Fig. 3. There was no difference between the groups after 3 and 6 months of plate therapy. After 9 months of plate therapy, however, the duration of 'inactive protrusion of the tongue' was significantly shorter ($p < 0.001$) in the test group than in the control group.

Table 1. Registered time (%) of variables evaluated on video tape in 29 children with Down syndrome. Mean values ($\bar{x}$) and standard deviations (SD)

	Base line				Follow-up							
					9 months				12 months			
	Test group (n = 14)		Control group (n = 15)		Test group (n = 14)		Control group (n = 15)		Test group (n = 14)		Control group (n = 15)	
Variables	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Closed mouth	1.5	2.9	4.7	12.5	24.0	22.0	4.7	8.2**	29.7	27.2	2.7	4.8***
Tip of tongue visible	3.6	10.1	2.4	4.0	9.6	10.4	5.1	7.0	9.5	12.2	4.9	6.1
Open mouth	61.3	28.9	70.8	26.3	64.2	19.8	58.1	29.5*	59.3	22.9	49.0	32.5
Inactive protrusion of tongue	27.9	22.1	20.8	27.5	1.1	1.9	27.3	28.6**	0.4	1.1	39.2	35.4***
Active protrusion of tongue	5.7	7.7	1.3	1.8	1.1	2.1	4.7	5.2	1.1	2.0	4.2	4.3*

Student's t test: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

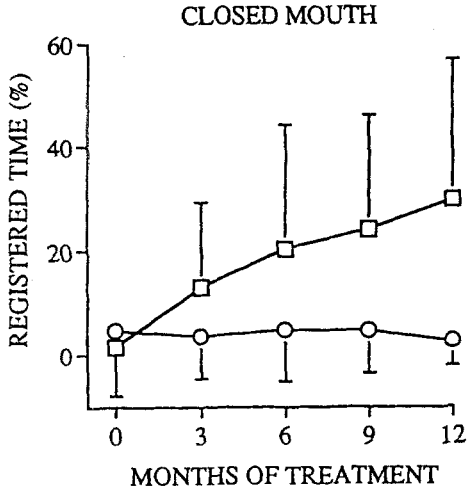

Fig. 2. Registered time in percentage (means and SD) of the factor 'closed mouth' assessed on video tapes in children of the test group (□) and in the control group (○) during the study period.

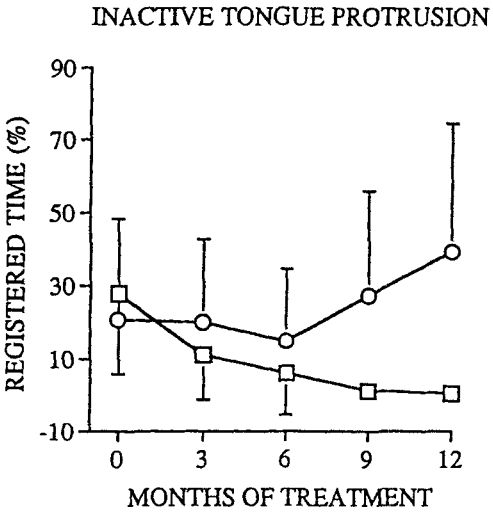

Fig. 3. Registered time in percentage (means and SD) of the factor 'inactive protrusion of the tongue' assessed on video tapes in children of the test group (□) and in the control group (○) during the study period.

Discussion

We here report that palatal plate therapy for 1 year in children with Down syndrome resulted in a longer duration of closed mouth and decreased protrusion of the tongue than in untreated controls. At the end of the study the children in the control group were also offered palatal plate therapy.

In accordance with Glatz-Noll & Berg (15), a video recording of the child's face was found to be a suitable method for evaluating orofacial muscle function, although the recording reflects oral function over a very limited period and may therefore be influenced by fatigue or the mood of the child.

The patients in the control and test groups cooperated well and received great support from their parents. The children in both groups followed a physiotherapy program including training of orofacial muscle function with intraoral and extraoral stimulation exercises (16, 17). Previous studies (7, 10, 15, 16) also stress the importance of physiotherapy as part of the treatment, showing that palatal plate therapy improved mouth closure and reduced the tongue protrusion in Down syndrome patients.

In Down syndrome children the tongue frequently protrudes over the lower lip, and the mean duration of 'inactive protrusion of the tongue' at base line was approximately 25% of the recording time. The magnitude is similar to that previously reported in Down syndrome patients (15).

After 9 months of treatment with palatal plate therapy the duration of 'inactive protrusion of the tongue' decreased markedly, compared with the controls. This factor seems to reflect the degree of hypotonicity in these children (4) and may therefore be suitable, together with the variable 'closed mouth', for demonstrating the effect of plate therapy in Down syndrome children. The mean duration of the 'closed mouth' factor was approximately 3% of the time registered at base line and increased continuously to approximately 30% after 12 months of treatment.

The result showing that the duration of 'closed mouth' increased continuously during the study period is compatible with the finding by Glatz-Noll & Berg (15), but they reported no additional effect on the duration of closed mouth after 7 months of plate therapy. The improvement in mouth closure found in our group of treated Down syndrome children is probably an effect of enhanced lip tonicity, since the plate may stimulate the neuromuscular activity of the lips and masticatory muscles (16). Moreover, as the tongue presses against the plate, a negative pressure is created in the hollow button, passively stabilizing the tongue in a retracted position, which may also contribute to mouth closure (7).

Unlike in Down syndrome children, however, palatal plate therapy did not influence the constant open-mouth habit in a group of children with cerebral palsy, although half of these subjects developed a better coordination of tongue movements (18, 19).

Although the duration of 'closed mouth' increased in children in the treatment group, the duration of an 'open mouth' did not decrease. This may be because children with Down syndrome have narrow nasal meatuses and therefore have a high frequency of mouthbreathing, leading to an open mouth. This condition is probably not related to neuromuscular activity and therefore cannot be influenced by using plate therapy.

The parents of the children in the treatment group reported improvements in eating and drinking habits and also less drooling, probably related to improved swallowing. According to Castillo-Morales et al. (6, 8, 16), plate therapy should be started at an early age to improve craniofacial development and reduce the orofacial dysfunctions of the children. However, we found that retention problems with the plates occur during that period, owing to interactions with tooth eruption.

Our results should be interpreted with caution, as a treatment period of 1 year may be too short for any definite conclusions as to whether the treatment has lasting effects on orofacial function. Further studies are needed to evaluate the long-term effects of plate therapy on the factors investigated.

In conclusion, this study shows that palatal plate therapy may be a valuable complement to a training program for improving orofacial muscle function in children with Down syndrome.

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