ORIGINAL ARTICLE

Longitudinal assessment of vertical and sagittal control in the mandibular arch by the mandibular fixed lingual arch

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The purpose of this investigation was to determine and quantify vertical changes in the position of the mandibular molars while maintaining arch perimeter with a fixed lingual arch. Twenty-three patients with a mean age of 10.4 ± 0.6 years were selected to receive fixed lingual arch treatment as the only appliance in the mandibular arch. Average treatment time was 18.3 ± 0.6 months. Longitudinal records for 12 and 24 months of 24 individuals matched by ethnic origin, age, gender, and mandibular plane inclination were used as controls. Pretreatment and posttreatment cephalograms were used to determine positional changes. Statistically significant differences between the fixed lingual arch and control groups were found. The results of this investigation indicated that the mandibular fixed lingual arch is a useful tool to control the vertical development of the mandibular molars. (Am J Orthod Dentofacial Orthop 2000;118:366-70)

Controlling the vertical development of molars is important, particularly in long-faced individuals with a high mandibular plane angle.[1-4] Excessive vertical development can exacerbate the existing long face by posterior rotation of the mandible.[3-5] Vertical control of the maxillary molars may be achieved with either a high-pull face-bow headgear, a vertical holding appliance, or a combination of both.[5-11] Mandibular molars have not received sufficient consideration in this matter.

In preventive and interceptive orthodontics, the use of a mandibular fixed lingual arch is a commonly accepted procedure. It has been used primarily to maintain arch length by controlling the anterior movement of the molars and preventing the collapse of the mandibular incisors in a lingual direction.[12-16] What effect, if any, the mandibular fixed lingual arch exercises on vertical control of the mandibular molars has not been adequately investigated.[13,15,16] The purpose of this investigation was to determine and quantify vertical changes in the position of the mandibular molars while maintaining arch perimeter with a fixed lingual arch.

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MATERIAL AND METHODS

The sample consisted of 23 white patients treated with a mandibular fixed lingual arch (FLA) on the permanent first molars. The mean age for the sample was 10.4 ± 0.6 years at initiation of treatment and 12.3 ± 0.4 years at termination of treatment. The sample included 11 males and 12 females. The findings are presented for the collective sample, because gender difference was found to be insignificant ($P < .001$).

The following criteria were used in selection of the sample:

1. At the time of initial records, the patients were in the late transitional dentition with the mandibular second primary molars already exfoliated and/or about to exfoliate.
2. Average mandibular plane inclination (FMA = 24° ± 2°) was present.
3. The fixed lingual arch was the only appliance used in the mandibular arch and was held for a minimum period of 12 consecutive months. No treatment was applied to the maxillary arch.
4. All patients possessed at least 2 good quality lateral cephalometric radiographs; 1 taken at the start of treatment and the other at removal of the appliance.

The mean observation period for the experimental group was 18.3 ± 0.6 months.

To serve as a control, longitudinal records of 24 untreated individuals from the Child Research Council, Denver, were collected and studied. This control sample was matched for ethnic origin, age, gender, FMA, and time of observation with the experimental group. All patients in this group possessed 3 consecutive lateral cephalograms taken at 1-year intervals, from the

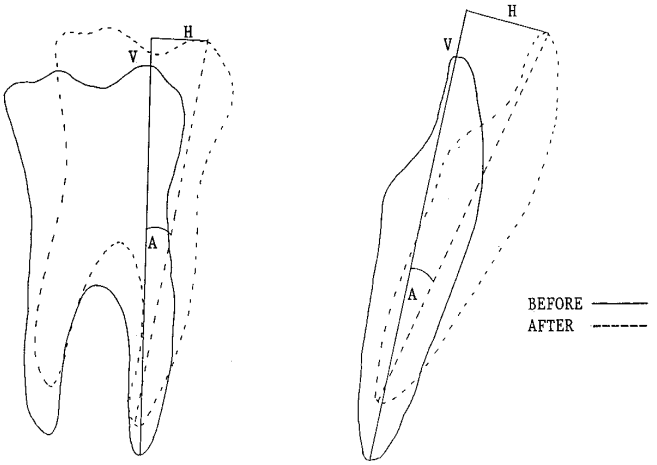

Fig 1. Positional change of mandibular incisor and molar. *A*, Angular change in degrees; *V*, vertical change in millimeters; *H*, horizontal change in millimeters.

age of 10.6 years to 12.6 years. The changes in the control sample were recorded separately for the first 12 months and 24 months of observation.

Measurements

All radiographs were traced and digitized using a Dentofacial Planner digitizing pad, and all pertinent information was stored and analyzed in an SAS statistical program. Sources of error included landmark identification, tracing, and digitization. To check the error of measurement, 20 radiographs were randomly selected, retraced, and redigitized by the same examiner 1 month after they were originally traced and digitized. A paired *t* test was used to compare the differences between the 2 measurements. None of the variables had a statistically significant error at $P < .05$.

The tracings of the mandible in each case were superimposed using Björk's[17,18] method of structural superimposition. The assessment of positional changes of mandibular incisors and molars was based on the original positions of the teeth being studied, according to Singer.[13] To determine dimensional changes in the horizontal and vertical directions, a line was drawn through the long axis of the tooth in its pretreatment position. This line in turn was extended occlusally and apically to draw a perpendicular to the posttreatment position of the incisal edge of the mandibular incisor or mesiobuccal cusp tip of the mandibular first molar (Fig 1).

In the case of the mandibular first molar, the long axis was drawn from the mesiobuccal cusp to the mesial root tip; for the mandibular incisor, the long axis was drawn from the incisal edge to the root apex. The changes were determined by comparing alterations in the long axes. The linear and angular changes in a mesial direction were assigned positive values, and those in a distal direction were given negative values. The vertical changes in an incisive or occlusal direction were assigned positive values; those in an apical direction were given negative values.

RESULTS

Tables I and II display the mean changes, standard deviations, and minimum and maximum values for the experimental (FLA) and control (untreated) groups. Measurements for the FLA group reflect a minimal mesial drift of 0.15 ± 0.67 mm, a backward tip of –0.54° ± 1.78° and a minimal extrusion of 0.29 ± 0.48 mm. In the control group for the 12-month observation period, the mandibular molars drifted mesially 1.15 ± 0.53 mm, tipped anteriorly 2.10° ± 1.54° and extruded 1.28 ± 0.73 mm. The differences were all found to be statistically significant ($P < .0001$). In the experimental group, the mandibular incisors tipped posteriorly –0.14 ± 0.73 mm and tipped –0.51° ± 1.92° (uprighting); in the control group, the incisal edge also tipped posteriorly –0.84 ± 0.63 mm, and the incisal angulation also presented a distal repositioning (uprighting) of –2.87° ± 1.36°. Both measurements were statistically significant at $P < .0001$ and $P < .01$, respectively. Vertically, the mandibular incisors extruded 0.56 ± 0.44 mm in the experimental group and 0.95 ± 0.46 mm in the control group. However, the difference was not significant.

In the control group for the 24-month observation period, the mandibular molars moved more mesially an average of 1.81 ± 0.75 mm, and the angular position showed an anterior tipping of 2.68° ± 0.98°. Extrusion

Table I. Mean changes, SDs, and minimum and maximum values for total experimental group (FLA) during study period (18 ± 0.6 months) (n = 23)

Measurements	*Mean*	*SD*	*Minimum*	*Maximum*
/6 Sagittal (mm)	0.15	0.67	–2.13	1.30
/6 Vertical (mm)	0.29	0.48	–1.30	1.53
/6 Angular (°)	–0.54	1.78	–4.00	3.00
/1 Sagittal (mm)	–0.14	0.73	–1.53	1.73
/1 Vertical (mm)	0.56	0.44	–0.30	2.15
/1 Angular (°)	–0.52	1.92	–3.00	4.50

Table II. Mean changes, SDs, and minimum and maximum values for control group at 12 and 24 months (n = 24)

Measurements	*Mean*	*SD*	*Minimum*	*Maximum*
/6 Sagittal (mm)				
at 12 months	1.15	0.53	–0.50	2.10
at 24 months	1.18	0.75	–0.53	3.33
/6 Vertical (mm)				
at 12 months	1.28	0.73	–1.03	3.33
at 24 months	2.12	0.98	–1.07	4.07
/6 Angular (°)				
at 12 months	2.10	1.54	–3.00	5.00
at 24 months	2.68	0.98	1.50	5.00
/1 Sagittal (mm)				
at 12 months	–0.84	0.63	–2.53	0.50
at 24 months	–1.24	0.91	–2.75	1.00
/1 Vertical (mm)				
at 12 months	0.95	0.46	0.33	2.33
at 24 months	1.68	0.51	0.53	2.77
/1 Angular (°)				
at 12 months	–2.87	1.36	–4.00	1.00
at 24 months	–3.85	1.59	–5.50	–0.50

of the mandibular molars also increased to 2.12 ± 0.98 mm. The mandibular incisors showed their incisal edges with greater distal tipping, which measured –1.24 ± 0.91 mm. The incisal angulation presented a distal repositioning (uprighting) of –3.85° ± 1.59°. Vertically, the mandibular incisors extruded 1.68 ± 0.51 mm. All the variables when compared between groups (FLA versus control 24-months) were found to be statistically significant ($P < .0001$). Figs 2 and 3 illustrate the relative magnitude of the differences between the treated group and the untreated controls.

DISCUSSION

A fixed lingual arch on the mandibular molars is commonly used as a holding device to maintain mandibular arch length and to prevent mesial migration of the mandibular first molars. Although its effectiveness as a device for space maintenance is universally accepted,[12,13,15,16] its effects on the vertical and sagittal changes of the molar and incisor position in growing patients have not been adequately documented.[13,15] Vertical control in molar position could be of special interest, particularly in patients with a high mandibular plane angle and a tendency toward open bite.

The sample collected is unique in as much as pre- and posttreatment cephalometric radiographs were available and could be compared with an untreated longitudinal sample of similar parameters. The cephalometric radiographs of the untreated sample were available at yearly intervals; instead of interpolating the changes to the 18.3 ± 0.6 months interval to match the observation in the experimental group, comparisons were made at both 12 and 24 months observations.

The assessment of changes in molar and incisor positions was made by superimposing the mandibular tracings on intramandibular landmarks as suggested by Björk and Skieller[17,18] and Enlow and Harris.[19] This procedure avoided the bias due to bone remodeling.

In analyzing changes in incisor and molar positions between the FLA-treated sample and the 12-month untreated control group, it was found that with the exception of the extrusion of the mandibular incisors, all measurements were statistically significant. When compared with changes in the 24-month untreated group, all measurements were significant.

The findings of this study indicate that the fixed lingual arch is an effective appliance for the control of vertical extrusion of mandibular molars. This is in agreement with the findings of Singer,[13] who determined a statistically significant value ($P < .05$) of 0.6 mm of extrusion when compared with his control sample (1.0 mm), but there was disagreement with Rebellato et al,[16] who did not report a significant difference in the amount of extrusion of the mandibular molars between their FLA and control groups. In our FLA group, the incisors showed almost 4 times the amount of extrusion as the molars. This is in agreement with the findings of Foster and Wylie[20] and Rebellato et al,[16] who also found that the incisors extruded more than the molars. However, our findings do not support Singer's observations that the molar extrusion was greater than that of the incisors.

The mandibular fixed lingual arch, as expected, also controlled the mesial movement of the molars and lingual tipping of the incisors. Therefore our results support the use of a mandibular fixed lingual arch for preserving arch length.

Based on our findings, it is apparent that the FLA placed in the period of early transitional dentition will restrict the mesial migration and use of the leeway space by the molars; therefore, a cusp-to-cusp molar relationship may not self-correct. However, in patients with marginal crowding, a fixed lingual arch is an

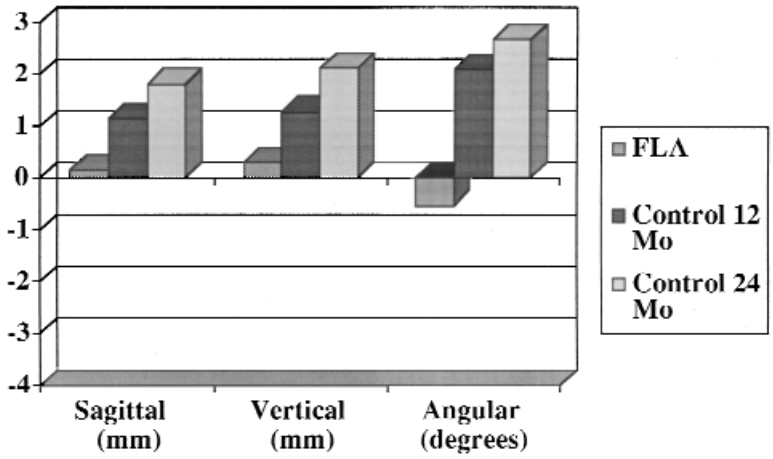

Fig 2. Mean changes in mandibular molar position during 18.3 ± 0.6 months' observation of experimental group and observations of the control sample over 12 and 24 months.

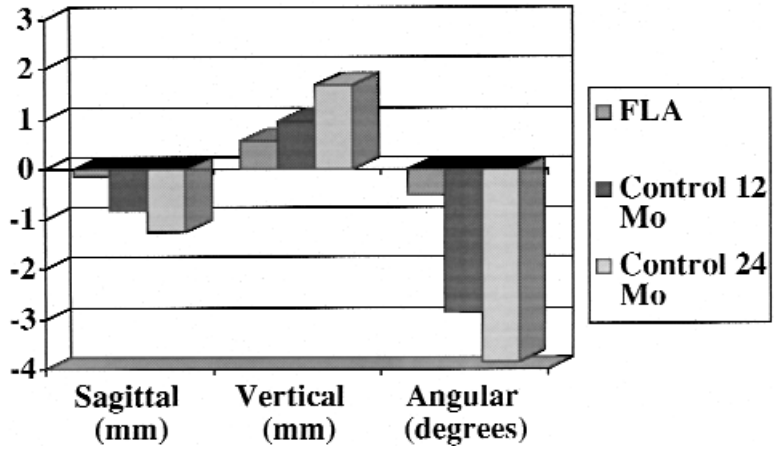

Fig 3. Mean changes in mandibular incisor position during 18.3 ± 0.6 months' observation of experimental group and observations of the control sample over 12 and 24 months.

effective way to control space utilization in the mandibular arch.

Another useful corollary is that patients who can sometimes be diagnosed as long-faced as early as the age of 7 years[21,22] could possibly benefit by simple placement of a mandibular fixed lingual arch to control vertical eruption of mandibular molars. Further research is needed to validate this observation.

CONCLUSIONS

1. The mandibular fixed lingual arch is a useful tool to control the vertical development of the mandibular molars.
2. The mandibular fixed lingual arch is an effective appliance for preserving arch length.

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