ORIGINAL ARTICLE

Influence of palatal expanders on oral comfort, speech, and mastication

Nanci L. Oliveira De Felippe,[a] Adriana C. Da Silveira,[b] Grace Viana,[c] and Bonnie Smith[d]
Edina, Minn, Austin, Tex, and Chicago, Ill

Introduction: It is not known whether the design of the expander has an effect on initial adaptation, comfort level, speech, chewing, and swallowing, or whether age is a crucial aspect when dealing with speech adaptations. The objectives of this study were to assess whether patients of different age groups undergoing palatal expansion with various types of expanders experienced discomfort, speech impairment, chewing difficulty, and swallowing disturbances. **Methods:** A questionnaire was developed and distributed to patients who had received palatal expanders in the preceding 3 to 12 months. **Results:** Regardless of the type of expander, most patients initially felt oral discomfort, and had problems with speech and mastication. However, these disturbances were confined to the first week after cementation of the device. Remarkable adaptation to the device in all aspects studied was observed by the end of the first week. In addition, age did not influence the variables; younger patients and older teenagers responded similarly to the survey. In addition, the questionnaire responses did not appear to be related to the respondents' sex. **Conclusions:** Discomfort might not be a deciding variable when choosing an appliance. Instead, clinicians should base their decision on factors such as its biomechanics. (Am J Orthod Dentofacial Orthop 2010;137:48-53)

Most adolescents consider orthodontic treatment a right of passage and something that is socially desirable during this time in their life. However, along with the benefits of achieving a beautiful smile, orthodontic patients can experience many problems. For example, Stewart et al[1] accurately stated that "orthodontic appliances must be interpreted as foreign bodies inserted in an important, and sensitive, area of the body." Brackets and wires often cause pressure and ulceration of the mucosa; lingual appliances cause displacement of the tongue; palatal appliances cause a feeling of constraint; and fixed and removable devices interfere with speech, swallowing, and chewing, not to mention the generalized dental soreness and pain caused by local inflammation that ultimately results in tooth movement.

One might ask whether orthodontic patients fully understand what to expect. It is well known that clinical management is more efficient when all explanations are given, with anticipatory guidance provided before the appliances are placed.[1-4] Moreover, information should be tailored to suit the type of treatment planned, should be accompanied by motivations, and should include a discussion of the effects of noncompliance.

In addition, few studies have monitored the long-term effects of orthodontic appliances on swallowing,[1,4] comfort,[1,5-10] and psychosocial aspects such as feelings of embarrassment.[1,4,11] Generally, current evidence suggests that most negative effects of appliance wear become more tolerable with time, but most investigations in this field have focused on pain and speech.

Speech production can be affected by any osseous, muscular, dental, or soft-tissue deformity or any device impairing the movement or appearance of the speech sound articulators. For example, Johnson and Sandy[12] evaluated malocclusion and abnormal tooth position in relation to articulation problems and concluded that, because of the potential for mechanism compensations and the ability of a motor act to adapt to changing landmarks, many patients achieve normal speech despite abnormal tooth position. Similarly, dental appliances might cause articulatory production errors of linguodental, labiodental, or linguoalveolar consonants, but these disruptions are minimized after a short period of wear because of functional adaptation.[13]

The effects of orthodontic appliances on speech have been extensively studied during the past decades.[14-16] Functional appliances have been rated the most deleterious to speech,[4,15,17,18] followed by maxillary retainers,[14-16] lingual fixed appliances,[8] and

[a]Private practice, Edina, Minn.
[b]Chief of orthodontics, Craniofacial Center, Dell Children's Medical Center of Central Texas, Austin, Tex.
[c]Biostatistician, Department of Orthodontics, University of Illinois at Chicago.
[d]Professor Emerita of Speech Pathology, University of Illinois, Chicago, IL; private practice, Murdock, Fla.
The authors report no commercial, proprietary, or financial interest in the products or companies described in this article.
Reprint requests to: Nanci L. O. De Felippe, 5101 Vermon Ave South, Suite 502, Edina, MN 55436; e-mail, orthonan@yahoo.com.
Submitted, December 2007; revised and accepted, January 2008.
0889-5406/$36.00

doi:10.1016/j.ajodo.2008.01.023

lingual retainers.[16] Usually, the impairment is temporary, varying from a few days to a few weeks; however, Stewart et al[1] reported speech problems up to 3 months. Strutton and Burkland[15] tested the effects of various designs of maxillary retainers on the clarity of speech at initial placement and concluded that Crozat type and modified horseshoe type retainers are superior to the traditional Hawley design.

With respect to speech problems, the most frequently affected sound is the /s/. In 1986, Laine[19] studied palatal appliances and /s/ production and found that the narrower the palate, the greater the distortion of the /s/ sound because the appliance added a physical barrier to the palate and, therefore, diminished the tongue's functional space. Haydar et al[16] used audiotape recordings of 15 patients to evaluate speech on the first day of wearing the appliance, at 24 hours, and 1 week later. They concluded that, on the day of placement, there were statistically significant distortions of the /t,d/ and /k,g/ sounds with maxillary retainers, and the /t,n/, /k,g/, and /s,j/ sounds with maxillary and mandibular removable retainers. They found, at 24 hours of appliance wear, improvement of the /d/ and /k,g/ sounds with the maxillary retainer and of /t,n/ and /s/ with both retainers. At 1 week, they found that no significant sound problems remained. Hohoff et al[8] evaluated speech and bonded lingual appliances. They concluded that these appliances caused speech problems, especially with the /s/ sound, and that smaller lingual appliances caused less-pronounced speech impairments.

Currently, there is little information about the effects of palatal expanders on speech and masticatory function, overall comfort of wear, chewing, and swallowing functions. Specifically, it is not known whether the design of the expander has an effect on initial adaptation, comfort level, speech, chewing, and swallowing, or whether age is a crucial aspect in speech adaptations. Therefore, the objectives of this study were to assess whether patients of different age groups undergoing palatal expansion with various types of expanders experienced discomfort, speech impairment, chewing difficulty, and swallowing disturbances.

In addition, our goal was to gather sufficient information to create future educational guidelines to help expedite patients' adaptation to palatal expanders.

MATERIAL AND METHODS

A questionnaire was developed, comprising 23 questions, to gather the data for this study. This questionnaire was distributed to patients who had received palatal expanders in the last 3 to 12 months from several private practices and an orthodontic graduate clinic. Of the 23 questions, 7 pertained to oral comfort (section 1), 6 to speech (section 2), 5 to chewing (section 3), and 5 to swallowing (section 4). The subjects' responses were further categorized according to their appliances (Fig 1).

The development of the questionnaire was based on previous published research.[1,4,7,8] The study's protocol was reviewed and approved by the institutional review board of the University of Illinois at Chicago. Subject and parental consents were obtained. Instructions were given to the subjects, and all their questions were answered before administration of the questionnaire.

The subjects were asked to read the questionnaire items and circle the response that most closely agreed with how they experienced this item. The questions and responses, in a multiple-choice format, were kept to a minimum to ensure optimal compliance. Examples of the questions are shown in Figure 2.

A total of 165 questionnaires were distributed and completed. Table I shows the demographics of the sample. Table II provides descriptive statistics for the sample. Cross-tabulation and appropriate statistical analysis with the Pearson chi-square test with the significance set at the 0.05 level were carried out.

RESULTS

Not all of the 165 questionnaires contained all information requested. For example, only 146 questionnaires listed sex. Of these, 60 were male (41.4%), and 86 were female (58.9%). Of the 132 questionnaires that listed age, 77 (58.3%) were in the age group between 11 and 14 years; 28 (21.2%) were between 15 and 18 years old; 24 (18.2%) were between 7 and 10 years old; and 3 (2.3%) were between 19 and 22 years old.

As noted earlier, section 1 of the questionnaire dealt with the physical traits of oral discomfort. Of the 163 respondents, 93.9% stated that their appliance generated pain and discomfort, especially in the first few days of treatment. There was no statistically significant correlation between the degree of discomfort and the type of appliance. Figure 3 gives the percentages of discomfort reported for each appliance. These results also show no statistically significant correlation between the demographic data (sex and age) and the responses about discomfort. Both sexes of all ages reported pain in the beginning of expansion regardless of the type of expander used.

Section 2 evaluated the effects of the expander on the articulation of speech. Ninety-eight percent of the respondents completed this section of the questionnaire. The results showed that 89.4% of this group stated that the expander affected their speech. No statistically

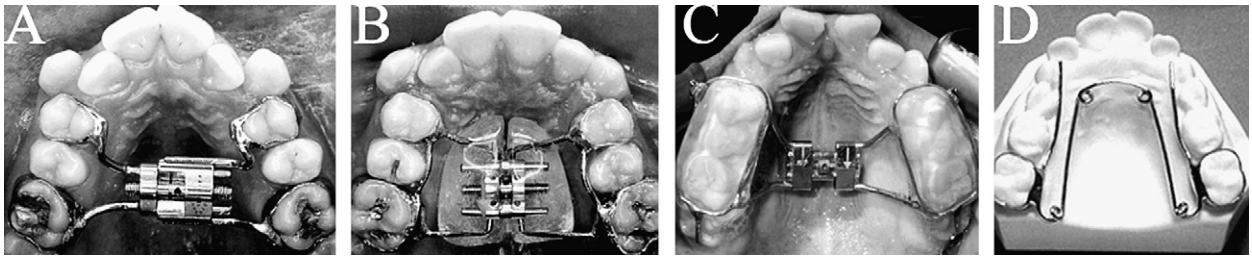

Fig 1. Types of expanders included in the study: **A,** Hyrax; **B,** Haas; **C,** bonded; **D,** quad-helix.

	Number of questions	Examples
Section 1 Oral Comfort	7	In a scale of 0 to 10 (being 10 worst), please grade your degree of discomfort: 0 1 2 3 4 5 6 7 8 9 10
Section 2 Speech	6	If there was a change in your speech, how did it sound when you talked with the appliance in your mouth? 1) totally different 2) with a lisp 3) hoarse 4) cannot explain 5) other
Section 3 Chewing	5	Was there any affect on chewing when you first ate with it in your mouth? 1) yes 2) no If yes, check all that apply: 1) it was hard to chew 2) it hurt my tongue 3) could not taste the food as usual 4) there was less room for the food 5) cannot explain 6) other
Section 4 Swallowing	5	Was there any affect on swallowing when you first ate/drank with the appliance in your mouth? 1) yes 2) no If yes, check all that apply: 1) could not swallow as usual 2) drooled more than the usual 3) had gagging reflexes 4) could not feel the presence of the food/drink 5) cannot explain 6) other
Total	23	

Fig 2. Examples of questions asked in each section of the survey.

significant correlation was found with sex, age, or type of appliance. In addition, it was impossible from their responses to determine which phonemes were statistically significantly affected. However, the alveolar sounds—/t/, /d/, /s/, and /z/—were reported by 13.3% as problematic. Also, in general, speech problems

Table I. Demographics of the sample

	Frequency	*Percentage*
Sex		
Male	60	41.1
Female	86	58.9
Total	146	100.0
Age (y)		
7-10	24	18.2
11-14	77	58.3
15-18	28	21.2
19-22	3	2.3
Total	132	100.0
Type of appliance		
Hyrax	12	8.6
Haas	50	36.0
Bonded	37	26.6
Quad-helix	32	23.0
Did not know	8	5.8
Total	139	100.0
System not noted	26	

Table II. Pain, speech, chewing, and swallowing findings

Category of discomfort	*Frequency*	*Percentage*
Pain		
Yes	10	93.9
No	153	6.1
Total	163	100.0
Speech		
Yes	144	89.4
No	17	10.6
Total	161	100.0
Chewing		
Yes	148	90.2
No	16	9.8
Total	164	100.0
Swallowing		
Yes	112	67.9
No	52	31.5
Total	165	100.0

resolved by the end of the first week after cementation of the expander.

Sections 3 and 4 dealt with chewing and swallowing, respectively. Almost all subjects completed these sections. Most respondents (90.2%) stated that the expander interfered with chewing, and 67.9% reported that it affected swallowing. These findings, however, were not correlated with sex, age, or type of appliance.

In our sample, the Haas expander was the most frequently used, accounting for 36.0% (Table I) of the surveyed population. The most respondents were in the age group of 11 to 14 years (58.3%). All types of appliances studied had similar effects on discomfort, speech, and mastication ($P > 0.05$).

DISCUSSION

Our questionnaire can be used by clinicians to review patients' adaptations to palatal expanders regarding oral discomfort, speech, and mastication in each patient's perception. For example, appliance design is often selected based on the clinician's personal preference and patient comfort.[20] However, our study results showed that all investigated appliances caused similar levels of discomfort for the patients. Therefore, discomfort might not be a deciding variable when choosing an appliance but, rather, its biomechanics in a given situation.

Our sample showed that, regardless of the type of expander, most patients initially felt oral discomfort, and had problems with speech and mastication. However, these disturbances were confined to the first week after cementation of the device. Remarkable adaptation to the device in all aspects studied was observed by the end of the first week. In addition, age did not influence the variables; younger patients and older teenagers responded similarly to our survey, and responses did not appear to be related to sex.

No prior studies have shown how patients perceive oral comfort in relation to the kind of palatal expanders. Sergl et al[4] assessed feelings of oral constraint and lack of confidence in relation to removable, functional, or fixed appliances. They concluded that significantly fewer complaints can be expected between 2 and 7 days after placement of the appliance. Pain and discomfort of moderate levels were reported by 93.9% of our subjects. Fortunately, these disappeared after the first week, in agreement with the study of Stewart et al.[1]

It has been hypothesized that dentures and orthodontic appliances interfere with speech production. In particular, maxillary appliances impact linguodental, linguoalveolar, and linguopalatal articulatory contacts. Therefore, the sounds most likely to be affected would include "th," /t/, /d/, /s/, /z/, /n/, /l/, "sh," "zh," /r/, "ch," and "j." Our study could not determine which sound was most affected by the expanders studied. In regard to speech adaptation, Hamlet[21] proposed that younger patients show more ability to adapt to a new oral environment. Our findings do not support this, since age was not significantly correlated to any of the variables studied.

Our findings suggest that chewing is slightly more affected that swallowing. Nonetheless, both variables were reported to return to normal after about a week.

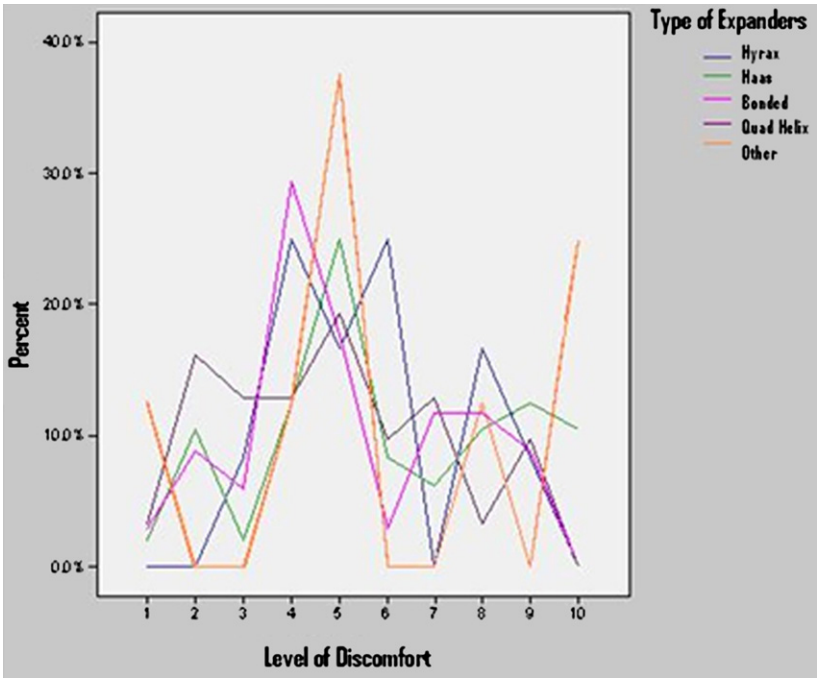

Fig 3. Percentages of the degree of discomfort by appliances included in the study.

CONCLUSIONS

We found that all potentially negative impacts of placing a palatal expander, including pain and discomfort, disruption of speech production, and chewing and swallowing problems were mild, transitory, and independent of appliance design, sex, or age. All issues were resolved within the first week of appliance wear.

Much of the information gathered in this study can be readily incorporated into the patient education process, so that patients can be counseled about the changes to expect with relation to pain, discomfort, speech, chewing, and swallowing immediately after an appliance is placed and up to a week after wearing it. The patient's psychological response to orthodontic treatment and ability to adapt to the appliance might be significantly improved with anticipatory guidance.[1,3,4] Providing such information to patients can be expected to expedite the adaptation process and improve cooperation.

Based on the limitations of this study, we suggest that future studies have stratified sample sizes (ie, the same numbers of subjects in every age group and for each type of expander). Furthermore, it is advisable that clinical assessments by a speech pathologist and an orthodontist to evaluate the patients' speech and the position of the teeth and tongue, respectively, at different times, are included. Finally, it would be desirable to compare the results of retrospective questionnaires, administered after the expander has been removed from patients' mouths, with those of prospective questionnaires containing their daily impressions of oral comfort, speech, and masticatory function.

We thank Monika Mahajan for help with the manuscript and Drs Andrew Hass, Cyril Sadowsky, Ashok Kothari, Terry Selke, Robyn Silberstein, and Heek Young Jo for help with the data collection.

REFERENCES

1. Stewart FN, Kerr WJ, Taylor PJ. Appliance wear: the patient's point of view. Eur J Orthod 1997;19:377-82.
2. Tedesco LA, Keffer MA, Davis EL, Christersson LA. Effect of a social cognitive intervention on oral health status, behavior reports, and cognitions. J Periodontol 1992;63:567-75.
3. Sergl HG, Zentner A. A comparative assessment of acceptance of different types of functional appliances. Eur J Orthod 1998;20: 517-24.
4. Sergl HG, Klages U, Zentner A. Functional and social discomfort during orthodontic treatment—effects on compliance and prediction of patients' adaptation by personality variables. Eur J Orthod 2000;22:307-15.
5. Sinclair PM, Cannito MF, Goates LJ, Solomos LF, Alexander CM. Patient responses to lingual appliances. J Clin Orthod 1986;20: 396-404.
6. Årtun J. A post-treatment evaluation of multibonded ceramic brackets in orthodontics. Eur J Orthod 1997;19:219-28.
7. Miyawaki S, Yasuhara M, Koh Y. Discomfort caused by bonded lingual orthodontic appliances in adult patients as examined by

retrospective questionnaire. Am J Orthod Dentofacial Orthop 1999;115:83-8.
8. Hohoff A, Stamm T, Goder G, Sauerland C, Ehmer U, Seifert E. Comparison of 3 bonded lingual appliances by auditive analysis and subjective assessment. Am J Orthod Dentofacial Orthop 2003;124:737-45.
9. Hohoff A, Fillion D, Stamm T, Goder G, Sauerland C, Ehmer U. Oral comfort, function and hygiene in patients with lingual brackets. A prospective longitudinal study. J Orofac Orthop 2003;64:359-71.
10. Hohoff A, Stamm T, Ehmer U. Comparison of the effect on oral discomfort of two positioning techniques with lingual brackets. Angle Orthod 2004;74:226-33.
11. Lewis HG, Brown WA. The attitude of patients to the wearing of a removable orthodontic appliance. Br Dent J 1973;134: 87-90.
12. Johnson NC, Sandy JR. Tooth position and speech—is there a relationship? Angle Orthod 1999;69:306-10.
13. Khalil AM. Short- and long-term effects of thumb-sucking habit breaking appliance on speech in children. Egypt Dent J 1994; 40:827-32.
14. Erb DP. Speech effects of the maxillary retainer. Angle Orthod 1967;37:298-303.
15. Strutton CS, Burkland GA. The effect of maxillary retainers on the clarity of speech. J Clin Orthod 1993;27:338-40.
16. Haydar B, Karabulut G, Ozkan S, Aksoy AU, Ciğer S. Effects of retainers on the articulation of speech. Am J Orthod Dentofacial Orthop 1996;110:535-40.
17. Garber SR, Speidel TM, Siegel GM. The effects of noise and palatal appliances on the speech of five-year-old children. J Speech Hear Res 1980;23:853-62.
18. Garber SR, Speidel TM, Siegel GM, Miller E, Glass L. The effects of presentation of noise and dental appliances on speech. J Speech Hear Res 1980;23:838-52.
19. Laine T. Articulatory disorders in speech as related to size of the alveolar arches. Eur J Orthod 1986;8:192-7.
20. Oliveira N, Da Silveira A, Kusnoto B, Viana G. Three-dimensional assessment of morphologic changes of the maxilla: a comparison of 2 kinds of palatal expanders. Am J Orthod Dentofacial Orthop 2004;126:354-62.
21. Hamlet SL. Speech adaptation to dental appliances: theoretical considerations. J Baltimore Coll Dent Surg 1973;8:51-63.