Expansion of the Mandibular Arch in Children during the Mixed Dentition Period - A Clinical Study

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A review of the dental literature revealed relatively few studies on the expansion of the mandibular dental arch. The present study attempted expansion of the mandibular arch using a Bihelix appliance. The subjects were 16 children, exhibiting crowding, age ranges from 7 to 11 years. The mandible was expanded 2.0 mm every 3 months. Significant expansion, not only of the individual tooth inter-arch dimensions but also of the overall arch length, was obtained during the period of incisor tooth replacement. The mode of expansion was classified as follows: Type I, those, which showed no effect on the apical base; Type II, those which showed no consistency of the measurement lines. In this study, 6 of16 cases were classified as type I and 10 cases as type II. Expansion was continued over a period of 1.5 to 3 years. We concluded that considerable lateral expansion of the mandibular arch is possible using the Bihelix appliance. It is suggested that this might contribute greatly to non-extraction orthodontic treatment. Further studies are recommended.
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INTRODUCTION

The relationship between teeth and alveolar bone in childhood has been long been the subject of considerable discussion in the Japanese dental literature. Prior to the1980s, it was considered that the trend towards a narrowing of the lower jaw in Japanese children was caused mainly by their tendency to favor a soft diet.1 However in the 1990s, it was reported that the jaws of Japanese were actually becoming larger.[2,3] Concurrently, it was documented that the size of the tooth crown was conducive to crowding.[4] The specific etiology of crowding has yet been to be clarified. An increasing tendency of patients to favor conservative treatment over tooth extraction has led to a review of the various treatment modalities. Although expansion of the dental arch is one effective way to manage arch length discrepancy, numerous unfavorable opinions around.[5,6] Relatively few studies have addressed expansion of the mandibular teeth arch.[5-10] This report documents apparently favorable results, using a Bihelix appliance to achieve mandibulat arch expansion.

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MATERIAL AND METHODS

The subjects were 16 children, exhibiting crowding, age ranges from 7 to 11 years who visited the Department of Pediatric Dentistry at Kyushu Dental College and Sorada Pediatric Dental Office. In each case, a Bihelix appliance was used to apply force to the mandibular arch sufficient to achieve 2.0 mm of movement every 3 months (Fig. 1). Rigidity was added to the anterior arm in the form of cobalt chrome 0.9 mm in diameter.

The arch widths between canines, primary molars (or premolars) and first molars in both mixed and permanent dentitions were measured during the incisor tooth replacement periods according to the method of Tsujino11 (Fig. 2). The readings were obtained by measuring the greatest distance between the contact points on proximal surfaces using a vernier gauge caliper. In order to investigate the morphological changes of the teeth and alveolar bone in those patients in whom lateral expansion with the Bihelix appliance was

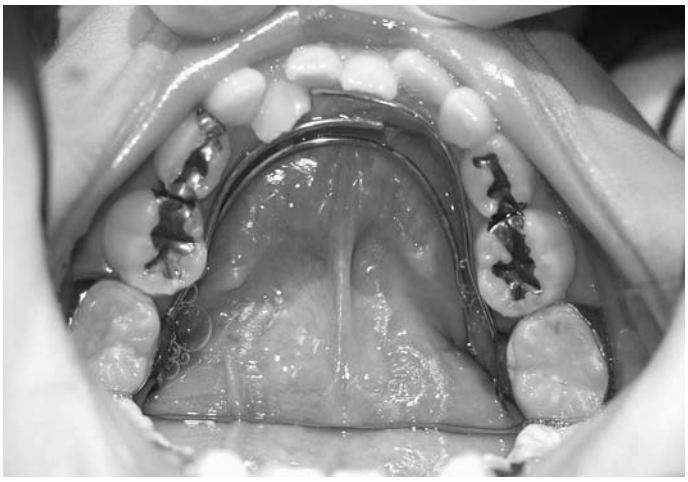

Figure 1. Expansion of mandibular teeth arch using a Bihelix appliance

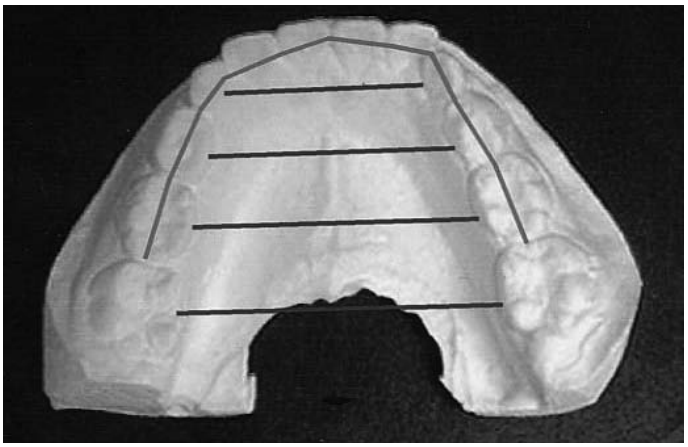

Figure 2. Measurement of arch length and inter-dental width
The inter-dental width was measured at the lowermost point of the tooth cervix on the lingual side. Arch length was calculated in accordance with Tsujino's criteria. Linear segments were made from the center of the mesial plane of the mandibular permanent first molar same point on the contra-lateral tooth between the contact points of approximating teeth. The sum of all segments was considered to be the arch length. In those cases exhibiting malalignment of the teeth, the arch length was calculated by excluding the site in accordance with the method proposed by Tsujino.11 Gray line: teeth arch length Black lines : Inter-dental width

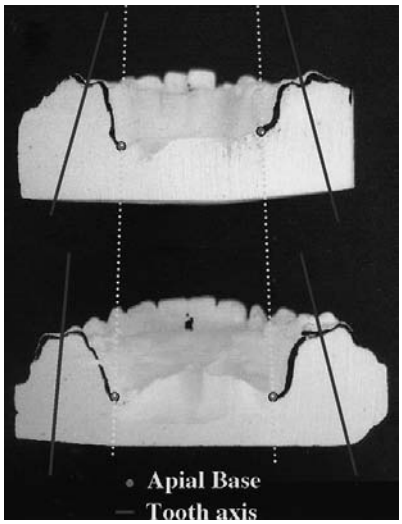

Figure 3. Sekizaki Type I mode of expansion
Before expansion (Upper) After expansion (Lower)

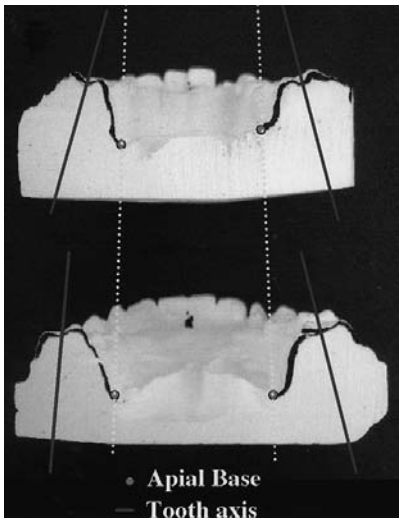

Figure 4. Sekizaki Type II mode of expansion
Before expansion (Upper) After expansion (Lower)

Figure 5. Study model of Case 5
Before expansion (Upper). After expansion (Lower)

successful, the occlusal planes that passed through the bilateral molar lingual groove were bisected and the tracings were compared pre- and post-expansion.

Expansion was classified according to the technique proposed by Sekizaki8. Those exhibiting no effect on the apical base were classified as Type I (Fig.3), while those which showed no consistency of the measurement lines were classified as Type II (Fig. 4).

RESULTS

The arch widths between canines, primary molars (or premolars) and first molars, in both mixed and permanent dentitions, were compared pre-, during and post-expansion (Tables 1 and 2). For the central incisor replacement period, the average inter-primary canine width was 3.92±1.81 mm, average inter-primary first molar width 4.74±1.86 mm, average inter-primary second molar width 5.45±1.35 mm and average inter-permanent first molar width 6.54 ±1.64 mm. Average arch length was 4.46±1.60 mm. During the lateral incisor teeth replacement period, the average inter-primary canine width was 2.78±0.98 mm, average inter-primary first molar (premolar) width was 4.23±0.97 mm, average inter-primary second molar (premolar) width was 5.30±1.16 mm and average inter-per-

Table 1. Individual inter-arch tooth dimensions and arch length for the posterior sections in the incisor replacement period. (mm)

Patient	Beginning (year)	Expansion period (years)	Inter-primary canine	Inter-first primary molar	Inter-second primary molar	Inter-first molar	Arch length
Case 1	7.80	2.50	2.60	4.20	4.60	7.20	4.20
Case 2	7.80	1.50	6.40	6.40	6.10	7.90	5.70
Case 3	7.00	3.50	3.90	5.80	6.60	8.00	6.20
Case 4	8.30	2.70	X	X	3.70	5.00	3.20
Case 5	7.90	3.00	X	X	X	8.20	3.20
Case 6	7.90	3.00	1.80	2.00	4.10	4.20	2.00
Case 7	8.00	2.00	2.50	3.00	4.10	6.40	5.50
Case 8	8.50	3.00	6.20	7.20	7.30	7.70	6.60
Case 9	6.20	3.00	4.10	4.60	6.80	4.30	3.50
Average	7.72 ± 0.69	2.34 ± 0.52	3.92 ± 1.81	4.74 ± 1.34	5.43 ± 1.34	6.54 ± 1.64	4.46 ± 1.60

X Measurement not possible due to early loss of primary teeth

Table 2. The inter-dental width at each of the 4 teeth and arch length in the lateral tooth replacement period. (mm)

Patient	Beginning Age (year)	Expansion period (year)	Inter-canine	Inter-first premolar	Inter-second premolar	Inter-first molar	Arch length
Case 10	9.80	2.00	3.00	3.80	X	7.10	5.30
Case 11	9.50	1.70	X	4.80	6.20	7.30	5.20
Case 12	11.30	2.50	2.20	3.20	5.70	6.00	2.60
Case 13	10.50	3.00	3.10	4.60	X	4.80	3.30
Case 14	10.20	3.00	1.50	5.70	X	7.90	5.60
Case 15	11.90	1.85	4.10	3.30	3.60	3.30	2.60
Case 16	9.60	2.25	X	X	5.70	4.80	4.20
Average	10.43 ± 0.89	2.69 ± 0.61	2.78 ± 0.98	4.23 ± 0.97	5.30 ± 1.16	5.89 ± 1.66	4.11 ± 1.29

X: Measurement was impossible due to unerupted permanent teeth

Table 3. Morphological changes of the teeth and alveolar bone

Patient	Type of mandibular movement	Type of tooth movement
Case 1	Type II	Tipping
Case 2	Type II	Tipping
Case 3	Type II	Tipping
Case 4	Type II	Bodily
Case 5	Type I	Tipping
Case 6	Type II	Bodily
Case 7	Type II	Tipping
Case 8	Type I	Tipping
Case 9	Type I	Tipping
Case 10	Type II	Tipping
Case 11	Type II	Tipping
Case 12	Type I	Tipping
Case 13	Type I	Tipping
Case 14	Type I	Tipping
Case 15	Type II	Tipping
Case 16	Type II	Bodily

manent first molar width 5.89±1.66mm. Average arch length was 4.11±1.29 mm(Fig.5). Six of the sixteen subjects were classified as Sekizaki Type I and ten as Sekizaki type II. All Type I patients showed tipping movement, while three of the Type II subjects demonstrated bodily movement (Table 3).

DISCUSSION:

In order to eliminate arch length discrepancy, it is necessary to control arch length by overcoming the shortage of space. Increasingly, patients are requesting that teeth not be extracted or ground as much as possible. Accordingly, resort must be made to obtaining space by expansion of the dental arch. While it is anatomically feasible to achieve lateral expansion in the maxilla by opening the median palatine suture, application of this method in the mandible is controversial since the suture closes rapidly.

Greenfield[7] expanded the mandible using a lip bumper and multibracket appliance in five patients, and reported that significant expansion could be attained in all. However that author reported that inter-first molar width relapsed somewhat. The same study also indicated that the inter-canine width could be expanded by 2.66 to 3.57 mm until the end of treatment. To our knowledge, the study by Sekizaki[8] is the only report addressing expansion of

mandibular arch length that included more than 10 subjects. That study comprised 11 patients in whom the mandibular arch was expanded using a Schwartz removable expansion appliance. The inter-canine width was reported as expanding a mean 1.66 mm, inter-first molar width 1.99 mm and arch length 1.90 mm. During the 9-12 months period of expansion, the mean inter-canine width was 3.20 mm, inter-first molar width 3.08 mm and arch length 3.08 mm. Interestingly, Tsujino and Machida[11] reported a physiological expansion associated with growth in the range of 0.5 -1.5 mm. In the present study, expansion was continued for a period of 1.5-3.5 years in most of the patients and was greater in all sites than that obtained in the previously cited study using the Schwartz removable appliance.

In this study, expansion was greatest in the inter-second primary molar (second premolar) and inter-first permanent molar widths. We rationalize that since the band of the Bihelix appliance is attached to the first permanent molar, the orthodontic force acted directly on that tooth. The mode of mandibular expansion was classified into the two types proposed by Sekizaki[2]. With regard to Schwartz's expanded floors, 7 of 11 cases in Sekizaki's[8] were classified as Type I and 4 cases as Type II. Ten of the cases demonstrated tipping movement while one showed bodily movement. In our study, 6 of 16 cases were classified as Type I and 10 cases as Type II. All the Type I cases demonstrated tipping movement, while 7 of the 10 cases classified as Type II showed tipping movement and 3 cases bodily movement.

In addition to causing tooth movement, compression and traction affect the periodontal membrane, inducing bone resorption on the compressed side and bone formation on the traction side. Suzuki and Takahama[12] described the expansion of the tooth arch as "alveolar deformation" and "tipping of the teeth and alveolar bone en mass". Sekizaki[8] speculated that tipping or bodily movement of the teeth and alveolar bone en mass might also exert an effect on the apical base. In the current study, we found an additional increase of Type II suggesting that, persistent orthodontic force for a long period of time exerted by the Bihelix appliance might have exerted a greater effect on the apical base intermittent force applied for a short period of time as in the case of Shwatz's expanded floor. This would appear to be consistent with Greenfield's[7] report on lateral expansion using a lip bumper.

Consequently, we considered that non-extraction treatment is an important consideration in overcoming problems with the apical base in the mixed dentition period.

The alveolar mucosal floor of the oral cavity is easily affected by numerous factors, such as impression material and lingual positioning. Accordingly, we consider it important to examine standard tomogram images obtained by dental X-ray CT scanning in order to obtain precise data. Further, the influence of the Bihelix appliance should be studied in greater detail, including histo-pathological examinations, additionally, the relapse rate following expansion of the mandibular arch should be evaluated over a longer period. To some extent, Greenfield[7] recognized the possibility of relapse but felt that it did not have an effect on the therapeutic results. We would recommend that the results be followed over a greater period and compared them with those reported by Greenfield.[7]

CONCLUSION

In a study involving 16 children, exhibiting crowding, age ranging from 7 to 11 years, the mandible was expanded 2.0 mm every 3 months mandible using a Bihelix appliance.

For those children in the central incisor tooth replacement period, the inter-primary canine width, inter-first primary molar width, inter-second primary molar width and inter-permanent first molar width, together with the arch length were expanded. For those in the lateral incisor tooth replacement period, the inter-canine width, inter-first premolar width, inter-second premolar width, inter-permanent first molar width and arch length were expanded. Favorable mandibular expansion results were obtained on both in the periods of central incisor tooth replacement the lateral incisor replacement.

The mode of expansion was classified as Sekizaki Type I for those who showed no effect on the apical base and Sekizaki Type II for those who demonstrated no consistency of the measurement lines. In the present study, 6 of the16 cases were classified as Type I and 10 cases as Type II.

Expansion was continued for 1.5 to 3 years. We consider that the Bihelix appliance is able to effect a significant lateral expansion of the mandibular arch. This might well be of importance when contemplating non-extraction orthodontic treatment.

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