

# Palatal Training Appliances in Children with Mild to Moderate Oral Dysfunctions

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**Objective:** The objective of the study was to evaluate the efficacy of palatal training appliances on speech articulation and orofacial functions in children undergoing speech therapy. **Study design:** The material consisted of 134 boys and 34 girls who were referred by speech and language therapists to the Public Dental Health Service in Vantaa due to mild to moderate problems with speech articulation or in oral motor skills. The mean age of the children at the start of the palatal plate therapy was 6.4 years (SD 1.9). The articulation assessment was performed by five speech and language therapist while the palatal plate therapy was carried out by an experienced dentist. The mean treatment time with the oral plates was 4.4 months (SD 2.3). **Results:** An improvement in speech articulation was observed by the speech and language therapists in 51% of the children. Tongue movements improved in 47%, and lip closure in 38% of the participants. Drooling decreased in 54% of the cases. A multiple logistic regression model revealed that with respect to speech articulation the best improvement was found in children with /r/-disorder, and in those with a cross-bite. **Conclusions:** Palatal training appliances during speech therapy seemed to be an efficient way to improve speech articulation and tongue movements in children with mild to moderate problems in orofacial functions.

**Keywords:** misarticulation, orofacial function, palatal training appliance  
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## INTRODUCTION

About 20% of Finnish schoolchildren have difficulties in speech articulation and problems in oral motor skills.<sup>1</sup> The most common misarticulations are errors in the dentoalveolar consonants, which are encountered in 10-34% of Finnish first graders.<sup>2,3</sup> Therapy of the articulatory speech problems usually starts at 4-6 years in health centers or in kindergartens. It usually consumes large amounts of time. Speech and language therapists are mainly responsible for this therapy. In a previous Finnish report, it was noted that even if speech therapy has been started before school age, about half of the children still present speech misarticulations into their second grade.<sup>4</sup> This suggests that either the resources for the speech therapy are inadequate or

the speech misarticulations are too complex to be treated exclusively by speech therapy.

Palatal training appliances have been used in conjunction with speech therapy to improve oral speech behavior. This requires a multidisciplinary team approach between speech therapists and dentists. In the Nordic countries, removable palatal training appliances have been used for over 20 years in order to stimulate the speech production in children. Most of the previous studies concern either children with Down's syndrome<sup>5-8</sup> or children with other mental retardation.<sup>9-11</sup> These studies have clearly highlighted the clinical usefulness of palatal plates. In addition, in a previous Finnish study examining children without neurological defects, palatal plate therapy has been able to normalize tongue movements and improve speech articulation.<sup>12</sup> However, there are no larger studies concerning the effectiveness of the palatal training appliances in children with mild or moderate problems in oral functions. Since access to effective speech therapy is often limited due to scarce resources, one could argue that palatal training appliances may be combined with speech therapy to correct more quickly and more efficiently some of the mild to moderate misarticulations and/or problems in oral motor skills.

The objective of the present study was to evaluate the effectiveness of the palatal training appliances on speech articulation and oral motor skills in children with mild and moderate oral dysfunctions.

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**MATERIAL AND METHODS**

The present study was approved by the city of Vantaa. Consent was obtained from the parents of each participant.

This retrospective study examined 168 four to thirteen year old children with mild to moderate articulatory speech disorders or other minor problems in orofacial functions diagnosed by five speech and language pathologists in Vantaa. The mean age of the children was 6.3 years (SD 1.9), living in the city of Vantaa. The group consisted of 134 (80%) boys and 34 (20%) girls, who had been referred to the Public Dental Care for palatal plate treatment. All the children were treated by an experienced dentist (MK) during the years 2002-2008. Two children had Down syndrome, one child presented Fragile X syndrome, and ten children had mild mental retardation; otherwise the children were healthy.

The oral functional problems requiring a dental consultation and palatal plate treatment are summarized in Table 1. One hundred and twelve (66%) of the children were cooperative and continued to use the palatal training appliances during the whole treatment period. Fifty-six children were excluded from the study because of the following reasons: it was not possible to obtain alginate impressions, the palatal plate fitted improperly, or no cooperation was obtained

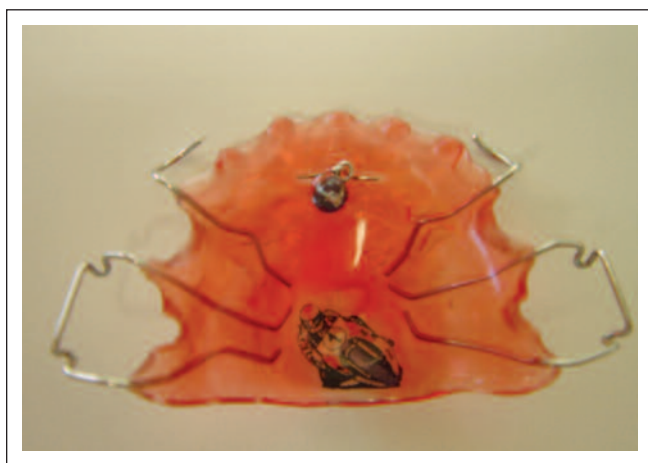
**Table 1.** Distribution of oral functional problems observed by the speech therapists in 168 Finnish children.

	n	%
Problems with speech articulation	151	90
Problems with tongue movements	79	47
Lip incompetence	31	18
Drooling	19	11

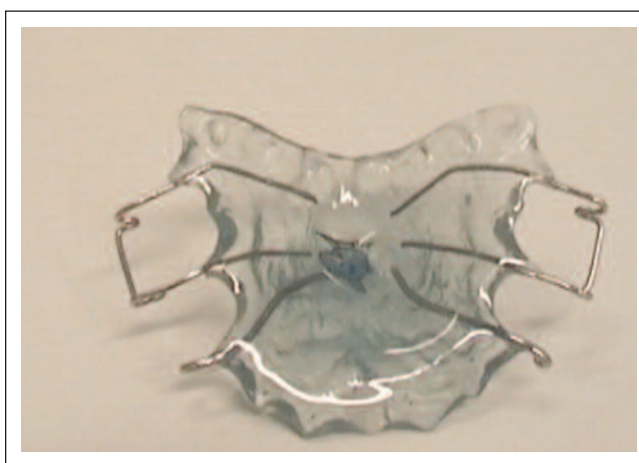
during the treatment period.

Alginate impressions were taken in the maxillary arch to manufacture the palatal training appliances. In addition, an experienced dentist (MK) recorded the occlusion of the children and the developmental stage of the dentition was classified as primary dentition, mixed dentition or permanent dentition.

The type of a stimulating component of the palatal plate was chosen according to the individual's problem, and was based on previous knowledge reported in literature.<sup>13</sup> The movable pearl in the dentoalveolar area was chosen in order to activate the tip of the tongue (Fig 1a), and knots in the same area were used in cases where the tongue encountered difficulties in finding the anterior part of the palate (Fig 1b). Distopalatal knots or "doughnut" were used to activate the posterior part of the tongue (Fig 1c), especially in /k/-



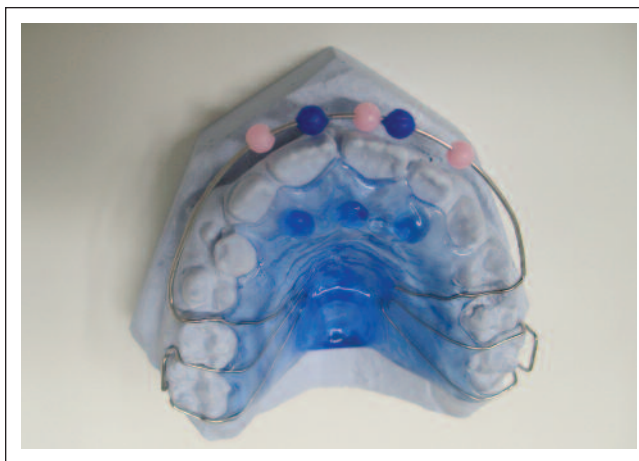
**Figure 1a.** Palatal plate with movable pearl in the dentoalveolar area.



**Figure 1c.** Palatal plate with distopalatal knots.



**Figure 1b.** Palatal plate with knots in the dentoalveolar area.



**Figure 1d.** Palatal plate with different kinds of stimulating components.

sounds. Figure 1d displays an example of a combination plate with different kinds of stimulating components, e.g. labial pellets to activate the lip seal. The five experienced speech and language therapists observed changes in speech articulation, in oral motor skills, in lip seal and/or in drooling.

The child and his/her parents were given both an oral and hands-on instructions on how to use the appliance. Basically the child was advised to use the plate for 30 minutes each day. The plates were attractively illustrated in order to increase children's acceptance and motivation.

**Statistical methods**

Mean values and standard deviations were used to describe the baseline characteristics of the study group. Analysis of variance (ANOVA) and chi-square statistics were used to evaluate the effectiveness of the palatal plate therapy (no improvement/slight improvement/clear improvement) on different orofacial functions and misarticulations of speech. Multiple logistic regression analysis with a backward selection setup procedure was used to evaluate the associations between the effectiveness of the palatal training appliance (0=no/slight improvement, 1=clear improvement) observed by the speech and language therapists, and occlusal features such as lateral crossbite (0=no, 1=yes), overjet (mm) and overbite (mm), treatment time (months), and different articulatory speech disorders (/r/-, /s/-, /l/-, /d/- and /k/-disorders (0=no, 1=yes for each disorder), drooling (0=no,1=yes) and inadequate lip seal (0=no,1=yes). The model was adjusted for age and gender. P-values of less than 0.05 were considered significant. All analyses were performed with the Statistical Package for the Social Sciences version 17.0 (SPSS Inc., Chicago, IL).

**RESULTS**

The most prevalent articulatory misarticulations were /s/- and /r/-disorders (Table 2). Those misarticulations were observed in 42 % and in 64% of the children, respectively. Altogether sixty-eight children were fitted with a palatal

**Table 2.** Prevalence of articulatory speech disorders in 112 children prior to palatal plate treatment.

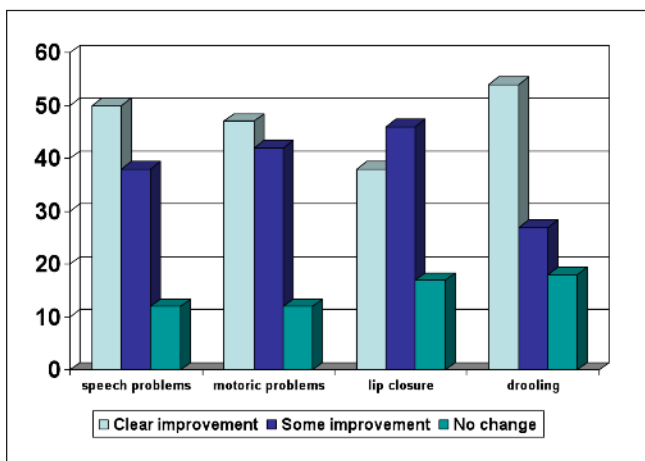
Speech disorder	n	%
/r/-sound	72	64
/s/-sound	47	42
/l/-sound	37	33
/d/-sound	19	17
/k/-sound	12	11
/t/-sound	6	5

plate with a movable pearl in the dentoalveolar area. Sixteen subjects had a plate with only fixed plastic knots on that area. Twelve subjects were provided with a distopalatal stimulating component, either knots in the area between the hard palate and the velum, or a doughnut. Sixteen children had combination plates with modifications of the former models. The mean treatment time with the plates was 4.4 months (SD 2.3), ranging from one month to sixteen months.

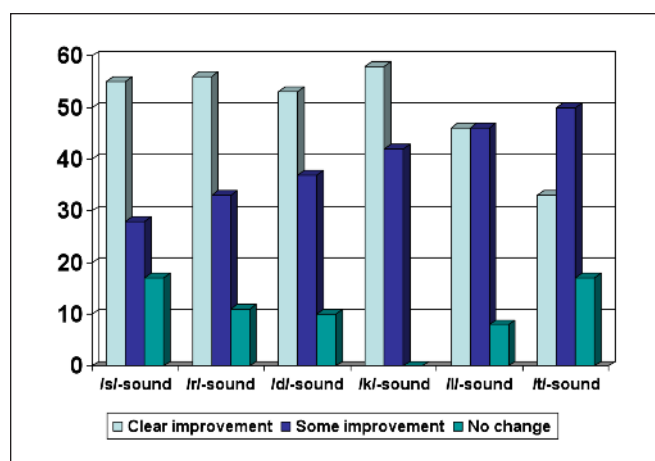
The results indicated that there was a clear improvement in about half of the children both in articulation of single sounds as well as in oral motor skills (Figs 2 and 3). However, no change was observed in 12% of the cases. Improvement in lip closure was clear in 38% and a reduction of drooling was noted in 54% of the subjects. The treatment has no effect on lip closure in 17 % and on drooling in 18% of the children.

With regard to the developmental stage of the dentition, 44% of the children were in their primary dentition, 55% had mixed dentition and 1% had all permanent teeth. In the present sample, lateral crossbite was the most prevalent malocclusion trait (18 %), and in 4 % of the cases some teeth were in a scissors bite. The mean value of the overjet was 1.7 mm (SD 1.5), whereas that of overbite was 1.7 mm (SD 2.3).

The multiple logistic regression model revealed that /r/-sound and crossbite were the only variables that were significantly related to a good response to the palatal plate treatment (p= .019 and p=.036, respectively) (Table 3).



**Figure 2.** Improvement in oral functions (%) after palatal plate treatment in 112 children assessed by speech and language therapists.



**Figure 3.** Improvement in speech sounds articulation (%) after palatal plate treatment in 112 children assessed by speech and language therapists.

**Table 3.** Relationship between the effectiveness of the palatal plate treatment (0=no/slight improvement, 1=clear improvement) assessed by the speech therapists, and occlusal features, different articulatory speech disorders (/r/-, /s/-, /l/-, /d/-, /k/- and /t/- sounds), problems with tongue movements, lip incompetence and drooling as well as treatment time (months) as estimated by logistic regression model. The model was adjusted for age and gender.

Independent variable	B	Exp(B)	95% CI for exp(B)	p
/r/-sound	1.42	4.14	1.23,13.6	.019
crossbite	1.48	4.39	1.1,17.5	.036
treatment time	-0.19	0.82	0.7,1.0	.091

**DISCUSSION**

The present results indicated that the use of palatal training appliances during speech therapy were objectively successful in improving speech articulation and oral motor skills in children with mild to moderate oral dysfunctions. These results indicate that in certain cases, the combination of speech therapy with the palatal training appliances is more effective to improve speech articulation than speech therapy alone.

Although most 2-year-old children can master the /s/-sound, and more than one third of them also some words with /r/-sound, those sounds are the last to be learned.<sup>14</sup> In general, speech sound production has been estimated to mature by the age of 5 years,<sup>15</sup> and adoption of the correct phonetic consonants takes place by school age.<sup>16</sup> However, since about 30% of the children at the age of five still have errors in producing /r/- and/or /s/-sounds,<sup>16</sup> it has been estimated that if by that age a child is not able to articulate clearly, it is unlikely that spontaneous improvement in speech articulation will occur without speech therapy.

According to the present results, it is possible, even preferable, to start the palatal plate treatment rather early, possibly at the age of five. Rotating movements of the jaw/tongue gradually develop into grinding movements, and mature chewing is fully developed by the age of three.<sup>17</sup> Soon after this age, the oral motor functions develop to such a functional level that an effective palatal plate can be implemented when needed. One prerequisite for a successful treatment is an early diagnosis of the problem and correction of the potential malocclusions, which otherwise might complicate the correct speech articulation.<sup>18</sup>

Children with articulatory speech disorders are reported to have systematically more inaccurate tongue movements and poor movement coordination than children without speech defects.<sup>19</sup> With regard to errors of individual sounds, /s/- and /r/- misarticulations are the most common in several semantic areas. Boys seem to make more articulating errors than girls, especially in the /r/-sound,<sup>3,20,21</sup> while /s/-disorders seem to be more common in girls.<sup>3</sup> In this present sample also, most of the children with speech disorders were boys, and /s/- and /r/-misarticulations were the most prevalent speech defects.

Furthermore, the present result observed that the best treatment results were found in children with /r/- disorders.

In a previous study on Finnish 7- year-old children, it was noted that /r/-disorders were rather resistant to speech therapy.<sup>3</sup> In both of these studies children were 6- to 7-year-olds, with mild to moderate articulatory speech disorders and received some speech training by that age. Thus, the combination of speech therapy to palatal plate treatment is more effective at improving /r/-misarticulation than speech therapy alone. This raises the question of whether there is the need to reassess the timing and form of speech therapy in subjects with mild to moderate oral dysfunctions either with or without palatal plates.

According to the logistic regression analysis, crossbite was significantly related to effectiveness of the palatal plate treatment. This positive association indicated that those children who had a lateral crossbite were more likely to benefit from the oral plates. Good skeletal and occlusal relationships enable the tongue to articulate optimally against the maxillary teeth and alveolus, encouraging a comfortable lip seal.<sup>22</sup> Structural deviations, including occlusal problems may contribute to poor speech sound production.<sup>23</sup>

Most of the children in the present sample were in the mixed dentition stage and their incisors were erupting. Thus no conclusions can be made on the effect of an extreme overjet/overbite or anterior open bite/anterior crossbite on speech articulation.

According to the logistic regression model, palatal training appliances were mildly effective in reducing drooling or improving lip seal. The ability to control saliva develops alongside normal feeding and oral-motor control, and drooling beyond the age of 4 years is considered to be neurodevelopmentally abnormal.<sup>24</sup> Chronic drooling is usually seen in children with a specific oral-motor difficulty.<sup>25,26</sup> Furthermore, it has been speculated that drooling is related to ineffective tongue and/or poor bolus control rather than to incompetent lip seal or hypersalivation.<sup>27</sup> Based on their study, Pani and Hedge<sup>28</sup> suggested that in some cases with mild to moderate oral dysfunctions intraoral training appliances can be successful in reducing drooling.<sup>28</sup> Drooling was not quantified but its reduction was based on the evaluation of the experienced speech therapists. This change is likely due to stimulation of tongue and palatal movements, encouraging the distal transfer saliva to the back of the oral cavity prior to swallowing.

The logistic regression model detected a tendency that the treatment time was negatively related to palatal plate success. This suggests that the best results with the plates are seen shortly after the treatment has initiated. Long treatment periods elicit poor responses to treatment or poor cooperation. It is important when treating the patients with the palatal training appliances to ensure that the correct speech articulation or oral motor movement has been corrected before stopping plate treatment.

Good motivation and cooperation as well as regular use of a palatal training appliance are the prerequisites of success in treatment. Individually designed and attractively illustrated plates are very important ways to increase children's acceptance and compliance to the treatment. In the

present study, only two children discontinued the plates. Clinical experience suggests that this approach is only applicable to children with mild to moderate oral dysfunction, good cognitive skills and a high level of motivation.

## CONCLUSIONS

Palatal training appliances proved to be successful in improving speech articulation and tongue movements in children with mild to moderate problems in oral functions. This underlines the importance of increasing the awareness of the benefits of oral stimulating plates in combination with speech therapy in children with mild and moderate oral dysfunction.

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