Effects of lingual arch used as space maintainer on mandibular arch dimension: A systematic review

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Introduction: The aim of this systematic review was to examine the effects of a lingual arch on mandibular arch dimensions when it is used as a space maintainer. **Methods:** PubMed, Medline, Lilacs, Cochrane Central, and Cochrane Database of Systematic Reviews were surveyed for articles published between January 1980 and January 2009. Inclusion criteria were human subjects, prospective or retrospective method, effect of the lingual arch used as space maintainer in the mandibular arch, and publication in English. **Results:** Of the 262 studies identified in the search, only 2 met the final inclusion criteria. **Conclusions:** The results showed that the lingual arch is effective for controlling mesial movement of molars and lingual tipping of incisors. (Am J Orthod Dentofacial Orthop 2010;138:382.e1-382.e4)

Space management continues to play an important role in dental practice. In 1887, Davenport[1] described space loss resulting from premature loss of deciduous teeth. The causes for tooth loss can be deep dental caries, trauma or iatrogenic damage, and congenital absence.[2] About 51% of the prematurely lost first deciduous molars and 70% of prematurely lost second deciduous molars cause loss of space and subsequent effects such as malposition or impaction of a permanent tooth in that quadrant,[3] tipping of the first permanent molar, and crowding in the dental arch.[4-6]

Space maintenance in the developing dentition can prevent unnecessary loss of arch length.

Various space maintainers have been used to cope with these problems. They are indicated for loss of at least 1 deciduous tooth, loss of arch perimeter, or a favorable prediction from the space analysis if it can be completed.

In preventive and interceptive orthodontics, the use of a mandibular fixed lingual applicance (FLA) is a commonly accepted procedure to maintain arch perimeter by preventing mesial tipping or drifting of the mandibular molars. Molar positions are stabilized against the mandibular incisors by the appliance, which also prevents the incisors from tipping lingually.[7]

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The movements occurring are molar uprighting and incisor protrusion.[8,9] The reason for protrusion is that the balance of the forces exerted on the incisors by the tongue and the perioral muscles is impaired.

The aim of this study was to conduct a systematic review to evaluate the effects of the lingual arch as a space maintainer on the mandibular arch dimension.

MATERIAL AND METHODS

To identify all studies about the effect of lingual arches as space maintainers, a computer search was conducted of PubMed, Medline, Lilacs, Cochrane Central, and Cochrane Database of Systematic Reviews from January 1980 to January 2009. The terms used in the literature search were "lingual arch*, space maint*, anchor*, arch length, arch width, incisor crowding, and orthodontics." The following journals were searched individually to locate any missing articles from the PubMed search: *Angle Orthodontist*, *American Journal of Orthodontics and Dentofacial Orthopedics*, *Journal of Orthodontics*, and *European Journal of Orthodontics*. The following inclusion criteria were chosen to initially select potential articles from the results in abstracts: human studies, prospective and retrospective studies, studies discussing the effect of lingual arches used as space maintainers in mandibular arch dimensions, and articles in English. Excluded articles were mainly animal studies, abstracts, in-vitro studies, discussions and interviews, case reports, case series articles in a language other than English, and studies that did not follow the objective of this review. No attempts were made at this stage to identify studies without adequate control groups or that did not report results as arch-dimension

Table. Final exclusion criteria of this systematic review

Year	*Authors*	*Reason for exclusion*
2003	Kinzinger et al[10]	No control group of patients without treatment; lingual arch combined with a maxillary appliance
2000	Brennan et al[11]	No control group of patients without treatment
1984	Miotti[12]	In the experimental group, in some patients, the lingual arch was combined with another maxillary appliance
1983	Odom[13]	Lingual arch was combined with a maxillary appliance

measurements. It was considered improbable that the abstracts would report sufficient information regarding this criterion, because this might exclude some articles.

All article abstracts that appeared to meet the initial inclusion criteria were selected, and the articles were collected. The articles ultimately selected were chosen with the following additional inclusion criteria: results expressed as millimetric or percentage data, a control group with no treatment, and a lingual arch used as a space maintainer as the only therapy in both arches.

Simultaneous use of fixed appliances was considered a confounder and a reason for exclusion.

The reference lists of the retrieved articles were also hand searched for additional relevant articles that might have been missed in the database searches.

RESULTS

Eligible studies were selected based on their titles and abstracts. I found 262 abstracts.

Medline identified 158 abstracts; PubMed, 71; Cochrane Central, 26; and Cochrane Database of Systematic Reviews, 7.

From the total abstracts identified in the electronic databases, only a few fulfilled the initial inclusion criteria. Only 6 of the 262 identified articles fulfilled the initial selection criteria (Table).

In the study by Kinzinger et al,[10] the study group included treated subjects in the mixed dentition and a control group of treated subjects in the permanent dentition. These patients had pendulum appliances and lingual arch appliances for a mean treatment time of 20 weeks. The results were reported in terms of molar uprighting; molar mesiobuccal rotation; transversal arch expansion in the molar, premolar, and canine regions; and incisor tipping. However, the study was not selected because lingual arches were used with a pendulum applied to the maxillary arch, and the control group did not include untreated patients.

Brennan and Gianelly[11] analyzed the effect of lingual arch appliances used as space maintainers in 107 patients with an average treatment time of 8.6 years. They reported their results in term of arch-length decrease, but there was no control group of patients without treatment. For this reason, the study was not selected.

In the study of Miotti,[12] the experimental group included 33 patients with a mandibular lingual arch, adapted as a passive space maintainer and placed immediately after extraction of the 4 first premolars. The control group (30 untreated subjects) and the study group were statistically similar in age, length of the observation period, sex, and skeletal pattern. In the experimental group, in some patients, the lingual arch was combined with another maxillary appliance. Thus, this article was excluded.

Odom[13] compared treatment changes among cervical traction alone, cervical traction combined with banded maxillary incisors and a mandibular lingual arch, and untreated controls. Therefore, it was impossible to indentify the effect of the lingual arch, because it was not the only appliance placed.

Only two studies fulfilled the additional inclusion and exclusion criteria.[14,15]

In this study of Villalobos et al,[14] the sample group consisted of 23 white patients treated with a mandibular FLA on the first permanent molars. At the time of initial records, the patients were in the late transitional dentition, with the mandibular second deciduous molars already exfoliated or about to exfoliate. The patients had an average mandibular plane inclination (FMA, 24° ± 2°).

The mean ages of the subjects were 10.4 ± 0.6 years at the beginning of treatment and 12.3 ± 0.4 years at the end of treatment. The mean observation period for the experimental group was 18.3 ± 0.6 months. To serve as a control, longitudinal records of 24 untreated subjects with similar characteristics as the experimental group (ethnic origin, age, sex, FMA, and time of observation) were obtained. All patients in this group had 3 consecutive lateral cephalograms taken at 1-year intervals, from the ages of 10.6 to 12.6 years. The changes in the control sample were recorded separately for the first 12 months and 24 months of observation.

Measurements for the treatment group reflected a minimal mesial drift of 0.15 ± 0.67 mm and a backward tip of –0.54° ± 1.78°. In the control group for the 12-month observation period, the mandibular molars drifted mesially 1.15 ± 0.53 mm and tipped anteriorly 2.10° ± 1.54°. The differences were all statistically significant ($P < 0.0001$). In the treatment group, the mandibular incisors tipped posteriorly by

–0.14 ± 0.73 mm and tipped by –0.51° ± 1.92° (uprighting); in the control group, the incisal edge also tipped posteriorly by –0.84 ± 0.63 mm, and the incisal angulation also had distal repositioning (uprighting) of –2.87° ± 1.36°. Both measurements were statistically significant at $P < 0.0001$ and $P < 0.01$, respectively. In the control group for the 24-month observation period, the mandibular molars moved more mesially by an average of 1.81 ± 0.75 mm, and the angular position showed anterior tipping of 2.68° ± 0.98°. The mandibular incisors showed their incisal edges with greater distal tipping, which measured –1.24 ± 0.91 mm. The incisal angulation had distal repositioning (uprighting) of –3.85° ± 1.59°. All variables when compared between groups (FLA vs control at 24 months) were statistically significant ($P < 0.0001$).

The study also considered the vertical extrusion of the molars and incisors, but these values were not included in my review.

In the study of Rebellato et al,[15] the 30 subjects had both mandibular second deciduous molars with some clinical mobility, mandibular crowding of 3 mm or more, permanent molar relationships of end-on to Class I, overbite of 1 mm or greater, mandibular plane inclination average (MP-SN) of 32° ± 6°, and the lower lip less than 4 mm in front of the Ricketts E-line.

The treatment group contained 14 patients who had only mandibular lingual arch appliances; the control group contained 16 patients, with similar features, who received no treatment. All patients were observed at least monthly. Records for this study consisted of a baseline cephalometric radiograph, a tomographic radiograph of the randomly selected left or right buccal segment, and study models. The records were repeated after both mandibular premolars were at least 90% erupted.

In the treatment group, molar tipping was –0.54° (backward tip), the center of resistance was 0.33 mm, and the cusp tip was 0.29 mm.

The same measurements for the control group were 2.19°, 1.44 mm, and 1.73 mm, respectively. The differences were all statistically significant ($P < 0.001$).

The data for the treatment group indicated a 0.73° forward tip of the incisor, a 0.32-mm advancement of the center of resistance, and a 0.44-mm advancement of the incisal edge. In the control group, the incisor angulation change was –2.28° (backward tip), the center of resistance came back 0.34 mm, and the incisal edge came back 0.65 mm. These differences were all statistically significant ($P < 0.0001$).

The study models showed increases in intermolar widths in both the treatment group (1.15 mm) and the control group (only 0.14 mm). Arch depth decreased by a smaller amount in the treatment group (0.37 mm) than in the control group (1.46 mm). A decrease in total arch length of 2.54 mm in the control group was found, whereas the treatment group actually had a slight increase of 0.07 mm.

All differences between the treatment and control groups were statistically significant ($P < 0.01$).

The study also considered the vertical movements of molars and incisors, but these values were not included in my review.

DISCUSSION

During the transition from the mixed to the permanent dentitions, developmental changes occur in the arch, including even the leeway space. Normally, the first molars move mesially into the leeway space, and arch length decreases.

An FLA on the mandibular molars is an effective device to maintain arch length by controlling mesial movement of the molars and to prevent the collapse of the mandibular incisors in a lingual direction. Although this effect is universally accepted, recent literature (the last 10 years) did not review it.

Therefore, in my systematic review, I tried to collect and analyze all data from previous articles related to my key question: what are the effects of the lingual arch used as a space maintainer on mandibular arch dimensions in the mixed dentition compared with untreated patients?

Of 6 articles, only 2 fulfilled the final selection criteria for this systematic review.

There were several reasons to exclude studies from this investigation (Table). Among these, the most important reason was the absence of a control group of untreated subjects to compare with the experimental group of treated patients. A control group is important to understand what physiologically happened during the transition from the mixed to the permanent dentition, and how a lingual arch appliance can influence that. Another exclusion criterion was the presence of other appliances during lingual arch treatment, in both the mandible and the maxilla, that could influence the final results.

There was an experimental group in only 2 studies, with the patients treated with a lingual arch as a space maintainer, and a control group (untreated) with similar characteristics.[14,15]

In these studies, to distinguish the influence of any other simultaneous treatment, the lingual arch was the only therapy used to affect the mandibular arch directly. No treatment was used in the maxillary arch.

Analyzing results from those 2 studies, I can summarize that (1) in a mean time of 14.4 months, in

subjects with mandibular second deciduous molars already exfoliated or about to exfoliate, treated with a mandibular FLA, the mandibular molars showed a backward tip of –0.54°, and the incisors tipped anteriorly by 0.11°; and (2) in untreated subjects for a mean time of 16.16 months, the mandibular molars tipped anteriorly by 2.32° and the incisor angulation changed by –3° (backward tip).

These results support the use of the lingual arch for preserving arch length: an FLA placed during the early transitional dentition will restrict the mesial migration and use of the leeway space by the molars, and will even cause a slight increase (–0.07 mm) of the total arch length.

The lingual arch could thus be not only an appliance for maintaining space for the eruption of the permanent teeth, but also an important way to resolve marginal crowding, by controlling space use in the mandibular arch.

The orthodontist must know that, as these data showed, these positive effects come at the expense of slight mandibular incisor advancement and tipping. If these are undesiderable side effects, other treatment methods might need to be used to achieve the desired results.

CONCLUSIONS

Although several investigations have evaluated the use of the lingual arch as a space maintainer, only 2 studies satisfied the inclusion and exclusion criteria of this systematic review.

The results showed that the lingual arch is an effective appliance for maintaining space during the eruption of the permanent teeth, preserving molar anchorage, preventing arch length decrease, obtaining in some patients an arch length increase, and preventing the molars from tipping and the mandibular incisors from tipping lingually. These effects could also resolve marginal crowding by controlling space use in the mandibular arch.

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